EVALUATION OF THE ROLE OF GLOBALGAP STANDARD ON SMALLHOLDERS INCOME AND TECHNICAL EFFICIENCY: A CASE OF FRENCH BEANS PRODUCTION IN KIRINYAGA AND NYERI COUNTIES, KENYA

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DECLARATION AND APPROVAL

Declaration

I hereby declare that this is my original work and has not been presented for the award of any other degree elsewhere.

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Supervisors' Approval

This work has been prepared under our supervision and is submitted for examination with our approval as supervisors:

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DEDICATION

I dedicate this work to the memory of my father, Mr. Alexander Mburu Njoba, 1926 -1987, who lit a spark in me for learning and higher learning, and in matters agriculture. A fire now burns continuously, everyday.

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Finally, and most sincerely, I recognize the hard working small-scale farmers of Kenya duly represented by the smallholders of Kirinyaga and Nyeri Counties who participated in this study. My hat goes off to them in recognition and support for their hard work in feeding this nation and for their great spirit towards overcoming all odds in becoming successful agri-preneurs. I salute you.

ABSTRACT

The study focused on the role of GlobalGAP standard on the income and technical efficiency of small-scale producers growing French beans *(Phaseolus vulgaris*) in Kirinyaga and Nyeri Counties in Kenya. The objectives were to determine the amount of income realized from production under a GlobalGAP farming system, establish the factors which predispose farmers into adopting GlobalGAP certification, compare the technical efficiency of production between certified and non-certified farming regimens, and finally, to establish the factors which constrain the efficient production of French beans and productivity gains. A randomly sampling technique was used to select the survey participants and a total of 266 small-scale farmers located in Kirinyaga and Nyeri Counties made up the study's sample. The two counties were selected because they had a long history of producing French beans for the export market; prior to, and after the introduction of GlobalGAP standard in Kenya. In the analysis, the propensity score matching method was used to address objectives one and two, while non-parametric data envelopment analysis and a second step tobit analysis was used to address objectives three and four. Results show that age, increasing the contact hours with extension agents through attendance to trainings and seminars, and the distance to local markets influence the chances of a household participating in GlobalGAP certification. Further, non-farm activities do not meet the households' financial needs and households largely depend on the income from the sale of the farm produce. The results also show that growing French beans under GlobalGAP occasions technical inefficiencies with respect to factor usage. The most technically inefficient farms could increase their efficiency by reducing their input usage by up to 59.8 percent for the same level of output. Productivity would then increase with the improved efficiency. The study recommends that the numbers of public sector extension officers are increased to boost the capacity of smallholders in export focused crop production methods, especially in input usage, and for targeted agricultural trainings that make efficient use of the time available to the farmers in order to encourage the attendance of female farmers. Intervention in the development of the roads and communication systems in the rural areas is also required so as to support the farmers' efforts in participating in international markets.

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ACRONYMS AND ABBREVIATIONS

EAC	East African Community
EU	European Union
Eurep	European Retailer Produce Working Group
FFVs	Flowers, fruits, and vegetables
FPEAK	Fresh Produce Exporters Association of Kenya
GlobalGAP	Global Good Agricultural Practices
GoK	Government of Kenya
HCDA	Horticultural Crops Development Authority
K.Shs.	Kenya Shillings
MRLs	Maximum Residue Levels
MT	Metric Tonnes
QMS	Quality Management System
TBT	Technical Barriers to Trade
USDA	United States Department of Agriculture
WDR	World Development Report of the World Bank
WHO	World Health Organization
WTO	World Trade Organization

CHAPTER ONE
INTRODUCTION

1.1 Background of the problem

GlobalGAP emerged in the late 1990s as a response to the devolution or shifting of responsibility for food quality and safety away from national governments to the food industry. A series of food safety scandals over the previous decades in Western Europe fundamentally shook the confidence of consumers regarding the safety and integrity of some food products, and undermined their confidence in national and European Union systems of regulation and safety enforcement (Yudin and Schneider, 2008). This led to private food safety and quality standards emerging (Asfaw, 2011). The first Good Agricultural Practices (GAP) standard, *Eurep*GAP, for fresh fruit and vegetables, was developed by a European consortium of fresh fruit and vegetable importers and retailers. Eurep, the Euro-Retailer Produce Working Group, was established in 1996 by thirteen (13) retailers (GlobalGAP, 2007), and by the year 2007 GlobalGAP members controlled 85% of the Western European fresh produce market (Humphrey, 2008).

EurepGAP (renamed GlobalGAP in 2007) refers to the pre-farm gate and has developed specific standards for the first stage of the supply chain which are likened to a process standard (Chia-Hui, 2008). The GlobalGAP scheme covers the whole agricultural production process of the certified product, from before the plant is in the ground (seed and nursery control points) to non-processed end product (produce handling control points) (GlobalGAP, 2007). On the producers' side, the standard requires growers to follow a minimum performance standard, with defined criteria, intended to stop or mitigate any adverse effects of their production processes. To acquire *EurepGAP* certification in order to become a producer member of the European markets, a farmer, or a group of farmers, is required to make an application to a recognized certifying body for a certification audit (GlobalGAP, 2007). The farmers must also adjust their production process to meet the GlobalGAP standards in addition to meeting the costs associated with actually demonstrating compliance (Okello and Sindi, 2006).

Meanwhile, as a quality management system, farmers need to prove they have the capacity to operate this system which requires the implementation of appropriate agronomic techniques (Humphrey, 2009). Thus, the smallholders' ability to maintain and strengthen their role in horticultural exports will depend on their capacity to fully comply with the standard (Asfaw *et al*, 2007). Collective action is, therefore, undertaken in order to invest jointly in facilities needed to

meet production standards and to pool together volumes of beans to attain economies of scale (Okello, 2005, unpublished doctoral thesis). However, the difficulties experienced in the implementation of *EurepGAP* as from 2000 led to the development of KenyaGAP in 2007 (Fresh Produce Exporters Association of Kenya (FPEAK), 2009a). According to FPEAK (2009a), KenyaGAP is benchmarked to *EurepGAP* and is fully equivalent to GlobalGAP.

The agriculture sector remains the most important, in terms of both employment and income generation, in developing countries (McCalla, 1998). Kenya's economic development goals recognize agriculture as one of the key sectors to deliver the desired ten (10) percent annual economic growth rate (Government of Kenya, 2012). Fresh produce horticultural crops that include fruits and vegetables, contribute about 25% to Kenya's agricultural GDP making this sub-sector an important foreign exchange earner and an important source of income generation for rural farm households, traders and investors. French beans (*Phaseolus vulgaris* L.), for example, are a major vegetable export crop and a potential income earner for small-scale farmers who are the main growers. However, the absolute numbers of small-scale farmers involved in export horticulture is falling (Minot and Ngigi, 2004), yet the absolute volume of produce has not fallen commensurately (Graffham *et al*, 2007a). This indicates a change in the composition of production with large scale growers taking over the export trade. Yet, an effective economic development strategy depends critically on promoting productivity and output growth in the agricultural sector, particularly among small-scale producers (Bravo-Ureta and Pinheiro, 1997).

Increased productivity in subsistence and smallholder agriculture is a powerful engine of labour-intensive growth, income improvement, and better access to food (McCalla, 1998). It is also a major contributor to poverty alleviation and equity improvement (Paarleberg, 2010). However, success in productivity-based agricultural growth in today's more integrated world economy critically depends on the expansion of market opportunities (Asfaw, 2011). The production of French beans for the export market by GlobalGAP compliant small-scale producers is faced with certain constraints which affect the potential productivity gains of the smallholders. One of the most significant barriers is market linkages (König *et al*, 2011). However, more importantly, smallholders are constrained in accessing the more lucrative market opportunities in European countries largely because they cannot meet the requirements to become GlobalGAP certified (Battisti *et al*, 2007).

Third party certification is also said to significantly reshape economic relations by expanding the capacity of some actors while limiting the capacity of others to participate in the agrifood trade. For example, in their study on the Mexican certification systems, Tovar *et al* (2005) found that small holders cultivated the positive reputation of the organic-agriculture industry and yet, today, the large scale producers are reaping larger profits from organic agriculture. Certification is, therefore, seen as reinforcing the social and economic advantages of large producers. This is also seen in the edging out of Kenya's small-scale farmers from participation in the export industry and the increasing participation of large scale producers.

GlobalGAP, and other private or retailer-led agrifood standards, are also increasingly being used to further other agenda on production processes, such as environmental sustainability and worker welfare on top of the standards on the products physical characteristics (Humphrey, 2008). The role of GlobalGAP and standards, in general, is also perceived to have an effect on a wider set of international and producer nations' relations (Casey, 2007). This agenda further complicates the certification process making it both capital intensive and information laden (Jaffee, 2003). For example, the standards continue to become more stringent. GlobalGAP 3 was introduced in 2007, and according to Cooper and Graffham (2007) it is more stringent than the previous standard. Thus, if Kenyan small-scale farmers were not able to fully comply with GlobalGAP 2 which was redesigned into KenyaGAP to make it more adaptable to Kenya's production circumstances, are the farmers able to adopt the newer versions of GlobalGAP which will be introduced in future?

1.2 Statement of the Problem

Kenya's response to the introduction of international private standards in the fresh produce export market is generally lauded as a success story when compared to other sub-Saharan countries. However, despite the viewed success, the growing number of GlobalGAP requirements in the production processes of small-scale farmers will continue to squeeze them out of export trade. According to Ashraf *et al* (2008), small-scale farmers will focus their production for the local markets over the more 'profitable' export market because, among other reasons, there continues to be misperceptions by researchers and policymakers about the true profit opportunities and risks of crops grown for the export market.

Kenya is pursuing agricultural policies which are dependent on increased productivity and others related to her continued participation in international markets. The role of GlobalGAP in export production and its impact in economic terms of absolute profit opportunities and efficiencies in production of crops grown for the export market remains unquantified and largely unknown to producers, researchers and policy makers. The questions that beg answers are whether the changes to GlobalGAP compliant systems are a motivation for producers to continue to seek ways to continue to participate in a market that demands more costs, and more of their time. In the face of all the above dilemma, scanty information exists on the supposed gains for producers engaging in the export market. It is against this background that this study was conducted.

1.3 Objectives

General Objective

To determine the effect of GlobalGAP on income and technical efficiency of small-scale farmers growing French beans in Kirinyaga and Nyeri counties.

Specific Objectives

1. To estimate the effect of adopting GlobalGAP certification on small-scale farmers' income.
2. To evaluate households' socio-economic factors that influence the decision to adopt GlobalGAP certification.
3. To evaluate the effect of GlobalGAP certification on farm-level technical efficiency.
4. To compare factor use, technical efficiency and productivity gains between GlobalGAP participants and non-participants.

1.4 Hypotheses

1. There is no significant difference in income between farmers who adopt GlobalGAP certification and those who do not adopt GlobalGAP certification.
2. There is no significant difference in socio-characteristics between farmers who adopt GlobalGAP certification and those who do not adopt GlobalGAP certification.

3. There is no significant difference in farm-level technical efficiency between farmers who adopt GlobalGAP certification and those who do not adopt GlobalGAP certification.

4. There is no significant difference in factor use, technical efficiency and productivity gains between farmers who adopt GlobalGAP certification and those who do not adopt GlobalGAP certification.

1.5 Justification of the Study

The impact of GlobalGAP on the livelihoods of small-scale farmers in Kenya has been widely studied. Impact of standards on farm production processes remain a concern in Kenya where interest continues to grow in the agriculture sector as a major contributor to the country's annual economic growth rate. By identifying constraints to smallholders' engagement in export markets, interventions aimed at improving the production processes would be attainable. The effects of GlobalGAP, established through empirical measurements, would be a useful tool in convincing policy makers on designing agricultural programmes focused at increasing Kenya's participation in the global food markets.

The findings will improve the understanding of the farmers circumstances that enhance (or diminish) their ability towards adopting a standard farming system. The findings will also improve the understanding of how a standard such as GlobalGAP affects the production processes of small-scale farmers by highlighting the gaps that exist in the standards literature. The study will make a worthy contribution to the body of knowledge on the impact of standards such as GlobalGAP among smallholder farmers in Kenya and in other developing countries worldwide.

1.6 Scope and Limitations

The year of reference of the study is two thousand and thirteen (2013) and the areas of coverage is limited to two counties, Nyeri and Kirinyaga, which represent long-standing French beans *(Phaseolus vulgaris*) production areas. Both areas produced French beans for the export market prior to and after the introduction of GlobalGAP standard. Production information is based on information available towards the end of three growing seasons.

1.7 Operational Definition of Terms

Small-scale farmer: A person who owns a land holding and farms French beans on less than or equal to 2.5 acres (approximately 1 hectare).

Certified: When a farmer knowingly chooses to adopt the GlobalGAP standard in his/her farming practices. In so doing, they meet all the costs and attendant requirements, either individually, or through group membership.

Compliant: When a farmer knowingly chooses to become GlobalGAP certified, adopts all the production practices required by the Standard, is audited and passed, they are said to be GlobalGAP compliant.

The terms *certified* and *compliant* are used interchangeably. They convey the same meaning of complying with the conditions required by the GlobalGAP standard.

Technological progress: Increases in the productivity of inputs so that a given output can be produced with a smaller quantity of inputs. Improvement in the state of technology by, for example, inventing new ploughs, pesticides, rotation plans, etc. is commonly referred to as technological change and can be represented by an upward shift in the production frontier.

Production Frontier: Defines the current state of technology in an industry showing firms in that industry which are operating either on that frontier, if they are perfectly efficient, or beneath the frontier if they are not fully efficient.

Efficiency: The implementation of better or more advanced procedures, such as improved farmer education, to enable farmers use the existing technology for increased outputs. This would be represented by the farms operating more closely to the existing frontier.

Productivity: Is achieved through either technological progress or efficiency. This study focuses on efficiency.

International Standards: In this study the focus is on GlobalGAP which is assumed to be part of the production process of export oriented French beans and is therefore treated as an existing technology.

CHAPTER TWO
LITERATURE REVIEW

2.1 Overview of GlobalGAP and Kenya's economic development plans

GlobalGAP emerged in the late 1990s as a response to the devolution or shifting of responsibility for food quality and safety away from national governments to the food industry. A series of food safety scandals over the previous decades in Western Europe fundamentally shook the confidence of consumers regarding the safety and integrity of some food products, and undermined their confidence in national and European Union systems of regulation and safety enforcement (Yudin and Schneider, 2008). Food safety is a matter of primary importance because foods that are unsafe can easily affect consumers' health and destroy their trust in the supplier, with significant negative effects on future sales (Jaffee, 2003). Even more important is that food safety problems can affect a large number of consumers simultaneously throughout several regions since food is often distributed nationwide (Herrmann *et al*, 1997). Thus, governmental regulation bodies in Europe had problems keeping pace with new developments in the globalization of the food sector which involved supply chains crossing many national borders, growing product differentiation and new technologies (Casey, 2007). This led to private food safety and quality standards emerging (Asfaw, 2011) and GlobalGAP members controlling 85% of the Western European fresh produce market by the year 2007 (Humphrey, 2008).

The first Good Agricultural Practices (GAP) standard, *Eurep*GAP, for fresh fruit and vegetables, was developed by a European consortium of fresh fruit and vegetable importers and retailers. Eurep, the Euro-Retailer Produce Working Group, was established in 1996 by thirteen (13) retailers (GlobalGAP, 2007). This was partly in response to the demands of the United Kingdom's Food Safety Act which placed new obligations on food business operators to take responsibility for food safety. The retailers were also responding to the European Union's programme of harmonization of maximum residue levels (MRLs) for pesticides which drastically restricted the range of pesticides that were acceptable at any level of detectable residue, and this greatly reduced the acceptable residue levels for others (Okello and Sindi, 2006). For example, in Kenya, Furadan (carbofuran), an insecticide used in the management of nematodes, was withdrawn from the market due to residues in beans (Monda *et al*, 2003). This withdrawal left the farmers with few options for nematode management. However, according to

Monda *et al* (2003), farmers in certain areas apply fungicides twice weekly, a frequency deemed to be too high as it leads to high maximum residue levels in the produce.

Kenya's economic development goals recognize agriculture as one of the key sectors to deliver the desired ten (10) percent annual economic growth rate (Government of Kenya (GoK), 2012). Fresh produce horticultural crops that include fruits and vegetables, contribute about 25% to Kenya's agricultural GDP making this subsector an important foreign exchange earner and an important source of income generation for rural farm households, traders and investors. French beans (*Phaseolus vulgaris* L.), for example, are a major vegetable export crop and a potential income earner for small-scale farmers who are the main growers. About 80% of the population lives in the rural areas and are engaged in different types of agricultural activities (GoK, 2007). For these reasons, the Government of Kenya is focusing on agriculture as an important instrument for promoting national development (Horticultural Crops Development Authority, 2008).

The agriculture sector remains the most important, in terms of both employment and income generation, in developing countries (McCalla, 1998). According to the World Development Report (World Bank, 2008), three out of four poor people in developing countries (83 million people) live in rural areas and most depend on agriculture for their livelihoods. In Kenya, Vision 2030, the country's development blue print (GoK, 2007) states that there are more than five million smallholders involved in various kinds of agricultural activities. Estates and plantations are fewer in number and make up a smaller part of the agricultural sector. Therefore, a more dynamic and inclusive agriculture is required to realize Kenya's Vision 2030 and the Sustainable Development Goals (SDGs).

The SDGs are the successor to the Millennium Development Goals (MDGs) (https://en.wikipedia.org/wiki/Sustainable_Development_Goals). Specific examples of the pertinent goals focusing on the agriculture sector are: SDG 1 which is to end poverty in all its forms everywhere, and SDG 2 which focuses on ending hunger, achieving food security and improved nutrition, and promoting sustainable agriculture. Thus, increased productivity in subsistence and smallholder agriculture is a powerful engine of labour-intensive growth, income improvement, and better access to food (McCalla, 1998). It is also a major contributor to poverty alleviation and equity improvement (Paarlberg, 2010). There is, therefore, real scope for

improving the distribution of income and enhancing the welfare of a major segment of the population through agricultural development (Norton *et al*, 2010). However, promoting productivity and output growth in the French beans sub-sector is challenged by the requirement to grow the produce under the GlobalGAP standard scheme.

2.2 The emergence and role of GlobalGAP in the fresh produce export market

In an effort to restore consumer confidence following several outbreaks of food safety scares in Europe in the 1990s, a broad set of institutional and regulatory changes at European Union and member state levels occurred (Casey, 2007). Major initiatives within the private sector also arose in response to these consumer concerns such as the emergence of GlobalGAP. Herrmann *et al* (1997) argue that it is the characteristics of food safety crises that make them newsworthy even though the stories represent only a small portion of total media content. According to Herrmann *et al* (*ibid*.), food crises are able to cause considerable public upset and also ensure that they continue to receive considerable public attention. Thus, greater clarity about who was accountable for food safety and who was responsible for breakdowns within the food chain became important requirements to restore consumer confidence and to meet the legal requirements of due diligence (Chia-Hui, 2008). For instance, under the Food Safety Act of 1990 in the United Kingdom, any supplier of a branded product is responsible for the safety of that product (Jaffee, 2003).

According to Mithöfer (2011), European Union legislation can be differentiated between regulations and directives which are both legislative acts of the EU but differ in the degree of prescriptiveness and their strategy for enforcement. Regulations automatically turn into enforceable law in member states and prescribe the result, as well as the means, to get there. Directives have to be translated into national law and prescribe the outcome, but not the means of getting there. Thus, the EU legislation combined with the UK government's policy of 'naming and shaming' retailers whose products were found to have excessive or prohibited residues, created serious reputational risks for the retailers (Humphrey, 2008). Meanwhile, in a producer country such as Kenya, mandatory public standards with effect on the horticultural sub-sector have been mostly part of EU legislation because the EU is the major export market (Mithöfer, 2011). The relevant EU legislation and private standards which influence Kenya's horticultural sector are shown in Table 1 below.

Table 1: European Union and private standards in Kenya's horticulture sector

Year	EU and private standards
2000	Directive 2000/29/EC : Control of the introduction of pests and diseases harmful to plants and plant products
2001	Directive 2000/42/EC: Maximum Residue Levels (MRL)
2000	First work on EurepGAP
2001	Packhouse and large-scale farm British Retail Consortium (BRC) and Tesco Nature's Choice (TNC) certified
2004/2005	First formal EurepGAP certification for small-scale farmers (large-scale farms EurepGAP, BRC, TNC already certified)
2005	EurepGAP Version 2.1 – Oct04 adopted widely
2005	Regulation EC/178/2002 Food Law & Regulation Hygiene of Foodstuffs EC/852/2004 (process-control/traceability)
2006	Regulation EC 1148/2001 & Regulation EC 431/2006: Certificate of Conformity (Kenya Plant Health Inspectorate Service (KEPHIS) laboratory accredited to international standard)
2007	KenyaGAP benchmarked to EurepGAP; EurepGAP renamed GlobalGAP - to give EurepGAP an international scope, i.e. beyond Europe
2008	Regulation EC 396/2005: Harmonization of MRL
2008	KenyaGAP Domestic – said to maintain all compliance criteria related to food safety

Source: Mithöfer, 2011

The development of KenyaGAP in 2007 followed the difficulties experienced in the implementation of *EurepGAP* as from 2000. KenyaGAP is benchmarked to *EurepGAP* and is fully equivalent to GlobalGAP (Fresh Produce Exporters Association of Kenya (FPEAK), 2009a). However, due to the stringent requirements of KenyaGAP/GlobalGAP, Kenyan producers started treating different plots of production differently depending on intended markets of the crops. In addition, given the short traceability chain between producers and consumers in

the domestic market another standard, KenyaGAP Domestic, was developed (FPEAK, 2009b). According to FPEAK (2009b), KenyaGAP Domestic is used by farmers growing for regional and domestic markets. Therefore, in the Kenyan horticulture context, EU regulations and GlobalGAP have parallels to process standards, while the EU directives on MRLs and traceability have more resemblance to performance standards (Mithöfer, 2011).

EurepGAP refers to the pre-farm gate and has developed specific standards for the first stage of the supply chain which are likened to a process standard. *EurepGAP* was created originally as a due diligence defense and participation in the scheme, for retailers, was voluntary (Humphrey, 2009). Nonetheless, *EurepGAP*/GlobalGAP certification has become a market access condition for European retailers as both reputation and financial resources are at stake, through liability claims, if firms fail to show due diligence in detecting and preventing problems in the food chain (Jaffee, 2003). On the producers' side, the standard requires growers to follow a minimum performance standard, with defined criteria, intended to stop or mitigate any adverse effects of their production processes (Asfaw *et al*, 2007). To acquire *EurepGAP* certification in order to become a producer member of the European markets, a grower or a group of growers is required to make an application to a recognized certifying body for a certification audit (GlobalGAP, 2007). Thus, the smallholders' ability to maintain and strengthen their role in horticultural exports will depend on their capacity to fully comply with the standard (Asfaw *et al*, 2007).

In addition to all the above, the role of GlobalGAP and standards, in general, is perceived to have an effect on a wider set of international and producer nations' relations. These effects filter to the community level through the actions of the actors in the supply chain. Standards are perceived in the context of trade barriers in some quarters, while in communities which have adopted standards, the standards are perceived to be the cause of changing social and economic relationships. The following section discusses these perspectives further.

2.2.1 Are standards barriers to trade?

Bilateral and multilateral trade negotiations have provided opportunities for liberalizing external restrictions on developing country trade (Norton *et al*, 2010). According to Norton *et al* (2010), several developed countries maintain preferential trading arrangements with particular groups of developing countries for certain categories of products. The World Trade Organization (WTO) and its predecessor, GATT (General Agreement on Tariffs and Trade), have attempted to

foster adherence to the principle that bilateral preferential agreements should not discriminate in the application of tariffs. Norton *et al* (2010) argue that, over time, it is the success in reducing tariff barriers that has increased the importance of non-tariff barriers. Non-tariff influences on trade, according to the authors, include certain types of health and safety regulations. The writers allege that environmental or health and safety restrictions sometimes appear to be used arbitrarily to protect the economic health of an industry when the true human health hazard is seriously in doubt.

There is a definition of a "non-governmental body" in point 8 of Annex 1 to the WTO Agreement on Technical Barriers to Trade (TBT), which reads,

> "Body other than a central government body or a local government body, including a non-governmental body, which has legal power to enforce a technical regulation" (Chia-Hui, 2008).

In the context and purpose of WTO Sanitary and Phytosanitary (SPS) agreements, "non-governmental entities" are not individual economic operators, nor their associations, but rather private entities which have been entrusted by government with the performance of certain tasks, or which have otherwise a special legal status as regards the development and implementation of SPS rules (WHO, 1997). Thus, GlobalGAP, being a voluntary standard, has no legal power and it is not entrusted by government (Chia-Hui, 2008).

From this perspective, Chia-Hui (2008) argues that GlobalGAP does not fit into the definition of a "non-governmental body" in the TBT Agreement and thus, if private standards do not fall within the scope of a non-governmental entity WTO cannot be called upon to regulate what the private organizations do. The author further argues that without referring to international agreements, the European Commission is also severely constrained in what it can do to influence, much less restrict, what the private sector is doing in the context of global sourcing. From this perspective, global sourcing commercial contracts are between two voluntary parties in a free market and the private sector organizations are reflecting consumer demands.

Another case in point is the WTO Agreement on SPS measures. This agreement requires WTO members to accept the SPS measures of other members as equivalent to theirs, even if they are not the same, so long as the exporting member can show that its own measures achieve the same level of protection as those set by the importing member (WHO, 1997). However,

GlobalGAP is neither a member state's requirement nor a non-governmental body's measure of meeting food safety standards. This situation seems, however, to be changing as new EU regulations are asking for GlobalGAP as a *de facto* requirement for market entry, therefore, raising concerns that small importers, European wholesalers and immigrant community markets, could become consolidated (Accord, 2007). Thus, it seems that GlobalGAP has usurped the role of the state in the governance of the agrifood sector as argued by Casey (2007).

The market and regulatory context for the international fresh produce trade is changing in ways that appear to be raising the bar for new entrants while throwing new challenges in the path of existing developing country suppliers (Jaffee, 2003). In the EU, official food safety requirements are becoming more stringent, while new standards are being applied to address previously unknown or unregulated hazards with respect to environmental and social concerns, and preferences of consumers and civil society organizations. Chia-Hui (2008) argues that given high compliance costs as well as technical and administrative burdens, private standards are often considered as barriers to the European Union (EU) markets for small-scale farmers or exporters in developing countries. It is, however, difficult to bring down barriers to international agricultural trade because, without import barriers, domestic farm support policies would be more expensive for governments to operate, especially in Europe and Japan (Paarleberg, 2010). According to Paarleberg (2010:106), it is politically easier to transfer income to farmers through import restrictions because they do not cost anything in budget terms and actually earn government revenues, and because they push some of their costs onto foreign producers who do not vote. Thus, with respect to being a trade barrier, GlobalGAP has invited most of the concerns because it is a food scheme for primary production with the potential to impact on all growers wishing to export to the EU (Casey, 2007).

In the present age of globalization, the conduct of food politics remains persistently local (Paarlberg, 2010) as discussed above. Paarlberg (2010) defines food politics as the struggle over how the losses and gains from state action are allocated in the food and farming sector. The author argues that while the politics of food and farming systems are addressed globally, for example, agricultural trade restrictions are considered by the WTO, they also remain significantly stubborn under the domination of separate and quite different national governments. As a result, most policy successes or failures in the food and agriculture sector take place nationally, or locally, rather than globally. GlobalGAP seems to fit the profile of food politics

being played out, from the importing nations' policy level to the effects seen at the community level of the producer nation, discussed next.

2.2.2 Effects of GlobalGAP at the producers' community level

Governments and retailers both recognize that regulations need to be transnational in scope and applicability if they are to be effective (Chesire and Higgins, 2004). However, certification schemes face significant pressure from interests located in state agencies, dominant market players, and social and environmental interest groups, and therefore find their voluntary character diminished (Klooster, 2005). Certification becomes "a site of social struggle" over who will define quality standards, set out certification practices through which quality standards are ratified, and who will control commercial channels through which certified goods are distributed to consumers (Mutersbaugh *et al*, 2005). The reason, it seems, does not lie in the efficiency advantage of large growers, but in the lead firms', the retailer's, sourcing strategies which are influenced by the expectations of consumers, NGOs and government agencies with regard to environmental sustainability and worker welfare, to mention but two. And this is in addition to the standards on the products physical characteristics (Humphrey, 2008).

Lead firms are the ones defining quality standards and controlling the commercial channels through which certified goods are distributed to consumers (Humphrey and Schmitz, 2001). Private retailers have become more involved in imposing requirements as to how food is produced throughout the commodity supply chain, even to the degree of monitoring and controlling production in developing countries (Dolan and Humphrey, 2000). The lead firms are also very demanding with regard to reducing cost, raising quality and increasing speed; and are therefore, unpopular with the local workforce. Lead companies supply seeds, fertilizer and pesticides (König *et al*, 2011) and are earning the distinction of being paternalistic (Blackmore and MacGregor, 2011). The decisions by the chains' lead firms may lead to particular types of producers and traders losing out, since to participate in export manufacturing, developing country producers need access to the lead firms of the chains, through the export companies.

However, a contrary scenario plays out in Kenya, whereby some export companies continually purchase produce from non-certified farms (Graffham *et al*, 2007b). This practice, according to the authors, causes frustration to the certified farmers who also question why they need to make large investments on standards compliance. The lack of any price premium for

certified produce is another distinct disadvantage of GlobalGAP certification. Kariuki *et al* (2011) argue that certified producers receive between 12% and 25% more per 3Kg. carton compared to non-certified producers, and that the trend of declining prices over the season is less steep for certified producers. Graffham *et al* (2007a) find that certified producers receive an extra KES 5 per kg. which may, or may not, be within the price range quoted by Kariuki *et al* (2011). However, smallholders who opt to withdraw from GlobalGAP face reductions in prices, volumes purchased and income from the export crop given that withdrawing leads to broken relations between the farmers and an export company.

