ECONOMIC VALUATION OF CHANGES IN SOIL QUALITY: A CASE OF GLOBAL GAP COMPLIANT AND NON-COMPLIANT FARMERS IN EASTERN AND CENTRAL, KENYA

Msc.THESIS

SUBMITTED TO THE BOARD OF POST GRADUATE STUDIES, UNIVERSITY OF NAIROBI,

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER IF SCIENCE IN AGRICULTURAL AND APPLIED ECONOMICS

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A56/60492/2010

November 2013

DECLARATION AND APPROVAL

Declaration

This thesis is my original work and has not been presented for examination to any other university.

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DEDICATION

I dedicate this work to my mother Rachael Waringa Mwangi, my wife Irene Christene Ongoche, my son Jeylani Wanderi Karira and, my friend and mentor Dr. Paul Maina Guthiga, they all made this possible each in their own unique way. Through your motivation, encouragement and advice, I have made it this far. May the almighty bless you always, and always in abundance……….

ACKNOWLEDGEMENT

First, I would like to acknowledge and appreciate the assistance and guidance of Dr. John Mburu and Dr. Paul Guthiga my university supervisors. Further, the invaluable guidance of Mr. Peter Shimon and his encouragement throughout the entire process of my research work is unquantifiable and so is my gratefulness. I would also like to recognize the assistance received from the rest of the students and members of staff that were involved in the DRIVLIC Project. In particular, I would like to recognize the efforts and assistance of Ms Clarice Mnyambo Njoli for her work in undertaking the soil sampling and analysis. In particular, I would like to recognize and appreciate the financial support from IDRC in this project in various forms and components of the study.

I would also like to acknowledge and appreciate the AERC for the CMAAE course that has opened opportunities and fulfilled a longstanding dream to me. Furthermore, I would like to appreciate the patience and support shown to me by Dr. Rose Nyikal, the CMAAE Coordinator at the University of Nairobi during the period that I started the course. In the same vein, I would like to recognize and appreciate my fellow classmates at the University of Nairobi and in the participating universities of the CMAAE program; their help and encouragement have been with me consistently.

Last but not least, I would like to recognize each and every individual who in their own way has assisted me in my academic pursuits.

ABSTRACT

Compliance with agri-regulation mechanisms like GLOBALGAP has been extensively studied with some studies focusing on the non-market benefits of smallholder compliance. Some of these have found that there are quantifiable health benefits that accrue to compliant farmers while others allude to possible environmental benefits of smallholder compliance with agri-food standards. This study focuses on this research gap and empirically analyzes economic values of changes in soil quality (an environmental attribute) as a result of compliance with GLOBALGAP standards in producing and marketing fresh vegetables for export under different compliance arrangements. Using the replacement cost and the contingent valuation economic valuation approaches, the study estimated the direct and total economic value of changes in soil conditions given the farmers compliance with GLOBALGAP standards. The study further utilizes the ordinary least squares regression approach to analyze the factors that influence the economic value of changes in soil quality.

The estimation of direct economic value of changes in soil quality is undertaken in only one of the study clusters i.e. Kirinyaga due to a resource and time constraint. Estimation of total economic costs is undertaken in three study clusters i.e. Kirinyaga, Mbooni and Buuri in Central and Eastern Kenya. Direct economic values are estimated at Kshs 2,462 and Kshs 2,666 for the compliant and non-compliant farmers respectively. Total economic values of changes in soil quality are estimated atKshs 2,621, Kshs 2,611 and Kshs 2,743 for compliant farmers in Kirinyaga, Buuri and Mbooni respectively. The estimated economic values of changes in soil quality for the non-compliant farmers are Kshs 1,993, Kshs 2,066 and Kshs 2,216 in Kirinyaga, Buuri and Mbooni respectively. Divergence in the direct and total economic values is attributed to the different methodologies, study areas and other factors considered in estimating the direct and total economic values of changes in soil quality.

Consistent with past studies, income has a significant and positive influence on the household's stated willingness to pay for changes in soil quality. The farmers' compliance status, the households' ownership of livestock, transport costs to the nearest urban centres, importance attached by the respondent to the hypothetical scenario posed, the gender of the household head and the respondent being from Mbooni are the other factors that were found to have a significant effect on the stated total economic value of changes in soil quality.

The study's value to agri-regulation policy is in the finding that agri-regulation benefits also benefits farmers in addition to consumers who have been the primary concern for such regulations. Farmer benefits include savings in health expenditures as found in other studies as well as environmental benefits.

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ABBREVIATIONS

C.S – Compensating Surplus

C.V – Compensating Variation

CVM – Contingent Valuation Method

DH – Double Hurdle

E.S – Equivalent Surplus

E.V – Equivalent Variation

GoK – Government of Kenya

Hh - Household

IPM – Integrated Pest Management

KNBS – Kenya National Bureau of Statistics

Kms - Kilometers

Kshs – Kenya Shillings

SQICMP – Soil Quality Improvement, Conservation and Management Programme

WTP – Willingness to Pay

1.0INTRODUCTION

The quality of a country's agricultural resource has important implications for its agricultural development. This importance is more pronounced in a country Kenya for which a majority of the population and especially the rural population whose livelihoods are agricultural based. It is in recognition and appreciation of this that the government policy relating to land, i.e. the Sessional Paper No. 003 on the National Land Policy (NLP), recognizes the threat that land quality continues to face by way of degradation; soil erosion, pollution, and mining (GoK 2009). In particular, section 124 of the NLP recognizes the need for the government to put in place measure to restore and conserve land quality in the country. This section further obligates the government to "establish measures to control degradation of land through abuse of inputs and inappropriate land use practices". Further, the Constitution of Kenya 2010 identifies productive and sustainable management of the land based resources as one of the key principles of land use and management in the country (GoK, 2010).

Continued degradation of land and other natural resources is at the heart of the sustainability debate with regard to sustainable utilization of the land resource. The NLP further recognizes the ever increasing population pressure as one of the driving factors of land quality deterioration besides soil erosion, variability in climatic patterns and other factors. Indeed, according to the latest demographic estimations, Kenya's population is growing by about 1 million people per year. Considering the increasing population against a background of a constraint in the country's land resource, there is need maintain a sustainable balance between the country's objectives of increasing food production through agricultural intensification and that of conservation of environmental quality.

World over, agricultural intensification is considered to be the surest means of increasing agricultural yields in the high and medium potential areas of Kenya where population densities are quite high. Often, agricultural intensification is characterized by use of high yielding varieties, which will usually require increased use of agro-chemical inputs. Generally, intensive agricultural practices/enterprises are characterized by high productivity and economic returns per unit of land. Often, intensive agricultural practices are highly commercialized enterprises with very little if any produce being consumed on farm. Thus, while several cropping / agricultural enterprises might be run by the farmer, the most intensive ones are the most commercialized with little produce being consumed on farm. Further, Shirley and Ayiko, (2008) posit that "when farmers are faced with a land constraint or low earnings, they often make the rational decision to put their land to high value use".

The Kenyan fresh vegetable sector produces for both the domestic and the export markets, 78% and 22% respectively, with a majority of the traded volume being in the domestic market which is thus the principal market for fresh vegetable produce in the country(Muendo and Tshirley, 2004; Tshirley et al., 2004). By the year 2003, the country's estimated fresh vegetable production stood at 14.5 billion Kenya shillings. By the year 2009, the annual fresh vegetable exports were valued at slightly over 214 million US dollars. This accounted for about 24 percent of all agricultural exports of the country in the year 2009 (HCDA, 2009).While the domestic vegetable sector and the agricultural sector in general are of immense commercial benefits to the country, there has been little regulation of the sector by the country's government and other players. Indeed, Muendo and Tshirley, (2004) contend that the ability of the traditional (domestic) fresh vegetable industry to contribute to and participate in future growth of smallholders is limited by the fact that they pay little or no attention to quality and safety issues. On the other hand, the internationally oriented fresh export vegetable sub-sector in the country is regulated by the international GLOBALGAP standards which have been imposed by both European country governments and European retail chains on developing country farmers (Campbell, 2005).

Environmental sciences/studies consider the contribution of the environment to most if not all economic activities to be two i.e. provision of inputs or by being a waste sink for by-products of economic activities (Pretty et al., 2000). Seeing that the fresh vegetable production in the country is an intensive enterprise characterized by high synthetic input usage and may thus be associated with high environmental degradation levels (Raut et al., 2010). Usage of agro-chemicals has in particular been associated with contamination of drinking water with pesticide residues, nitrates, soil sediments due to erosion, and phosphates among other negative environmental effects (See Pretty et al., 2000). While these maybe off farm-effects that may not be of interest to an individual farmer, they become relevant in cases where the polluting farmer is also consuming the polluted resource.

On-farm, agro-chemicals have been found to negatively affect soil micro-organisms as well as being poisonous to domestic animals and even humans when ingested accidentally or even during application. Broad spectrum pesticides have in particular been found to kill non-target beneficial insect species thus reducing the pool of natural enemies of agricultural pests. The population, type and density of soil micro-organisms is known to have an effect on the quality of any given soil and thus its ability to sustain any given crop. It thus follows that any type of regulation on permitted agro-chemicals will in some way affect the quality of a given soil due to the chemicals effect on the type, population and density of soil micro-organisms. Further, the degree of intensity of agricultural practices means that there will be varying degrees of soil nutrient elements from farmer to farmer. At the same time, it might occur that a farmer's chosen compliance arrangement imposes certain requirements with regard to the frequency of cropping and thus this will affect the quality of their soils but of course depending on their soil nutrient replenishment practices.

Fresh export vegetable producers operate in the context of GLOBALGAP institutional arrangement. These standards seek to regulate the producers' actions vis a vis the use of chemicals, and the handling of the product during harvesting and marketing. By their design and intent, GLOBALGAP standards require farmers to practice good agricultural practices thus constraining their behavior to that which is considered relatively more sustainable and acceptable. There's thus a possibility that the agricultural practices of GLOBALGAP compliant farmers are less degrading to the environmental resource of the farmer.

