SMALLHOLDER FRENCH BEANS FARMERS GLOBAL-GAP STANDARDS RISK ATTITUDES, AND THEIR EFFECTS ON WELFARE IN KIRINYAGA COUNTY, KENYA

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DECLARATION AND RECOMMENDATION

Declaration

I declare that this is my original work and has not been presented in this or any other University for the award of a degree.

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DEDICATION

To my daughter Marvel and my wife Caroline.

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ABSTRACT

Despite the importance of Global-GAP standards in promoting production and marketing of quality French beans in Kenya, compliance is still low. Using data from randomly selected 492 French beans, farmers, the study sought to determine the link between risk preferences, Global-GAP certification, observed poverty, and vulnerability to future poverty. The study used social experiment and 5-point Likert scale to solicit risk attitudes parameters, binary Logit model to determine the effect of risk attitudes on Global-GAP certification decision and observed poverty status. Foster-Greer-Thorbecke class of poverty and Propensity Score Matching approaches were used to determine the impact of Global-GAP certification on observed poverty while Vulnerability as Expected Poverty approach was used to determine vulnerability to future poverty. SPSS and STATA were used in data analysis. The study found that French bean farmer who underweighted expected returns and overweighted production costs and losses ($p = 0.046|\beta = -4.079$), as well as those who were loss averse ($p = 0.094|\beta = -0.192$), were less likely to comply with Global-GAP standards. However, those who were risk averse ($p = 0.081|\beta = 3.263$) were more likely to comply with Global-GAP standards to avoid expected risks and losses. Global-GAP certification significantly and positively influenced French beans income per acre ($p < 0.05$|MD = KES -9,216.86) and household annual income ($p < 0.05$|MD = 370,352). Compliance with Global-GAP increased net annual French beans income per acre by at least KES 17,307.70 ($t = 3.876$), total annual household income per adult equivalent increased by at least KES 18,146.20 ($t = 1.998$) and annual expenditure per adult equivalent increased by 25.9 percent. Aversion to risks ($p = 0.051|\beta = -2.802$) increased household observed poverty. Mean vulnerability was 19.6 percent, which is below 50 percent threshold. Farmers who were expenditure poor ($p < 0.05$) and income poor ($p < 0.05$) were vulnerable to expected poverty. French beans farmers who like taking risks ($p = 0.051|\beta = 0.8198$) were more vulnerable to future poverty. The results suggest that French beans farmers should take more risks by expanding the acreage under Global-GAP certified French beans to increase their income and expenditure, thus reducing observed and expected poverty facing them. Since the production of Global-GAP certified French beans is a profitable venture, Government (both national and County Governments) in collaboration with financial institutions (insurance companies and banks) should develop insurance and credit products relevant to farmers producing vegetables for export. This will mitigate aversion to risks and lack of capital among vegetable farmers.

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LIST OF ABBREVIATIONS AND ACRONYMS

ATT	Average impact of Treatment on Treated
ATE	Average Treatment Effect
Eurep-GAP	European Retailer Produce Working Group for Good Agricultural Practices
EUT	Expected Utility Theory
FGT	Foster Greer and Thorbecke
GAPs	Good Agricultural Practices
GDP	Gross Domestic Product
Global-GAP	Global Good Agricultural Practices
GM	Genetically Modified
GoK	Government of Kenya
IFAD	International Fund for Agricultural Development
KES	Kenyan Shillings
Kenya-GAP	Kenya Good Agricultural Practices
KMM	Kernel Matching Method
MTs	Metric Tons
NNM	Nearest Neighbour Matching
PSCORE	Propensity Score
PSM	Propensity Score Matching
PT	Prospect Theory
RMM	Radius Matching Methods
RPs	Risk Premiums
SE	Standards Errors
SMM	Stratification Matching Method
SPSS	Special Packages for Social Sciences
USA	United States of America
VEP	Vulnerability as Expected Poverty
VER	Vulnerability as Uninsured Exposure to Risk
VEU	Vulnerability as low Expected Utility

CHAPTER ONE

INTRODUCTION

1.1.1.1 Background information

Agriculture is an important sector in the Kenyan Economy. In the year 2014, the sector contributed at least 27.3 percent of Gross Domestic Product (GDP) up from 26.4 percent in 2013. Horticulture sub-sector, which entails the production of fruits, vegetables, and flowers, is growing fast in Kenya. Major vegetables exported include French beans; snow peas, sugar snaps, and baby corn dominate export markets (Horticulture Study, 2017). Horticultural exports increased by 3.0 percent in 2014, with market value increasing from Kenyan Shillings (KES) 83.4 billion in 2013 to KES 84.1 billion in 2014.

Nonetheless, the value of vegetables exported declined by 17.9 percent from KES 22.9 billion in 2013 to KES 18.8 billion in 2014 due to the failure to adhere to the minimum residue limits for French beans and peas destined for Europe. At the same time, sales from small farms decreased slightly from KES 244.5 billion in 2013 to KES 243.6 billion in 2014 (Economic Survey, 2015). The value of exports of fresh horticultural produce increased from US$816 million in 2014 to US$877 million in 2015 due to better unit prices for vegetables exported. Vegetable production in Kenya contributes at least 36 percent of the domestic value of horticulture. The area, production, and value stand at 326,837 Hectares (Ha), 4.1 million metric tons (MTs), and KES 70.9 billion ($641 million) respectively. The area under vegetables, production, and value all increased by 26, 12, and 11 percent in the year 2014. The value of vegetables exported increased by 11.2 percent from US$182 million in 2014 to US$203 million in 2015 Kenya's earnings from horticulture exports rose 20 percent to KES 77.81 billion ($755 million) in the first nine months of 2016 compared to 2015 (Horticulture Study, 2017).

French beans produced in Kenya are mainly destined for export markets. The markets fall into two major seasons, namely low demand season (June to September every year) and high demand season (September to March). Over-supply, low demand, and low price characterize low demand season while vice versa is true for high demand season[1] Area under French beans have remained constant at 5000 Ha from the year 2012 to 2015. Within the same period, production levels had increased steadily from 84 MTs IN 2012 TO 126 MTs in 2015. Value of French beans

[1] See http://topfarmer.co.ke/how-to-grow-french-beans-market-and-make-money/.

has been fluctuating between 2012 and 2015. For instance, the value dropped from 50.92 (000 US$) to 42.54 (000 US$) between 2012 and 2013. However, the value has been increasing from 42.54 (000 US$) to 51.36 (000 US$) between 2013 and 2015 (Horticulture Study, 2017).

Recent statistics show that poverty headcount in Kenya stands at 53 percent (International Fund for Agricultural Development, 2013). For instance, the probability of falling non-poor, moderately poor, and extremely poor is 42, 13, and 45 percent, respectively, in rural areas (Oxford Poverty and Human Development Initiative, 2017). Muyanga *et al.* (2006) further demonstrated that poverty is common in rural areas, and it has been increasing since the late 1980s. Statistics from the Economic Survey (2007) indicates that poverty rates rose from 40 to 52.3 percent between the year 1994 and 1997. In 2007, the rate reduced to 45.9 percent, but according to the International Fund for Agricultural Development (2013), the rate rose again to 53 percent in 2013. The current national poverty rate is still high at 51.4 percent while rural poverty level stands at 39.9 percent (Oxford Poverty and Human Development Initiative, 2017). Shepherd *et al.* (2014) predicted that over 10.57 million Kenyans would remain poor by the year 2030.

In Central Region of Kenya, where Kirinyaga County is located, observed poverty per adult equivalent was high at 30.4 percent in 2007 (Kenya National Bureau of Statistics, 2007) and was expected to increase to 31.9 percent in 2017 (Oxford Poverty and Human Development Initiative, 2017). Households face two types of poverty: observed poverty and vulnerability to future poverty. Vulnerability to expected poverty is the likelihood or probability of one falling into poverty or reduction in one's well-being in the future (Pritchett *et al.*, 2000; World Bank, 2000). Observed poverty (also known as *ex-post* poverty) is seen as static or defined at a single point in time while vulnerability to poverty is seen as a dynamic concept or *ex-ante* (Chaudhuri, 2000 and Chaudhuri, 2003).

Static poverty analysis generates information on who is poor or not poor today as well as their respective characteristics. Nonetheless, it neglects those who are likely to be poor in the future. It ignores the fact that those who are not poor today may be poor tomorrow (Dercon and Krishnan, 2000; Yaqub, 2000; Chaudhuri, 2002; Mckay and Lawson, 2002). According to Deressa (2013), static poverty analysis tells very little about the dynamic processes that push households to poverty or move from poverty. The concept of dynamic poverty is increasingly gaining popularity in poverty analysis. The change in vulnerability to expected poverty is because of static poverty levels over time (Bidani and Richter, 2001). Besides, the formulation of poverty eradication policies based on information generated from static poverty analysis is ineffective (Chaudhuri *et al.,* 2001).

Effective poverty prevention and reduction should, therefore, take account of clear understanding of vulnerability to poverty. This will help put in place effective policies and strategies to prevent future poverty. Despite the importance of understanding vulnerability to future poverty concept in pursuit of effective poverty alleviation interventions, very few studies have attempted to assess the vulnerability of French bean farmers to expected poverty in the face of Global-GAP certification. Previous studies on French bean farming in the face of Global-GAP standards analysed static poverty. These studies include Asfaw (2007), Humphrey (2008), Asfaw *et al.* (2009), Asfaw *et al.* (2010), and Muriithi *et al.* (2011).

According to the International Fund for Agricultural Development (2013), agriculture in Kenya can reduce poverty two times more than the reduction by other sectors of the economy. McCulloch and Ota (2002) further demonstrated that horticultural farming is crucial in reducing poverty both in urban and rural areas of Kenya. Generally, horticultural crops are high yielding, more profitable relative to cereal crops (Kibet *et al.,* 2011) and thus their ability to reduce poverty even under situations of high risks (Obare *et al.,* 2003; Kuyiah *et al.,* 2006). According to Diao *et al.* (2007), African farmers need to adopt new agricultural technologies and adequately use inputs to produce more, earn more income, and hence alleviate their current poverty and vulnerability to expected poverty. In the Central region of Kenya, farmers are diversifying towards the production of Global-GAP certified French beans for export. In Kenya, approximately 2.57 million people are farmers, and out of these 60,000 are farmers producing French beans (Ebony Consulting International, 2001).

The increasing awareness of healthy foods among consumers has seen export markets increasingly demand French beans that are Global-GAP certified. Global-GAP standards are implemented mainly on French beans destined for export markets (FPEAK, 2014). The standards incorporate the principles of Hazard Analysis Critical Control Point (HACCP) principles that ensure decency in production and marketing of horticultural products and International Labour Organization (ILO) principles, which ensure decency in workers welfare (Global-GAP, 2017).

Jaleta *et al.* (2009) found that the shift from subsistence to commercial farming might expose households to risks such as volatile market prices, especially in rural areas where the markets are inefficient. Specifically, Tschirley *et al.* (2004) indicated that the production of vegetables in the presence of different institutional arrangements expose farmers to varying degrees of returns and risks. Global-GAP standards are examples of such institutional arrangements that French beans farmers in Kirinyaga County have been embracing with an objective of accessing lucrative export markets in Europe in order to increase household income and thus reduce poverty. According to Humphrey (2008), Asfaw *et al.* (2010), and Muriithi *et al.* (2011), compliance with the private standards are associated with high and volatile returns due to price fluctuation and high cost of production. This, therefore, raises the doubt on whether French beans production in the face of Global-GAP standards negatively or positively influences farmer's welfare.

According to Economic Survey (2015), implementation of Global-GAP standards in French beans production make it a challenging venture. Incomplete compliance with the standards poses the risk of commodity rejection in the export market. For instance, in the year 2014, the value of vegetables exported dropped by 17.9 percent due to Minimum Residue Limits challenges. Previous studies have shown that risk preferences (Feder, 1980; Cavane, 2011; Bradford *et al.*, 2013) are important factors in influencing farmers' decisions to adopt new agricultural technologies. Some studies have found that risk-averse farmers tend to avoid uptake of risky agricultural technologies (Fafchamps, 2010; Gloede *et al.*, 2012). Also, Christiansen and Subbarao (2004) found that risks and shocks that households face create unstable income, which may push households to poverty.

In Kenya, many studies on French beans farming in the face of Global-GAP standards (Asfaw, 2007, Humphrey, 2008, Asfaw *et al.*, 2009, Asfaw *et al.*, 2010, Muriithi *et al.*, 2011, Nyota, 2011, Kangai and Mburu, 2012, and Karira *et al.*, 2013 just to mention a few) have been conducted. However, the studies failed to link between French bean farmers' risk attitudes and their decisions to comply with the Global-GAP standards and poverty situations. The studies may have analyzed each case in different dimensions without linking them. To fill this knowledge gap, the study linked French bean farmers' risk attitudes to their decisions to comply with the Global-GAP standards, welfare indicators, and poverty.

This study hypothesized that when French beans farmers take the risk of complying with the Global-GAP standards, their household incomes and consumption expenditures will increase, which in turn reduce their observed and expected household poverty. The argument was based on the "risk chain" concept which assumes that a link exists between households' risk attitudes, activities chosen, incomes from the activities, consumption levels, observed poverty, and vulnerability to expected poverty (Chaudhuri *et al.*, 2002; Chaudhuri, 2003; Hoddinott and Quisumbing, 2008).

1.1.1.2 Statement of the problem

Horticultural export markets for Kenya are increasingly demanding Global-GAP certified French beans. Since export markets are lucrative *vis-à-vis* local markets, French beans farmers in Kenya are obliged to embrace Global-GAP standards as a pathway to increase income and eradicate household poverty. Production of French beans in the face of Global-GAP standards is challenging due to expected varying levels of returns and risks.

Currently, limited knowledge exists on the link between risk attitudes of the farmers, Global-GAP certification decisions, household welfare, observed poverty, and vulnerability to expected poverty. This is because many studies conducted on French bean farmers in the face of Global-GAP standards analysed each case in different dimensions but failed to link between them. To fill this knowledge gap, the study linked French bean farmers' risk attitudes to their decisions to comply with the private standards and poverty situations

1.1.1.3 Objectives

1.1.1.4 Broad objective

To determine the link between risk attitudes, Global-GAP certification decisions, welfare indicators, observed poverty, and vulnerability to expected poverty among smallholder French beans farmers in Kirinyaga County, Kenya

1.1.1.5 Specific objectives

The study aimed to:

i. solicit risk attitudes of French beans farmers in Kirinyaga County.
ii. determine the effect of risk preferences on French beans farmers' decisions to comply with the Global-GAP standards in Kirinyaga County.

iii. establish the impact of Global-GAP standards on welfare indicators and observed poverty among French beans farmers in Kirinyaga County**.**
iv. determine the effect of risk attitudes on observed poverty of French beans farmers in Kirinyaga County.
v. assess the level of vulnerability to expected poverty among French beans farmers in Kirinyaga County.
vi. find out factors influencing French beans farmers' vulnerability to expected poverty in Kirinyaga County.

1.1.1.6 Research questions

The study research questions were:

i. What are the risk attitudes of French beans farmers in Kirinyaga County?
ii. What is the effect of risk preferences on French beans farmers' decisions to comply with the Global-GAP standards in Kirinyaga County?
iii. What is the impact of Global-GAP standards on welfare indicators and observed poverty among French beans farmers in Kirinyaga County?
iv. What is the effect of risk attitudes on observed poverty in Kirinyaga County?
v. How vulnerable to expected poverty are certified and non-certified French beans farmers in Kirinyaga County?
vi. What are the factors influencing French beans farmers' vulnerability to expected poverty in Kirinyaga County?

1.1.1.7 Justification of the study

According to De Brauw and Eozenou (2014), projects and programmes aimed at eradicating poverty in developing countries like Kenya do fail because risk attitudes of farmers are not considered in designing and implementing them. To inform policies, projects, and programmes that are aimed at eradicating poverty among vegetable farmers in Kenya, the study determining the link between French bean farmers' attitudes toward risks and their welfare in the face of Global-GAP standards.

1.1.1.8 Scope and Limitation

The study was conducted in Kirinyaga County within the Central region of Kenya because it is one of the areas with large numbers of French beans farmers. The study used single cross-sectional data involving small-scale Global-GAP certified and non-certified farmers producing French beans. The study encountered several limitations. These include reliance on farmer's memory during data collection, costly lottery games that led to a small number of respondents subjected to the social experiment. Finally, the study was limited only to the analysis of the link between risk attitudes of French beans farmers and their decisions to comply with Global-GAP standards, household incomes, observed and expected poverty situations.

1.1.1.9 Definition of basic terms

i. **Compliance –** Means adherence to the Global-GAP and Kenya-GAP standards.

ii. **Certification –** Formal procedure by which an accredited or authorized person or agency assesses and verifies (and attests in writing by issuing a certificate) the attributes, characteristics, quality, qualification, or status of individuals or organizations, goods or services, procedures or processes, or events or situations, in accordance with established requirements or standards.

iii. **Private standards –** They are standards enforced in Kenya's horticulture industry to ensure transparency in food safety, reduce the use of harmful agrochemicals, protect the environment, and ensure workers health, safety, and welfare and to ensure product traceability**.**

iv. **Global-GAP standard** – Standards mainly enforced on the exported horticultural products.

v. **Income poverty –** State in which an individual lives below an international poverty line of $1.25 a day

vi. **Expenditure poverty –** State in which an individual spends an amount below the national poverty line of KES 2,900 expenditure per month per adult equivalent

vii. **Risk attitude -** A chosen response to uncertainty that matters and is influenced by perception.

viii. **Idiosyncratic shocks –** This is a risk, which when it materialises it causes a significant negative welfare effect on an individual household in a given place or location

ix. **Covariate shocks -** This is a risk, which when it materialises, it causes a significant negative welfare effect on all households in a given place or location.

x. **Vulnerability to expected poverty -** Vulnerability is defined as the probability of a household or an individual falling below the poverty line in future if not currently poor or will remain poor in future if currently is poor (Chaudhuri *et al.*, 2002).

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview of the chapter coverage

This chapter presents an overview of the importance of agriculture in the economy, the role of horticultural in poverty alleviation and the effect of compliance with private standards on household welfare and poverty. The chapter also highlights the concepts, theories, and approaches used in the determination of risk attitudes, the study of observed poverty, determinants of observed poverty, the concept of vulnerability to expected poverty, and its determinants and theoretical framework.

2.2 Agriculture and its role in the economy

According to IFAD (2001), poverty in Africa is because of low farm incomes and unemployment. Jayne *et al*. (2001) and Nyoro *et al*. (2004) further illustrated that the increasing land sub-division and fragmentation coupled with the high cost of production are responsible for low farm incomes, which in turn increase chances of falling into poverty. In developing countries, agriculture an important sector of the economy that is relied on economic growth and development, food provision for the increasing population (Datt and Ravallion, 1996) and Mendola, 2007). However, studies have shown that agriculture as a source of livelihood faces many challenges. For example, a study by Hertel *et al.* (2010) indicates that agriculture is a challenging venture and therefore risks and vulnerabilities are common among poor rural dwellers in Sub-Saharan Africa who rely heavily on agriculture as a source of livelihoods. Thus, the success of agriculture in promoting economic growth and development in these less developing countries depend on the status of technology uptake.

Hossain (1989) and Mendola (2007) demonstrated that due to diminishing land sizes and irrigation opportunities, innovation and utilisation of the innovations in agriculture are necessary for promoting its growth to boost rural economies and poverty reduction. According to Pinstrup-Andersen *et al.* (1976), Hossain *et al.* (1994), Winters *et al.* (1998), Irz *et al.* (2001) and Mendola (2007), new agricultural technologies influence the income of the poor farmers. That is, new agricultural technologies increase farm income through increased sales, creation of employment, and a reduction in food prices. Studies by Mellor and Desai (1985) and Mendola (2007) further show that agricultural research positively reduces poverty among the poor.

In Kenya, Agriculture is the main economic activity contributing at least 26 percent of the total Gross Domestic Product (Government of Kenya, 2010 and Muona, 2016). Despite the important role agriculture play in poverty alleviation in rural areas, productivity levels have remained low over a long period because of subsistence farming resulting from diminishing land sizes (Kenya National Bureau of Statistics, 2013 and Machio, 2015). Few large-scale farms and majority small-scale farms characterise agricultural sector in Kenya.

According to Economic Survey (2017), the value of agricultural productions from large scale farms increased by 9.9 percent while the value of production from small-scale farms increased from KES 272.3 to 300.8 billion between the year 2015 and 2016. Between the year 2015 and 2016, the overall agricultural share in the Gross Domestic Product decreased from 7.2 percent to 4.4 percent, respectively, due to insufficient rainfall. However, within the same period, the value of horticultural exports increased from 238, 700 MTs to 261, 200 MTs. Also, within the same period, the value of the marketable surplus increased by 10.3 percent.

2.3 Overview of horticultural industry in Kenya

Horticultural industry in Kenya mainly deals with the production of flowers, fruits, and vegetables. It is an important sub-sector in terms of employment and foreign exchange earnings. In Kenya, horticultural sub-section is the leading in growth. The sub-sector contributes at least 25 percent to the Gross Domestic Product. The sub-sector is a major source of income for traders and rural households (Government of Kenya, 2012). The latest statistics indicate that horticultural export is the second highest source of foreign income after tea with earnings rising by 9.2 percent in 2016. Horticultural exports increased from KES 90.4 to KES 101.5 billion between the year 2015 and 2016. Flower export is the largest in horticultural sub-sector, accounting for 69.8 percent of the total horticultural exports (Economic Survey, 2017).

Horticulture farming is carried out in Central, Eastern, Rift Valley, and Nyanza regions of Kenya (Export Processing Zone Authority, 2005 and Mwende, 2016). According to the Republic of Kenya (2007) and HCDA (2008), few exporters and majority smallholder producers who are in rural areas characterise the horticultural industry. In the year 2012, the total industry productions stood at 12.2 million MTs with a market value equivalent to KES.119 billion (Kenya National Bureau of Statistics, 2015 and Mwende, 2016).

According to Gehrig *et al.* (2009), sub-sector grows at a rate of 10 percent annually. According to Whittle *et al.* (1994), approximately 50,000 farmers in Kenya are French beans producers. Sief *et al.* (2001) further demonstrated that approximately 100,000 people directly depend on French beans production, while 500,000 depend directly on French beans export. According to Jaffe *et al.* (2005), Kenya is the largest exporter of vegetables in Africa. The exports are mainly destined to European countries and the Middle East. The commonly exported vegetables are French beans, peas, *karella*, chillies, aubergines, and okra (Harris *et al.*, 2001, Voor den Dag, 2003 and Asfaw *et al.* 2010). Previous studies indicate that producers of vegetables and fruits for the export range between 12,000 and 80,000 small-scale farmers (Jaffee, 1995, Karuga and Masbayi, 2004 and Mithofer *et al.*, 2006).

Harris *et al.* (2001) categorise vegetable producers as a small scale (Those with land less than 10 acres), medium scale (with a land size that ranges between 10 and 20 acres), and large scale (Those with land size greater than 20 acres). A study by Muona (2016) indicates that Machakos County is the leading exporter of French beans and the employment of youth. The study further demonstrated that farmers in Machakos County sell French beans at KES 20 per kilogram during the off-season and the French beans do well in an altitude that ranges between Zero (0) and1, 800 meters above sea level. The temperature should range between 12 and 34 ^{0}C. The crop also requires adequate and well-distributed rainfall of about 600 to 1,500 mm per annum. It also requires fertile and well-drained soils.

2.3.1 The effect of horticulture farming on farmer's welfare

Existing studies show that horticultural farming can reduce household poverty in rural areas. For instance, a study by Achieng' (2014) used Difference-in-Differences method to determine the impacts of compliance with Global Good Agricultural Practices on farmer's level of observed poverty in Kenya. The study found that compliance with the standards significantly reduces poverty among horticultural farmers in Buuri and Kirinyaga County. Using regression on panel household survey data from small-scale commercial horticultural farmers in five districts in Kenya, Muriithi and Matz (2014) determined the effect of marketing vegetables using different marketing outlets on household income and asset ownership. The study found a significant and positive effect of vegetable commercialisation through export markets on household income. Nonetheless, the study found no relationship between commercialization and asset ownership. When compared to export markets, the study found that participation in domestic markets increases farmer's probability of becoming poor.

Using endogenous switching regression and single cross-sectional data, Rao and Qaim (2010) determined the impact of marketing vegetables using supermarket outlets on farmer's income and poverty in rural areas of Kenya. The study found a significant and positive relationship between marketing the vegetables using supermarket outlets and farmer's incomes and poverty reduction. The study further demonstrated that for the small-scale farmers to benefit more from the supermarkets, there is a need for government and other stakeholders to improve rural institutional support, infrastructure and formulation of effective and efficient policies.

According to Weinberger and Lumpkin (2007), horticultural products face high demand both locally and in international markets, and this will push prices up hence end up benefiting producers. That is, diversification into horticultural farming can contribute to poverty reduction through the generation of employment and wages in rural areas where labour is plenty hence enabling expansive and equitable growth. The study further indicated that despite the crucial role horticulture farming play in poverty reduction, the same case might not be true in rural areas of developing countries due to high land sub-division that leads to low yields and thus low income.

Using Probit regression model on single cross-sectional data, Maertens and Verhofstadt (2013), determined the effect of participation on horticultural exports on female off-farm income and the effect on primary school enrolment. The study found a significant and positive link between some household characteristics, village characteristics, and individual child characteristics and the primary school enrolment. Specifically, the study found a significant and positive link between horticultural exports, women income, and primary education enrolment. Furthermore, the study findings show that women participation in horticulture is critical in poverty reduction.

In Zambia, Hichaambwa *et al.* (2015) used regression model on single cross-sectional data to determine the effect of horticultural farming in poverty alleviation. The study compared incomes of maize and horticultural farmers and found that, statistically, horticultural farmers earned more income than maize farmers did. Mendola (2007) used a Propensity Score Matching (PSM) approach to determine the effect of the adoption of high yielding varieties of rice on poverty reduction among rural farming households in Bangladesh. The study found a positive relationship between the technology adoption and well-being of rural smallholder farmers.

In Kenya, a positive relationship exists between horticulture farming and poverty reduction. For instance, a study by Mwende (2016) determined the impact of smallholder horticultural farming on household poverty in rural parts of Kenya. The study found that a farmer who engages in horticultural farming is less likely to be poor than a non-horticultural farmer because of the high production value per unit land area, high labour intensity, and short production cycles of horticultural crops. Using household survey data, McCulloch and Ota (2002) determined the effect of horticulture exports on farmer's incomes in Kenya. The study found that rural farming households who exported their horticultural commodities earned more income *vis-a-vis* those who sold through other markets. The study further demonstrated that a farmer who engages in horticultural farming earns more income than those who engages in the production of cereal crops. The reason why households failed to engage in horticultural farming is due to lack of managerial and marketing skills as well as high post-harvest losses resulting from lack of post-harvest facilities.

Using propensity score matching approach on single cross-sectional data, Chege *et al.* (2015) determined the impact of horticultural exports on household food security among Kenyan farmers. The study found a significant and positive relationship between horticultural farming and household food security status. The study further indicated that factors such as marketing conditions, climate, and income distribution within a household are key in determining whether a household is food secure or not.

2.3.2 Horticulture farming and its role in poverty alleviation

In Kenya, the sub-sector is growing fast at an annual growth rate of 15 percent (Horticulture Study, 2017). French beans grow in warm-wet parts of the country. These are areas like Thika, Murang'a, Machakos, parts of Kajiado, Uasin Gishu, Nakuru, Western Kenya, and Kisumu. Local export agents coordinate French beans for export. They mentor, train and offer market advice to the farmers. The agents are very crucial in connecting farmers to the international market. Examples of these export agents include Fresh Produce Exporters Association of Kenya, Home-grown Kenya Limited, VegPro Kenya Limited, Wamu Enterprises, Everest Enterprises, and Kenya Horticultural Exports Limited, just to mention a few. One acre of land require at least 25Kg bag of seeds of French beans, and it takes around 50 days to mature, and an acre produces approximately 4 to 6 MTs of French beans. It costs at least KES 130, 000 to certify one care of French beans under Global-GAP standards. A Kilogram of French beans costs at least KES 100[2].

The sub-sector faces numerous challenges. These include low availability of capital and affordable credit for horticultural farmers, low productivity in horticulture, inadequate storage and packhouse facilities, which constrain marketability of horticultural products, poorly organized information and infrastructure, over-dependence on external market outlets (mainly EU), underdeveloped rural roads and other key physical infrastructure and multiple numbers of taxes at both national and local levels. Other challenges facing French beans production and marketing include rejection of the products if they do not meet the set quality standards and poor disease and pest management can lead to poor quality produce[3]. For instance, in 2011 and 2012, European supermarkets rejected some horticultural exports for not being straight enough[4].

Investment opportunities include increased production and productivity for export, the need to establish cold chain from farm level to the export point, the need for fruits and vegetable processing facilities, marketing and distribution in the source markets, investment in storage technologies and inventory credit system, investment in quality supply chain of niche products (Horticulture Study, 2017). Another opportunity is that the United States of America in 2016 accepted imports of French beans from Kenya. The United States of America has benefited many farmers, especially in Mwea, Kirinyaga, Matuu, and coastal area of Taveta[5].

In Kenya, French beans (also known as Green beans) are mainly produced for export. Currently, there is a growing demand for processing and consumption both in local and export markets. The growing demand has seen French beans production spread in various parts of the Country. In Kenya, the common areas where French beans are produced include Machakos, Thika, Murang'a, Nyandarua, Kirinyaga, Naivasha, Nyeri, and Embu[6].

According to Matuu, Taveta, Kirinyaga, and Mwea are the areas where French beans are major produced[7]. Because of the increasing demand for the beans, the export market recently

[2] See www.kenyatalk.com/index.php?threads/french-beans-farming-has-anyone-tried-it.84048/.

[3] See http://topfarmer.co.ke/how-to-grow-french-beans-market-and-make-money/.

[4] See www.hortinews.co.ke/2017/05/19/kenya-french-beans-exports-look-promising/.

[5] See www.hortinews.co.ke/2017/05/19/kenya-french-beans-exports-look-promising/.

[6] See www.farmerstrend.co.ke/basic-knowledge-french-beans-mishiri-farming-higher-returns/.

[7] See www.selinawamucii.com/.

expanded to the United States of America. The alternative lucrative American market is a boost to the rural smallholder farmers who have been for long constrained by the requirements of export markets in Europe. The Kenya Plant Health Inspectorate Service (KEPHIS) controls the export of French beans by storing the product in special warehouses before they disposed off. Exports to Europe recorded fluctuations between the year 2015 and 2016[8].

The beans grow well in lower mid and highland areas of altitudes ranging between 1500 and 2100 metres above sea level. Its production is done using either rain-fed or irrigation. Rain-fed is only possible in areas with rainfall ranging between 900 to 1,200mm per year. In areas with low rainfall (of up to 50mm per week), irrigation is necessary. French beans do well in either sandy soils, loam or clay soils. The soils should be well drained and fertile. The temperature should range between 14 to 32^0C depending on the variety. Desired soil pH should range between 4.5 and 7.5. The commonly grown varieties include Amy, Teresa, Samantha, Julia, Paulista, Vernando, Serengeti, Cupvert, Tokai, Bakara, Monel, Gloria, Claudia, Morgan, Amy coby, Espada, Maasai, Nerina, Pekara, Rexas, and Sasa[9].

According to Value Chain Analysis for Development (2018), Kenya is the second largest exporter of French beans to Europe because of comparative advantage in terms of good climatic conditions, value-adding activities, competitive geographic advantages, investment in marketing, investments in standards certification schemes, and market segmentation. Currently, French beans farming contribute approximately 0.33 percent to the Gross Domestic Product and balance of trade of approximately €62 million per annum that is equivalent to 1.5 percent. The study further demonstrated that at least 34,000 MTs of French beans were exported in 2016. In 2017, production increased to 62,000 MTs. Exports are mainly destined to Europe (England, Netherlands, Belgium, and France). The French beans are produced under an area estimated to be 7,500ha. Both small and large-scale farmers produce French beans. Out of 7,500ha, 4,500ha were under small-scale while remaining ha was under a large scale. Production per ha ranges between 4,000 – 12,500kg. Harvest is carried out several times in a year and production relies mainly on rainfall and irrigation.

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[8] See www.selinawamucii.com/.

[9] See www.farmerstrend.co.ke/basic-knowledge-french-beans-mishiri-farming-higher-returns/.

A study by the International Centre of Insect Physiology and Ecology (2004) shows that approximately 60 percent of the horticultural farmers in Kenya are small scale and medium scale. The study further indicated that approximately 60,000 of people directly depend on vegetable farming while 2,000,000 people indirectly depend on vegetable exports as their main source of livelihoods. Other studies have shown that vegetable production for export is a profitable venture for farmers. For instance, according to Aksoy (2005), international trade increases the export of agricultural products, and in the process, it helps improve economic development in developing countries, especially in rural areas. Asfaw *et al.* (2010) used a two-stage standard treatment effect model on single cross-sectional data to determine the impacts of European Retailer Produce Working Group for Good Agricultural Practices on farm financial performance. The study found that *ceteris paribus*, farm diversification towards the production of one more crop increases net export vegetable income by KES 7,658. Humphrey *et al.* (2004) also concur with Asfaw *et al*. (2010) that export of vegetables increase the household incomes of small-scale farmers.

Kimathi (2017) used descriptive statistics to determine the impact of fair-trade on poverty reduction among small-scale vegetable farmers in Meru County. The study found that fair-trade standards benefit farmers in many ways that include; increase in household incomes, access to ready markets, access to credit facilities, and improved health and safety of both farmers, and workers. According to Goedele and Maertens (2016), the export of horticultural commodities significantly and positively influences household income via employment. The increase in income then positively influences food security. A study by Harris *et al.* (2001) found that diversification of farming activities to export of agricultural commodities help reduce household poverty in Sub-Saharan poverty. The study further revealed that production and reliance on primary commodities is the reason why most farmers are poor in Africa.

Previous studies have also shown that French beans production in the face of Global-GAP standards is a profitable venture for farmers. For instance, according to FAOSTAT (2009), French beans prices in export markets have been increasing between the year 1990 and 2007. That is, the price per kilogram of French beans increased from US$ 0.81 to 3.21 within the period. A study by Muona (2016) determined the effects of market intelligence systems on sales revenue among French bean farmers in Machakos County. The study found that selling French beans as a group to exporters increase household income relative to selling as an individual.

Minot and Ngigi (2004) in their study, demonstrated that French beans production for export benefits farmers more than the production of other crops such as maize. Kariuki *et al.* (2012) determined the impact of Global-GAP Standards on French beans Price. The study found a significant and positive relationship between Global-GAP certification and farm gate prices. The study revealed that certified farmers earn between 12 and 25 percent more per 3 kg carton relative to non-certified farmers. Asfaw *et al.* (2010) in their study, found that because of compliance with the standards, certified farmers earn a net income of KES 5,271 above what non-certified farmers earn.

A study by Graffham *et al.* (2007) concurs that compliance with private standards is a profitable venture for farmers. The study found that certified farmers earn KES 5 per kilogram above what non-certified farmers earn. Njoba *et al.* (2016) used a Propensity Score Matching approach to determine the effect of Global Good Agricultural Practices certification on the income of small-scale French Beans farmers in the Central region of Kenya. The study found no significant effect of compliance with the standards on farmer’s incomes. The study found that certified French beans farmers received an annual income of approximately KES. 2,671, which is less than what non-certified farmers received.

Elsewhere in Ghana Valerie *et al.* (2014) determined the impact of fair-trade standards on cocoa farmer’s income. The study found no significant impact of certification on the farmer’s income. The study demonstrated that both household income and cocoa incomes increased for both certified and non-certified farmers within the same period. The study further revealed that a farmer certified under fair-trade standards earn a net income that ranges between USD 6.5 and 66. In Madagascar, Minten *et al.* (2005) determined the effect of compliance with phytosanitary standards of supermarkets on farmer’s welfare. The study found that compliance with the standards improves farmer’s welfare. That is, farmers who comply with the standards get more income than their counterparts do.

2.4 Agri-private standards

2.4.1 Overview of agri-private standards in the horticultural industry

For a long period, international markets of agricultural commodities have witnessed dynamic changes in terms of institutional arrangements. Initially, taxes and quotas regulated markets. Currently, new institutional arrangements or private standards regulate the markets (Hoekman and Nicita, 2011). These private standards include European Retailer Produce

Working Group for Good Agricultural Practices/Global Good Agricultural Practices (Global-GAP). Global-GAP was European Retailer Produce Working Group for Good Agricultural Practices. European Retailer Produce Working Group for Good Agricultural Practices were first initiated in vegetable industry and later in flowers (European Retailer Produce Working Group for Good Agricultural Practices, 2003, Global-GAP, 2007 and Asfaw *et al.* 2010).