Critics of the retailer-led private standards schemes see some sinister motives behind the 'imposition' of the standards on farmers and other primary producers. Major concerns of the critics are the stringent mechanisms which allow coordinated global supply chains through the standardization of both product and process requirements on an international level (Casey, 2007), and what others see as the usurping of states' roles by the private standards schemes. Initially standards were aimed at addressing the problem of microbial contaminants in food, but have evolved to cover three broad areas: pesticide residue standards, hygiene standards, and traceability requirements, while new standards are still being applied to address previously unknown or unregulated hazards (Asfaw, 2011). For example, GlobalGAP 3, introduced in 2007, is more stringent than the previous standard (Cooper and Graffham, 2007) with additional requirements of an ISO-type Quality Management System (QMS), an audit that takes about half a day and involves about 400 documents (Chia-Hui, 2008). Campbell (2005) argues that GlobalGAP in developing countries is Europe's (re)invention of colonial food relations and that the standardization process is inappropriate and insensitive to local economic, social, religious and cultural contexts.

2.3 Requirements for producers to gain certification

The challenge of international competitiveness in the food trade has become increasingly linked to the development of the capacity to manage food safety (Asfaw, 2011). The selection, however, of smallholders who will participate as suppliers for the international market does not lie in the capacity to manage food safety or the efficiency advantage of any farmer, but on the exporters' sourcing strategies (Mutersbaugh *et al*, 2005). Compliance with the food safety standards of importing countries has been an issue for food exporters since the nineteenth century (Humphrey, 2009). According to Humphrey (2009), the difference with GlobalGAP is

that it is extending controls to primary agricultural activities and imposing process standards right down to the field.

Global*GAP* is a set of normative documents suitable for one (a firm, organization or an individual) to be accredited to internationally recognized certification criteria similar to the International Organization for Standardization (ISO) standard. Normative elements are defined in ISO Directives Part 2 as "elements that describe the scope of the document, and which set out provisions". Provisions include "requirements", "recommendations" and "statements" (https://en.wikipedia.org/wiki/Normative#Standards_documents). In standards terminology used by some organisations, "normative" means "considered to be a prescriptive part of the standard". Normative characterizes that part of the standard which describes what *ought* to be done within the application of that standard. Thus, GlobalGAP is a set of general regulations or Protocols for Good Agricultural Practices (GAP), and an auditing system with a checklist. The GlobalGAP scheme covers the whole agricultural production process of the certified product, from before the plant is in the ground (seed and nursery control points) to non-processed end product (produce handling control points)(Chia-Hui, 2008).

To become certified, farmers must adjust their production process to meet both public and GlobalGAP standards in addition to meeting the costs associated with actually demonstrating compliance (Okello and Sindi, 2006). On the other hand, as a quality management system, farmers need to prove they have the capacity to operate this system which requires the implementation of appropriate agronomic techniques (Humphrey, 2008). Thus, the planning and timing of input usage is imperative as the requirements to meet food quality and safety affect the choice of inputs (Rao *et al*, 2010). Collective action is, therefore, undertaken in order to invest jointly in facilities needed to meet production standards and to pool together volumes of beans to attain economies of scale and (Okello, 2005, unpublished doctoral thesis). Table 2 below shows the costs borne by various types of farmers in Kenya to become GlobalGAP compliant.

Table 2: Costs (in Kenya Shillings, KES) associated with GlobalGAP certification by grower type, 2006

Cost Item	Farmer group (in KES)	Small farmer (in KES)	Large farmer (in KES)
Grading shed	59,800	20,000	34,000
Charcoal cooler	41,000	5,400	32,000
Toilet	5,000	-	-
Pesticide storage unit	24,450	8,000	37,000
Disposal pit	1,000	-	-
Needs & Quality Assessment manuals	24,750	21,500	31,000
Analyses (soil, water, MRL)	45,064	40,000	41,800
Pre-audit	132,000	56,750	32,000
Certification	105,890	94,540	94,500
Total investment costs	438,954	228,190	311,340
Cost of compliance as % of total income	4	68	24

Source: Okello *et al*, 2007.

The table shows the costs to become certified are high. Small-scale farmers, therefore, face lower costs of compliance, estimated to be 4% of total income, as group members. On the other hand, if one is not a member of a group they meet the costs individually, estimated to be 68% of total income, or the farmer seeks donor funding through NGOs (Graffham *et al*, 2007b). Therefore, a farmer not belonging to a group faces a great threat of being marginalized by the GlobalGAP standard due to high certification costs (Okello *et al*, 2007).

The requirement to form groups is also led by the difficulty experienced by small-scale farmers to sign individual contracts with exporters. Smallholders producing for the export market organize themselves in producer associations which are registered as self-help groups with the Ministry of Culture and Social Services as required by law (Okello, 2005, unpublished doctoral thesis). The farmer associations may have their own technical assistants or trained leaders to help members meet the standards. Some exporters advance seeds on loan, supervise association

members individually and penalize individuals who deviate from agricultural practices and the standards demanded in the contract. However, one aspect which has arisen within the groups which is not well received by the farmers is the policing or close monitoring of one another to ensure that production standards are implemented (Okello *et al*, 2007). The policing and the strict rules and penalties imposed by export companies go against the whole concept of voluntary group formation and may influence the decision made by some farmers to leave the groups focused on export production.

One factor which may be overlooked is that it takes time to restructure the production process in order to conform to the standards requirements. The adoption and certification of standards such as GlobalGAP cannot be seen as a single event that takes place on a farm, but rather, it must be described as a process over time with different stages; from the first knowledge of the standard until its implementation (Asfaw, 2011). Asfaw argues that the decision to adopt safety standards is an investment decision, which may involve sizeable fixed costs, such as a grading shed, pesticide store, office, etc. while the benefits will be realized over time. Thus, the choice of whether to adopt emerging standards will be based on a careful assessment of a large number of technical, economic and social factors with the technical feature of the standards having a direct consequence on the decision-making process. Decision-making, thus, takes time, as does the time taken to train farmers in understanding and implementing compliant recordkeeping (Okello *et al*, 2005). Moreover, the real challenge lies in the requirement of an *ISO*-type Quality Management System (QMS). Small-scale farmer groups cannot implement this *ISO*-type document control procedure without extensive external support, and donor support has been lagging in recent years (Okello and Swinton, 2005).

In their study on group culture and the role of social organization of smallholders in value chains, Paalhaar and Jensen (2011) turn to anthropology to help broaden the concept of the person in social life. The study confirms that the group dimension is important for the effective functioning of groups and successful participation in the export market. The authors, however, argue that the structure, rules and penalties, and the internal organization of the groups influence their functioning and success in the export market. The overall picture is that the current environment of a standard such as GlobalGAP which is mediated by the export companies supports a more hierarchical way of social organization that puts the emphasis on a system of strict rules and penalties (Paalhaar and Jensen, 2011). One interesting feature of the groups found

to be successful by export companies seem to defy the expectations of the writers in that the groups exhibit 'competitive individualism' which, according to the writers, is not a characteristic of successful association. This implies that the farmers are individualistic in terms of wanting to achieve their own successes, as business people. Nevertheless, the differences between the two most successful groups in the study conducted by Paalhaar and Jensen (2011) suggest that the group dimension is not unimportant.

A lesson from history may assist us to better understand more about group culture and what may ail those considered to be unsuccessful. Tanzania, in the sixties, was lead by President Julius Nyerere and he was dedicated to bring his country into a new socialism status built upon traditions of villages and cooperation among the citizens (Powelson, 1990). According to Powelson (1990), the state-sponsored cooperatives in Tanzania had to meet certain terms in order to access government assistance in terms of roads, schools, health services, etc. The terms relevant to this discussion are: (1) Corruption was to be eliminated through careful controls in which each member had to be accountable to the others through discussion and inspection; and (2) Government spending followed self-help agriculture which, unfortunately, was generated unevenly throughout the country. Therefore, government favours were also unevenly distributed. The parallels to the situation within the French beans export sector are obvious with farmers policing fellow farmers, and the benefits and resources from export companies being distributed to those farmer groups linked to the exporters. This may explain the dilemma faced by the farmers, their groups and the export companies.

2.4 Constraints facing smallholders participating in export market production

The production of French beans for the export market by GlobalGAP compliant small-scale producers is influenced by certain constraints. The constraints, discussed briefly in the following sub-sections, affect the potential productivity gains which may be realized by the smallholders.

2.4.1 Lack of information on importing country requirements

The imposition of tighter food safety standards has led to significant organizational changes resulting in new forms of collective action that try to minimize the asymmetries in information across exporters and the farmers (Narrod *et al*, 2009). Information asymmetries exist where one party lacks information that the second party may have. According to Asfaw (2011), producers in developing countries are often unaware of consumers' preferences and the regulatory standards

of the importing country, while consumers' in importing countries are often misinformed about the actual production conditions in the developing countries. The perception of the consumers' can be, therefore, heavily influenced by reports of misuse of outdated pesticides, child labour or otherwise poor labour conditions.

It is, however, reasonable to argue that without GlobalGAP farmers and exporters would have to come to grips themselves with complicated EU regulations on food safety and those of the member states as well (Chia-Hui, 2008). In this sense, private standards help to reduce the transaction costs by making information about European regulations on food safety systematically available and practically achievable. Small-scale farmers lack information regarding production and marketing mainly because acquiring and processing the information involves large fixed costs (Narrod *et al*, 2009). Thus, in order to access export market information among other services, some producers are dependent on export companies (Graffham *et al*, 2007a). However, the linkages to export companies by the producers are usually exporter driven (Blackmore and MacGregor, 2011) and this has led to the absolute numbers of small-scale farmers involved in export horticulture falling (Minot and Ngigi, 2004)

2.4.2 Expansion of the economic capacity of certain actors in the export industry

International standards expand the capacity of some actors while limiting the capacity of others to participate in the agrifood trade (Hatanaka *et al*, 2005). GlobalGAP has elevated the role of the buyers in institutional support and they have become more involved in imposing requirements as to how food is produced throughout the commodity supply chain, even to the degree of monitoring and controlling production in developing countries (Dolan and Humphrey, 2000). Most farmers have, therefore, become dependent on the buyers for maintaining their certification status, and for their purchases of recommended agricultural inputs (Graffham *et al*, 2007a).

Tovar *et al* (2005) argue that certification has compounded the income inequality gap between the large scale producers and the small holders in Mexico. Tovar *et al* (2005) suggest that a dual certification modality has developed that favours the large scale producers, is less costly to them than for the small holders, and in the end, it allows the large producers to 'ride on' the positive reputation (and reap larger profits) small holders have cultivated in the organic-agriculture industry. Mutersbaugh *et al* (2005) also support the viewpoint that it is the small

producers who conform to the values of organic agriculture. In Kenya, farm size and the whole spectrum of farm capital resources contribute to both the probability of obtaining an export contract and the degree of compliance with GlobalGAP once a contract is obtained. Okello (2005, unpublished doctoral thesis) argues that contracted farmers have higher income and wealth when compared to non-contracted farmers although the degree of wealth inequality among the contracted farmers is higher than for the non-contracted farmers. GlobalGAP is, therefore, reinforcing the social and economic advantages of larger producers and buyers at the expense of the smallholders (Mausch, 2009).

Public and private extension services are value chain supporters and provide information and advice (Konig *et al*, 2011). Konig *et al* (2011) determine that the extension service available to horticultural farmers is ineffective, primarily due to a lack of personnel capacity within the Ministries of Agriculture in Kenya and Tanzania and that farmers rely on their neighbours, friends and relatives for information. This viewpoint is contrasted by Okello (2005, unpublished doctoral thesis) who argues that French bean producers rely on public extension sources to meet international standards. According to Okello (2005), the responsibility for extension services pertaining to French beans had been relegated to exporters, however, farmers had more trust in government extension agents than in those provided by the export companies. An additional viewpoint on ineffective extension services is that farmers often receive extension services in a menu of topics that do not match their needs (Cerdán-Infantes *et al*, 2010). According to Cerdán-Infantes *et al* (2010), better targeting of the requirements of the farmers, for example, designing a specific extension program or trainings for producers with low productivity, can have a large impact on increasing yields. Thus, the search for complementarities between public and private roles would form a more effective and more efficient approach to problem solving (Bonnen, 1998).

2.4.3 Market linkages and available alternative markets

The most significant barrier to the inclusion of small-scale producers and SMEs in formal markets is market linkages. For buyers, market linkages must provide a reliable supply of safe, quality products and services at competitive prices with low transaction costs (König *et al*, 2011). However, smallholders are constrained in accessing the more lucrative market opportunity in European countries largely because they cannot meet the requirements to become GlobalGAP certified (Battisti *et al*, 2009). One option that would counter this power imbalance

would be the creation of a brand of Kenyan fresh produce, if well enacted (Narrod *et al*, 2009). However, if a group of suppliers develop a standard that consumers want, the retailers would then be forced to source it from the brand owners thus reducing their (retailers) sourcing options and power (Humphrey, 2008). Brand creation would translate into an incentive for an individual farmer to invest in quality improvement, a situation that is currently lacking in the fresh produce market in developing countries.

Alternatively, farmers could organize themselves to own the entire supply chain and become exporters. Graffham *et al* (2007b) describe one farmers' group which, having been frustrated in their experience with export companies over many years, allowed their certification to lapse. Soon thereafter, the group registered their own export company with the intention to access international markets. Thus, once the company became operational, the farmer-members were to re-engage GlobalGAP farming practices and their company would purchase all their produce. This group exemplifies group empowerment as argued by various authors. Powelson (1990) determines that co-operatives, groups or associations are successful when designed by co-operants in response to perceived opportunity and not when forced upon them. Then, with the aim of becoming self-reliant and entrepreneurs, the group could seek expertise and expert knowledge in capacity building to engage in efficient and competitive practices (Higgins, 2005). In addition, with the use of management tools availed through trainings, groups or communities could become empowered to manage their lives and improve their sustainability (Chesire and Higgins, 2004).

Brokers, described as agents who arrange sales without taking ownership of the commodity and earn their money on a commission, are a common and frequently controversial presence in the wholesale markets of east and southern Africa (Tschirley *et al*, 2011). Tschirley *et al* (2011) evaluate the Zambian marketing structure and find that all produce moving through South Africa's system of modern wholesale markets is legally sold through brokers. However, most farmers do not favour this system mainly because some the brokers are suspected of adding price mark-ups, in addition to their commissions. However, profitable opportunities created by new technology and improved infrastructure, such as roads, cannot be exploited without the activities of middlemen (Hayami, 1996). According to Hayami (1996) brokers are solely motivated by their own profit but also provide essential support for farmers such as creating new opportunities

by matching supply with demand at a lower cost than if all sellers and buyers conducted their own search. They also provide information on new or emerging market opportunities.

Another option is for farmers to redirect their focus on supplying the domestic and regional markets. Rapidly growing urban populations and renewed growth in per capita incomes in sub-Saharan Africa (SSA) are creating major opportunities for local farmers by driving rapid growth in the domestic market demand for food (Tschirley *et al*, 2011). The estimated annual domestic consumption of horticultural products (flowers, fruits, and vegetables, or FFVs) in Kenya is 5.6 million metric tonnes (MT), and for Nairobi city its 741,221 MT, for an estimated population of 37 million and 3.0 million, respectively (HCDA, 2008). According to HCDA (2008), the estimated consumption in Nairobi alone is expected to increase much faster than in the rest of the country from both natural population growth estimated at 5% per annum and migration into the city. Thus, projected consumption of FFVs in Nairobi is estimated to increase to 2.3 million MT by 2030. Also, as the smallholder share in French beans export declines, their share in the production of French beans for the domestic canning industry is increasing (Paalhaar and Jansen, 2011). This is largely because the canning industry applies fewer food safety standards where only the pesticide residue limits remain and this industry mainly sources from smallholders. Another option available to fresh produce marketers is the development of hubs for adding value such as washing and packing, and the higher prices paid for value-added goods can be channeled back to the farmers (Lenné and Ward, 2011).

The availability and quality of rural roads, in particular, have a strong influence on marketing costs and on the willingness of farmers to adopt new technologies and in selling any surplus production (Norton *et al*, 2010). Improvements in transportation and communication by public investments are critically important for reducing trade risk and transaction costs and thereby promoting new entry and competition in marketing (Timmer, 1998). However, the development of rural roads must not be construed as avenues to pursue higher fees collection by the local government. Kariuki *et al* (2011) argue that French beans marketed along all-weather tarmac roads in Kenya attract additional costs of marketing bureaucracies such as horticultural fees. The negative effect of better roads is seen as a deterrence to buyers and the cause of low realization of the benefits of improved accessibility for smallholders as the situation further exacerbates marketing inefficiencies.

The participation of smallholders in export production, however, is questioned by some authors. In what may be seen as a morally objectionable viewpoint, from their study conducted in Senegal, Maertens *et al* (2011) refute the inclusion of smallholders in the export vegetable value chains. The authors advocate for the return of the plantation system with rural households reduced to the role of providing the labour input on the plantations. Plantation refers to large farms based on hired wage labour (Hayami, 1996). Maertens *et al* (2011) argue that "the main poverty-reducing effects of vegetable export expansion come through labour markets and the creation of employment accessible to the poorest rural households, rather than through product market effects and the inclusion of smallholder producers in vegetable export chains through contract farming mechanisms" (p.123).

This viewpoint departs from a previous study by one of the authors of the above study, Maertens, in which he and another argue about the potential labour market effects of standards for creating employment for unskilled labour (Maertens and Swinnen, 2009), and not the total exclusion of smallholder producers from the vegetable export market. A more acceptable proposition is the one in support of unskilled labour and the poorest households in rural areas gaining employment on large-scale farms as argued by Ehlert *et al* (2011). A plantation system has the potential of becoming a source of class conflict between the labourers and the managers (Hayami, 1996), and this discourages the plantation proposition.

The opening up of more lucrative market opportunities in European countries have not been achieved since most farmers are unable to get certified, and are, therefore, unable to produce for the export markets (Battisti *et al*, 2009). Given the vast array of documentation necessitated by compliance, it is debatable whether increased documentation on-farm translates into efficient production. For a country like Kenya, an effective economic development strategy depends critically on promoting productivity and output growth in the agricultural sector, particularly among small-scale producers (Bravo-Ureta and Pinheiro, 1997). Sustaining productivity gains in agriculture will have to come from more efficient use of inputs, including land and labour (Pingali, 1998). According to Pingali (1998), the profitable adoption of knowledge-intensive input management technologies will, however, depend on the value of input saving relative to the cost of additional time required for learning and decision making. This argument is relevant for the production strategies employed in producing French beans for the export market.

In view of the above literature, it is evident that despite there being a large amount of literature on GlobalGAP and its effects on smallholder production practices, little information exists on the effects of GlobalGAP on household income and on on-farm productivity levels.

2.5 Theoretical Background

This section explores the theory underpinning the role of resource-poor smallholders in the production of a cash crop under an international standards regimen, specifically GlobalGAP standard. It begins with the theory of the behavior of farm-households as encompassed in agricultural household models and later introduces a discussion on the dilemmas faced by the farmers and export companies in meeting their contractual obligations as sellers and buyers of the produce, respectively. This problem is captured in what is known as the principle – agent problem. Both theories provide the theoretical background to the evaluation of small-scale producers of French beans for the export market under the GlobalGAP scheme.

2.5.1 The theory of agricultural households in developing countries

The neoclassical economic theory of farm production begins with the farmer as an individual decision maker concerned with questions of what, how, when and how much to produce (Ellis, 1988). Neoclassical economics rests on three assumptions, although certain branches of neoclassical theory may have different approaches. These assumptions are that people have rational preferences between outcomes that can be identified and associated with values; individuals maximize utility and firms maximize profits; and people act independently on the basis of complete and relevant information (May, 1992, unpublished doctoral thesis). From these three assumptions, neoclassical economists have built a structure to understand the allocation of scarce resources among alternative ends (Koopmans, 1991). For example, profit maximization lies behind the neoclassical theory of the firm, and utility maximization is the source for the neoclassical theory of consumption. It is said, therefore, that neoclassical economics dominates microeconomics.

According to May (1992), micro-level information is important in the formulation of appropriate policy that will correctly anticipate individual behavior under a particular policy environment, whether the goal of that policy is household welfare or increased production. For example, some micro-level studies have revealed that households pursuing various income diversification strategies, usually including off-farm options, are more likely to take up new

farming technologies (Iiyama *et al*, 2008). Furthermore, that these households are relatively well endowed with respect to education and skills. Agricultural household models, therefore, serve as a starting point to explore microeconomic impacts of policy and market changes (Taylor and Adelman, 2003).

An assortment of theories exists on farm household decision-making and the prospects for rural households in a capitalistic world economy (Ellis, 1998). Inquiries into farm-household economic behaviour represent the outcome of the social interactions within the household, and market interactions outside the household (Ellis, 2000). Most theories, according to Ellis (1998), assume that farm-households have an objective function to maximize, subject to a set of constraints, and also make assumptions about the workings of the wider economy within which agricultural production takes place. The set of assumptions are not shared by all theories, but all adopt the same theoretical method to explain farm household behavior.

2.5.2 Agricultural household models

A large part of agriculture comprises semi-commercial farms in which some inputs are purchased and some outputs are sold (Singh *et al*, 1986). According to Singh *et al* (1986), in these circumstances, producer, consumer, and labor supply decisions are not made simultaneously although they are obviously connected because the market value of consumption cannot exceed the market value of production less the market value of inputs. The integration of the production and consumption decisions allows the theoretical model of farm household behavior to determine both farm profit and wage income (Barnum and Squire, 1978). In other words, the model is one in which the household may be visualized to first make the production decisions according to the profit maximization principle, and then subject to the level of planned profits, determine the optimal choice of leisure, work and consumption, and thus, maximize its utility (Yotopoulos and Lau, 1974). This implies that, on the production side, the agricultural household may be visualized as a 'firm' which maximizes profits from agriculture; while on the consumption side it is assumed that the household maximizes its utility. And a salient point raised by Urdy (1996) is that production decisions in the model are independent of preferences.

The idea of recording and studying the actual behavior of farm-households began in Russia in the 1880s (May, 1992). According to May (1992), A.V. Chayanov is credited with having conducted a highly detailed examination of farm life in pre-Revolutionary Russia which then

formed the basis of inquiry on agricultural households. Chayanov held that agricultural households were unique economic units in that the household "firm" provided the bulk of its needed production inputs, principally labor, while at the same time consuming the bulk of its own production. Thus, the impact of their decisions would be different from those expected from the neoclassical theory of the firm.

Theodore W. Shultz had earlier, in 1964, initiated a theoretical discussion about farm families in developing countries being 'efficient but poor' (Schultz, 1971, in Ellis, 1998:65). This viewpoint, which earned Schultz a Nobel prize in 1979, radicalized the way agriculture in developing countries was treated by development economists who, at the time, presumed that standard economic theory could not be applied to understand low-income countries, and that a separate economic theory was needed. According to Hayami (1996), Schultz had, in 1964, convincingly argued that farm households in traditional agriculture are rational and efficient in resource allocation. Further, that these households remained poor not because they were irresponsive to economic incentives but because only limited technical and market opportunities were available to which they could respond.

This change in thought led to a new wave of empirical estimation of agricultural household models which started in earnest in the mid-1970s with most studies being undertaken in Asian countries such as Taiwan, Thailand, Malaysia and India (May, 1992). By the 1980s, agricultural household models had become a useful analytical technique for examining cross-sectional data in developing country agriculture. The proposition about efficient farm households ascribes the motivation of profit maximization. However, with imperfect or missing markets for inputs and labour, utility maximization has taken a more central role in analyzing farm-households in developing countries. The theory utilizes the basic framework showing that if all markets are well functioning and all goods are tradable, prices are exogenous and production decisions are taken independently of consumption decisions (Singh *et al*, 1986). In such conditions, the decision making process could be regarded as recursive (or separable) because time spent on leisure and time used in production become independent. In general, though, these models can be characterized as standard optimization problems.

Consistent with Singh *et al* (1986), for an agricultural household that obtains a preponderance of its income from the sale of agricultural commodities, it is the production technology that first

dictates income, which is usually modeled via a profit function. The utility of farm labour will be directly linked to the market determined wage rate, and income is singled out as the only link between production and consumption. This is described as the recursive or separable nature of farm-household models as household decisions are thought to be sequential; that is, one set of decisions precedes and subsequently sets parameter values for other decisions. In other words, a set of initial decisions are assumed to be made separate from subsequent decisions. The validity of recursive modeling of farm household decision-making, therefore, depends on the household being a price taker and the absence of missing or imperfect markets for output or inputs, including labour and capital (Mendola, 2007). Using this framework, production decisions are thought to have no influence on the decisions in consumption, and the causality is one way and not interactive. It is, therefore, expected that if there is a change in an exogenous variable, then there will be some response in production and a restructuring of consumption patterns because of this more realistic assumption that consumption decisions are dependent on the household's production behavior (Strauss, 1984).

Further developments and concerns about agricultural household models are being expressed in the economic literature on developing country agriculture. For example, using a change in the price of the main agricultural output, Barnum and Squire (1978) demonstrate the importance of farm household theory as a basic tool to predict household response. In this example, when the authors first ignore the production side of the model, a change in price is found to affect own-consumption of the output as well as the consumption of other items including leisure. However, when the production side of the model is introduced, the change in price is found to affect farm output and, hence, farm profit and total household income which initiates a further change in the household's consumption pattern. Thus, according to Barnum and Squire (1978), the production side of the model influences consumption decisions through its impact on total household income and expenditure.

Ericksson (1993), however, takes a different stand from Barnum and Squire (1978) and connects the production and consumption sides of the model via leisure. This work examines the production of two kinds of crops by the farm-household; a food crop and a cash crop. The production decisions involve the allocation of time between different income-generating types of production, food production for own consumption, and leisure. The consumption decision, on the other hand, consists of allocating consumption between food, purchased commodities and

leisure. Ericksson finds that in the case of cash crops of which everything that is produced is also marketed, if the price of the cash crops rises, while the other prices remain unchanged, the substitution effect tends to increase labour time in cash crop production. The income rise also tends to increase consumption of consumer goods more than consumption of food and leisure. Thus, provided that the substitution effect is stronger than the income effect, the total effect on labour time devoted to cash crop production is positive, and the marketed supply of cash crops will increase.

Other studies have used the agricultural household model to explore various impacts on household behavior from various policy and market changes, such as, the effect of migration on the size of the family labour force and its impact on household output, consumption and labor supply (Barnum and Squire, 1978); the changes in farm produce supply due to price incentives (Ericksson, 1993); to examine the wage-rate for agricultural labor with respect to household labor supply and demand for hired labor (Benjamin, 1992); gender roles in agricultural production (Udry, 1996), and household food consumption and the consequent impact on household nutritional well being (Strauss, 1984). de Janvry *et al* (1991) use a programming model of a hypothetical household-farm to explore the effects of a change in the price of a cash crop under four different market scenarios Their simulation results reveal the intuitive finding that missing markets reduce the own-price supply response of cash crops. In all these works, and in general, the farm household's objective remains that of utility maximization from a list of consumption goods including home produced goods, market purchased goods and leisure. This is captured in a conditional or constrained utility maximization function presented ahead in the conceptual model section. The other theory relevant to this study is discussed next.

2.5.3 Principal – Agent theory

Inasmuch as this study is focused on the impact of GlobalGAP on on-farm production and the farmer's objective remains the maximization of household utility, an evaluation of the theoretical background of the crop procurement process is necessary going forward. This knowledge lends support in understanding the relations between the principle and the agent, and how these relations are defined by the actors at the local level. A new economic framework provides the theory required to investigate the relationships between the farmer, as the agent, and the vertical coordinator (or integrator/agribusiness), as the principal. Known as the New Institutional Economics (NIE), this school of thought extends from neo-classical economics because it was

thought that neo-classical economics ignored the role of institutions or that economic agents were assumed to operate in a vacuum (Kherallah, and Kirsten, 2001). NIE, therefore, incorporates a theory of institutions into economics and builds on, modifies, and extends neoclassical theory.

Institutions are defined as the humanly devised constraints that structure political, economic and social interaction (North, 1991). They consist of both informal constraints (sanctions, taboos, customs, traditions, and codes of conduct), and formal rules (constitutions, laws, property rights) that facilitate coordination or govern relationships between individuals or groups. Institutions have an influence on behavior and, therefore, on outcomes such as economic performance, efficiency, economic growth and development. There is, therefore, a sort of two-way causality between institutions and economic growth (North, 1998). On the one hand, institutions have a great influence on economic growth, and on the other hand, economic growth and development often result in a change in institutions. This new direction of economics helps to determine the types of institutions needed (either formal or informal) to improve economic performance in developing countries and is used to analyze the problems that could constrain or lead to the break-down of contractual relations in developing country agriculture (Kherallah and Kirsten, 2001). Thus, the economics of contract theory, agency relationships (principle-agent problems), and transactions costs have become key focus areas in NIE.

The principal–agent problem, also known as the agency dilemma, occurs when one person or entity (the agent) is able to make decisions that impact another person or entity, the principal. The dilemma exists because sometimes the agent is motivated to act in his own best interests rather than those of the principal. Recall from the agricultural household theory, the farmer's (agent) objective is to maximize his utility. The principal (the export company or the brokers), however, aims to maximize a profit function. These two objectives seem to collide or go against each other in developing countries because many of the institutions or formal rules of behavior, which facilitate market exchange, are absent (de Janvry *et al*, 1991). Contracts are formed because the parties involved expect to benefit. However, the principal-agent problem crops up any time agents are not inclined to do what principals want them to do. Therefore, to sway the agents, the principals have to make it worth the agents' while through the provision of incentives.

The export crop procurement relationship can be modeled as a principal – agent problem where a buyer (the principal) engages the agent (a farmer) to grow a crop which has specific quality attributes (Okello and Swinton, 2006). According to Okello and Swinton (2006), as part of the contract, the farmer carries out effort-demanding activities that affect the quality attributes of the crop. On the other hand, the buyer faces uncertainty about the farmer's effort and performance under the contract because these cannot be completely observed by the buyer. Both the buyer and farmer now face various types of risks in this contractual relationship, and the most prevalent risk arises from opportunistic behavior such as the risk that one of them will renege on the agreement (e.g. in meeting or measuring the agreed quality attributes). In addition, market price risks are a concern for both parties, however, in addition the farmer also faces production risks from pest or disease outbreaks, and weather shocks.