Evidence from recent studies on GLOBALGAP standards in developing countries suggests that there exists non-market benefits that accrue to smallholders and developing countries in general as a result of compliance (Asfaw et al., 2008; Okello and Swinton, 2009;Okello and Okello, 2010). These have been identified as health and environmental benefits which accrue to farmers from use of protective gear, use of less toxic chemicals, safer pesticide storage and disposal, strict regulations on agro-chemical application rates and timings, and use of integrated pesticide management.

While there is an evident move towards more sustainable agricultural practices under GLOBALGAP standards, variations in compliance from farmer to farmer means that there is a mixed outcome of the standards in the country. Further, while distinct factors such as resource requirements and individual farmer capacities are some of the key factors that determine the choice of compliance arrangement[1], the effects of such a choice on the non-observable benefits/costs that accrue to the farmer need to be well understood.

Environmental valuation is a tool that can be used to quantify the non-market benefits or costs that accrue to farmers as a result of compliance with GLOBALGAP standards. Indeed, Pretty et al., (2000) contends that environmental valuation approaches offer an opportunity for costing externalities (either positive or negative) that are associated with a

[1] In this study, the term compliance arrangement refers to a household's chosen mode of compliance with the GLOBALGAP standards. Broadly, the farm household may choose to either comply or not comply with the GLOBALGAP standards thus giving two distinct compliance arrangements i.e. compliant and non-compliant. Further, the compliant farmers may choose to comply within a group set-up or as individuals thus giving two distinct sub-compliance arrangements under the compliant farmers i.e. individually compliant farmers and group compliant farmers. Depending on specific arrangements within each sub-category, there may be other compliance arrangements.

given economic activity. With such quantified information, policy formulation at both the national and international levels would be better informed by farmer level effects of agricultural regulation policy at both levels. Environmental valuation approaches are thus used in this study to quantify the monetary equivalent of the effect of changes in soil quality due to compliance or lack of with GLOBALGAP standards.

1.1 Problem Statement

Kenya is among the top African exporters of horticultural produce to Europe and the rest of the world. Horticultural production in the country is by and large an intensive activity with high rates of agro-chemical inputs besides use of high yielding varieties. With this in mind, there is a need to exercise caution and care as the country moves towards increased agricultural intensification. The need for caution is informed by research evidence which points to the existence of some negative effects of agriculturally intensive practices on the environment (Pagiola, 1995; Urama, 2005; Raut et al., 2010).

Ecobichon (2010) attributes these negative effects on the environment to the tendency of developing country farmers to both inappropriate and excessive use agrochemicals. As a food security strategy, more and more African countries including Kenya are increasingly turning to subsidizing agricultural inputs especially fertilizers with a view to increasing their agricultural production. Though increased fertilizer and agro-chemical usage by African farmers is something that should happen, African countries should learn and consider the lessons of the green revolution in Asia in these quest. Increasingly, literature indicates that there are negative consequences of high levels of subsidized and unregulated agro-chemical usage (Pingali and Rosegrant, 1994). As such, in endeavoring to attain increased agricultural productivity and yields through an African green revolution, measures should be put in place to militate against any negative environmental effects that may arise due to the increased agricultural intensification. Thus, the basics of sustainable development as contained in the

Rio Declaration of 1992 should be incorporated into Africa's efforts to increase agricultural productivity.

Regulation is one of the main ways of reducing the occurrence and the magnitude of negative environmental effects attributable to any economic activity. An example is the use of stringent regulatory requirements on Maximum Residue Levels (MRLs) by developed countries which has effectively reduced the amount of chemical residues found in fresh vegetables imported from developing countries. These regulatory requirements are currently known as GLOBALGAP standards but originated from the EUREPGAP standards imposed upon Developing countries' farmers by European and developed countries' retailers, consumers and governments. These standards require products sold under them not to exceed the set MRLs and further require the compliant farmers to adopt and practice the set Good Agricultural Practices(GAP) such as integrated pest management, use of organic fertilizers, specific period of applying pesticides, specific types of pesticides to apply etc.

These standards have largely attained the original objectives of protecting consumers from unsafe food products, other benefits have been found to exist and specifically in the areas of farmers' health and environmental benefits among the compliant farmers (Pretty, 2006; Okello and Swinton, 2009; Okello and Okello, 2010).This can be attributed not only to compliance with the GLOBALGAP standards but also to the fact that GLOBALGAP compliant farmers have a better extension system at their disposal. Given differences in compliance arrangements from one household to the other, there arises a question of how the household's choice of compliance arrangement interacts (including the direction of such interactions if any) with the magnitude of the aforementioned non-market benefits of compliance with GLOBALGAP standards.

Studies conducted over the recent past points to farmers' health benefits due to compliance with GLOBALGAP practices(Okello and Swinton, 2009; Okello and Okello, 2010). However, there is insufficient evidence on the magnitude of environmental benefits that accrue from farmer compliance with GLOBALGAP standards (Asfaw et al., 2008;Ragona and Mazochi, 2008; Okello and Okello, 2010).As such, there is an apparent need to estimate the possible environmental impacts of GLOBALGAP standards on developing countries' farmland environmental value, and the possible implications of their wide implementation by developing country governments. Estimation of these impacts will provide reliable estimates of the economic benefits/costs of smallholder compliance with GLOBALGAP standards due to changes in environmental quality[2] which are associated with agricultural activities. This is especially important in view of research evidence which shows that trends in the international markets are influencing the practices of developing country markets with international regulations being adopted in developing countries, (Tshirley et al., 2004; Dolan and Humphrey, 2007).

1.2 Purpose and Objectives

The general objective of this study is to analyze the economic value of changes in soil quality under different GLOBALGAP compliance arrangements of producing and marketing fresh vegetables for export in Central and Eastern Kenya.

The specific objectives of the study are;

- To estimate the direct economic value of changes of soil quality[3] changes among smallholder farmers producing and marketing fresh vegetables for export under different GLOBALGAP compliance arrangements.

[2] Given the wide scope in the term environment, this study is confined to evaluating changes in soil quality as a proxy for changes in environmental quality. This is because the study is intended to look at farmer level economic benefits/costs of compliance with GLOBALGAP standards. The limitation in scope is also due to funding and methodological constraints.
[3] In this study, the scope of soil quality is limited to the soil's chemical properties owing to time and resource constraints; these are easier to measure in the replacement cost exercise.

- To estimate total economic value of soil quality changes among smallholder farmers producing and marketing fresh vegetables for exports under different GLOBALGAP compliance arrangements[4].
- To assess the factors influencing the economic value of changes in soil quality among smallholder farmers producing and marketing fresh vegetables for export under different GLOBALGAP compliance arrangements.

1.3 Hypotheses

- There are no differences in the direct economic value of soil quality changes for smallholder farmland under the different GLOBALGAP compliance arrangements for producing and marketing fresh vegetables for export.
- Compliance with GLOBALGAP standards has no influence on the total economic value of changes in soil quality among smallholder produces of fresh vegetables for export.

1.4 Justification

According to Pretty et al., (2000), there is need for costing externalities attributable to agricultural activities at the national and international policy formulation levels, and at the policy, program or project level. The economic values estimated from this study can thus be used as guiding tools to agricultural policy especially in the areas of agricultural extension and agro-chemical usage in the country. At the same time, environmental valuation plays a key role in the management and containment of environmental risk so as to ensure sustainability in agricultural systems (Travisi and Nijkamp, 2009).

[4] In the initial design of the study, a total of 5 compliance arrangements entailing individual compliance, group compliance, exiters, non-compliance and non-growers had been identified. However, due to the size of the sample and analytical procedures, the compliance arrangements had to be collapsed into three i.e. compliant farmers, non-compliant farmers and the non-growers. This enabled effective analysis of the data by study area owing to identified significant difference in the means of some respondent attributes.

Developing country smallholder farmers are often thought to be operating at levels below the agricultural and productivity potential of their land. While there is an increased drive towards increased agricultural intensification in African countries, there is an acute need regulate / guide the agricultural intensification process. Such guidance will enable or steer farmers towards integrating environmental considerations into their production and indeed intensification decisions in addition to profitability. The guidance to farmers can be effected through various approaches including but not limited to; extension advice on agro-chemical usage, establishment of agri-regulation mechanisms such as global gap with all geared towards encouraging farmers to adopt good agricultural practices. Essentially, this study then serves to point out the possible environmental effects and essentially economic effects of increased chemical use, with and without guided / regulated use of agro-chemicals among smallholder farmers based on compliance or non-compliance with GLOBALGAP standards by the farmer.

The importance of this knowledge relates primarily to increased calls for an African Green Revolution that essentially entails increased use of agro-chemicals. Of secondary importance is the move by a majority of African countries towards an increased use of fertilizer subsidies among other agro-chemical subsidies in the agricultural sector to deal with the high agro-chemical input costs. Muendo and Tshirley, (2004) contend that there is need to exercise caution so as to ensure that unsustainable government subsidies do not claw back on the market liberation gains made in the agricultural sector.

Beyond the direct market impacts of such policies, there is need to evaluate farmer level impacts of agro-chemical inputs by the lowly educated smallholder farmers. Indeed, there is a need to guide and probably regulated the usage of agro-chemicals by Kenyan smallholder farmers. Agri-regulation mechanisms such as GLOBALGAP and KenyaGAP offer an opportunity to regulate farmer behavior with regard to the usage of agro-chemicals.

The GLOBALGAP standards present a case of an existing mechanism which can be readily evaluated with regard to arising environmental benefits or lack thereof. Compliance with GLOBALGAP standards imposes certain restrictions on farmers' behavior in terms of the permissible agro-chemicals, and their usage patterns. Though the permissible chemicals are friendlier to the environment, exporters offer additional technical advice on fertilizer usage for maximum yields.