The two major standards developed in the early 1990s according to European Retailer Produce Working Group for Good Agricultural Practices (2003), Asfaw *et al.* (2010), and Global-GAP (2007) were British Retail Consortium, and European Retailer Produce Working Group for Good Agricultural Practices. The first implementation of British Retail Consortium was in 1996. Its objective was to ensure the quality and safety of products. British Retail Consortium incorporates Hazard Analysis Critical Control Point.

European Retailer Produce Working Group for Good Agricultural Practices began when European consumers started demanding healthy horticultural products. That is products with less agro-chemical residues. In 1990, the United Kingdom government passed the Food Safety Act that required food retailers to adhere to ensure supply of safe products in the markets. In response to this, restaurants and supermarkets developed rules and regulations that ensured supply of safe commodities in the markets of United Kingdom especially from African countries (Dolan *et al.*, 1999, Global Good Agricultural Practices, 2007 and Asfaw *et al.* 2010). The standards cover agrochemicals usage, handling, storage, disposal of leftovers, and containers. The institutions also cover sanitation of grading and storage facilities, general personal hygiene, traceability of products through the keeping of records concerning production, usage of the agro-chemical, and labelling of the products (Jaffee *et al.,* 2005).

European Retailer Produce Working Group for Good Agricultural Practices (now called Global Good Agricultural Practices) is widely applied in Kenya's horticultural industry. This is because most of Kenya's horticultural produce is destined to European markets. European Retailer Produce Working Group for Good Agricultural Practices in Kenya was designed to cover food quality and food safety (occupational health and safety), environmental protection (for instance, water, wildlife, and soil protection) and internal audits and complaint procedures.

In Kenya, another standard called Kenya Good Agricultural Practices (Kenya-GAP) has been developed. According to Kenya-GAP (2014), Kenya Good Agricultural Practice (Kenya-GAP) was developed in Kenya in 1996. Currently, the Fresh Produce Exporters Association of

Kenya (FPEAK) implements the standard. Vegetable producers, both in Kenya and in Africa, consider the Kenya-GAP scheme a Global-GAP equivalent. Kenya Good Agricultural Practices was also developed to ensure food quality and safety, environmental conservation, and worker safety in the production of commodities for local markets. Kenya Good Agricultural Practices covers commodities that are mainly destined to supermarkets and some selected restaurants. Kenya Good Agricultural Practices is an important scheme since it incorporates small-scale farming methods and concerns.

European Retailer Produce Working Group for Good Agricultural Practices certification gives applicant options to choose. The procedure of the first option entails an individual certification where an individual farmer applies certification, carry out internal self-inspection, and external inspection by a body mandated by European Retailer Produce Working Group for Good Agricultural Practices. The second option is group certification. Under this option, a group of farmers apply certification, put in place management control systems, carry out individual self-inspection, and then followed by group inspection, and later inspection by an external body mandated by European Retailer Produce Working Group for Good Agricultural Practices. Option 3 and 4 is for those farmers who may have adopted other private standards recognised by the European Retailer Produce Working Group for Good Agricultural Practices.

Under these options, farmers are required to apply for European Retailer Produce Working Group for Good Agricultural Practices benchmarked scheme certificate (European Retailer Produce Working Group for Good Agricultural Practices, 2003 and Asfaw *et al.* 2010). According to Asfaw *et al.* (2010), by 2005, approximately 3,400 smallholders were in the process of getting certification under European Retailer Produce Working Group for Good Agricultural Practices in Central and Eastern Province of Kenya (Mithöfer *et al.*, 2006). By 2006, a total of 43 farmer groups (or 267 fruit and vegetable farmers) had been certified under the European Retailer Produce Working Group for Good Agricultural Practices. The number by 2007 had risen to 12,000 small-scale farmers.

Implementation of private standards in production and marketing of vegetables is characterized by several challenges, which negatively influence the participation and performance of the small-scale vegetable farmers (Augier *et al.*, 2005, Barrett *et al.*, 1999, Farina and Reardon, 2000, Reardon *et al.*, 2003, Weatherpoon and Reardon, 2003, Jeffee, 2003, Jensen, 2004, Kotler *et al.*, 2009, Muona, 2016, and Jaffee, 2004). Certification and audit processes cost a group of small scale farmers approximately US$632 and US$154, respectively (Graffham *et al.*, 2007 and Kariuki *et al.*, 2012). According to Asfaw *et al.* (2010), Global-GAP compliance and certification costs approximately KES 37,000 per group of organised farmers. The study revealed that major costs are associated with production practices and infrastructure construction. Global-GAP infrastructure costs at least KES 30, 300 per acre of land. These costs are a burden for small-scale farmers who want to engage in export markets. According to Hobbs (2003), Global-GAP (2007), and Kariuki *et al.* (2012), numerous control points, administrative requirements, as well as technical skills required to implement the standards are the major constraints deterring small-scale farmers from compliance. The standards require small-scale farmers to keep records on agro-chemicals used; trainings attended, irrigation water, soil testing and crop handling facilities.

The costs of compliance and certification procedures are estimated to be at least US$6,000, according to Jaffee (2003). Humphrey (2005) found that the high cost of standards compliance and certification is because of low acreage cultivated by farmers as well as lack of collective action among farmers. According to Okello and Swinton (2007), high cost of standards, compliance and certification negatively affect the uptake of standards among small-scale farmers in Kenya. A study by Kotler *et al.* (2009) revealed that there is exploitation of African vegetable producers participating in the production of export vegetables in the face of the private standards. According to Asfaw *et al.* (2010), due to huge costs incurred in compliance and certification processes, small-scale farmers need some external support or loans to enable them to comply with the Global Good Agricultural Practices. According to Muona (2016), farmers get support from development agencies such as German International Cooperation. A study by Jaffee (2004) demonstrated that horticultural farming is also responsible for global warming or climate change since in the production process, greenhouse gases are emitted to the atmosphere.

Previously conducted studies revealed that it is extremely difficult to quantify benefits of private standards in the production of horticultural products for export (Casey *et al.,* 2006, Chia, 2006; Glassheim and Nagel, 2006 and Graffham *et al.*, 2007). For instance, Minae *et al.* (2006) and Thiagarajan *et al.* (2005) found that it is difficult to determine the impact of private standards on farm gate prices. Despite the costly processes of Global Good Agricultural Practices compliance and certification, farmers do get some benefits out of it. For instance, a study by

Graffham *et al.* (2007) found that exporters pay at least 86 percent of maintenance costs. A study by Jaffee and Henson (2004) reported that implementation of the agri-food standards in low-income countries helps in promoting effective and efficient food supply systems. According to Asfaw *et al.* (2010), the benefits associated with the adoption of European Retailer Produce Working Group for Good Agricultural Practices include farmers being assured of ready markets for their produce and access to better prices. They become price makers instead of price takes due to increased bargaining power when they come together in a group. Besides, quality commodities are produced, thus reducing the chances of rejects in the market. Furthermore, health and safety of both farmers and workers are assured due to proper handling of the agrochemicals, access to good toilets, hand washing facilities and proper disposal of wastes (Golan *et al.*, 2004 and Asfaw *et al.*, 2010).

In the production of French beans for export in the face of private standards, contracts are necessary because of enormous risks expected. According to Eaton *et al.* (2001) and Muona (2016), contract farming is an agreement between farmers, processors or marketers for the production and supply of agricultural products under forwarding agreements, frequently at pre-determined prices. Muona (2016) further demonstrated that contract farming is essential for small-scale farmers who take risks in complying with private standards in the process of producing vegetables. In contract farming, export companies through their technical field officers mobilise farmers into groups and train them on implementation of the standards. Contractors role is to supply inputs on credit, provide agricultural extension services on grading, marketing and transportation. The role of farmers, on the other hand, is to provide labour, land and tools (Ndegwa *et al.,* 2010). According to Ochieng (2005), contract agreements specify quantity needed, a quality required, agreed prices and the technology to be used in the production process.

2.4.2 The effect of compliance with private standards on household welfare and poverty

Commercial horticultural farming improves the welfare of farmers (Muriithi *et al.*, 2011). Nonetheless, according to Diao *et al.* (2007), African farmers need to adopt new agricultural technologies and adequately use inputs to move out of poverty. Private standards are examples of new agricultural technologies that farmers should adopt to improve their welfare and that for workers. Humphrey (2008) argued that, despite farmers incurring huge costs, compliance with private standards increases farmers’ incomes due to increased agricultural productivity.

Elsewhere, using an endogenous switching regression model to study compliance with the Global-GAP standards among pineapple farmers in Ghana, Kleemann *et al.* (2013) found that compliance with the Global-GAP standards increases farm profits.

Chiputwa *et al.* (2015) used Propensity Score Matching with multiple treatments to determine the impact of coffee certification on farmer's welfare in Uganda. The study found that compliance with the fair-trade standards increases the living standards of farmers by 30 percent. The study further revealed that coffee certification significantly reduces poverty prevalence and depth. In Senegal, Maertens and Swinnen (2009) used single cross-sectional data from households and companies to determine the effect vegetable export on household incomes in the face of quality vegetable standards. The study found that exports in the face of quality standards increase household income and poverty reduction.

Using a two-stage Poisson regression model on single cross-sectional data, Asfaw (2008) determined the Global-GAP standards on farmers' incomes in Kenya. The study found that small-scale horticultural farmers who comply with the standards get more income when compared to those who fail to comply. However, a study by Mwende (2016) on the effect of horticultural farming in the face of Global-GAP standards on rural poverty in Kenya indicates that significant and negative relationship; exist between the implementation of the standards and household poverty. The reason given is that compliance with the standards involves many costs, which is a big challenge to farmers, especially small-scale. Even though compliance with private standards improves the welfare of farmers, contradicting research findings have been reported in Kenya. For instance, a study by Tschirley *et al.* (2004) found that horticulture farming in the presence of different institutional arrangements exposes farmers to many risks and volatile returns. Asfaw *et al.* (2010) demonstrated that compliance with Global-GAP standards pays high returns, but the high cost of compliance and certification reduces the returns.

Most of the studies in Kenya used indicators of welfare (expenditure, income, and asset) to measure the effect of private standards on household poverty. Such approaches may not determine precisely the impact of private standards on household poverty. The contradicting research findings call for more research and application of other approaches to determine if the private standards truly improve horticultural farmers' welfare. In this regard, the international poverty line of $1.90 and Propensity Score Matching approaches were used in assessing the contribution of Global-GAP standards to the French beans farmers' welfare.

2.4.3 Factors influencing compliance with Global-GAP standards or private standards

2.4.3.1 Social, economic and institutional factors

In Kenya, studies on factors influencing the uptake of private standards are enormous. For instance, by using a binary Probit model to determine factors influencing the uptake of European Retailer Produce Working Group for Good Agricultural Practices (Eurep-GAP) standards among French beans farmers in Kenya, Muriithi *et al.* (2011) found that cost of Global-GAP compliance and off-farm income negatively influence farmers' compliance decisions. Access to extension services, credit facilities, large farm size, contract farming, and farmer groups positively influence farmers' decisions to comply with private standards. It was also established that the study by Muriithi *et al.* (2011) failed to link French beans farmers' attitudes toward risks with the uptake of Eurep-GAP standards and vulnerability to expected poverty.

Kangai and Mburu (2012) used Institutional Analysis and Development framework and descriptive statistics on a single cross-sectional data to determine factors influencing youth participation in compliance with Global-GAP standards. The study found that unfavourable land tenure systems, insecure lease agreements, limited funds, insufficient information, and non-binding contracts discourage youth from complying with Global-GAP standards. On the other hand, farm diversification, access to information, higher education level, contract farming, and large farm sizes positively influence youth's decisions to comply with Global-GAP standards. The study by Kangai and Mburu (2012) also failed to link risk attitudes of youth farmers with the uptake of Global-GAP standards and vulnerability to poverty.

Njoba *et al.* (2016) used a Propensity Score Matching approach to determine factors influencing compliance with Global Good Agricultural Practices in French Beans production among small-scale farmers in the Central region of Kenya. The study found the distance to the nearest market negatively influencing compliance decisions. The study argued that high transaction costs brought about by long distances lowers farmer's ability to comply with the standards. The study also found age and access to agricultural training positively influencing compliance decisions of the farmers. Asfaw *et al.* (2010) used a two-stage standard treatment effect model on cross-sectional data to determine factors influencing the uptake of Global-GAP standards. The study found lack of credit services, smaller farms, low level of education, and lack of organisation and less social, physical, and human resources as the factors that negatively influence farmers' decisions to comply with the standards. The study, however, failed to capture and link farmers' risk attitudes to the uptake of Global-GAP standards and farmers' vulnerability to expected poverty.

Using binary Logit model on a cross-sectional data to determine factors influencing French bean farmers' decisions to comply with the Global-GAP standards as an individual or group, Nyota (2011) found that high household income positively influences farmers' decisions to comply with the standards. Long distances to the market, farmers' age, number of groups a farmer belongs and household size significantly and negatively correlated with farmers' compliance decisions. Although financially constrained, younger farmers are risk takers because they are more educated and thus can easily understand the benefits of food safety standards. Farmer groups facilitate compliance and certification processes as well as protecting farmers from quantity risks, income scarcity, and contract termination. Large farms reduce cost per unit, while wealth enables farmers to meet the cost of compliance and certification. The study by Nyota (2011) also failed to determine the effect of farmers' risk attitudes on the decisions to comply with Global-GAP standards as well as on household observed and expected poverty.

Karira *et al.* (2013) used a Contingent Valuation Approach on cross-sectional data to analyse farmers' willingness to protect the environment through the uptake of Global-GAP Standards. The study found that farmers are willing to comply with the standards if and only if benefits were to be realized. The study, however, failed to link the risk attitudes with the farmers' observed poverty and vulnerability to expected poverty. According to Dolan and Humphrey (2000), Weatherpoon and Reardon (2003) and Okello (2005) lack of access to information and services among small-scale farmers is the key constraint in the adoption of agri-food safety standards.

Elsewhere, Kersting and Wollni (2012) used a bi-variate Probit model on cross-sectional data to determine factors influencing the uptake of Global-GAP standards among fruit and vegetable farmers in Thailand. The study found that higher education level, availability of family labour, high irrigation intensity, farmers' experience in high-value supply chains and support from donors and exporters positively influence farmers' decisions. Using a three-stage compliance process to study mango farmers in Peru, Kleinwechter and Grethe (2006) found that lack of access to information constraint uptake of Eurep-GAP standards. In this study, risk attitudes were estimated together with the socio-economic and institutional factors to determine their effect on French beans farmers' decisions to comply with Global-GAP standards.

2.4.3.2 The role of risk preferences in the uptake of new agricultural technologies

Studies on agricultural technology adoption in the face of risk preferences of farmers have been extensively conducted using experiments, both real and hypothetical pay-off. Liu (2013) used an experiment to estimate the effect of loss aversion, risk aversion, and nonlinear probability weighting on the adoption of genetically modified cotton adoption in China. The study found that farmers averse to risks and losses adopted genetically modified cotton. In addition, farmers who overweighed smaller probabilities adopted genetically modified cotton.

By using an experiment (under prospect theory) to solicit risk attitudes and Tobit model to determine the effect of risk attitudes on uptake of new rice varieties among farmers in Lao PDR, Ross *et al.* (2012) found no significant relationship. Kirumba and Pinard (2010) used hypothetical payoffs to determine Kenyan coffee farmers' willingness to protect the environment by embracing Global-GAP standards. The study revealed that farmers' perception towards potential benefits from compliance is the major factor that drives coffee farmers in Kenya to comply with coffee eco-certification standards. By using the 5-point Likert scale to solicit risk attitudes and Logit model to determine the effect of farmers' attitudes toward risks on the adoption of new maize varieties in Mozambique, Cavane (2011) found that risk-averse farmers avoid the adoption of improved maize varieties and chemical fertilisers.

In Nigeria, Chinwendu *et al.* (2012) also used Likert scale to solicit risk attitudes of poultry farmers and found that farmers who are risk takers and aware of the benefits of agricultural insurance were able to acquire and use the insurance services. In Senegal, Niane *et al.* (2012) used an experimental approach to solicit risk attitudes of smallholder horticultural farmers and went further to determine their effect on allocative efficiency of choice of inputs. The study found that allocative efficiency in the use of inputs increased with the risk aversion of farmers. Koundouri *et al.* (2006) used moment-based approach proposed by Antle (1987) to solicit risk attitudes and Probit model to determine the effect of risk attitudes on the uptake of modern irrigation technologies among farmers in Greece. The study found that as production risks increase farmers' probability of adopting modern irrigation technologies also increases.

Using experiment approach (prospect theory) and survival model to determine the effect of risk attitudes on uptake of Genetically Modified (GM) soybeans and soy seeds in the United

States of America (USA), Bradford *et al.* (2013) found that farmers who are risk averse failed to embrace them. In Ireland, Vollenweider *et al.* (2011) used moment-based approach model by Antle (1987) to solicit risk attitudes of dairy farmers and Probit model to determine the effect of risk attitudes on the adoption of Rural Environment Protection Scheme (REPS). The study found that dairy farmers' probability of adopting the REPS increased as production risks increased.

Risk-averse farmers tend to adopt new and risky agricultural technologies. The argument behind it is that; risk-averse farmers decide to adopt new and risky technologies if and only if they expected risks that could diminish their expected incomes or benefits. The decision to either comply or not comply with the Global-GAP standards is equally risked for the farmers producing French beans in Kenya. This is because failure for the farmers to comply with the standards will lead to a lack of access to lucrative markets, which then lead to low household incomes. On the other hand, compliance comes with huge costs, which in turn reduces farmers' gross margins/profits. Since either decision seems to be better for the vegetable farmers, it was expected that both risk-averse and risk-loving vegetable farmers would comply with the private standards.

Even though risk preferences are important factors in determining uptake of new agricultural technologies worldwide, studies on the relationship between risk preferences and Global-GAP compliance decisions in Kenya are scanty. This is because existing studies on private standards operating in the horticulture industry have been done (Asfaw, 2007; Humphrey, 2008; Asfaw *et al.*, 2009; Asfaw *et al.*, 2010; Muriithi *et al.*, 2011; Nyota, 2011; Kangai and Mburu, 2012; Karira *et al.*, 2013). However, none of these studies captured and linked vegetable farmers' risk attitudes to their decisions to comply with the private standards. The studies may have studied each case in a different dimension but failed to study the link between them.

2.5 The concept of observed poverty, theories and approaches used in the measurement

2.5.1 The concept of observed poverty: Definition and its status in Kenya

Since independence, the key priorities of each government in Kenya are poverty reduction, elimination of ignorance and diseases (The Republic of Kenya, 1965). Different authors and organisations have defined the concept of poverty differently. For instance, United Nations (1995) defines poverty as lack of access to formal education, lack of access to essential factors of production, lack of access to adequate income, poor health and lack of access to housing among other essential things in life. World Bank (2000) and Muyanga (2007), defines poverty as states of lack of access to nutrition, basic education, income, housing, and health.

Observed poverty can be classified as absolute or relative. According to IFAD (2000) and Mendola (2007), absolute poverty is a situation where an individual in an economy faces challenges of raising income sufficient to meet basic needs of survival like food, clothing, and shelter among other things. On the other hand, relative poverty refers to a situation where an individual is having less income relative to his/her neighbours or those around him/her. In this study, the absolute poverty approach was adopted in determining the effect of Global-GAP standards on farmer's welfare indicators and observed poverty.

Poverty has been growing in Kenya despite various interventions by the Government and other stakeholders in the economy. For instance, poverty rates rose from 40 percent to approximately 52 percent between the year 1994 and 1997. However, a slight reduction was experienced in 2007, whereby the poverty rate dropped from 52 percent to approximately 46 percent (KNBS, 2007). According to the Kenya Institute of Public Policy Research and Analysis (2013), the poverty rate increased to approximately 51 percent in 2008 but slightly reduced to approximately 50 percent in the year 2012. Poverty rates in North Eastern, Coastal, Eastern, Nyanza, Rift Valley and Western regions of Kenya stand at approximately 74 percent, 70 percent, 51 percent, 48 percent,49 percent, and 52 percent respectively (Kenya National Bureau of Statistics (KNBS, 2007; Machio 2015).

Empirical studies show that poverty rates are higher in rural areas than in urban areas, and the trend has been the same over a long period. For instance, in the year 1992, rural and urban poverty rates stood at approximately 46 and 29 percent, respectively. In 1997, rural and urban rates were approximately 53 and 49 percent. By the year 2007, rural and urban poverty rates eased to approximately 49 and 34 percent, respectively. Predictions had shown that by 2012, rural and urban poverty rates will be approximately 55 and 36 percent respectively (Machio, 2015 and KNBS, 2007).

In Kenya, studies on observed poverty are enormous. However, specific studies on vegetable farmers and particularly on French bean farmers in the face of Global-GAP standards are scanty. Besides, the existing few reported general findings. That is, their findings are not disaggregated to give information on which type of farmer is poor, in where and why. The study, therefore, tried to contribute to answering these questions by studying poverty among French beans farmers in the face of Global-GAP standards in the Central region of Kenya.

2.5.2 Theories of observed poverty

One of the theories of poverty is "individualistic theory of poverty." According to Asen (2002), poverty in this theory is viewed as a self-imposed thing. That is, an individual in an economy is taken as poor because of his or her choices, which is a function of his or her inner or inherited traits. The theory goes further to say that, in such a case, an individual will overcome poverty on if he or she puts in more effort to earn more income. Secondly is the classical theory of poverty. According to this theory, markets are taken as perfectly competitive. That is, the outcome of market forces is assumed efficient and effective so that an individual is considered poor or not poor based on his or her abilities or characteristics. Such characteristics may include low education level, lack of work ethics, and personal skills among other characteristics, but not the market or economic characteristics (Rank *et al.*, 2003 and Davis, 2015).

The third theory is Neo-classical theory of poverty. According to this theory, an individual in the economy is poor not because of his or her wish but due to factors beyond one's control. The theory attributes individual poverty to lack of adequate initial endowments of talents, skills and capital, which are essential in determining whether one is poor or not. The theory assumes that markets are inefficient due to the existence of market failure. The theory supports government intervention to help those who are poor by developing and implementing policies that increase one's productivity and thus, poverty reduction (Davis, 2007 and Davis, 2015). The fourth theory is the structural theory of poverty. According to Machio (2015), the structural theory of poverty blames poor politics, social issues, and economic conditions as the key causes of poverty among actors in a given economic system. The theory, therefore, does not blame an individual for his poverty situation as in classical theory. According to the theory, changes in political, social, and economic conditions eventually limit one's opportunities, thus may lead to poverty.

The fifth theory is the Keynesian theory of poverty. Unlike classical and neoclassical theories, this theory blames underdevelopment in an economy or country as a major source of poverty an individual face in a given economy. According to this theory, underdevelopment in a given country leads to low or lack of access to essential capital such as human, natural and institutional, among other essential types of capital. That is, low development leads to unemployment, unemployment leads to low income, and low income leads to high poverty levels (Sachs, 2005). The sixth theory is the Marxian theory of poverty. The theory blames politics and classes in society as the major causes of poverty among actors. According to this theory, given the capitalistic economic system and poor politics are played based on classes, it will lead to market failure. Market failure leads to unemployment, which consequently leads to low income and hence increases in poverty. The theory recommends strong government regulation in the markets to eliminate poverty (Davis, 2015).

Lastly is the contemporary economic theory of poverty. According to Morazes and Pintak, (2008) and Davis (2015), contemporary economic theory takes poverty as a state of wholly or partially not engaged in politics, production, social, and consumption activities. According to the European Union (2004), this theory is not popular in poverty analysis because it is difficult to measure the concept of social capital. Also, it is difficult to address in terms of the policy. The study relied mainly on individualistic, classical, neoclassical, and Keynesian theories in the development of theoretical and conceptual frameworks.

2.5.3 Measurement of observed poverty and approaches used

Poverty in Kenya is one of the key development problems that need proper understanding to deal with it effectively. To understanding poverty clearly, there is a need to measure it accurately, and in doing so, efficient and effective policies aimed at eradicating it will be developed. Currently, several approaches are acceptable in poverty estimation. These approaches include but not limited to biological approach, relative deprivation, expenditure, income inequality and the asset approach. Biological approach looks at the access to adequate nutritional requirements for a healthy life. That is the nutritional requirements that enable an individual to be productive.

Previous studies show that the major limitation of this approach is difficult in accurately defining the nutrients required and how much is need for one to be optimally productive (Machio, 2015). According to relative deprivation approach, an individual is poor if he or she owns less of what is desirable attributes. Desirable attributes, in this case, may include access to employment, power, and adequate income, among other attributes considered desirable. The limitation of this approach is that it is difficult to map and identify the group(s) for benchmarks and attributes considered desirable for one to be well off or not (Machio, 2015).

In the expenditure approach amount, an individual spend (per adult equivalent expenditure) within a given period is used to determine if the individual is poor or not given expenditure poverty. Any person with expenditure below the predetermined poverty line is considered poor, but if his/her expenditure is equal or above the predetermined poverty, then the individual is considered not poor. This approach, however, is highly criticised because of its assumption that consumption levels of both the poor and non-poor are determined through the same process. It is also criticised based on its assumption that increasing expenditure reduces poverty, which is not true in reality because excess expenditures eventually render an individual poor (Okwi, 1999 and Geda *et al.*, 2001).

In the income approach, poverty is determined based on the income of an individual given a predetermined poverty line. The commonly used poverty line is the international rate of one dollar per day per adult equivalent expressed on local currency given the current exchange rate. If the income of an individual per day is below a dollar per day, then he or she is considered poor. On the other hand, if his or her income is equal or above the dollar per day, then he or she is considered not poor. Foster, Greer, and Thorbecke (1984) measures of poverty utilise the income of an individual and the income poverty line to measure three indices of poverty in a given population. These three components are poverty rate (headcount), the gravity of poverty (depth of poverty) and intensity of poverty or the severity of poverty (Foster *et al.*, 1984). Some of the studies that have utilised the income approach include Fissuh and Harris (2005) and Mathenge and Tshirley (2008), among other studies.

The asset approach is also used in welfare assessment. The total value of assets per adult equivalent at a given time is used to gauge if one is likely to be poor or not. Accumulation of assets acts as security for future use or helps during the occurrence of risks in life. Some assets do yield regular incomes hence helps households prevent or overcome poverty. Burke *et al.* (2007) explored poverty movements using an asset-based measure of poverty in Kenya, among other studies. In this study, expenditure and income approaches were used in the estimation of observed and vulnerability of French beans farmers to future poverty in the face of Global-GAP standards.

2.5.4 Determinants of observed poverty and approaches used

Nortney *et al.* (2011) used binary Logit regression to determine factors affecting poverty in Ghana. The study findings show that large household sizes, location (residing in rural), low education level and agriculture being the main occupation increases the probability of households falling into poverty. In Nigeria, Okwoche *et al.* (2012) used a Tobit regression model on single cross-sectional data to determine factors influencing poverty among farmers in peri-urban in Benue State. The study found age, level of education, total farm economic efficiency, household size, years of experience in farming, income level, land size, access to credit, household members being employed, group membership, and asset ownership to be the key determinants of poverty.

In Eritrea, Fissuh and Harris (2005) used ordered Logit on data obtained from a household survey to determine factors influencing poverty. The findings show that the level of education, household size, access to remittances, and age of the household head, regional unemployment, house ownership, and access to sewage system are important factors in explaining household poverty. A study by Bogale *et al.* (2005) used Foster, Greer and Thorbecke (FGT) measures of poverty on single cross-sectional data to determine poverty in rural Ethiopia. The study found that asset accumulation is important in cushioning households against poverty. The study found that ownership of key assets such as the number of oxen and land are important in poverty alleviation in rural areas of Ethiopia. Other important factors influencing poverty include household size, education level, dependency ratio, and age of the household head.

Using latent welfare model on household survey data, Masanjala (2006) determined the effect of liberalisation of cash crop on poverty alleviation in Malawi. The study found that households that grow cash crops get more income when compared to those who do not. However, the study discovered that the increase in income is not sufficient to move households out of poverty. Using binary Logit regression model on household survey data, Ennin *et al.* (2010) determined factors influencing poverty among households in Ghana. The study found that large household sizes, low education level and agriculture as the main occupation increases the likelihood of households falling into poverty. Using a logistic regression model and a two-fold Blinder-Oaxaca decomposition, Twerefou *et al.* (2014) determine factors influencing poverty in the face of gender in Ghana. The study found that male-headed households are more likely to be poor relative to female-headed households because of large household size.

According to Mendola (2007), factors that influence the wellbeing of an individual can be categorized as demographic, human assets, institutional assets, land assets, and new technology. In determining the effect of these factors on poverty or probability of an individual falling into poverty, discrete (for example, poor versus not poor or sample can be categorized into more than two poverty groups) and continuous (can be income or expenditure in a given currency per day per adult equivalent) dependent variables can be used. In cases where the dependent variable is discrete binary choice models, for instance, binary Logit, Tobit or Probit models, multinomial Logit, and ordered Probit among other regression models can be used in determining factors influencing poverty or probability of an individual falling into poverty.

In cases where the dependent variable is continuous, models such as Ordinary Least Squares can be used. According to Mariara (2002) and Geda *et al.* (2001), many studies prefer discrete choice models because the probability of an individual falling into poverty can be determined including factors associated with the probability of falling into the poverty. Despite discrete choice models being preferred, they are associated with some weaknesses. It is considered that in the process of categorizing individuals into various poverty groups, some information is lost. The assumption that an individual within a poverty group is homogenous is unrealistic. Other problems include difficulty in determination of accurate poverty line and the restrictiveness of some models such as ordered Logit and Multinomial Logit model (Small, 1987 and Jollife and Datt, 1999 and Mwabu *et al.*, 2000). McCullagh (1980), Geda *et al.* (2005) and Nortney *et al.* (2011) are some of the studies that have applied ordered Logit and Multinomial Logit models and found them more appropriate for use in estimation of factors influencing poverty.

Geda *et al.* (2005) used binomial and polychotomous Logit models on single cross-sectional data to estimate factors influencing observed among individuals in rural and urban areas of Kenya. The study found that the two models give similar results. Household size, education, and agriculture as the main occupation were the major determinants of poverty. Using binary Probit model on single cross-section data, Oyugi *et al.* (2000) determined factors influencing poverty in Kenya. The study found age, location, household size, education level, off-farm income, and agriculture as the main occupation to be important factors explaining poverty status in Kenya. Mwabu *et al.* (2000) used household welfare function approach (household expenditure per adult equivalent) and binary Probit model. The study found location factors (rural and urban), age, household size, education level, livestock ownership, and hygienic conditions as important factors influencing poverty status of an individual in Kenya.

Using Ordinary Least Squares (OLS) and binary logistic regression analyses on single cross-sectional data, Elhadi *et al.* (2012) determined factors affecting transient poverty among agro-pastoral communities Baringo County. The study identified diversification in household sources of income, level of education, extension service, and distance to the nearest market, and access to relief food as factors that are significantly and positively affecting household income per adult equivalent. Household size and herd size significantly and negatively influenced household income. Using regression analysis on household survey data, Kiiru (2010) determined the effect of remittances on household poverty in Kenya. The study findings show that the level of remittances significantly and positively influences household consumption expenditure, which in turn reduces poverty. The study found that access to remittances act as a shock absorber when households face risks.

A study by Muyanga (2007) indicates that the lack of formal education among household heads increases household's probability of falling into transient and chronic poverty by 54 and 76 percent, respectively. The study argued that access to higher formal education increases household income, which in turn enables households to acquire basic needs and wants hence improvement in living standards or reduction in poverty. Other studies in Kenya with similar findings include Kristjanson *et al.* (2004) and Mango *et al.* (2004). A study by Oyugi *et al.* (2000) used binary Probit model on household survey data to determine factors influencing poverty in Kenya. The study found off-farm income, education levels of household members, source of water, and household size to be important factors influencing poverty among households in Kenya.

Onyeiwu and Liu (2013) determined factors influencing household income and observed poverty among rural dwellers in Kenya. The study found education level, household size, and mean household age, the ratio of female household members, land size, and asset value to be important factors explaining the poverty status of rural households in Kenya. Using binary Probit and OLS regression models on single cross-sectional data, Mariara (2002) determined the effect of asset accumulation on poverty reduction among pastoralists in Kajiado County. The study found that asset accumulation among households is critical in poverty alleviation. Studies by Quach (2005), Davis (2015), and Mwende (2016) concur that access to credit is essential in household poverty reduction. Households who have low incomes tend to save and invest less. This will lead to low income, the continuous cycle of low incomes, and eventually high poverty levels. Davis (2015) studied the effect of access to credit on poverty reduction among small-scale horticultural farmers in rural Kenya and found that horticultural farmers who accessed credit facilities were less likely to be poor relative to those who did not access.

Some studies also show that marital status, household size, and dependency ratio are related and significantly and negatively influencing poverty (Nyariki *et al.*, 2002, Andersson *et al.*, 2006 and Akona, 2014). Marriage increases or determines the household size, and as household increases, poverty reduces first, but after some time, poverty tends to increase with the level of household size due to more dependants per household. Other studies include Kristjanson *et al.* (2004), Mango *et al.* (2004), and Muyanga (2007) who found that high dependency ratio significantly and positively influence household poverty. On the role of education in poverty alleviation, several studies have been conducted (Mariara, 2002, Okurut *et al.*, 2002, Fissuh and Harris, 2005, Wasonga, 2009, Githinji, 2011, Akona, 2014, Davis, 2015, and Mwende, 2016). These studies concur that access to education reduces the probability of households falling into poverty, especially in rural areas. The studies further demonstrated that an increase in education level or years of schooling significantly and positively influences poverty reduction. The other reason is that access to higher education enables farmers to make informed decisions such as adoption technologies associated with high yields and returns, which eventually increases household income and hence poverty reduction. To effectively ensure education positively reduce poverty, there is a need for government to subsidize the cost of education.

According to Herlocker (1999) and Elhadi *et al.* (2012), overdependence on agriculture or agriculture as the main occupation increases the household probability of falling into poverty. The reasons are, agricultural activities are characterized by high risks, including drought and floods, which causes low and income fluctuations. Herlocker (1999) and Elhadi *et al.* (2012) suggest that access to both farm and off-farm sources of income such as remittances are critical in poverty alleviation. Similar findings are reported in Krishna *et al.* (2004), Mango *et al.* (2004), and Muyanga (2007) who found that income diversification plays an important role in poverty reduction in Kenya.

Existing studies show that access to markets reduces the probability of a household falling into poverty (Githinji, 2011). A study by Mwende (2016) found that market channel used in the marketing of horticultural produce determines household poverty status. The study found that farmers who export horticultural produce are less likely to be poor and vice versa. The study also found that access to post-harvest facilities, skills, and being a member of a cooperative society reduces the probability of a household falling into poverty. The study argued that access to post-harvest facilities minimizes losses and the savings from losses increases household income and hence poverty reduction. A study by KNBS (2015) shows that cooperatives increase horticultural farmer's bargaining power in the markets. Bargaining power enables farmers' access better prices, which in turn increases their incomes and thus poverty reduction.

Akona (2014) studied factors influencing poverty among rural farmers in Busia, Kenya. The study found that an increase in the age of the household head significantly and negatively influencing the poverty status of households. The argument is that as household head grow older, one is assumed to have accumulated more income sufficient to move households out of poverty. Akona (2014) revealed that access to land is crucial in reducing poverty among rural households in Kenya. Access to land enables the household to carry on agricultural activities, which will increase household income and thus poverty reduction.

Furthermore, the study discovered that asset ownership, such as livestock reduces the probability of households falling into poverty. Livestock provide households with animal products such as meat and milk, which generates income and an increase in the household income, will reduce household poverty due to access to basic needs. Location characteristics also contribute to poverty reduction. Okwi *et al.* (2007) determined the effects of geographical factors on the level of poverty in rural Kenya. The study found areas with goods soils increases agricultural productivity, which in turn increases farmers income and hence poverty reduction.

2.6 The concept of vulnerability to expected poverty and its determinants

2.6.1 The concept of vulnerability to poverty

Several authors have tried to define the term vulnerability to future poverty, and all seem to have similar definitions. According to Glewwe and Hall (1998), household vulnerability to future poverty arises from the interaction of household characteristics and their earning capacity. World Bank (2000) defines vulnerability to expected poverty as "a measure of the likelihood that shock will result in a decline in well-being." According to Pritchett *et al.* (2000), vulnerability to expected poverty is a dynamic concept rather than static. They defined it as the probability of a household falling into future poverty. Likewise, Chaudhuri (2003) defined household vulnerability to expected poverty as the probability of a household falling below the poverty line in future while observed poverty refers to the current well-being of a household. Dercon and

Krishnan (2000) define it based on the philosophy that "being well today is not a guarantee for being well tomorrow".