If effort cannot be completely observed, then it makes sense to base the reward on outcomes. For example, tying a farmer's income more closely to production outcomes provides the incentive to improve these production outcomes, according to the literature emphasizing production efficiencies (Knoeber, 1999). Risk, in this case, is then treated as a cost of providing better incentives. Minimizing the cost of such risks through risk-sharing and providing the agent with adequate rewards to motivate a high level of effort is the substance of the principal-agent theory

In the crop procurement relationship, perfect monitoring of input use and farmer effort is impossible (Okello and Swinton, 2006). Therefore, the buyer could monitor the farmer so as to isolate the farmer's effort from outside influences such as the weather and pests, and reward this effort accordingly. Kariuki (2014) finds that built up loyalty and trust between buyers and farmers enhances their business relationship. According to Kariuki (2014), the probability of a long duration of business to farm business (B2B) relations is higher where farmers are offered a supply contract, have access to credit and prior information on prices, contractual experience, and know a higher number of farmers selling to the same buyer (social capital). The findings support the theory that long duration principal – agent relationships can be effected through the provision of incentives, the reduction of transaction costs and social capital. NIE thus recognizes that individuals depend on others in order to operate any business and offers a theoretical framework for the examination of these relations.

2.5.4 Conceptual framework

The conceptual basis of this study is adapted from Asfaw's (2009) 'EurepGAP potential impacts on welfare model' (see figure 1 below). It shows that there are socio-economic and institutional factors that influence the decision of the farm household to become certified, or to remain not certified (the inflow). Once the decision is made to adopt certification, at the farm level, the standards influence farm operations and decisions, such as, those relating to input use such as the use of specific agrochemicals and seeds, and management of the export crop using family and hired labour. The overall input-use and management skills influences the farmer's efficiency of production and productivity levels. Increased efficiency implies high productivity gains. The adoption of a certified farming regimen also has an influence on household and worker health, environmental effects and spill-over effects into the production practices of other crops assuming that a certified farmer will transfer his skills and knowledge learnt in the certification process to the other crops. Non-certified households may also be included here as they may benefit from sharing knowledge with certified households. These additional effects are ignored in this study as the focus is on the impact of GlobalGAP on farm-level production. In all, the resultant effect is fresh produce that meets international standards for the benefit of both domestic and foreign consumers.

Produce bound for the export market is aggregated at a collection center from all certified households which would ideally be in a contract arrangement to supply one export company. Certified households are contracted as one registered farmer group not as individuals. It is at this point where the principal-agent problem arises in the sale/purchase of the produce and some farmers may opt out of this contract and sell to middle men. The price received for the produce has an effect on a household's income, and thus, its capacity to meet its consumption needs. These include household expenditures, such as, the purchase of non-farm goods, purchase of farm inputs for the next season, and ability to increase its assets base. Income from off-farm employment boosts a household's capacity to meet these expenditures, however, this has an effect on the household's total time available in agriculture as discussed previously in the behavior of an agricultural household (section 2.5.2). Production decisions, therefore, affect expenditure decisions, and the cycle continues.

In view of the above, the framework indicates that certification impacts on all farm operations and decisions made by the household. Once a household adopts a GlobalGAP farming system,

the choice of inputs and crop management strategies are impacted leading to some influence on on-farm technical efficiency and productivity levels. From the sale of the export crop and the price received this determines the household's income level, expenditure on household needs and the acquisition of household assets. Given that certified households receive a higher price for being in export production, it may be deduced that their consumption choices are of a higher value than those of non-certified households.

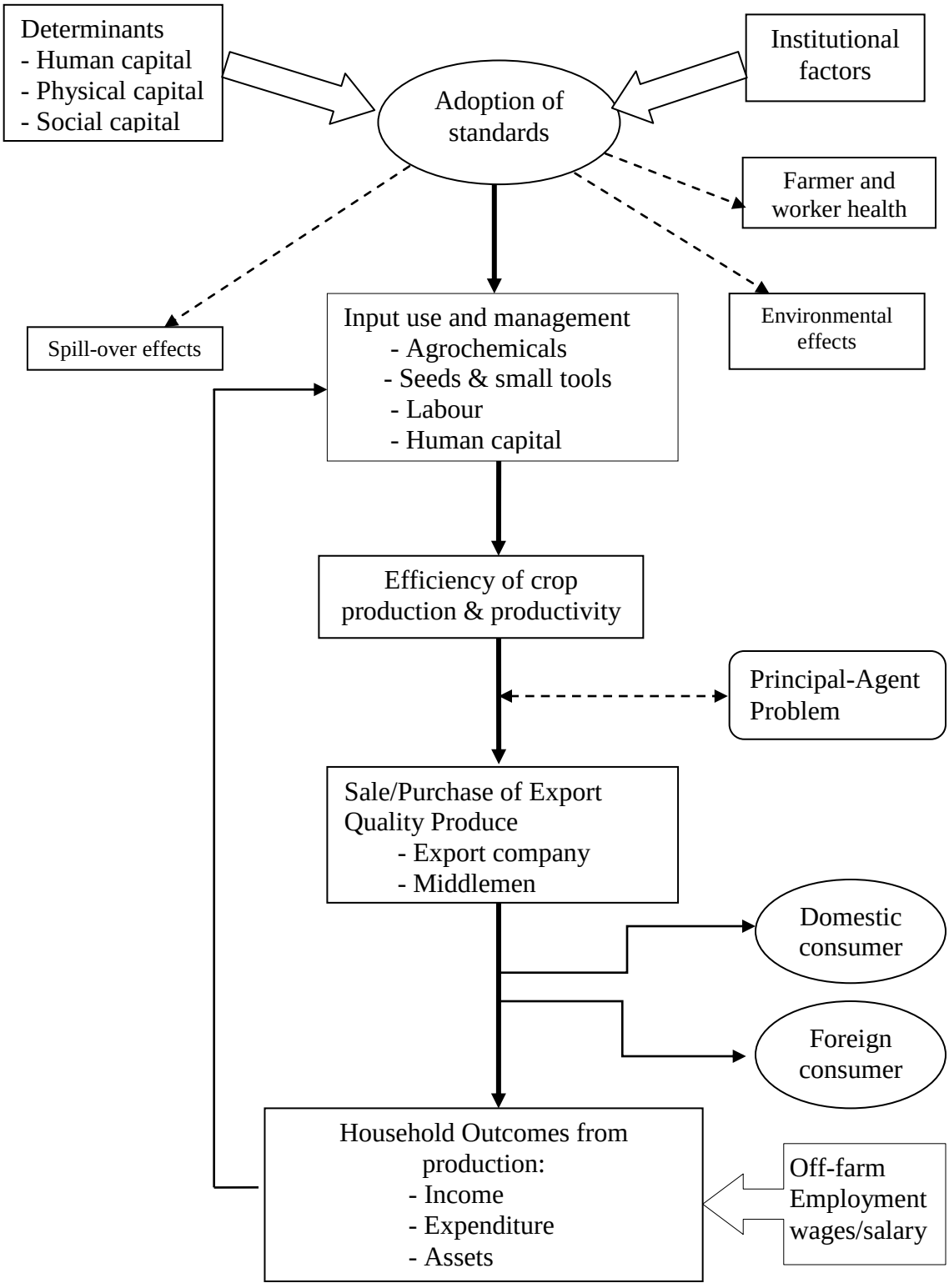

Figure 1: GlobalGAP Adoption Effects Framework
Adapted from Asfaw, 2009, EurepGAP Potential Impacts on Welfare model

2.5.5 Conceptual model

To analyse the effects of GlobalGAP on a household's productive performance and welfare, the general utility theory within the household model is modified to include the GlobalGAP requirements and the model is written as a constrained utility optimization problem. Thus, consistent with Singh *et al* (1986) and Ericksson (1993), for any production cycle, the agricultural household is assumed to maximize a utility function which is a function of food, purchased commodities and leisure and the household enjoys higher utility the more it consumes of each of these 'goods'.

The household produces two types of crops which are substitutes in production: food crops (X_a) and cash crops (X_c). Food crops may be both consumed on the farm and/or sold, while cash crops are produced for sale only. Agricultural output is primarily produced with the inputs of land (L), capital (K), variable inputs of which any items required in meeting the GlobalGAP standard are implicitly included in the variable inputs factor (V), and the stock of time available to the household (T). The production of food and cash crops is consequently a function of all the inputs available to the household, and time allocation is between farm work (the production of food and/or cash crops) and leisure (X_l). The utility the household derives from the various consumption combinations depends on the preferences of its members which are influenced by household size and its composition between workers and dependants (Ω_{hh}).

The optimization problem is, thus:

$$\text{Max } U(X_a, X_c, X_m, X_l, \Omega_{hh}) \quad \text{.....Equation 1}$$

Subject to:

a. Production constraint: $Q = f(L,V, A, K)$ ……..Equation 2

where Q is a vector of a household's production of staple and cash crop production. The household faces two kinds of two production functions, $Q_a = f(L,V, A, K)$ and $Q_c = f(L,V, A, K)$ for food production and cash crops respectively. However, since the crops are grown on the same field, share fixed inputs, and with the assumption that the crop are substitutes in production, then Equation 2 depicts the household's production capacity as defined by the amount of available variable inputs for both food production and cash crop production (in the factor variable, V), labour in farm work, and fixed inputs.

The second constraint faced by an agricultural household is the time constraint:

b. Time constraint: $T = F + X_l$ .....Equation 3

where T is the total stock of household time; F is family labour (so that (Full Family labour, F_F – F) is marketable labour which may be positive or negative: if positive, household is a net buyer of labour (hired labour, H_H), and if negative, is a net seller (off-farm labour, F_W). The household allocates its total time between farm work (the production of food and cash crops), off-farm employment and leisure, that is, the sum of the time spent on work and leisure cannot exceed the total amount of labour time available. Family labor and hired labor are assumed to be perfect substitutes and can be added directly, thus, GlobalGAP requirements which include, amongst others, recording and monitoring the entire French beans production process, spending time in regular meetings with extension agents, and attending trainings/seminars, are being assumed to buy out the amount of time that a household would otherwise have put into leisure.

The time constraint could also be presented in terms of the separation of labour input to the various household tasks – time in food production, T_F, time in cash crop production, T_C, time in wage labour, T_W, as in Ericksson (1993). The time constraint in Ericksson's work is presented as: $T = T - T_F - T_C - T_W$.

However, the separation of the total time allocation to food and cash crop production, seems to imply that the household can make a decision to allocate its time to *either* food crop or cash crop production. This is not the case in this study as French beans farmers produce the two crops on the same piece of land and therefore work on the crops at the same time. Also, Ericksson, includes off- farm employment in the time constraint while in the general model off-farm employment is included as a factor in the budget or cash constraint (as applied here below). The two kinds of equations are, however, consistent in that the sum of the time spent on work and leisure cannot exceed the total amount of labour time available.

The third constraint faced by a household is the budget or cash income constraint:

c. Cash constraint: $P_mX_M = P_a(Q_a - X_a) + P_cQc - P_wF_w - P_vV + E$ .....Equation 4

where P_m, P_a and P_c are the prices of the market purchased commodity (X_m), the staple (X_a) and the cash crop (Q_c), respectively; $(Q_a - X_{a)}$ is the household's marketable food surplus while Q_c is the household's production of the cash crop all of which is marketed; P_w is the wage rate; P_v is

the variable inputs market price, and *E* is any non-labour, non-farm income such as transfers and remittances. The household's income is determined by the marketed quantity of food and cash crops, which, in the case of the food crop, depends on the quantity produced and on the amount of food that is retained for consumption. The income further depends on the prices of food, prices received from the sale of the cash crop, and the prices of the purchased commodities.

The cash constraint depicted in Equation 4 implies that the household expenditure on purchased commodities may not exceed income. The household needs an equivalent of P_mX_M cash to purchase the goods that it cannot produce. The cash is generated from its marketable surplus $P_a(Q_a - X_a)$ and from the sale of the cash crop, P_cQ_c. Then, from its surplus income, the household must pay out hired labour (P_HH_H) and all material inputs (P_vV), as well as paying for purchased marketed consumed goods (P_mX_m). If the household surplus income is not adequate to finance production costs inclusive of GlobalGAP costs contained in the variable factor, V, then the household would depend on non-labour, non-farm income, *E*, such as borrowings and transfers and remittances.

The three constraints on household behavior can be collapsed into a single constraint:

$$P_mX_m + P_aX_a + P_lX_l = P_lT + \prod + E \quad \text{.....Equation 5}$$

where $\Pi = P_aQ_a(L,V,A,K) + P_cQ_c(L,V,A,K) - P_FF_F - P_vV$ and is a measure of farm profits.

In equation 5, the left hand side shows total household expenditure on three items: the market purchased commodity (P_mM_m), the household's purchase of its own output (P_aX_a), and the household's purchase of its own time in the form of leisure (P_lX_l). The right hand side indicates full income, in which the value of stock of time (P_FF_F) owned by the household is explicitly recorded as is any labour income. The inclusion of a measure of farm profits, $P_aQ_a + P_cQ_c - P_FF_F - P_vV$ with all labor valued at the market wage is a consequence of the assumption of price-taking behavior in the labor market (Singh *et al*, 1986).

Denoting full income by 'Y' gives equation 6.

$$P_mX_m + P_aX_a + P_lX_l = Y \quad \text{……..…….....…Equation 6}$$

When all relevant markets function perfectly, farm production decisions can then be made separately from consumption decisions. The household then maximizes net farm earnings subject to the technology and expenditure constraints and allocates the earnings, together with other income, among consumption goods. However, production and consumption decisions of the

household cannot be separated when labour markets and markets for other inputs are imperfect. In effect the left hand side constraints in Equation 6 can be reduced into output influencing factors such as household specific characteristics represented by vector $\Omega_{hh,}$ farm specific characteristics represented by vector Ω_{ff}, market characteristics represented by vector $\Omega_{mk,}$ *and* GlobalGAP constraints represented by vector Ω_{gg}, (Equation 7 below).

$$\varnothing = f(\Omega_{hh}, \Omega_{ff}, \Omega_{mk}, \Omega_{gg},) \quad \text{Equation 7}$$

The decision to choose to be certified or to be chosen to be certified could be biased, implying that certification imposes an intercept effect as well as a slope effect. The effect of certification on production is, therefore, best estimated by models that solve for selection bias. Examples of such models are propensity score model, Heckman's sample selection model, treatment effect model or endogenous-switching regime model. The choice of any one of the models depends on the objective function. For this study, a propensity score econometric model was used.

2.5.6 Propensity score matching for evaluation of average effect of programme

Propensity Score Matching (PSM) approach is used to evaluate the average effect of a programme on participant's outcome, conditional on the pre-participation characteristics of such participants. An individual may have access to a programme, for example GlobalGAP certification, but for various reasons may not seek to become certified or to participate in this programme. Literature on programme evaluation shows that if the survey design, sample selection and econometric analysis are appropriately conducted to solve for endogeneity of participation status in programmes, then the estimated coefficients should correctly measure the average impact of the programme on participants' outcome (Winship and Mare, 1992; Heckman and Smith, 1995; Dehejia and Wahba, 2002; Hirano *et al*, 2003).

The PSM analytical method summarizes the pre-certification characteristics of each farmer, after filtering non-participants with similar attributes as participants, into a single-index variable (the propensity score), which makes the matching feasible. This allows for the reduction, not the elimination, of the bias generated by the unobservable confounding factors (Becker and Ichino, 2001). The matching subsequently generates the average effects of participation (AEP, which is certification in this study) through computation of the differences in outcome between participants and controls. The programme, therefore, identifies subjects that meet the participation conditions and drops those who do not based on their characteristics.

Structurally, the propensity score model is presented as:

$p(x_i) = pr\ \{D = 1|x_i\ \} = E\ \{D|x_i\ \}$ …….....Equation 8

where $p(x_i)$ is the propensity score or probability of participation; $D = 1$ if individual is a participant and 0 otherwise; and x_i is the vector of pre-participation characteristics. The model indicates that probability of participation is conditional on x_i covariates since we want to know what influences some individuals to adopt the certification and others not to. Thus, the higher the probability, the higher the likelihood of participation. This, however, does not imply that non-participants have equal propensity scores, but the scores may fall within a given range known as blocks of propensity scores which are generated during the estimation process.

Subsequently, once the propensity score $p(x_i)$ is known, the average effect of treatment on the treated (ATT), that is, the average effect of GlobalGAP certification on certified participants (AEC) can be estimated as below:

$$\begin{aligned} AEC &= E\{Y_{1i} - Y_{10}|D_i = 1\} \\ &= E\{E\{Y_{1i} - Y_{0i}|D_i = 1, p(x_i)\}\} \\ &= E\{E\{Y_{1i}|D_i = 1, p(x_i)\} - E\{Y_{oi}|D_i = 0, p(x_i)\}|D_i = 1\} \end{aligned}$$ .....Equation 9

Y_{1i} and Y_{0i} are the potential outcomes for the two counterfactual situations of participants and control groups respectively, $p(x_i)$ is the propensity score AECscore), 'D' is the participation variable as stated earlier. The counterfactual problem arises in that it is impossible to observe individual treatment effects since we do not know the outcomes for non-participants were they in the programme, and for participants if they were not in the programme. So given that the participants are already in the programme, we need to find a close match for them and use their outcomes, then compare these outcomes for participants and control groups for observations that are very similar to each other (Katchova, 2013). This model works under two lemmas as follows:

The Balancing Property (Lemma 1)

If we take two individuals with the same propensity score (or predicted probability of treatment), and divide them into two groups – those who are participants in the programme, and those who are not – the groups will be approximately balanced on the variables predicting the propensity score (Katchova, 2013). In other words, balancing is through the propensity score. Thus, the balancing lemma dictates that the propensity score $p(D = 1x_i) = p(x_i)$ must be a pre-condition for the evaluation of the effect of the programme on the observations.

The Conditional Independence Assumption (Lemma 2)

The Conditional Independence Assumption (CIA) is based on the balancing lemma, and results in a common support for the matching approaches (Caliendo & Kopeinig, 2005; Grilli and Rampichini, 2011; Sianesi, 2001). The estimation of the average effect of participation is computed under these assumptions: that the CIA holds and common support is reached. Common support is reached after propensity score estimation, and a second variable 'comsup' is added to the data which defines the region of common support. Observations whose 'comsup' variable reads 0 (from the dummy variable with 1, 0) are those that do not meet participation condition and are eliminated in the estimation of average effect of the programme. The routines generate a variable 'AEP*block*' which groups observations within the common support into blocks of similar propensity scores.

Common support rules out the phenomenon of perfect predictability of '*D*' given x_i. CIA assumes that selection is solely based on observable characteristics and that the researcher simultaneously observes all variables that influence participation and potential outcomes. It is expressed as:

$$Y_1, Y_0 \perp D | p(x_i) \quad \text{.....Equation 10}$$

Where Y_1, Y_0 are the potential outcomes with and without the programme, '*D*' is the participation variable, and $p(x_i)$ is the propensity score. It implies that because the participation (*D*) is conditioned by x_i, then its determination of the level of outcome is influenced by the probability of the exposure itself, $p(x_i)$. If the balancing hypothesis is satisfied, observations with the same propensity score must have the same distribution of observable (and unobservable) characteristics independent of the participation status.

After determination of the variable propensity index and score, the matching estimation of the average effect of participation then follows. The approaches used in matching participants and controls are Nearest Neighbour, Radius, Stratified and Kernel matching methods. The matching approaches assume similarity between participants and non-participants with respect to their pre-participation characteristics captured in the propensity score with the only exception being that participants participated in the programme while non-participants did not.

Nearest Neighbour matching takes a case in the control group to match it to a participant, drawn randomly and based on the closest propensity score. In Radius matching, a control group case is matched to a participant lying within a specified radius in terms of the propensity score. A radius, or tolerance level on the maximum propensity score distance, is formed, and matching uses the closest nearest neighbour within each radius and with all the individuals in the control group within that radius.

Stratification matching uses a set of intervals or strata to divide the common support of propensity score, then matches the participants and controls within each strata. The average treatment effect is the mean of the strata-specific treatment effect, weighted by the number of cases in the treatment strata. And finally, Kernal matching uses weighted averages of all cases in the control group to estimate counterfactual outcomes. The weight is calculated by the propensity score distance between a participant and all control cases. The closest control cases are given the greatest weight and distant cases are given lower weights. Developed by Heckman *et al* as an econometric evaluation estimator, Heckman *et al* (1998) estimate the propensity score both parametrically and non-parametrically in improving the efficiency of the estimator.

2.5.7 Non-parametric production frontier estimation

To evaluate the effect of certification on farm-level technical efficiency, the study used a non-parametric production frontier model known as data envelopment analysis. Thereafter, a second step analysis, consistent with Bravo-Ureta and Pinheiro (1993), was performed whereby a separate two-limit tobit equation was estimated as a function of various attributes of the farms/farmers in the sample.

Modern efficiency measurement begins with Farrell (1957), who, according to Coelli (1996), drew upon the work of G. Debreu and J. Koopmans to define a simple measure of firm efficiency which could account for multiple inputs. And in the 1960s, the "poor but efficient" hypothesis by T.W. Schultz generated a great deal of empirical work designed to test the various efficiencies. Examples of the empirical works on efficiency include, among others, Charnes *et al*, 1978; Coelli, 1995, 1996; Bravo-Ureta and Reiger, 1990; Bravo-Ureta and Pinheiro, 1993, 1997; Battese and Coelli, 1995; Piesse *et al*, 1996; Alene and Hassan, 2003; Chirwa, 2003; Chen *et al*, 2006; Owuor *et al*, 2009; and more recent works by Aye, 2011, and Langat, 2013 (unpublished doctoral theses). Coelli (1996) argues that Farrell proposed that the efficiency of a firm consists

of two components: technical efficiency, which reflects the ability of a firm to obtain maximal output from a given set of inputs, and allocative efficiency, which reflects the ability of a firm to use the inputs in optimal proportions, given their respective prices. These two measures are then combined to provide a measure of total economic efficiency.

One method of estimating technical efficiency is by the use of Data Envelopment Analysis (DEA), a technique Charnes *et al* (1978) extended from Farrell's approach. Charnes *et al* (1978) proposed a model which has an input-orientation in which they reformulated Farrell's approach into calculating the individual input saving efficiency measures by solving a linear programming problem for each unit under the constant returns to scale (CRS) assumption. The technique involves the construction of a non-parametric envelopment frontier over the data points such that all observed points lie on or below the production frontier assuming CRS or variable returns to scale (VRS). Each DEA model tries to determine which firms form this piecewise linear envelopment of the technological set (the efficient frontier) and DEA provides a methodology for the analysis of individual firms' efficiency relative to this best practice frontier. Efficient firms are, thus, those that produce a certain amount of, or more, outputs while spending a given amount of inputs, or use the same amount of, or less, inputs to produce a given amount of output as compared with other firms in the test group. This approach generalizes Farrell's approach of computing the efficiency frontier as a piecewise-linear convex hull in the input coefficient space to multiple outputs. Banker *et al* (1984) extended this technique to the case of variable returns to scale (VRS) since imperfect competition, financial constraints, etc. may cause a firm not to be operating on an optimal scale, the assumption upon which CRS is appropriate.

The PSM and efficiency model specifications are presented in the following chapter on the research methodology. The following section discusses previous empirical studies which have applied these two econometric approaches.

2.6 Previous studies on programme effect and on efficiency measurements

The application of the propensity score matching model has been popular in the medical field since the original work by Rosenbaum and Rubin (1983). Other works have followed to further improve the model and its application has resulted in a large volume of theoretical and empirical literature in treatment or programme effects. This application of the model has gone beyond the medical field and into economics, especially the evaluation of economic policy interventions,

and it is increasingly being employed in agriculture. The use of propensity score matching method as an efficient estimator of treatment or programme effects is determined through its application in observational (non-randomized) studies. The review below includes both the theoretical literature and empirical studies on the application of PSM models followed by a review on DEA efficiency model which utilize a second stage Tobit model.

2.6.1 Theoretical studies on the propensity score matching model

The role of the propensity score matching (PSM) model in the literature is often motivated by Rosenbaum and Rubin's (1983) argument about the use of balancing scores to enable the direct comparison between treated and untreated, or control, units from observational studies for casual effects on outcomes. The authors argue that in randomized experiments, the results from the treatment and control groups may often be directly compared because subjects are likely to be similar. However, such direct comparison may be misleading in non-randomized or observational studies since treatment selection is often influenced by subject characteristics. As a result, baseline characteristics of treated subjects/units may differ systematically from the control units. And thus, the balancing score, namely the propensity score, can be used to group treated and control units to allow for direct comparisons when estimating the effect of treatment outcomes.

The propensity score is, therefore, the conditional probability of treatment or programme participation given some observed characteristics, and it plays a crucial role in controlling bias to obtain the estimator of the impact of the program (Hahn, 1998). In building upon the initial Rosenbaum and Rubin argument, Hahn (1998) evaluates the role of the propensity score as an efficient estimator of average treatment effects by examining it from an efficiency point of view. The study shows that the propensity score is ancillary, i.e. it provides necessary support or that it is secondary for estimation of the average treatment effects but it is not ancillary (its important or key) for estimation of average treatment effects on the treated.

Hirano *et al* (2003) explores the efficiency of the estimated average treatment effect and their concern is with the loss of efficiency in the propensity score which results after the removal of all biases associated with adjusting for differences in the covariates between treated and control units. They argue that given the unconfoundedness assumption underlying the propensity score model which states that if the assignment to treatment is independent of potential out-comes

conditional on covariates or pre-treatment variables, also known as selection on observables, the propensity score may not be as efficient as adjusting for differences in all covariates.

Austin (2011) assesses various methods for reducing the effects of confounding in observational studies. He argues that observational (non-randomized) studies aim to mimic some particular characteristics of randomized controlled trials which are considered the high ideal when estimating the effects of treatments or interventions on outcomes. Randomized controlled experiments ensure that treatment status will not be confounded with either measured or unmeasured baseline characteristics and, therefore, by measuring the propensity score, one is able to analyze an observational study as closely and effectively as with a randomized experiment.

Dehejia and Wahba (2002) focus on matching methods and build on their earlier work of 1999. They assess the problem of having fewer units or subjects in the control group for comparisons with the treated group and the problem of having a large number (or high-dimensional set) of pre-treatment characteristics. They suggest that the propensity score matching methods are useful under such circumstances because they provide a natural weighting scheme that yields unbiased estimates of the treatment impact.

2.6.2 Empirical studies applying propensity score matching methods

Nkonya *et al* (2010) explore the impact of Farmers Field Schools (FFSs) on agricultural productivity and poverty alleviation East African. According to the writers, FFSs are traditionally an adult education approach and method used in farmer learning and set in an informal setting within their own environment. To overcome the problem of attribution to the program's interventions, whereby any outcome from the program may have many other factors that could affect it thus making it difficult to attribute the impacts to one particular program intervention, the study uses a longitudinal impact evaluation (difference in difference approach) with quasi-experimental methods (propensity score matching and covariate matching) together with qualitative approaches. Results show that membership in savings and credit groups and non-FFS farmer groups, proximity to tarmac roads, and low education of spouses increased the propensity to participate in an FFS.

Liebenehm *et al* (2009) evaluate the impact of agricultural research on cattle farmers' knowledge and capacities to achieve a higher level of disease control in Mali and Burkina Faso.

The study uses a logit model to estimate the propensity score and from the data collected according to a knowledge, attitude and practice (KAP) questionnaire, the results indicate a significant gain in farmers' know-how due to participation in livestock research activities.

Deschamps-Laporte (2013) investigates the impact of a national agricultural extension programme (NALEP) and the adoption of technological packages by farming households in Lugari of Western Kenya. According to the writer, NALEP aims at uplifting productivity, encourages commercialization, and strives to enhance resilience through the increased use of agricultural technologies and improved inputs, and applies demand driven and participatory agricultural extension approaches. Using an *ex-post* analysis of the effects of NALEP and a logit model to estimate the propensity score, the results show that the program's beneficiaries have adopted a set of practices and technologies such as increased fertilizer dosage by at least 24.91%. However, the study does not conclusively determine that productivity per acre improves or not due to participation in NALEP.

Mapila *et al* (n.d.) assess the extent to which the use of innovative agricultural research interventions impact upon the livelihood outcomes of rural smallholder farmers in Malawi. Innovative agricultural research system, according to the writers, is geared at enabling greater individual and community innovation and proper knowledge utilization, and is a recent shift in global agricultural research systems away from the previous focus on only strengthening national research systems. In this study, propensity scores for each household in the sample are estimated using the logit regression model to measure the impact of the interventions. And the results establish that while rural incomes are significantly impacted upon by agricultural research interventions that are driven by this concept, and participating households gain better livelihood outcomes during the implementation of the programme. However, this gain reduces after the phasing out of the programme.

Owuor (2009) evaluates the effects of micro-finance credit (MFC) on borrower's productive performance in Kenya. Employing propensity score matching method to evaluate the marginal impact of group based lending programme on smallholder farmers' productive performance, the study reveals that participation in MFC credit improves household productive incomes by a range of between US$ 200 and US$ 260 in a single production period. However, participation in the MFC among smallholder farmers is constrained by low literacy levels, gender differentials in

asset endowment, poor road infrastructure, and maintenance of indigenous group structures. The author makes a call for a repackaging of the MFC to meet the different needs for smallholders' in both productive and consumptive motives.

In investigating the impact of non-farm employment on food security in Ghana, Owusu *et al* (2009) query whether, and to what extent, nonfarm employment contributes to household food security. Employing a probit model to estimate the propensity scores, non-farm employment is found to have a significant positive relationship with household income. Significant negative relationship is found between non-farm employment and the food insecurity indicator when the duration of the households food crops last for only the first six months of the year. And the joint participation by couples in non-farm employment is found to have high direct causal effects although women appear to be disadvantaged in financial capital and time which are key factors to job entry.

Chirwa (2010) conducts a program evaluation of agricultural input subsidies in Malawi, and their impact on household income between two production periods of 2003/04 and 2006/07. The goal of input subsidies in Malawi are mainly meant to increase household income, reduce food insecurity and impact on poverty reduction. The study uses panel data to evaluate the interventions using treatment evaluation techniques and algorithms developed by Becker and Ichino (2009, in Chirwa, 2010) to assess the other determinants of household income such as access to basic services (roads, markets) and how they impact on household income. The main conclusions made are that government interventions geared towards complementing input subsidies should be supported with interventions aimed at improving basic services such as the development of markets and roads in rural areas.