2.0 LITERATURE REVIEW

2.1 Agricultural Practice – Environment Nexus

The agricultural productivity of an area is linked to the environment's capacity which is in turn influenced by the sustainability or its lack thereof, in the agricultural activities carried out in the area (Zhang et al., 2007; Dale and Polasky, 2007).As such, effective management of agricultural activities influences the flow of ecosystem services and dis-services from the environment and thus the economic value of the agricultural resource and the environment over the long run. Agricultural management practices that result in an increase in the flow of ecosystem services and a reduction in ecosystem dis-services are thus deemed to be more sustainable and result in a higher economic value of the agricultural resource under consideration (Roka and Palmquist, 1997, cited in Zhang, 2007).

Intensive agricultural practices are known to be more degrading than the less intensive practices. For instance, use of irrigation as an intensification strategy in Nigeria has been associated with various negative externalities both on-farm and off-farm (Urama, 2005). Of particular importance in the study by Urama (2005), is the finding that irrigated soils were more degraded and thus of lower quality than non-irrigated soils. While the source of the soil degradation in highly irrigated soils as those studied by Urama (2005) may be debatable, what is important is the fact that intensive agricultural practices will almost always have some negative effects on the environment. These may be more visible in cases where the intensification regimes being adopted by a farmer are not subject to some form of regulation/control.

The environmental degrading effect of agro-chemicals on the other hand has been attributed to their over-application mainly due to the risk averse nature of most farmers (Pearce and Koundouri, 2003). Further post Asian Green Revolution studies show evidence pointing to the adverse environmental impacts of the Asian green revolution. Pingali and Rosegrant, (1994) point to the need for considering the end-results of intensive agricultural practices beyond the initial productivity increases associated with intensification for proper long term management of the agricultural resource base. Thus while there might be some rational justification for agro-chemical use by farmers especially in the wake of an ever increasing world population, there is a need to regulate or guide the farmer's intensification behavior and practices. In-efficiencies and misuse in the usage of agro-chemical inputs and the environmental resource for agricultural purposes is the principal reason for the non-sustainability of most intensive agricultural practices and this usually results in negative agricultural externalities (Piot-Lepetit et al., 1997). In developing countries, these inefficiencies are usually manifested through either inappropriate or excessive use of agro-chemical inputs (Ecobichon, 2010).

Ultimately, the flow of externalities that arises due to inefficiencies in agricultural practices among other things results in degradation of the farmer's environmental resource and the decline in incomes derived from agricultural activities (Rasul and Thapa, 2003). Degradation is inherently a negative change in the quality of an environmental resource and affects the rate of ecosystem service flows from the environmental resource e.g. in this particular study, overuse and misuse of synthetic fertilizers has resulted in increased acidity of the soil, high erosion due to cultivation on slopes, and a general decline in the soil's fertility level due to the continuous and intense cultivation on the same piece of land year after year. From welfare economics, it can be shown that the decline in environmental value associated with environmental degradation due to in-efficiencies in agricultural practices results in a loss of welfare to society.

2.2 Regulation of Agro-chemical Use for Sustainability of Agricultural Systems

Due to the interplay between economic activities generally and agricultural activities in particular, and the environment, regulation in the agricultural sector is an important tool that can be used in Kenya to encourage the adoption of more sustainable agricultural practices among farmers. Pearce and Koundouri, (2003) assert that even where the famer is economically efficient in the use of agro-chemicals, there exists a need to regulate this usage so as to cater for the negative externalities associated with the use of agro-chemicals. Use of regulation in ensuring better, efficient and sustainable use of agro-chemicals is best illustrated by the existence of GLOBALGAP standards in Kenya. Compliance with these standards confers access to Kenyan fresh produce growers to European markets. The standards have been shown to drive the fresh vegetable sector towards more sustainability and the required quality levels in terms of chemical residue attributes in the harvested product. Research efforts focusing on the sustainability effects of the GLOBALGAP standards in Kenya are discussed in this section.

Studies by Okelloand Okello, (2010); Okello and Swinton, (2009) and Asfaw et al., (2008) provide insights on the sustainability implications of smallholder compliance with the GLOBALGAP standards. The study by Asfaw et al., (2008) finds that smallholder compliance with GLOBALGAP standards translates to usage of safer pesticides and higher revenues. The higher revenues are obtained despite the fact that there is no observable reduction in pesticide expenditure among the compliant farmers. However, the jury is still out on whether the lack of reduction in pesticide expenditures is due to the high costs of safer pesticides or non-reduction in the magnitude of pesticide usage (Okello and Okello, 2010; Cuyno et al., 2001). The findings by Okello and Swinton, (2009) that compliance results in lower pesticide induced morbidity and lower pesticide related health expenditures are related to those by Asfaw et al., (2008) on the safeness of pesticides and agricultural practices of compliant farmers as well as on higher revenues due to compliance.

The environmental safeness of agricultural practices due to compliance with the GLOBALGAP standards can be deduced from Okello and Okello, (2010). They found that compliance results in farmers increasing use of Integrated Pest Management (IPM).The use of IPM as an agricultural practice has been found to not only reduce pesticide usage but also the environmental risk associated with pesticide usage, (Cuyno, 2001). From the findings of Cuyno et al., (2001) and Okello and Okello, (2010), it can be inferred that compliance with GLOBALGAP standards can actually reduce the environmental risk associated with pesticide usage. Borrowing from this and the fact that GLOBALGAP standards advocate for good and sustainable agricultural practices, it would be reasonable to expect that the value of soil quality should be higher under the GLOBALGAP standards compliance regimes.

However, in some instances, farmers have been found to demand safer agricultural practices / systems despite the absence of regulation on their production practices. The study by Cuyno et al., (2001) is especially illuminating on this issue. Using the contingent valuation method they estimate a maximum Willingness to Pay (WTP) of 2,000 pesos for use of IPM to reduce environmental risks associated with pesticide usage. Non-market environmental valuation methods have as such been used in past studies to estimate the willingness to pay (WTP) for environmentally friendly and safer products by both consumers and producers (Ngigi et al., 2010; Cuyno et al., 2001).

2.4 Environmental Valuation

2.4.1 Concept of Economic Value

The attachment of economic and / or monetary value to both market and non-market goods/services is highly reliant on the economic concept of value. This arises due to the preferences that individuals have with regard to goods and services and which is expressed by choices and tradeoffs that individuals will make between different goods and services (Sundberg, 2003; Soderqvist et al., 2004). Individuals thus reveal the value they attach to a good or service when they make tradeoffs in that the good/service which is favored in the tradeoff is of more value compared to that against which the tradeoff is made. Indeed, according to Soderqvist et al., (2004), these tradeoffs can typically be measured as the individual's willingness to pay for a change in the quality of an environmental resource. Further, considering that economics is principally concerned with the allocation of scarce resources to unlimited wants and / or needs, then indeed individual's hierarchy of using resources to acquire goods/services will be initially biased towards the more valuable ones and progressively followed by the acquisition of progressively less valuable (important) goods. While this offers a rather rudimentary exposition of the concept of value, this concept is what belies the economic rationality upon which all economic agents are premised to be using when participating in both market and non-market allocation mechanisms.

Thus, in a market scenario, a market devoid of distortions will result in an allocation that is not only efficient but one in which the value of a good is evident and captured correctly. However, for this to happen, there are a several conditions that need to be met such as the good being a pure private good, non-existence of externalities, non-existence of information asymmetry for any of the actors etc. Where such conditions exist, the resulting allocation is efficient and the value attached to a good is its true value. However, for environmental goods the perfect market conditions do not necessarily hold as they are characterized as being public goods in nature and due to the existence of either negative or positive externalities. As such, there is market failure which thus necessitates alternative methods of valuing environmental goods.

Due to the non-market nature of most environmental goods / services, various unique approaches exist for the economic valuation of environmental goods / resource services. These are broadly categorized into the direct and the indirect valuation approaches. The choice for the approach to use in valuing an environmental resource is largely determined by the inter-relationships between the environmental resource and other marketed goods and on the type of value being estimated i.e. whether it is the use values, the non-use values or the total economic value and whether the good is a market or a non-market good.

Non-market valuation methods have been used in the past to estimate the welfare losses or gains associated with changes in environmental attributes for example, Weldesilassie et al., (2009) looked at the economic value of improved waste water in Ethiopia. Revealed preference techniques have especially been used to estimate the willingness to pay for more environmentally sound/friendly food production systems (Dupraz et al., 2003; Quaim and De Janvry, 2003). The contingent valuation method has been used by Ngigi et al., (2010) to estimate consumer WTP for higher quality leafy vegetables in Kenya. As such, the revealed preference techniques offer a means to accurately value goods and services as well as to determine the effect of changes in quality of non-market goods on societal welfare e.g. the study by Weldesilassie et al., (2009) estimates that agricultural households in their study area are willing to contribute around 0.37% of their income to improvement in the quality of irrigation water.

2.4.2 Environmental Valuation Approaches

As a starting point, environmental values can be determined using either direct / stated preference or indirect / revealed preference valuation approaches as indicated above. Where an environmental good /resource is closely associated with a marketed good and the use values are being sought, the most appropriate valuation approaches are the indirect approaches. These rely on observed market behavior to model a demand curve for the good in question and thus estimate its economic value (Adamowicz, Louviere, and Williams 1993). The reliance on observed market behavior on choice in estimating economic value restricts the indirect valuation techniques to the estimation of use values. An example is air quality in a city with high levels of air pollution, the aversive expenditure the city's residents are willing to incur would be a good indicator of the value attached to air quality. For such a scenario, the indirect valuation approach known as the avertive behavior approach. While this is just one of the methods of indirect valuation, others are: hedonic price and wage techniques, the travel cost method and the replacement cost method. Of importance is that these set of methods do not rely on an individual's direct response to a question on the amount of money they be willing to pay or accept for a change in quality or quantity of an environmental good / resource but rely on observed market behavior (Pearce and Moran, 1994; Adamowicz, Louviere, and Williams 1993).