According to Yang (2014), vulnerability to future poverty is measured based on consumption or income less than the poverty line. Deaton and Zaidi (2002) defined consumption as the sum of all values of food items and non-food items (though expenditure on non-food items is less frequently used. According to Dercon (2001), household assets such as land, labor, and capital belonging to households generate income. The generated income would increase household consumption, which in turn increases household welfare. Existing studies show that over 60 percent of the world population will be poor by the year 2025, especially in rural areas persistence.

Moreover, given the projections, there is need to increase research on rural poverty, identify possible strategies to alleviate it and concerned stakeholders should redirect their attention and expenditure towards agricultural development (IFAD, 2000 and Mendola, 2007). The difference between observed poverty and vulnerability to expected poverty situations is explained by the presence and changes in the covariate and idiosyncratic shocks (such as inflation, job insecurity, drought, health problems) within the environment in which decision makers operate. As a result, a household that is not poor today may remain not poor or become poor in future while poor household today may remain poor or not poor in future (Chaudhuri, 2003).

Information on the link between risks and other shocks versus households' vulnerability to poverty is important in many ways. According to Chaudhuri (2003), it helps in identifying who is poor today and in the future, which is important in designing poverty prevention and poverty alleviation interventions. The information further helps farmers to identify in advance risks/shocks that are likely to occur and the relevant strategies to prevent the occurrence of such risks. Changes in risks or shocks create risks in the environment in which decision makers operate. The changes in the shocks influence households' consumption levels over time, which in turn determines households' vulnerability to poverty. The study analysed vulnerability to expected poverty using the logarithm of consumption expenditure per adult equivalent.

2.6.2 Determinants of vulnerability to poverty

Many studies on the determinants of households' vulnerability to expected poverty report various factors influencing vulnerability to future poverty. Hardaker *et al.* (2004) found that the common risks/shocks facing farming households include production, price, market, institutional risk, personal, and financial risks. These can further be classified as health (illness and death), climate (drought, floods, pests, diseases), economic (lack of access to inputs, fluctuation in input and output prices and lack of market for agricultural commodities), politics (arbitrary taxation and contract disputes) and crime (theft, destruction of crops and livestock) as indicated in Dercon *et al.* (2005). Other authors further classify the shocks or risks as a covariate or idiosyncratic.

Idiosyncratic shocks are those that are specific to a household and include illness, death of a household member and loss of employment. Covariate shocks are those that affect households across and include fluctuation in input and output prices, erratic rainfall, and pests and diseases among other shocks (Chaudhuri *et al.,* 2002; Dercon *et al.,* 2005). Several studies have been conducted to determine the vulnerability of farmers to expected poverty and determinants. For instance, studies by Mapfumo and Giller (2001), Frost *et al.* (2007), Nyikahadzoi *et al.* (2012) and Mapfumo *et al.* (2013) indicate that small-scale farmers are more vulnerable to future poverty because of climate change, fluctuation in market prices, and loss of soil fertility, population growth, and decline in safety nets.

Changes in climate lead to fluctuations in household income, while fluctuations in household incomes increase household vulnerability to expected poverty. In Kenya, Mbakahya and Ndiema (2015) conducted a study to determine the vulnerability of farming households to climate change. The study found that high levels of education, being household head, access to credit, and agricultural extension services and knowledge in rainfall pattern reduces farmer's vulnerability to risks and shocks related to climate change, hence less likelihood of becoming poor. Cherotich *et al.* (2012), Hassan *et al.* (2013), and Thabane *et al.* (2014) also concur that probability of falling into poverty is high among households who fail to access agricultural extension services. They argued that access to agricultural extension services tends to increase household incomes, which in turn reduces the probability of becoming poor. Through access to agricultural extension services, farmers will adopt new and high yielding agricultural technologies. Given better market prices, high yields translate to high household income, which in turn reduces household vulnerability to poverty.

A study by Opiyo *et al.* (2014) on the vulnerability of pastoralists to climate-induced stresses in Kenya indicates that at least 27 percent, 44 percent, and 29 percent of the households were highly, moderately and less vulnerable to climate-induced stresses respectively. The study found that the vulnerability levels varied according to the age of the household head, access to rights and adequate information on climate change, household size, gender of the household head, marital status, type and number of livestock owned, distance to the nearest markets, access to agricultural extension services, extent of farm diversification, access to credit, and off-farm income.

Muyanga *et al.* (2006) determined factors affecting chronic and transient poverty in Kenya and found low asset value, large household size, long distances to markets, low education level, high poverty level, small farm sizes, low crop diversification, low income diversification, limited access to credit facilities and high yielding technologies as critical factors increasing household vulnerability to poverty. Deressa (2013) assessed the household's vulnerability to poverty in Rural Ethiopia. The study found that the age of the head of the household significantly and negatively influenced vulnerability to future poverty. That is, as the age of the household head increases, his/her skills, experience, and assets increases, and thus, the low probability of falling into poverty.

Other studies have shown that large-sized households are more income-poor than their counterpart; small sized households are (Dirway, 2010 and Khamaldin *et al.*, 2015). However, Megersa (2015) found a vulnerability to poverty lower among households with a larger number of family members. Large family size is a good labor force for the household in the future that will undermine vulnerability to poverty. A study by Zerai and Gebreegziabher (2011) found that large households are more vulnerable to food insecurity due to high demand resulting from high dependency ratio, unemployed, and schooling among household members. Similar findings are reported in Deressa (2013), who found that household size significantly and positively influences vulnerability to poverty among households. An increase in household size exerts more pressure on consumption, thus decreasing household welfare. The study, however, demonstrated that when squared household size is included in the model, households would be less vulnerable to poverty in the future. Large household size can provide productive labor, which can reduce the probability of falling into future poverty. Regassa (2011) also found a positive relationship between household size and the level of household coping strategies. Meenakshi and Ray (2000) and Mok *et al.* (2011) advocate the need to adjust the household size and composition in terms of an adult equivalence scale to deflate income.

In Thailand and Vietnam, Gloede *et al.* (2012) used to survey and descriptive statistics to determine the effect of various shocks on rural households' vulnerability to poverty via their risk attitudes. The study found that adverse shocks, which include agricultural, economic, social, and demographic shocks, increase risk aversion of rural households, and vulnerability to expected poverty. Using Vulnerability to Expected Poverty approach on cross-sectional data to assess households' vulnerability to poverty in Indonesia, Chaudhuri *et al.* (2002) found that 45 percent of the population was vulnerable to future poverty. Using an experimental approach, Mosley and Verschoor (2005) found that poor people tend to be risk-averse to the extent that they are unwilling to invest, leading to low asset accumulation. Low asset accumulation consequently leads to high poverty and a high probability of falling into future poverty.

On the other hand, Chaudhuri (2003) findings show that low household income leads to low consumption expenditure and hence, vulnerability to future poverty. The effect of an uninsured risk is that an individual may suffer losses when risks struck and individual lack protection (such as insurance) from the risks (Dercon, 2004). Risk-averse decision makers in the presence of risks are, therefore, more likely to be vulnerable to expected poverty (Hulme and Shepherd, 2003). Using panel data to determine shocks affecting the consumption growth of rural households in Ethiopia, Dercon (2004) found that erratic rainfall negatively affects both current and future consumption patterns of households. Illness and crop pests did not affect household incomes and consumption patterns.

In Bangladesh, Shafiul *et al.* (2009) used household income and expenditure approaches on panel data to determine households' vulnerability to poverty. The study found that households with a low level of education and agriculture as a major occupation were more vulnerable. According to Dirway (2010), an increase in remittances (off-farm income), livestock income, education level, age, and skills of the household head reduces the vulnerability of households to food poverty. Harttgen and Günther (2006) used Vulnerability to Expected Poverty (VEP) approach on a single cross-sectional data to assess households' vulnerability to poverty in Madagascar. The study found that idiosyncratic and covariate shocks influence households' vulnerability to poverty in urban and rural areas, respectively. Off-farm income serves as an additional income, which serves as a hedge against future poverty.

Aging of the household head tended to increase the level of vulnerability (Khamaldin *et al.* 2015). Aging is widely perceived to be associated with higher vulnerability and insecurity

(Barrientos, 2007; Mwanyangala *et al.* 2010). Old age tends to correlate with vulnerability and social insecurity (Barrientos 2007). Because of a range of psychological, physiological, and socio-economic dispositions, older people are more vulnerable to the impacts of climate change and weather extremes (Harvison *et al.* 2011). As the age of the female-headed household increases after certain years, vulnerability to poverty also increases (Muleta and Deressa, 2014).

A study Khamaldin *et al.* (2015) shows that experience in farming reduces the probability of future vulnerability. However, the relationship with vulnerabilities was reversed when the farming experience was increased exponentially, indicating nonlinearity. The farming experience is widely accepted as one of the factors enhancing farming efficiency. Megersa (2015) found that an increase in experience (higher age) will improve earning capacities and thereby lowers poverty. Contrary findings are reported in Inayatullah *et al.* (2012) who found that an increase in age reduces household's vulnerability to food insecurity and thus poverty.

Asset accumulation enhances the level of household income. For instance, an increase in farm size reduced future vulnerability through an increase in incomes. Higher income contributed to wealth formation through improved access to assets and housing amenities (Khamaldin *et al.* 2015). Aikaeli (2010) and Harvey *et al.* (2014) found that possession of physical assets indicate wealth. According to Gbetibouo (2009) and Shiferaw (1998), wealth indicates past cumulative income achievements of households and wealth accumulation enhances the ability of risk-bearing among households. Muleta and Deressa (2014) found that livestock ownership significantly reduces housed probability of falling into poverty. According to Megersa (2015), households can easily dispose of livestock whenever risks or shocks hit them.

Hulme and McKay (2005) found that crop failure, unemployment, accidents, increase in age, and alcoholism are significantly and positively influence the vulnerability of households to future poverty. Deressa (2013) demonstrated that households with secondary and tertiary levels of education were less likely to be vulnerable to future poverty. Education provides knowledge and skills, which increase the household probability of using modern agricultural technologies, which in turn cushions farmers against inevitable risks and uncertainties are hence reducing their probability of falling into future poverty. Muleta and Deressa (2014) also found similar results. The study found that illiterate household heads were more vulnerable to future poverty. The more the household head is educated, the probability of households using modern agricultural technologies increases, which in turn help households cope with risks and uncertainties hence reduces the probability of households falling into future poverty.

On gender issue, Muleta and Deressa (2014) found that vulnerability to future poverty is higher among female-headed households than male-headed households are. Jama (2012) found similar findings in Maphutseng. The study found that female household heads are more likely to be vulnerable to shock on their key livelihoods relative to male-headed households who have diversified livelihood coping strategies. Despite the importance of understanding future poverty and its drivers in addressing household poverty (World Bank, 2001), such information is scanty in Kenya. Existing statistics and information is not well disaggregated across specific target groups on their geographic, socio-economic, institutional, and psychological characteristics. To contribute to this knowledge gap, the study determined the vulnerability of French beans farmers to poverty in the face of Global-GAP standards and examined the socio-economic, institutional, and psychological characteristics of the farmers that are likely to be associated with their vulnerability to future poverty.

The findings of this study are expected to contribute to the understanding of the poverty dynamics within rural areas in Kenya, especially during this new era of devolution. According to KNBS and SID (2014), such information is critical in informing National and County government policies concerning poverty eradication at the grass root level. The generated information will also help in future poverty benchmarks, within and between various Counties in the Country as well as informing the public on what they require to do to mitigate the increasing poverty and in guiding resource allocation at the national level.

1.1.1.10 2.6 Theoretical framework

The theoretical framework was based on "risk chain" concept outlined in Hoddinott and Quisumbing (2008). The concept assumes that a link exists between risks facing households, households' attitudes toward the risks, households' activities chosen, households' incomes, household consumption expenditure levels, and the household observed poverty and vulnerability to future poverty. Some studies have shown that the presence of risks undermines the adoption of new agricultural technologies (Kirumba and Pinard, 2010; Bradford *et al.*, 2013). In Kenya, the environment in which French beans farmers make decisions is also characterized by risks due to high costs and volatile returns associated with the private standard.

According to Muriithi (2008), compliance with private standards is a costly activity, which squeezes out farmers' profits. Since compliance with the standards is a challenging venture, it was hypothesized that farmer's attitudes towards risks would influence French beans farmers' decisions to comply with the Global-GAP standards. Also, the French beans farmers were assumed to be after profit maximization and cost minimization. In this regard, it was expected that the farmers would consider losses and gains (as assumed in PT) rather than their current assets (as assumed in EUT) as a reference point in making decisions to comply with the standards. That is, French beans farmers who viewed compliance with Global-GAP standards as a profitable decision were expected to comply and those who viewed it as a loss due to the high cost of compliance and certification were expected not to comply (non-probability weighting).

Since there was a likelihood that risk aversion, loss aversion, and non-probability weighting would explain French beans farmers' decisions to comply with the standards, PT was adopted. Expected Utility Theory does not consider loss aversion and non-probability weighting behavior of decision makers. Both EUT and PT can be used to explain risk aversion behavior of the French beans farmers, but the problem was that it was not known whether EUT or PT would explain better. To clear the doubt, approach by Tanaka *et al.* (2010) was applied because it combines both EUT and PT. The approach enables researchers to estimate both the coefficient of risk aversion, loss aversion, and non-linear probability weighting.

An experiment, Likert scale, and econometric estimation of a production function concerning an input of interest can be used to solicit farmers' attitudes towards the risks. In this study, the estimation of a production function was not appropriate because not all standards within Global-GAP have a direct impact on the yields of French beans. Even though there is no universally accepted method of soliciting risk attitudes (Ghartey *et al.*, 2014), the experimental approach has been widely used in many studies (Binswanger, 1980; Holt and Laury, 2002; Bradford *et al.*, 2013). This is because it directly solicits the risk attitudes of decision-makers and more precise. EUT and PT have widely applied theories where social experiments are used to solicit risk attitudes of decision makers. EUT was first proposed by Bernoulli (1738) and later further developed by Neumann and Morgenstern (1944). Its underlying assumption is that decisions made under risky situations are like making choices between prospects. If this assumption is valid, then according to Neumann and Morgenstern (1944), a prospect let say *A*, can be defined as a function of outcomes and their respective probabilities of occurrence. This is given as:

$$A = f\{(M_1, \text{Prob}_1),......,(M_n, \text{Prob}_n)\} \tag{2.1}$$

where $M_{1\text{-}n}$ is the outcome of prospect A and $\text{Prob}_{1\text{-}n}$ are the respective probabilities of the outcomes. Under EUT decision-makers are assumed to consider final net wealth/assets as the reference point when making decisions under risky situations (Kahneman and Tversky, 1979). Mathematically, this is given as:

$$EV = (1 - \text{Prob})U(M_1 + W) + \text{Prob}U(M_2 + W) \tag{2.2}$$

where EV is the expected value of the prospect, U represents utility, and W represents wealth/assets. Under EUT, risk aversion is the only parameter that determines the shape of the utility function. The utility function of a risk-averse decision maker is concave, linear for risk neutral and convex for a risk-loving (Kahneman and Tversky, 1979). Contrary, Prospect Theory (PT) assume decision makers consider gains and losses from a certain reference point and not their final asset base (as assumed in EUT) while making choices under risky situations. In PT, decision makers become risk averse when faced with gains/positive prospects and risk-seeking when faced with losses/negative prospects (reflection effect). In addition, the decision makers are assumed to consider more the "value" of a prospect (non-linear probability weighting) rather than the level of probability attached to a prospect as assumed in EUT. That is, decision makers overweigh the outcomes that are considered certain relative to risky outcomes (Kahneman and Tversky, 1979).

In PT risk aversion, loss aversion, and non-linear probability weighting determine the shape of the utility function of an individual decision maker. As a result, value function for decision makers who consider an outcome of a prospect as a loss is convex and relatively steep and concave, but not so steep, for those who consider an outcome of a prospect as a gain (Plus, 1993). A prospect in PT is further assumed to have two components, namely "common" and "unique." The components yield different preferences (isolation effect) and thus possible to decompose a given prospect into risk and riskless components (Kahneman and Tversky, 1979). Both EUT and PT are suitable for soliciting risk attitudes of farmers. However, some studies acknowledge that PT predicts better than EUT due to some unrealistic assumptions in EUT (Plus, 1993; Squiggling, 1993; Camerer, 2001; List, 2005).

In particular, Squiggling (1993) found EUT not suitable for soliciting risk attitudes when individuals are faced with losses and gains. In PT, three parameters Λ, $\Pi(\text{Prob})$ and *v* are introduced to capture psychological impacts of the decision makers. Λ represents the overall value of an edited prospect, $\Pi(\text{Prob})$ is a decision weight, which reflects the impact of Prob (probability) on the overall value of the prospect and *v* is the value function that measures the value of deviations from the reference point (gains and losses). The prospect is strictly positive if its outcomes are all positive, strictly negative if its outcomes are all negative and regular if it is neither strictly positive nor strictly negative (Kahneman and Tversky, 1979). Assuming (*x*, Prob *; y, q*) is a regular prospect, then,

$$\Lambda(\text{x}, \text{Prob}; \text{y}, q) = \Pi(\text{Prob})\nu(\text{x}) + \Pi(q)\nu(\text{y}) \tag{2.3}$$

A prospect is segregated into riskless and risky components at the evaluation phase as follows:

$$\Lambda(\text{x}, \text{Prob}; \text{y}, q) = \nu(\text{y}) + \Pi(\text{Prob})[\nu(\text{x}) - \nu(\text{y})] \tag{2.4}$$

where q = 1- Prob, $v(y)$ represents the riskless component, [$v(x)$-$v(y)$] represents the risky component, and $\Pi(\text{Prob})$ is the ratio of the weight associated with the probability to the weight associated with the sure event (Kahneman and Tversky, 1979). French beans farmers' decisions to embrace Global-GAP standards are like the prospects in EUT and PT. This is because uptake of the standards comes with varying levels of returns and risks (Tschirley *et al.*, 2004). Mathematically (Tanaka *et al.*, 2010) utility function is given as:

$$U(x, \text{Prob}; y, q) = \begin{cases} v(y) + w(\text{Prob})(v(x) - v(y)) & x > y > 0 \;\; or \;\; x < y < 0 \\ w(\text{Prob})v(x) + w(q)v(y) & x < 0 < y \end{cases} \tag{2.5}$$

where *U*(*x*, Prob *; y, q*) is the expected value of a prospect, *x* and *y* are the outcomes of the prospect while Prob and *q* are the respective probabilities for the outcomes.

$$v(x) = \begin{cases} x^{1-\sigma} & for \quad x > 0 \\ -\lambda(-x)^{1-\sigma} & for \quad x < 0 \end{cases} \tag{2.6}$$

where $v(x) = x^{1-\sigma}$ is value function for gains $x > 0$ and $v(x) = -\lambda(-x)^{1-\sigma}$ represent value function for losses $x < 0$ while σ denote the shape of the value function (concavity) which is as a result of increase/decrease in marginal value of money. If $\sigma < 0$ the French bean farmer is risk loving, risk neutral if $\sigma = 0$ and risk-averse if $\sigma > 0$. λ denotes the midpoint of the lower and upper bounds of the switching point in the questions of series. It also indicates the degree of loss aversion such that a higher value of λ will mean decision maker is more loss averse. The probability weighting function is given as:

$$w(\text{Prob}) = \exp[-(-\ln \text{Prob})^{\alpha}] \tag{2.7}$$

where α is the non-linear probability weighting measure such that probability weighting function is linear if $\alpha = 1$, S-shaped if $\alpha > 1$ (the individual under-weights small probabilities and over-weighs large probabilities), inverted S-shaped if $\alpha < 1$ (the individual over-weighs small probabilities and under-weights large probabilities). According to Tanaka *et al.* (2010), weighting function by Prelec (1998) is appropriate for use since it fits well cases where individual decision makers have either inverted-S or S-shaped weighting functions. When $\alpha = 1$ and $\lambda = 1$, Tanaka *et al.* (2010) model reduces to EUT model. It was hypothesized that household socio-economic characteristics ($\mathbf{X}_{HSC}$), household risk preferences ($\mathbf{X}_{HRP}$), institutional and policy characteristics ($\mathbf{X}_{IPC}$), technology characteristics ($\mathbf{X}_{TC}$) and farm characteristics ($\mathbf{X}_{FC}$) would influence French beans farmers' decisions to comply with the private standards (ST_i) as shown in Figure 1.

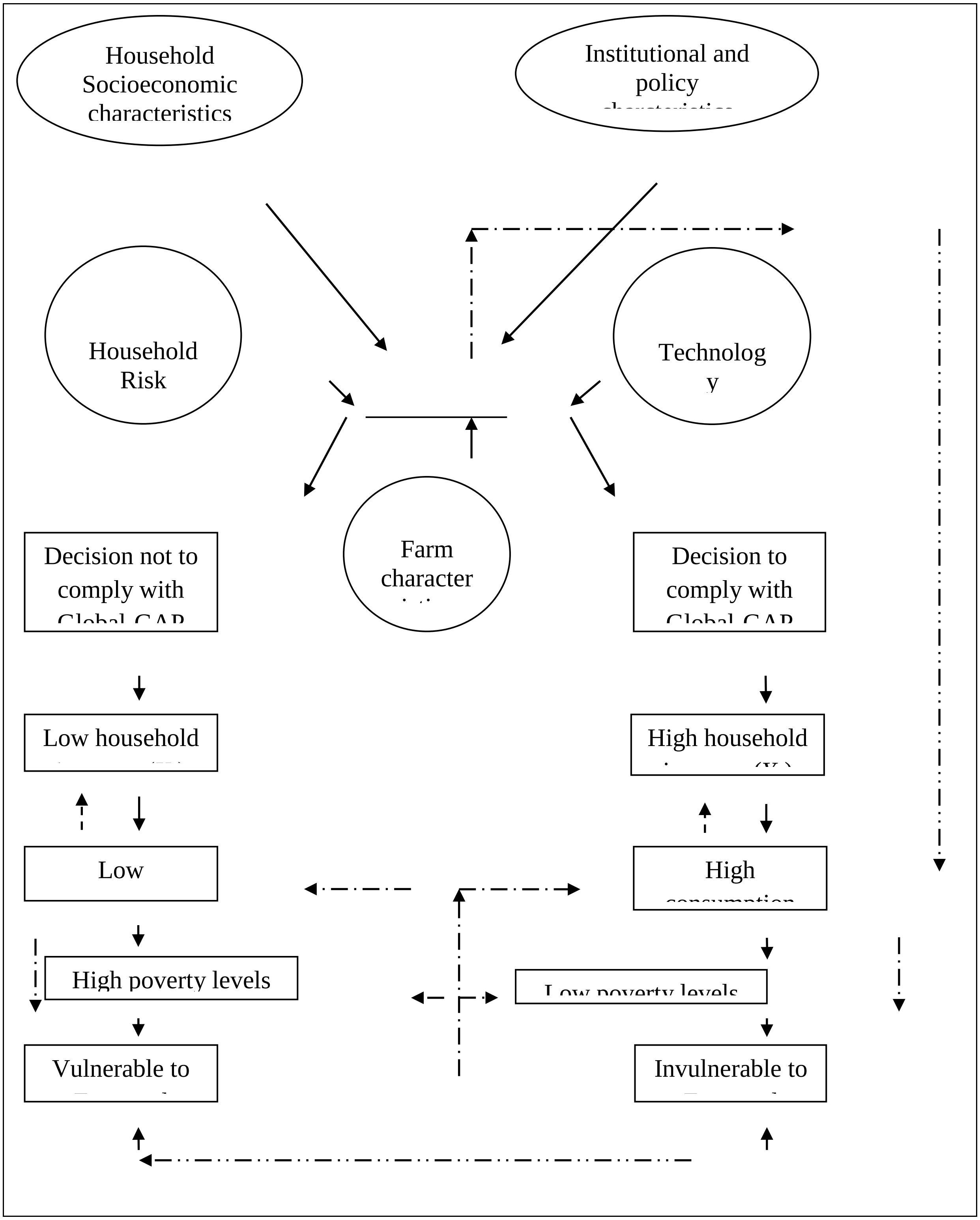

Figure 1: Conceptual framework of the risk chain concept

Functionally, this is given as:

$$ST_i = \alpha + \mathbf{X}_{HSC}\boldsymbol{\beta}_1 + \mathbf{X}_{IPC}\boldsymbol{\beta}_2 + \mathbf{X}_{HRP}\boldsymbol{\beta}_3 + \mathbf{X}_{TC}\boldsymbol{\beta}_4 + \mathbf{X}_{FC}\boldsymbol{\beta}_5 + e_i \qquad (2.8)$$

where ST_i denotes French beans farmer's decisions to comply with the private standards such that, ST_i takes value 0 for Global-GAP non-certified French beans farmers and value 1 for certified farmers, α is a constant, $\boldsymbol{\beta}$ is a vector of coefficients for the socio-economic, household preferences, institutional and policy factors, technology and farm characteristics while e_i is an error term.

French beans farmers' decisions to or not to comply with Global-GAP standards are binary, and thus factors influencing such decisions are estimated using binary Logit or Probit regressions. Both models are based on the random utility model and yield similar results (Gujarati, 2004). Nonetheless, binary Logit assumes that error terms are logistically distributed while binary Probit assumes a normally distributed error terms (Greene, 2003; Gujarati, 2004; Nyota, 2011). Ordinary Least Squares (OLS) regression was unsuitable because the endogenous variable is discrete and the fact that the non-linear relationship was expected to exist between the endogenous and exogenous variables. Using OLS, therefore, might have resulted in estimates being inefficient and heteroscedastic (Gujarati, 2004). Multinomial Logit (MNL) model was also unsuitable because its endogenous variable takes more than two categories (Greene, 2003; Gujarati, 2004). Compliance with the Global-GAP standards enables French beans, farmers, to access lucrative markets, which in turn increases their household income. Mathematically this is given as:

$$Y_i = \alpha + b(ST_i(\alpha + \mathbf{X}_{HSC}\boldsymbol{\beta}_1 + \mathbf{X}_{IPC}\boldsymbol{\beta}_2 + \mathbf{X}_{HRP}\boldsymbol{\beta}_3 + \mathbf{X}_{TC}\boldsymbol{\beta}_4 + \mathbf{X}_{FC}\boldsymbol{\beta}_5 + e_i)) + e_j \qquad (2.9)$$

where Y_i represents the French beans farmers' household income, and it takes value 0 for non-certified and value 1 for Global-GAP certified households, b represent income resulting from the decision to comply with private standards and represent other sources of household income while e_j is an error term. Based on the "risk chain" concept, it was assumed that an increase in the French beans farmers' incomes as a result of complying with the Global-GAP standards would also increase their consumption expenditure. Mathematically this is given as:

$$C_i = f(Y_i(\alpha + b(ST_i(\alpha + \mathbf{X}_{HSC}\boldsymbol{\beta}_1 + \mathbf{X}_{IPC}\boldsymbol{\beta}_2 + \mathbf{X}_{HRP}\boldsymbol{\beta}_3 + \mathbf{X}_{TC}\boldsymbol{\beta}_4 + \mathbf{X}_{FC}\boldsymbol{\beta}_5 + e_i)) + e_j)) + e_k \quad (2.10)$$

where C_i represents household consumption expenditure for both certified and non-certified French beans farmers while e_k is an error term. An increase in the household income was expected to increase household consumption expenditure and consequently reduce observable household poverty (PV_i). PV_i takes value 0 for non-poor French beans farmers and values 1 for poor farmers. Mathematically this is given as:

$$PV_i = f(C_i(Y_i(\alpha + \mathrm{b}(ST_i(\alpha + \mathbf{X}_{HSC}\boldsymbol{\beta}_1 + \mathbf{X}_{IPC}\boldsymbol{\beta}_2 + \mathbf{X}_{HRP}\boldsymbol{\beta}_3 + \mathbf{X}_{TC}\boldsymbol{\beta}_4 + \mathbf{X}_{FC}\boldsymbol{\beta}_5 + e_i)) + e_j)) + e_k) + e_l \quad (2.11)$$

Based on the "risk chain" concept, the study further assumed that an increase in household consumption expenditure would reduce household vulnerability to expected poverty (V_{hi}). That is, non-certified French beans farmers were expected to be vulnerable to future poverty (V_{h0}) while Global-GAP certified ones would be invulnerable (V_{h1}). Mathematically this is given as:

$$V_{hi} = f(C_i(Y_i(ST_i(\mathbf{X}_i))) + e_n \quad (2.12)$$

2.7 Determination of risk attitudes

2.7.1 Likert scale approach

According to Binswanger (1980), Likert scale approach used in the solicitation of risk attitudes is simple in application and fit for illiterate respondents. Most of the respondents were illiterate and thus the suitability of the approach. The study used a 5-point Likert scale designed as follows: 1 denotes "*I never like take risks*," 2 denotes "*In most cases I don't like take risks*", 3 denotes "*I sometimes like take risks*," 4 denotes "*In most cases I like take risks*" and 5 denotes "*I always like take risks*." Respondents were briefed on the meaning of each scale before there were asked to assess themselves in terms of whether they preferred taking risks or not.

2.7.2 Experimental approach

Lottery experiments oriented to Expected Utility (EUT) and Cumulative Prospect Theory (CPT) were used in this study. EUT and CPT have been applied by many studies on agriculture. Some of these include Binswanger (1980) and Holt and Laury (2002) which used experiments oriented to EUT and Liu (2008) and Tanaka *et al.* (2010) which used experiments oriented to

EUT and CPT. Experiments under EUT and CPT are framed such that the outcome probabilities are held constant while lottery stakes are varied. Also, CPT Experiments incorporate gains and losses as well as their respective probabilities. Summary of the studies is shown in Table 1.

Table 1: Summary of studies that used EUT and CPT perception frameworks

Study	Country	Lottery-type	Perception framework	Utility function
Binswanger (1981)	India	Hypothetical and real	EUT	CRRA
Holt and Laury (2002)	USA	Hypothetical and real	EUT	CRRA and POWER
Liu (2008)	China	Real	EUT and CPT	CRRA
Tanaka *et al.* (2010)	Vietnam	Real	EUT and CPT	CRRA
Love *et al.* (2014)	Kenya	Real	EUT and CPT	CRRA

Notes: EUT means Expected Utility Theory; CPT means Cumulative Prospect Theory; CRRA means Constant Relative Risk Aversion, and RDUT means Rank-Dependent Utility Theory.

This study adopted lottery experiments similar to those in Tanaka *et al.* (2010) and Love *et al.* (2014). Two (2) and one (1) experiment series for PT and loss aversion were implemented respectively. Samples of PT and loss aversion series used are shown in Table 2 and 3, respectively.

Table 2: Prospect Theory series

Task No.	Starting point	Option A	Option B	How to identify a switching point
1		100 if 1 2 3 4 5 6 7 200 if 8 9 10	50 if 1 2 3 4 5 6 7 8 9 200 if 10	If option A is chosen, move DOWN the table If option B is chosen, move UP the table
2		100 if 1 2 3 4 5 6 7 200 if 8 9 10	50 if 1 2 3 4 5 6 7 8 9 250 if 10	

In the PT series (Table 2), each respondent was asked to make choices between two options: option A and B in each series of experiment. Option A involved a 70 percent probability of receiving KES 100 and a 30 percent probability of receiving KES 200. Option B involved a 90 percent probability of recipients receiving KES 50 and a 10 percent probability of their receiving KES 200, which increases, by KES 50 in each task until it surpasses the expected value of Option A. Each lottery series had nine tasks and the percentages in each option remained unchanged. The lotteries were structured in such a manner that ensures that more/less risk-averse decision maker is identified based on the point at which he or she decided it was worth the risk to switch from Option A to Option B (Love *et al.,* 2014). To estimate loss aversion, one of the series of two options (A and B) was used (Table 3).

Table 3: Loss aversion series

Task No.	Starting point	Option A	Option B	How to identify a switching point
1		185 if 1 2 3 4 5 -30 if 6 7 8 9 10	200 if 1 2 3 4 5 -150 if 6 7 8 9 10	If option A is chosen, move DOWN the table. If option B is chosen, move UP the table
2		30 if 1 2 3 4 5 -30 if 6 7 8 9 10	200 if 1 2 3 4 5 -150 if 6 7 8 9 10	

In each option, respondents were making choices between gains and losses. Also as done in the risk aversion series, more or less loss-averse decision-makers were identified based on the point at which they decided to switch from Option A to Option B. Participants were paid KES 100 with certainty, and won more money based on their responses gave the series (Love *et al.*, 2014)

2.8 Approaches used in determining the causal effect of new agricultural technologies on farmers' wellbeing

Evaluation of the impact of new agricultural technologies on farmers' welfare involves a comparison between before and after or with/treated/participants and without/controlled/non-participants. Before and after relies on time series or panel data while with/treated/participants and without/controlled/non-participants relies on single cross-sectional data. In this study, single cross-sectional data was used, and thus, the comparison between with/treated/participants and without/controlled/non-participants was performed. Many approaches have been proposed for use in evaluation in such scenarios. For instance, Endogenous Switching Regression that can control for unobservable selection bias and Randomized Control Trial (RCT) approach, which helps avoid selection bias because participants can be random, assigned to either control or treatment groups.

Difference-in-Difference (DID) approach requires data to be collected before and after the introduction of new technology and then fixed component is differenced out as an impact. Like the RCT approach, DID approach reduces selection bias (Shafiul *et al.,* 2009). Unlike DID, Propensity Score Matching (PSM) approach is applicable in situations of single cross-sectional data, and unlike experimental and DID cannot reduce selection bias. Use of a dummy variable and Ordinary Least Squares (OLS) regression can also be used in determining the impact of new agricultural technologies. However, this approach is likely to generate biased estimates. Heckman's two-step method, on the other hand, can reduce selection bias but depends on the restrictive assumption that the unobserved variables are normally distributed.

Heckman two-step, DID, and PSM is semi-parametric matching methods which do not require an assumption about the functional form specifying the relationship between outcomes and outcome predictors (Kassie *et al.,* 2010). PSM approach by Rosenbaum and Rubin (1983) is applicable in both situations of with and without and before and after, and both single cross-sectional and panel data can be used. The approach is easy to use, and it reduces selection bias (Mendola, 2007). The approach statistically compares participants and non-participants of new technologies to determine the direct causal impact of the new technology.

In the PSM approach, treated/participants/with is matched with non-treated/non-participants/without based on the probability to participate (propensity score) using observed characteristics. The Average Treatment effect on Treated (ATT) is then calculated. The disadvantage of the PSM approach is that it is only useful if the assumption that unobserved factors do not affect participation and the existence of common support across the participant and non-participant samples hold. Also, it requires a large data set to allow proper matching (Khandker *et al.,* 2009). Poverty measures of Sen (1976), Kakwani (1980) and Foster *et al.* (1984) are also commonly applied in the estimation of observable poverty of a given population. Unlike measures of Sen (1976) and Kakwani (1980), Foster *et al.* (1984) measures are additively decomposable. It identifies who is poor or not (poverty headcount measures), determines the extent of poverty (poverty gap measures) and the severity of poverty (squared poverty gap measures). Additively decomposable poverty measures are also useful in profiling the poverty status of sub-groups in a given population (Foster *et al.,* 1984).

Sen (1976) and Kakwani (1980) poverty measures are not additively decomposable because it combines both the poverty headcount and poverty gap, weighted by the Gini coefficient of the poor. That is, their measures identify the poor by considering the "relative position of the poor" in a given population (Kakwani, 1993). The study by Kakwani (1993) shows that the idea of "relative position of the poor" is not the ideal way of measuring poverty in developing countries because the majority of the population live below the poverty line. PSM approach was used on since single cross-sectional data (combining both certified and non-certified French beans farmers) to determine the impact of Global-GAP certification on welfare indicators.

2.9 Estimation of household vulnerability to future poverty

There are three methods of estimating household vulnerability to poverty: Vulnerability as Expected Poverty (VEP) approach, Vulnerability as low Expected Utility (VEU) approach and Vulnerability as uninsured Exposure to Risk (VER) approach (Chaudhuri *et al.*, 2002). VEP and VEU approaches determine the probability of a household falling below a predetermined poverty line while VER approach does not construct probabilities. Also, VEP and VEU approach measure vulnerability to future poverty at an individual or household level, and it is possible to aggregate the individual measures of vulnerability to a single measure. VEP approach predicts the future impacts of shocks while VER approach evaluates the current impacts of shocks. Cross-sectional data can be used in VEP, and VEU approaches, while VER approach requires time series or panel data (Hoddinott and Quisumbing, 2008). Since cross-sectional data were used in this study, the VEP approach was adopted. See sub-section 3.5.4 for more details.