Mendola (2006) investigates the impact of adopting agricultural technology of the Green Revolution kind (high yielding varieties of rice)on the wellbeing of smallholder households and as a potential poverty reduction strategy in rural Bangladesh. Using a logit model for the propensity score matching analysis, the study finds a robust and positive effect of resources poor farmers adopting the new rice varieties, and therefore contributing directly to poverty alleviation.

In conclusion, some noteworthy practical guidance on the implementation of propensity score matching is offered by Caliendo & Kopeinig (2005), Grilli and Rampichini (2011), Love (2003), Chen and Zeiser (2003), while Sianesi (2001) offers a guide to implementing PSM in Stata as is

the web learning resources on UCLA's website (www.atas.ucla.edu/stat/stata). Invaluable videos explaining the uses and applications of propensity score matching methods are offered by Katchova (2013).

2.6.3 Theoretical studies on the data envelopment analysis model

According to Cooper *et al* (2000a), there is a great variety of applications of DEA because DEA requires very few assumptions, DEA has also opened up possibilities for use in cases which have previously been resistant to other approaches because of the complex (often unknown) nature of the relations between the multiple inputs and multiple outputs involved in decision making units (DMUs). The writers offer up a discussion on the fundamental DEA models and some of their extensions.

Coelli (1995) argues that efficiency measurements by frontier estimations is a better approach than simple partial measures such as output per unit of labour or land. And in Coelli (1996), he presents a computer program which conducts data envelopment analyses for the purpose of calculating efficiencies in production.

Bravo-Ureta and Pinheiro (1993) review and critique the frontier literature and draw our attention to some pertinent issues researchers should be aware of and possibly address. These include their concerns about the sensitivity of efficiency measurements to variations in input quality across farms and to the choice of variables included in the models, which are not similar across the studies. The latter is noted as being most influential on efficiency than any other feature of the technology such as economies of size. Another concern, relevant to this study, is the use of the two step procedure to examine the determinants of efficiency. The conclusion is that one can justify the use of this procedure because socio-economic attributes have a roundabout effect on production and, therefore, should be incorporated into the analysis indirectly. There are, however, critics to the use of the two-step approach one of which is included in the following section.

The application of the DEA procedure in agricultural studies continues to grow and its use in studies from a wide selection of fields is reviewed next. Focus is on the use of DEA in the first step of analysis and use of the tobit model in a second step.

2.6.4 Empirical studies applying data envelopment analysis and second step tobit model

The popularity of DEA rests on its capability to consider multiple inputs and outputs for calculating relative efficiency. DEA comes up with a single scalar value as a measure of efficiency and does not require any specification of functional forms as is required under stochastic frontier analysis (Tripathy *et al*, 2011). The CRS and VRS efficiency scores obtained from DEA in the first stage become the dependent variables in the second stage of the Tobit model. Tobit models refer to regression models in which the range of the dependent variable is constrained or limited, i.e. the technique uses all observations, both those at the limit and those above it, to estimate a regression line (Cooper *et al*, 2000b). This is to be preferred, in general, over alternative techniques that estimate a line only with the observations above the limit (Macdonald and Moffitt, 1980). In statistics literature, the tobit model is an extension of profit analysis developed by Tobin in 1958, and is also referred to as a censored normal regression model (Yu *et al*, 2012). This procedure allows for the analysis of the impact of technological innovation and other policy and socioeconomic variables such as gender, age, education, household size, land, off-farm employment, membership in a farmer group, access to extension, credit and market, on efficiency.

A review of the literature on studies using the tobit model as a second stage model after DEA is supported by the work of Banker and Natarajan (2008) who argue that it is reasonable to expect that any problems associated with using efficiency estimators from a first stage analysis of outputs and inputs will be less acute if DEA rather than a parametric approach is used in the first stage. Thus, the two stage procedure is well accepted in the case of non-parametric DEA models.

Macdonald and Moffitt (1980) investigated the coefficients obtained from using tobit and found that these coefficients provide some additional information. In particular, they demonstrate that Tobit can be used to determine both changes in the probability of being above the limit and changes in the value of the dependent variable if it is already above the limit. They also demonstrate that this decomposition could be quantified in useful and insightful ways by applying their theory to several journal articles which had used Tobit analysis. The writers were therefore able to demonstrate the additional information that could have been obtained in these articles if the decomposition had been used. Roncek (1992) analyses this proposition from a sociology view point and also reaches the same conclusion.

Ojimba (2012) applies McDonald and Moffitt's theory on the decomposition of the tobit coefficients to examine the socio-demographic factors that influence poverty in crude oil polluted crop farms in Rivers State, Nigeria. Ojimba is thus able to measure the elasticity of the probability that farmland affected by crude oil pollution increases poverty as well as the intensity of poverty among farmers in these farmlands. The results show that the intensity of poverty was generally lower than the probability of poverty in all estimated coefficients. According to Ojimba, this means that because of crude oil pollution on crop farms, there is a tendency that the probability of poverty will increase more sharply while the likelihood of poverty becoming more intensified in all farm-households is possible.

However, critics of the use of the second stage procedure using the tobit model as mentioned earlier. McDonald (n.d.) asserts that DEA efficiency scores are not generated by a censoring data generating process (DGP) and are, therefore, a particular kind of fractional or proportional data. According to McDonald, this makes tobit estimation inappropriate since the dependent variable data is fractional data and that tobit would only be appropriate when the dependent variable is generated by a censoring DGP. He supports the use of ordinary least squares (OLS) as an unbiased and consistent estimator.

Yu *et al* (2012) refute McDonald's stance. In their study using the Charnes, Cooper and Rhodes (CCR) model of DEA built on the assumption of constant returns to the scale (CRS), the fractional form of the CCR model is modified based on Cooper's modification (Cooper *et al*, 2000a) and a dual linear model developed to facilitate solving the linear problem. The model then yields efficiency scores that range between 0 and 1, making the dependent variable a limited dependent variable. The use of Tobit model is therefore justified as an accurate performance measurement estimator and they argue against using OLS estimation stating that it may lead to a biased estimation.

Banker and Natarajan (2008) provide a formal statistical basis in support of the use of DEA efficiency score in a second stage analysis following critiques that the procedure had no theoretical basis. They explore DEA's cross-sectional association with contextual variables or socio-economic factors and suggest that the contextual variables should be independent of the input variables, but that the contextual variables need to be correlated with each other. The authors determine that they cannot theoretically justify the use of a Tobit regression in the second stage in terms of an underlying DGP; however, they note that several empirical studies

assume that the Tobit approach is superior to OLS since the estimated DEA productivity scores are bounded above at 1.

In a similar study to Banker and Natarajan (2008) above, Simar and Wilson (2007; 2011) examine, compare and contrast the different assumptions underlying the two models, OLS and Tobit, and argue that second-stage OLS estimation is consistent only under very peculiar and unusual assumptions on the data-generating process which, therefore, limit its applicability. They suggest that in either case, bootstrap methods provide the only feasible means for inference in the second stage.

The use of the second stage Tobit model in empirical studies from diverse fields continues even in more recent works. These include Hedeman (2014), Jara-Rojas *et al*, (2012), Tripathy *et al* (2011), Chavas *et al* (2005), and lastly, Fethi *et al* (2000) who investigate the efficiency of European airlines by using DEA to assess the efficiency of airlines and tobit analysis to identify the effects of various explanatory variables on efficiency. The study uses panel data of 17 European airlines over the period of 1991-1995.

In conclusion, there is much to be learnt about rural household behavior and current research efforts are directed towards 'behavioural' economics through experimental analysis. The utility maximization theories continue to be utilized for a deeper understanding of the influencers of agricultural performance in resource-poor rural settings. The market imperfections, high transaction costs and the resilience of the smallholders to continue to engage in agriculture exhibits utility maximization behavior in the farmers' decision making. According to Waibel (2011), any theoretically sound production economic framework for vegetables has to fulfill a few requirements in order to produce results that allow solid conclusions to be drawn and facilitation of policy recommendations.

Specifically, Waibel suggests that foremost, an economic analysis of vegetables production systems requires baseline information, and at a minimum, the productivity of the particular vegetables, as well as alternative cropping activities, must be known. Some information on the resource endowment of the farmers or households, depending on the type of system, is also needed. Especially important are labour profiles as labour is a major input in vegetables production. Information on the efficiency of the production methods and the existing knowledge gaps of production managers and labourers is necessary to access the feasibility and relative

attractiveness of new technologies. Waibel cautions that detailed data on inputs and outputs are sparse and this study strove to fulfill these conditions.

2.7 Pilot study for estimation of survey sample size

A pilot study is a smaller scale research study conducted before the intended study, is executed in the same manner planned for the main intended study (Sarantakos, 1998). The objective for this study is to test the questionnaire on a small group of farmers who are as similar as possible to the target population and this would lead to the estimation of the variability in outcomes to help determine the sample size (Teijlingen and Hundley, 2001). Testing the questionnaire in this manner would also reveal whether there were any confusing or misleading questions, and whether it was possible to maintain maximum objectivity throughout the interview process. The data gathering exercise allows for the testing of the amount of time it would take to interview each respondent to assist with the planning and budgeting of the final survey which would be affected by the results of the pilot study in determining the sample size (Neuman, 2003). Another reason for conducting the pilot study is to identify the variables of interest and how these would be measured and/or computed.

2.8 Qualitative method of focus group discussions

Focus groups are used as a form of qualitative data collection that employs discussion in a non-standardised form and observation as its sources. In the 1950s, group discussion was employed systematically and on a large scale by the Frankfurt Institute of Social Research to study opinions and attitudes (Sarantakos, 2003:181). Originally the method concentrated on group processes, but later it was used to study the content of discussion. Thus, its main aim is not to analyse the group; it is primarily a way of gaining information about the breadth or variation of opinions, and of establishing a mechanism of opinion formation. This kind of interview is a joint production of a researcher and a member. Members are active participants whose insights, feelings and cooperation are essential parts of a discussion process that reveals subjective meanings (Neuman, 2003:390). According to Neuman (2003), to lead a group discussion the researcher is encouraged to have the theoretical and methodological knowledge of the research topic, experience with group work, and the ability to control the discussion effectively, that is, encouraging involvement, controlling dominating participants and keeping the discussion moving in the right direction.

Group discussions as a data collection method have their own problems according to (Sarantakos, 2003:185). Firstly, while this kind of discussion encourages people to express their views and to evaluate situations, group conditions might force people to hide their real opinions, especially if they feel that their views can have an effect on their personal life given that the members live in the same area. There might also be the domination of the discussions by some people which might affect the direction and outcome of the discussion, or some members might not participate in the discussion. Especially problematic is a trend of the group to please the leader, for many reasons, for example, to 'get it over with', or to please the leader when he or she holds a decisive position in the respondents personal, political or professional life. For these problems to be minimized, the encouragement of active and participatory involvement of all the members in each discussion, and by keeping the group size to a manageable size of not more than 25 participants in each meeting is suggested by Sarantakos (2003).

CHAPTER THREE
METHODOLOGY

3.1 Introduction

This chapter describes the study area, the research design and the empirical models used in the study. A description of the selected variables and their hypothesized effects on the outcomes of interest concludes the chapter. The following sub-section provides a description of the geographical location and agro-ecological characteristics of the study area. The description of survey design and sampling procedure follows in sub-section three, and in sub-section four data types, sources and data collection methods are presented. The final section provides a description of the variables used for estimation in the various models as well as a discussion on the hypothesized effects of each variable on the relevant outcome.

3.2 The study area

The study was conducted in two counties, Kirinyaga and Nyeri counties of the central region of Kenya. The two counties were selected because each county had a long history of producing French beans for the export market; prior to, and after, the introduction of GlobalGAP standard in Kenya. Nyeri and Kirinyaga counties surrounded Mount Kenya in a south to west direction and were interspersed with permanent rivers. Altitude ranges were between 1,000 – 2,000 meters above sea level (a.s.l.) and the region experienced a bimodal rainfall pattern with long rains in March – May and short rains in October – December. Temperate conditions in the higher mountain ranges were suitable for vegetables and fruit growing while tropical agriculture, such as coffee production, was practiced in the lower regions of the lower altitudes which experienced warmer temperatures. In the low lying areas of the southern region lay an extensive government-sponsored rice irrigation scheme. Horticultural crops were also grown in the irrigation schemes as the irrigation waters enabled production all year round.

The administrative boundaries of districts and provinces in Kenya were adjusted and renamed as Counties in the year 2008, therefore, what were once referred to as districts are currently known as Counties, and what were divisions are now Sub-counties. A map of the two counties for the study is presented here below in figure 2.

Figure 2: Map of the study areas in Nyeri and Kirinyaga counties of central Kenya region
Source: http://www.flickr.com/photos/albertkenyaniinima/4486607367

In Kirinyaga county, the study was conducted in Mwea East and Mwea West sub-counties which lay to the south-south east of the county and were traversed by an extensive government-sponsored rice irrigation scheme (area A in the map above). Kirinyaga county was medium-sized (in comparison to other counties in Kenya) with favourable climate for agriculture. Altitude ranged from 1,000 – 2,000 meters a.s.l., and the county experienced a bimodal rainfall pattern

with long rains in March – May and short rains in October – December. Thus, a wide range of crops were grown either under rain-fed agriculture or by irrigation. The main crops grown and the levels of production in 2013 in the study area are presented in Table 3 below. Other vegetables grown under irrigation all year round and in varying quantities were kales, spinach, bulb onions, butternuts, pumpkins, capsicum (sweet pepper), and fruits, such as, water melons, mangoes, avocadoes and paw-paws.

According to statistics gained at the sub-county level (Ministry of Agriculture, 2013a), Mwea West lay 1,195meters a.s.l. and received an average annual rainfall of 950mm per year. It had good terrain and good soils, and two large rivers flowed from Mount Kenya; Rivers Thiba and Sagana, which enabled the irrigation scheme to thrive. The sub-county was 243.64 km^2 in size and there were 18,240 farms and 20,255 farm families from a total number of 24,950 households. Rice cultivation was the main income generating activity followed by horticulture production. The irrigation scheme was maintained by the National Irrigation Board which catered to rice farming only, thus leaving other non-rice growing farms without access to water. The main market centers were Kagio, 115 kilometers (kms.) from Nairobi; Kutus, 11 kms eastwards from Kagio, and Kerugoya town, the capital of Kirinyaga county, was 50kms. north from Kagio. Kagio was the main center for inputs and fresh horticultural produce marketing, and there were two market days for fresh produce buyers from Nairobi and elsewhere.

Mwea East was the southern-most part of Kirinyaga county and the closest in distance to Nairobi at 117 kms. The sub-county lay between 1000 – 1400 meters a.s.l. in altitude and experienced annual rainfall amounts of between 400 – 1200 mm (Ministry of Agriculture, 2013b). It had a size of 301.1 km^2, a population of 103,248 persons, and 30,891 farm families. Horticulture, dependant on irrigation, was the predominant agricultural activity and generated the highest household income. The main market center, Wang'uru, was located on the Nairobi-Embu-Meru highway making it a vibrant commercial center and the main outlet for rice and horticultural produce for retail markets. Large rice mills and warehouses were in abundance and favoured Mwea East as a supplier of produce to Nairobi and the other towns such as Embu town and Meru county. There were a large number of producer groups based in the irrigation scheme, and thus, a larger number of survey participants were identified in these two sub-counties.

Table 3: Main crops grown in the study area and yield (in tonnes) in 2012/13

Crop	Mwea East	Mwea West	Mathira East
Rice	19 517	29 625	-
Tomatoes	46 125	2 160	n/a
Maize	15 455	20 280	31 380
French beans	4 820	520	n/a
Beans	2 794	768	999
Bananas	10 640	875	15 400
Tea	-	-	17 783
Coffee	-	-	10 104
Irish/sweet potatoes	675	n/a	1 096

Source: Ministry of Agriculture, 2013a, b, c.

The second county, Nyeri, was located 153kms. north of Nairobi and lay at the base of the Aberdare ranges which formed a part of the eastern end of the Rift Valley. With a size of 3,356 km^2, Nyeri had a wide climatic range. Temperate conditions were suitable for vegetables and fruit growing in the high altitude areas while tropical agriculture was practiced, for example coffee production, in the lower regions of the mountain ranges which had warmer temperatures. The study area in Nyeri was in Mathira East and Mathira West sub-counties, located 20kms south-east from Nyeri town and 137 kms. from Nairobi (area B in the map above), and in Kieni East sub-county which was located 41kms. from Nyeri town and 174kms from Nairobi (area C in the map).

The commercial center serving both Mathira East and West sub-counties was Karatina town which was 137kms. from Nairobi and 21kms. from Kerugoya town in Kirinyaga county. The two sub-counties were one district prior to the creation of the Counties and were, therefore, similar in nearly all aspects related to agriculture. Altitude ranged between 1580 to 2070 meters a.s.l., bimodal rainfall distribution was between 800-1400 mm. annually, and temperature ranges were between 18-24^oC (Ministry of Agriculture, 2013c). In the high altitude areas, the climatic conditions made the sub-counties ideal for temperate crop production such as French beans and other vegetables, and a vast array of fruits. The population size was 166,700 persons and 55,000 farm families. The area had four irrigation schemes which drew their waters directly from Mount Kenya which facilitated the production of vegetables all year round. The rivers were Kangocho,

Kanjuri, Kimbiria and Sagana. An area named after the River Sagana and named Sagana in Mathira West sub-county as it was found that many farmers in other areas of the sub-county had turned away from French beans production for the export market and towards production for the canning industry. Sgana was a large irrigation scheme with a well organized farmers' cooperative which owned the entire French beans supply chain, from farms to oversees retailers, thus by-passing the local export companies.

To the northern part of Nyeri county was Kieni East sub-county. Administratively, Kieni East was under Nyeri County, however, the neighbouring County of Laikipia was closer for commercial purposes and traders frequented the main town, Nanyuki, for most business transactions. Nanyuki was a major commercial link to the northern towns of Kenya such as Isiolo, and Marsabit. The main local commercial center for Kieni East was, however, Naro Moro, located 22 kms. from Nanyuki town and 41 kms. from Nyeri town. Kieni East lay lee-wards of Mount Kenya and in the past was more favoured for livestock ranching. However, closer to the mountain, with cooler temperature ranges and water supply from permanent down-flowing streams from the mountain, horticultural crops was predominant. The study area was in Munyu and Lusoi locations which were about 20 and 25kms., respectively, from Naro Moru and closer to the mountain. The two locations had volcanic soils and an adequate road system made up mainly of murram roads which lead into the villages. However, these roads would become fairly impassable during the rains. Crop production was largely rain-fed as a result of water diversion upstream into larger farms closer to the mountain. In the study period, 2013, no French beans were grown in Lusoi location because of a reportedly high incidence of pests. Thrips were said to be the reason for export buyers moving away from the area and sourcing for the produce in other regions.

The agricultural extension offices in both Counties were still in transition from the national government to the County government system, and most offices were under-staffed. For example, where there had been a minimum of five technical officers and two livestock production officers, only two extension officers were found serving both crops and livestock matters. This situation had impacted negatively on extension service delivery to the farmers, and farmers relied more on the services offered by private companies which, however, focused on the crops of their interest. In all, however, the two Counties of Nyeri and Kirinyaga, had reasonable

infrastructure which enabled the efficient production and marketing of French beans for the export market.

3.3 Sample selection design

The study was interested in small-scale farmers owing a maximum of 2.5 acres, and certified as GlobalGAP compliant growers at the time of data collection in November, 2013. To be certified, an individual small-scale farmer was a member of a group due to economies of size with respect to the collection of French beans from the farms by the export companies, among other necessities discussed in Chapter 2. Thus, as a group, the farmers' were contracted to supply one export company in any given production period. The control group for the study were those farmers who were not GlobalGAP certified. This latter group consisted of those who had never been certified in addition to those farmers who had discontinued with, for any reason, the process of becoming GlobalGAP compliant.

The initial sample selection design planned for the study was intended to be a systematic random sampling method to gain access to those farmers who were GlobalGAP certified. Respondent farmers would have been randomly selected from registers provided by randomly selected export companies. There were 18 major exporters who were to participate in the first stage of the sampling. However, the export companies, both large ones and small, failed to respond positively to requests to participate in the survey and/or to gain their producer lists. The sampling method, therefore, collapsed at the first stage level and another strategy was designed. A "cold-turkey" or direct approach to participants was adopted which required enumerators to randomly select the survey participants in the five research study areas.

Once in the field, enumerators confirmed the farm size at the earliest opportunity since a farm size of 2.5 acres maximum was the main unit of interest. To select non-certified farmers, a system was adopted in which, on each day, enumerators identified the first participant as either certified or non-certified and subsequent participants were identified from this reference point. A key requirement was that non-certified participants were located within a radius of 1 km. from certified participants. Further, in each of the participating farm households, the household head who made the day-to-day decisions on farm activities, input use and technology adoption was targeted as the main survey participant. This design was adopted for both the pilot study and the main survey.

3.3.1 Pilot study for estimation of survey sample size

A pilot study was undertaken in January 2012, according to the objectives of a pilot study discussed in section 2.7 (p. 51). Ten farmers were selected to participate in six (6) locations in Kieni East, Mathira West and Mwea East sub-counties. These locations were in the three (3) counties of interest but where not the same ones targeted for the main survey. However, the selected locations allowed for a familiarization exercise of the region and a critical examination of the main study's resources, including time, finances and materials, given the distances to be covered in the field. Ninety (90) farmers in total volunteered to participate in the study and their responses led to adjustments in the flow of the questions in the questionnaire and the rewording of questions found to be ambiguous. The survey questionnaire is presented in Appendix 1.

According to Hoshmand (1988), the pilot study was to provide the standard deviation, s, which was required in the calculation for the main study's sample size. The variables of interest were related to French beans production under a GlobalGAP farming regimen. Variables included French beans output (in kgs.), family labour (measured in average hours per day), hired labour (measured in average hours per day), and age of the household head. Given that the pilot study was also intended as a practical exercise on how the variables would be measured and computed, the measurement of the labour variable was re-evaluated and changed accordingly. Thus, prior to data entry, family and hired labour hours were extrapolated to cover an entire production period of three months. This change was also recorded for adjustment in the main questionnaire.

The data was evaluated using SPSS and the estimated descriptive statistics revealed wide dispersions about the mean for French beans output (in thousands of kgs.), for family and hired labour hours (in hundreds of hours for a three month production period). The figures were found to be too large and, therefore, inappropriate for use in the sample size calculation as they generated an enormous sample size and were, therefore, discarded. Nevertheless, an adjustment was made as to how family and hired labour would be measured. Worker-days for the year 2013 were found to be more suitable. The mean age of the sample in the pilot study was 36 years and the standard deviation was 20. Thus, age was determined as having a more reasonable dispersion and this was used in calculating the sample size.

3.3.2 Determining the sample size

Using the following formulae, sample size was determined as follows:

$$n = \frac{s^2}{\sigma_x} \quad \text{or} \quad n = \left(\frac{z.s}{E}\right)^2$$

where; n = sample size

z = the z-score associated with the selected degree of confidence (95% is an advisable confidence limit)

s = sample standard deviation of the pilot study

E = allowable error (± 5 margin of error is allowable in agricultural sciences).

The sample standard deviation from the pilot study was 20, and using a 95% confidence level (z-score = 1.96), and an allowable error of ± 5; the sample size was calculated as follows:

$$n = \left(\frac{z.s}{E}\right)^2$$

$$n = \left(\frac{1.96x20}{5}\right)^2 = (7.84)^2 = 61.46 \approx 60$$

The necessary sample size for the desired level of precision was taken as 60 farmers for each of the targeted locations. However, this number proved too large due to considerations of financial constraints, and the availability and adequacy of other resources such as time and trained manpower. Thus, taking these issues into account and given that, theoretically, a sample size of 30 and above was considered to be asymptotically normal, thirty (30) farm households growing French beans were considered to be sufficient for the study. The strength of the propensity score matching model which was to be used for data analysis was in reducing any selectivity bias which would be occasioned from reducing the sample size in this manner. In all, a total of 480 randomly selected farm households participated in the main survey. The numbers of survey participants achieved, by county and location, are presented in Table 4 below.

Table 4: Locations and numbers of smallholders who participated in the survey

County	Location	Number of growers participants in survey
Kirinyaga	Kiarukungu	15
	Gathya	25
	Mikarara	20
	Nyanyati	35
	Kiamiari	18
	Gathigiriri/Muhigaini	45
	Kiaga	27
	Githumbu	21
	Kiarukungu	45
	Kirogo	35
	Mutitu/Kianjanga/Gitakwa	50
Nyeri	Munyu	30
	Lusoi	29
	Karatina	41
	Sagana	30
	Gaturiri	14

Source: Survey data, 2013

3.4 Data collection

Data was collected on all aspects that were relevant to the study. The study made use of both primary and secondary data. A field survey method of obtaining information was adopted for collecting the needed primary data given the poor farm-record keeping skills of smallholders. The data was collected using a structured questionnaire designed for a single visit in consideration of the time and financial constraints. The questionnaire was designed in a way that participants provided information on household characteristics which would enable the examination of socio-economic factors which influenced the adoption of GlobalGAP certification by smallholder French beans farmers and the effect of GlobalGAP on income; input and output data required for the assessment of the production efficiency and the probable sources of inefficiency. The data also supported the comparison between GlobalGAP participants and non-participants.

To realize objective 1 and 2, data was collected on socioeconomic factors such as farm size, age, education, farmer's experience, household and hired labour size; institutional factors such as access to extension services, access to market and membership in farmer associations; technology adoption variables such as use of inorganic fertilizer, use of herbicides and adoption of GlobalGAP requirements. To realize objectives 3 and 4, data was gathered on the quantities of inputs and crop outputs for the whole farm. The data included that on output of French beans and other crops; input data on seeds, inorganic fertilizer, land planted under each enterprise, family and hired labour. Data on livestock was also required for an assessment of households' assets base. A comparison of all the data between certified and non-certified households was central to the study.

The primary data was collected with the assistance of enumerators who were trained a day prior to the commencement of the exercise. The training lasted one full day and included a testing of the questionnaire on a randomly selected farmer located near the training grounds. The enumerators were sourced, with the assistance of both public and private extension staff, from among the local university and/or secondary school level students who had completed their final "O' level examinations and were at home on vacation. In each location, the enumerators were trained on the survey instrument through discussions on the requirements of each question and clarity on the intended meaning of the questions. The majority of the questions in the questionnaire were closed and, therefore, enumerator or respondent bias was minimized.

In addition, data was collected on the farmers' perceptions of the attributes of GlobalGAP. Spontaneous, *ad hoc,* group discussions involving French beans farmers and the principal investigator were held in each location. The group discussions were a source of additional information on the producers' experiences in a wide range of issues related to the production of an export crop, such as, the group formation requirement, export company support, and any other issues which developed during the discussion. An open-ended questionnaire was used for the group discussions and participants were encouraged to expound on any topic that developed (Appendix 2). Group discussions were held in three sub-counties; Kieni East, Mathira East and Mwea East; groups included 15 – 25 participants and discussions lasted between 2-3 hours.

At the end of the data collection exercise and in preparation for data entry, an evaluation of all the records showed that, after discarding incomplete records, a sample of 343 farms remained.

Further examination of the records revealed farms not meeting the required maximum size of 2.5 acres and other anomalies. The anomalies may have arisen as a result of the 10 enumerators suffering from fatigue from filling in the same questionnaire and working six days per week, or general lack of awareness in filling the data in the wrong columns. Thus, upon discarding these records, a sample of 266 farms remained for analysis.

Secondary data was obtained to supplement the primary data. Data on French beans, other crops and livestock production systems and yields was gathered from the Ministry of Agriculture sub-county offices while the national offices provided statistics and more information on export horticultural crops. Data on French beans and GobalGAP was obtained from FPEAK who also provided the technical manuals on GlobalGAP and KenyaGAP. The secondary data added to the literature on French beans production trends under GlobalGAP in Kenya.

3.5 Empirical models

The specification begins with the propensity score matching model followed by the technical efficiency and second stage tobit models.

3.5.1 Propensity score model

Estimation of propensity score was accomplished using a probit model consistent with Katchova (2013), as shown below:

$$\Pr ob[y_i = j] = \frac{\exp(\beta_j x_i)}{s(j = 0 - j)\exp(\beta_j x_i)}, j = 0,1....., J \text{ ….....……Equation 11}$$

where the left hand side represents the probability of participation in GlobalGAP certification in the production of French beans for the j^{th} household, and 'x_i ' variables are characteristics of the observed household which are the same across all outcomes. The strength of the propensity score modeling approach is that the selection bias in reduced when comparisons of outcomes is performed using participants and non-participants who are as similar as possible since it allows for the estimation of average effect of the certification while controlling for the unforeseen factors in selection process. In linear form, equation 9 is reduced to:

$D(0,1) = \beta_o + \beta_{1i}x_{1i} + \boldsymbol{\varepsilon}$, $pscore(mypscore)\, blockid(myblock)\, comsup$……...Equation 12

where D is the indicator for participation, whereby D=1 if a household is a participant and 0 otherwise. x_i represents a vector of participation covariates of the household such as household

head's age, gender of the household head, education level, value of livestock assets, value of household assets, income from off-farm employment, value of remittances and transfers received, exposure to information on the certification process through extension contact, farm size, value of intermediate assets (machinery and equipment), expenditure on material inputs (i.e. farm stock), family labour, hired labour, and distance to the nearest market.

This was followed by options that command for generation of propensity score index '*mypscore'*, generation of variable '*myblock'* for the identification of blocks of propensity scores, and '*comsup'* option for common support that generated a dummy variable which identified households that met the matching condition. The common support variable attached numeral '1' corresponding to the subjects that met the matching condition and '0' to those that did not meet the condition. Estimation of average effect of participation in certification followed commands in STATA, namely '*attnd'* for nearest neighbor matching, '*attr*' for radius matching, *'attk*' for kernel matching and *'atts'* for stratified matching method. The general formulation of the empirical model is as follows:

$$Command: y = \beta_0 + \beta D + \beta_i x_i + \varepsilon, pscore(mypcore), com\sup, \log it \ldots\ldots\ldots\ldots\ldots \text{Equation 13}$$

where command stands for either one of the matching estimation above (*attns, attr, atts, attk*), 'y' is the outcome of output, x_i is a vector of participation covariates, followed by the propensity score option, then the common support option.