On the other hand, the direct or stated preference valuation methods rely on directly posing a question to an individual with regard to changes in the quality or quantity of an environmental good / resource (Adamowicz, Louviere, and Williams 1993). The individual's response may then be analyzed to determine the value that the individual attached to the environmental good / resource in question. One of such methods is the contingent valuation method which elicits value from an individual by directly asking the respondent a value question with regard to an environmental good / resource. The direct approaches have an advantage over the indirect ones in that in addition to capturing the use values of an environmental good, they also capture the non-use values and can thus be said to have the ability to capture the total economic value of environmental goods. While the indirect approaches are restricted to estimation of only the use values of environmental goods and for only those goods /services which have closely related market goods / services which can either be substitutes or complements, the direct approaches do not suffer from this restriction. As such, in addition to use situations in which the indirect approaches can be used to estimate economic value, the direct approaches can be used in situations in which the indirect ones cannot be used.

In this study, both the direct and indirect economic valuation methods were utilized. The replacement cost direct valuation approach was used in this study to assess the direct economic value of changes in soil quality due to compliance with GLOBALGAP standards. In using this method, the study assumes that the costs of restoring or replacing lost soil quality is at least equivalent to the minimum direct economic value of the soil resource in a farmer's land. Further, use of this method necessitates an assumption that the restored soil quality is a perfect substitute for the natural soil quality condition (Sundberg, 2003). However, in the use of this method, a market transaction does not directly take place; rather a potential or indirect replacement or restoration technique of an environment is used to estimate the minimum economic value of change in environmental quality (Sundberg, 2003).

Given the wider spectrum of values that can be estimated using the Stated Preference approaches, the Contingent Valuation Method is employed in this study to estimate the total economic value of changes in soil quality.

2.5Theoretical Framework

Theoretically, environmental valuation is anchored in welfare economics and by extension in the micro-economic utility maximization theory. As such, a key pillar of this study basically assumed is that farmers derive their utility from maximizing the profits generated from their agricultural production activities (Debertin, 1986). The choice of the profit maximization framework as opposed to the consumptive utility maximization framework is informed by the fact that soil quality changes are a productive resource quality issue and hence impacts on the yields that a farmer is able to harvest and ultimately the profitability of his agricultural enterprise. Further, with the assumption of full separability of the farmers' consumption and production decisions, fluctuations in the qualitative aspects of productive inputs can be modeled through the profit function and by extension the production function to reflect the associated changes in the households' utility levels. Pattanaya and Kramer, (2001) taken this route to theoretically model a producer's WTP for a productive input by finding an optimal solution to the profit maximization problem approach for the agricultural household model.

Assuming the farmer's revenue generation activities utilize a number of variable inputs captured by the vector X, and the soil quality of their land, S is a fixed input. His generated revenues Y are a function of X and S and can be captured by the function Y = Y (X; S). The farmer derives utility by spending the income generated from his agricultural activities to purchase consumable goods. As such, an indirect utility function can be defined for the farmer as V (P, M) with P being the price of the consumer goods while M is the income generated from his farming activities. Thus, M = Y, and the indirect utility function can now be written as V (P, Y). As such, it is possible to map the effect of changes in household's farm revenues attributed to changes in soil quality on the household's utility through the indirect utility function V (P, M)

In agriculture, soils play the economic role of a fixed input for agricultural production. Ideally, there is a specific quality level that is ideal for agricultural production with any changes/deviations resulting in observable changes in agricultural production. These changes in agricultural production will result in changes in economic welfare with increased production causing an increase in economic welfare while a decrease results in a loss of economic welfare (Pattanayak and Bultry, 2005).

A deterioration in soil quality (due to inappropriate and excessive use of fertilizers, and pesticide residues in the soils) from season to season, i.e. $S^1>S^2$, results in depressed revenues for the household due to either the low productivity of his soil resource or the higher costs required to rectify the low quality of his soil through increased costs required for either liming or manure application. Thus whether corrective action is taken or not $Y^1>Y^2$, and it can thus be shown that $V(P, Y^1) > V(P, Y^2)$. A Hicksian Equivalent Surplus (E.S) measure can thus be defined for the change in soil conditions associated with the deterioration in soil quality due to inappropriate or excessive use of fertilizers by the farmer. The equivalent surplus associated with changes in soil quality can thus be defined as;

$$E.S = V(P, Y^1) - V(P, Y^2) \tag{1}$$

$$E.S = V\big(P, Y(X; S^1)\big) - V(P, Y(X; S^2)) \tag{2}$$

The decision on which question to ask the respondent i.e. whether a willingness to accept payment question or a willingness to pay question depends on whether we are focusing on a degradation of improvement in the quality of the environment (Carson and Haneman, 2005). Since we are looking at the deterioration in quality of the farmer's soil, the E.S is captured by asking the amount of money the respondent would be willing to pay (WTP) to prevent the deterioration in quality of soil in his farm?

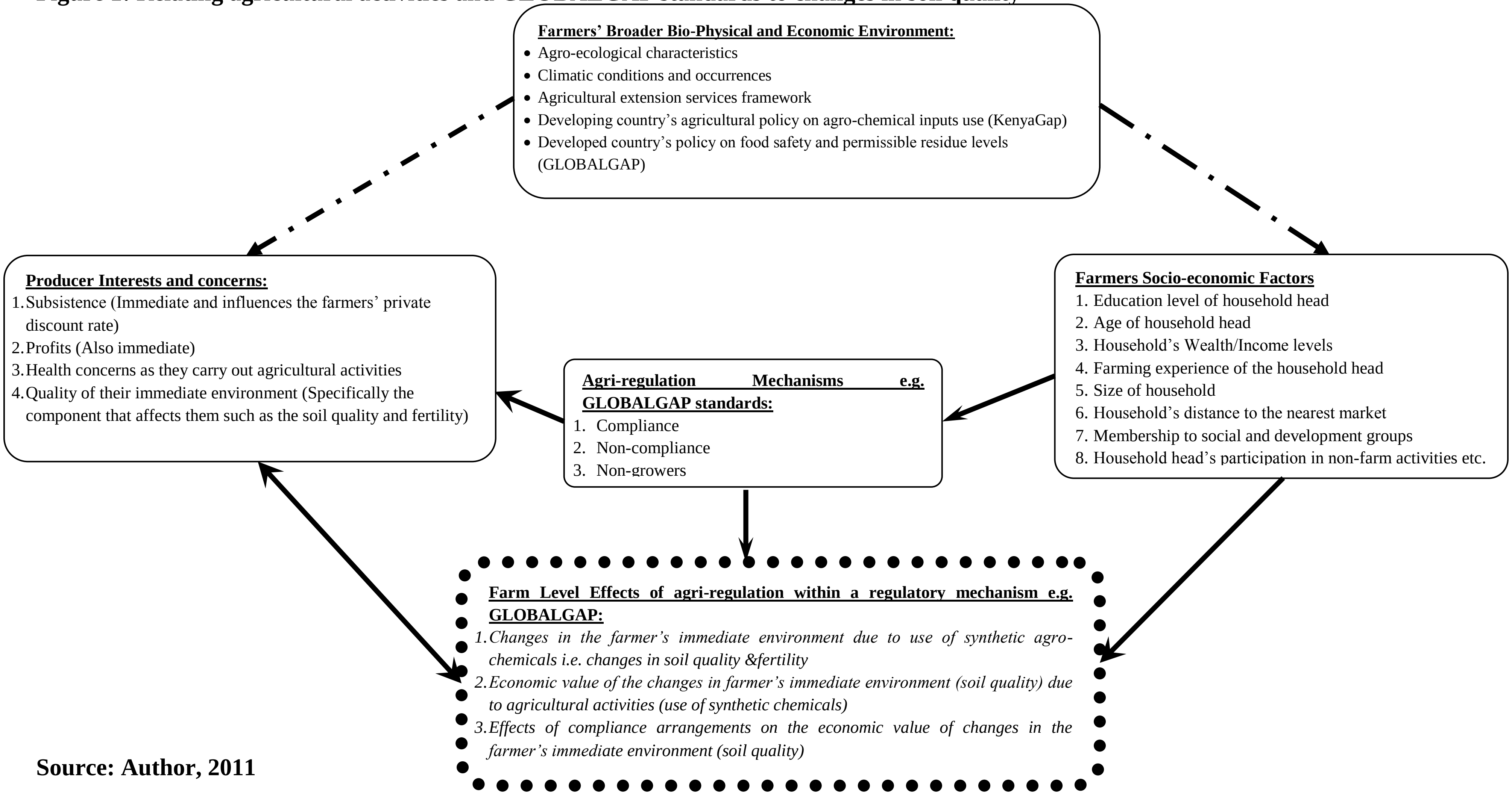
3.0 METHODOLOGY

3.1Conceptual Framework

The broader bio-physical and social-economic environment in which developing country farmers operate in by and large determines farmers' behavior. This environment is composed of those factors which the producers have little or no ability to control. These factors include policy factors relating to their production activities in both the developing countries and the developed countries, and the agro-ecological and climatic conditions in developing country agricultural locations where French beans are grown (Figure 1). These determine the agricultural systems that the farmer adopts and eventually the environmental effects of the agri-systems adopted.

The policies on agro-chemical inputs, the MRL and the extension package provided to French bean farmers are especially important with regard to the environmental effects of adopted agri-systems. The broader bio-physical and socio-economic environment also has an influence on some socio-economic characteristics of farmers in a country. For example, Kenya's Vision 2030 and other medium term development strategies aimed at wealth creation in the country. The farmer's socio-economic characteristics determine the extent to which he achieves his interests and concerns e.g. profit maximization, conservation of his environment etc. For example, the more experienced a farmer is, the more likely he is to take better care of his crops. Further, factors like education are known to influence an individual's production activities. Socio-economic characteristics also influence the choice of compliance arrangement. Okello and Swinton (2005) show that the high costs of initial compliance with GLOBALGAP standards had the effect of initially locking out smallholder producers from the production of fresh produce for export.