CHAPTER THREE
RESEARCH METHODOLOGY

1.1.1.11 Overview of the chapter coverage

This chapter presents an overview of the study area, research design, sample size and sampling procedure, data collection and analysis, analytical techniques, research ethics and validity and reliability of data collection instrument.

1.1.1.12 Study area

The study was carried out in Kirinyaga County because of the importance of French beans in the farming systems and the implementation of Global-GAP standards between the French beans farmers in the County. Kirinyaga County is located at the foot of Mount Kenya, and it covers an area estimated to be 1479.09 square KMs[10]. According to Economic Survey (2009), the County is located approximately 120 Kilometres North West of Nairobi and has a total population of 153,095. The County has five Sub-Counties namely: Kirinyaga Central, Kirinyaga East, Kirinyaga West, Mwea East, and Mwea West. French beans are mainly produced under irrigation and rain-fed. The County borders Embu, Machakos, Murang'a, and Nyeri Counties.

Kirinyaga County hosts the largest rice irrigation scheme in Kenya (The Mwea irrigation scheme). The scheme produces at least 50 percent of all rice in Kenya. The major economic activity in the County is Agriculture. At least 70 percent of the farmers are small scale, and the rest are executives and women. Horticulture (French beans, onions, tomato, snow peas, avocado, mango, and pawpaw), rice, coffee, bananas, tea, dairy, maize, and beans are the major farming activities. The County has a total population of 528,054 people. The County receives rainfall of approximately 1250mm per annum while temperature ranges between 12 °C and 26 °C per annum[11]. The map of the study area is shown in Figure 2.

[10] See www.kenya-information-guide.com/kirinyaga-county.html.

[11] See www.kenya-information-guide.com/kirinyaga-county.html.

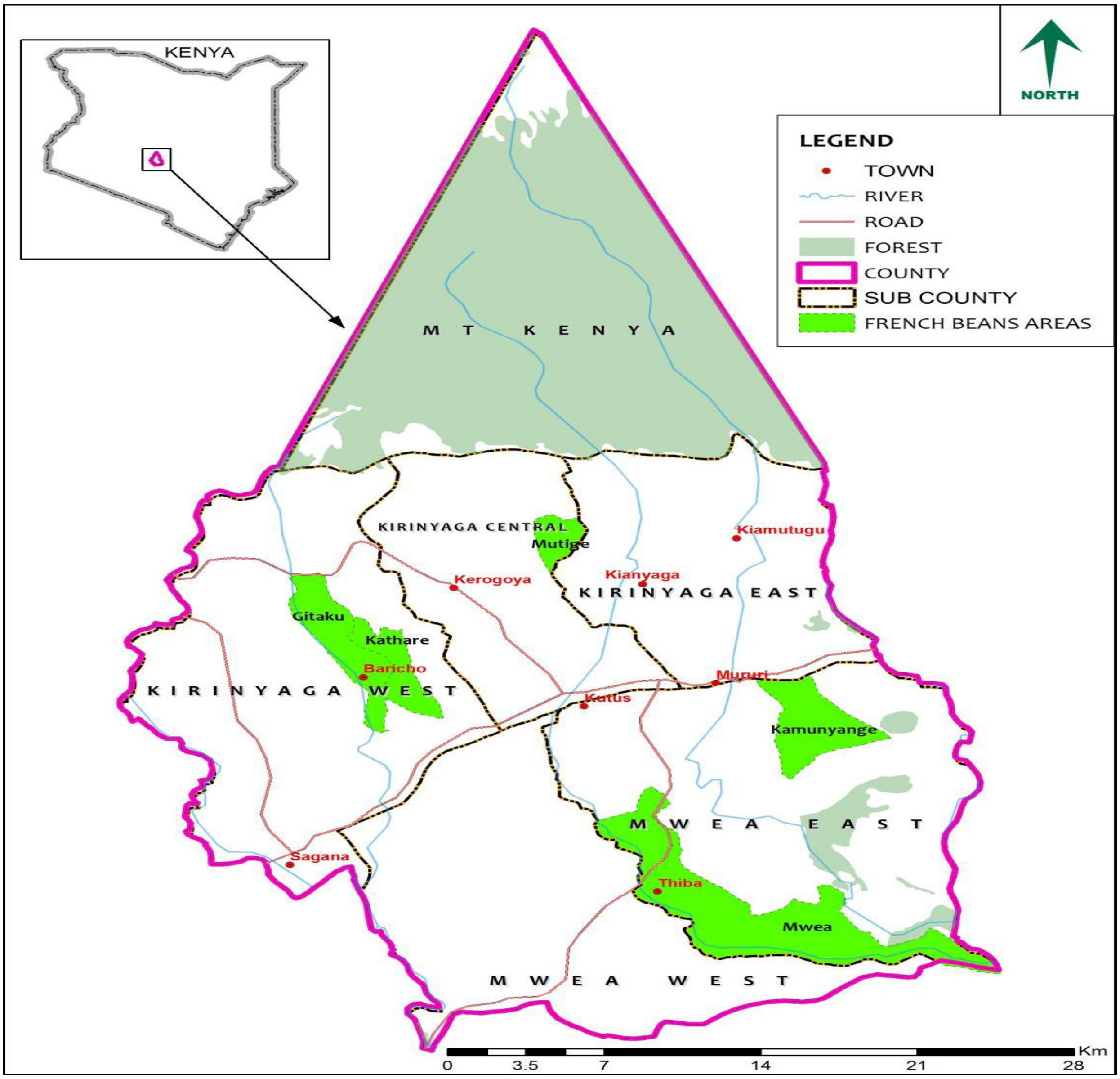

Figure 1: Map showing French beans growing areas in Kirinyaga County[12]

1.1.1.13 Preliminary study

Site pre-visits to the study area were conducted to familiarise with the area before the actual study was conducted. The other objective was to map and identify areas of actual. Several meetings were held. The first meeting was between County and Sub-County Agricultural Officers. The officers then organized a series of meetings with village elders and farmer groups.

[12] See www.google.com/search?q=WRI,+DIVA-GIS+and+ILRI&tbm=isch&source

1.1.1.14 Research design

Since the study was a survey involving the collection and analysis of data, the descriptive research design was applied. This is because according to Mugenda (2003) descriptive research design is a scientific method of investigation in which data is collected and analyzed to describe the current circumstances and relationships concerning a certain specific field problem.

1.1.1.15 Sample size and sampling procedure

1.1.1.16 Sampling procedure

The study adopted a multistage sampling procedure in the selection of respondents. Within Kirinyaga County, Kirinyaga Central, Kirinyaga East, Kirinyaga West, Mwea East, and Mwea West Sub-Counties were purposively selected because this is where French beans are mainly produced. Mutige in Kirinyaga Central, Gitaku, and Kathare in Kirinyaga West and Kamunyange and Mwea in Mwea East were randomly selected. French beans farmers in each area were then stratified into two groups: Global-GAP certified and non-certified. Sampling frames for the certified and non-certified French beans farmers were generated with the help of village elders, French beans farmer's group leaders, County Agricultural extension officers. The study applied a systematic random sampling procedure to select the certified and non-certified French beans farmers from the sampling frames. Both certified and non-certified French beans farmers were selected proportionately depending on the respective generated sampling frames to give a total sample size of 492 respondents. All five Sub-counties were sampled proportionately based on the certification status of the French beans farmers.

1.1.1.17 Sample size

Lists containing French beans farmer's certification details were obtained from Kirinyaga County Agricultural Office, farmer groups and exporters of French beans contracting farmers. The lists were then used to generate a sampling frame of 1,943 certified and non-certified farmers. The formula by Krejcie and Morgan (1970) was then used to determine the sample size. Mathematically, the formula is given as:

$$s = \frac{\chi^2 N P_P (1 - P_P)}{d^2 (N - 1) + \chi^2 P_P (1 - P_P)} \qquad (3.1)$$

where s is the required sample size, χ^2 is the table value of Chi-square with a 1 degree of freedom at the desired confidence level (1.96 × 1.96 = 3.84), N is the population size, P_P is the proportion of sample size to population size, and d is the degree of accuracy expressed as a proportion (0.05). Using the formula, sample size corresponding to N = 1,943 is 322. However, due to the need to increase accuracy of the results, the sample size was increased to 492. The systematic random sampling procedure was used to select the 492 respondents (certified and non-certified) from the sampling frame. The sample size was drawn in such a way that all the Sub-Counties (Kirinyaga Central, Kirinyaga West, Mwea East, Mwea East, and Mwea West) were represented proportionately. A sub-sample of 119 respondents (comprising of 69 and 50 certified and non-certified French beans farmers respectively) were drawn from the overall sample size of 492 respondents using systematic random sampling procedure and subjected to social experiment (lottery games) to solicit the risk attitudes. All the four Sub-counties: Kirinyaga Central and East, and Mwea East and West) were represented in the selection of both the certified and non-certified farmers.

1.1.1.18 Data collection and analysis

1.1.1.19 Data collection

Single cross-sectional data was used. The data was collected using structured and semi-structured questionnaire (Appendix A8). Enumerators were recruited to collect the data. Data on incomes, consumption expenditures, and household socio-economic, psychological, and institutional characteristics were collected.

1.1.1.20 Data analysis

SPSS and STATA computer programs were used in data analysis. Results were presented in the form of tables and graphs. Chi-square (χ^2) and *t*-test values were used to test if certified and non-certified French beans farmers defer on the socio-economic, institutional, and psychological characteristics before discussions of the results.

1.1.1.21 Analytical techniques

1.1.1.22 Effect of risk preferences on Global-GAP certification decisions among French beans farmers

Risk preferences of French bean farmers were solicited using a 5-point Likert scale and social experiment (Lottery games).

1.1.1.23 The 5-point Likert scale

Respondents were asked to assess themselves in terms of whether they preferred taking risks or not using the following Likert scale:

1. "I never like take risks"
2. "In most cases I don't like take risks"
3. "I sometimes like take risks"
4. "In most cases I like take risks"
5. "I always like take risks"

1.1.1.24 Experimental approach

Lottery games involving real pay-offs (See sub-section 2.6.2 and appendix A1 and A8 for more details) were used. From these lottery games, the coefficient of risk aversion, loss aversion, and non-linear probability weighting was estimated at switching point of each respondent using the utility function outlined in Tanaka *et al.* (2010). Mathematically this is given as[13]:

$$U(x, \text{Prob}; y, q) = \begin{cases} v(y) + w(\text{Prob})(v(x) - v(y)) & x > y > 0 \;\; or \;\; x < y < 0 \\ w(\text{Prob})v(x) + w(q)v(y) & x < 0 < y \end{cases} \tag{3.2}$$

$$v(x) = \begin{cases} x^{1-\sigma} & for \quad x > 0 \\ -\lambda(-x)^{1-\sigma} & for \quad x < 0 \end{cases} \tag{3.3}$$

$$w(\text{Prob}) = \exp[-(-\ln \text{Prob})^{\alpha}] \tag{3.4}$$

[13] Refer to section 2.7 for the defition of symbols used in equation 3.2, 3.3 and 3.4.

Experiments similar to those of Binswanger (1980) and Holt and Laury (2002) were used. Experiment procedures used in the study were adopted and modified from Adoption Pathways Project of 2013, implemented by International Maize and Wheat Improvement Centre (CIMMYT) and Egerton University (CIMMYT, 2013).

1.1.1.25 Estimation of the effect of risk preferences on Global-GAP certification decisions

French beans farmers' Global-GAP certification decisions are binary. Factors influencing binary decisions can be estimated using binary Logit or Probit model. Both models are based on the random utility model and yield similar results (Gujarati, 2004). Nonetheless, binary Logit assumes that error terms are logistically distributed while binary Probit assumes a normally distributed error terms (Greene, 2003; Gujarati, 2004; Nyota, 2011). Ordinary Least Squares (OLS) regression is unsuitable because the endogenous variable is discrete, and the fact that the non-linear relationship is expected exists between the endogenous and exogenous variables. Use of OLS, therefore, might result in inefficient estimates and heteroscedasticity (Gujarati, 2004). Multinomial Logit (MNL) model is also unsuitable since its endogenous variable takes more than two categories (Greene, 2003; Gujarati, 2004).

In this study, binary Logit regression was used instead of binary Probit because of its simplicity. The model applies maximum likelihood estimation after transforming the dependent variable into a Logit variable. A vector of Logit coefficients correspond to beta ($\boldsymbol{\beta}$) coefficients in the logistic regression equation, and a pseudo R^2 statistic summarises the strength of the relationship between the exogenous and endogenous variables. Normally, rational decision-makers are expected to choose an alternative that maximises their utility or profit when faced with many alternatives. The alternative chosen depends on both the non-error term component of the utilities and the values of the error terms associated with the utilities of the decision maker (Nyota, 2011). In this study, it was assumed that French beans farmer *i* make decision *j* from a bundle of decisions available (ST_n)[14] to maximise utility level $U(ST_{ij})$ subject to a vector of his/her socio-economic, institutional, household preferences, farm and technology constraints ($\mathbf{X}_i$). The random utility model for the French beans farmer *i* is given as:

[14] Bundle of decisions available to French beans farmers are either to comply with Global-GAP standards (ST_1) or not (ST_0)

$$U(ST_{ij}) = \mathbf{X}_{ij}\boldsymbol{\beta}_j + e_{ij} \tag{3.5}$$

where *i* denotes individual French bean farmer, *j* refers to alternative decisions facing the farmers *i*, and $U(ST_{ij})$ is an underlying unobserved/latent variable which denotes the level of indirect utility derived by farmer *i* associated with the j^{th} decision.

The unobservable variable is related to the actual/observed decision of the farmer. The observed variables are defined as: $U(ST_i) = 1$ *if* $U(ST_i{*}) = \max\ (U(ST_1{*})\ ,\ U(ST_2{*})\ ,\ \ldots.,\ U(ST_m{*}))$ and $U(ST_i) = 0$ otherwise (Nyota, 2011). Assuming there are no ties, then:

$$U(ST_i^{*}) = \mathbf{X}_i\boldsymbol{\beta}_j + \varepsilon_i \tag{3.6}$$

where $\mathbf{X}_i$ represents a vector of household charactersistics (socio-economic and institutional factors, household preferences, and technology and farm characteristics) influencing Global-GAP compliance decision of French beans farmer *i*, $\boldsymbol{\beta}_j$ indicate a vector of parameters estimated while ε_i is the error term that captured unobserved variations in French beans farmers' perceptions, choices, and attributes of the alternative choices. Functionally, the binary Logistic regression model is given as:

$$E(U(ST_i) \mid \mathbf{X}_i) = F(\beta' \mathbf{X}_i) = \frac{e^{\boldsymbol{\beta}'\mathrm{X}_i}}{1 + e^{\boldsymbol{\beta}'\mathrm{X}_i}} \tag{3.7}$$

If the residuals are independent and identically distributed with a cumulative distribution function given as $F(\varepsilon_i < E) = \exp(-e - E)$ and whose probability density function is $F(\varepsilon_j) = \exp(-\exp(-\varepsilon_{i,j}))$, an analytical solution exists, and the probability of a given choice alternative for the i^{th} French bean is given as:

$$\text{Prob(Certified} = 1) = \frac{\exp(\mathbf{X}'_{ij}\boldsymbol{\beta}_j)}{1 + \sum_k \exp(\mathbf{X}'_{ik}\boldsymbol{\beta}_j)}, k = i, \ldots., j \tag{3.8}$$

where Prob(Certified = 1) denotes the probability of French beans farmer being certified, $\mathbf{X}_i$ is a vector of the exogenous variables while $\boldsymbol{\beta}_j$ is avector of the parameters/coefficients of the exogenous variables estimated using maximum likelihood method. Binary logistic regression can yield either the odds ratio or marginal coefficients. Odds ratios are interpreted such that a unit change in an exogenous variable leads to changes in the probability of complying with Global-GAP standards by a factor of exp β**.** On the other hand, marginal coefficients indicate the effect of each exogenous variable on the probability to comply with Global-GAP standards, *ceteris paribus,* and are interpreted as typical beta coefficients in a linear regression model (Nyota, 2011). In this study, marginal probabilities were used because of their ease in interpretation. The empirical model is given as shown in equation 3.9.

$$\text{Prob(Certified} = 1) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + ... + \beta_n X_n + e_i \quad (3.9)$$

Table 4 shows a description of the variables used in the binary Logit model.

Table 4: Description of variables used in Binary Logit Model

Variable name	**Variable label**	**Variable code**	**Expected sign**
Global-GAP certification decisions	ST_i	Dummy (Certified = 1, otherwisw = 0)	None
Alpha (α)	X_1	Numbers	-/+
Sigma (σ)	X_2	Numbers	-/+
Lambda (λ)	X_3	Numbers	-/+
Access to irrigation	X_4	Dummy (Yes = 1, otherwise = 0)	+
Net French beans income	X_5	KES	+
Group membership	X_6	Dummy (Yes = 1, otherwise = 0)	+
Household size	X_7	Numbers	+/-
Distance to the nearest French beans market	X_8	Kilometers	+/-
Years of experience in farming	X_9	Number of years	+
The education level of HH	X_{10}	Categorical	+
Contract agreements	X_{11}	Dummy (Yes = 1, otherwise = 0)	+

Daily household income per adult equivalent	X_{12}	KES	+
Marital status of HH	X_{13}	Categorical	+/-
Cost of French beans production	X_{14}	KES	-
Number of times of access to extension services	X_{15}	Number of times	+
Land size under French beans	X_{16}	Acres	+
Daily household expenditure per adult equivalent	X_{17}	KES	+/-
Total asset value	X_{18}	KES	+/-

Notes: KES means Kenyan Shillings, HH means household head, and (+/-) indicates a positive or negative relationship with the dependent variable.

Empirically, the model was determined, as indicated in equation 3.10:

$$\text{Prob(Certified} = 1) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \beta_{12} X_{12} + \beta_{13} X_{13} + \beta_{14} X_{14} + \beta_{15} X_{15} + + \beta_{16} X_{16} + + \beta_{17} X_{17} + + \beta_{18} X_{18} + e_i \tag{3.10}$$

1.1.1.26 The causal effect of Global-GAP compliance on French bean farmer's welfare indicators and observed poverty

1.1.1.27 Determination of adult equivalent values

There are many ways of determining Adult Equivalent Values (AEV). They include the World Health Organization (WHO) adult equivalent conversion factors (Table 5), Organisation for Economic Co-operation and Development (OECD) method, and Harold Watts's approach. WHO approach considers the effect of household gender, age, and size in the determination of adult equivalent values per household. Men are given higher weights than women while children and the old are given lower weights (OECD, 2008 and 2011).

Table 5: World Health Organization adult equivalent conversion factors

Age (years)	Males	Females
Under 1	0.33	0.33
1-1.99	0.46	0.46
2-2.99	0.54	0.54
3-4.99	0.62	0.62
5-6.99	0.74	0.70
7-9,99	0.84	0.72
10-11.99	0.88	0.78
12-13.99	0.96	0.84
14-15.99	1.06	0.86
16-17.99	1.14	0.86
18-29.99	1.04	0.80
30-59.99	1.00	0.82
60 and over	0.84	0.74

Source: Muyanga *et al.* (2007)

Under Organisation for Economic Co-operation and Development (OECD) approach, which is also called "Oxford scale", equivalence scales are determined as follows: First adult (which is commonly the household head) is given value equal to 1.00, any other adult (for this case any person having age equal or more than 18 years) is given value equal to 0.70. Each child (in this case, any household member having age greater than 0 and equal or less than 17 years) is given value equal to 0.50 (OECD, 2008 and 2011). In Watts' approach, adult equivalent values are determined by getting the square root of household size. Household income, within a given period, is then divided by the square root of household size to get per adult income equivalent (OECD, 2008 and 2011). When the three approaches are compared, OECD scales display much smaller economies of scale than Watts' approach. On the other hand, the composition of the family is accounted in OECD scales but not in Watts' approach. The Watts method is concerned with the scale effects of larger family sizes (OECD, 2008 and 2011). Mathematically, Watts approach is expressed as:

$$AEVs = (A + K)^{0.50} \quad (3.11)$$

where A and K denotes the number of adults and children in the family, respectively while the power 0.50 is the economies of scale elasticity. As denoted by the scale elasticity, Watts' approach assumes that both children and adults have equal needs. It also assumes that an increase in household size will not affect household needs. This is not true in reality because as household size increases, economies of scale are achieved. Also, the needs of children and adults are never the same. Questions have been raised concerning the basis in which scale elasticity of 0.50 is arrived at. OECD approach, on the other hand, ignores the economies of scale but addresses the problem of Watts' approach where children needs are equated to adult needs by converting every member of the family into its adult equivalence. Mathematically, the OECD approach is expreesed as:

$$AEVs = (1.0 + 0.70*(A-1) + 0.50*K)^{1.00} \quad (3.12)$$

where A and K are as defined in equation 3.11. However, the economies of scale elasticity in this approach are equal to 1.00, which indicate that the OECD approach does not take into account economies of scale. The interpretation of the approach is that an individual in the household is given value equal to 1, and any additional adult represent 70 percent of the needs of the first adult. Children's needs are 50 percent of the needs of an adult. Questions have also been raised on this OECD approach on the basis in which the adult equivalent values assigned to the adults and children in a household were generated. This is because there are not adequate empirical studies to support the same (OECD, 2008, and 2011). Watts' and OECD approaches are simple to implement but faced with serious shortcomings as discussed above.

In this study, therefore, WHO approach, as outlined in Muyanga *et al.* (2007) was used because, relative to Watts' and OECD approaches, it is multidimensional in the determination of AEVs. It considers not only the economies of scale (household size) but also gender and age issues. In this study, AEVs was determined using the WHO approach. Following Kirimi *et al.* (2013), household income, household expenditure, and asset values of French beans farmers were computed per annum, monthly and daily. Daily household income and expenditure of each household was then divided by the AEVs from the WHO approach to get daily income and expenditure per adult equivalent. Asset value per adult equivalent was determined by dividing total annual asset value by adult equivalent values generated from the WHO approach.

1.1.1.28 Poverty line used

The rural income poverty line of KES 1,562 per month per adult equivalent generated by the Kenya National Bureau of Statistics was last updated in 2006 (Kenya National Bureau of Statistics, 2007). The poverty line has been widely applied in many studies, including Kirimi *et al.* (2013). The latest survey launched by Kenya National Bureau of Statistics (KNBS) to update the poverty line was launched in 2015, and that was after the collection of household survey data for this study. The first international poverty line was developed by Ravallion *et al.* (1991) in 1985 and was set at $1.01.

This poverty line was later updated to $1.08 per adult equivalent per day by Chien and Ravallion (2001). Ravallion and Shaohua (2009) further updated to $1.25 per adult equivalent per day. Because of the increasing cost of living in developing nations due to inflation, it makes poverty lines of KES 1,562 and $1.25 less effective. World Bank has been using $1.25 poverty line from 2009 to 2014 when Narayan *et al.* (2015) updated it again to $1.90. This new poverty line is highly recommended for poverty estimations, especially in developing countries. This is because it was partly generated from data collected in African nations (Narayan *et al.*, 2015). Given that, Kenya is a developing country and the fact that few studies have applied the new poverty line, it was imperative to embrace in this study. Certified and non-certified French beans farmers were categorized as poor if their daily income per adult equivalent fall below KES 193.56 ($1.90 at the exchange rate of KES 101.87 per dollar during data collection period) poverty line and non-poor if equal or fall above the poverty line.

1.1.1.29 The causal effect of Global-GAP standards on observed poverty using Foster Greer and Thorbeke (FGT, 1984) measures of poverty

In this study, FGT measures of poverty were used because their values are easy to interpret and the fact that it is possible to tell the extent and significance of poverty in a given population. Specification of FGT measure of poverty is given as:

$$PI_i = \frac{1}{n}\sum_{t=1}^{q}\left(1-\frac{Y_i}{z}\right)^{\alpha} \tag{3.13}$$

where n is the sample size of both certified and non-certified vegetable farmers, Y_i is the per capita income of the i^{th} French bean farmer, z is poverty line of KES 193.56 ($1.90 at the exchange rate of KES 101.87 per dollar), q represents the number of poor French beans farmers (those lives below the poverty line), PI_i is the poverty index, and α is the poverty aversion variable which takes value of 0, 1 and 2 to denote headcount ratio, extent of poverty, and severity of poverty respectively (Foster *et al.*, 1984).

The headcount index (PI_0) measures the proportion of the population that is poor. It is a popular measure because it is easy to understand and measure. However, it does not indicate how poor the poor are. Functionally, this is given as:

$$PI_0 = \frac{1}{n}\sum_{t=1}^{q}\left(1-\frac{Y_i}{z}\right)^0 \tag{3.14}$$

which is equivalent to:

$$PI_0 = \frac{1}{n} \tag{3.15}$$

The poverty gap index (PI_1) measures the extent to which individuals fall below the poverty line (the poverty gaps) as a proportion of the poverty line. The sum of these poverty gaps gives the minimum cost of eliminating poverty if transfers were perfectly targeted. Nonetheless, the measure does not reflect changes in inequality among the poor.

$$PI_1 = \frac{1}{n}\sum_{t=1}^{q}\left(1-\frac{Y_i}{z}\right)^1 \tag{3.16}$$

The poverty severity index (PI_2) average the squares of the poverty gaps relative to the poverty line. Mathematically this is given as:

$$PI_2 = \frac{1}{n}\sum_{t=1}^{q}\left(1-\frac{Y_i}{z}\right)^2 \tag{3.17}$$

Several studies have applied this approach, including Ajijola *et al.* (2011) in the study of rural farmers in Nigeria. They found poverty headcount (PI_0), depth (PI_1), and severity (PI_2) to be 0.40, 0.811, and 0.0510, respectively. Ghartey *et al.* (2014) also applied among cassava farmers in Ghana and found poverty headcount and depth to be 0.58 and 0.31, respectively.

1.1.1.30 The causal effect of Global-GAP standards on welfare indicators using Propensity Score Matching (PSM) approach

The study assumed that a rational French beans farmer would decide to comply with Global-GAP standards if his/her expected net returns $U(ST_1)$ exceeded returns for the case of non-compliance $U(ST_0)$. Mathematically this is given as:

$$U(ST_1) - U(ST_0) > 0 \tag{3.18}$$

The difference between the utility with and without certification may be denoted as a latent variable $U(ST_i)^*$ such that $U(ST_1)^* > 0$ indicates that the returns from Global-GAP certification are greater than the returns from non-certification. $U(ST_i)^*$ is unobservable but can be expressed as a function of the observed characteristics $\mathbf{Z}_i$ in a latent variable model such that:

$$U(ST_i)^* = \boldsymbol{\beta}_i \mathbf{Z}_i + \mu_i \tag{3.19}$$

$$U(ST_i) = \begin{cases} 1 if \ \ U(ST_i) > 0 \\ 0, \text{otherwise} \end{cases} \tag{3.20}$$

where $U(ST_i)$ is a binary indicator such that utility derived by Global-GAP certified French bean farmer = 1 and non-certified = 0, $\boldsymbol{\beta}_i$ is a vector of the parameters estimated, $\mathbf{Z}_i$ is a vector of observable socio-economic and institutional characteristics of French beans farmer *i*, and μ_i is the error term, which was assumed to be normally distributed. The probability of certification (Prob(Certified = 1)) by a French bean farmer based on observable characteristics can then be estimated using either a binary Probit or a model as:

$$\text{Prob(Certified = 1)} = \text{Prob}(ST^*_i > 0) = \text{Prob}(\mu_i > -\boldsymbol{\beta}_i \mathbf{Z}_i) = 1 - F(-\boldsymbol{\beta}_i \mathbf{Z}_i) \tag{3.21}$$

where F is the cumulative distribution function for μ_i, which is commonly assumed normally distributed in the Probit model or extreme value distributed in the Logit model. PSM approach statistically compares participants and non-participants of new technologies to determine the direct causal impact of the new technology. Participants are matched with non-participants based on the probability to participate (propensity score) using observed characteristics (Rosenbaum and Rubin, 1983). There are two major versions of aggregated treatment effects in PSM. First is the average treatment effect (ATE) which is the average effect that would be observed if everyone in the treated and the control groups received treatment, compared with if no one in both groups received treatment. Secondly is the average treatment effect on the treated group (ATT) which is the average difference that would be found if everyone in the treated group received treatment compared with if none of these individuals in the treated group received treatment (Harder *et al.*, 2010).

Many studies have utilized the PSM approach in the study of the impacts of new agricultural technologies on farmers' poverty levels. For instance, Becerril and Abdulai (2010) utilized a PSM approach to estimate the impact of improved maize varieties on farmers' poverty in Mexico. Mendola (2007) used the same approach to estimate the impacts of adopting agricultural technologies on poverty reduction among farmers in Bangladesh. In Ethiopian highlands, the same approach was used to the effect of adopting soil conservation on farmers' returns (Kassie *et al.*, 2010).

Mathematically, the PSM model is derived as follows: Let ST_i denote a dummy variable such that $ST_i = 1$ if the i^{th} French beans farmers are certified and $ST_i = 0$ otherwise. Similarly, let W_{1i} and W_{0i} denote potential observed welfare outcomes for Global-GAP certified and non-certified French beans farmers respectively so that $\Delta = W_{1i} - W_{0i}$, where Δ denotes the impact of the Global-GAP certification on the i^{th} French beans farmer welfare. Since: $W_i = ST_i W_{1i} + (1-ST_i) W_{0i}$ is observable rather than W_{1i} and W_{0i} for the same French beans farmer, it is not possible to compute the impact of Global-GAP certification for every French bean farmer. In this study, the Average Treatment Effect on the Treated was estimated. PSM estimation process involves two major steps. In the first step, the study followed methodology by Rosenbaum and Rubin (1983) whereby the propensity score was determined by using a standard Probit model such that certified = 1 and non-certified = 0. Mathematically, the propensity score is given as:

$$\text{Prob}(\mathbf{X}_i) = \text{Prob}(\text{Certified} = 1/\ \mathbf{X}_i) \tag{3.22}$$

where $\mathbf{X}_i$ denotes a vector of observable covariates (socio-economic, institutional and psychological factors) used in the determination of the propensity scores while $\text{Prob}(\mathbf{X}_i)$ is the probability of participation in Global-GAP certification given participants' characteristics $\mathbf{X}_i$. All the other variables are as defined above. Given the assumption that $W_{1i}, W_{0i}\ \pi\ ST/\ \mathbf{X}_i$, potential impacts of Global-GAP certification on French beans farmers welfare are independent of Global-GAP certification given $\mathbf{X}_i$. This further implies that:

$E\ (W_{1i}/ST_i = 1, \text{Prob}(\mathbf{X}_i)) = E\ (W_{0i}/ST_i = 0, \text{Prob}(\mathbf{X}_i))\ and\ 0 < \text{Prob}(\mathbf{X}_i) < 1$ (3.23)

For all $\mathbf{X}_i$, there is a positive probability of either adopting or not adopting Prob(ST_i). This guarantees every adopter a counterpart in the non-adopter population. Table 6 shows the description of variables estimated.

Table 6: Description of variables used in PSM selection stage

Variable name	**Variable label**	**Variable Code**	**Expected sign**
Dependent variable: Global-GAP certification decisions	ST_i	Dummy (Certified = 1, Otherwise = 0)	None
Age of HH	X_1	Years	+/-
Acreage under French beans	X_2	Acres	+/-
Access to donor support	X_3	Dummy (Yes =1, Otherwise = 0)	+
Education level of HH	X_4	Dummy (Yes =1, Otherwise = 0)	-
Membership to a group	X_5	Dummy (Yes =1, Otherwise = 0)	+
Total distance to the nearest market	X_6	Kilometers	+/-
Credit access	X_7	Dummy (Yes =1, Otherwise = 0)	+
Access to agricultural training	X_8	Dummy (Yes =1, Otherwise = 0)	+
Access to irrigation	X_9	Dummy (Yes =1, Otherwise = 0)	+
Gender of HH	X_{10}	Dummy (Male =1, Otherwise = 0)	+/-
In most cases don’t like taking risks	X_{11}	Dummy (Yes =1, Otherwise = 0)	-

Notes: HH means household head and (+/-) indicates a positive or negative relationship with the dependent variable.

Empirically, the model was determined as given in equation 3.24:

$$\text{Prob}\,(Certified = 1) = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + e_i \quad (3.24)$$

A number of matching algorithms were used. First, is the Nearest Neighbour Matching method whereby observations are randomly ordered, and the first treatment observation is matched with the first control group observation having the nearest propensity score. Secondly is the Caliber or Radius Matching method whereby a predefined propensity-score radius identifies all possible matches. Thirdly is the Stratification Matching Method, and fourth is the Kernel Matching method, which utilizes nearly all of the control group participants in creating a counterfactual. These methods numerically search for "neighbors" that have a propensity score for non-treated individuals that is very close to the propensity score of treated individuals. All methods should give similar results. Otherwise, trade-offs in terms of bias and efficiency are more likely with each algorithm (Mendola, 2007; Caliendo and Kopeinig, 2008; Becerril and Abdulai, 2010 and Kassie *et al.,* 2010).

The three matching algorithms were to determine the robustness of the results. French beans farmers' welfare was estimated using income and consumption expenditure such that an increase in income and household expenditure indicates increased welfare and vice versa (Chaudhuri, 2000 and 2003). In the second step, the Average Treatment Effect on Treated was determined as the average impact of Global-GAP certification on Certified French beans farmers' income, total household income, household expenditure, and asset value (Welfare indicators (W)). Mathematically this is given as:

$$\text{ATT} = E\,(W_{1i} - W_{0i} / \text{Certified} = 1) \qquad (3.25)$$

$$\text{ATT} = E\,[E\,(W_{1i} - W_{0i} / \text{Certified} = 1, \text{Prob}(\mathbf{X}_i))] \qquad (3.26)$$

$$\text{ATT} = E\,[E\,(W_{1i} / \text{Certified} = 1, \text{Prob}(\mathbf{X}_i)) - E\,(W_{0i} / \text{Otherwise} = 0, \text{Prob}(\mathbf{X}_i))] \qquad (3.27)$$

The soundness of the PSM approach depends on two assumptions: First, is the conditional independence (CIA) which states that given a set of observable covariates $\mathbf{X}_i$, the respective treatment outcomes W_{1i} and W_{0i} are independent of the actual participation status ST. The assumption permits the use of matched non-participants to measure how the participants would have performed had they not participated (Pan, 2014). Mathematically CIA is given as:

$$\text{Prob}(\mathbf{X}_i) = \text{Prob}(\text{Certified} = 1 \mid \mathbf{X}_i) = E\,(ST_i \mid \mathbf{X}_i);\ \text{Prob}(\mathbf{X}_i) = F\{h\,(\mathbf{X}_i)\} \qquad (3.28)$$

The second assumption is common to support, which ensures that every individual has a positive probability of either being a participant or a non-participant (Pan, 2014). According to Dehejia and Wahba (2002), when there is no random participation of individuals in a given technology a balancing score, which is a function of the observed characteristics ($\mathbf{X}_i$) of the individuals, is needed. According to Pan (2014), this is given as:

$$0< \text{Prob}(\text{Certified} = 1 \mid \mathbf{X}_i) <1 \qquad (3.29)$$

The balancing property ensures that the treatment and control observations are equal concerning the observable covariate set. Therefore, any chosen specification should satisfy the balancing property. Existing literature presents several ways to test the balancing property. According to Rosenbaum and Rubin (1983), one can check the differences in covariates between adopter and non-adopters before and after the procedure. Secondly, the propensity score can be re-estimated on the matched sample to verify if the pseudo R^2 after the matching is low. Thirdly, the likelihood ratio test can be done on the joint significance of all repressors, as suggested by Sianesi (2004).

The *pscore* in PSM estimates the propensity score based on a model specification and tests the balancing properties of the sample. The sample is split into equally spaced intervals of the propensity score. Propensity scores are then compared between treated and control observations within each interval to ensure that propensity scores do not differ. Additionally, *t*-tests were performed within each interval to ensure that the means of the covariate set do not differ between treatment and control observations. Blocks (*myblock*) identify propensity scores while common support option (*com*sup) ensures matching is done only on controls that are similar to treated group (Becker and Ichino, 2002; Vigani and Magrini, 2014).

The issue of selection bias may occur because of the failure of the common support condition, selection on unobservable, selection of a comprehensive set of covariates not related to treatment or outcome, and geographic mismatch among other factors (Heckman and Navarro-Lozano, 2004; Smith and Todd, 2005). To overcome the problem, the study ensured that, the independent variables used were not affected by the adoption of Global-GAP standards, as suggested in Caliendo and Kopeinig (2008). The study further ensured that the samples of certified and non-certified French beans farmers were drawn from the same region, which is Kirinyaga County, and the same questionnaire was used in all the respondents.