The two options were important in the sense that the average effect of certification (AEC) was computed from the propensity score index which was the differences in outcomes for certified farmers and controls/non-certified farmers who were as similar, in personal characteristics, as possible. Common support was also a mandatory option to ensure matching was done only on controls that were similar to participants. The model is estimated using a computer program, STATA version 12.0. The programme gave estimates of the propensity score using a probit model while matching commenced immediately thereafter.

3.5.2 Data envelopment analysis (DEA) model

The input oriented Data Envelopment Analysis (DEA) technique proposed by Charnes *et al*. (1978) involved calculating the individual input saving efficiency measures by solving a linear programming problem for each unit under the constant returns to scale (CRS) assumption. The use of the variable returns to scale (VRS) model was also undertaken in accordance with Banker

et al. (1984) since the French beans households were assumed to face imperfect markets and capital constraints among other factors which caused a farm to operate on a below optimal scale. The farm households also tended to have greater control over their inputs than over their outputs. Thus, an efficient farms on the frontier would have an efficiency score equal to 1, and this score would decrease with inefficiency.

Consistent with Coelli (1995, 1996), the constant returns to scale DEA model requires that for each household, a measure of the ratio of all outputs over all inputs, uy_i/vx_i, is obtained, where u is an M×1 vector of output weights and v is a K×1 vector of input weights. To select optimal weights, we specify the mathematical linear programming problem as:

$$\max_{u,v}(uy_i/vx_i)$$

Subject to $uy_j/vx_j \leq 1$, j=1,2,.....,N

$u, v \geq 0$ …….....……...…….....Equation 14

The constant returns to scale (CRS) DEA model states that the optimal mix of inputs and outputs is independent of the firm's scale of operation, which implies that a proportionate increase in the inputs results in the same proportionate increase in the output (Tripathy *et al.*, 2011). The objective function specified in Equation 12 involves finding values for u and v, so that the efficiency of the ith farm is maximized, subject to the constraint that all efficiency measures must be less than or equal to 1. The above model is non-linear in nature and has an infinite number of solutions. Since linear programming cannot handle fractions, the above formulation is transformed in such a way that the denominator of the objective function is limited and maximization of the numerator is allowed. For this purpose, an additional constraint is added. Thus, the above non-linear model transforms into the following linear model:

$$\max_{u,v}(\mu y_i)$$

Subject to $\nu x_i = 1$

$\mu y_j - \nu x_j \leq 0$, j=1,2,.....,N

$\mu, \nu \geq 0$ ……..….....…..….....……Equation 15

where the notation changes from u and v to μ and ν to reflect the transformation. By using the duality in linear programming which will enable the model yield efficiency scores that range

between 0 and 1, we derive an equivalent envelopment form to the multiplier form of the linear programming problem, as follows:

$$\min_{\theta,\lambda} \theta$$

Subject to $-y_i + Y\lambda \geq 0$

$$\theta x_i - X\lambda \geq 0$$

$$\lambda \geq 0 \quad \text{.....Equation 16}$$

where θ is a scalar and and is the efficiency score of the ith DMU. λ is a N×1 vector of constants. The value of θ will satisfy $\theta \leq 1$, with a value of 1 indicating a point on the frontier and, therefore, a technically efficient household as per Farrell's definition. The linear programming problem will need to be solved N times, once for each household in the sample and a value of θ will then be obtained for each household.

The CRS assumption is appropriate in cases where all DMUs operate at an optimal scale, as stated above. However, given there exist constraints on farms which do not allow them to operate at the optimal scale, using CRS would yield technical efficiency (TE) scores which are affected by scale efficiencies. Therefore, one needs to use the variable returns to scale model of DEA. VRS implies that an increase in inputs may result in either more or less than proportionate increase in the output. The CRS LP programming problem is modified to account for VRS by adding the convexity constraint on λ in Equation 14 above. Thus, the final LP model to be estimated was as below:

$$\min_{\theta,\lambda} \theta$$

Subject to $-y_i + Y\lambda \geq 0$

$$\theta x_i - X\lambda \geq 0$$

$$N1\lambda = 1$$

$$\lambda \geq 0 \quad \text{.....Equation 17}$$

where θ is a scalar and λ is an N×1 vector of ones.

According to Coelli (1995), this approach would form a convex hull of intersecting planes which enveloped the data points more tightly than the CRS conical hull, and thus, provide

technical efficiency scores which were greater than or equal to those obtained using the CRS model. To compute the technical efficiency scores a user-written DEA computer program implemented in STATA version 12.0 was used.

3.5.3. Second stage tobit model

To analyse the impact of GlobalGAP and the socioeconomic variables on farm level technical efficiency, a second stage analysis was performed whereby the efficiency scores obtained from the first stage were regressed on the explanatory variables using a double-bounded tobit model. According to Banker and Natarajan (2008), in a typical two-stage study based on DEA, the relative productivity of each farm was to be evaluated in the first stage based on data on input consumption and output production. The productivity score was then regressed on potential contextual factors or socio-economic factors in the second stage to identify the factors whose impact on productivity was statistically significant. The DEA efficiency scores would lie in the interval 0 and 1, thus, the dependent variable became a limited dependent variable. Therefore, it was apt to use the tobit model, which is a censored regression model, and applicable for cases where the dependent variable was constrained in some way.

The Tobit model is defined as:

$$Y_i = \begin{cases} Y_i^*, \text{ if } 0 \le Y_i^* \le 1 \\ 0, \text{ if } Y_i^* < 0 \\ 1, \text{ if } 1 < Y^* \end{cases} \quad \text{.....Equation 18}$$

$$Y_i^* = \beta_o + \sum_{n=1}^{15} \beta n \, X_{in} + \varepsilon_i, \;\; \varepsilon_i \sim N(0, \sigma^2)$$

$$\text{If,} \quad L_i < \beta_o + \sum_{n=1}^{15} \beta n \, X_{in} + \varepsilon_i, < U_i$$

where, Y_i is the observed dependant variable, Y_i*is a latent variable representing the efficiency measure for each farm household (the DEA efficiency score), β is a k x 1 vector of unknown parameters to be estimated and which determines the relationship between the explanatory variables and the latent variable, and X_i is a n x1 vector of explanatory variables for the ith farm. L_i and U_i are the distribution's lower and upper censoring points, respectively (Macdonald and Moffitt, 1980).

The study thus followed this two step approach in which each endogenous variable was estimated in a first stage, and the predicted values were included in a second step as additional explanatory variables which yielded unbiased estimates of the impact of GlobalGAP certification on technical efficiency.

3.5.4 Analysis of qualitative data from group discussions

To analyse the data collected on farmers' perceptions of the attributes of GlobalGAP and on their experiences in the production and marketing of French beans for the export market, the study employed a qualitative method of recording verbal communication. The method was employed as a post-research method after the quantitative data had been collected in an area. Group discussions were conducted in order to seek further information, from the participants' perspective, on their experiences in French beans production and marketing activities. The data was collected using an unstructured interview process with the groups, meaning that there were no restrictions in the wording of the questions, the order of questions or the interview schedule. The data was written down manually in note books as the discussions flowed.

To analyze the qualitative data collected, the units of analysis were the themes and content generated in the three group discussions. According to Neuman (2003:441), "a qualitative researcher organizes data into categories on the basis of themes, concepts, or similar features. Eventually, he or she links concepts to each other in terms of a sequence or as sets of similar categories that he or she interweaves into theoretical statements". Thus, the analysis involved the identification and evaluation of the themes/concepts which appeared to be theoretically important and meaningful to the study, and relating them to the central questions of the study.

3.6 Variable description and measurement

The description of all the variables used for analysis is presented in this section. For the propensity score matching (PSM) model, according to Austin (2011), there are theoretical arguments in favor of the inclusion of only those variables that affect treatment assignment in the propensity score model. Austin (2011) argues that the variables to be included must be those measured at baseline and not post-baseline covariates which may be influenced or modified by the treatment. Thus, the author proposes that guidance for identifying variables may be provided from the literature. In line with this proposition, the choice of variables for the PSM model was guided by a previous empirical study on Kenyan smallholders by Owuor (unpublished doctoral

thesis, 2008). Table 5 below shows the selected variables and the hypothesized influence of each variable on the treatment assignment in the model which is the adoption of GlobalGAP certification.

Age was expected, theoretically, to reduce productivity because as people advanced in age, their ability to commit to highly physical activities declined, and this would negatively affect productivity. Lower productivity, in turn, would reduce income from farming which was then expected to limit the participation in GlobalGAP certification which demanded annual, recurring costs. With respect to the sexes, as men were known to seek employment in urban centers, their participation in agriculture declined leaving the women as the active decision-makers on the farms. Women tended to have better access to rural based information such as on GlobalGAP certification, and were, thus, hypothesized to have a higher likelihood of participation in GlobalGAP. Education imparted skills that enabled individuals to better conceptualize issues and combine resources in a more efficient manner, consequently improving the probability of adopting GlobalGAP.

Table 5: Factors hypothesized to influence adoption of certification

Variable	Definition and Units	Effects
Household characteristics (x_i)		
Age	Years	(+, -)
Gender	Dummy (male=1, female=0)	(+, -)
Education level of decision maker	No. of years of formal schooling	(+)
Livestock assets	Total value of livestock in KES.	(+)
Off-farm income	Income from businesses in KES.	(+)
Other household assets	Value of furniture, electronics, cell phones, etc. in KES.	(+,-)
Remittances and transfers	Average value of transfers and gifts received in KES.	(+)
Exposure to information such as on certification process and other agricultural information	No. of contact hours in the year with extension, NGOs and/or export companies in the year.	(+)
Farm characteristics (x_j)		
Farm size	Farm size in acres	(+)
Intermediate assets	Value of machinery and equipment in KES.	(+)
Material inputs	Expenditure on stock (fertilizer, seeds, feeds, veterinary & crop chemicals) in KES.	(+)
Family labour	Family labour non-remunerated (man-days)	(+)
Hired labour	Hired labour on the farm (man-days)	(+)
Market access	Distance to the market in kilometers	(-)
Participation dummy (D)	If farmer is GlobalGAP certified: (Yes = 1, No = 0)	(+, -)

Wealth and exposure to information through seminars and extension were associated with better access to input and product markets and, therefore, increase the chances of adopting GlobalGAP. Wealth was measured in the form of livestock ownership, farm machinery, small tools and equipment, and household assets. Assets could be sold in times of financial stress to generate cash for smoothing consumption expenditures such as on food, school fees and medical expenses. Contact with extension agents was also expected to influence adoption of GlobalGAP practices through better understanding of requirements for production of export produce. Income in the form of gifts and remittances enabled households to acquire consumptive goods as well as productive inputs, thus improved the chances of gaining certification. Market access measured in distance to the market was theoretically expected to negatively influence productivity the further a farm was located from a market center. This was in consideration of the effect of distance on transaction costs for both input acquisition and output marketing. Consequently, long distances from the market center would lead to a low probability of participation in GlobalGAP certified farming practices.

The output variable for French beans used in the PSM model was the value of the quantity of French beans produced during the year 2013 by farm households and was measured in Kenya Shillings (KES). In the irrigated areas, three crops, on average, were produced during the year while in rain-fed areas, two crops are produced. However, on average, four pickings (harvests) were done in each crop cycle. Further, prices received for the produce ranged between KES. 25 per kg. and KES.50 per kg. The variance in prices received had a direct effect on the value of the French beans output variable, FBout.

The propensity score model for the study was specified as follows:

$$Y = f(\beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \ldots\ldots\ldots\ldots\ldots \beta_{15} x_{15}) + \varepsilon_i \text{ and } Y = (1, 0) \text{ if certified or not}$$

and where x_i were the variables representing the socio-economic characteristics of the observed individual as follows: x_1 = certified (Dummy value, 1 = certified, 0 = not certified); x_2 = age; x_3 = gender; x_4 = education; x_5 = livestock value; x_6 = household assets value; x_7 = annual off-farm employment income (wages/salary); x_8 = transfer gifts and remittances; x_9 = contact hours with extension agents; x_{10} = total farm size; x_{11} = farm equipment; x_{12} = value of farm input stock; x_{13} = family labour hours on-farm; x_{14} = hired labour hours; and, x_{15} = distance of local market

In addition, the average effect of certification (AEC), as a second stage analysis, was expressed as being a function of the output influencing factors presented in the household model in Section 2.5.5. (pp.38) in Equation 7, re-presented below as:

$$AEC = f(\Omega_{hh}, \Omega_{ff}, \Omega_{mk}, \Omega_{gg},)$$

The household specific characteristics were represented by vector $\Omega_{hh,}$ farm specific characteristics were represented by vector Ω_{ff}, market characteristics were represented by vector $\Omega_{mk,}$ *and* GlobalGAP constraints were represented by vector Ω_{gg}. This would determine the average effect of participating in GlobalGAP farming scheme on the income level of the participants.

For the frontier models, the explanatory variables were those commonly used in estimating agricultural production frontiers for developing countries as suggested by Bravo-Ureta and Pinheiro (1997). In addition, the variables were to meet three other conditions. According to Mostafa (2007, in Tripathy *et al.*, 2011), in using the DEA model, the chances of an inefficient firm being declared efficient reduced if the minimum number of farms chosen was more than three times the total number of inputs and outputs. In this study, there are six inputs and one output, therefore, the minimum requirement for the number of sample farms required for the use of DEA was twenty-one (21). This condition is fulfilled as the study sample had 266 farms. Another condition required for DEA was that the function relating inputs and outputs possessed the monotonicity property, which essentially meant that an increase in the inputs would lead to an increase in the output. This relationship was observed in the choice of inputs and outputs included for analysis in the study. The third condition was that all inputs and outputs were positive. This condition was also fulfilled.

The explanatory variables were: FBACRES (X_1) which represented all cultivated land under French beans, that is, the size of the farm that each household cultivated French beans. In some cases and in what was an unexpected practice found in some areas, the size of cultivated land included rented land. This was whereby some farmers extended the permissible areas under French beans. Export companies' limited farm size under French beans to not more than 0.25 acres per farm in consideration of production of food and other cash crops. Rented land was therefore included for these cases since the objective was to capture all cultivated land under French beans per household. FAMLAB (X_2) included both family and hired labour measured in

worker-days for the year 2013. On-farm labour was distributed between the various farm-operations ranging from land preparation to the harvesting of all crops, thus, on-farm labour was applied simultaneously in the production of all crops. To arrive at the final measurement, the French beans enterprise had the largest labour input, and therefore, the family and hired labour recorded for French beans was used in the model. FERT (X_3) represented the quantities of fertilizer used on the whole farm in 2013, and was measured in kilogrammes. STOOLS (X_4) corresponded to total expenditures, in Kenya Shillings (KES.) on small farm tools for the year, and SDRFTPR (X_5) was the value of seed and draft power used in the production process, in KES. And an additional variable, GCSTS (X_6), was included in the model. This represented the total expenditures, in KES, on certification, inclusive of both the initial and recurring (annual) expenditures. The output variable (Y), ALCROPS was the farm value (in KES.) of all crops produced on the farm, such as, coffee, bananas, rice, other vegetables including French beans.

The model to perform the efficiency analysis was specified in general form as:

Alcrops=*f*(Fbacres, Famlab, Fert, Stools, Sdrftpr, Gcsts).....Equation 19

And the tobit model was specified as:

$$Y^* = \beta_0 + \beta_1 CERT + \beta_2 AGE + \beta_3 GEN + \beta_4 EDUC + \beta_5 LVV + \beta_6 HHA + \beta_7 OFFE + \beta_8 TRGT + \beta_9 TRNG + \beta_{10} FRMS + \beta_{11} MEQP + \beta_{12} MATS + \beta_{13} FLAB + \beta_{14} HLAB + \beta_{15} DMKT + \varepsilon_i$$

i.e. using all the explanatory variables used in the propensity score model to investigate the influence of farm and household characteristics on technical efficiency. This was expected, for policy implications, to identify the sources of inefficiency. The tobit model were implemented in STATA version 12.0.

The hypothesized effect of the explanatory variables on efficiency was as follows: Engagement in non-farm activities was, theoretically, an important determinant of efficiency. While on one hand off-farm employment increased the household's income base thus enabling the increase of purchased industrial inputs, on the other hand, it reduced the labour available for agricultural production which would have a negative effect on efficiency. Land size was expected to have a large influence on efficiency, and it was hypothesized that given the limited acreage used in French beans production land, this size would have a positive influence on efficiency. French beans production was a labour intensive process and family labour was

expected to influence efficiency positively while hired labour was ambiguous being dependent on the quality of agricultural technical skills of hired labour.

Personal wealth, measured in the form of number of livestock, value of intermediate assets such as farm machinery and equipment, the amount of stock of material inputs such as fertilizer, seeds, feeds, and agricultural chemicals maintained, and ownership of household assets such as furniture, household electronics, and probably a personal vehicle, were hypothesized as being associated with better access to input and product markets. Thus, a household would increase its assets base from increased production and sale of farm produce. Therefore, a large assets base was taken as an indicator of high productivity and was, therefore, hypothesized would have a positive influence on efficiency.

CHAPTER FOUR
RESULTS AND DISCUSSION

This chapter presents and discusses the results from the data analysis undertaken using propensity score matching method and data envelopment analysis and a second step tobit efficiency analysis methods. The chapter is organized as follows: In sub-section 4.1 the results of the socio-economic attributes of the sampled households are described and discussed. Subsection 4.2 contains the results of the average effect of participation in GlobalGAP farming on household income from the different matching methods followed by sub-section 4.3 in which the results on the factors that influence participation in GlobalGAP are presented. Sub-section 4.4 contains the efficiency scores estimated using the non-parametric DEA model; and in subsection 4.5 are the results from the tobit analysis on the farm and household characteristics which influence technical efficiency. The results of the group discussions are presented and discussed in sub-section 4.6 while sub-section 4.7 is a summary of the findings of the study.

4.1 Households characteristics of sample households

In this sub-section a description of the variables used in the study is undertaken. The results set the stage for the following sections once an overview of the household and farm characteristics is presented. The discussion focuses on the description of the characteristics of the sample households and the identification of the key differences between certified and non-certified households is central in the discussion.

Various household and farm characteristics of the farmers were hypothesized to influence the adoption of GlobalGAP certification. These were age, gender of household head, education, regular contact with agricultural extension agents, wealth, regular engagement in off-farm employment, access to transfer income, distance to the local market and membership in farmers' group. The distribution of household and farm characteristics is presented below in Table 6.

Table 6: Household and farm characteristics of study sample

Variable	Percentage	Variable	Percentage
Sex of HH Head:		**Off-farm employment:**	
Male	94.36	Engaged	46
Female	5.64	Not engaged	54
Household Size:		**Membership in farmer group:**	
1	2.25	No	11.65
2 – 3	29.7	Yes	88.35
4 – 5	57.9	**Extension Contact (hours per year):**	
6 – 7	9.4	108	25.94
8 – 11	0.75	156	27.82
Mean Household Size: 4		204	31.95
AGE (years):		312	3
< 25	0	624	3.75
25 – 30	3.39	936	2.63
31 – 35	5.64	1248	3
36 – 40	21.44	1560	1.5
42 – 45	13.16	2496	0.38
46 – 50	23.7	Mean Extension Contact: 849.33	
51 – 55	10.52	**GlobalGAP certified status:**	
56 – 60	15.41	Not certified	23
61 – 65	3.0	Certified	77
66 – 70	3.0	**Distance to Market (kms):**	
71	0.37	≤1	55.6
80	0.37	1 – 5	29
Mean Age: 47.7		6 – 10	11
EDUC (years):		10 - 20	5
No formal education	0	25	0.38
4 – 8	40.23	40	0.38
8 – 12	53.77	Mean distance: 7.85	

> 12	6.0
Mean Education: 10.5	
LAND (acres):	
< 0.25	0
0.25 – 0.5	7
0.75 – 1	24
1 – 1.5	26
1.5 – 2	29
2 – 2.5	14
Mean Land size: 1.27	

Source: Survey data, 2013

4.1.1 Household head's age and education level

Results presented in Table 6 show that male headed households were 251 representing 94 percent out of 266 sample households while 15 were female headed households (6 percent). The average household size was 4 persons. Thus, while larger family size was considered an important asset as a source of farm labour, this number was considered to be sufficient given that the average farm size in the study area was 1.27 acres. The average age of the respondents was 47 years showing that majority of the farmers were still in their productive years. However, one farmer in the sample was 80 years old and influenced the average age upwards.

The proportion of the household heads who had adopted GlobalGAP in French beans farming was high for the various age groups between 25 – 50 years (Figure 3 below). Eighty one (81) respondents were between 25 – 40 years, with 53 being certified and 28 non-certified. However, when the age band was expanded to include those upto 50 years, the number of household heads increased to 179 heads, 137 certified and 42 not certified. One inference from these statistics is that the respondents were relatively young when GlobalGAP was first introduced in Kenya in 2000, and some were probably in their teenage years. Thus, it may be surmised that the early exposure to GlobalGAP influenced their decision to adopt the standard into their farming practices.

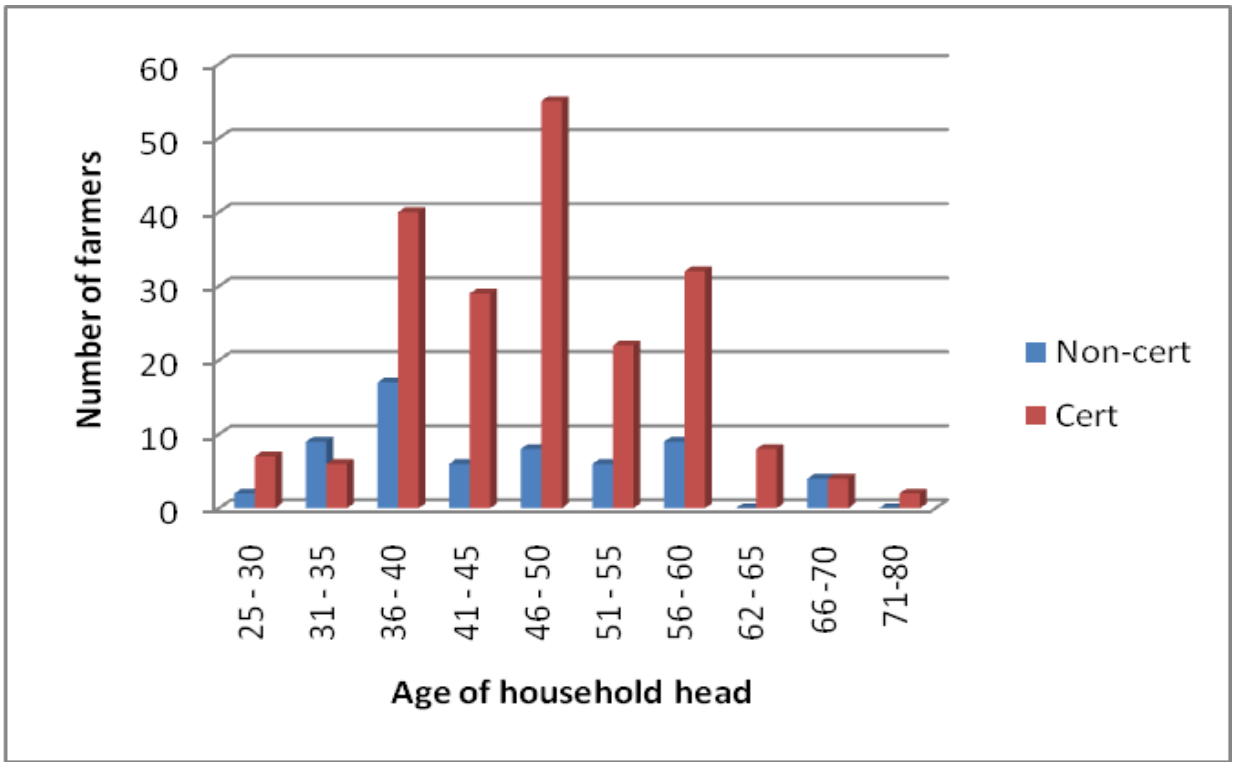

Figure 3: Distribution of household heads' age according to GlobalGAP status

Education level was relatively high, with an average of 10.5 years of schooling. This implied that most household heads managed to complete their primary school (8 years in Kenya since 1988, 7 years previously) and acquired an additional 2.5 years of secondary education. 53.7% had acquired secondary school education while 6% of the household heads had acquired a university education. With respect to GlobalGAP certified household, 110 heads had attained secondary school education in comparison to 33 non-certified household heads, while 12 certified household heads had acquired university education compared to 4 non-certified heads.

The Pearson's r correlation coefficient between education and age was -0.167 (Appendix 3). This indicated that the study did not detect a relationship between the two variables. The difference in average age and average education level between certified and non-certified farmers were not statistically significant at $t(264) = 1.660$ and 0.383 at the 5% level of significance, respectively (Appendix 4). Therefore, it was concluded that there is no significant difference between the average age nor between the average education level between certified and non-certified households

4.1.2 Land size and labour use in French beans production

Land and labour usually accounts for the largest share of agricultural inputs in Kenya. Land serves as a means of survival for most rural populace. French beans smallholders were owners of ≤ 3 acres of land. 14 percent of the farms in the sample were between 2 to 2.5 acres while 7 percent of the farms were between 0.25 and 0.5 acres. The mean farm size of the whole sample was 1.27 acres, however, the mean land size of GlobalGAP certified farms was 1.6 acres and 1.5 acres for non-certified farms as shown in Table 7 below. The difference in average land size between certified and non-certified households was not statistically significant at the 5% significance level. Thus, the study did not detect any significant difference between the mean land size of the two groups.

Export companies recommend that French bean farmers use, at most, a quarter of their land holding and up to a maximum of half (1/2) an acre for French beans production, thus leaving the remaining land for the production of food and other cash crops, and for livestock keeping. At the most, 0.5 acres was put under French beans, however, for smaller land holdings, smaller units of land of about a quarter (1/4) or even an eighth (1/8) of an acre was used for French beans. Nevertheless, with an average of three crop cycles per year and multiple harvests of the beans in one cycle, land size cannot be said to be a determining factor for adopting GlobalGAP. A few respondents also stated that they leased additional land for additional French beans production. One case leased up to 3 acres in each crop cycle in 2013. The practice was, however, dependent on the ability of a farmer to meet the high labour requirements of French beans production.

The household's labour contribution to French beans production was considered together with that of hired labour. The average household size in the study area was 4 persons as shown in Table 6, and this number was presumed to be sufficient in supplying labour on the 1.27 acre average farm size of 1.27 acres. On further consideration, the low household size could imply that hired labour was of great importance in French beans production and in the other farm enterprises. The distribution of labour hours for the year 2013 is show in Table 7 below. The difference in farm labour supply between certified and non-certified households was not statistically significant at the 5% level. Thus, there is no significant difference in the average family labour supply provided on certified and on non-certified farms.

Table 7: Farm size, labour supply and t-test of the mean difference based on certification status

Item	Certification status 1: n = 205 0: n = 61	Mean (Std. Dev)	Equal variances	t	df	Sig. (2-tailed)
Farm Size	1	1.57 (.581)	Equal variances assumed	.456	264	.649
	0	1.53 (.639)	Equal variances not assumed	.433	91.531	.666
Family Labour	1	1566.04 (479.608)	Equal variances assumed	-.279	264	.781
	0	1585.57 (484.338)	Equal variances not assumed	-.277	97.676	.782
Hired Labour	1	1819.08 (552.311)	Equal variances assumed	-1.367	264	.173
	0	1925.90 (475.718)	Equal variances not assumed	-1.482	112.462	.141

Source: Survey data, 2013

The recorded labour supply hours were converted from the annual averages used in Table 7 to daily averages so that there was further clarification on labour usage. This had been noted during the pilot study that an in-depth review of labour supply was essential. The total annual hours were converted to a six (6) days working week and one month had 28 days. The results are presented in Table 8 below. The mean family labour hours for the whole sample was approximately 4.7 hours per day, and the distribution for certified and non-certified farmers was close to the sample mean at 4.67 hours per day and 4.71 hours per day, respectively. The amount of hired labour was, however, more dispersed around the sample mean at 5.48 hours/day for the two categories of respondents.

Table 8: Annual labour supply converted into hours per day

GlobalGAP certification status	Mean Labour Supply (Mean Hours for 2013)
Family Labour:	
Certified	1566.04 (approx.4.67 hours/day)
Non-certified	1585.57 (approx. 4.71 hours/day)
Hired Labour:	
Certified	1819.08 (approx.5.41 hours/day)
Non-certified	1925.9 (approx. 5.73hours/day)

Source: Survey data, 2013

On certified farms, hired labour supplied approximately 5.41 hours per day while on non-certified farms, hired labour hours was approximately 5.73 hours per day. This showed that both certified and non-certified respondents applied hired labour, and hired labour put in additional hours than family labour. The study detected that the average family labour supply on certified farms was not significantly smaller than family labour supply on non-certified farms. There was also no significant difference between the average hired labour supply of the two groups.

The correlation between family labour and hired labour for certified and non-certified farms was -0.1196, and 0.1598, respectively (see Appendix 3). This indicated that the study detected an absence in the relationship between family and hired labour.

4.1.3 Wealth of households

Personal wealth was measured in the form of livestock ownership, intermediate assets such as farm machinery and equipment, the amount of stock of material inputs such as fertilizer, seeds, feeds, and agricultural chemicals maintained, and ownership of household assets such as furniture, household electronics, and probably a personal vehicle. With respect to the adoption of GlobalGAP certification and its attendant expenses, assets such as livestock, could be sold to enable the household meet any expenses not met from the sale of the cash crop. The value of the distribution of household assets in the sample is shown in Figure 4 below.