Figure 1: Relating agricultural activities and GLOBALGAP standards to changes in soil quality[5]



Source: Author, 2011

[5] The broken arrows represent indirect relationships between the identified key factors informing this study. Single arrows denote unidirectional influences / relationships while double arrows denote bi-directional influences / relationships. The study evaluated the relationships influencing the dotted panel at the bottom i.e. farm level effects of agri-regulation with particular focus on the environmental benefits of compliance.

It is only with the emergence of the group compliance mechanisms that smallholder farmers were able to comply with the standards due to the low costs associated with group compliance (Okello et al., 2007).

In furtherance of his interests and concerns, the farmer inherently affects the environment. Usually, through agricultural production, the soil resource is depleted and thus needs nourishment either through the application of manure or fertilizer, practicing either crop rotation or mixed cropping and / or leaving the land fallow. The most sensitive and yet the most dominant soil nourishment strategy is the application of synthetic fertilizer which if done inappropriately or excessively may result in soil degradation. As such, astute fertilizer application requires soil testing before applying the fertilizer to determine the soil's mineral deficiency and needs in terms of type and amount of fertilizer to apply.

Indeed, while soil analysis and testing services in Kenya are offered by two government parastatals i.e. Kenya Plant Health Inspectorate Service (KEPHIS) and Kenya Agricultural Research Institute (KARI), these services are known by very few farmers and utilized by an even smaller number of farmers. At the same time, a few agri-food exporters who offer extension services to farmers take soil samples from their producers for purposes of analysis with a view to providing appropriate and effective advice to their farmers on soil management.

Given the farmer's production interests and concerns within the broader bio-physical and socio-economic environment, and his individual socio-economic characteristics, there is an associated and distinct compliance arrangement. Since a farmer's activity affects the quality of his soil resource as highlighted above, the bio-physical and socio-economic environment, the individual's socio-economic characteristics and his choice of compliance arrangement will affect the magnitude of changes in the quality of the soil resource.

Further, given the extent to which the farmer is able to meet his goals (maximizing the profits realized), he has an associated economic value for the changes in the quality of the soil resource. This is best manifested in that with any change in the environmental resource upon which the farmer relies upon for his production, there is an associated change in productivity level. Through welfare economics, the effect of such changes in productivity can be mapped to determine the loss or gain in producer surplus. Assuming a welfare loss (decline in producer surplus), the farmer would theoretically be willing to pay a certain amount of money to avoid any decline in his utility level due to a deterioration in the quality of his soil (immediate environment). This amount that the farmer would be willing to pay gives his economic value for changes in soil quality.

3.2 Description of the Study Area

The study was undertaken in fresh vegetable growing districts (majority of the production being for the export market) located in the high to medium potential agricultural lands of Central and Eastern Kenya. Specifically, three distinct areas were sampled:

- Buuri – Part of Buuri and Laikipia East Districts.
- Mbooni – Mbooni East and Mbooni West Districts.
- Kirinyaga – Kirinyaga West, Kirinyaga South and Kirinyaga West Districts.

Buuri and Mbooni East and West Divisions are located in the former Eastern Province of Kenya with Mbooni East and West being on the climatically somewhat drier Ukambani region of Easter Province while Buuri is located on the Slopes of Mount Kenya. Buuri District borders Laikipia East which is in the Rift Valley province of Kenya while Kirinyaga West, East and South Districts are located in Central Province of Kenya. The study areas thus exhibit significant differences in their agro-ecological characteristics ranging from upper highlands to upper midlands.

Population projections by the Kenya National Bureau of statistics place the study area's population at 1,106,867 people (KNBS, 2012). Further, the residents of the study area are contained in roughly 305, 498 households with the average land holding per household estimated at about 2.25 acres per household. The study areas collectively cover an estimated land area of 6, 884 Kilometers squared.

Table 1 gives the demographic characteristics of the three principle study sites i.e. Mbooni, Buuri and Kirinyaga.

Table 1: Chosen Demographic Characteristics of the Study Areas

Characteristic	**Mbooni**	**Kirinyaga**	**Buuri**
Male	84,788.00	260,630.00	201,563.00
Female	93,044.00	267,424.00	199,418.00
Total	177,832.00	528,054.00	400,981.00
No. of Hh	37,302.00	154,220.00	113,976.00
Area in Sq. Km	894.61	1,479.14	4,511.07
Poverty Rate[6] (%)	64.10	25.20	40.65
Educated to Primary Level – Rural / Male (%)	62.00	62.00	60.50
Educated to Primary Level – Rural / Female (%)	60.00	59.00	57.00
Educated to Primary Level – Urban / Male (%)	46.00	51.00	44.00
Educated to Primary Level – Urban / Female (%)	42.00	49.00	44.50

Source: GoK, 2012.

From table 1, it can be seen that in terms of the identified characteristics, Mbooni is the smallest followed by Kirinyaga and thus the Buuri cluster is the biggest chiefly because it includes Laikipia East and Imenti North as the data collection areas. It should however be noted

[6] This is from the data collected by the government in 2005/06 and for Mbooni; this is the data for the larger Makueni District from which it was carved while for Buuri, this is the data for the larger Imenti North District and Laikipia from which again Buuri and Laikipia East Districts were carved.

that in terms of the sampled households, Kirinyaga had the highest number of sampled households compared to the other two. This is due to the fact that while the whole of Mbooni and Kirinyaga were sampled, for Buuri, only the fresh vegetable for export producing zones were sampled and thus effectively, the area sampled for this cluster is smaller though in terms of demographics, national records[7] show that this area has a higher population and size compared to the other two.

Further, while focusing on the demographic characteristics of the study area, it can be seen that for all the study areas, the population of women is consistently higher than that of men. Given that these are primarily rural and agricultural areas, the role of women and their contribution to agricultural incomes cannot be overlooked and indeed in this study, the gender impact on the WTP for changes in environmental resources is evaluated as one of the key factors. Moreover, given that generally women are consistently less educated than men across the three clusters; the impact of education levels also needs to be evaluated especially with the gender perspective in mind. However, and quite surprisingly, it appears that for all study clusters, the rural dwellers are more educated than the urban population for education levels up to primary schools while the urban dwellers have more advanced levels of education beyond primary schools i.e. secondary and university level. Finally, for all the parameters of education, the people in the Mbooni cluster seem to be the most educated while those from the Buuri cluster are the least educated.

With an estimated poverty rate of 64.10%, Mbooni has the highest poverty levels among the sampled areas with the Buuri cluster following at 40.65% and Kirinyaga having the lowest incidence at 25.20%. Given that the Mbooni cluster has the highest education levels; it is quite

[7] Government records do not provide a mechanism for disaggregating the data by the new districts, divisions, sub-divisions and sub-locations. As such, it was not possible to exactly zero in on the specific study areas that were covered by this study.

contradictory and indeed surprising for the same district to show the highest levels of poverty incidence in terms of the poverty rate. Thus, given that the contingent valuation results are highly influenced by income levels, this study will go a step further and evaluate the influence of income levels on the WTP estimates.

The study area exhibits significant variation in the agro-ecological characteristics from one cluster to the other as outlined in the Farm Management Handbooks for Eastern and Central Provinces (Jaetzold, 2007). Despite the differences in their agro-ecological characteristics, the study clusters are key productions zones for fresh vegetable produce in the country. This is mainly attributed to the study areas' climate, and availability of irrigation facilities in the study areas. The areas' horticultural farming is predominantly characterized by smallholder producers who are either compliant or non-compliant with regard to GLOBALGAP standards. Compliant farmers can be grouped into different compliance arrangements i.e. individually compliant, and group compliant. To ensure robustness of the study, non-horticultural growing households were used as the reference point for this study. Further, their inclusion was aimed at reducing any incidences of sample selectivity bias in the event that the farmers growing the fresh vegetables for export were doing so because of certain specific characteristics.

3.3 Empirical Methods

3.3.1 Estimation of Direct Use Value of Changes in Soil Quality

In economic valuation of non-market goods, there exist various approaches for estimating direct use values. The revealed preference techniques have been used for a long time to estimate direct use economic values of non-market goods which have closely related market goods. As such it is a pre-requisite that there exist a closely associated market good and market data for transactions involving the good associated with the non-market good. Since there is lack of data on market transactions of associated/related goods by individuals, it is impossible to use the revealed preference valuation methods. As such, the replacement cost methodology will be used to estimate the direct use economic value of the soil resource. Though this method is inferior to the revealed preference economic valuation techniques, its results have been used by economics over time to guide policy direction (Pretty et al., 2000).

This approach was applied only in the Kirinyaga cluster of the study area owing to the high amount of work required and its associated cost in terms of collections and analysis of soil samples (for instance, analysis of each sample of soil for a farmer was done at about 2,000 Kshs)[8]. Further, this method is best undertaken in areas with more or less comparable environmental attributes and in this case soil types and characteristics so as to reduce margins of error in estimation of the direct costs. Further, applying this approach, the researcher worked closely with a soil scientist to ensure successful implementation of the replacement cost exercise. Basically, from the soil tests undertaken by the soil scientist, the current and existent soil quality levels were established. The soil attributes against which the collected soil samples were evaluated were:

- Soil PH
- Nitrogen
- Organic Carbon
- Phosphorus
- Potassium
- Calcium
- Magnesium

Using the obtained attribute levels, estimations were carried out on the direct economic costs of restoring a farmer's soil resource to the levels of the non-growers of fresh vegetables for export. The non-growers were used as the baseline / reference category owing to the non-

[8] In the study, the soil chemical properties were used as proxies for determining soil quality as they are relatively easy and less costly and time consuming to analyze and indeed restore for any replacement cost estimates to be drawn. The key soil chemical elements evaluated are; total nitrogen content, organic carbon content, phosphorus, potassium, calcium, magnesium, sodium, and ph level.

availability of data on initial soil quality levels before planting horticultural crops and before compliance with GLOBALGAP standards.