1.1.1.31 Effect of risk attitudes on observed poverty

French beans farmers' poverty status (PV_i) was captured as binary such that PV_i = 1 indicates not poor while PV_i = 0 indicates otherwise. Factors influencing binary dependent variable can be estimated using binary Logit or Probit model. Binary Logistic model, as outlined in Nyota (2011), was used to determine factors affecting poverty among French beans farmers. The study assumed that the probability of French beans farmer *i* being either poor or non-poor (PV_i) is subject to his/her socio-economic, institutional, and psychological characteristics ($\mathbf{X}_i$) as indicated in equation 3.30.

$$\text{Prob(Not poor} = 1) = \mathbf{X}_i \boldsymbol{\beta}_i + e_i \tag{3.30}$$

An underlying unobserved or latent variable (PV_i*) can be defined to denote the level of poverty and the unobservable variable is related to the characteristics $\mathbf{X}_i$ of the farmer. That is assuming there are no ties, then

$$PV_i{}^* = \mathbf{X}_i \boldsymbol{\beta}_i + e_i \tag{3.31}$$

where $\boldsymbol{\beta}$ is a vector of parameters estimated while e_i is the error term that captured unobserved variations in French beans farmers' poverty status. Functionally, this is given as:

$$E(PV_i \mid \mathbf{X}_i) = F(\boldsymbol{\beta}' \mathbf{X}_i) = \frac{e^{\boldsymbol{\beta}'\mathbf{X}_i}}{1 + e^{\boldsymbol{\beta}'\mathbf{X}_i}} \tag{3.32}$$

If the residuals are independent and identically distributed with a cumulative distribution function given as $F(e_i < E) = \exp(-e - E)$ and whose probability density function is $F(e_j) = \exp(-\exp(-e_{i,j}))$, an analytical solution exists, and the probability of a given choice alternative for the i^{th} French bean is given as:

$$\text{Prob(Not poor} = 1) = \frac{\exp(\mathbf{X}'_{ij} \boldsymbol{\beta}_j)}{1 + \sum_k \exp(\mathbf{X}'_{ik} \boldsymbol{\beta}_j)}, k = i, ..., j \tag{3.33}$$

where Prob(Not poor = 1) denotes the probability of French beans farmer *i* being poor, $\mathbf{X}_i$ *is* a vector of characteristics of farmer *i* while $\boldsymbol{\beta}_j$ is a vector of parameters of the exogenous variables estimated. The parameters were estimated using maximum likelihood (ML) method. Binary logistic regression can yield either the odds ratio or marginal coefficients. Odds ratios mean a unit change in an exogenous variable leads to changes in the probability of French beans farmer not being poor (Prob(Not poor = 1)) by a factor of exp β**.** On the other hand, marginal

Variable name	**Variable label**	**Variable code**	**Expected Sign**

coefficients indicate the effect of each exogenous variable on the probability of French beans farmer being poor, *ceteris paribus,* are interpreted as typical beta coefficients in a linear regression model (Nyota, 2011). Descriptions of these variables are summarized in Table 7**.**

Table 7: Description of variables estimated on observed poverty

Social characteristics			
Poverty status	PV_i	Dummy (Not poor = 1, Otherwise = 0)	None
Gender of HH	X_1	Dummy (Male = 1, Otherwise = 0)	+/-
Household size	X_2	Number of household members	+/-
Primary education level	X_3	Dummy (Primary = 1, Otherwise = 0)	-
Age of HH	X_4	Years	+/-
Secondary education level	X_5	Dummy (Secondary = 1, Otherwise = 0)	+/-
Psychological factors			
Never like take risks	X_6	Dummy (Yes = 1, Otherwise = 0	+/-
		Dummy (Yes = 1, Otherwise = 0)	
Always like take risks	X_7		
Institutional characteristics			
Global-GAP certification status	X_8	Dummy (Certified = 1, Otherwise = 0)	+
Credit access	X_9	Dummy (Yes = 1, Otherwise = 0)	+
Group membership	X_{10}	Dummy (Yes = 1, Otherwise = 0)	+
Economic characteristics			
Total annual asset value	X_{11}	KES	+
Net annual off-farm income	X_{12}	KES	+
Net annual French beans income per acre	X_{13}	KES	+
Total annual household income	X_{14}	KES	+
Total annual expenditure per adult equivalent	X_{15}	KES	+/-
Total land size owned	X_{16}	ACRES	+

Notes: KES means Kenyan Shillings, HH means household head, and (+/-) indicates a positive or negative relationship with the dependent variable.

According to Laduber *et al.* (2016), the slope of a logistic regression function tells how the log odds ratio in favor of not being poor changes as explanatory variables change. For instance, given that Prob(Not poor = 1) is the probability of not being poor then, (1 - Prob(Not poor = 1)) represents the probability of being poor. Mathematically this is given as:

$$1-\text{Prob(Not poor}=1)=1-\frac{e^{X_i}}{1+e^{X_i}}$$

$$=\frac{e^{-X_i}}{1+e^{-X_i}}$$

$$=\frac{1}{1+e^{X_i}} \tag{3.34}$$

Given the equations above, the odds ratio equation is given as:

$$\frac{\text{Prob(Not poor}=1)}{1-\text{Prob(Not poor}=1)}=\frac{1+e^{X_i}}{1+e^{-X_i}}=e^{X_i} \tag{3.35}$$

such that $\frac{\text{Prob(Not poor}=1)}{1-\text{Prob(Not poor}=1)}$ is the odds ratio in favor of Global-GAP compliance. That is the ratio of the probability that the farmer would comply with Global-GAP standards to the probability that the farmer will not comply with the standard. Empirically, the model was determined as:

$$\begin{aligned}\text{Prob (Not poor}=1)&=\alpha+\beta_1X_1+\beta_2X_2+\beta_3X_3+\beta_4X_4+\beta_5X_5+\beta_6X_6+\beta_7X_7+\beta_8X_8\\&+\beta_9X_9+\beta_{10}X_{10}+\beta_{11}X_{11}+\beta_{12}X_{12}+\beta_{13}X_{13}+\beta_{14}X_{14}+\beta_{15}X_{15}+\beta_{16}X_{16}+e_i\end{aligned} \tag{3.36}$$

Proper estimation of binary logistic regression depends on certain assumptions. First is the assumption that the dependent variable should be ordinal. Secondly is the linearity assumption, which states that independent variables should have a linear relationship with the dependent variable. Thirdly is the assumption of independent errors, which states that errors should not be correlated. The fourth and last assumption is that there should not be multicollinearity[15]. In chapter four, these assumptions are explained broadly to how they were addressed in the estimation of the binary logistic model.

1.1.1.32 The vulnerability of French beans farmers to expected poverty and its determinants

The relationship between uptake of Global-GAP standards and French bean farmers' vulnerability to future poverty was assessed using VEP approach, as originally proposed by Chaudhuri *et al.* (2002). It has also been widely used in many studies that include; Chaudhuri *et al.* (2002), Oni and Yusuf (2008), Kathage *et al.* (2012), and Megersa (2015). Total consumption expenditure per adult equivalent was used in the prediction of French bean farmer's vulnerability to poverty. VEP approach assumes that a household let say h in time t becoming vulnerable to future poverty is the probability (Prob) that the household is consumption poor in time $t + 1$ (Chaudhuri *et al.*, 2002) as given in equation 3.37.

$$V_{ht} = \text{Prob}(C_{h,\,t+1} \leq \forall) \tag{3.37}$$

where $C_{h,\,t+1}$ is the per-capita consumption of household h in time t+1, and $\forall$ is the consumption poverty line that is predetermined for benchmark purposes. There are two recommended consumption poverty lines namely: standard vulnerability to future poverty threshold of 0.5 (50 percent) and mean poverty rate of a given population (Hoddinott and Quisumbing, 2008), in which in this study it is given as KES 2900 per month. Consumption of household h at any period depends on factors such as current income, expected income, the uncertainty of future income, wealth and household's ability to smoothen consumption in the face of various shocks (Deaton, 1993). Such factors are assumed to depend on observable and unobservable household characteristics and the macro-environment in which household h operates in as given in equation 3.38.

$$C_{ht} = C(\mathbf{X}_{\boldsymbol{h}}, \boldsymbol{\beta}_{\boldsymbol{t}}, \alpha_h, e_{ht}) \tag{3.38}$$

where $\mathbf{X}_{\boldsymbol{h}}$ is a vector of observable characteristics for household h, $\boldsymbol{\beta}_{\boldsymbol{t}}$ represents a vector of parameters explaining the macro-economic environment at time t, α_h represents an unobserved

[15] See (www.restore.ac.uk/srme/www/fac/soc/wie/research-new/srme/modules/mod4/9/index.html).

time-invariant household-level effect and e_{ht} represents idiosyncratic shocks that contribute to differences among households in terms of wellbeing (Chaudhuri *et al.*, 2002). Equation 3.38 was substituted into equation 3.37 so that vulnerability level of household *h* can be obtained as:

$$\mathrm{V}_{ht} = \mathrm{Prob}(C_{h,t+1} = C(\mathbf{X}_{\boldsymbol{h}}, \boldsymbol{\beta}_{\boldsymbol{t}} + 1, \alpha_h, e_h, t+1) \leq \forall \mid \mathbf{X}_{\boldsymbol{h}}, \boldsymbol{\beta}_{\boldsymbol{t}}, \alpha_h, e_{ht}) \qquad (3.39)$$

Equation 3.39 indicates that the vulnerability level of household *h* depends on the changes that occur in consumption levels of the household *h* over time. The consumption levels of household *h* over time are determined by household characteristics and changes in the setting in which the household operate in (environment). Equation 3.39 further indicates that multicollinearity and the poverty trap is likely to occur. This is because; household's *h* vulnerability level is determined by the future consumption prospects, which is in turn influenced by current observed and unobserved household characteristics. Furthermore, aggregate shocks and changes in the macro-economic environment (as denoted by $\boldsymbol{\beta}_{\boldsymbol{t}}$) influence the vulnerability level of household *h* (Chaudhuri *et al.*, 2002). Since vulnerability of household *h* to expected poverty depends on its expected mean consumption and changes on its consumption stream over time, both the expected mean and variance of the household consumption level were estimated to determine vulnerability to poverty.

Nonetheless, this requires time series or panel data to allow direct estimation of the inter-temporal variance of consumption at the household-level without any assumption. Because of the unavailability of reliable time series data in developing countries (Chaudhuri *et al.*, 2002) developed a model that predicts a household's vulnerability to expected poverty using single cross-sectional data. However, for one to use such a model, strong assumptions need to be made on the stochastic process that generates consumption. Mathematically, the stochastic process generating the consumption of household *h* is given as:

$$\ln C_h = \mathbf{X}_{\boldsymbol{h}} \boldsymbol{\beta} + e_h \qquad (3.40)$$

where ln C_h is the log of per capita consumption expenditure of household *h*, $\mathbf{X}_{\boldsymbol{h}}$ represents a vector of observable characteristics of household *h*, $\boldsymbol{\beta}$ is a vector of parameters, and e_h is an error term (with mean-zero) that captures idiosyncratic shocks that explain the differences among households in terms of per capita consumption levels. Variables estimated on consumption expenditure are described in Table 8.

Table 8: Determinants of household per capita consumption expenditure

Variable name	Variable label	Variable code	Expected sign
Per capita consumption expenditure	C_i	KES	None
Asset value per adult equivalent	X_1	KES	+
Household size	X_2	Number of household members	+/-
Total off-farm income	X_3	KES	+
Net crop income	X_4	KES	+
Net livestock income	X_5	KES	+
Net French beans income	X_6	KES	+
Age of household head	X_7	Years	+/-
Credit access	X_8	Dummy (Yes = 1, Otherwise = 0)	+
Gender of HH	X_9	Dummy (Male = 1, Otherwise = 0)	+/-
Education level of HH	X_{10}	Number of years	+/-
Acreage under French beans	X_{11}	Acres	+/-
Risk preferences	X_{12}	Categorical	+/-
Group membership	X_{13}	Dummy (Yes = 1, Otherwise = 0)	+
Distance to the nearest market	X_{14}	Kilometers	+/-

Notes: KES means Kenyan Shillings, HH means household head, and (+/-) indicates a positive or negative relationship with the dependent variable.

Empirically, the model was determined, as indicated in equation 3.41:

$$C_i = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \beta_{12} X_{12} + \beta_{13} X_{13} + \beta_{14} X_{14} + e_i \quad (3.41)$$

According to Chaudhuri *et al.* (2002), the idiosyncratic shocks are assumed to be identical and independently distributed over time for each of the households. Equation 3.41 also shows that unobservable household-specific characteristic and macro-economic environment (β_i) are assumed to have no influence on the household's consumption level over time. Without time series data, it is not possible to identify parameters that determine individual consumption levels and the stochastic process generating β_i. In such cases, the variance of e_h and ln C_h is allowed to depend on observable household characteristics in some parametric way, thus.

$$\sigma^2_{e,h} = \mathbf{X_h}\,\theta \tag{3.42}$$

A three-step Feasible Generalized Least Squares (FGLS) was then used to estimate β and θ, a procedure outlined in Amemiya (1977). According to Chaudhuri *et al.* (2002), equation 3.40 was estimated first by the use of ordinary least squares (OLS) procedure. The resulting estimates were then used to estimate the following equation:

$$\hat{e}^2_{OLS,h} = \mathbf{X_h}\,\theta + \eta_h \tag{3.43}$$

Equation 3.43 was further transformed as:

$$\frac{\hat{\sigma}^2_{OLS,h}}{\mathbf{X_h}\,\hat{\theta}_{OLS}} = \left(\frac{\mathbf{X_h}}{\mathbf{X_h}\,\hat{\theta}_{OLS}}\right)\theta + \frac{\eta_h}{\mathbf{X_h}\,\hat{\theta}_{OLS}} \tag{3.44}$$

OLS procedure is then applied to obtain an asymptotically efficient FGLS estimate denoted as $\hat{\theta}_{FGLS}$. $\mathbf{X_h}\,\hat{\theta}_{FGLS}$ is a consistent estimate of the variance of the idiosyncratic component of household consumption $\sigma^2_{e,h}$. The variance was estimated as:

$$\hat{\sigma}_{e,h} = \sqrt{\mathbf{X_h}\,\hat{\theta}}_{FGLS} \tag{3.45}$$

The estimated variance was then used to transform equation 3.45 as:

$$\frac{\ln C_h}{\hat{\sigma}_{e,h}} = \left(\frac{\mathbf{X_h}}{\hat{\sigma}_{e,h}}\right)\boldsymbol{\beta} + \frac{e_h}{\hat{\sigma}_{e,h}} \tag{3.46}$$

Estimation of equation 3.42 using OLS procedure yields a consistent and asymptotically efficient estimates of $\boldsymbol{\beta}$ (vector of coefficients). The standard error of the estimated vector of coefficients $\hat{\boldsymbol{\beta}}_{FGLS}$ was then obtained by dividing the reported standard error by the standard error of the regression. Expected log consumption and variance of log consumption of each household were then directly estimated using a vector of $\boldsymbol{\beta}$ and θ estimates (Chaudhuri *et al.*, 2002) as:

$$\hat{E}[\ln C_h \mid \mathbf{X_h}] = \mathbf{X_h}\,\hat{\boldsymbol{\beta}} \qquad (3.47)$$

$$\hat{\mathrm{V}}[\ln C_h \mid \mathbf{X_h}] = \hat{\sigma}^2_{e,h} = \mathbf{X_h}\,\hat{\theta} \qquad (3.48)$$

It was assumed that ln C_h is normally distributed so that the estimates in equation 3.47 and 3.48 were used to form an estimate of the probability that household *h* with a vector of characteristics $\mathbf{X}$ will be poor in future given poverty line $\forall$ (Chaudhuri *et al.*, 2002). Expenditure poverty line of KES 2,900 per month was used in the analysis. Mathematically, vulnerability to expected poverty is given as.

$$\mathrm{V}_h = \hat{\mathrm{Prob}}(\ln C_h < \ln \forall \mid \mathbf{X_h}) = \phi\left(\frac{\ln \forall - \mathbf{X_h}\,\hat{\boldsymbol{\beta}}}{\sqrt{\mathbf{X_h}\,\hat{\theta}}}\right) \qquad (3.49)$$

such that ϕ represents the cumulative density of the standard normal. Variables estimated on the vulnerability of expected poverty are described in Table 9.

Table 9: Description of determinants of vulnerability to expected poverty

Variable name	**Variable label**	**Variable code**	**Expected sign**
Vulnerability of household to expected poverty	V_{hi}	Dummy (Vulnerable = 1, Otherwise = 0)	None
Never like take risks	X_1	Dummy (Yes = 1, Otherwise = 0)	-
In most cases don't like take risks	X_2	Dummy (Yes = 1, Otherwise = 0)	-
Sometimes like take risks	X_3	Dummy (Yes = 1, Otherwise = 0)	+/-
In most cases like take risks	X_4	Dummy (Yes = 1, Otherwise = 0)	+/-
Always like take risks	X_5	Dummy (Yes = 1, Otherwise = 0)	+/-
Certification status	X_6	Dummy (Certified = 1, Otherwise = 0)	+
Assets value PAE	X_7	KES	+/-
No education	X_8	Dummy (Yes = 1, Otherwise = 0)	-
Primary education	X_9	Dummy (Yes = 1, Otherwise = 0)	-
Secondary education	X_{10}	Dummy (Yes = 1, Otherwise = 0)	-
Tertiary education	X_{11}	Dummy (Yes = 1, Otherwise = 0)	+
Household size	X_{12}	Number of household members	+/-
Age of HH	X_{13}	Years	+/-
Gender of HH	X_{14}	Dummy (Male = 1, Otherwise = 0)	+/-
Group membership	X_{15}	Dummy (Yes = 1, Otherwise = 0)	+
Net livestock income	X_{16}	KES	+
Off-farm income	X_{17}	KES	+
Net crop income	X_{18}	KES	+
Distance to the market	X_{19}	Kilometers	+/-

Notes: KES means Kenyan Shillings, HH means household head, and (+/-) indicates a positive or negative relationship with the dependent variable.

Empirically, the model is given as:

$$V_{hi} = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \beta_{12} X_{12} + \beta_{13} X_{13} + \beta_{14} X_{14} + + \beta_{15} X_{15} + + \beta_{16} X_{16} + + \beta_{17} X_{17} + + \beta_{18} X_{18} + + \beta_{19} X_{19} + e_i \tag{3.50}$$

The estimated variance was assumed to equal for all households so that equation 3.40 is estimated using Ordinary Least Squares (OLS) to obtain an estimate of β and the standard deviation of e_h and ln C_h. The estimates were then used to determine the probability that household h with a vector of characteristics **X** will be poor in the future. Vulnerability to expected poverty for each household was determined by comparing V_{hi} values with standard vulnerability threshold of 0.5 such that any household with VEP value equal to or above 0.5 was considered vulnerable to future poverty and any household with a value below 0.5 was considered non-poor (Chaudhuri *et al.*, 2002).

1.1.1.33 Research Ethics

During the implementation of this study:

i. Rights and dignity of all respondents were respected.
ii. Bias in experimental design, data analysis, and interpretation was avoided.
iii. Data from respondents was handled with high confidentiality.
iv. Respondent's consent was sought before the interview/data collection.
v. The existing laws and rules governing data collection in Kenya were followed.
vi. Researcher promoted social good and prevented social harms through research.

1.1.1.34 Validity and reliability of data collection instrument

To validate and ensure the reliability of the questionnaire, field pre-visits were conducted. Supervisors before actual data collection also approved the questionnaire.

CHAPTER FOUR
RESULTS AND DISCUSSION

4.1 Overview of the chapter coverage

This chapter presents an overview of the effect of risk attitudes on Global-GAP certification decisions, the causal effect of Global-GAP standards on French beans farmer's welfare and observed poverty, the effect of risk attitudes, and other factors on welfare indicators and observed poverty among French beans farmers and French beans farmer's vulnerability to expected poverty.

4.2 Effect of risk attitudes on Global-GAP certification decisions

4.2.1 Descriptive statistics

Table 10 summarizes characteristics of 119 certified (N = 69) and non-certified (N = 50) French beans farmers. To facilitate comparisons and discussions, *t*-test was done to determine if the two categories of farmers were statistically and significantly similar based on their socio-economic, psychological, and institutional characteristics. The results indicate that Years of experience in farming was statistically significant ($p = 0.066$) with a mean difference of 1.32 years. This indicates that, on average, non-certified French beans farmers had 1.32 years of experience above the average age of certified farmers. The results established that majority of non-certified farmers have been in the farming of French beans for a relatively long time *vis-a-vis* certified ones. The total cost of producing French beans is highly significant ($p = 0.003$) with a mean difference of KES -5,060.25.

Table 10: Descriptive statistics of the respondents by Global-GAP certification status

	Global-GAP certification status (*ST_i*): Binary (Certified = 1 and Otherwise = 0)								
Variable	**Overall Sample (N = 119)**		**Non-Certified (N = 50)**		**Certified (N = 69)**				
	Mean	**S.D**	**Mean**	**S. D**	**Mean**	**S.D**	**MD**	***t* -value**	***p*-value**
Acreage under French beans	0.53	0.50	0.52 (0.06)	0.43	0.55 (0.07)	0.54	0.74	-0.34	0.554
Times of training attended	1.31	1.60	1.06 (0.24)	1.67	1.49 (0.18)	1.53	-0.43	-1.47	0.623
Total Land size owned (acres)	2.54	6.84	1.85 (0.22)	1.58	3.05 (1.07)	8.88	-1.20	-0.94	0.245
Household adult equivalent (WHO)	3.26	1.37	3.01 (0.18)	1.26	3.44 (0.17)	1.43	-0.43	-1.71	0.731
Household size	3.73	1.28	3.62 (0.20)	1.40	3.81 (0.14)	1.19	-0.19	-0.81	0.202
Total distance to French beans market	5.25	3.97	5.33 (0.67)	4.75	5.20 (0.40)	3.34	0.14	0.19	0.225
Years of experience in farming	14.09	11.10	14.86 (1.77)	12.49	13.54 (1.21)	10.04	1.32*	0.64	0.066

Age (Household head)	43.95	12.72	43.38 (1.95)	13.76	44.36 (1.44)	12.00	-0.98	-0.41	0.135
French beans total costs per acre	12421.09	12832.31	9487 (1043.36)	7377.69	14547.25 (1847.87)	15349.50	-5060.25***	-2.16	0.003
French beans net income per acre	35028.57	58507.05	29850.40 (4749.76)	33585.90	38780.87 (8591.54)	71366.70	-8930.47*	-0.82	0.089
Annual expenditure on non-food items	84367.50	86265.83	86263.22 (10941.34)	77367.00	82993.79 (11161.50)	92714.40	3269.43	0.20	0.855
Annual expenditure on food items	86578.04	96988.19	76506.68 (7913.26)	55955.20	93876.13 (14212.99)	118062.00	-17369.44**	-0.96	0.028
Total annual expenditure	170945.54	130714.32	162769.90 (13442.75)	95054.60	176869.91 (18278.87)	151836.00	-14100.01	-0.58	0.206
Net annual income	199473.61	319167.05	197107.60 (48835.38)	345318.00	201188.12 (36283.27)	301391.00	-4080.52	-0.07	0.757
Total annual asset value	2082670.03	2529007.17	2147845 426039.83)	3012557.00	2035441.78 (256894.65)	2133927.00	-112403.22*	0.24	0.076
Income per adult per day (WHO)	201.98	423.59	230.36 (80.44)	568.81.00	181.42 (33.45)	277.85	48.94	0.62	0.411
Annual asset value per adult	712046.47	941349.56	827943.57 (177221.99)	1253149.00	628063.07 (75092.18)	623763.00	-199880.50***	1.15	0.002

(WHO)									
Daily food expenditure per adult (WHO)	87.41	98.29	88.71 (11.73)	82.9589.00	86.47 (13.079)	108.64	2.24825.00	0.12	0.406
Daily total expenditure per adult (WHO)	165.26	142.58	175.69 (21.34)	150.90	157.70 (16.48)	136.86	18.00	0.68	0.818

Notes: Figures in parentheses are standard errors of means, S.D means Standard Deviation, MD means Mean Difference, and WHO means adult equivalent determination approach recommended by the World Health Organization (Muyanga *et al.*, 2007).

***$p < 0.01$, ** $p < 0.05$, *$p < 0.1$.

On average, certified French beans farmer incurred KES 5,060.25 per acre above what non-certified farmer incurred. Global-GAP compliance and certification processes are costly and inflate the cost of producing French beans. Net income from French beans per acre is also statistically significant at (p = 0.089) with a mean difference of KES -8,930.47 per acre. This indicates that each certified French beans farmer earned a net income of KES 8,930.47 per acre above what non-certified farmer earned from the same unit of land. The results suggest that the decision to comply with the Global-GAP standards in French beans production is a marginally profitable venture.

Expenditure on food is statistically significant (p = 0.028) with a mean difference of KES -17,369.44 per household per annum. The results indicate that certified French beans farmers spent on average KES 17,369.44 above what non-certified farmers spent per annum per household on food items. The results suggest that French beans farmer’s decisions to comply with Global-GAP standards significantly and positively influence household income and expenditure on food items. Table 10 further indicates that on average, certified French beans farmers had total asset value per annum than non-certified farmers as indicated by p = 0.076 and mean difference of KES -112,403.22. That is, certified farmers had assets valued at KES 112, 403.22 per household per year above what non-certified households had. Considering total asset value per adult equivalent per annum, certified farmers still had the highest value as indicated by p = 0.002 with a mean difference of KES -199,880.50 per annum (Table 10). This means that, on average, the certified farmer had the value of assets amounting to KES 199, 880.50 per adult equivalent per annum, above what non-certified farmer had. The results show that *ceteris paribus*, Global-GAP compliance, and certification in the production of French beans increases household asset accumulation.

Table 11 indicates that both certified and non-certified French beans farmers did not statistically differ in terms of the gender of the household head, education level of the household head, marital status, group membership, and access to credit as indicated by p-values greater than 10 percent level of significance.

Table 11: Descriptive statistics of French bean farmers

Certification status (*ST_i*): Binary (Certified = 1, otherwise = 0)				
Variable name	**Variable indicators**	**Non-Certified (N = 50)**	**Certified (N = 69)**	**Total (N = 100)**
Gender of HH	Female	5	6	11
		(45.50)	(54.50)	(100.00)
	Male	45	63	108
		(41.70)	(58.30)	(100.00)
Education level	None	1	1	2
		(50.00)	(50.00)	(100.00)
	Primary	23	33	56
		(41.10)	(58.90)	(100.00)
	Secondary	16	30	46
		(34.80)	(65.20)	(100.00)
	Diploma	69.20	4	13
		(9)	(30.80)	(100.00)
	Degree	1	1	2
		(50.00)	(50.00)	(100.00)
Marital status	Single	3	5	8
		(37.50)	(62.50)	(100.00)
	Married	43	63	106
		(40.60)	(59.40)	(100.00)
	Divorced	1	0	1
		(100.00)	(0.00)	(100.00)
	Widow	3	1	4
		(75.00)	(25.00)	(100.00)
HH sick	No	36	55	91
		(39.60)	(60.40)	(100.00)
	Yes	14	13	27
		(51.90)	(48.10)	(100.00)
Contract	No	39	13	52

farming		(75.00)	(25.00)***	(100.00)
	Yes	11	56	67
		(16.40)	(83.60)***	(100.00)
Farmer training	No	28	27	55
		(50.90)	(49.10)*	(100.00)
	Yes	22	42	64
		(34.40)	(65.60)*	(100.00)
Group membership	No	19	19	38
		(50.00)	(50.00)	(100.00)
	Yes	31	50	81
		(38.30)	(61.70)	(100.00)
Credit access	No	39	50	89
		(43.80)	(56.20)	(100.00)
	Yes	11	19	30
		(36.70)	(63.30)	(100.00)

Notes: Figures in parentheses are percentages, N means number of observations, HH means Household Head, and ST_i means Global-GAP certification status.
***$p < 0.01$, ** $p < 0.05$, *$p < 0.1$.

Majority of the Global-GAP certified French farmers (83 percent) were contracted (p = 0.000) while the majority of non-certified ones (75 percent) were not in any form of contract. Furthermore, Table 11 shows that the majority of Global-GAP certified French beans farmers (65.6 percent) accessed formal farmer training when compared to 50 percent of non-certified ones who did not access. The results mean that farmer training and availability of contract agreements in marketing may have played a role in influencing Global-GAP compliance and certification decisions among French beans farmers.

4.2.2 Risk preferences by Global-GAP certification category

4.2.2.1 Social experiment results

Summary of risk preferences (sigma (σ), alpha (α), and lambda (λ)) generated from the social experiment are summarized in Table 12. The results show that both certified and non-certified French beans farmers did not statistically and significantly differ in terms of aversion to risks (p = 0.334) and probability weighting (p = 0.862).

Table 12: Lottery games results by Global-GAP certification decisions

Certification status (ST_i): Binary (Certified = 1, otherwise = 0)									
Variable name	**Overall sample (N = 119)**		**Non-Certified (N = 50)**		**Certified (N = 69)**				
	Mean	**S.D**	**Mean**	**S. D**	**Mean**	**S.D**	**MD**	***t***	**Sig.**
Alpha (α)	0.48	0.36	0.53 (0.05)	0.36	0.45 (0.04)	0.36	0.08	1.21	0.862
Sigma (σ)	0.61	0.40	0.65 (0.06)	0.39	0.58 (0.05)	0.41	0.08	1.038	0.334
Mean lambda (λ)	2.04	3.15	2.33 (0.49)	3.45	1.83 (0.35)	2.93	0.50*	0.86	0.062
Upper - lambda	2.28	3.22	2.60 (0.50)	3.55	2.04 (0.36)	2.96	0.56**	0.94	0.041
Lower - lambda	1.81	3.12	2.06 (0.48)	3.38	1.62 (0.35)	2.93	0.44*	0.76	0.097

Notes: Figures in parentheses are standard errors of means, Sig. means significance, S.D means Standard Deviation, MD means Mean Difference, and N means number of observations.
***$p < 0.01$, ** $p < 0.05$, *$p < 0.1$.

However, non-certified farmers were averse towards losses as indicated by significant lambda value (p = 0.062) with a mean difference of 0.50. Upper (p = 0.041) and lower (p = 0.097) lambda values are also statistically significant with a mean difference of 0.56 and 0.44 respectively. This indicates that non-certified farmers were more averse towards losses than certified farmers were. The results mean that non-compliance among French beans farmers may have been informed by farmer's aversion towards the high probability of expected losses in French beans farming.

The mean values of σ, α, and λ stand at 0.61, 0.48, and 2.04, respectively, as indicated in Table 12. Comparatively, the values are close to those found in Love *et al.* (2014), Tanaka *et al.* (2010) and Liu (2013) as indicated in Table 13. Love *et al.* (2014) found values of σ, α, and λ to be 0.50, 0.86 and 3.18 respectively, Tanaka *et al.* (2010) found to be 0.59, 0.74 and 2.63 respectively while Liu (2013) found to be 0.48, 0.69 and 3.47 respectively (Table 13).

Table 13: Comparison of Sigma, Alpha and Lambda values of previous studies

Study	Country	Lottery -type	Perception framework	Utility function	Sigma (σ)	Alpha (α)	Lambda (λ)
Love *et al.* (2014)	Kenya	Real	EUT and CPT	CRRA	0.50	0.86	3.18
Liu (2013)	China	Real	EUT and CPT	CRRA	0.48	0.69	3.47
Tanaka *et al.* (2010)	Vietnam	Real	EUT and CPT	CRRA	0.59	0.74	2.63

Notes: EUT means Expected Utility Theory and CPT means Cumulative Prospect Theory.

4.2.2.2 Likert scale results

The 5-point Likert scale results show that both risk-taking and aversion towards the risks drove compliance with Global-GAP standards. The reason is that the majority of those who never like taking risks (55.6 percent) were certified French beans farmers when compared to 44.4 percent of non-certified. Majority of those who sometimes like taking risks (66.7 percent), in most cases like taking risks (65.9 percent) and those who always like taking risks (59.3 percent) were certified, farmers. On the other hand, at least 80 percent of those who in most cases, do not like taking risks were non-certified farmers. Nevertheless, when the cumulative percentage is considered, the majority of risk takers were certified, farmers. The results, therefore, suggest that risk-taking positively influence Global-GAP certification decisions in French beans farming (Table 14).

Table 14: Risk preferences by Global-GAP certification category

Risk preferences	Certification status (ST_i): Binary (Certified = 1, otherwise = 0)		
	Non-Certified (N = 50)	**Certified (N = 69)**	**Total (N = 119)**
Never like take risks	4 (44.40)	5 (55.60) **	9 (100.00)
In most cases I don't like take risks	12 (80.00)	3 (20.00) **	15 (100.00)
I sometimes like take risks	9 (33.30)	18 (66.70) **	27 (100.00)
In most cases I like take risks	14 (34.10)	27 (65.90) **	41 (100.00)
I always like take risks	11 (40.70)	16 (59.30) **	27 (100.00)

Notes: Figures in parenthes are number percentages and N means number of observations

***$p < 0.01$, ** $p < 0.05$, *$p < 0.1$.

4.2.2.3 Effect of risk attitudes and other factors on Global-GAP certification decisions

Risk attitudes (alpha, sigma, and lambda) and other factors perceived to influence French beans farmer's decisions to comply with the Global-GAP standards was estimated using binary Logit model. The χ^2 of model coefficients is significant at 1 percent (p = 0.000) indicating that the model fitted the data well. Nagelkerke R^2 is 0.641, which indicates that the estimated explanatory variables explained 64.1 percent of the variation in the explained variable (Global-GAP compliance and certification decisions). Hosmer and Lemeshow Test of goodness of fit are statistically insignificant (p = 0.100) indicating that the model predicted well the relationship between the dependent and independent variables (Table 15).

Alpha (α), which is a measure of probability weighting, is statistically significant (p = 0.046) and negatively (β = -4.079) influences Global-GAP certification decisions of French bean farmers. When α >1 it means individual under-weights small probabilities and over-weighs large probabilities and vice versa. French beans production is characterized by more risks and high cost of production as well as unstable returns. Based on this, the odds ratio for alpha indicates that, *ceteris paribus*, French bean farmer who under-weighed expected returns and over-weighed costs and losses expected in Global-GAP compliance and certification processes were 0.017

times more likely not to comply with Global-GAP standards (Table 15). This means that French bean farmer's Global-GAP compliance decisions were guided by high-expected costs and losses resulting from a lack of compliance with the standards.

Table 15: Effects of risk attitudes on Global-GAP certification decisions

Dependent variable: Certification status ST_i (Certified = 1, otherwise = 0)							95 percent C.I. for Exp(β)	
Variables	**Coefficients (β)**	**S.E**	**Wald**	**df**	**Sig.**	**Exp(β)**	**Lower**	**Upper**
Gender	1.490	1.325	1.264	1	0.261	4.437	0.331	59.552
Alpha	-4.079**	2.040	3.998	1	0.046	0.017	0.000	0.923
Sigma	3.263*	1.867	3.053	1	0.081	26.130	0.672	1015.545
Lambda (Mean)	-0.192*	0.115	2.803	1	0.094	0.825	0.659	1.033
No education			3.956	4	0.412			
Primary	-3.621	2.820	1.650	1	0.199	0.027	0.000	6.719
Secondary	-2.327	2.700	0.743	1	0.389	0.098	0.000	19.396
Certificate and Diploma	-3.664	2.858	1.644	1	0.200	0.026	0.000	6.936
Degree	-0.542	4.504	0.014	1	0.904	0.582	0.000	3963.682
Single			3.433	3	0.330			
Married	1.981	1.554	1.626	1	0.202	7.250	0.345	152.344
Divorced	-22.444	40192.970	0.000	1	1.000	0.000	0.000	43.263
Widow	-0.898	2.331	0.148	1	0.700	0.407	0.004	39.294
Irrigation farming	1.912	1.717	1.239	1	0.266	6.765	0.234	195.932
Contract farming	-4.481***	0.949	22.282	1	0.000	0.011	0.002	0.073
Cost of producing French beans	0.885**	0.450	3.866	1	0.049	2.424	1.003	5.858
Net income from French beans	0.337	0.291	1.343	1	0.246	1.401	0.792	2.478
Daily income per adult equivalent (WH0)	-0.001	0.001	0.665	1	0.415	0.999	0.996	1.002
Total household asset value	0.387*	0.230	2.832	1	0.092	1.473	0.938	2.313

Distance to the nearest French beans market	0.059	0.085	0.490	1	0.484	1.061	0.898	1.254
Group Membership	-0.725	0.747	0.942	1	0.332	0.484	0.112	2.094
Household size	-0.241	0.309	0.610	1	0.435	0.786	0.429	1.439
Daily expenditure per adult equivalent (WHO)	-0.003*	0.002	2.958	1	0.085	0.997	0.993	1.000
Number of times attended farmer trainings	0.148	0.226	0.431	1	0.512	1.160	0.745	1.807
Years of farming experience	0.012	0.034	0.121	1	0.728	1.012	0.946	1.082
Acreage under French beans	1.631**	0.763	4.567	1	0.033	5.108	1.145	22.793
Constant	-12.384**	5.897	4.410	1	0.036	0.000		
χ^2 test of model coefficients ($p < 0.05$)	$p = 0.000$							
Nagelkerke R^2	0.641							
Hosmer and Lemeshow test of goodness of fit ($p > 0.05$)	0.100							

Notes: C.I means Confidence Interval, S.E means Standard Errors, and WHO means World Health Organization approach used in the determination of household adult equivalent values (Muyanga *et al.*, 2007).