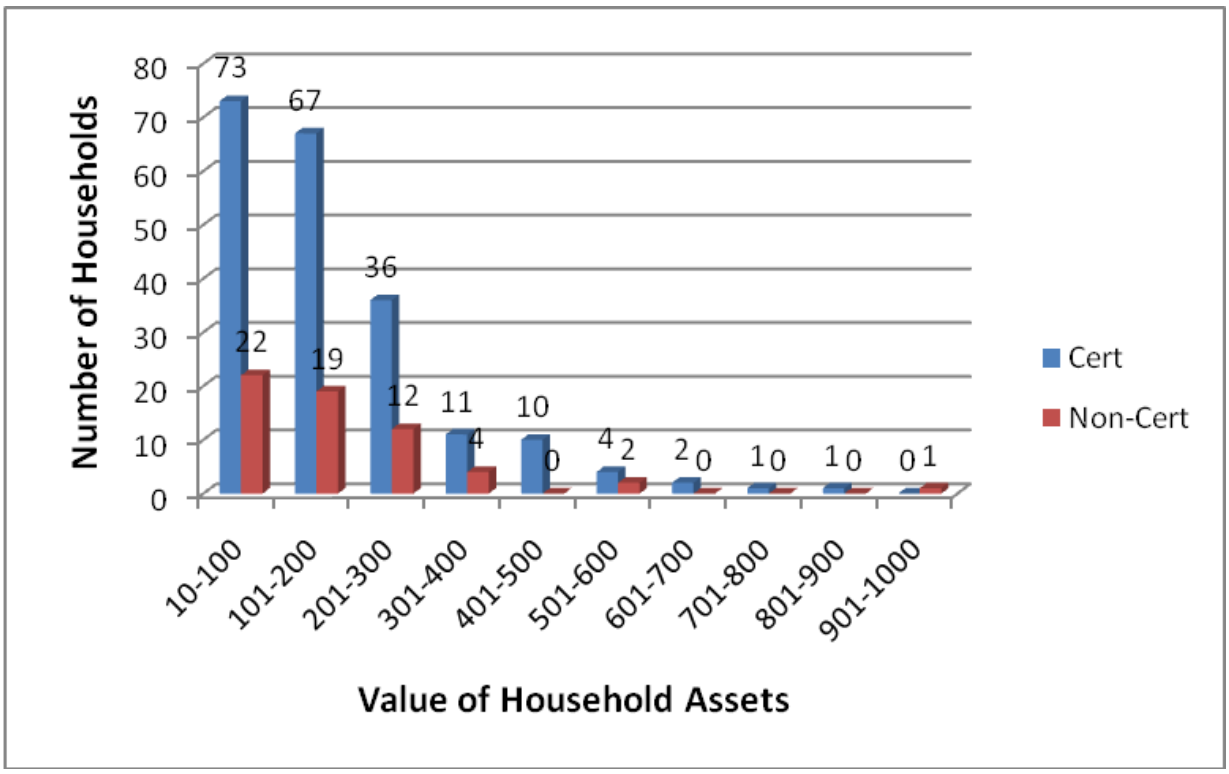

Figure 4: Distribution of household assets according to GlobalGAP status

The results showed that with the distribution of assets, a high percentage of certified households were at the lower end of the figure with assets valued between Ksh.10,000 – Sh. 300,000. Thus, a closer examination of this was required in order to confirm or reject that certified respondents had a smaller assets base given the hypothesis that wealth was associated with better access to input and product markets. Certified farmers had an assured market for their French beans through supplier contracts with export companies, therefore, it was expected they would have a larger assets base than the non-certified respondents. The data was disaggregated between certified and non-certified respondents and Table 9 below shows the results according to assets ownership.

Table 9: Value of households' assets according to GlobalGAP status

Item	Non-certified (n=61) Mean (Std. Dev.)	Certified (n =205) Mean (Std. Dev.)	Equal Variance	t	df	Sig. (2-tailed)
Livestock	55 445 (87 412)	65 984.8 (84 241)	Assumed	-0.850	264	0.396
			Not assumed	-0.834	95.6	0.407
Household Assets	40 050.6 (60 632.5)	45 979 (74 462)	Assumed	-0.568	264	0.570
			Not assumed	-0.634	119	0.527
Farm machinery and equipment	10 772.5 (51 123.9)	6 323.6 (6 877.9)	Assumed	1.215	264	0.226
			Not assumed	0.678	60.65	0.500
Stock of farm inputs	62 479.7 (51 458)	62 452.8 (47 958)	Assumed	0.004	264	0.997
			Not assumed	0.004	93.19	0.997
Total Wealth	171 560 (150 436)	180 740.5 (137 899)				

Source: Survey data, 2013

The results showed that certified households had an edge over non-certified households for livestock and household assets, however, certified households owned less farm machinery and equipments. This inferred that in implementing a GlobalGAP farming system the households employed more manual methods than non-certified households. The two groups of households were similar in the amount of stock of farm inputs maintained throughout the year 2013.

The dispersion around the mean for the assets was wide for both categories of households, for example, the dispersion around the mean for livestock assets was KES. 84,241 for certified households, and KES. 87,412 for non-certified households. This was equivalent to two large animals (cattle), or approximately 10 goats or sheep, if the amount in Kenya shillings was converted into live animals. However, farm machinery was more widely dispersed around the

mean for non-certified households at Ksh. 51,458 compared to certified households at Ksh.6,878. This dispersion determined that within each category there were large differences in assets ownership.

The bottom row in the table shows all the assets summed up as total wealth, and the differences between the certified and non-certified reduced significantly. The mean total wealth for non-certified households was KES. 171,560 (std. dev. KES.150,436) and for certified households, the mean total wealth was KES.180,740 (std. dev. KES.137,899). However, the dispersion around the means remained large within each category of households with non-certified households having a wider dispersion. Therefore, it is concluded that there is no significant difference in average wealth between certified households and non-certified households, although there is a high degree of inequality within each group. This finding supports Okello (2005, unpublished doctoral thesis) that contracted (certified) households have more wealth than non-contracted farmers. However, the difference in inequality contrasts with Okello (2005) who argues that the degree of wealth inequality among the contracted farmers was higher than for the non-contracted farmers. This study found the opposite, non-certified households have a higher degree of wealth inequality than certified households.

Given the above discussion, it is debatable whether certified farmer can rely on their assets to meet GlobalGAP costs if they are faced with the need to sell off any assets in order to do so. The total investment costs faced by an individual smallholder are KES. 228,190 or 68% of total income to demonstrate compliance with GlobalGAP and the required adjustments to their production process according to Okello and Swinton (2005). However, as a group member, the investment costs facing an individual household add up to 4% of total income. This finding thus supports the argument by Okello *et al* (2007) and Graffham *et al* (2007a) that it is out of necessity, not choice, that smallholders benefit more from working in groups to realize lower investment costs for compliance with GlobalGAP.

The study found an absence in the relationship between the assets except for that between farm machinery and equipment and household assets. The correlation coefficient was the largest found in the study at 0.449, significant at the 0.01 level (two tailed). This implies, correctly, that an increase in farm machinery and equipment translates to an increase in household assets.

4.1.4 Engagement in off-farm employment and cash transfers from family members

The injection of constant income from off-farm activities in the form of business revenues, wages or salary, was hypothesized would lessen the burden of cash demands within households. However, if the household head was the one who attends the technical trainings on production of French beans for the export market, then off-farm employment would reduce the chances of the household participating in GlobalGAP. Thus, the contribution of off-farm activities was evaluated in the context of increased disposable income and this additional income would enable a household purchase improved inputs.

Access to constant cash transfers implied regular cash incomes from either working siblings or other sources such as gifts in cash form. The argument was that households which received regular cash injections had financial assistance for meeting household cash needs similar to the effect of off-farm employment. Thus, cash transfers and gifts, were evaluated together with off-farm employment as possible sources of disposable household income.

The results on off-farm income and other cash injections are shown in Table 10 below. 46% of the households engaged in some form of off-farm income earning activities while 54% did not. The average amount of household income in the total sample from off-farm employment was KES. 91,785 and dispersion about the mean was KES. 166,872. This dispersion was large; however, a look at the range which contributed to this dispersion showed that the minimum amount was KES. 10,500 and the maximum amount was KES. 922,600. This is an indicator that there is a much wider range from off-farm sources within the sample households.

For certified households, the results showed earnings were less than for non-certified households at KES. 86,989 and KES. 107,903, respectively. The dispersion within each category of households was wide as in the previous case on the size of the assets base. However, the difference in the average non-farm incomes between certified households and non-certified households was not significant.

Table 10: Total non-farm incomes and t-test of the mean differences according to GlobalGAP Status

OFF-FARM EMPLOYMENT/BUSINESS						
GlobalGAP status	Mean (KES.)	Std. Dev.	Equal Variance	t	df	Sig. (2-tailed
Certified farmers	86,989	171,098	Assumed	0.859	264	0.391
	107,903	152,023	Not assumed	0.916	109.2	0.362
Non-certified farmers						
Total Sample	91,785	166,872				
CASH TRANSFERS – Gifts and Remittances						
Certified farmers	15,023	38,606	Assumed	1.915	264	0.057
	29,328	80,393	Not assumed	1.344	68.4	0.183
Non-certified farmers						
Total Sample	18,306	51,449				

Source: Survey data, 2013.

Cash gifts and remittances displayed a similar pattern to off-farm employment. Total sample mean was KES.18,307 and dispersion around the mean of KES.51,446. Certified households received less than non-certified households at KES.15,027 and KES.29,328 respectively. The dispersion round the mean was, however, not as large for certified households at KES. 38,606 as it was for non-certified households at KES.80,393. This demonstrates the wide differences in cash transfers and gifts within each category of farmers but with non-certified households having a wider difference within the group than certified households..

The findings confirm that off-farm employment makes a contribution to meeting household cash requirements. An inference made from the low off-farm employment cash injection in certified households is that their financial needs are being met by their earnings from the sale of their produce to the export markets. On the other hand, using the second assumption, low off-farm employment for certified farmers is an indicator that if the household head is the one who

attends the technical trainings on production of French beans for the export market, then the information gained through trainings is being applied by the household head given they are not engaged in off-farm employment.

No relationship was detected in the study between off-farm employment and cash transfers and gifts, nor between off-farm employment and the other assets variables. Similar results were detected between transfer gifts and remittances to all assets categories. It is, therefore, deduced that both categories of households depend on the income earned from the sale of farm produce to meet all financial obligations such as, medical care, school fees, etc. as well as the purchase of large farm items such as livestock, machinery and equipment, and household assets.

4.1.5 Household heads' contact with extension agents

Contact with extension agents was expected to influence the acquisition of information on the requirements for producing an export crop. Further, with respect to the sexes, as men seek employment in urban centers their participation in agriculture was expected to decline leaving women as the active decision-makers on the farms. Women also tended to have better access to rural based information such as on GlobalGAP certification, and therefore, had closer contacts with extension agents.

The study sample had a total of 251 (94%) male headed households and 15 (6%) female headed households. The distribution of the sexes according to the amount of contact hours in the year 2013 is presented in Figure 5 below. The results showed that female household heads were concentrated in the lower (left) side of the figure with contact hours of 100-150 to 200-300 contact hours throughout the year 2013. Male household heads had a wider range of contact hours with extension hours. However, as hypothesized, more female headed households than male were certified, with 86.6% female headed households being certified in comparison to 76.5% male headed households. 13.4% and 23.5% female and male headed households respectively, were not certified.

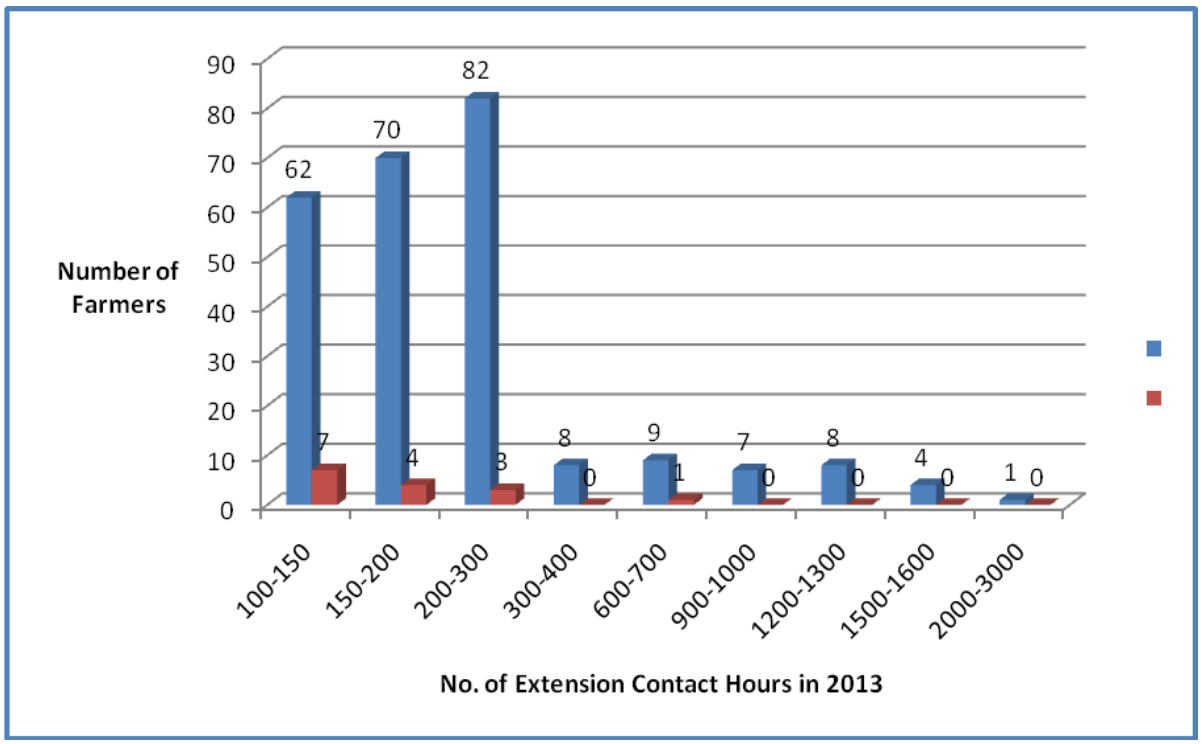

Figure 5: Household heads' gender and contact hours with extension agents

The number of contact hours with respect to certification is shown below in Table 11. The average contact hours for male household heads was 269.8 hours was close to the sample average of 264.45 hours, however, for female household heads' the average was 174.4 contact hours. The minimum and maximum ranges showed the stark differences between the sexes. The range for the females is 108-624 (i.e. 9–52 hours per month) contact hours in the year, while for males it is 108-2496 (i.e. 9-208 hours per month). 208 hours per month translated to an equivalent of 7.5 hours per day which, though not realistic on a day-to-day basis would point to male household heads attending agricultural seminars and trainings which were day long or longer. This inferred that female household heads, whether certified or not, had difficulties in having the time to attend agricultural seminars which took longer than just a few hours. Yet, this did not hamper their participation in GlobalGAP certification given the high percentage (86.6%) of certified female household heads. The findings support the hypothesis that women have access to rural based information and maintain close contacts with extension agents.

Table 11: Mean extension contact hours by household head according to GlobalGAP status

		SEX		Certified	Non-Certified
	TOTAL	**FEMALE**	**MALE**	**Households**	**Households**
	(N=266)	(N=15)	(N=251)	(N=205)	(N=61)
Mean	264.45	174.4	269.8	289.7	179.6
S.D.	317.8	130.1	325	352.2	121.8

Source: Survey data, 2013.

The study detected the absence of a relationship between the sexes and extension contact hours. However, there was a significant difference between the average number of contact hours of certified and non-certified households as shown in Table 12 below. Certified households, as hypothesized, invested a lot of time in agricultural trainings, seminars and in maintaining contact with extension agents. This is expected for a knowledge intensive system such as GlobalGAP in which the required production information is received from the export companies.

Table 12: Extension contact hours and t-test of the mean difference based on GlobalGAP status

GlobalGAP status	Mean Contact Hours	Equal Variance	t	df	Sig. (2-tailed)
Certified	289.7	Assumed	-2.396	264	.017
Non-Certified	179.6	Not Assumed	-3.780	258.8	.000

Source: Survey data, 2013.

4.1.6. Distance to the nearest local market

Market access measured by the distance to the nearest market center was related to transaction costs both in input acquisition as well as output marketing, thus, households located further from local markets were hypothesized to experience high transaction costs which impacted on their farm incomes. The results showing the number of households according to distance from local markets are presented in Figure 6 below.

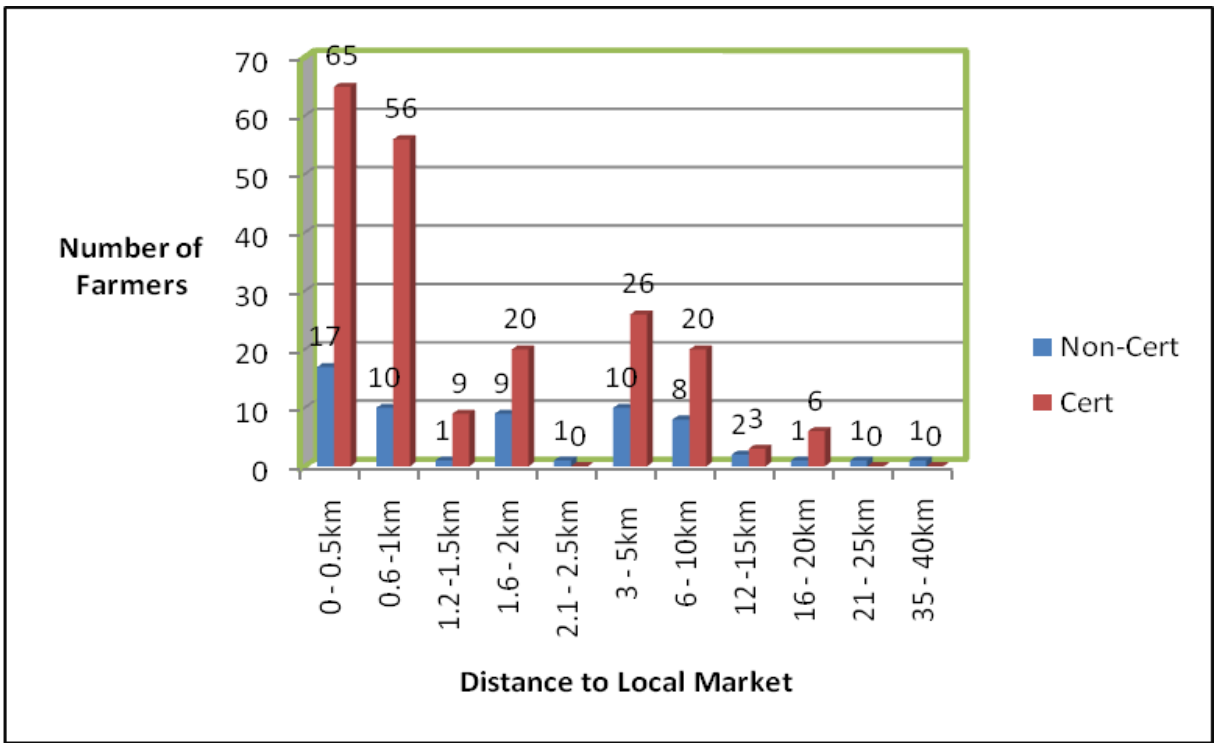

Figure 6: Market access for sample households according to GlobalGAP status

The figure shows a large concentration of certified respondents around local markets with one hundred and fifty (150) of the certified farmers being within 0 – 2 kilometers from the local markets, and the number expanding to one hundred and seventy-six (176) if the distance is extended from 0 – 5kilometers from the local market. For non-certified, the number of households within these ranges are thirty-seven (37) and forty-eight, respectively. However, a look at the mean distance for the two categories of respondents gives a better perspective as shown in Table 13 below.

Table 13: Distance to local markets and t-test of the mean difference based on GlobalGAP status

	Mean	Std. Dev.	Range	Equal Variance	t	df	Sig. (2-tailed)
Certified Farmers	2.6	4.2	≤ 20kms.	Assumed	2.341	264	.020
Non-certified Farmers	4.2	6.67	≤ 40kms.	Not assumed	1.770	72.3	.081

Source: Survey data, 2013.

The average distance to local markets for certified households were 2.6kms (range ≤ 20kms), while for non-certified it was 4.2kms (range ≤ 40kms). Certified farmers were clearly located

closer to local markets from being as close as 1 km. (12 respondents) up to 20kms, while non-certified were more widely dispersed from 1 km. (4 respondents) up to 40 kms. away from a local market. The 4 non-certified households located close to the market challenge the hypothesis that distance from market center influences GlobalGAP participation, and shows that there are other factors involved in the decision to not adopt GlobalGAP. However, a majority of the non-certified households were located much further from the market center. The t-test results showed that there is a statistically significant difference between the average distances to local markets between the two categories of farmers. It is, therefore, concluded that there is a significant difference between the average distance to the nearest local market of certified and non-certified households.

4.1.7 Section summary

The sub-section presented and discussed the results on the household and farm characteristics of the sampled households in preparation to address the first objective of the study in the following sub-section. The findings are: the average contact with extension agents and attending agricultural trainings, and the average distance to local market centers are the two significant differences between GlobalGAP certified households and non-certified households. There are no significant differences in the averages of all the other factors, such as age of the household head, education level, farm size, labour input, wealth status, and cash injections from non-farm activities between the two groups of households.

The findings lead to a conclusion that female household heads, whether certified or not, are constrained in attending extension meetings and seminars which take longer than a few hours. By maintaining close contacts with extension agents, female heads are able to acquire information on relevant production processes. The average distance to the nearest local market is significantly different between the two categories of households. However, the non-certified households located close to the market center show that there are other factors not related to the distance from the market center which influence the decision not adopt GlobalGAP.

The absence of a relationship between the non-farm activities such as, off-farm employment and cash transfers from remittances and gifts, and the wealth categories illuminate an important finding. Both categories of households depend on the income earned from the sale of farm produce to meet all household financial obligations such as, medical care, school fees, etc. as

well as the purchase of large farm items such as livestock, machinery and equipment and household assets. The importance on farm income from farm produce sales is, therefore, elevated given that non-farm activities do not meet the households' financial needs.

Having identified the socio-economic characteristics which differentiate certified households from non-certified households, the next step was to determine which of these factors influenced the decision to adopt GlobalGAP certification. This required the evaluation of programme treatment effect using the propensity score matching method, presented and discussed in the following section.

4.2 Impact of adopting GlobalGAP certification in French beans production

The results from the propensity score matching analysis further addressed objective 1 and also addressed objective 2 of the study. The propensity score matching method first produced the propensity scores which were subsequently used in the estimation of the treatment effect using the various matching methods (Appendix 5). The factors that influence the decision to adopt GlobalGAP are the results of the second step analysis using a logit analytical method. The following sub-section presents the results of the average effect of participation in GlobalGAP farming on households' income from all the factors discussed in the previous sections and presented in Table 14 below. The incomes were from multiple cropping cycles, and multiple harvests within one cycle for the year 2013. The discussion of the results refers to the different matching methods, namely, nearest neighbor matching, radius, kernel and stratified matching.

Table 14: Average effects of participation in GlobalGAP certification production

Matching Method	Participants	Non-Participants	AEC (KES.)	Std. Error	t-value
Nearest Neighbour	205	45	-2,670.976	9,205.755	-0.290
Radius	205	55	-2,221.404	8,237.557	-0.270
Kernal	205	55	-2,176.801	6,868.812	-0.317
Stratified	205	55	-2,646.269	9,417.962	-0.281

Source: Computed from survey data, 2013.

The impact of adopting GlobalGAP certification in French beans production was not statistically significant in all the four (4) matching methods. The matching was aimed at generating the average effects of certification (AEC) from the differences in incomes between

GlobalGAP participants and non-participants. Forty five (45) non-participants were matched to 205 participants in the Nearest Neighbour Matching method, while in the other three methods 55 non-participants were matched to 205 participants. However, all the test statistics, the t-values, were not statistically significant at the 5% significance level with t-values of between -0.270 and -0.317. This implied that the difference in income between GlobalGAP participants and non-participants was a reduction of KES. 2,670.97 per household for participating in GlobalGAP.

This result supports the literature that GlobalGAP is costly for individual smallholders involved in French beans production for the export market given that the costs for GlobalGAP compliance are not included in the estimation and are, therefore, still to be met by the certified households from the income. Okello *et al* (2007) argue that the costs of compliance are 4 percent of total income for farmers who are members of a farmer groups and 68 percent of total income for individual farmers. However, the results were for farmers who are group members, and point at French beans farmers not being any better-off than non-certified farmers. To boost certified farmers income, however, Kariuki (2014) found that reducing transaction costs has the potential to unlock the producers' potential through long duration relationships/contracts between the farmers and the exporters.

It may be concluded, then, that if certified farmers' incomes cannot be enhanced through reliable and consistent contracts with the exporters, then following Asfaw's (2011) proposition, it may be time to consider policies that will shift small-scale producers away from these demanding global markets and investments are made in domestic and south-south trade. For example, if the domestic market in Kenya is estimated to increase to 2.3 million metric tonnes (MT) by 2030 from the current consumption level of 5.6 million MT, and an estimated annual population growth rate of 5% for Nairobi alone (HCDA, 2008), then policies should begin focusing at how this local demand will be met in the coming years.

However, the decision by Britain, an important market for Kenyan's French beans, to leave the European Union in June 2016 (http://www.businessdailyafrica.com/Fruit--vegetable-exporters-feel-pinch-of-Brexit-vote/539552-3295146-11h8uq2/index.html), may become a game changer for smallholders in Kenya in the near future. There may arise two critical markets for Kenya's French beans which may result in increased demand and, therefore, increased income for the small-holders. There may, however, also result in more standards being introduced in the

production processes. Thus, predictions about the consequences of Brexit on African markets are ambiguous for now (see http://thenationonlineng.net/brexit-impact-nigeria-kenya-south-africa/). However, the nature of Britain's exit (Brexit) and what this will mean for global markets will be fully known in 2017 when the exit negotiations are expected to be completed.

4.3 Factors that influence participation in GlobalGAP certification

Following the estimation of the average effect of certification, a logit analysis was conducted on the explanatory variables to identify the factors which pre-dispose households to participate in a GlobalGAP compliant farming regimen. This analysis met the first objective of this study. The results are presented in Table 15 below.

First off, the table shows that the significant variables met the cut-off point at the 5% significance level. The chi-square (X^2) statistic was 31.35 and a small p-value for the overall model specification. LR test result was 0.0049 which indicated the significance in the explanatory powers of the variables included in the model. The covariates showed marginal changes in the predicted probabilities of participation in GlobalGAP certification. The estimation of marginal probabilities enabled the ease in the interpretation of the covariates, and reflected marginal changes of the dependent variable, due to a unit, or smaller, change in the covariates. Specifically, the table shows the predicted probability of success for an individual who is certified rather than for one who is not certified.

From the first sub-section 4.1, contact with extension agents including attendance to agricultural trainings and/or seminars, and distance to the nearest local market had significantly different averages between certified and non-certified households. These variables were, therefore, expected to be among others that positively influenced the chances of participation in GlobalGAP. The marginal effects results confirmed these expectations and showed that age, increasing the contact hours with extension agents through attendance to trainings and seminars, and the distance to local markets significantly influence the marginal probability of a household participating in GlobalGAP certification.

Table 15: Logit marginal effects for factors that influence participation in GlobalGAP

Conditional marginal effects	Number of obs = 266			LR chi2 (14) = 31.35		
Log likelihood: -127.5539	Prob > chi2 = 0.0049			Pseudo R^2 = 0.1094		
Variable	Semi-elasticities	Std. Err.	z	P> |z|	95% Confidence Interval		Mean
Age	0.006	0.003	2.02	0.044	0.000	0.011	47.86
Education	0.011	0.01	1.06	0.289	-0.009	0.031	9.78
Family Labour	0.000	0.000	-0.37	0.71	-0.0001	0.0001	1 570.5
Livestock assets	0.000	0.000	0.66	0.509	0.000	0.000	63 567.8
Household Assets	0.000	0.000	1.02	0.306	0.000	0.000	44 619.7
Off-farm employment	0.000	0.000	-1.42	0.156	0.000	0.000	91 785
Transfer gifts and Remittances	0.000	0.000	-1.61	0.108	0.000	0.000	18 306.8
Extension Contact	0.000	0.000	2.54	0.011	0.000	0.000	264.5
Farm Size	-0.002	0.044	-0.04	0.971	-0.09	-0.085	1.56
Small equipments and tools	0.000	0.000	-1.32	0.187	0.000	0.000	7 343.8
Farm inputs held in stock	0.000	0.000	0.36	0.716	0.000	0.000	6 2459
Hired Labour	-0.000	0.000	-1.63	0.102	-0.000	0.000	1 843.6
Distance to local market	-0.012	0.005	-2.29	0.022	-0.022	-0.002	2.943

Source: Computed from survey data, 2013.

4.3.1 Age of Household Head and participation in GlobalGAP certification

The results presented in Table 15 show that age was significant at 5% with marginal influence on probability of participating in GlobalGAP of 0.0056. The significant and positive influence of age confirms the hypothesis on the positive side since age was hypothesized to be either a positive or negative influencer. Age is a factor for adopting GlobalGAP which is a costly process which may not be easily adopted by younger farmers. The average age from the study is 47 years, and shows that French beans farmers are still in their productive years. However, as Asfaw (2011) suggested, the decision to adopt safety standards is an investment decision, which may involve sizeable fixed costs, such as a grading shed, pesticide store, office, etc. while the benefits will be realized over time. Thus, this finding infers that older household heads are more pre-disposed to participate in GlobalGAP since they can afford the investment costs.

4.3.2 Contact with extension agents and participation in GlobalGAP certification

The results show the amount of contact hours with extension agents increases the probability of participating in GlobalGAP by 0.0004 at 5% level. The Z and p-values of 2.54 and 0.011 respectively, signify that the role of extension contact in the adoption of GlobalGAP is important. Contact with extension agents was hypothesized to influence adoption of GlobalGAP practices as farmers would gain better understanding of the requirements for producing French beans for the export market. Agricultural trainings are traditionally organized at local level, which may be in the form of on-farm demonstrations, or group meetings at a local center such as a school or any open space. These normally take a few hours to half-a-day at most. However, workshops and seminars may take place at the county level, and require some travel to the venue or location. Workshops typically involve discussions on various topical issues and, therefore, are held for more than one day. This, therefore, requires an overnight stay at the venue, or longer. This requirement influences female household heads' attendance in long duration agricultural workshops as was discussed previously in sub-section 4.1.

The significant influence of exposure to the trainings and workshops reflects the positive role of access to information and knowledge about GlobalGAP. The conclusion drawn about the influence of age enhancing ones chances of participation supports the importance of knowledge gained through continued contact with extension agents. Ensuring that women also access information should be promoted and extension providers could locate their trainings and workshops closer to the local or farm level.