In conducting the replacement cost methodology for the estimation of the direct economic value of changes in soil conditions, the following assumptions were made in this study:

- If the farmers had maintained their crop production practices i.e. food crops and were not growing crops for export, their soils would have changed at more or less the same rates. Thus, any changes in soil quality that would have been observed above or below the mean rates would be due to household specific characteristics. The mean soil quality levels for the non-growers of export vegetables in the study area thus formed the baseline soil quality level across against which the growers of fresh produce were compared. Since compliance is postulated to have some environmental effects at the farm level, compliance and non-compliance were compared against the soil quality levels of the non-growers in the replacement cost framework.
- With the growth of export vegetables, there is a change in the farmer's soil quality attributes that can be attributed to the growth of the export vegetables. Further, the pre-condition for compliance with the GLOBALGAP standards places an additional cropping management constraint to the farmer that may either encourage conservation or over-exploitation of the farmer's soil resource. Further, the potential for higher income generation from cultivation of export vegetables may somehow compel growers of export vegetables to exploit their land to a greater degree than the non-growers of export vegetables. Thus, the cost of restoring the quality of the farmer's soils to the mean soil quality level represents the direct economic value of the soil quality resource.

- The differences between the parameters of the baseline group versus the other categories were used to compute the replacement costs. The parameters that were used in computing the replacement costs were; the soil ph and various chemical element levels in the soil such as Nitrogen, Carbon, calcium, magnesium etc. Thus where the soil nutrient levels were lower than for the baseline category, positive replacement costs were computed. However, where they are higher, no costs are estimated as replacement is not required.
- The mean number of years for which farmers in Kirinyaga District have been growing French beans and complying with the global gap standards was used to determine the rate at which the restored nutrients would be exhausted in the soil, thus sort of giving a time angle to the direct economic costs of soil quality. This in essence resulted in the costs that were eventually estimated being the direct annual costs. The rational that informed this was the fact that the total economic costs were estimated on annual basis for each acre of land.

*3.3.2*Estimation of the Total Economic Value of Changes in Soil Quality

There exist various methods that have are used in eliciting the WTP of an individual in a contingent valuation study. The WTP / WTA elicitation formats are generally categorized into two groups i.e. the direct or the referenda type elicitation formats, (Carson et. al., 2001).Among the open ended elicitation formats; we have the direct payment method and iterative bidding game. With the direct payment method, the respondent is asked to state her WTP using either a payment card. From this, the researcher is able to estimate directly the economic value for an environmental good or service. Closely similar to this is the iterative bidding game in which the researcher sort of plays a game in which alternatively higher or lower prices for the good or service in question is consistently offered to the respondent given their response to the first amount of money asked by the researcher. An improved version of this is the open ended bidding game in which the respondent is allowed to give his final bid outside the figures given either as an in between acceptable bid or a higher or lower bid than that proposed by the researcher. The estimation of the WTP / WTA is then as simple as taking the mean, median or mode of the respondents' amount depending on the researcher.

On the other hand, we have the referenda type elicitation formats which are also popularly known as the dichotomous / discrete choice WTP / WTA elicitation formats. Under these methods, a figure is proposed to the respondent and she is either willing or not willing to pay or accept the proposed amount. Econometric techniques are then used to estimate the mean WTP or WTA as the case may be. A slightly different and perhaps more advanced method of eliciting the WTP / WTA is the double bounded discrete / dichotomous choice format in which the initial referenda question is followed by a second referenda question which can either be lower or higher than the initial amount given the respondents response to the initial referenda question. As such, the respondent's WTP / WTA can be said to either fall between the first and second referenda question, below the second referenda question or above the second referenda question. The mean WTP / WTA is then estimated using econometric techniques. As such, while the respondents in the direct elicitation formats state their WTP / WTA directly, they provide an interval within which their WTP must lie, (Carson and Haneman, 2005).

This study adopted one of the direct elicitation formats i.e. Iterative Bidding. Using this approach, the researcher directly obtained the respondents willingness to pay for the good in question from either the final bid value or the in-between values that respondents stated as their willingness to pay for the good in question. With this, it was possible to compute the mean WTP for the changes in soil conditions for all the sampled respondents and for the different categories of the sampled farmers' i.e. the non-growers, the non-compliant farmers and the compliant farmers.

$$MeanWTP = \frac{1}{n}\sum_{i=0}^{n} WTP_i \qquad (3)$$

Where, n is the total number of households sampled, i is the i^{th} household. And by extension, the mean WTP for a given category can be computed as:

$$MeanWTP_j = \frac{1}{n_j}\sum_{i=0}^{n_g} WTP_{i,j} \qquad (4)$$

Where, j denotes the j^{th} category/group within the sampled farmersn_j denotes the number of households belonging to category/group j within the sample and $WTP_{i,j}$ denotes the WTP for i^{th} individual in category/group j.

The data used in the estimation of the total economic value of changes in soil quality was obtained through a socio – economic survey that was conducted in the three study clusters of Kirinyaga, Mbooni and Buuri over the months of June to October 2011. A total of 550 respondents were interviewed but after data cleaning and elimination of the protest bids, the number of effective respondents in the analysis reduced to around 454.

3.3.3Empirical Model to Asses the Factors Influencing the Economic Value of Changes in Soil Quality

Regression analysis is a useful tool often used in economics to determine causal effects links between various factors that are manifested by different households at varying degrees of variability (Gujarati, 2007 – pg 7) i.e.

$$WTP_i = \beta X_i + \varepsilon_i \qquad (5)$$

Where, WTP_i denotes the WTP value for the i^{th} individual, β is a vector of parameters, X is a vector of explanatory variables and ε is the error term. This is the generic regression model.

However, in determining the causal effect links between households WTP and the other household specific characteristics, a decision had to be made on the most appropriate regression approach to take. This was informed by among other things the existence of zero bids which were either true zeros – indicating zero values, or protest zeros – thus indicating unacceptability/discomfort of the hypothetical scenario in a WTP estimation exercise. Unacceptability of the hypothetical scenario usually captures two distinct sets of information which may or may not occur together. The first is the respondent not thinking that the scenario posed is plausible or realistic and will often result in what is commonly referred to as hypothetical bias in Contingent valuation studies. The other is the respondent having a negative WTP value for the good being valued and since this is not an option; the respondent then gives a zero WTP value. An example in this study was for farmers who were taking good care of their soils including the application of manure and compost in addition to undertaking crop rotation. In such a case they are already incurring costs to preserve the quality of their soils and thus they are not willing to pay but would prefer to be paid their conservation efforts.

A variety of regression approaches have been used to determine the factors influencing the WTP for an environmental good or service. The choice of the adopted regression model is however largely influenced by the nature of the WTP elicitation tool and the type of WTP responses obtained from field surveys. For example, with dichotomous choice WTP elicitation approaches, the influencing factors are modeled in the same model used to estimate the mean WTP for the sampled respondents (Carson and Haneman, 2005). Since the open ended WTP elicitation formats allow the mean WTP to be estimated directly, several regression approaches have been used to analyze the factors influencing the respondents WTP values. Some of the major regression models that have been used range from the ordinary linear regression to the

Tobit and the double hurdle regression approaches. Stepwise regression has also been used in the recent past (Ngigi et al., 2011).

For a censored dependent variable and where the occurs a high number of zero WTP responses, use of the OLS to estimation the WTP influencing factors results in biased and inconsistent estimates(Salazar and Koster, 2007, Gujarati, 2007 pg 616). Due to this, several higher level regression approaches are advocated for in dealing with open ended generated WTP data. These include the Tobit, the Double Hurdle Model and Heckman Sample Selection Models which are primarily used due to their ability to deal with existence of zero WTP responses either by virtue of truncation or censoring (Liebe et al., 2011). They take into account the zero WTP responses in the analysis of factors influencing the WTP values and analyze this influence in a two stage decision process i.e. first, the decision of whether or not to pay ("In-principle WTP") and finally, a decision on the magnitude of the payment to make towards the good or service in question (Liebe et al., 2011).

Conventionally, the Tobit regression model is used with a censored regression model for which there exist a large number of zeros in the dependent variable to deal with the biasness and inconsistency that would occur if the OLS was applied (Tobin, 1958). However, in the event of a low proportion of the dependent variables being zero, the estimates of the Tobit model and the OLS model tend to converge(Tobin, 1958; Cynthia et al., 1986 and Clevo et al., 2002). Indeed, the study undertaken by Clevo et al., (2002) found that in cases where the proportion of zeros in the dependent variables occurs below 25% of all dependent variables, there are no noticeable differences in the OLS and the Tobit estimates.

Given this finding by past studies, an analysis of the Stated WTP values from the socio-economic survey was undertaken. It was found that the proportion of observed zero WTP values in the study was below the recommended 25% i.e. 13.1%. This was attributed to the use of the Open Ended Iterative Bidding WTP elicitation approach which also results in continuous Stated WTP values. Indeed, after the elimination of protest bids during data cleaning and analysis, the proportion of observed zero WTP stated values further fell to 7.8%. Thus, the OLS was chosen as the preferred regression model as follows:

Final_WTP_Bid = βTot-land + βManure-Use + βAware Soil-lab + βHH_size+ βHHeadOccup + βComstatus + βMembr-Grp + βHhead-Exp + βLivestock + βTotl-laborers +

3.4 Data Collection Methods and Procedures

3.4.1Research Design and Data

A quantitative research design was used in this study. This involved the use of survey data in pursuit of the study's objectives. Both quantitative and qualitative primary and secondary data were collected.