***$p < 0.01$, ** $p < 0.05$, *$p < 0.1$.

The results are consistent with those of the 5-point Likert scale. Similar findings are reported in Love *et al.* (2014), who found that female-headed households in Kenya overweigh the probability of drought, thus compelling them to adopt drought-tolerant maize hybrid varieties as insurance. Lambda, which is a measure of aversion to loss, is statistically significant (p = 0.094) and negatively (β = -0.192), influences Global-GAP certification decisions. λ denote the midpoint of the lower and upper bounds of the switching point in the lottery of series. It indicates the degree of loss aversion such that a higher value of λ mean decision maker is more loss averse and vice versa. The odds ratio for Lambda (0.825) indicates that *ceteris paribus*, loss aversion among French bean farmers decreases their log odds of being certified under Global-GAP standards by 0.825 times, and vice versa. French beans farming under Global-GAP standards are characterized by high costs, highly expected losses, and unpredictable returns which act as a disincentive for farmers to comply and get certified under Global-GAP standards. Lambda results are also consistent with those of the 5-point Likert scale. The findings concur with the findings of Edmeades and Smale (2006), who found that perceived yield losses in the production of transgenic banana in Uganda reduced farmer's demand for the variety significantly.

Sigma, which indicates an aversion to risks, is statistically significant (p = 0.081) and positively (β = 3.263) influencing Global-GAP certification decisions. French bean farmer is risk-loving if $\sigma < 0$, risk neutral if $\sigma = 0$ and risk-averse if $\sigma > 0$. The odds ratio for sigma (26.13) indicates that *ceteris paribus*, risk aversion among French bean farmers decreases their log odds of being certified under Global-GAP standards by 26.13 times relative to risk loving and risk-neutral farmers. Risk-averse farmers overweighed the probability of expected losses resulting from pests and diseases and rejection of produce in the export market, thus an incentive to comply with the Global-GAP standards to avoid the losses. The findings concur with those of Love *et al.* (2014) who found that maize farmers in Kenya overweigh the probability of drought, thus compelling them to adopt drought-tolerant maize hybrid varieties as insurance. The findings, however, contradict those of Koundouri *et al.* (2006), Chinwendu *et al.* (2012) and Bradford *et al.* (2013) who found a negative relationship between risk aversion and uptake of improved agricultural technologies.

Variable denoting access to contract agreements is statistically significant (p = 0.000) and negatively (β = -4.481) influences Global-GAP certification decisions. The odds ratio for variable denoting access to contract agreements (0.011) indicates that *ceteris paribus*, French bean farmers who participated in contract farming decreased their log odds of being certified under Global-GAP standards by 0.011 times and vice versa. Most of the farmers fear contracts because of their strict rules and regulations. Studies have shown that most farmers drop out of the contracts after one year of entering into the agreements due to strict rules and regulations (Lind and Pedersen, 2011). According to Asfaw *et al.* (2010), farmers who are in contracts easily comply with the Eurep-GAP standards if and only if they have been in the contracts for a long time.

Variable denoting the cost of producing French beans is statistically significant (p = 0.049) and positively (β = 0.885) relates to Global-GAP certification decisions. The odds ratio for variable denoting the cost of French beans production (2.424) indicates that *ceteris paribus*, an increase in the costs of French beans production by KES 1, increases farmer's log odds of being certified under Global-GAP standards by 2.424 times. Despite Global-GAP compliance and certification processes being costly in the production of French beans, it is still a more profitable venture, and this may have been an incentive for the farmers to invest more in the enterprise to gain more income. The study findings concur with those of Nthambi *et al.* (2013) who found that as visible transaction costs increases, the probability of French bean farmers complying with the Global-GAP standards through group contract and scheme increases by 0.2 and 0.3 times respectively in Kirinyaga County. However, individual compliance with the Global-GAP standards reduces by 0.4, 3.1 and 5.4 times in Kirinyaga, Mbooni and Laikipia Districts respectively as visible transaction costs increased by one unit (Nthambi *et al.*, 2013).

The variable denoting total asset value is statistically significant (p = 0.092) and positively (β = 0.387) relates to Global-GAP certification decisions in French beans production. The odds ratio for total asset value variable (1.473) indicates that *ceteris paribus*, an increase in the asset value of French bean farmers by KES 1, their log odds of being certified under Global-GAP standards increases by 1.473 times and vice versa. More assets generate more income for the farmers hence increasing their ability to meet the high cost of compliance and certification. The findings concur with those of Okello (2005), who found that farmers' endowments such as physical capital, human capital, and social capital increases the degree of Global-GAP compliance among smallholder farmers in Kenya.

Variable indicating daily household expenditure per adult equivalent is statistically significant (p = 0.085) and negatively (β = -0.003) relates to Global-GAP certification decisions. The odds ratio for variable denoting total daily household expenditure per adult equivalent (0.997) indicates that *ceteris paribus*, an increase in the daily household expenditure per adult equivalent by KES 1, decreases log odds of the household being certified under Global-GAP standards by 0.997 times and vice versa. As household expenditure increases, the less the likelihood that French bean farmer will comply with the Global-GAP standards. The reason is that households have many commitments that include expenditure on food and non-food items and given low-income levels coupled with the high cost of compliance and certification, poor households will be less likely to comply with the standards.

Acreage under French beans is statistically significant at 5 percent level of significance (p = 0.033) and positively (β = 1.631) affecting French beans farmer's Global-GAP compliance and certification decisions. The odds ratio for variable denoting acreage under French beans (5.108) indicates that *ceteris paribus*, an increase in the acreage under French beans increases the log odds of French beans farmers being certified under Global-GAP standards by 5.108 times and vice versa. French beans farming is a profitable venture, and cultivation of more acres implies more income and consequently increases farmers' ability to meet the cost of Global-GAP compliance and certification processes. Asfaw *et al.* (2010), however, found contrary results. They found a negative relationship between land size and compliance with Eurep-GAP standards among vegetable farmers in Kenya. They argue that households with large and fertile farms tend to prefer the production of cash crops like tea and coffee, which requires large land sizes. Similar findings have been reported in Nthambi *et al.* (2013) where they found that an increase in farm size by one unit increases group scheme compliance by 2.1 and 3.1 percent in Laikipia and Kirinyaga Counties respectively. They argued that larger farm sizes enable farmers to enjoy economies of large scale, which in turn increases their probability to comply with Global-GAP standards.

4.3 The causal effect of Global-GAP standards on French beans farmer's welfare and observed poverty

4.3.1 Farmer characteristics by Global-GAP certification category

Socio-economic, institutional, and psychological characteristics of French bean farmers were compared based on Global-GAP certification status. A t-test and Pearson Chi-square test

(χ^2) were carried out to determine whether the certified and non-certified French bean farmers were statistically and significantly different or similar based on the characteristics. The results indicate that certified farmers were on average older (45.8 years) than non-certified (43.5 years) by 2.3 years. Certified farmers earned more income per acre of French beans (KES 35,421.5) than the non-certified (KES 26,204.6) by KES 9,216.9. The reason is that Global-GAP certified French beans have higher market value relative to traditional crops such as maize. The results suggest that Global-GAP compliance and certification positively influences French beans income and subsequently, total household income. The findings concur with those of McCulloch and Ota (2002), Muriithi and Matz (2014) and Hichaambwa *et al.* (2015) who found a positive relationship between the commercialization of vegetables through the export market channel and household income (Table 16).

Table 16: Summary of respondents' characteristics by Global-GAP certification category

Variable	Global-GAP certification status (ST_i): Certified = 1 and otherwise = 0						
	Certified (N = 294)			Non-Certified (N = 198)			
	Mean	**S.E**	**S.D**	**Mean**	**S.E**	**S.D**	**MD**
Household size	3.68	0.09	1.46	3.80	0.10	1.46	0.12
Age of household head	45.79	0.74	12.71	43.49	0.95	13.30	-2.29*
Total household adult equivalent	3.14	0.08	1.41	3.56	0.42	5.89	0.42
Years of experience in farming	15.62	0.67	11.42	14.71	0.81	11.38	-0.90
Number of times household head sick	0.59	0.11	1.88	0.55	0.11	1.48	-0.04
Total Land size owned	2.39	0.28	4.73	1.93	0.10	1.43	-0.46
Acreage under French beans	0.51	0.03	0.43	0.54	0.03	0.41	0.04
Net French beans income	35421.45	2980.42	51103.54	26204.59	2282.67	32119.97	-9216.86**
Net crop income	83787.17	8792.93	150767.39	76570.34	10093.30	142025.31	-7216.84
Net livestock income	12145.13	2867.58	49168.76	6897.58	2955.59	41588.83	-5247.55349
Total off-farm income per adult equivalent	80987.76	9001.26	154339.53	96307.07	16804.26	236456.89	15319.32
Total net income per adult equivalent	67535.01	6005.44	102971.84	68230.96	9565.00	134591.52	695.95
Total asset value per adult equivalent	746110.81	80305.97	1376960.60	649166.93	106570.04	1499573.34	-96943.89

Expenditure on food items per adult equivalent	44066.70	6447.48	110551.34	42979.11	6738.33	94816.75	-1087.60
Expenditure on non-food items per adult equivalent	44303.34	13960.69	239375.99	43237.37	12600.92	177310.67	-1065.98
Total expenditure per adult equivalent	88370.04	19947.12	342021.94	86216.47	17799.94	250467.33	-2153.57
Total distance to the market	5.68	0.27	4.68	5.62	0.39	5.44	-0.06

Notes: S.D means Standard Deviation, S.E means Standard Error, N means Number of Observations, and MD means Mean Difference.

***$p < 0.01$, ** $p < 0.05$, *$p < 0.1$.

Table 17 further indicates that the majority of non-certified farmers were significantly ($p = 0.001$) risk-averse, did not borrow a loan, and did not join any form of collective action.

Table 15 Summary of respondents' socio-economic, institutional and psychological characteristics

Global-GAP certification status (ST_i): Certified = 1 and otherwise = 0				
Variable	**Indicators**	**Non-certified (N = 198)**	**Certified (N = 294)**	**Overall sample (N = 492)**
Marital status	Single	7.07 (14)	9.18 (27)	8.33 (41)
	Married	86.36 (171)	87.07 (256)	86.79 (427)
	Divorced	3.03 (6)	1.02 (3)	1.83 (9)
	Widow	3.54 (7)	2.72 (8)	3.05 (15)
Risk preferences	"I never like take risks"	6.06 (12)	3.74 (11)	4.67 (23)***
	"In most cases I don't like take risks."	20.20 (40)	9.18 (27)	13.62 (67)***
	"I sometimes like take risks."	29.29 (58)	23.47 (69)	25.81 (127)***
	"In most cases I like take risks"	30.30 (60)	41.16 (121)	36.79 (181)***
	"I always like take risks"	13.64 (27)	21.77 (64)	18.50 (91)***
	No response	0.51 (1)	0.68 (2)	0.61 (3)***
Gender	Female	11.11 (22)	12.59 (37)	11.99 (59)
	Male	88.89 (176)	87.41 (257)	88.01 (433)
Education level	None	1.52 (3)	2.04 (6)	1.83 (9)
	Primary	51.01 (101)	51.36 (151)	51.22 (252)
	Secondary	38.38 (76)	40.14 (118)	39.43 (194)
	Certificate and Diploma	8.59 (17)	5.44 (16)	6.71 (33)
	Degree	0.51 (1)	1.02 (3)	0.8 (4)
Access to	No	83.33	74.15	77.85

credit		(165)	(218)	(383)**
	Yes	16.67	25.85	22.1
		(33)	(76)	(109)**
Group membership	No	34.34	22.11	27.03
		(68)	(65)	(133)***
	Yes	65.66	77.89	72.97
		(130)	(229)	(359)***

Notes: Figures in parentheses are number of observations, *ST* means Global-GAP certification status, and N is the number of observations.

***$p < 0.01$, ** $p < 0.05$, *$p < 0.1$.

Majority of those who never like taking risks (6.1 percent), in most cases don't like taking risks (20.2 percent) and sometimes like taking risks (29.3 percent) were also non-certified French bean farmers while majority of those who in most cases (41.2 percent) and always like taking risks (21.8 percent) were certified farmers. Variable indicating access to credit is statistically significant at 5 percent level of significance ($p = 0.016$) indicating that majority of those who borrowed loan was certified farmers (25.9 percent) when compared to 16.7 percent of non-certified ones. At least 83.3 percent of non-certified farmers did not borrow relative to 74.2 percent of certified ones who did not borrow. Membership to a group is statistically significant at 1 percent level of significance ($p = 0.003$). That is, the majority of Global-GAP certified farmers (77.9 percent) were members of either a formal or an informal form of collective action relative to 65.7 percent of non-certified farmers. Both Global-GAP certified and non-certified French beans farmers did not statistically and significantly differ in terms of marital status, gender, and education level.

4.3.2 Level of observed poverty using the international poverty line

Certified and non-certified French beans farmers were categorized as poor and non-poor by using the global poverty line of KES 193.56 ($1.90 per day per adult equivalent). A household was considered poor if income per day fell below KES 193.56. Results in Table 18 indicate that the majority of French beans farmers were poor (72.6 percent).

Table 1816: Summary of respondents' socio-economic, institutional and psychological characteristics

[1]Poverty status (PV_i): Poor = 0 and otherwise = 1	N	Percent
Poor	357	72.6
Not poor	135	27.4

Notes: PV means Poverty Status, N is the number of observations, and [1]poverty status means poverty status of farmers was generated using international poverty line of $1.90 per day per adult equivalent or KES 193.56 per day per adult equivalent.

Income from French beans was not sufficient to move the households out of poverty brackets due to low acreage cultivated. Poor farmers cultivated an average of 0.5 acres of French beans while non-poor ones cultivated an average of 0.5 acres as indicated in Table 18a. Asfaw *et al.* (2010) concur that for Eurep-GAP standard to significantly and positively reduce poverty, the scale of adoption needs to be increased, and this means land size also need to be increased. Other studies have found that enforcement of Global-GAP standards is positively related to poverty. That is, enforcement of the standards increases the likelihood of households to be poor by 2.3 percent (Mwende, 2016). Also, a study by Machio (2015) indicates that farmers who produce and rely on cash crops are more likely to be poor than those that do not.

4.3.2.1 Level of observed poverty by Global-GAP certification category

Results in Table 19 revealed that Global-GAP certified and non-certified French beans farmers did not statistically and significantly (p = 0.281) differ in terms of observed poverty.

Table 17: Relationship between poverty and certification decisions

Variable name	Variable	[1]Poverty status (PV_i): Poor = 0 and otherwise = 1	
(Certification status)	Indicators	Poor	Not poor
Non-Certified (ST_0)	N	147_a	51_a
	Percent	41.2	37.8
Certified (ST_1)	N	210_a	84_a
	Percent	58.8	62.2

Notes: N is the number of observations, ST menas certification status, and "a" means no significant difference, and [1]poverty status means poverty status of farmers, which was generated using poverty line of KES 193.56 ($1.90 at exchange rate of KES 101.87).

The results revealed that income earned from Global-GAP certified French beans was not sufficient enough to alleviate observed poverty among French beans farmers.

4.3.2.2 Farmer characteristics by observed poverty category

Socio-economic and institutional factors were considered in comparing the poor and non-poor groups of farmers. Given the poverty line, both poor and non-poor French beans did not statistically and significantly differ in terms of household size, age, household adult equivalent, total land size owned, distance to the market, years of experience in farming, total annual asset value, annual expenditure on non-food items, number of trainings attended and acreage under French beans. On the other hand, the poor and non-poor farmers differed based on costs incurred per acre of French beans, net income per acre of French beans, annual net crop income, annual net livestock income, annual off-farm income, annual total income, annual expenditure on food items, and annual total expenditure per adult equivalent (Table 20).

Table 20: Farmer characteristics by observed poverty category

	[1]Poverty status (PV_i): Poor = 0 and otherwise = 1				
	Poor (N = 357)		Not poor (N = 135)		
Variable	**Mean**	**S.D**	**Mean**	**S.D**	**MD**
Household size	3.9	1.4	3.4	1.4	0.5
	(0.1)		(0.1)		
Age	45.7	12.6	42.6	13.8	3.1
	(0.7)		(1.2)		
Adult equivalent	3.6	4.5	2.6	1.0	1.1
	(0.2)		(0.1)		
Years of experience	15.5	10.9	14.6	12.8	0.9
	(0.6)		(1.1)		
Total land size owned	2.2	4.2	2.2	2.5	0.1
	(0.2)		(0.2)		
French beans acreage	0.5	0.4	0.5	0.5	-0.0
	(0.0)		(0.0)		
French beans costs	11045	11534	14606**	16633	-3562
	(610)		(1432)		
Net French beans	25090	29135	49223***	67980	-24133
income	(1542)		(5851)		
Net crop income	39557	61488	190166***	229732	-150608
	(3254)		(19772)		
Net livestock income	4086	25772	25760***	75798	-21674
	(1364)		(6524)		
Off-farm incomes	32804	55459	230874***	312476	-198070
	(2935)		(26894)		
Annual income	76448	82700	446800***	382574	-370352
	(4377)		(32927)		
Asset value	1806168	4269445	1997603	2207316	-191435
	(225963)		(189976)		

Expenditure on food items	89141 (6661)	125863	141683*** (19879)	230968	-52541
Non-food expenditure	87952 (11333)	214134	115137 (17114)	198843	-27185
Total expenditure	177093 (15836)	299218	256820** (31400)	364833	-79726
Number of trainings	1.1 (0.1)	1.5	1.3 (0.1)	1.7	-0.2
Distance to the market	5.4 (0.3)	4.7	6.2 (0.5)	5.6	-0.8

Notes: Figures in parentheses are standard errors, N is the number of observations, MD means Mean Difference, S.D means Standard Deviation, SD and MD values were rounded off to two (2) decimal places, and [1]Poverty status means poverty status of farmers, which was generated using the international poverty line of $1.90 per day per adult equivalent or KES 193.56 per day per adult equivalent.

***$p < 0.01$, ** $p < 0.05$, *$p < 0.1$.

Relative to the poor non-poor had the highest net annual French beans income (MD = KES 24,133), French beans production costs (MD = KES 3,562), net crop income (MD = KES 150,608), net livestock income (MD = KES 21,674), incomes from other sources (MD = KES 198,070), total net annual household income (MD = KES 370,352), total annual expenditures (MD = KES 79,726) and expenditure on food items (MD = KES 52,541) as indicated in Table 20.

Poverty status of the respondents statistically and significantly varied according to the location (p = 0.020), an education level (p = 0.000) and risk preferences (p = 0.026) of French beans farmers. On the other hand, poverty status did not vary according to Global-GAP certification status, gender, and marital status. Majority of poor farmers are located in Kirinyaga West Sub-County (83.2 percent) followed by Kirinyaga East Sub-County at 75 percent. Mwea West Sub-County had the lowest poverty rate at 60 percent. Majority of those who were poor (88.9 percent) had no education at all while the majority of those who were non-poor had certificate and diploma (Table 21). Education enables French beans farmer’s access to formal employment, which later increases their income and thus poverty reduction. Farmers can also use the knowledge acquired from the education process to improve farming activities such as identification and uptake of high yielding agricultural technologies, which eventually increases farm yields and income and hence poverty reduction.

Table 21: Farmer characteristics by observed poverty category

		[1]Poverty status (PV_i): Poor = 0 and otherwise = 1		
Variable	**Indicators**	**Poor (Percent) N = 357**	**Not poor (Percent) (N = 135)**	**Overall (Percent) (N = 492)**
Sub-Counties	Mwae East	71.1 (192)	28.9 (78)	100 (270)**
	Mwea West	60 (33)	40 (22)	100 (55)**
	Kirinyaga East	75 (18)	25 (6)	100 (24)**
	Kirinyaga Central	66.7 (20)	33.3 (10)	100 (30)**
	Kirinyaga West	83.2 (94)	16.8 (19)	100 (113)**
Certification status	Certified	71.4 (210)	28.6 (84)	100 (294)
	Not certified	74.2 (147)	25.7 (51)	100 (198)
Gender	Female	78 (46)	22 (13)	100 (59)
	Male	71.8 (311)	28.2 (122)	100 (433)
Education level	None	88.9 (8)	11.1 (1)	100 (9)***
	Primary	78.6 (198)	21.4 (54)	100 (252)***
	Secondary	69.1 (134)	30.9 (60)	100 (194)***
	Certificate and Diploma	45.5 (15)	54.5 (18)	100 (33)***
	Degree	50 (2)	50 (2)	100 (4)***
Marital status	Single	68.3 (28)	31.7 (13)	100 (41)
	Married	72.8 (311)	27.2 (116)	100 (427)
	Divorced	77.8 (7)	22.2 (2)	100 (9)
	Widow	73.3 (11)	26.7 (4)	100 (15)
Risk preferences	"I never like take risks"	87 (20)	13 (3)	100 (23)**
	"In most cases I	77.6 (52)	22.4 (15)	100 (67) **

don't like take risks"			
"I sometimes like take risks"	74 (94)	26 (33)	100 (127) **
"In most cases I like take risks"	74 (134)	26 (47)	100 (181) **
"I always like take risks"	59.3 (54)	40.7 (37)	100 (91) **
No response	100 (3)	0 (0)	100 (3) **

Notes: Figures in parentheses are number of observations, N is the number of observations, and [1]poverty status means poverty status of farmers, which was generated using the international poverty line of $1.90 per day per adult equivalent or KES 193.56 per day per adult equivalent.

***$p < 0.01$, ** $p < 0.05$, *$p < 0.1$.

Finally, among the poor French beans farmers, the majority never like taking risks (87 percent) and in most cases do not like taking risks (77.6 percent) while among the non-poor, the majority always liked taking risks (40 percent). The results show that aversion to risks positively relates to poverty. The findings concur with those of Hulme and Shepherd (2003) who found that risk-averse persons in the face of risks are more likely to be poor because they prefer low risky ventures which are associated with low returns. Mosley and Verschoor (2005), however, found a very weak link between farmers' risk attitudes and poverty.

4.3.3 Level of observed poverty using FGT (1984) measures of poverty

Poverty line of $1.90 (KES 193.56) per day per adult equivalent) was used in the determination of the three FGT measures of poverty. The results in Table 22 show that 42.68 percent and 29.88 percent of certified and non-certified French bean were poor, respectively. The poverty headcount ratios (PI_0) indicate that the majority of the poor (42.68 percent) were Global-GAP certified farmers and hence suggesting that Global-GAP certification may not have alleviated poverty. Poverty depth (PI_1) among certified and non-certified were 0.299 and 0.190 respectively, implying that certified and non-certified French beans farmers would require 29.90 percent and 19 percent of KES 193.56 respectively to get out of poverty. Furthermore the results indicate that majority of Global-GAP certified farmers (25.2 percent) were severely affected by poverty as indicated by PI_2 = 0.252.

Table 22: Household-level of observed poverty using FGT (1984) poverty measures

	FGT Poverty Indicators (PI_i)		
Certification status	**PI_0 (Percent)**	**PI_1**	**PI_2**
Certified (ST_1)	42.68	0.299	0.252
Non-certified (ST_0)	29.88	0.190	0.156

Notes: PI_0 means poverty headcount ratio, PI_1 means poverty gap, PI_2 means severity of poverty, and *ST* means Global-GAP certification status.

4.3.4 Causal effects of Global-GAP certification on welfare indicators using PSM approach

4.3.4.1 Determinants of Global-GAP certification (Probit regression results)

Probit regression results are presented in Table 23. Propensity score indicates that Pseudo R^2 after the matching is low at 0.3862 (38.62 percent) as recommended earlier. The χ^2 test of model coefficients is significant at 1 percent (p = 0.000) indicating that the model fitted the data well. The results further show that the balancing property in all the outcome variables was satisfied.

Table 18: Probit regression Results

Global-GAP certification status (ST_i): Certified = 1 and otherwise = 0						
Variable	**Coefficients (β)**	**S. E**	**z**	**P>z**	**[95 percent CI]**	
Gender of HH	-0.1233	0.219	-0.56	0.574	-0.5525	0.3060
Age of HH	0.0049	0.006	0.89	0.375	-0.0059	0.0158
In most cases don't like taking risks	-0.6285	0.209	-3.01	0.003**	-1.0374	-0.2195
Acreage under French beans	-0.2113	0.169	-1.25	0.211	-0.5423	0.1197
Access to donor support	1.9481	0.147	13.22	0.000***	1.6593	2.2369

Secondary education level	-0.2465	0.146	-1.69	0.092*	-0.5331	0.0402
Membership to a group	0.2914	0.169	1.72	0.085*	-0.0400	0.6227
Total distance to the nearest market	0.0280	0.016	1.75	0.080*	-0.0034	0.0594
Credit access	0.0530	0.180	0.29	0.769	-0.3008	0.4067
Access to agricultural training	0.5358	0.149	3.60	0.000***	0.2442	0.8274
Access to irrigation	-0.4293	0.281	-1.53	0.127	-0.9807	0.1221
Constant	-0.7290	0.434	-1.68	0.093*	-1.5801	0.1220
Number of observations	492					
Prob > χ^2	0.000					
Pseudo R^2	0.3862					
Likelihood Ratio χ^2 (11)	256.1					
The region of common support	(0.10111224 -0.99524621)					
The balancing property	The balancing property in all the outcome variables was satisfied					

Notes: Figures in parentheses are standard errors, C.I means Confidence Interval, HH means Household Head, and Coefficients and standard error values were rounded off to three decimal points.
***p < 0.01, ** p < 0.05, *p < 0.1.

Distance to the nearest French beans markets is statistically significant (p = 0.080) with a positive effect (β = 0.0280) on Global-GAP compliance decisions. *Ceteris paribus*, 1 kilometer increase in the distance to the nearest French beans market increases the probability of Global-GAP compliance and certification among French beans farmers by 2.8 percent. This indicates that French beans farmers who were far from the nearest French beans market were more likely to comply with the Global-GAP standards. Long distances to the market induce farmers to act collectively to reduce costs of production and marketing through the collective purchase of inputs and sale of products (Muriithi, 2008). However, the results contradicted those of Nduta (2011) and Njoba *et al.* (2016) who found that long distances to the market negatively correlate with farmers' Global-GAP compliance decisions among French beans farmers in Kenya. That is, an increase in the distance to the market by one kilometer reduces the chances of individual compliance by 18 percent and increases the chances of group compliance by the same value.

Variable denoting donor support is statistically significant (p = 0.000) with positive influence (β = 1.9481) on Global-GAP compliance and certification decisions in French beans production. *Ceteris paribus*, access to donor support increases the probability of Global-GAP compliance and certification among French beans farmers by 194.8 percent. French beans farmers who got support (financial or in-kind) related to the production and marketing of French beans were more likely to comply with Global-GAP standards relative to non-certified farmers. Donor support is critical in determining the success of Global-GAP compliance and compliance in French beans production because it is costly processes, especially among small-scale farmers. The findings concur with those of Kersting and Wollni (2012) who determined factors influencing the uptake of Global-GAP standards among fruit and vegetable farmers in Thailand and found that support from donors and exporters positively influenced farmers' certification decisions.

Variable indicating the number of times of access to agricultural training is statistically significant (p = 0.000) and positively influencing (β = 0.535816) Global-GAP compliance and certification decisions. *Ceteris paribus*, 1 percent increases in the number of times of access to agricultural training increase the probability of Global-GAP compliance and certification among French beans farmers by 54 percent. That is French beans farmers who accessed more agricultural extension training and services were more likely to comply with the Global-GAP standards. Access to adequate agricultural training and information equips farmers with knowledge and skills necessary to take risks associated with compliance and certification. Similar results are reported in[16] that exports of French beans increased in Kenya after farmers learned how to grow well and maintain as well as adhere to the requirements of both local and export markets. Okello (2005), Kleinwechter and Grethe (2006), Muriithi *et al.* (2011) and Kangai and Mburu (2012) reported similar findings, and they argued that lack of access to information negatively influences the uptake of Global-GAP standards in Kenya. Asfaw *et al.* (2010) found no evidence that access to agricultural extension services from the Government increases the probability of farmers in the adoption of Eurep-GAP standards. They argued that exporter companies, Non-Governmental

[16] See www.selinawamucii.com/

Organizations, and trained technical personnel of exporters on the ground frequently provides information to the farmers, thus rendering government extension services less important.

The results further indicate that variable denoting membership to a farmer group is statistically significant (p = 0.085) with a positive effect (β = 0.2914) on Global-GAP certification decisions. *Ceteris paribus*, membership of a French beans farmer in a group increases the probability of Global-GAP compliance and certification by 29 percent. Collective action helps farmers reduce costs and mitigate risks in doing business through sharing of information and cost sharing among members. For instance, Nthambi *et al.* (2013) argues that Global-GAP compliance and certification processes are characterized by high costs that include: putting upgrading sheds, purchase of fertilizer and pesticide, putting up stores and purchase of protective clothing and maintenance costs which eventually encourages farmers to participate in group compliance and certification in order to achieve economies of scale.

Okello (2005) and Asfaw *et al.* (2010) also concur that farmer groups provide services necessary for farmers to meet the requirements of Eurep-GAP standards. For instance, through a group, farmers get technical knowledge necessary in pest scouting, record keeping, and pesticide application, among other activities. The findings also concur with those of Muriithi (2008, who found that high social capital encourages farmers to comply with the Global-GAP standards. That is, the more the number of groups, the higher the chance of complying with the Global-GAP standards due to the homogeneity of interests and norms as well as higher levels of trust among members. When a household is in more groups, there is reduced the fear of the probability of forfeiture by the other members as they already know them, and their interests are similar (Nyota, 2011).

Variable indicating secondary education level of the household head is statistically significant (p = 0.085) with a negative effect (β = -0.24648) on compliance with Global-GAP standards among French beans farmers. That is, *ceteris paribus*, French beans farmers who attained secondary education level were 25 percent less likely to comply with the Global-GAP standards. The results demonstrated that as French bean farmers get more of formal education, the likelihood to comply with the Global-GAP standards decreases. That is, secondary education in Kenya is associated with a low level of knowledge and probability of employment relative to tertiary education. Low education leads to low household income, which in turn limits the farmer’s ability to comply with the standards. Access to such low income coupled with costly Global-GAP compliance and certification processes, farmers find it difficult to comply with the standards. Similar findings are reported in Kersting and Wollni (2012) and Kangai and Mburu (2012) who found that higher education level positively influences French bean farmer’s decisions to comply with Global-GAP standards in Kenya. Other studies include Salasya *et al.* (2007) and Alene and Manyong (2007) who also found the significant and positive influence of education on the technology adoption decisions of farm households.

Variables denoting French beans farmers who in most cases, do not like taking risks (p = 0.003|β = -0.62845) is statistically significant and negatively influencing compliance with Global-GAP standards. The results mean that aversion to risks negatively influenced compliance with the Global-GAP standards among French beans farmers. That is, *ceteris paribus*, French beans farmers who in most cases, do not like taking risks were 63percent less likely to comply with the Global-GAP standards and vice versa. The findings concur with those of Feder (1980), Koundouri *et al.* (2006), Cavane (2011), Chinwendu *et al.* (2012) and Bradford *et al.* (2013) who found a negative relationship between aversion to risk and adoption of new agricultural technologies. However, Ross *et al.* (2012) found no significant relationship.

4.3.4.2 Effect of Global-GAP standards on French beans farmer’s welfare indicators

PSM results are presented in Table 24. The minimum critical value of “*t*” that is significant at 10, 5, and 1 percent is 1.645, 1.960, and 2.56, respectively. Based on these critical values, the results revealed that Global-GAP compliance and certification significantly and positively influenced net income per acre of French beans, total annual household income per adult equivalent and total household expenditure per adult equivalent but statistically had no effect on annual household asset value per adult equivalent.

On average, the four PSM estimation methods (Nearest Neighbour Matching (NNM), Stratification Matching Method (SMM), Kernel Matching Method (KMM) and Radius Matching Methods (RMM)) indicated that the effect of Global-GAP certification on French beans income is highly significant. That is, net annual French beans income per acre increased by KES 23,000.70 (t = 4.073) for NNM, KES 17,307.70 (t = 3.876) for SMM, KES 26,269.80 (t = 2.794) for RMM and KES 18,095.10 (t = 4.033) for KMM among Global-GAP certified farmers. The results further show that, relative to non-certified farmers, total annual household income per adult equivalent among Global-GAP certified farmers increased by KES 18,146.20 (t = 1.998) for SMM, KES 33,094.30 (t = 1.675) for RMM and KES 19,218.50 (t = 2.012) for KMM.

Finally, nearest-neighbour' estimation method indicates that Global-GAP certification significantly and positively influenced annual household expenditure per adult equivalent. The average annual expenditure per adult is given as KES 0.259 (t = 1.825) for NNM. Because annual expenditure per adult equivalent was expressed in logarithmic, the value 0.259 means that annual expenditure per adult equivalent among Global-GAP certified farmers is 25.9 percent higher than those of non-certified farmers.

Table 19: Causal effect of Global-GAP certification on French beans farmer's welfare indicators

Global-GAP certification status (*ST_i*): Certified = 1 and otherwise = 0				
Method	**Certified**	**Non-certified**	**ATT**	***t*-values**
ATT on net annual French beans income per acre				
NNM	294	68	23000.70***	4.073
			(5647.40)	
SMM	294	175	17307.70***	3.876
			(4465.20)	
RMM	80	59	26269.80***	2.794
			(9401.50)	
KMM	294	175	18095.10***	4.033
			(4487.10)	
ATT on total annual income per adult equivalent				
NNM	294	68	5529.90	0.145
			(38226.70)	
SMM	294	175	18146.20**	1.998
			(9080.70)	
RMM	80	59	33094.30*	1.675
			(19762.60)	
KMM	294	175	19218.50***	2.012

			(9552.20)	
ATT on the log of total annual expenditure per adult equivalent				
NNM	294	68	0.15 (0.172)	0.875
SMM	294	175	0.226 (0.147)	1.538
RMM	80	59	0.259* (0.142)	1.825
KMM	294	175	0.215 (0.142)	1.515
ATT on log of total annual asset value per adult equivalent				
NNM	294	68	0.061 (0.382)	0.159
SMM	294	175	0.118 (0.318)	0.371
RMM	80	59	0.430 (0.342)	1.257
KMM	294	175	0.111 (0.338)	0.328

Notes: Figures in parentheses are standard errors, ATT means Average impact of Treatment on Treated, ST_i means certification status, NNM means Nearest Neighbour Matching, SMM means Stratification Matching Method, KMM means Kernel Matching Method, and RMM means Radius Matching Methods.
***$p < 0.01$, ** $p < 0.05$, *$p < 0.1$.

PSM approach confirms that Global-GAP compliance and certification positively influence French beans farmer's welfare indicators (income and expenditure). The results suggest that there is a high possibility of Global-GAP standards contributing to poverty alleviation among French beans farmers in Kirinyaga County. The results concur with those of Asfaw *et al.* (2009) who found that sustaining Global-GAP compliance in French beans production in Kenya enable farmers to reach a pay-off period whereby compliance begins to increase farmer's income. Similar findings are also reported in Achieng' (2014), who found that Global-GAP compliance and certification reduces the poverty status of French beans farmers by 1.120 to 0.843 times. The findings concur with those of Asfaw *et al.* (2010), Graffham *et al.* (2007), Muona (2016) and Kariuki *et al.* (2012) who found that French beans production in the face of Global-GAP standards increases its market prices and thus household income. The findings also corroborate with those of McCulloch and Ota (2002), Muriithi and Matz (2014) and Hichaambwa *et al.* (2015). The study found a significant and positive relationship between vegetable commercialization through export and household income and no effect on asset ownership.