4.3.3 Distance to local market and participation in GlobalGAP certification

Market access measured in distance to the local market indicated the relative effects of transaction costs and remote location on participation in GlobalGAP certification. The results showed that market distance was significant at 5% with a marginal influence on probability of participating in GlobalGAP of -0.01207. The negative influence was as hypothesized, that the further a household was located from the market center, the lower were the chances of participation in GlobalGAP certified French beans production. In the previous section, it was found that a high concentration of certified participants were located around local markets and were in the range of between 1 km. to 20kms of the market, while non-certified households were widely dispersed from 1 kms to 40 kms. The few non-certified households located close to market center challenged the assumptions made that distance was a factor in participating in GlobalGAP. However, the majority of non-certified households' were located much further than certified households and support the view that high transactions costs reduce farm incomes, which invariable lowers the probability of participating in GlobalGAP certified farming.

This finding implies that with respect to the buying of French beans, the group collection method used by export companies does not include those households located far from market centers. Brokers who also participate in the buying process do not engage those households located far from markets. This may be as a result of poor infrastructure in rural areas the further one goes from market centers, and this finding supports the various writers (Bravo-Ureta and Pinheiro (1997), McCalla (1998), Paarlberg (2010), and Norton *et al* (2010) who point to the critical need for national and County governments to invest in the development of rural economies. The finding also supports Kariuki (2014) who argues that farmers with short duration contracts (0-4 seasons) are located further from the market center. His finding implies that these farmers have only been contracted in recent times in comparison to those located closer to the market centers who have been in longer contracts of over 10-20 seasons. Thus, considering these points together, then support is given to Timmer's (1998) argument that improvements in transportation and communication could reduce trade risks and transaction costs.

The other factors hypothesized to significantly influence participation in GlobalGAP certification but found not to be statistically significant were land size, having a large assets base, engaging in off-farm employment, and the size of family and hired labour. The analysis thus met the 1st objective of the study. The following sub-section presents the results on whether, the

above results notwithstanding, French beans are produced efficiently, or whether there is a gap for increasing farm-level productivity.

4.4 Efficiency scores from the non-parametric DEA model

In line with objective 3 of the study which was to determine the impact of GlobalGAP on small-scale farmers' technical efficiency, sub-section, 4.4.1 next, includes the presentation and discussion of the results from the non-parametric data envelopment analysis (DEA) model. In the subsequent sub-section, 4.4.2, the results from the tobit model are presented and discussed. The analysis was used to determine the factors which influence on-farm technical efficiency in order to identify the sources of inefficiency and to compare factor usage between certified and non-certified farmers to achieve objective 4 of the study. Sub-section 4.5 closes the chapter with a presentation of the group discussion results.

4.4.1 Technical efficiency of GlobalGAP certification in French beans farming

The technical efficiencies (TE) were estimated using data envelopment analysis (DEA). Both the variable returns to scale (VRS) and constant returns to scale (CRS) input-oriented efficiency measures were obtained mainly for comparison purposes. The VRS is said to be suitable where farms do not operate on an optimal scale due to imperfect markets and other constraints, while the CRS model is appropriate in cases where all DMUs operate at an optimal scale. Further, according to Coelli (1995), the VRS approach provides technical efficiency scores which are greater than or equal to those obtained using the CRS (model). The results from the two models are presented in Table 16 below.

On the assumption of VRS-TE, the scores ranged from 40.17 to 100 percent, and a mean of 87.5 percent. Thus, the most technically efficient farm household was operating on the frontier. Therefore, if the average farm household in the sample was to achieve the TE level of its most efficient counterpart, then the average farm household could realize a 12.5 percent input savings (i.e., 1–[87.5/100]) without reducing output. A similar calculation for the most technically inefficient farm household revealed input savings of 59.8 percent (i.e., 1– [40.17/100]).

Table 16: Frequency distribution of efficiency estimates from VRS and CRS DEA models

Efficiency level (%)	VRS-TE		CRS-TE	
	Frequency	Percent	Frequency	Percent
≤ 40	1	0.38	117	44.45
41 - 50	4	1.52	32	12.16
51 – 60	9	3.41	16	6.07
61 – 70	27	10.26	15	5.7
71 – 80	44	16.72	13	4.94
81 – 90	44	16.71	12	4.56
91 - 100	137	51.57	61	22.96
Mean	87.58		54.1	
Min	40.18		3.95	
Max	100		100	
Std. Dev.	14.46		30.98	
Coefficient of variation	16.5		57.26	

Source: Computed from survey data, 2013.

Under the CRS-TE assumption, scores ranged from 3.95 to 100 percent with a mean of 54.1 percent. Again, the most technically efficient farm household was operating on the frontier. This suggested that if the average farm household was to achieve the TE level of the most efficient farm household, then the average farm household could achieve an input saving of 45.9 percent while the least efficient farm household would achieve a cost saving of 96.05 percent without reducing its output.

The technical efficiency scores under the VRS assumption were higher than those under the CRS assumption as per Coelli's (1995) argument. More farms are 100 percent efficient under the VRS model (120 farms) which captured market imperfections, among other constraints. Under the CRS model which presumed that all the farms were operating at an optimal scale, fifty-four (54) farms exhibited 100 percent efficiency level. And in terms of variability, the efficiency scores from VRS were less variable than those from CRS as indicated by the coefficient of variation of 16.5 percent to 57.26 percent variation, respectively.

The differences in technical efficiency between certified and non-certified farms were analysed under the assumption of VRS which was more suitable for the French beans sub-sector

as per the reasons mentioned above. The results are presented in Table 17 below. Over 50 percent of non-certified farms were within the range of 91 to 100 percent technical efficiency while 48.3 percent of certified farms were in the same range.

Table 17: Distribution of farm efficiency level according to GlobalGAP status

Frequency Level	Non-Certified Farms		Certified Farms	
(%)	Number	Percent	Number	Percent
≤ 40	0	0	1	0.5
41 - 50	1	1.63	3	1.5
51 - 60	5	8.2	4	1.6
61 - 70	3	4.91	24	11.8
71 - 80	10	16.4	34	16.7
81 - 90	4	6.56	40	19.6
91 - 100	38	62.3	99	48.3
TOTAL No.	61	100	205	100

Source: Computed from survey data, 2013.

These results considered together with the general results presented earlier, imply that GlobalGAP certified farming with respect to French beans production is not an efficient method of farming. This is in terms of the factors of production included in the efficiency models, which are; land usage, farm inputs usage and the production of other crops on each farm. However, for GlobalGAP certified farms there is the additional cost of maintaining certification and purchasing the recommended agro-chemicals. This additional cost is a contributor to the source of inefficiency shown between the two categories of farms. This implies that even with the well intended benefits of group formation for reducing the costs of implementing a GlobalGAP farming regimen, at the farm-level, the costs are still high for the smallholders. This finding contradicts the proposition made by Graffham *et al* (2007a), that efficiency has increased as a consequence of GlobalGAP. The authors attribute increased efficiency to the numbers of skilled agricultural technicians from the private sector, however, while it is not possible to prove cause and effect, that is, more agricultural technicians have positively impacted on-farm efficiency, the results show that in 2013, growing French beans under GlobalGAP incurred technical inefficiencies.

Another consideration is that certified farmers seemed to spend more in training themselves, thus making the cost consideration even higher than for the non-certified farmers. There could also be transfer of knowledge at zero cost for non-certified farmers who were benefiting from learning from their certified neighbours and, therefore, becoming just as efficient as their certified counterparts. If we take these two scenarios as a given, then their influence on the efficiency gains for certified farmers are higher, thus making the costs of maintaining GlobalGAP certification much higher. This is an important finding for policy and for intervention by the county agricultural offices. Cost issues relate to net gains, so high costs reduce net gains, and therefore, the income that may have been quoted by certified farmers may have taken into account these high costs. If this were the case, then, certified farmers' incomes were compressed downwards which made for the significant differences in efficiency between certified and non-certified farmers.

This subsequently points to the matter of productivity gains which may be realized through improved efficiency. The results determined that the most technically inefficient farms could increase their efficiency by reducing their input usage by up to 59.8 percent for the same level of output. Productivity, then, would increase with the improved efficiency in crop production which this study determined was relatively low. However, factor usage may not have been the only constraints to efficiency. A look at the factors which may influence efficiency, and subsequently the productivity of GlobalGAP certified farms is discussed in the following section.

4.4.2 Factors that influence technical efficiency - Results of tobit analysis

After obtaining the DEA scores, the scores were regressed on the explanatory variables using a tobit model. This would identify the factors that influenced on-farm technical efficiency to meet the study's 4th objective. The results of the tobit estimations are presented in Table 18. Three models are presented in the table as Model 1 for the whole study sample, Model 2 for GlobalGAP certified farms, and Model 3 for non-certified farms. The results for each of the three models show the significant variables meet the cut-off point of 5% significance level and the Prob > $\chi 2$ is zero. This implies that the set of independent variables considered together satisfactorily explain the variations in the dependent variable.

Table 18: Tobit marginal effects of factors that influence technical efficiency

Variables	Model 1		Model 2		Model 3	
Dependent Variables	VRS TE All Farms		VTS TE Certified Farms		VRS TE Non-Certified Farms	
Explanatory Variables	Mean	Semi-elasticities	Mean	Semi-elasticities	Mean	Semi-elasticities
Education in years	9.78	-0.009	9.81	-0.029*	9.67	-0.009
Family Labour	1570.5	-0.000*	1566.0390	-0.000	1585.6	0.000
Livestock assets	63567.8	-3.65e-07*	65984.8	-7.42e-07*	55445.1	-7.68e-07*
Off-farm employment	91785.1	0.000	86989	0.000	107903	2.11e-07*
Transfer gifts and Remittances	18306.8	0.000	15027	0.000	29327.9	-4.78e-07*
Extension Contact	264.45	-0.000	289.7	0.001*	179.6	0.000
Farm Size	1.5653	-0.083*	1.5740	-0.1025	1.5348	-0.062*
Farm inputs held in stock	62459	-6.81e-07*	62452.8	0.000	62479.7	0.000
Hired Labour	1843.6	-0.000*	1819	-0.000	1925.9	0.000
No. of observations	266 x 14 = 3724		205 x 14 = 2870		61 x 14 = 854	

* Significant at 5% level.

Source: Computed from survey data, 2013.

4.4.2.1 Factors influencing technical efficiency for the sample households

From the *a priori* effects of the factors on technical efficiency presented in sub-section 3.6, farm size, engaging in off-farm employment, having a large assets base, and the size of family and hired labour amounts were hypothesized to have an influence on efficiency. The marginal effects results in Model 1 for the total survey sample showed that farm size, assets in the form of livestock and the amount of stock of material inputs, such as fertilizer, seeds, feeds, and agricultural chemicals maintained, and both family and hired labour had a statistically significant negative influence on efficiency .

The marginal effect on efficiency showed farm size had a statistically significant negative effect on efficiency at the 5% level. A one percent increase in farm size, holding all the other factors constant, the efficiency score would reduce by approximately 0.08 percent. This implies that a solution to increased efficiency is to use the available land to the best of its production capacity. This points to the use of inputs in the right quantities and at the right time, because at the time of the study, input usage was higher than necessary on the available quantity of land.

The results showed that family labour and hired labour were statistically significant at the 5% level, and both are negative. This implies that even though French beans production is a labour intensive process, increasing labour by one unit will reduce the efficiency score by approximately 0.0001. This points to the above, that given the current farm sizes; more labour is not a necessity for increased efficiency. This also suggests that the present labour size is not being utilized optimally and there is room for an increase in output levels from increased labour productivity on-farm.

Assets in the form of livestock and the stock of material inputs maintained were the two forms of personal wealth to have a statistically significant and negative effect on efficiency at the 5% level. The results were contrary to the hypothesis and implied that increasing these factors by one unit, the efficiency score would reduce by 0.0001percent. This suggests that livestock ownership reduces the efficiency of French beans production probably through the taking away of labour which could have been applied to the crop production activities. The hypothesis on the ownership of assets being associated with better access to input and product markets was used in the context of the effect on efficiency. The results showed that a one unit increase in the stock of material inputs reduced technical efficiency. The average quantities of stocks maintained were

worth KES. 62,458 (Std. Dev. KES. 51,458) which was a rather large amount for the given farm sizes. However, this could have been a pointer to the high cost of the inputs being maintained, and is supported by literature that, in the quest to address the problem of pesticide residue standards within the GlobalGAP standard, the recommended pesticides are very costly to the farmers (Asfaw, 2011).

4.4.2.2 Factors influencing technical efficiency according to GlobalGAP status of farms

The evaluation of the farms in separate categories depending on whether the farm was under GlobalGAP certification or not, produced different results from those above which were for the whole study sample. The marginal results for certified farms (Model 2) show that the education level of the household head, assets in the form of livestock, and the amount of time taken in attending training sessions significantly influenced the crop production technical efficiency. For non-certified farms, livestock assets, engaging in off-farm employment, the amount of transfers and remittances to the household, and farm size are the factors which significantly influenced the technical efficiency (Model 3). All these factors influence efficiency negatively except for training and off-farm employment which have a positive influence on efficiency. All other variables in each of the two models were not statistically significant in influencing technical efficiency. Appendix 6 and 7 contain the full tobit results according to GlobalGAP status.

For certified farms, education influences efficiency negatively by reducing the TE score by 0.029. This result goes against expectations since GlobalGAP is an information laden process and one would expect education, as a measure of the quality of human capital, to produce positive impacts. However, this result is similar to that found by Owuor *et al* (2009) in their study on smallholders' economic efficiency in two districts in Kenya. The authors explain that the formal years of schooling used in the study is of a general nature and may not be significant in improving technical management on-farm. However, in explaining the effect of agricultural training via extension agents, the authors suggest that, in developing countries, the technical skills required in agricultural activities are more influenced by hands-on training. This suggestion is supported by the results which show that training, in the context of amount of contact hours with extension agents and attending workshops/seminars, positively influences the technical efficiency of certified farms.

The results showed that livestock ownership reduced technical efficiency on certified farms. And as suggested for the same factor for the whole study sample, it is maintained that livestock ownership reduces efficiency by taking away labour which could have been applied to the crop production activities.

For non-certified farms the results indicate that farm size, engaging in off-farm employment, transfers and remittances received and livestock ownership influence efficiency negatively and are statistically significant. Land size was hypothesized to influence efficiency negatively given the quantity of inputs used as seen from the VRS-TE analysis. For non-certified farms, this hypothesis is confirmed as the results show a significant but negative relation between farm size and efficiency. This lends support to the results presented so far that the quantities of inputs on the current land size are high and need to be reduced.

Engaging in off-farm employment was hypothesized to influence efficiency in any of two ways. It had been suggested that on the one hand it increases the income base of the farm household thus helping them increase their use of industrial inputs (a positive effect), and on the other hand, it reduces the labour available for agricultural production which may have a negative effect on efficiency. The results show that off-farm employment for non-certified farms has a positive effect on efficiency and this implies that the increase in income is significant. This result, however, contradicts the result for transfers and remittances which has a negative but significant influence on efficiency. If it is assumed that an increase in income from off-farm employment influences efficiency positively, we now have income from transfers and remittances having a negative influence. This is a strange result as it seems to differentiate between the sources of the additional incomes while one would expect the source to be immaterial. However, the additional income from transfer probably enables the purchase of additional inputs and therefore, additional input usage, which has been indentified, so far, needs to be reduced in order to increase efficiency.

Livestock ownership also has an impact on the efficiency of non-certified farms as for certified and the same argument applies. It was hypothesized that a large assets base, of which livestock was included, was an indicator of high productivity, and therefore, was expected to have a positive influence on efficiency. However, the results contrast the hypothesis and livestock is found to have a significantly negative effect on efficiency.

4.5 Results from informant group discussions

Discussions with groups of French bean growers were sought in each of the five (5) sub-counties in the study area. However, only three meetings were achieved mainly because of the busy farming schedule of French beans producers at the time of the data collection in November – December, 2013. The meetings targeted group leaders and farmers who were not participants of the study interviews and these interviews were conducted by the principal investigator. The aim was to gain further information on the production and marketing constraints experienced by the farmers in export production. This would add to the data collected through the main survey.

Two groups located in Kieni East sub-county participated in this forum, and one in Mwea West sub-county. An open-ended questionnaire was used to guide the discussions and participants were encouraged to add any related topic to the discussions. The major themes which developed during the group discussions centered around contract arrangements between the farmer groups and the export companies, and the farmers experiences with brokers. These two themes largely fall within the marketing segment of agriculture and show where there are still major problems or hurdles facing smallholders.

French beans production for the export market is usually undertaken under a contract arrangement between a farmer group and an export company. The export companies provide the seeds and insecticides as per GlobalGAP requirements as part of an agreement with a group. The costs would be recovered by the company upon receipt of the produce. The companies also provide the necessary production trainings through their extension agents who visit individual farms to ensure the production of the beans is in accordance with the standards regulations. The companies provide teams of sprayers to ensure that the chemicals used are applied at the right time and in the required quantity. The chemicals are supplied to the farmers as part of the contract arrangement and costs are also recovered from the delivered produce.

The first concern of the arrangement of chemicals on credit was that different chemicals were supplied each year, and the costs of the chemicals had increased in every successive year. This reduced the amount of expected income since the farmers purchase one chemical in one year and if they do not use all of it in that material year, they were left with dead-stock as a different chemical was introduced in the following year. And under GlobalGAP rules, unused agro-

chemicals were destroyed. This is a loss which farmers had to bear and was viewed as a burden on their financial obligations.

The buying of French beans was the other main concern of the farmers. Various experiences, ranging from good to bad, were reported and these were dependent on the export company they were contracted by. The contract arrangements seemed not to be binding on both parties, for example, a contracting company would honour the agreements to buy from one group at certain times, then would fail to do so in an arbitrary manner. According to the discussions on this topic, one group's contract stated they would supply French beans and receive their payment after every two weeks. French beans harvests were done three times a week and the beans were collected by the export company at the end of the week. Upon collection, the farmers would retain a record of the quantities collected from their individual farms. This arrangement was followed for one month, however at the beginning of the second month, the company collected the produce over one week then failed to make payments for the produce collected. The farmers were limited to sell to this particular company because no other buying companies were in the area. This left the farmers exposed to brokers of whom they could not negotiate prices with. Most farmers subsequently stopped producing French beans for the export market because of the uncertainty experienced with the export company.

One company was deemed as being the most honourable in its dealings with the producers. The company honoured its agreements with the farmer groups and paid regularly every week. It however, stopped buying from the area citing low water amounts in the area which resulted in reduced quantities, and quality, of French beans. Interestingly, while this large exporter was buying from this area, the other export companies were also present with their own contracted suppliers, and payments were made on time. The companies observed good business practices by restricting their purchases from contracted producers and they also paid well. However, once the large company left, the problems about lack of payment for delivered produce began, and this had been the situation since that time. Other irregular business practices included the lack of a defined procedure or method of airing their concerns to the export companies. Meanwhile, some companies refused to sign-up farmer groups as their suppliers, preferring instead, to deal with individual farmers. In this arrangement, the farmers were left without any arbitration mechanism if the contract was breached by the company and were subsequently left to make arrangements with brokers.

The arrangements and agreements between farmers and brokers defied all business rules and confirmed the existence of the Principal–Agent problem as discussed in section 2.5.3. The brokers, as the principal, buy the French beans having all the information about where there is a demand for the produce, and most importantly, the price of the beans on that market, which is likely to be an international market. At this time, the farmers would not have an available market for their produce given the flimsy contracts with export companies. Thus, when they agree to sell to the brokers they are in a disadvantaged position and cannot negotiate for better prices. The farmers, as the agents, may be concerned about being exploited by the principal, but given there are no other buyers available and the produce would easily spoil, have no other recourse and become price-takers.

One arrangement that was reported which did not make any business sense was where one export company contracted farmers and later reneged on purchasing the produce at the agreed upon time. However, a broker came into the area soon after and bought up the produce upon offering a higher price than that initially offered by the company. The farmers latter learnt that the produce was sold to the same company which had contracted and failed them. This makes no business sense for a company to have rejected a deal with the farmers and later turn around and buy from a broker at a higher price. These kinds of dealings were said to be common in the French beans growing areas and had contributed greatly to farmers moving into the production of French beans for the canning industry. The prices offered in the canning industry were lower however the production process was less stringent than the export focused production process. The buyers were also more readily available as they were supplying local manufacturers.

Brokers seem to be the main influencers of the breached contracts between farmers and export companies. At the beginning of a planting season, farmer groups enter an agreement with the export companies and thus know their obligations with respect to making payments for the seeds and insecticides which are supplied on credit. Then prior to the beginning of the harvest seasons, export companies fix a buying price and convey this information to the farmers. However, brokers come in at harvest time and offer higher prices which entice the farmers away from their contractual obligations with the exporters. This breach of contracts/agreements has been an on-going cause for the strained relations between farmers and export companies. According to the growers, in such situations they were ‘forced’ to accept the better prices from

the brokers because higher prices indicate higher market prices of which the export companies are reluctant to reveal in order to retain the added price benefits.

The canning industry seemed to be making in-roads in those areas that export companies have reduced their buying from. One area was found to be producing French beans for one local canning company. They produce under KenyaGAP rules especially in maintaining the correct spraying regimen which is overseen by the company's extension agents, and the required on-farm hygiene practices during harvest time such as harvesting using clean hands, clean clothes, using hair nets when handling the produce, and wearing clean clothes when delivering the beans to the collection centers. The maximum residual level (MRL) tests are conducted in Nairobi on randomly selected produce from every collection centers and rejected produce is returned to the individual farmer. In collaboration with the Horticultural Crops Development Authority (HCDA), the company and HCDA personnel inspect the collection centers, and on-farm facilities. This arrangement was much preferred by the farmers who placed their trust in this industry mainly because the company maintained a close collaboration with a state agency.

The opinion of farmer trust hinged on the presence of a state agency led to the question about farmers' trust of export companies. On the one hand, the farmers saw they were exploited with respect to the prices offered by the companies. They found it unlikely that the exporters were acting in their best interest given that when offered one price by one company, another company or the brokers would come in and offer a higher price. This inconsistence was unexplainable to the farmers who then concluded that they were being exploited by the first contracting company. However, the trainings provided by export companies were appreciated although advance information on changes in the type of chemicals to be used remains unresolved.

In closing, the information gathered from the only group of farmers who own the entire supply chain, from farm to final buyers abroad, is instructive. According to group members, after witnessing similar problems as those discussed above, the group pulled out of all arrangements with export companies and undertook extensive training from HCDA. The group then formed a co-operative which took charge of the export process for the various horticultural produce, inclusive of French beans. Members receive steady payments through this process and although they do not receive price premiums, they remain positive knowing that their cooperative was in-charge of the process. The group demonstrates some traits contained in the reviewed literature

(Chesire and Higgins, 2004; Higgins, 2005). They have been through the process of capacity-building to develop their bargaining strength, have developed strategies of self-help, self-reliance and entrepreneurship, and grown into business people who engage in efficient and competitive practices. Thus, looking at the area from an outsider's viewpoint, the group could be said to be on the path to an equitable distribution of wealth.

CHAPTER FIVE
CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary and Conclusions

The production of a cash crop under an international standard such as GlobalGAP requires following a production system that is defined by the standard. The capacity to manage this production system rests on the household head who is also the decision-maker. Firstly, the costs related to complying with the standard must be met. The findings show that farming under households that participated in GlobalGAP had an annual income of KES. 2,670.97 less than non-participating households, and the recurrent GlobalGAP costs were yet to be met. This shows that engaging in GlobalGAP is costly for individual smallholders involved in French beans production for the export market.

Descriptive results show that the age of the head of the household, the number of contact hours with extension agents through agricultural trainings and seminars, and the distance between a farm and a local market significantly influence the chances of a household in participating in GlobalGAP certified farming. On the other hand, on-farm technical efficiency is positively influenced by the number of contact hours with extension agents. However, the education level of the household head and livestock ownership influence efficiency on certified farms negatively. The findings, therefore, revealed that the factors related to human capital are important in the implementation of GlobalGAP farming system.

The age and education level are key influencers on the decision to adopt GlobalGAP and on efficiency and point to the capacity of the household head. Contact with extension agents and attending agricultural trainings and seminars are capacity building activities and influence both outcomes; adoption of GlobalGAP and efficiency. Thus, given that age and education level are not changeable, the importance of extension services and participation in agricultural trainings/seminars is elevated. Formal years of schooling is construed to be of a general nature and not significant in improving technical management on-farm. Technical skills required in export production are more influenced by hands-on training. Female household heads are constrained in attending extension meetings and seminars which take longer than a few hours. Thus, extension agents need to be aware of women's circumstances and structure extension meetings and trainings closer to women farmers. The numbers of public sector extension agents

were fewer than those provided by export companies, however, as gained from the group discussions, public trust is placed on public extension agents.

Ownership of livestock on certified farms is a diversion of labour away from the production of French beans, thus a household involved in export production would need to be mindful of this and allocate labour accordingly. In mixed farming areas similar to this study's, livestock ownership is both a cultural and a financial necessity thus a recommendation that livestock keeping could be forgone is not realistic. This is where extension services also play a vital role. With constant contact between the farmers and the extension agents, the management of cash and food crops in conjunction with livestock keeping could be resolved for added benefits in outputs.

Finally, the findings on distance to local markets confirmed that the further a farm was from a local market the lower were the chances for adopting a system of production such as GlobalGAP. High transaction costs for both inputs and outputs affected these farms as a result of the poor roads and communication system. For now, households located further from local markets are constrained in seeking opportunities to pursue international market linkages mainly due to poor infrastructure.

5.2 Recommendations

The number of public sector extension officers need to be increased if on-farm productivity for export production is to be increased. The technical skills provided through agricultural trainings and seminars are vital for the export production process and should not be limited to those provided by the export companies. Targeted trainings that make efficient use of the time available to the farmers are paramount in order to encourage the attendance of female farmers. Farmer trust is higher on public sector agents and this is an advantage the public sector could cultivate further.

Government intervention is required in the development of the roads and communication systems in the rural areas to boost the participation of farmers in international market. Farmers need not be constrained to participate in international markets due to constraints such as the state of infrastructure. Opening up areas located further from the current local markets, will allow for closer market linkages between the farmers and the prospective businesses which would be attracted into the areas.

5.3 Avenues for further research

The demonstrated effects of GlobalGAP standard on household income and on technical efficiency shows that there is potential in further investigating the effect of standards on on-farm productivity. There is still need to establish the relationship between GlobalGAP and factor usage as there is still a need to compare household income effects. This measurement needs a follow-up as various studies, including this study, have generated a broad range of figures.

The export market is set for changes given the changes in the structure of the European Union following Britain's exit from the EU, the main market for Kenya's fresh produce. The final decision of what this change will entail will be known as from 2017 when the EU members complete the exit negotiations with Britain. Thus, it is expected that the changes in the international market scene will affect the fresh produce market in Kenya, including the French beans export industry. Should the changes affect the substance and intent of standards such as GlobalGAP, new avenues of research will open up. A close monitoring of the changes within the EU and in Britain are necessary for producer nations such as Kenya.

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APPENDIX 1 : QUESTIONNAIRE

Section A: General Information

1. Date of interview _____
2. Name of enumerator _____
3. Name of Respondent (optional) _____
4. Respondent's relation to Household Head: 1= Household Head 2=Spouse 3=Child 4=Employee 5=Other(specify)
5. County _____
6. District _____
7. Division _____
8. Sub-location _____

Background Information to farming

9. Are you the major decision maker on farming practices in the household? Yes _____Other _____(Please state)
10. Are you GlobalGAP certified? Y = 1, N = 0 _____

    If yes, who made decision to become GlobalGAP certified? 1= Household Head

    2= Export company (explain below)

    3= Agric. Extension Officer (explain below)

    4= Other (specify) _____

    Please explain (for choices 2, 3 or 4) _____

    _____
11. Are you a member of a GlobalGAP farmers' group? Y = 1, N = 0 _____

    If yes, please provide name of group _____

12. SECTION B: STRUCTURE OF LAND OWNERSHIP (in acres)

TOTAL SIZE		T E N U R E S Y S T E M			
Plot #	Acres	Owned	Rented In	Rented Out	Communal
[_____]	[_____]	[_____]	[_____]	[_____]	[_____]

13. Cropping System:

a. Do you practice farming as subsistence or commercial? _____

b. If commercial, what are the main crops for the market?_____

c. If subsistence, do you sell any or all the surplus? Y/N___ Please explain_____

_____

14. Farm allocation to the various farming activities undertaken, in Acres.

Activity	Number	Farm Size Allocated	Output
Cash crops			
Subsistence crops			
Livestock			
French beans			
Other vegetables:			
Other			

15.a. CROP ENTERPRISES

Land Use Long Rains 2013

Crop Enterprise Name	Acres	Number of Times planted per year	Seeds kg. used (during long rains)	Insecticides per crop (litres)	Planting fertilizer (kg.)	Top - dressing (kg.)	FYM (kg.)	Family Labour Hours	Hired Labour Hours	Production Output in Kgs.	Production in Ksh.
1. French Beans											
2.											
3.											
Others–name?											