3.4.2 Sampling Procedure

The multistage sampling approach was used in this study with the first step being purposive sampling of three study areas i.e. Mbooni, Kirinyaga and Mbuuri study clusters[9]. These study areas were purposively chosen owing to their importance with regard to the fresh produce for export production practices and importance to the country. At the same time, the three study clusters were chosen due to their similarity in terms of agricultural production practices especially for the fresh produce for export; as well as similarities in GLOBALGAP compliance approaches by the farmers in these areas. All the famers in the study area thus comprised the sampling frame for the study. The second stage of sampling was the clustering of

[9] Referred to as; Mbooni cluster, Kirinyaga Cluster, and Buuri Cluster respectively throughout the text of this document.

farmers into two key groups, i.e. growers of fresh vegetables for export and non-growers of fresh vegetables for export. The growers of fresh vegetable for export were then grouped according to their compliance arrangement with regard to the GLOBALGAP standards. Thus, three general clusters / groups of farmers were defined for each study area i.e. GLOBALGAP compliant growers of fresh produce for export, GLOBALGAP non-compliant growers of fresh produce for export and the non-growers of fresh produce for export. Having defined the different sets of clusters i.e. from the study area to the sub-groups of each study area, probability proportionate to size sampling was undertaken as the last stage of the multi-stage sampling approach utilized in this study.

Since this study used to different approaches in attaining its objectives, it is important to note that as mentioned earlier on, the households which were chosen for interviewing in Kirinyaga also had their soil samples collected and analyzed by a soil scientist so as to determine the cost estimates under the replacement cost methodology and thus the direct economic costs of changes in soil conditions. As such, for all the households that were sampled a pre-tested semi-structured structured questionnaire was used to elicit the households WTP amount using iterative bidding – open ended – CVM elicitation format. In addition to this, other data on the household were collected mainly relating to the quality of the households soil resource. In addition to this, the sampled households in Kirinyaga had their soils samples collected for analysis at soil testing laboratories in Nairobi.

In addition to the semi-structured question that was utilized during the data collection exercise for this study, some socio-economic data collected earlier on during the baseline phase of the larger study under which this particular study was tackling one of the key components was also utilized in the study. For purposes of understanding the WTP elicitation format used in this study, the WTP elicitation tool that was used in this study is provided as appendix 1 at the end of this document. For the replacement cost methodology, the data obtained from the analysis of farmers' soil samples was tabulated into an excel sheet and the averages of the three categories i.e. non-growers, the compliant growers and the non-compliant growers. These averages were then used to compute the replacement costs for the two categories of the compliant farmers and non-compliant farmers while comparing their soils to those of the non-growers.

The data obtained from the field survey was used together with the secondary data on farmer and farm specific attributes that had been collected earlier in a baseline survey of the study area. Data analysis was done using statistical software i.e. SPSS, and STATA.

4.0 RESULTS AND DISCUSSIONS

4.1 Descriptive Analysis

4.1.1Demographic Characteristics

The average sampled household in the study area is headed by a male aged about 48.94 years. In Kirinyaga, the average age of the household head is 49.50 years while for Mbooni and Buuri, they average household head are relatively younger at 48.13 and 48.90 years. On average, households in the study area have about 3.95, 4.60 and 5.88 members in Kirinyaga, Buuri and Mbooni respectively. The largest sampled household in the three clusters had 11 members while the least had 1 member. For the households with only one household member, they were either unmarried men in their 20s or senior citizens who were living alone with the rest of their families living either in urban centers or further away from their current location. This is supported by data on the age of household heads which shows that the minimum age was about 20 years old while the maximum age of the household head was about 97 years. In all the households, the proportion of women to men in the composition of the household ranged from 49% in Kirinyaga to 58% in Buuri and 69% in Mbooni. On average, the households in Kirinyaga had more men compared to women while the converse was true for Buuri and Mbooni. For the interviews conducted, approximately 57%, 61% and 47% of the respondents were the heads of the households in Kirinyaga, Buuri and Mbooni. This is shown in Table 2.

Table 2: Demographic Indicators for the Sampled Households by Cluster

Variable	Statistic	Kirinyaga	Buuri	Mbooni
Age of Household Head	Minimum	25.00	20.00	24.00
	Maximum	91.00	97.00	83.00
	Mean	49.50	48.90	48.13
	Std Error	13.61	14.25	13.53
Size of household (no of members)	Minimum	1.00	1.00	1.00
	Maximum	11.00	11.00	11.00

	Mean	3.95	4.60	5.88
	Std Error	0.12	0.16	0.20
Household composition by gender	N – Female - Male	111.00 112.00	80.00 57.00	98.00 44.00
	Percentage – Female - Male	49.80 50.20	58.40 41.60	69.00 31.00
	Minimum - Female - Male	1.00 1.00	1.00 2.00	1.00 1.00
	Maximum – Female - Male	11.00 9.00	11.00 8.00	11.00 11.00
	Mean – Female - Male	3.82 4.07	5.09 3.91	5.74 6.18
	Std Error – Female - Male	0.17 0.16	0.20 0.23	0.23 0.36
Household head interviewed	Yes (percentage)	57.40	61.30	47.90
Gender of Household Head (%)	Female Male	16.40 83.60	12.00 88.00	20.40 79.60

Source: Survey Data, 2010 - 2011

As such, it can be observed that there are slight variations in the demographic characteristics of the sampled respondents and especially with the gender dynamics and issues. Further, age is varies for the sampled respondents with sampled individuals ranging from 20 years old to 97 years old. Due to the wide variation in the age of sampled respondents, it was expected that age would somewhat have an effect on the stated WTP though caution had to be exercised to detect and eliminate its correlation with the farming experience of the respondent for existence of these would result in inconsistent and biased regression results.

4.1.2 Infrastructure Access and Proximity to Markets and Urban Centers

Previous studies have shown that infrastructure access is a key determinant of agricultural productivity and has an influence on the obtained rates of return from agricultural investments. Further, Pinstrup-Andersen and Shimokawa (2006) contend that the availability of appropriate rural infrastructure is a key factor in reducing the transaction costs associated with the agricultural sector. With good infrastructural access, it becomes easier for farmers to transport their produce and travel to urban centers for market information and input purchases thus lower transaction costs of accessing markets for inputs and outputs as well as for information. It is with this background in mind that various infrastructural access issues were evaluated among the sampled respondents. Table 3 shows the characteristics of respondents with respect to some infrastructural access characteristics.

Table 3: Infrastructure Access and Proximity to Market and Urban Centers

Variable	Statistic	Kirinyaga	Buuri	Mbooni
Cost of Transport the most important town (Kshs)	Minimum	5.00	20.00	40.00
	Maximum	500.00	500.00	400.00
	Mean	102.47	186.32	153.19
	Std Error	4.31	8.85	6.47
Distance to the Nearest Most Important Town / Urban Centre (Km)	Minimum	0.40	1.00	1.00
	Maximum	100.00	100.00	99.00
	Mean	9.32	21.22	15.93
	Std Error	0.61	1.45	1.48
Distance to the Nearest Health Centre (Km)	Minimum	0.20	0.10	0.50
	Maximum	26.00	32.00	50.00
	Mean	3.49	7.04	7.95
	Std Error	0.23	0.52	3.52
Distance to the Nearest Market Centre (Km)	Minimum	0.30	0.40	0.20
	Maximum	100.00	30.00	30.00
	Mean	4.33	5.85	6.11
	Std Error	0.50	0.46	0.42
Type of road from farm to nearest market (%of respondents)	Tarmac – All season	18.90	8.90	0.00
	Murrum – All season	8.60	5.20	7.10
	Murrum– Seasonal	68.90	76.30	92.90
Distance to the nearest fresh produce for export collection point (Km)	Minimum	0.00	0.00	0.00
	Maximum	10.00	8.00	15.00
	Mean	5.23	2.78	8.60
	Std Error	3.81	0.44	4.62
Distance to the main source of water for domestic use (meters)	Minimum	0.00	0.00	0.00
	Maximum	10.00	10.00	20.00
	Mean	0.32	0.80	0.78
	Std Error	0.06	0.74	0.17
Main source of water for domestic use (% of respondents)	River	22.90	8.10	10.10
	Well	6.90	0.00	17.30
	Protected spring	0.50	0.00	19.40

	Un-protected spring	3.20	1.50	46.80
	Borehole	2.80	0.00	0.00
	Piped	47.70	90.40	5.00
Main watering system for production of fresh vegetables for export (% of respondents)	Rain-fed	9.10	3.70	2.50
	Irrigation	90.90	97.30	97.50

Source: Survey Data, 2010 - 2011

On average, the sampled households are located 9.32, 21.22 and 15.93 Kms in Kirinyaga, Buuri and Mbooni respectively from the most important towns or urban centers and it costs them on average about Kshs 102, 186 and 153 respectively for a one way trip to the most important towns / urban centers. Commonly, all agricultural inputs and most agri-services will be found in most major towns and thus it can be seen that there is a substantial cost element associated with travel to the major urban centre for the Buuri cluster and the Mbooni cluster compared to the Kirinyaga cluster. Important to note is the fact that Kirinyaga has a larger number of urban centers compared to the other two study clusters. The sampled households are however relatively close to market centers in their immediate localities and this is principally attributed to the fact that in rural Kenya, almost every division and location has its own market centre. The farthest located households from the nearest market centers on average were those in Mbooni at 6.11 Km followed by Buuri and Kirinyaga at 5.85 and 4.33 Km. Seasonal Murrum roads are the most predominant road systems in all the clusters with the highest incidence being in Mbooni at 92% of the sampled households. The effect of the seasonality of transportation infrastructure has great implications on agri-produce marketing during the rainy season when these roads are made impassable thus leading to post harvest product losses and rejections.