4.4 Effect of risk attitudes on welfare indicators and observed poverty among French beans farmers

4.4.1 Risk preferences by welfare indicators categories

Risk preferences were captured using the 5-point Likert scale while welfare was captured based on total income, total asset value, and total household expenditures on food and non-food items. Results in Table 25 indicate that the levels of income, asset values, and expenditure per adult equivalent of French beans farmers statistically and significantly varied according to their risk preferences.

Table 20: Farmers' preferences toward risks by welfare indicators

Risk preferences	The daily income per adult equivalent (WHO) N = 492			Annual asset value per adult equivalent (WHO) N = 492		Daily expenditure per adult equivalent (WHO) N = 492	
Indicators	**N**	**Mean**	**S.D**	**Mean**	**S.D**	**Mean**	**S.D**
"I never like to take risks"	23	101.52*** (23.11)	110.81	377,808.30*** (82991.07)	398011.20	194.87**** (33.76)	161.92
"In most cases I don't like to take risks"	67	134.34*** (24.66)	201.87	718,639.70*** (102114.10)	835839.70	185.58*** (34.18)	279.75
"I sometimes like to take risks"	127	192.35*** (26.27)	295.99	699187.40*** (110457.90)	1244798.00	406.72** (143.63)	1618.68
"In most cases I like to take risks"	181	188.27 *** (29.08)	391.18	613,369.30*** (58859.51)	791873.70	185.21*** (22.62)	304.27
"I always like to take risks"	91	250.05 *** (33.46)	319.19	965,129.10** (276712.60)	2639670.00	185.48*** (17.94)	171.14
No response	3	28.85 (15.11)	26.17	1136593.00 (828441.50)	1434903.00	205.95 (102.73)	177.93

Notes: Figures in parentheses are standard errors, S.D and MD values were rounded off to two (2) decimal places, N is the number of observations, S.D means Standard Deviation, WHO means World Health Organization approach of determining adult equivalent values of Means (Muyanga *et al.*, 2007), and MD means Mean Difference.
***$p < 0.01$, ** $p < 0.05$, *$p < 0.1$.

In terms of daily income, French beans farmers who never like taking risks (KES 102) and those that do not like taking risks (KES 134) realized the lowest annual income level per adult equivalent relative to those who always like taking risks (KES 188), who sometimes take risks (KES 192) and them that liked to take risks (KES 250). Annual asset value per adult equivalent ranged from the lowest at KES 377,808.30 for those who never like to take risks to the highest (KES 965,129.10) for those who always like to take risks. The average daily expenditure per adult equivalent varied from who never like to take risks (KES 194.87) to those who always like to take risks (KES 185.48) while those who in most cases do not like to take risks spent an average of KES 185.58 and them who in most cases liked to take risks KES 185.21.

The results demonstrate that farmers' risk aversion negatively correlate with income, total asset value but positively correlates with household expenditure per adult equivalent. A study by Hulme and Shepherd (2003) concur that risk-averse persons in the presence of risks are more likely to be poor because they prefer low risky ventures which are associated with low returns. Using an experimental approach, Mosley and Verschoor (2005) found a very weak link between farmers' risk attitudes and poverty.

4.4.2 Relationship between risk preferences and observed poverty

Given the 5-point Likert scale, poverty line, and French beans farmer's income per day per adult equivalent, the results revealed that poverty situations of French bean farmers statistically and significantly differ across their risk preferences (p = 0.026) as indicated in Table 26. Majority of French beans farmers who never (5.6 percent) and in most cases didn't like taking risks (14.6 percent) were poor while the majority of those who always like to take risks (27.4 percent) were not poor. Cumulatively, the majority of risk takers (86.6 percent) were not poor when compared to the cumulative percentage of the poor category (78.9 percent) that was risk averse. Therefore, the results suggest that there is a positive relationship between risk-taking and poverty reduction and vice versa.

Table 21: Risks preferences by observed poverty status category

Risk preferences	[1]Poverty status (PV_i): Poor = 0 and otherwise = 1		
Indicators	**Poor (N = 357)**	**Not poor (N = 135)**	**Overall sample (N = 492)**
"I never like take risks"	20	3**	23
	(5.6)	(2.2)	(4.7)
"In most cases I don't like take risks"	52	15**	67
	(14.6)	(11.1)	(13.6)
"I sometimes like take risks"	94	33**	127
	(26.3)	(24.4)	(25.8)
"In most cases I like take risks"	134	47**	181
	(37.5)	(34.8)	(36.8)
"I always like take risks"	54	37**	91
	(15.1)	(27.4)	(18.5)
No response	3	0**	3
	(0.8)	(0.0)	(0.6)

Notes: Figures in parentheses are percentages, HH means Household, PAE means Per Adult Equivalent, C.I means Confidence Interval, *PV* means Poverty Satus; S.E menas Standard Errors, and [1]poverty status means poverty status of farmers, which was determined using poverty line of KES 193.56 ($1.90 per day per adult equivalent at the rate of KES 101.87 per dollar) per day per adult equivalent,

***$p < 0.01$, ** $p < 0.05$, *$p < 0.1$.

4.4.3 Risk preferences effects on observed poverty among French beans farmers

A binary Logistic regression analysis was conducted to determine the factors affecting observed poverty among French beans producers in Kirinyaga County, Kenya (Table 27). The dependent variable (poverty status) was captured as poor = 0 and Not poor = 1 based on the poverty line of KES 193.56 ($1.90 per day per adult equivalent. Hosmer and Lemeshow Test are statistically insignificant (p = 0.281) indicating that the model fits the data well. The model is statistically significant, indicating that the explanatory variables estimated reliably distinguished between the poor and non-poor (χ^2 = 153.314, p = 0.000). Nagelkerke R-square value is 0.626 indicating that 62.6 percent of the variation to be observed in the poverty situations of the French beans farmers were explained by the combined effects of all the independent variables in the model specified. Binary logistic regression is based on four crucial assumptions that need to be addressed. First, the dependent variable should be ordinal. In this study, the dependent variable was captured as a binary variable. Secondly is the linearity assumption. Linearity in the binary logistic model assumes that independent variables have a linear relationship with the dependent variable. This assumption can be verified by checking the model fit statistics and pseudo R^2.[17]

Table 22: Determinants of observed poverty among French beans farmers

Dependent variable: [1]Poverty status (PV_i): Poor = 0 and otherwise = 1					
Variables	**Coefficients (β)**	**S.E.**	**Wald**	**P>Z**	**Odds Ratio**
Certification status	1.095	0.685	2.556	0.110	2.990
Household size	-5.032	1.215	17.149	0.000***	0.007
Total annual household income	7.733	1.514	26.097	0.000***	2282.773
Total annual asset value	-0.482	0.247	3.802	0.051*	0.618
Access to credit	1.187	0.690	2.956	0.086*	3.277
Expenditure per adult equivalent	2.016	0.581	12.025	0.001***	7.509
Net annual French beans income	0.425	0.381	1.246	0.264	1.529
Always like taking risks	-0.447	0.832	0.289	0.591	0.640
Never like taking risks	-2.802	1.436	3.810	0.051*	0.061
Off-farm income	0.431	0.464	0.862	0.353	1.538
Group membership	1.171	0.790	2.200	0.138	3.226
Primary level of education	0.600	1.061	0.320	0.571	1.823
Secondary level of education	-0.999	1.143	0.763	0.382	0.368
Age of household head	-2.009	1.093	3.379	0.066*	0.134
Gender of household head	-1.783	1.417	1.583	0.208	0.168
Total land size owned	-0.108	0.448	0.058	0.810	0.898
Constant	-105.154	21.150	24.719	0.000***	0.000
Omnibus tests:	$p < 0.05$ (0.000)				
Nagelkerke R^2	0.626				
Hosmer and Lemeshow:	$p > 0.05$ (0.281)				

[17] See www.restore.ac.uk/srme/www/fac/soc/wie/researchnew/srme/modules/mod4/9/index.html.

Notes: HH means Household, PAE means Per Adult Equivalent, C.I means Confidence Interval, *PV* means Poverty Satus, S.E menas Standard Errors, and [1]poverty status means poverty status of farmers, which was determined using poverty line of KES 193.56 ($1.90 per day per adult equivalent at the rate of KES 101.87 per dollar) per day per adult equivalent,
***$p < 0.01$, ** $p < 0.05$, *$p < 0.1$.

In this study, the model fit statistics and pseudo R^2 in Table 27 indicate that the model fits well data. Also, binary logistic regression does not need a linear relationship between the dependent and independent variables because it applies a non-linear log transformation to the predicted odds ratio[18]. Thirdly is the assumption of independent errors. The assumption of independent errors states that errors should not be correlated for two observations. That is, data should be drawn from independent samples and not dependent samples such as before and after or matched pairings. In this study, single cross-section data was drawn from an independent sample. The fourth assumption is that there should not be Multicollinearity. Binary logistic regression requires that independent variables should not be highly correlated with each other, but to some degree. Correlation analysis is one of the tests that can be used to check the existence of multicollinearity. Pearson's value (*r*) that is equal to 0.8 or above indicates a serious problem of multicollinearity[19]. In the study, correlation analysis was conducted, and results presented in Appendix A2. The results show that all the Pearson's values (*r*) are below *r* =0 .8, and hence, multicollinearity was not a problem.

Variables indicating certification status and net income from French beans are statistically insignificant, with a positive relationship with poverty reduction. The results suggest that income earned by the farmers from participating in the production of Global-GAP certified French beans was not sufficient to move households out of poverty brackets. The reason may be due to the low acreage of French beans cultivated. Risk preference variable was coded using a 5-point Likert scale starting from "I never like taking risks" to "always I like taking risks." A response indicating, "I never like taking risks" is statistically significant ($p = 0.051$) with a negative coefficient ($\beta = -2.802$). The results suggest that French beans risk-averse farmers are likely to be poor and vice versa. The odds ratio = 0.061 mean that, *ceteris paribus*, a farmer who is risk averse increases his/her log odds of becoming poor by 0.061 times. The findings are in line with those of Moscardi and De Janvry (1977), Dillon and Scandizzo (1978), Binswanger (1980), Antle (1987), Hulme and Shepherd 2003, Dohmen *et al.* (2005), Booij and De Kuilen

[18] See www.statisticssolutions.com/wp-content/uploads/wp-post-to-pdf-enhanced-cache/1/assumptions-of-logistic-regression.

[19] See www.restore.ac.uk/srme/www/fac/soc/wie/researchnew/srme/modules/mod4/9/index.html.

(2009), Kwesi *et al.* (2012), and Ghartey *et al.* (2014) who found that risk-averse farmers are more likely to be poor.

Household size variable is highly significant (p = 0.000) with a negative coefficient (β = -5.032). The results revealed that an increase in household size increases farmer's chances of becoming poor. The odds ratio value of 0.007 indicates that *ceteris paribus*, an increase in household size by one adult equivalent increases household log odds of becoming poor by 0.007 times. Increase in household size constraints existing incomes. Reduction in incomes reduces consumption expenditure, thus increases the poverty status of the households. Previous studies in Kenya and elsewhere report similar findings. For example, Oyugi *et al.* (2000), Nyariki *et al.* (2002), Alemayehu *et al.* (2005), Geda *et al.* (2005), Muyanga *et al.* (2006), Muriithi (2008), Elhadi *et.al.* (2012), Onyeiwu and Liu (2013), Achieng' (2014), and Macho (2015) found that an increase in household size, directly and indirectly, increases household poverty through reduction in income per adult equivalent which eventually impairs standard of living. The findings also concur with those of Swanepoel (2005) and Igbalajobi *et al.* (2013) who found that large family size with more dependants increase the severity of poverty because it decreases per capita expenditure. A study by Megersa (2015) reported contrary findings.

Variable indicating daily household annual expenditure per adult equivalent is statistically significant (p = 0.001) with a positive coefficient (β = 2.016). The results suggest that households that spend more are less likely to be poor. The odds ratio = 7.509 mean that *ceteris paribus*, an increase in annual expenditure per adult equivalent by KES 1 decreases household log odds of becoming poor by 7.509 times and vice versa. Expenditure is a welfare indicator, such that households, which spend equal to or above the poverty line of KES 2,900 per month per adult equivalent, are regarded as non-poor and vice versa. It is clear in Table 20 that non-poor and poor households statistically and significantly deferred in terms of household expenditure per annum. Poor households spent KES 89,141 per annum relative to non-poor counterparts who spent KES 141,683 within the same period. Similar studies indicate that household's expenditure on aspects such as education increases their chances of access to well-paying jobs, which in turn increases household income and hence reduction in poverty. Expenditure on health and household food increases household member's productivity, which in turn translates to high income and consequently reduction in Poverty (Kiiru, 2010; Edoumiekumo *et al.,* 2014).

Variable indicating access to credit is statistically significant (p = 0.086) with a positive coefficient (β = 1.187). The results revealed that access to credit reduces household poverty among French beans farmers. The odds ratio = 3.277 mean that *ceteris paribus*, access to credit reduces household log odds of becoming poor by 3.277 times and vice versa. Credit access provides capital to purchase key inputs of production, which increase yields, income, and savings, and eventually, poverty reduction (Igbalajobi *et al.*, 2013). Access to credit also provides income for spending on necessities such as medical, school fees, food, social emergencies, and farm inputs (Muyanga *et al.,* 2006; Owuor *et al.,* 2007). Furthermore, access to credit enables farmers to acquire modern farming techniques and good farm management principles which can improve farm productivity and thus poverty reduction (De Janvry and Sadoulet, 2000; Apata *et al.,* 2010). A study by Machio (2015) found no effect.

Variable denoting household asset value is statistically significant (p = 0.051) with a negative coefficient (β = -0.482). The results suggest that as households accumulate more assets, their chances of becoming poor increases. The odds ratio = 0.618 indicates that, *ceteris paribus*, an increase in asset accumulation by KES 1 increases household log odds of becoming poor by 0.618 times and vice versa. Two types of assets exist assets that generate income for the households and those that do not. Accumulations of assets that do not generate income do leave households with little or no cash to transact daily household needs, and this may lead to poverty. In this case, French bean farmers seem to be accumulating assets that do not generate income and hence their high chance of becoming poor. Similar findings are reported in Achieng' (2014) who found that, *ceteris paribus*, an additional high valued asset positively influences severity of poverty by 0.280 times among French bean farmers in Kirinyaga County while contrary findings are reported in studies conducted by Mariara (2002), Muyanga *et al.* (2006) and Mbakahya and Ndiema (2015) in Kenya. For instance, a study by Mariara (2002) found that asset accumulation is critical in poverty alleviation among pastoralists in Kajiado County, Kenya.

Variable indicating total household annual income is statistically significant (p = 0.000) with a positive coefficient (β = 7.733). The results demonstrate that an increase in household income decreases its chances of becoming poor. The odds ratio = 2282.8 mean that the odds ratio in favor of not being poor decreased by a factor of 2282.8 per unit increase in annual household income. The findings concur with those found in Elhadi *et al.* (2012). The study revealed that income diversification significantly reduces household poverty. Oyugi *et al.* (2000), Alemayehu *et al.* (2005), Burke *et al.* (2007) and Machio (2015) demonstrated that livestock provides milk, meat, and other products which increases household income and subsequently reduces household poverty. Similarly, Geda *et al*. (2005), Muyanga *et al.* (2006), Achieng' (2014), and Mwende (2016) found that an increase in income from crop diversification activities significantly reduces household poverty. However, contrary findings are reported in Mwabu *et al.* (2000) and Machio (2015) who found that dependence on agriculture and cash crops respectively increases the probability of farmers being poor.

Variable indicating age of household head is statistically significant (p = 0.066) with a negative coefficient (β = -2.009). The results mean that an increase in the age of household head increases his/her chance of becoming poor and vice versa. The odds ratio = 0.134 shows that *ceteris paribus*, an increase in the age of household head one year, increases log odds of a household becoming poor by 0.134 times and vice versa. As age increases, the productivity of household head decreases due to poor health associated with old age. The findings concur with those in Barrientos (2007), Mwanyangala *et al.* (2010), Harvison *et al.* (2011), Muleta and Deressa (2014) and Khamaldin *et al.* (2015). The studies revealed that the aging of the household head tends to increase the household probability of falling into poverty. Contrary results are reported in Akona (2014), who found that an increase in the age of household head significantly reduces household observed poverty. The study argued that as the household head grows older, he/she should accumulate more income that is sufficient to move their households out of poverty. Deressa (2013) concur with Akona (2014) that as the age of the household head increases his/her skills, experience, and assets and thus, the low probability of falling into poverty.

4.5 French beans farmer's vulnerability to expected poverty

4.5.1 Mean monthly consumption expenditure per adult equivalent

On average, households of French bean farmers, irrespective of whether certified or not certified spend KES 7,292 per month per adult equivalent (Table 28).

Table 28: Mean monthly consumption expenditure of French beans farmers

Variable	Mean (N = 492)	Std. Dev.	Min	Max
Mean consumption expenditure per month per adult equivalent	7,292	25,682	160	477,381

The mean monthly consumption expenditure is above the national consumption-based poverty line of KES 2,900 expenditure per month per adult equivalent. Given the poverty line and the consumption expenditure, the results suggest that on average, French bean farmers in Kirinyaga County are not poor.

4.5.2 Determinants of mean monthly consumption expenditure per adult equivalent

Determinants of mean household consumption expenditure were estimated using Ordinary Least Squares (OLS) nested in the Vulnerability to Expected Poverty approach and results presented in Table 29.

Table 29: Determinants of mean annual consumption expenditure

Variable	**Coefficients (β)**	**S. E**	**t**	**P>t**	**[95 percent C. I]**	
Dependent variable: [1]Consumption expenditure per adult equivalent (C_h)						
Distance to market	0.1171	0.0449	2.610	0.009**	.02883	0.2053
Assets value PAE	0.0910	0.0250	3.640	0.000***	0.0419	0.1401
Household size	-0.3842	0.0854	-4.500	0.000***	-0.5520	-0.2163
Net livestock income	0.0059	0.0084	0.710	0.479	-0.0105	0.0224
Off-farm income	0.0158	0.0068	2.310	0.021**	0.0024	0.0293
Acreage under French beans	-0.0414	0.0503	-0.820	0.411	-0.1404	0.0575
Net crop income	0.0300	0.0107	2.810	0.005**	0.0090	0.0509
Age of HH	0.0435	0.1394	0.310	0.755	-0.2304	0.3174
Credit access	0.0063	0.0859	0.070	0.942	-0.1625	0.1750
Gender HH	-0.1754	0.1318	-1.330	0.184	-0.4345	0.0837
No education	0.8573	1.5939	0.540	0.591	-2.2753	3.9899
Primary education	1.0633	1.5781	0.670	0.501	-2.0384	4.1649
Secondary education	1.2647	1.5780	0.800	0.423	-1.8367	4.3661
Tertiary education	1.1866	1.5846	0.750	0.454	-1.9278	4.3010
Net French beans income	-0.0374	0.0375	-1.000	0.319	-0.1111	0.0363
Risk preferences	-0.0392	0.0341	-1.150	0.251	-0.1063	0.0279
Group membership	0.0631	0.0844	0.750	0.456	-0.1029	0.2290
Constant	6.3042	1.7032	3.700	0.000***	2.9568	9.6517
Prob > F	0.0000					
R^2	0.1752					
Adjusted R^2	0.1430					

Notes: HH means Household, PAE means Per Adult Equivalent, C.I means Confidence Interval, S.E menas Standard Errors, and [1]consumption expenditure means annual consumption expenditure per adult equivalent generated using WHO conversion factors. ***$p < 0.01$, ** $p < 0.05$, *$p < 0.1$.

The first stage of the OLS shows that adjusted R^2 is 0.1430, indicating that at least 14.30 percent of the variation in the household means the explanatory variables explained consumption expenditure. The results show that the model statistically significant (p = 0.0000), indicating that the independent variables as a group had a significant influence on the output. Distance to the nearest market is statistically significant (p = 0.009) and positively (β = 0.1171) influencing household to mean consumption expenditure of French beans farmers. *Ceteris paribus*, an increase in the distance by one kilometer, mean household consumption expenditure per adult equivalent of French beans farmers increases by KES 0.1171 and vice versa. Transport cost increases with distance; hence, French beans farmers who covered longer distances to the nearest markets incurred more expenditure relative to those covered shorter distances.

Total annual asset value per adult equivalent is statistically significant (p = 0.000) and positively (β = 0.0910) influencing household to mean consumption expenditure of French beans farmers. *Ceteris paribus*, an increase in asset value by one unit will lead to an increase in mean household consumption expenditure per adult equivalent of French bean farmers by KES 0.0910 and vice versa. The results suggest that French bean farmers with more assets have high consumption levels. The study findings concur with those of Iqbal (2013) who found that rural households with higher physical and human capital enjoy higher consumption levels in Afghanistan.

Household size is statistically significant (p = 0.000) and negatively (β = -0.3842) impacted on the mean consumption expenditure. *Ceteris paribus*, an increase in household size by one member, reduces household consumption expenditure by KES 0.3842 and vice versa. That is, more household members increase the demand for limited household resources, and as the number of members increases, more money is needed to meet the increasing demand. Similar findings were reported in Iqbal (2013), who found that as household size increases the predicted consumption level also increases. Same results are reported in Sricharoen (2011).

Off-farm (p = 0.021|β = 0.0158) and net crop (p = 0.005|β = 0.0300) incomes are statistically significant and positively influencing the mean consumption expenditure. That is, *ceteris paribus*, an increase in off-farm and net crop incomes by KES 1 each, will lead to an increase in household consumption expenditure by KES 0.0158 and KES 0.0300 respectively and vice versa. Household expenditure depends on household income, and therefore, as household income increases, it is expected to affect household expenditures and vice versa positively.

4.5.3 French beans farmers' mean vulnerability to expected poverty

On average, French bean farmers, irrespective of whether certified or not, were not vulnerable to expected poverty as indicated by vulnerability level of 0.196 (19.6 percent), which is below the vulnerability threshold of 50 percent (Table 30).

Table 30: Mean vulnerability to expected poverty of French beans farmers

Variable	Mean	Standard Error	[95 percent Confidence interval]	
Mean vulnerability to expected poverty	0.196	0.0187	0.1597	0.2332

4.5.4 Vulnerability to expected poverty by French beans farmers' characteristics

Results in Table 31 show that the vulnerability of French beans farmers to expected poverty did not statistically and significantly vary according to their Global-GAP certification status (p = 0.347). The reason could be that income earned from the sale of certified French beans was not sufficient enough to drive French bean farmers out of poverty. The findings are in line with those of Masanjala (2006), who found that engagement in cash crop increases farmer's income but sometimes not sufficient enough to move households out of poverty.

Results in Table 31 further reveal that the majority of those who were expenditure poor (56.3 percent), and income poor (92.2 percent) were vulnerable to future poverty. The vulnerability rates are higher than the national vulnerability rate of 28.3 percent, rural rate of 31.9 percent, and Central Region of Kenya rate of 30.1 percent (Oxford Poverty and Human Development Initiative, 2017). The study confirms that there is a high likelihood that poverty among French beans farmers in Kirinyaga County will remain high in the future unless proper interventions to mitigate poverty are put in place. Given education, majority of those without education (4.7), primary education (64.1) and secondary education (28.9) are vulnerable to future poverty when compared to those with Certificate and Diploma (1.6) and Degree (0.8). Higher education levels are associated with high income from formal employment. High income increases household's consumption expenditure on basic needs and wants, thus reducing poverty. Similar findings are reported in Wasonga (2009).

Table 31: Respondent's characteristics by vulnerability to expected poverty

Vulnerability status (V_i): Vulnerable = 1 and otherwise = 0

Variable	N	Not Vulnerability	N	Vulnerable
Certification status (*ST_i*): Certified = 1 and otherwise = 0				
non-certified	142	39.1	56	43.8
Certified	222	60.9	72	56.2
Risk preferences				
I never like take risks	17	4.67	6	4.7
In most cases I don't like take risks	50	13.7	17	13.3
I sometimes like take risks	99	27.2	28	21.9
In most cases I like take risks	132	36.3	49	38.3
I always like take risks	64	17.6	27	21.1
No response	2	0.6	1	0.8
[1]Expenditure poverty: Not poor = EP_1 and Poor = EP_0				
Poor	123	33.8	72	56.3***
not poor	241	66.2	56	43.7***
[2]Income poverty: Not poor = PV_1 and Poor = PV_0				
Poor	239	65.7	118	92.2***
not poor	125	34.3	10	7.8***
Gender of HH				
Female	48	13.2	11	8.6
Male	316	86.8	117	91.4
Education level of HH				
No education	3	0.8	6	4.7***
Primary education	170	46.7	82	64.1***
Secondary education	157	43.1	37	28.9***
Certificate and diploma	31	8.5	2	1.6***
Degree	3	0.8	1	0.8***
Group membership				
Not a member of a group	94	25.8	39	30.5
Member of a group	270	74.2	89	69.5

Credit access				
No credit access	279	76.7	104	81.3
Credit access	85	23.3	24	18.7

Notes: HH means Household Head, PAE means Per Adult Equivalent, S.E menas Standard Errors, [1]expenditure poverty means expenditure poverty of farmers was determined using a poverty line of KES 2,900 per month, and [2]income poverty means income poverty of farmers was determined using poverty line of $1.90 per adult equivalent per day
***p < 0.01, ** p < 0.05, *p < 0.1.

4.5.5 Determinants of vulnerability to poverty

Determinants of vulnerability to poverty were estimated using Vulnerability to Expected Poverty Approach and results presented in Table 32.

Table 32: Determinants of vulnerability to expected poverty among French beans farmers

Dependent variable: [1]Vulnerability status (V_i): Vulnerable = 1 and otherwise = 0						
Variable name	**Coefficients (β)**	**S.E**	**z**	**P>z**	**[95 percent Confidence Interval]**	
Never like take risks	0.0652	0.4372	0.150	0.881	-0.7917	0.9220
In most cases don't like take risks	0.1015	0.4108	0.250	0.805	-0.7037	0.9066
Sometimes like take risks	0.3575	0.3974	0.900	0.368	-0.4214	1.1364
In most cases like take risks	0.8198	0.4194	1.950	0.051*	-0.0022	1.6417
Always like take risks	0.6978	1.0261	0.680	0.496	-01.313	2.7089
Certification status	-0.1303	0.1762	-0.740	0.459	-0.4756	0.2150
Assets value PAE	-0.4309	0.0605	-7.120	0.000***	-0.5495	-0.3124
No education	-5.5593	225.4922	-0.020	0.980	-447.5160	436.3974
Primary education	-6.9053	225.4916	-0.030	0.976	-448.8607	435.0500
Secondary	-7.2872	225.4916	-0.030	0.974	-449.2426	434.6681

education						
Tertiary education	-8.0017	225.4919	-0.040	0.972	-449.9578	433.9544
Household size	1.2671	0.2377	5.330	0.000***	0.8011	1.7331
Age of HH	-0.5472	0.3211	-1.700	0.088*	-1.1765	0.0822
Gender of HH	0.9689	0.2943	3.290	0.001**	0.3922	1.5457
Group membership	-0.2437	0.1963	-1.240	0.215	-0.6285	0.1411
Net livestock income	-0.0245	0.0191	-1.280	0.199	-0.0620	0.0129
Off-farm income	-0.0749	0.0160	-4.680	0.000***	-0.1062	-0.0435
Net crop income	-0.2023	0.0230	-8.810	0.000***	-0.2474	-0.1573
Distance to the market	-0.4360	0.1081	-4.030	0.000***	-0.6479	-0.2242
Constant	13.9598	225.4969	0.060	0.951	-428.0061	455.9256
Number of observation	492					
Likelihood Ratio χ^2 (11) (19)	275.26					
Prob > χ^2	p = 0.0000					
Pseudo R^2	0.4880					

Notes: HH means Household Head, PAE means Per Adult Equivalent, S.E menas Standard Errors, and [1]vulnerability means vulnerability to expected poverty, which was captured as Vulnerable = 1 and Not vulnerable = 0,
***p < 0.01, ** p < 0.05, *p < 0.1.

Variable indicating Global-GAP certification status is statistically insignificant (p = 0.459) indicating that income farmers receive from producing Global-GAP certified French beans (given several needs facing the households), will not guarantee poverty alleviation in future. Variable indicating asset value per adult equivalent is statistically significant (p = 0.000) and negatively (β = -0.4309) influencing vulnerability to poverty of French bean farmers. *Ceteris paribus*, an increase in asset values by one Kenyan Shilling, vulnerability of French bean farmers to expected poverty will reduce by 43.1 percent and vice versa. Asset accumulation, coupled with an increase in their value cushion farmers from future poverty. Similar findings are reported in Gbetibouo (2009), who found that wealth accumulation enhances the ability of households to bear anticipated risks. Ajijola *et al.* (2011) also revealed that an increase in the disposable household assets such as stored grains and livestock by one unit reduces poverty by 0.0000127 units. Similar findings are also reported in Muyanga *et al.* (2006) and Mbakahya and Ndiema (2015). However, Achieng' (2014) reported contrary findings that *ceteris paribus,* an additional high valued asset positively influences the severity of poverty by 0.280 times among French bean farmers in Kirinyaga County.

Household size is statistically significant (p = 0.000) and positively (β = 1.2671) influencing vulnerability to expected poverty. While everything else is held constant, an increase in household size by one member increases vulnerability to expected poverty by 126.7 percent and vice versa. Increasing the number of household members while holding income constant will lead to a decrease in the welfare of all members due to high competition for the existing scarce resources. Similar findings are reported in Muyanga *et al.* (2006), Muriithi (2008), Meenakshi and Ray (2000), Swanepoel (2005), Dirway (2010), Damisa *et al.* (2011), Mok *et al.* (2011), and Achieng' (2014) who concur that an additional household member increases household poverty. For instance, a study by Achieng' (2014) found that an additional household member increases the severity of poverty by 0.827 times among French beans farmers in Kirinyaga County. Contrary findings are reported in Megersa (2015) who found that large family size is a good source of labor for the household in the future that will undermine vulnerability to poverty.

Age of household head is statistically significant (p = 0.088) and positively (β = -0.5472) influencing French beans farmers vulnerability to expected poverty. That is, *Ceteris paribus*, an increase in the age of the household head by one year decreases the vulnerability of French beans farmers to expected poverty by 54.7 percent and vice versa. Household heads are household providers, as their age increases coupled with the poor health, their strength, and productivity decreases. As a result, household expenditure increases with dwindling income opportunities, thus increasing the household probability of falling into future poverty (Igbalajobi *et al.*, 2013). Similar findings are reported in Bogale *et al.* (2005) who found that as the age of household head increases they tend to own more assets and experience changes in the structure of the family as children grow and leave the household or contribute in lab our force to various farm activities.

Gender of the household head is statistically significant (p = 0.001) and positively (β = 0.9689) influencing French beans farmers' vulnerability to expected poverty. That is, *Ceteris paribus,* households headed by males are 0.9689 times more vulnerable to expected poverty and vice versa. Similar findings are reported in Hichaambwa *et al.* (2015) and Machio (2015).

According to Hichaambwa *et al.* (2015), female-headed households are less likely to be poor because they are more willing to participate in horticultural farming than male-headed households are. Machio (2015) found that headed male households in Kenya are 2 percent more likely to be poor compared to households that are headed by a female. Male-headed households control household incomes and expenses, and since they are the sole decision makers, they might decide to spend the money on personal effects rather than on the household income generating activities thus leading his household being poor. On the other hand, contrary findings are reported in Oyugi *et al.* (2000), Geda *et al.* (2005) and Githinji (2011).

Variable indicating French beans farmers who in most cases like taking risks is statistically significant (p = 0.051 and β = 0.8198) and positively relating to vulnerable to future poverty. This means that if farmers in Kirinyaga County continue producing French beans in the face of Global-GAP standards while holding current acreage constant, their vulnerability to expected poverty will increase by 82 percent and vice versa. That is, Global-GAP certification positively increases household's income, but the increase in French beans income is not sufficient to move the households out of poverty brackets. The findings are contrary to those of Mosley and Verschoor (2003) and Ghartey *et al.* (2014) who found that risk aversion increases poverty among farmers.

Net annual crop income (p = 0.000 and β = -0.2023) significantly and negatively influenced vulnerability to future poverty of French bean farmers. That is, *ceteris paribus*, an increase in net crop income by one Kenyan shilling will decrease vulnerability to expected poverty by 20.2 percent and vice versa. The findings concur with those of Muyanga *et al.* (2006), who found that income from crop diversification reduces a household's probability of falling into poverty among Kenyan farmers. Hulme and McKay (2005) argue that crop failure is associated with household vulnerability to poverty.

Off-farm income (p = 0.000 and β = -0.0749) significantly and negatively influence vulnerability to future poverty of French bean farmers. That is, *ceteris paribus*, an increase in net crop income and off-income of French bean farmers by one Kenyan shilling, vulnerability to expected poverty decrease by 7.5 percent and vice versa. In most cases, agricultural income is seasonal and unpredictable, thus, off-farm income or formal employment becomes one of the coping mechanisms that cushion farmers against observed and future poverty. The findings concur with those of Oyugi *et al.* (2000), Burke *et al.* (2007), Githinji (2011), Onyeiwu and Liu (2013) and Megersa (2015) who found that an increase in off-farm income cushion farmers from falling into poverty.

Distance to the nearest market is statistically significant (p = 0.000) and negatively (β = -0.4360) influencing vulnerability of French beans farmers to future poverty. That is, c*eteris paribus,* an increase in the distance to the nearest market by one kilometer, French beans farmers vulnerability to future poverty decreases by 43.6 percent and vice versa. Local or farm gate markets do offer lower prices, which translate to lower income. Lower income increases current and future poverty. Therefore, far markets like those in Nairobi and overseas, offer higher prices which translate to more income and thus a reduction in the future poverty. Contrary findings, however, are reported in Elhadi *et al.* (2012).

CHAPTER FIVE
CONCLUSIONS AND RECOMMENDATIONS

5.1 Overview of the chapter coverage

This chapter presents an overview of the key findings, conclusions, policy implications, and suggestions for further research.

5.2 Key findings

The study determined the effect of risk attitudes on Global-GAP certification decisions among French beans farmers. Using 5-point Likert scale on 492 respondents, the study found that cumulatively majority of risk-averse French beans farmers (55.6 percent) were not Global-GAP certified while the majority of risk takers (63 percent) were Global-GAP certified. The same trend was witnessed when a sample of 119 respondents was used. Majority of French beans farmers who sometimes (66.7 percent), in most cases (65.9 percent) and always like taking risks (59.3 percent) were the certified farmers while the majority (80 percent) of those who in most cases do not like taking risks were non-certified. Logistic regression results show that, *ceteris paribus,* French bean farmer who underweight expected returns and overweight production costs involved in compliance and certification processes (p = 0.046|β = -4.079) was 0.017 times more likely not to comply and get certified under Global-GAP standards. Also, given *ceteris paribus,* French bean farmers who were loss averse (p = 0.094|β = -0.192) were 0.825 times less likely to comply with the Global-GAP standards. However, French bean farmer who was risk-averse (P = 0.081|β = 3.263) were 26.130 times more likely to comply and be certified under Global-GAP standards to avoid expected risks and losses. Other important factors influencing Global-GAP certification decisions include contract farming (p = 0.000|β = -4.481), Cost of producing (p = 0.049|β = 0.885), total asset value (p = 0.092|β = 0.387), daily household expenditure per adult equivalent (p = 0.085|β = -0.003), and acreage under French beans (p = 0.033|β = 1.631).

Global-GAP certification significantly and positively influenced French beans income per acre. Global-GAP certified French beans farmers earned more income per acre of French beans as indicated by Mean difference of KES -9,216.86 per acre. Results further indicate that Global-GAP certification had no impact on observed poverty. On average, irrespective of whether Global-GAP certified or not, the majority of the French beans farmers were poor (72.6 percent). Non-poor households had the highest: Net annual French beans income (MD = 24,133), French beans production costs (MD = 3,562), net crop income (MD = 150,608), net livestock income (MD = 21,674), incomes from other sources (MD = 198,070), total net annual household income (MD = 370,352), total annual expenditure (MD = 79,726) and expenditure on food items (MD = 52,541). The results mean that income earned from Global-GAP certification increased household income and expenditure, but the increase was not sufficient enough to alleviate observed poverty among French beans farmers. The possible reason is the low acreage Global-GAP certified French beans since the farmers cultivated an average of 0.5 acres.