15.b. Land Use Short Rains 2013

Enterprise (Crop/Livestock)	Acres	Seeds/Feeds/ Fodder in kg.used	Insecticides/Pesticides Ksh.	Vet drugs Value Ksh.	Planting kg. & type	Top-dressing kg. & type	FYM	Compost	Family Labour Hours	Hired Labour Hours	Production in Kgs/Litres	Value per unit	Production in Ksh.	Leisure Hours
French Beans														

The following section is for GlobalGAP certified French bean farmers **ONLY.**

SECTION C: Information on FRENCH BEANS PRODUCTION

I would now like to learn more from you about the farming practices under GlobalGAP certification, and invite you to kindly provide an accurate account of the following :-

1. What year were you first certified under GlobalGAP? _____
2. Why did you, or the household head, decide to become certified? _____

   _____
3. Have you maintained your certification since _____ (the year mentioned in 1 above)? Y/N _____If Y, move to next question. If N, please explain why not_____

   _____

   _____
4. How do you maintain your certification? Individually or through a group/export company, please explain further _____

   _____

   _____
5. Kindly describe the certification process which you undergo, either individually or as a group member? _____

   _____

   _____
6. What are the benefits, or challenges, to being GlobalGAP certified? _____

   _____

   _____
7. Kindly comment on any other issue about the certification process? _____

   _____

Enumerator advice to respondent: You indicted that you became GlobalGAP Certified in the year ……. Kindly recall as much as you can about the following:-

8.a. Production of French Beans **Three (3) years BEFORE GlobalGAP certification,** going backwards from year of Certifcation

Production of French Beans		About how much was used and produced (kgs.) over the previous 3 years before Certification?											
		Year 1 before certification				**Year 2** before certification				**Year 3** before certification			
		Qty1 (Kgs) Long Rains(LR)	Price1 (Ksh.) LR	Qty1 Short Rains (SR)	Price1 SR	Qty2 LR	Price2 LR	Qty2 SR	Price2 SR	Qty3 LR	Price3 LR	Qty3 SR	Price3 SR
Seeds	1												
Insecticides	2												
Planting fertilizer	3												
Top-dressing	4												
Farm yard manure	5												
Family Labour Hours	6												
Hired Labour Hours	7												
French beans output	8												

8.b. Production of French Beans **Three (3) years AFTER GlobalGAP certification,** going forward from year of Certifcation

Production of French Beans		About how much was used and produced (kgs.) over the 3 years after Certification?											
		Year 1 after certification				**Year 2** after certification				**Year 3** after certification			
		Qty1 (Kgs) Long Rains(LR)	Price1 (Ksh.) LR	Qty1 Short Rains (SR)	Price1 SR	Qty2 LR	Price2 LR	Qty2 SR	Price2 SR	Qty3 LR	Price3 LR	Qty3 SR	Price3 SR
Seeds	1												
Insecticides	2												
Planting fertilizer	3												
Top-dressing	4												
Farm yard manure	5												
Family Labour Hours	6												
Hired Labour Hours	7												
French beans output	8												

9.a. Asset Endowments (Numbers and Value) – <u>BEFORE GlobalGAP</u>

Asset	Number	Value per item (Ksh.)
Oxen		
Dairy cattle		
Other cattle		
Goats		
Sheep		
Pigs		
Poultry		
Donkeys		
Camels		
Vehicles		
Tractor		
Plough		
Wheel barrow		
Hoes/Jembes		
Pangas/Slashers		
Bicycle		
TV		
Radio		
Mobile Phone		
Computer		
Furniture		

Other Assets		
Group membership		
Other (Please specify)		

9.b. Asset Endowments (Numbers and Value) – <u>AFTER GlobalGAP</u>

Asset	Number	Value per item (Ksh.)
Oxen		
Dairy cattle		
Other cattle		
Goats		
Sheep		
Pigs		
Poultry		
Donkeys		
Camels		
Vehicles		
Tractor		
Plough		
Wheel barrow		
Hoes/Jembes		
Pangas/Slashers		
Bicycle		
TV		
Radio		

Mobile Phone		
Computer		
Furniture		
Other Assets		
GlobalGAP Requirements:		
Sorting shed		
Packing structure		
Cooling structure		
Other structure		
Training and Quality assessment manuals		
Control systems		
Record books & manuals		
Traceability system		
Group membership		
Other (Please specify)		

10. Labour Hours in Maintaining GlobalGAP Certification

Category	Time period in hours
Investment in required facilities: Storage structure	
: Packing structure	
: Cooling structure	
: Other	
Establishment of traceability systems: Training	
: Recurring activity	

Maintaining regular control systems (itemize)	
Annual verification audits	
Record-keeping	
Implementation of traceability systems	
Leisure Hours : Before certification	
: During certification	
: After certification: Year 1	
: Year 2	
: Year 3	
: Year 4	

11. Access to Market

		Km. Tarmac	Km. Earth
Input market	Nearest		
	Most important (urban)		
	Other		
Output market	Nearest		
	Most important (urban)		
	Other		

12. In your opinion, what are the challenges facing the French beans industry?

Activity	Challenge	Probable Solution
Farming		
Selling – whether individually,		

or as a group or through an export company, please state?		
Marketing – as above		
Use or consumption of French beans on-farm		
Other issue(s) – please state, and then explain.		

Enumerator advice to respondent: It is important to the study that we gain an understanding of the socio-economic status of French beans farmers. Kindly provide this information and remember this information will be kept in a highly CONFIDENTIAL manner and is for the sole purpose of this study. It will NOT be shared with any other source outside of this study.

Section D: Household Profile

No. in Household	Household Members	Age	Gender	Resident 0=No 1=Yes	Education (Yrs)	% of time working on farm	% of time working Off-farm	Wages per period of time	Period worked	Type of work off farm	
1	Head										
2	Spouse										
3	Children:1										
4	2										
5	3										
9	Relatives:1										
10	2										

11	3										
12	4										

Type of work: 1=Casual in agriculture, 2=Casual other work**,** 3=Permanent in agriculture, 4=Permanent other work

B. Household Income Sources in Ksh.

Type of Source	Amount	Time period in days	Acres
Off-farm Employment Income			
Income from farm produce sales - milk			
- crop produce			
Income from sale of livestock & other assets e.g. land, machinery			
Income from business			
Transfer earnings from relatives, children, etc.			
Monetary gifts received			
Income: Land rented out			
: Buildings rented out			
: Other structures rented out			
: Motor vehicle rented out			
: Farm machinery rented out			
Other incomes e.g. Dividends			

C. Household Expenditures in Ksh.

Item	Amount	Time period in days
Expenditure on fertilizer		
Seeds		
Livestock feeds		
Vet drugs/services		
Crop chemicals (list each) – - -		
Labour		
School fees		
Foods		
Clothing		
Rental		
Health		
Transport & Fuel		
Entertainment		
GlobalGAP Requirements:		
Training and training manuals (list)		
Quality assessment manuals		
Pre-audit costs		
Certification costs		
Maintaining regular control systems		
Annual verification audits		

	INSTITUTION	Borrowed 0-No 1-Yes	Credit type Money –1 In kind-2	Amount LR 2013 (Ksh)	Amount SR 2013 (Ksh)	Total annual amount (Ksh)

Traceability systems		
Group membership: Initial costs		
: Monthly costs		
: Annual costs		
Other		

SECTION E: INSTITUTIONAL SUPPORT – For All Respondents, certified and non-certified.

1.a. Have you attended farmer training school? (Y/N) _____

b. If yes, how frequent, in number of days per year, over the last 5 years _____

2. a. Have you received agricultural extension contacts in the last one year _____

b. If yes, how many times per day/week/month/year in last 5 years, please be specific. _____

c. Who provided the extension service – government/NGO/export company? _____

3. Have you received any other technical extension contacts in last year? (Y/N) _____

List these & number of days of contact._____

_____

_____

5.a. How frequent do you attend farmer group meetings?_____ Times per week/month

b. Do you attend agricultural field days? Y/N____ Number times per year? _____

6. Do you receive any other services from the export company you are attached to? Y/N. If yes, please list them _____

7. Did you access credit last year (Yes=1, No=0). If yes, fill in the table below:

Formal	Commercial banks					
Semi-formal	AFC					
	Cooperatives					
	Micro-Finance institution					
	NGO project					
	Other					
Informal	Input-store					
	Self-help Groups					
	Moneylender					
	Neighbors					
	Friends					
	Family					
	Other					

APPENDIX 2: GUIDE FOR GROUP DISCUSSIONS

Questionnaire for Group Discussions

Name of group

Number of members

Year formed

Meetings per month

Group linked to export company? (Y/N)

If yes, which export company (Optional)? Name.

Assistance received from export company to your group: - Technical support (list)

- Financial support

Assistance received from Government/NGOs to your group (Please state name(s):

- Technical
- Financial

Assistance received from other sources to your group (Please state name(s):

- Technical
- Financial

QUESTIONS FOR CERTIFIED FARMERS

1. Did you choose to become certified? (Y/N) _____
2. Did you negotiate for certification? (Y/N) ____ If Yes, with whom?
3. What are the benefits of certification? Please list, with the most important first. What are the challenges of certification? Please list, with the most important first.

4. Is your name on the certification documents?

5. a. Who represents you in matters related to GlobalGAP certification?

b. Describe how they represent you?

c. Are you satisfied with this representation? Y/N. If No, how can this be improved?

6. Describe or add to the information above, any other concerns or general information about GlobalGAP?

QUESTIONS FOR <u>NON-CERTIFIED</u> FARMERS

1.a. Do you intend to become certified in the near future? Y/N. If yes, continue. If no, skip to Question 5 herebelow.

b. What is the expected time period to becoming certified as from now?

c. Why do you want to become certified?

d. Has anything, or any event, motivated you to plan this?

2.a. Do you expect any benefits from being certified? If yes, please list with the most important first.

b. If not, why not? Please list as in 2.a. above

3. Who will meet the costs for certification? Explain.

4. Do you foresee any constraints with your gaining certification? Please describe these.

5. What are your perceptions about GlobalGAP?

6. Do you know the conditions required for certification? Y/N. Kindly describe them.

7. Provide any other information about GlobalGAP.

8. Should the government be involved in the GlobalGAP certification process? Y/N. If yes, how?

9. How would you like your concerns, as listed above, to be addressed? And by whom?

10. In your view, are your farming practices (production of vegetables/green beans) better, or comparable, to those of other farmers who are certified? Describe this.

11.a. What would you attribute any output differences between you (non-certified) and those who are certified to be as a result of?

b. Can this be related to the other farmers being certified or to other factors? Please explain.

12. Do you consider your farming practices to be better than for those who are certified? Explain.

Questionnaire for Export Companies

Name of company

When did you start operations in this country?

How many counties do you operate in at present?

Specify the counties and when you started operations in each:

How do you select farmer groups to supply you?

Are you confident with small-scale farmer groups as your source of supplies?

Do you offer them any assistance?(Y/N)

List assistance offered.

Do you contract the groups for long-term periods (5 – 10 years) or annually?

Do you collect produce from farms or site?

How often?

During which months?

Do you have any large scale producers as your suppliers?

Do you have your own farm to supply you?

APPENDIX 3: CORRELATIONS BETWEEN SOCIO-CONOMIC FACTORS

		CERT	AGE	GEN	EDUC	FLAB	LVV	HHA	OFFE	TRGT	TRNG	FRMS	MEQP	MATS	HLAB	DMKT
CertifiedERT	Pearson Correlation	1	.102	.056	.024	-.017	.052	.035	-.053	-.117	.146*	.028	-.075	.139*	-.084	-.143*
	Sig. (2-tailed)		.098	.365	.702	.781	.396	.570	.391	.057	.017	.649	.226	.023	.173	.020
	N	266	266	266	266	266	266	266	266	266	266	266	266	266	266	266
AGE	Pearson Correlation	.102	1	-.018	-.167**	-.093	-.069	-.021	-.002	-.119	-.195**	.184**	-.033	.008	-.247**	.205**
	Sig. (2-tailed)	.098		.766	.006	.131	.264	.739	.971	.053	.001	.003	.592	.898	.000	.001
	N	266	266	266	266	266	266	266	266	266	266	266	266	266	266	266
GEN	Pearson Correlation	.056	-.018	1	-.030	.090	.116	-.038	-.063	-.047	-.069	-.109	-.018	.035	.079	-.095
	Sig. (2-tailed)	.365	.766		.623	.142	.059	.534	.308	.450	.259	.075	.766	.568	.197	.123
	N	266	266	266	266	266	266	266	266	266	266	266	266	266	266	266
EDUC	Pearson Correlation	.024	-.167**	-.030	1	.053	.073	.033	.286**	.137*	.065	-.048	.007	.127*	.088	-.074
	Sig. (2-tailed)	.702	.006	.623		.390	.238	.594	.000	.026	.293	.440	.908	.038	.153	.227
	N	266	266	266	266	266	266	266	266	266	266	266	266	266	266	266
FLAB	Pearson Correlation	-.017	-.093	.090	.053	1	.183**	.017	-.063	.011	-.128*	-.076	.021	.023	-.061	-.123*
	Sig. (2-tailed)	.781	.131	.142	.390		.003	.788	.306	.864	.037	.217	.730	.712	.323	.045
	N	266	266	266	266	266	266	266	266	266	266	266	266	266	266	266
LVV	Pearson Correlation	.052	-.069	.116	.073	.183**	1	.213**	-.065	.182**	-.012	-.040	.003	.210**	.096	-.225**
	Sig. (2-tailed)	.396	.264	.059	.238	.003		.000	.287	.003	.844	.511	.966	.001	.117	.000
	N	266	266	266	266	266	266	266	266	266	266	266	266	266	266	266

HHA	Pearson Correlation	.035	-.021	-.038	.033	.017	.213**	1	.149*	.023	-.022	-.056	**.449****	.092	-.010	-.141*
	Sig. (2-tailed)	.570	.739	.534	.594	.788	.000		.015	.712	.717	.360	.000	.134	.873	.021
	N	266	266	266	266	266	266	266	266	266	266	266	266	266	266	266
OFFE	Pearson Correlation	-.053	-.002	-.063	.286**	-.063	-.065	.149*	1	-.042	.000	.107	-.033	.094	-.098	.052
	Sig. (2-tailed)	.391	.971	.308	.000	.306	.287	.015		.497	.999	.082	.595	.125	.111	.401
	N	266	266	266	266	266	266	266	266	266	266	266	266	266	266	266
TRGT	Pearson Correlation	-.117	-.119	-.047	.137*	.011	.182**	.023	-.042	1	.017	-.040	-.008	.010	.190**	-.057
	Sig. (2-tailed)	.057	.053	.450	.026	.864	.003	.712	.497		.787	.515	.896	.877	.002	.353
	N	266	266	266	266	266	266	266	266	266	266	266	266	266	266	266
TRNG	Pearson Correlation	.146*	-.195**	-.069	.065	-.128*	-.012	-.022	.000	.017	1	.106	-.036	-.008	.149*	-.070
	Sig. (2-tailed)	.017	.001	.259	.293	.037	.844	.717	.999	.787		.084	.564	.900	.015	.253
	N	266	266	266	266	266	266	266	266	266	266	266	266	266	266	266
FRMS	Pearson Correlation	.028	.184**	-.109	-.048	-.076	-.040	-.056	.107	-.040	.106	1	-.061	.050	-.203**	.194**
	Sig. (2-tailed)	.649	.003	.075	.440	.217	.511	.360	.082	.515	.084		.320	.421	.001	.001
	N	266	266	266	266	266	266	266	266	266	266	266	266	266	266	266
MEQP	Pearson Correlation	-.075	-.033	-.018	.007	.021	.003	**.449****	-.033	-.008	-.036	-.061	1	.051	-.002	-.078
	Sig. (2-tailed)	.226	.592	.766	.908	.730	.966	.000	.595	.896	.564	.320		.411	.979	.207
	N	266	266	266	266	266	266	266	266	266	266	266	266	266	266	266
MATS	Pearson Correlation	.139*	.008	.035	.127*	.023	.210**	.092	.094	.010	-.008	.050	.051	1	.068	-.184**
	Sig. (2-tailed)	.023	.898	.568	.038	.712	.001	.134	.125	.877	.900	.421	.411		.273	.003

	N	266	266	266	266	266	266	266	266	266	266	266	266	266	266	266
HLA B	Pearson Correlation	-.084	-.247**	.079	.088	-.061	.096	-.010	-.098	.190**	.149*	-.203**	-.002	.068	1	-.179**
	Sig. (2-tailed)	.173	.000	.197	.153	.323	.117	.873	.111	.002	.015	.001	.979	.273		.003
	N	266	266	266	266	266	266	266	266	266	266	266	266	266	266	266
DMK T	Pearson Correlation	-.143*	.205**	-.095	-.074	-.123*	-.225**	-.141*	.052	-.057	-.070	.194**	-.078	-.184**	-.179**	1
	Sig. (2-tailed)	.020	.001	.123	.227	.045	.000	.021	.401	.353	.253	.001	.207	.003	.003	
	N	266	266	266	266	266	266	266	266	266	266	266	266	266	266	266

*. Correlation is significant at the 0.05 level (2-tailed).

**. Correlation is significant at the 0.01 level (2-tailed).

Source: Computed from survey data 2013

APPENDIX 4: T-TESTS OF THE AVERAGE DIFFERENCES BASED ON CERTIFICATION STATUS

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
age	Equal variances assumed	4.201	.041	-1.660	264	.098	-2.356	1.419	-5.149	.438
	Equal variances not assumed			-1.537	88.537	.128	-2.356	1.533	-5.401	.690
gen	Equal variances assumed	3.467	.064	-.908	264	.365	-.031	.034	-.097	.036
	Equal variances not assumed			-1.070	132.485	.287	-.031	.029	-.087	.026
educ	Equal variances assumed	.704	.402	-.383	264	.702	-.143	.373	-.876	.591
	Equal variances not assumed			-.365	92.177	.716	-.143	.390	-.917	.632
flab	Equal variances assumed	.607	.437	.279	264	.781	19.535	70.107	-118.505	157.575
	Equal variances not assumed			.277	97.676	.782	19.535	70.482	-120.340	159.410
lvv	Equal variances assumed	.144	.705	-.850	264	.396	-10539.682	12392.986	-34941.354	13861.989
	Equal variances not assumed			-.834	95.599	.407	-10539.682	12644.284	-35639.732	14560.367

hha	Equal variances assumed	.839	.360	-.568	264	.570	-5928.768	10436.000	-26477.152	14619.616
	Equal variances not assumed			-.634	118.895	.527	-5928.768	9344.203	-24431.390	12573.854
offe	Equal variances assumed	.222	.638	.859	264	.391	20914.269	24349.918	-27030.488	68859.026
	Equal variances not assumed			.916	109.192	.362	20914.269	22840.110	-24353.192	66181.730
trgt	Equal variances assumed	11.112	.001	1.915	264	.057	14300.552	7466.143	-400.212	29001.316
	Equal variances not assumed			1.344	68.422	.183	14300.552	10640.517	-6929.896	35530.999
trng	Equal variances assumed	18.512	.000	-2.396	264	.017	-110.091	45.946	-200.559	-19.623
	Equal variances not assumed			-3.780	258.801	.000	-110.091	29.128	-167.449	-52.733
frms	Equal variances assumed	1.129	.289	-.456	264	.649	-.039554	.086751	-.210365	.131257
	Equal variances not assumed			-.433	91.531	.666	-.039554	.091338	-.220971	.141863
meqp	Equal variances assumed	6.631	.011	1.215	264	.226	4448.898	3662.384	-2762.302	11660.098
	Equal variances not assumed			.678	60.647	.500	4448.898	6563.343	-8676.860	17574.656
mats	Equal variances assumed	.864	.354	.004	264	.997	26.848	7113.839	-13980.233	14033.929
	Equal variances not assumed			.004	93.193	.997	26.848	7391.110	-14650.032	14703.727

hlab	Equal variances assumed	1.775	.184	1.367	264	.173	106.819	78.155	-47.067	260.704
	Equal variances not assumed			1.482	112.462	.141	106.819	72.097	-36.026	249.664
dmkt	Equal variances assumed	10.226	.002	2.341	264	.020	1.5844	.6768	.2518	2.9171
	Equal variances not assumed			1.770	72.264	.081	1.5844	.8949	-.1995	3.3683

Source: Computed from survey data 2013

APPENDIX 5: DETAILED RESULTS FOR PROPENSITY SCORE MATCHING

****

Algorithm to estimate the propensity score

****

The treatment is cert

CERT	Freq.	Percent	Cum.
0	61	22.93	22.93
1	205	77.07	100.00
Total	266	100.00	

Estimation of the propensity score

Iteration 0: log likelihood = -143.22967
Iteration 1: log likelihood = -126.72267
Iteration 2: log likelihood = -125.82884
Iteration 3: log likelihood = -125.79973
Iteration 4: log likelihood = -125.79964

Probit regression Number of obs = 266

LR chi2(14) = 34.86

Prob > chi2 = 0.0015

Log likelihood = -125.79964 Pseudo R2 = 0.1217

cert	Coef.	Std. Err.	z	P>z	[95% Conf. Interval]

age	.0191546	.0101863	1.88	0.060	-.0008102	.0391194
gen	.4096687	.4407343	0.93	0.353	-.4541547	1.273492
educ	.0297957	.038197	0.78	0.435	-.045069	.1046604
flab	-.0000519	.0002078	-0.25	0.803	-.0004592	.0003554
lvv	-2.09e-07	1.16e-06	-0.18	0.857	-2.49e-06	2.07e-06
hha	2.23e-06	1.91e-06	1.17	0.244	-1.52e-06	5.98e-06
offe	-8.68e-07	5.81e-07	-1.49	0.135	-2.01e-06	2.71e-07
trgt	-2.53e-06	1.77e-06	-1.43	0.152	-6.00e-06	9.36e-07
trng	.0013303	.0005102	2.61	0.009	.0003302	.0023303
frms	-.0251886	.1618314	-0.16	0.876	-.3423723	.2919951
meqp	-6.88e-06	4.78e-06	-1.44	0.150	-.0000163	2.49e-06
mats	1.90e-06	8.46e-07	2.24	0.025	2.39e-07	3.56e-06
hlab	-.0003539	.000198	-1.79	0.074	-.000742	.0000342
dmkt	-.0393298	.0197815	-1.99	0.047	-.0781009	-.0005587
_cons	-.5034892	.970715	-0.52	0.604	-2.406056	1.399077

Note: the common support option has been selected
The region of common support is [.3897313, .99971718]

Description of the estimated propensity score
in region of common support

Estimated propensity score

Percentiles	Smallest		
1%	.4156821	.3897313	
5%	.5395877	.400746	
10%	.5944525	.4156821	Obs 260
25%	.7107558	.4385458	Sum of Wgt. 260
50%	.8029106		Mean .7814452
Largest		Std. Dev.	.1303797

75%	.879224	.9915841		
90%	.9324689	.9992196	Variance	.0169989
95%	.9694355	.9997016	Skewness	-.64155
99%	.9992196	.9997172	Kurtosis	3.026395

****

Step 1: Identification of the optimal number of blocks
Use option detail if you want more detailed output
****

The final number of blocks is 5
This number of blocks ensures that the mean propensity score
is not different for treated and controls in each blocks
****

Step 2: Test of balancing property of the propensity score
Use option detail if you want more detailed output
****

The balancing property is satisfied

This table shows the inferior bound, the number of treated
and the number of controls for each block

Inferior of block of pscore	CERT 0	1	Total
.2	0	1	1
.4	10	17	27
.6	32	66	98
.8	13	121	134
Total	*55*	*205*	*260*

Note: the common support option has been selected

****
End of the algorithm to estimate the pscore
****
ATT estimation with Nearest Neighbor Matching method
(random draw version)
Analytical standard errors

n. treat.	n. contr.	ATT	Std. Err.	t
205	45	-2,670.976	10,517.095	-0.406

Note: the numbers of treated and controls refer to
actual
nearest neighbour
matches

Bootstrapping of standard errors
note: label truncated to 80
characters

Bootstrap statistics Number of obs = 266
Replications = 100

Variable	Reps	Observed	Bias	Std. Err.	[95% Conf. Interval]
attnd	100	-2,670.98	9,363.137	9,205.755	-18566.55 10019.72(N)

-18288.81 11203.38 (P)
-20305.77 7443.069 (BC)

Note: N =
normal
P = percentile
BC = bias-
corrected

ATT estimation with Nearest Neighbor Matching method
(random draw version)

Bootstrapped standard
errors

n. treat.	n. contr.	ATT	Std. Err.	t
205	45	-2,670.976	9,205.755	-0.290

Note: the numbers of treated and controls refer to actual
nearest neighbour
matches

ATT estimation with the Radius Matching method

n. treat.	n. contr.	ATT	Std. Err.	t
205	55	-2,221.404	9,509.818	-0.489

Note: the numbers of treated and controls refer to actual
matches within radius
Bootstrapping of standard errors

note: label truncated to 80 characters

Bootstrap statistics Number of obs = 266
Replications = 100

Variable	Reps	Observed	Bias	Std. Err.	[95% Conf.	Interval]	
attr	100	-2,221.404	-18,129.46	8,237.557	-12492.33	15323.76	(N)
					-13409.27	14797.74	(P)
					-14025.7	13442.5	(BC)

Note: N = normal
P = percentile
BC = bias-corrected

ATT estimation with the Radius Matching method
Bootstrapped standard errors

n. treat.	n. contr.	ATT	Std. Err.	t
205	55	-2,221.404	8,237.557	-0.270

Note: the numbers of treated and controls refer to actual
matches within radius

ATT estimation with the Kernal Matching method

n. treat.	n. contr.	ATT	Std. Err.	t

205	55	-2,176.801	9,648.351	-0.416

Note: the numbers of treated and controls refer to actual
matches within radius
Bootstrapping of standard errors
note: label truncated to 80 characters

Bootstrap statistics Number of obs = 266
Replications = 100

Variable	Reps	Observed	Bias	Std. Err.	[95% Conf. Interval]	
attr	100	-2,176.80	-11534.86	6,868.812	-11454.86	16546.46 (N)
					-125038.47	14649.32 (P)
					-13859.47	15246.9 (BC)

Note: N = normal
P = percentile
BC = bias-corrected

ATT estimation with the Kernal Matching method
Bootstrapped standard errors

n. treat.	n. contr.	ATT	Std. Err.	t
205	55	-2,176.80	6,868.812	-0.317

ATT estimation with the Stratified method

n. treat.	n. contr.	ATT	Std. Err.	t
205	55	-2,646.269	10,389.84	-0.374

Note: the numbers of treated and controls refer to actual
matches within radius
Bootstrapping of standard errors
note: label truncated to 80 characters

Bootstrap statistics Number of obs = 266
Replications = 100

Variable	Reps	Observed	Bias	Std. Err.	[95% Conf.	Interval]	
attr	100	-2,646.269	-10959.254	9,417.962	-17513.47	19726.10	(N)
					-16455.63	182371.18	(P)
					-18469.11	17886.95	(BC)

Note: N = normal
P = percentile
BC = bias-corrected

ATT estimation with the Stratified Matching method
Bootstrapped standard errors

n. treat.	n. contr.	ATT	Std. Err.	t
205	55	-2,646.269	9,417.962	-0.281

Source: Computed from survey data, 2013

APPENDIX 6: Tobit marginal effects for factors that influence technical efficiency in GlobalGAP certified farms

Conditional marginal effects — Number of obs = 205

Model VCE : OIM — LR chi2(**14**) = 55.53

Prob > chi2 = 0.0000

Log likelihood = -92.680842 — Pseudo R2 = 0.2305

Variable	Delta-method Semi-elasticities	Std. Err.	z	Pr>|z|	[95% Conf.	Interval]	Mean
Age	-.0025073	.0035583	-0.70	0.481	-.0094814	.0044667	48.4
Gender	.0661907	.1180183	0.56	0.575	-.1651209	.2975023	
Education	-.0290334	.0121211	-2.40	0.017	-.0527904	-.0052764	9.81
Family Labour	-.0000798	.0000747	-1.07	0.286	-.0002262	.0000666	1566
Livestock	-7.42e-07	3.58e-07	-2.07	0.038	-1.44e-06	-4.020e-08	65984.78
Household assets	9.06e-07	4.89e-07	1.85	0.064	-5.32e-08	1.86e-06	45979.34
Off-farm employment	9.64e-08	1.94e-07	0.50	0.619	-2.84e-07	4.77e-07	86989
Remittances & cash gifts	3.02e-07	7.91e-07	0.38	0.703	-1.25e-06	1.85e-06	15027
Training/extension	.0010525	.0003126	3.37	0.001	.0004398	.0016652	289.7
Farm size	-.102547	.059027	-1.74	0.082	-.2182377	.0131438	1.57
Small equipments	-7.62e-06	5.04e-06	-1.51	0.131	-.0000175	2.26e-06	6323.6
Materials in stock	-5.61e-07	6.45e-07	0.87	0.384	-7.03e-07	1.82e-06	62452.8
Hired Labour	-.0000743	.0000614	-1.21	0.227	-.0001947	.0000461	1819.08
Distance to markets	.0114527	.0083569	1.37	0.171	-.0049265	.0278318	2.58

Source: Computed from survey data 2013

APPENDIX 7: Tobit marginal effects for factors that influence technical efficiency in non- certified farms

Conditional marginal effects					Number of obs = 61		
Model VCE : OIM					LR chi2(**15**) = 50.75		
					Prob > chi2 = 0.0000		
Log likelihood = **52.155305**					Pseudo R2 = -0.9476		
	Delta-method						
Variables	Semi-elasticities	Std.Err.	z	Pr>|z|	[95% Conf.Interval]		Mean
Age	-.0026574	.0013723	-1.94	0.053	-.005347	.0000321	46.05
Gender	.0650921	.0806409	0.81	0.420	-.0929613	.2231454	
Education	-.0086247	.0059986	-1.44	0.150	-.0203817	.0031324	9.67
Family Labour	-8.33e-06	.0000294	-0.28	0.777	-.0000659	.0000493	1585.6
Livestock	-7.68e-07	2.13e-07	-3.60	0.000	-1.19e-06	-3.50e-07	55445.1
Household assets	2.01e-07	4.92e-07	0.41	0.683	-7.64e-07	1.17e-06	40050.6
Off-farm employment	2.11e-07	1.02e-07	2.07	0.038	1.13e-08	4.11e-07	107903.3
Remittances & cash gifts	-4.78e-07	2.01e-07	-2.37	0.018	-8.72e-07	-8.32e-08	29327.9
Training/extension	.0000111	.0001398	0.08	0.936	-.0002629	.0002852	179.6
Farm size	-.0623271	.0225741	-2.76	0.006	-.1065715	-.0180826	1.53
Small equipments	-1.56e-07	5.491e-07	-0.28	0.777	-1.23e-06	9.2e-07	10772.46
Materials in stock	-5.40e-07	3.02e-07	-1.79	0.074	-1.13e-06	5.18e-08	62479.6
Hired Labour	-.0000214	.0000329	-0.65	0.515	-.0000858	.000043	1925.9
Distance to markets	.0022042	.0024311	0.91	0.365	-.0025607	.0069691	4.16

Source: Computed from survey data 2013

LIST OF PUBLICATIONS

Njoba, J. W., Owuor, G., & Wolukau, J. (2016). The influence of Global GAP certification on the performance of small-scale French beans growers in Central Kenya. *International Journal Of Business & Management*, *4*(8), 196-204.

Njoba, J. W., Owuor, G., & Wolukau, J. (2016). Does GlobalGAP certification influence smallholders technical efficiency in French beans production? A case study of Nyeri and Kirinyaga Counties, Kenya. *Journal of Agricultural Economics, Extension and Rural Development*, *4*(7), 496-504.