PSM results show that Global-GAP compliance and certification significantly and positively influenced net income per acre of French beans, total annual household income per adult equivalent and total household expenditure per adult equivalent but statistically had no effect on annual household asset value per adult equivalent. On average, net annual French beans income per acre increased by KES 23,000.70 (t = 4.073) for NNM, KES 17,307.70 (t = 3.876) for SMM, KES 26,269.80 (t = 2.794) for RMM and KES 18,095.10 (t = 4.033) for KMM among Global-GAP certified farmers. Asfaw *et al.* (2010) found that *ceteris paribus*, Eurep-GAP certified vegetable farmers earn a net income of KES 5,271 per acre that is directly associated with compliance with the standards. The results further show that relative to non-certified farmers, total annual household income per adult equivalent among Global-GAP certified farmers increased by KES 18,146.20 (t = 1.998) for SMM, KES 33,094.30 (t = 1.675) for RMM and KES 19,218.50 (t = 2.012) for KMM. Finally, Nearest-Neighbour estimation Method shows that annual expenditure per adult equivalent among Global-GAP certified farmers is 25.9 percent higher than expenditure among non-certified farmers. The study concludes that Global-GAP certification significantly and positively increases household welfare. That is, it increases French beans farmers household income and expenditure.

The study further determined the effect of risk preferences on observed poverty among French beans farmer. Results indicate that risk-averse farmers had the lowest annual income per adult equivalent ranging between KES 102 and KES 134, while risk takers had the highest annual income per adult equivalent ranging between KES 188 and 250. Majority of risk takers (86.6 percent) were not poor when compared to the cumulative percentage of the poor category (78.9 percent) that were risk averse. Aversion to risks ($p = 0.051|\beta = -2.802$), household size ($p = 0.000|\beta = -5.032$), daily household expenditure per adult equivalent ($p = 0.001|\beta = 2.016$), net annual household income ($p = 0.000|\beta=7.733$), access to credit ($p = 0.086|\beta = 1.187$), household annual asset value ($p = 0.051|\beta = -0.482$) and age of household head ($p = 0.066|\beta = -2.009$) statistically and significantly influence poverty status of French beans farmers.

Finally, the study determined the vulnerability of French beans farmers to future poverty in the face of Global-GAP standards using Vulnerability to Expected Poverty approach. The results show that on average, French beans farmers spent KES 7,292 per month per adult equivalent. This figure is above the national consumption-based poverty line of KES 2,900 expenditure per month per adult equivalent. Mean vulnerability to expected poverty stood at 0.196 (19.6 percent), which is below the vulnerability threshold of 50 percent. That is, on average, French bean farmers were not vulnerable to expected poverty. Global-GAP certification status (p = 0.347) and risk preferences (p = 0.866) were statistically insignificant indicating that income associated with Global-GAP certification will not be sufficient enough to drive French bean farmers out of poverty in future. Majority of French beans farmers who were expenditure (56.3 percent) and income poor (92.2 percent) were vulnerable to future poverty. French beans farmers who in most cases like taking risks ($p = 0.051|\beta = 0.8198$) were more likely to be vulnerable to future poverty. That is, if farmers continue producing French beans in the face of Global-GAP standards while holding current acreage constant, their vulnerability to expected poverty will increase by 82 percent and vice versa. That is, although Global-GAP certification significantly and positively increases household's income, the increase in income is not sufficient to move the households out of the current and future poverty brackets. Other important factors influencing French beans farmers vulnerability to expected poverty include asset value per adult equivalent ($p = 0.000|\beta = -0.4309$), household size ($p = 0.000|\beta = 1.2671$), age of household head ($p = 0.088|\beta = -0.5472$), gender of household head ($p = 0.001|\beta = 0.9689$), net crop income ($p = 0.000|\beta = -0.2023$), off-farm income ($p = 0.000|\beta = -0.0749$), and distance to the nearest market ($p = 0.000|\beta = -0.4360$).

5.3 Conclusions

French beans farmers who were loss averse and those who under-weighed expected returns and over-weighed costs involved in Global-GAP compliance and certification processes were less likely to comply with the standards and vice versa. However, risk-averse French beans farmers were more likely to comply with Global-GAP standards. Although High returns characterize Global-GAP compliance and certification, it is also associated with high losses. Due to the fear of risks, risk-averse farmers who produced Global-GAP certified French beans were forced to comply fully with the standards to avoid the risks associated with them.

Global-GAP compliance and certification statistically and significantly influenced welfare indicators positively. Global-GAP certification increased net French beans income per acre, daily total household income per adult equivalent, and daily annual household expenditure. The global-gap certification did not statistically and significantly influence observed poverty among French beans farmers, possibly due to low acreage cultivated under Global-GAP certified French beans.

The study found a positive relationship between risk-taking and poverty reduction. Relative to the risk takers, risk-averse French beans farmers had the lowest total annual income per adult equivalent. Majority of risk takers were not poor when compared to the cumulative percentage of the poor category that was risk averse. From the results, it is clear that access to crop insurance to mitigate aversion to risks, access to credit facilities, household income diversification and reduction in current asset accumulation are necessary for French beans farmers to overcome observed poverty. Results further show that there is no relationship between Global-GAP certification and vulnerability to expected poverty. Nonetheless, the majority of those who were expenditure and income poor were more vulnerable to expected poverty.

5.4 Policy implications

Given that French beans farmers are loss averse, French beans farmers should take up crop insurance to cushion them against risks and losses associated with compliance with Global-GAP standards. Also, processes involved in Global-GAP compliance and certification are costly. French beans farmers, therefore, should take up credit facilities to enable them to comply fully with the standards with ease and hence prevent the risks and losses associated with the standards. Both National and County Governments should also help French beans farmers comply with the standards by subsidizing necessary inputs required for compliance and certification processes.

Compliance with Global-GAP standards increased household income and expenditure, but the increase in the income and expenditure did not reduce observed poverty. French beans farmers are therefore advised to take more risks by expanding the acreage under Global-GAP certified French beans to increase their income and expenditure, thus alleviate observed poverty facing them. French beans farmers should also diversify their farming activities and seek off-farm sources of income to reduce their observed poverty. National and County Governments should identify viable interventions and set different strategies to strengthen the grassroots economy in the County.

Since a positive relationship exists between risk-taking and poverty reduction in the face of Global-GAP certification, French beans farmers are advised to continue producing and expanding the acreage under Global-GAP certified French beans. Risk and loss averse farmers are encouraged to venture into French beans production in the face of Global-GAP standards since it is profitable, and it can reduce household poverty. French beans farmers should do away with non-profitable family enterprises and venture into French beans farming in the face of Global-GAP standards. Since the production of Global-GAP certified Frenchs is a profitable venture, Government (both national and County Governments) in collaboration with financial institutions (insurance companies and banks) should develop insurance and credit products relevant to farmers producing vegetables for export. This will mitigate aversion to risks and lack of capital among vegetable farmers.

French bean farmers who were expenditure and income poor were more vulnerable to expected poverty. To address this, French beans farmers should take more risks by continuing producing and expanding the acreage under Global-GAP certified French beans to increase household income and expenditure and hence alleviating future poverty. Also, both National and County Governments should come up with projects and programs that will increase farmers' incomes and consequently reduce household poverty. For instance, the development of insurance scheme for vegetable farmers producing for export and subsidies on key inputs such as agrochemicals, fertilizer, and credit facilities need to be implemented by the Government.

5.5 Suggestions for further research

Given that French beans farmers are averse to losses and risks, studies on factors influencing French beans farmers' attitudes towards risks are recommended. Further research is also recommended on the impact of Global-GAP compliance and certification on poverty among French beans farmers using other different empirical models such as the double hurdle model for verification purposes. The study determined risk preferences using a 5-point Likert scale and estimated the risk preferences on the observed and vulnerability to expected poverty. Therefore, a study to determine risk preferences using social experiment and estimate them on the observed and vulnerability to expected poverty among French beans farmers is recommended for verification purposes.

Further studies are recommended to use Vulnerability as low Expected Utility and Vulnerability as uninsured Exposure to Risk approaches in determining the vulnerability of French beans farmers to future poverty for benchmark purposes. In the literature review, it is clear that poverty in a household is a function of several factors. In this study, not all the factors influencing compliance with Global-GAP standards and vulnerability to expected poverty were estimated. Further research on the same is therefore recommended.

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APPENDICES

1.1.1.35 APPENDIX A1: EXPERIMENTS FOR SOLICITING RISK ATTITUDES

A1.1 Risk preference experiments

A1.1.1 Procedure

Lead enumerator gave a demonstration first and explained that everyone would receive a payment from the series as follows. “Payments will take place today. Local enumerators-it is your job to make sure 2-3 respondents understand the concepts presented by lead enumerator”.

i. The purpose o this series is to estimate risk preferences from respondents as they choose between 2 different options. In each series, there are 9 tasks, each with one riskier (option B) and less riskier option (option A) to choose between. As one moves down a single table, the probability of a bad outcome (number of bad outcomes out of 10) is the only thing changing. As the probability of a bad outcome increases, respondents are more likely to choose the less risky prospect (expect a switch from option B to A).
ii. The lead enumerator will choose a random starting point. Remember after the random starting point is chosen; work individually with one respondent until their switching point has been identified. Then work with the next respondent.
iii. Rationa behaviorur implies that, there will be only one switch point in each of the series, or no switch point at all. As the local enumerator, it is your job to make sure the respondent understand and makes careful and preferred choices. Circle respondent’s choices. Once a switch has occurred, stop respondent and fill in the rest of the table with expected choices
iv. Be patient, especially at the beginning to make sure respondents understand.

A1.2 Prospect theory experiments

A1.2.1 Procedure

Lead enumerator will give a demonstration first. Remind respondents that, the last series will be played for real payments, so make choices carefully. Local enumerators – it is your job to make sure your 2-3 respondents understand the concepts presented by the lead enumerator.

i. In each of the following two series, the probabilities of good and bad outcomes stay constant across tasks but vary across prospect. Option A is kept constant within series but the better outcome in option B is increasing as you move down the table

ii. The lead enumerator will use a random starting point procedure as before for each series. After this is chosen, local enumerators will work with 1 respondent until a switch point is identified. Then work with the other respondent.
iii. Respondents should switch from option A to B at some point (or not at all), so the switch point opposite from the previous series. Thus if the random starting point is at task 4 and the respondent chooses A, begin moving down the table until you identify a switch point. It is possible that you will not observe a switch point. Do not allow respondents to switch back and forth.
iv. Circle respondent's choices as before.

A1.3 Loss aversion experiments

A1.3.1 Procedure

Lead enumerator will give a demonstration first. Remind respondents that this is when they could potentially lose some of the KES 200 they have received today to play the games. They should expect to win more or lose some of this KES 200 today. Local enumerators – it is your job to make sure your 2-3 respondents understand the concepts presented by the lead enumerator.

i. Introduce each of the 7 tasks in a similar way to the previous experiments
ii. Lead respondent will determine the random starting point
iii. You should expect a switch from option A to Option B, or no switch at all (all A or all B)
iv. Circle the preferred option in each row as in the previous series. Once the switch point is identified, stop the respondent and fill in the remaining tasks following their choices.

1.1.1.36 APPENDIX A2: CORRELATION OF FACTORS AFFECTING OBSERVED POVERTY

		Gender of the household head	House hold size	Primary	Secondary	Age of Household head	Never Like Risks	Always Like Risks	Type of farmer	Membership to groups	Did the household try to access credit last year	Net French Bean Income	Total Net Household Income	Total annual asset value	Off-farm income	Expenditure per adult equivalent	Total Land size owned (acres)
Gender of the household head	Pearson Correlation	1	.082	-.074	.052	-.007	.022	.031	-.022	.071	.016	.033	.075	.070	.034	-.035	.035
	Sig. (2-tailed)		.068	.102	.253	.882	.619	.495	.622	.115	.721	.464	.097	.123	.456	.435	.432
	N	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492
Household size	Pearson Correlation	.082	1	.015	.004	.100*	.034	.016	-.040	.017	-.016	.053	.026	.075	.012	-.025	.017
	Sig. (2-tailed)	.068		.741	.924	.027	.449	.725	.373	.711	.723	.241	.569	.098	.794	.586	.703
	N	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492
Primary	Pearson Correlation	-.074	.015	1	-.816**	-.048	.082	-.078	.000	-.047	-.045	-.034	-.147**	-.100*	-.129**	-.016	-.065
	Sig. (2-tailed)	.102	.741		.000	.291	.069	.085	.998	.297	.318	.450	.001	.027	.004	.725	.150
	N	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492
Secondary	Pearson Correlation	.052	.004	-.816**	1	.004	-.059	-.048	.011	.027	.065	.007	.071	.091*	.054	.030	.056
	Sig. (2-tailed)	.253	.924	.000		.933	.193	.284	.812	.547	.151	.877	.118	.044	.231	.506	.215
	N	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492
Age of Household head	Pearson Correlation	-.007	.100*	-.048	.004	1	-.079	.003	.087	.064	-.004	.033	.018	.114*	.029	.035	.113*
	Sig. (2-tailed)	.882	.027	.291	.933		.082	.956	.055	.155	.931	.460	.685	.011	.515	.438	.012
	N	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492
Never Like Risks	Pearson Correlation	.022	.034	.082	-.059	-.079	1	-.105*	-.054	-.060	-.049	-.008	-.051	-.044	-.053	-.012	-.028
	Sig. (2-tailed)	.619	.449	.069	.193	.082		.019	.233	.182	.282	.851	.261	.335	.240	.782	.538
	N	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492
Always like risks	Pearson Correlation	.031	.016	-.078	-.048	.003	-.105*	1	.103*	.042	.061	.087	.132**	.113*	.105*	-.032	-.008
	Sig. (2-tailed)	.495	.725	.085	.284	.956	.019		.023	.348	.177	.054	.003	.012	.020	.478	.862
	N	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492
Type of farmer	Pearson Correlation	-.022	-.040	.000	.011	.087	-.054	.103*	1	.135**	.108*	.101*	-.005	.032	-.039	.003	.059

	Sig. (2-tailed)	.622	.373	.998	.812	.055	.233	.023		.003	.016	.025	.908	.473	.385	.940	.189
	N	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492
Membership to groups	Pearson Correlation	.071	.017	-.047	.027	.064	-.060	.042	.135**	1	.137**	.046	.046	.049	.054	.044	-.054
	Sig. (2-tailed)	.115	.711	.297	.547	.155	.182	.348	.003		.002	.313	.312	.278	.233	.327	.228
	N	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492
Did the household try to access credit last year	Pearson Correlation	.016	-.016	-.045	.065	-.004	-.049	.061	.108*	.137**	1	.095*	.099*	.045	.020	-.028	-.080
	Sig. (2-tailed)	.721	.723	.318	.151	.931	.282	.177	.016	.002		.036	.029	.317	.657	.536	.076
	N	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492
Net French Bean Income	Pearson Correlation	.033	.053	-.034	.007	.033	-.008	.087	.101*	.046	.095*	1	.397**	.034	.187**	.058	.019
	Sig. (2-tailed)	.464	.241	.450	.877	.460	.851	.054	.025	.313	.036		.000	.457	.000	.199	.673
	N	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492
Total Net Household Income	Pearson Correlation	.075	.026	-.147**	.071	.018	-.051	.132**	-.005	.046	.099*	.397**	1	.069	.826**	.007	.044
	Sig. (2-tailed)	.097	.569	.001	.118	.685	.261	.003	.908	.312	.029	.000		.126	.000	.880	.327
	N	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492
Total annual asset value	Pearson Correlation	.070	.075	-.100*	.091*	.114*	-.044	.113*	.032	.049	.045	.034	.069	1	.030	.024	.079
	Sig. (2-tailed)	.123	.098	.027	.044	.011	.335	.012	.473	.278	.317	.457	.126		.509	.600	.080
	N	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492
Off-farm income	Pearson Correlation	.034	.012	-.129**	.054	.029	-.053	.105*	-.039	.054	.020	.187**	.826**	.030	1	.002	.048
	Sig. (2-tailed)	.456	.794	.004	.231	.515	.240	.020	.385	.233	.657	.000	.000	.509		.957	.285
	N	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492
Expenditure per adult equivalent	Pearson Correlation	-.035	-.025	-.016	.030	.035	-.012	-.032	.003	.044	-.028	.058	.007	.024	.002	1	-.008
	Sig. (2-tailed)	.435	.586	.725	.506	.438	.782	.478	.940	.327	.536	.199	.880	.600	.957		.854
	N	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492
Total Land size owned (acres)	Pearson Correlation	.035	.017	-.065	.056	.113*	-.028	-.008	.059	-.054	-.080	.019	.044	.079	.048	-.008	1
	Sig. (2-tailed)	.432	.703	.150	.215	.012	.538	.862	.189	.228	.076	.673	.327	.080	.285	.854	
	N	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492	492

1.1.1.37 APPENDIX A3: SURVEY QUESTIONNAIRE

A.	**ENUMERATOR'S NAME**____	
B.	**ENUMERATOR'S MOBILE NO:**____	
C.	**HOUSEHOLD ID:** ____	
D.	**COUNTY:**	1=Nandi, 2=Uasin-Gishu, 3=Trans-Nzoia, 4=Elgeiyo-Marakwet
E.	**TYPE OF FARMER (circle):**	1= Certified 0= Non-certified

RESEARCH TOPIC

RISK ATTITUDES TOWARD PRIVATE STANDARDS AND EFFECTS ON WELFARE AMONG FRENCH BEANS FARMERS IN CENTRAL REGION OF KENYA

HALLO, my name is NOAH KIBET and I am a PhD student at Egerton University. As part of my PhD studies, I am conducting research on the above-mentioned topic. You have been randomly chosen to participate in this study and therefore requested to provide the enumerator with accurate information. Your participation is **VOLUNTARY** and information you provide will be treated with **CONFIDENTIALITY.** You are also assured that information you provide will be used for the sole purpose of research. Your support is highly appreciated. Thank you**.**

General information

1. Date of interview [____]

2. Name of Respondent (optional) [____________________________]

3. Sub-County [____ ____]

4. Ward [____]

5. Respondent's gender 1=Male, 2= Female

6. Age of HH head [____]

7. Education level (circle) 0=None, 1=Primary, 2=Secondary, 3=Diploma, 4=Degree.

8. Marital status (circle) 0=Single, 1=Married, 2=Divorced, 3=Widow.

9. If married, many wives[____________________________________]

10. Years of experience in farming[_____________________________]

11. If a farmer is certified, did he/she get any support? 0=No, 1=Yes

12. If yes, who provided the support? 1=Donor, 2=Exporter, 3=Other (specify)_______

13. Is farmer under any form of contract in farming? 0=No, 1=Yes

14. If yes, is it 1=Formal, 2=Informal, 3=Other (specify)__________________________

15. Purpose of the contract____

16. If certified under Global-GAP standards, please indicate your level of awareness (*Circle*)

i) Not aware (*Have not heard about*) =0

ii) Aware (*Have heard about but know few details*) =1

iii) Interest (*Know details but have not considered using*) =2

iv) Evaluation (*considered using, but have made no decision*) =3

v) Trial (*Have definitely decided to use*) =4

vi) Adoption (*Have already been using in my farm*) =5

vii) Rejection (*Have definitely decided not to use*) =6

17. Experiment series for assessing risk attitudes of farmers

17.1 Risk preference series 1

Risk preference series 1				
Task No.	Starting point	Option A	Option B	How to identify a switching point
1		100 if 1 150 if 2 3 4 5 6 7 8 9 10	20 if 1 200 if 2 3 4 5 6 7 8 9 10	
2		100 if 1 2 150 if 3 4 5 6 7 8 9 10	20 if 1 2 200 if 3 4 5 6 7 8 9 10	
3		100 if 1 2 3 150 if 4 5 6 7 8 9 10	20 if 1 2 3 200 if 4 5 6 7 8 9 10	If option A is chosen, move UP the table
4		100 if 1 2 3 4 150 if 5 6 7 8 9 10	20 if 1 2 3 4 200 if 5 6 7 8 9 10	
5		100 if 1 2 3 4 5 150 if 6 7 8 9 10	20 if 1 2 3 4 5 200 if 6 7 8 9 10	
6		100 if 1 2 3 4 5 6 150 if 7 8 9 10	20 if 1 2 3 4 5 6 200 if 7 8 9 10	
7		100 if 1 2 3 4 5 6 7 150 if 8 9 10	20 if 1 2 3 4 5 6 7 200 if 8 9 10	If option B is chosen, move DOWN the table
8		100 if 1 2 3 4 5 6 7 8 150 if 9 10	20 if 1 2 3 4 5 6 7 8 200 if 9 10	
9		100 if 1 2 3 4 5 6 7 8 9 150 if 10	20 if 1 2 3 4 5 6 7 8 9 200 if 10	

17.2 Risk preference series 2

Risk preference series 2				
Task No.	**Starting point**	**Option A**	**Option B**	**How to identify a switching point**
1		185 if 1 275 if 2 3 4 5 6 7 8 9 10	20 if 1 375 if 2 3 4 5 6 7 8 9 10	If option A is chosen, move UP the table
2		185 if 1 2 275 if 3 4 5 6 7 8 9 10	20 if 1 2 375 if 3 4 5 6 7 8 9 10	
3		185 if 1 2 3 275 if 4 5 6 7 8 9 10	20 if 1 2 3 375 if 4 5 6 7 8 9 10	
4		185 if 1 2 3 4 275 if 5 6 7 8 9 10	20 if 1 2 3 4 375 if 5 6 7 8 9 10	
5		185 if 1 2 3 4 5 275 if 6 7 8 9 10	20 if 1 2 3 4 5 375 if 6 7 8 9 10	
6		185 if 1 2 3 4 5 6 275 if 7 8 9 10	20 if 1 2 3 4 5 6 375 if 7 8 9 10	If option B is chosen, move DOWN the table
7		185 if 1 2 3 4 5 6 7 275 if 8 9 10	20 if 1 2 3 4 5 6 7 375 if 8 9 10	
8		185 if 1 2 3 4 5 6 7 8 275 if 9 10	20 if 1 2 3 4 5 6 7 8 375 if 9 10	
9		185 if 1 2 3 4 5 6 7 8 9 275 if 10	20 if 1 2 3 4 5 6 7 8 9 375 if 10	

18. Prospect theory experiments

18.1 Prospect theory series 1

Prospect theory series 1				
Task No.	Starting point	Option A	Option B	How to identify a switching point
1		100 if 1 2 3 4 5 6 7 200 if 8 9 10	50 if 1 2 3 4 5 6 7 8 9 200 if 10	
2		100 if 1 2 3 4 5 6 7 200 if 8 9 10	50 if 1 2 3 4 5 6 7 8 9 250 if 10	
3		100 if 1 2 3 4 5 6 7 200 if 8 9 10	50 if 1 2 3 4 5 6 7 8 9 300 if 10	If option A is chosen, move DOWN the table
4		100 if 1 2 3 4 5 6 7 200 if 8 9 10	50 if 1 2 3 4 5 6 7 8 9 350 if 10	
5		100 if 1 2 3 4 5 6 7 200 if 8 9 10	50 if 1 2 3 4 5 6 7 8 9 400 if 10	
6		100 if 1 2 3 4 5 6 7 200 if 8 9 10	50 if 1 2 3 4 5 6 7 8 9 450 if 10	
7		100 if 1 2 3 4 5 6 7 200 if 8 9 10	50 if 1 2 3 4 5 6 7 8 9 500 if 10	If option B is chosen, move UP the table
8		100 if 1 2 3 4 5 6 7 200 if 8 9 10	50 if 1 2 3 4 5 6 7 8 9 550 if 10	
9		100 if 1 2 3 4 5 6 7 200 if 8 9 10	50 if 1 2 3 4 5 6 7 8 9 600 if 10	

18.2 Prospect theory series 2

Prospect theory series 2				
Task No.	**Starting point**	**Option A**	**Option B**	**How to identify a switching point**
1		100 if 1 200 if 1 2 3 4 5 6 7 8 9 10	50 if 1 2 3 250 if 4 5 6 7 8 9 10	
2		100 if 1 200 if 1 2 3 4 5 6 7 8 9 10	50 if 1 2 3 285if 4 5 6 7 8 9 10	
3		100 if 1 200 if 1 2 3 4 5 6 7 8 9 10	50 if 1 2 3 320 if 4 5 6 7 8 9 10	If option A is chosen, move DOWN the table
4		100 if 1 200 if 1 2 3 4 5 6 7 8 9 10	50 if 1 2 3 355 if 4 5 6 7 8 9 10	
5		100 if 1 200 if 1 2 3 4 5 6 7 8 9 10	50 if 1 2 3 385 if 4 5 6 7 8 9 10	
6		100 if 1 200 if 1 2 3 4 5 6 7 8 9 10	50 if 1 2 3 420 if 4 5 6 7 8 9 10	
7		100 if 1 200 if 1 2 3 4 5 6 7 8 9 10	50 if 1 2 3 455 if 4 5 6 7 8 9 10	If option B is chosen, move UP the table
8		100 if 1 200 if 1 2 3 4 5 6 7 8 9 10	50 if 1 2 3 490 if 4 5 6 7 8 9 10	
9		100 if 1 200 if 1 2 3 4 5 6 7 8 9 10	50 if 1 2 3 525 if 4 5 6 7 8 9 10	
10		100 if 1 200 if 1 2 3 4 5 6 7 8 9 10	50 if 1 2 3 560 if 4 5 6 7 8 9 10	

NB: payment for risk preference and prospect theory games will take place at the end of the session

19. Loss aversion experiments

19.1 Loss aversion series 1

Prospect theory series 1				
Task No.	Starting point	Option A	Option B	How to identify a switching point
1		185 if 1 2 3 4 5 -30 if 6 7 8 9 10	200 if 1 2 3 4 5 -150 if 6 7 8 9 10	
2		30 if 1 2 3 4 5 -30 if 6 7 8 9 10	200 if 1 2 3 4 5 -150 if 6 7 8 9 10	If option A is chosen, move DOWN the table
3		5 if 1 2 3 4 5 -30 if 6 7 8 9 10	200 if 1 2 3 4 5 -150 if 6 7 8 9 10	
4		5 if 1 2 3 4 5 -30 if 6 7 8 9 10	200 if 1 2 3 4 5 -120 if 6 7 8 9 10	
5		5 if 1 2 3 4 5 -60 if 6 7 8 9 10	200 if 1 2 3 4 5 -120 if 6 7 8 9 10	
6		5 if 1 2 3 4 5 -60 if 6 7 8 9 10	200 if 1 2 3 4 5 -100 if 6 7 8 9 10	If option B is chosen, move UP the table
7		5 if 1 2 3 4 5 -60 if 6 7 8 9 10	200 if 1 2 3 4 5 -80 if 6 7 8 9 10	

NB: Payments for in loss aversion will take place after time preference payments, risk preference payments and prospect theory payments.

<u>PAYMENTS</u>

I. Payment in risk preference experiments

The lead enumerator will put 2 balls in the bag and have a random respondent draw a ball to determine which series will be for real payout. For the chosen task, it is possible that, your respondents will have chosen different options (document below). Pay attention when the lead enumerator draws the balls for different options. Record your respondents' results below.

	Question	Response
D.1	What series was chosen for payout?	
D.2	What task was selected for payout?	
D.3	Identify the option that the respondent had chosen for task in C.2 (A or B)	
D.4	Amount won by this respondent	

II. Payment for loss aversion experiments

The lead enumerator will put balls into the bag and draw 1 to determine which task will be played for real payment (document below). See whether your respondent chose A or B for that particular task (document below). The lead enumerator will then have someone draw one ball from balls to determine whether it was a gain or loss.

	Question	Response
E.1	What task was selected for payout?	
E.2	Identify the option that the respondent had chosen for the task in D.1 (A or B)	
E.3	Record the amount of money won or loss by respondent in this series (put KES XXX for winnings; put-KES XXX for losses	
E.4	Total amount won by respondent to be paid (KES 200 + D.4 + E.3)	
E.5	Signature of player signifying they received their payments (not including any potential time preference payment)	

FOR ACCOUNTING PURPOSES, PLEASE FILL AND DETACH TO GIVE TO YOUR SUPERVISOR

Risk and time preference games: Central Region, Kenya	
Respondent name	
Household ID number	
Respondent village	
Enumerator name	
Date of games	
Future payment for time preference (if any)	
Date on which it is to be paid	
Total payment received by farmer (KES 200 + risk/prospect theory +/- loss aversion)	
Signature for farmer having received payment after the games but not including time preference payments	
Signature for supervisor for verification	

20. GLOBAL-GAP STANDARDS ADOPTION AND RISKINESS

a) If certified, for how many years have you been certified 1=1year, 2=2 years, 3=3 Other (*specify*)________

b) Why did you choose to be certified under Global-GAP standard (state reasons)

i. ____

ii. ____

iii. ____

iv. ____

v. ____

c) What type of certification:

1. Individual
2. Group

20.1 The 5-point Likert scale

20.1.1 Please assess yourself in terms of whether you prefer taking risks or not using a 5-point likert scale provided below (Circle appropriate choice)

1. "I never like take risks"

2. “In most cases I don’t like take risks”
3. “I sometimes like take risks”
4. “In most cases I like take risks”
5. “I always like take risks”

21. What strategies do you employ as a household to prevent future poverty

S. No	Strategy
1	
2	
3	
4	
5	
6	
7	
8	
10	
11	
12	
13	

22. Crop production and income information

22.1 Land ownership and types of crops produced (Jan-Dec, 2014) (Ask for major crops grown)

Total Land size owned (acres)	**S. No**	**Crops produced within the year 2014**	**Acreage (acres)**
	1		
	2		
	3		
	4		
	5		

22.2 Labor se information in crop production

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

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

22.3 Physical input expenditure in crop production

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

Totals					

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

22.4 Total crop income (Jan-Dec 2014)

Crop type	**Total output per year (Kgs)**	**Total amount sold/year**	**Price received / Unit in (KES)**	**Total income received**	**Buyer type** 1. Export (certified) 2. Local (certified) 3. Local (Non-certified)
Others					
Total					

23. Livestock production and income information

23.1 Labor use information in livestock production

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

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

23.2 Physical input expenditure in livestock production

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

23.3 Livestock ownership, mortalities, consumed, sold and income received

S.No	Livestock type	No. owned within Jan-Dec, 2014	Total value using current market prices	No. consumed	No. died	No. Sold	Price/ Unit sold (KES)	Total income received
1	Local dairy cows							
2	Exotic dairy cows							
3	Total bulls (local and exotic)							
4	Total Calves (local and exotic)							
5	Total goats (local and exotic)							
6	Total sheep (local and exotic)							
7	Total poultry (chicken, turkeys, ducks e.t.c)							
8	Donkeys							
9	Pigs							
10	Rabbits							
11	Beehives							
12	Others (*specify*)							
Total								

23.4 Income from livestock products

Livestock product	Unit of measurement	Total output/year	Total value using current market prices	Total amount consumed /year	Total amount Sold /year	Price /Unit (KES)	Total income received
Cow Milk							
Goat milk							
Eggs							
Other poultry products							
Honey							
Hides and skins							
Fish							
Manure							
Others (specify):							
Total							

24. Other sources of income (Off-farm income) for the household

Type of earning	Total months income earned	Total annual income earned

Total		

25. Current assets owned by the household in their current value

Item		Current No.	Unit value	Total current value	Item		Current number	Unit value	Total current value
Cow shed (s)	**1**				Farm house(s)	**19**			
Ox plough	**2**				Furniture	**20**			
Food store	**3**				Panga	**21**			
Water trough	**4**				Jembe	**22**			
Milking shed	**5**				Vehicle(s)	**23**			
Fence for paddocks	**6**				Tractor	**24**			
Chuff cutter	**7**				Tractor trailer	**25**			
Wheel barrow	**8**				Water tank	**26**			
Sprayer pump	**9**				Posho mill	**27**			
Donkey/ox cart	**10**				Cereals Sieve	**28**			
Feed troughs	**11**				Well	**29**			
Milk Buckets	**12**				Power saw	**30**			
Bicycle	**13**				Mobile phone	**31**			
Television	**14**				Fish pond	**32**			
Radio	**15**				Irrigation equip.	**33**			
Spade	**16**				Borehole	**34**			
Solar Panel	**17**				Generator	**35**			
Total land value	**18**				**Other (Specify)**	**36**			
						37			
						38			
						39			
					Total				

26. Household size and labour availability (within Jan-Dec, 2014)

HH member	First Name	Sex 1=Male 0=Female	Relationship to head 1=Head 2=Spouse 3= Child 4=Relative 6= Worker 7= Grand parent 8=Others	Number of months living at home in the last 12 months	Age in years	Months worked on HH farm activities	Months involved in off-farm activities	Average income earned /year from the activity(s) in KES
1								
2								
3								
4								
5								
6								
7								
8								
9								

26.1.1. Which type of labour do you use? **1=Family 2=Hired**

26.1.2. If hired, what is the total cost incurred in 2014 season? (KES) **wage___________**

27. Access to institutional support, training and extension services

27.1.1. Please indicate the following details on road conditions in the region

Issue	Distance for all-weather portion (Kms)	Distance for tamarked portion (Kms)	Cost of transporting unit of farm produce to this market (KES)
Nearest shopping centre			
Nearest market for agricultural products			
Nearest urban Centre			
Total			

27.1.2. Access to training services

27.1.2.1. Has anyone in the household attended a farmer training last year? **1= Yes, 0= No**

27.1.2.2. If yes, how many times _______________________________________

27.1.2.3. What was the training about?________________________________

27.1.3. Access to extension services

27.1.3.1. Distance to the nearest extension service (Kms) _________________

27.1.3.2. Did you receive extension contacts in 2014 season: **1= Yes, 0 = No**

27.1.3.3. If yes, fill in the details in the table

Type of crop or livestock the extension services offered	Provider (Gov't , NGO e.t.c)	Number of times (year 2014)	Did you pay? 1=Yes 0=No	If yes, cost per each time
Total				

27.1.4. Access to credit services

27.1.4.1. Did the household try to access credit last year? **1=Yes 0=No**

27.1.4.2. If yes, fill in the table below:

Credit source	Granted? 1=yes 0= No	Credit type 1=Money 2=In kind	Purpose for borrowing	What was purpose of credit?	Repayment period	If not granted, give reasons

27.1.5. Membership to a group/association

27.1.5.1. Is anybody in the household a member of a group? **1=Yes 0=No**

27.1.5.2. If yes, fill the details in the table

Group type	No. of female members	No. of male members	Year started	Group activities	Meetings per month	Savings per month

28. HOUSEHOLD EXPENDITURES

28.1.1. Ask for the expenditure incurred by the household in the last 12 months (January – December 2014) and fill table details

Has this household purchased any of these items?		Frequency purchased	**Period** 1=Day 2=Week 3=Month 4=6 months 5=Yearly	Quantity	Unit	Average price per unit	Has this household purchased any of these items?		Frequency purchased/ contribution made	**Period** 1=Day 2=Week 3=Month 4=6 months 5=Yearly	Quantity	Unit	Average price Per Unit/
Staples							***Non-Fresh Food Items***						
Maize grains	**1**						Sugar	**22**					
Maize flour	**2**						Salt	**23**					
Millet	**3**						Cooking oil	**24**					
Sorghum	**4**						Coffee/Tea	**25**					
Wheat flour	**5**						Drinks	**26**					
Rice	**6**						Tobacco/Cigarettes	**27**					
Cassava (Fresh form)	**7**						Other non Fresh Items	**28**					
Cassava (Dry)	**8**												
Sweet potatoes	**9**												
Irish potatoes	**10**						***Non-food Items***						**Amount**

Matoke	**11**						School fee, textbooks, etc	**29**				
Beans	**12**						Medical fee	**30**				
Ground nuts	**11**						Transportation	**31**				
Other staples	**12**						Clothing/Shoes	**32**				
Non-Staple Fresh Food							Soap/washing products	**33**				
Green Peas	**13**						Other non food items	**34**				
Meats	**14**											
Eggs	**15**						***Contributions***					**Amount**
Chicken (meat)	**16**						**Remittances to relatives**	**35**				
Fish	**17**						Churches/Mosques	**36**				
Vegetables	**18**						Mutual Support	**37**				
Fruits	**19**						Cooperatives/committees	**38**				
Dairy products	**20**						Other local organizations	**39**				

Unit codes: 1=90 kg bag 1=50 kg bag 2=Kgs 3=Litre 4=Crates 5=Numbers 6=Bunches 9=Gorogoro 10=Metric tons 12=Debe 13=Grams 18=2kg packet 20=Other specify)________________

29. Threats to household consumption expenditure/food security

S. No	Threat	Perceived impact (1=No effect, 2=Low, 3=Moderate, 4=High)
1	Illness	
2	Drought	
3	Pests and diseases	
4	Market risks/price fluctuations	
5	Floods	
6	Death	
7	Lack of access to farm inputs	
8	High farm input costs	
10	Household size	
11	Marital status (1=single, 2=Married)	
12	Total farm/Land size	
13	Unemployment	
14	Low income	
15	School fees	
16	Farm characteristics (soil type, topography e.t.c)	
17	Others specify	
18		
19		
20		
21		
22		
23		

1.1.1.38