For French beans production, the predominant production systems are irrigated with large percentages occurring in Mbooni and Buuri at 97% and above followed by Kirinyaga at 90%. This is mainly attributed to the fact that fresh vegetable production is a year - long production enterprise with 2 – 3 cropping seasons per year and thus the high reliance on irrigation for production so as to augment the natural rainfall patterns. On the other hand, the main sources of domestic water in the study area were found to be rivers and piped water in Kirinyaga at a combined total percentage of 70.60% while in Buuri, piped water was found to be the main source at above 90% of the sampled households. On the other hand, in Mbooni, unprotected springs, wells and protected formed the primary source of water for domestic use with a combined proportion of 83.50%. The rates of piped water connectivity were lowest in Mbooni at 5% and highest in Buuri at 90% while for Kirinyaga it was 46%. Access to clean and safe water for domestic uses forms a basic factor in influencing agricultural production as household members are not then forced to spend a lot of time looking for water for domestic water. This essentially is a time substitution factor for commitment of the household's labor resource to agricultural production, (Were, Swallow and Roy 2006).

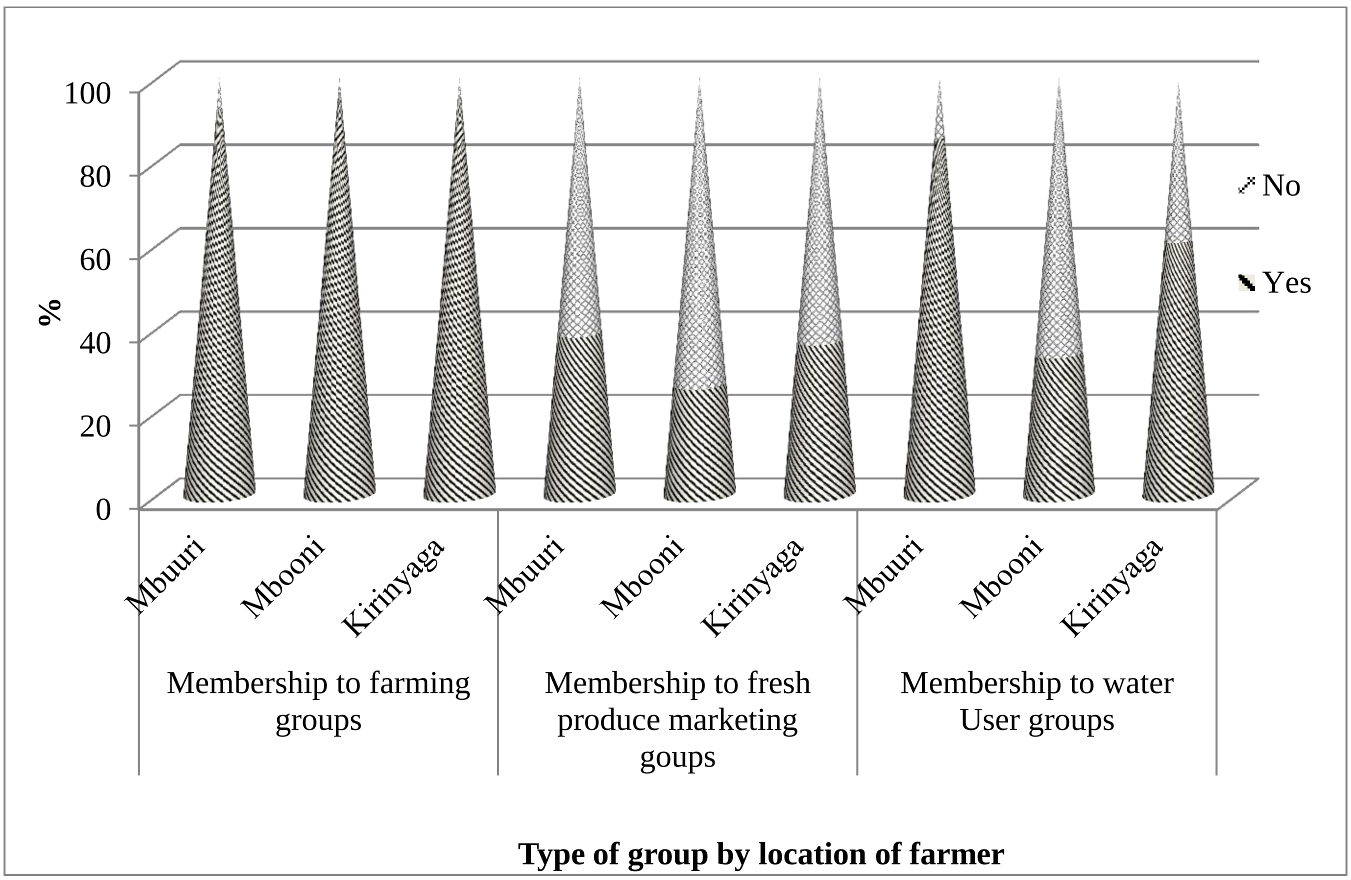
4.1.3 Human and Social Capital

Social capital is commonly defined as the "value of connectedness and trust between people" (Pretty, 2003). Social capital simply refers to the social inter-connectedness between individuals in societies with other individuals and peers, and the importance or value that they attach to those relationships. The importance of this form of capital has been ranked at the same level as that of the other forms of capital and studies have shown that households with a greater level of connectedness in society are more likely to derive higher incomes from their agricultural and economic activities (Acharya et al., 2010).While thought to have the same effect on agricultural productivity, human capital is defined differently from social capital with its definition focusing more on the capacity of the individual in terms of his expertise and knowledge. This is evident in Djomo and Sikod's (2012) definition of human capital as "the stock of competencies, knowledge and personality attributes embodied in the ability to perform labor so as to produce economic value".

Keeping in mind the effect of the two on agricultural productivity, this study focuses on the social and human capital among the sampled respondents in this section. Further, it evaluates them in the analysis of the factors that influence the total economic value of the changes in soil quality.

Figure 2 presents an overview of the socio-capital formations that the farmers are involved in and the proportion of the respondents in them.

Figure 2: Group Membership by type of group and by area of respondent



Source: Author, 2012

Table 4 shows that with regard to the fresh produce for export marketing groups, a majority of the farmers benefit from access to larger markets through these groups, and learning opportunities about better agricultural practices. Others also benefit from product bulking; pooled transportation to the city; meeting exporter requirements; collective purchasing of inputs and having greater bargaining power then it comes to price negotiations for their harvested produce.

Table 4: Social and Human Capital

Variable	Statistic	Kirinyaga	Buuri	Mbooni
Reasons for Membership in farming group (% of respondents)	Access to larger markets	48.90	57.90	42.90
	Learn better agri-practices	6.70	18.40	19.00
	Product bulking	4.40	2.60	9.50
	Exporter requirement	4.40	7.90	
	Collective transportation	-	7.90	-
	Collective purchase of inputs	13.30	2.60	4.80
	More bargaining power	20.00	-	19.00
Satisfaction with services offered by farming groups (% of respondents)	Satisfied	64.70	86.00	33.30
	Moderately satisfied	11.80	2.30	33.30
	Not satisfied	23.50	11.60	33.40
Hh member registered with the fresh produce for export marketing group	Hh Head	77.80	92.90	83.30
	Spouse	14.80	4.80	16.70
	Other member of the household	7.50	2.40	0.00
Hh head's education level (years)	Minimum	0.00	0.00	0.00
	Maximum	16.00	16.00	16.00
	Mean	8.04	8.03	7.86
	Std Error	0.28	0.35	0.37
Hh head's primary activity	Farming	84.50	85.80	70.20
	Salaried employment	5.00	2.20	11.30
	Self employed	5.50	5.20	7.80
	Laborer	3.20	4.50	8.50
	Retired	1.80	0.70	2.10
Hh head's farming experience (years)	Minimum	1.00	1.00	0.00
	Maximum	60.00	50.00	60.00
	Mean	20.17	18.53	20.01
	Std Error	0.88	1.00	1.03

Source: Survey Data, 2010 – 2011

For a majority of the sampled households, it is the household heads that are registered with the fresh produce marketing groups and a majority of the sampled households are satisfied with the services offered by these groups. A majority of the household heads in the sampled households are primarily farmers with the proportions being above 80% for Kirinyaga and Buuri while for Mbooni, 80% of the households are headed by farmers. For the sampled households, the farming experience of the households stretched from 0 – 60 years for Kirinyaga and Mbooni and 1 – 50 years for Buuri. Furthermore, the average household head is educated up-to the primary level of education though we have some with no education level at all while some have been educated up to the tertiary level of education principally being either post-secondary college or university.

4.1.4 Farm and Agro-enterprise Characteristics

On average, a normal household in the study area practices it's agricultural activities on about 2.86, 2.99 and 3.53 acres for Kirinyaga, Buuri and Mbooni respectively. Of these, less than an acre is rented-in land in Kirinyaga and Buuri while in Mbooni, this figure is less than 0.40 acres. Furthermore, the households in the study area have set aside about 0.22 to 0.35 acres of their land for the homestead and thus no agricultural activity can be practiced on this portion of land. For the available land size, the average Hh has about 3.53 to 4.55 laborers working on the farm with about 2 of the laborers being members of the household.

In reviewing the household land ownership data versus the total availability of the sampled households, a clearly discernible pattern emerges in that while the average land sizes are lowest in Kirinyaga, this cluster of respondents happens to have the highest average number of laborers per household. This is a possible indicator that the area's agricultural practices being more labour intensive and intensive in general compared to the other two clusters of Mbooni and Kirinyaga. This is shown in Table 5.

Table 5: Farm and Agri-enterprise Characteristics

Variable	Statistic	Kirinyaga	Buuri	Mbooni
Total Hh land (acres)	Minimum	0.13	0.25	0.25
	Maximum	13.50	23.00	20.13
	Mean	2.86	3.54	2.99
	Std error	0.16	0.32	0.23
Total farm labour (No)	Minimum	1.00	1.00	1.00
	Maximum	31.00	41.00	10.00
	Mean	4.55	3.81	3.53
	Std error	0.27	0.34	0.15
Family members working on farm (No)	Minimum	0.00	0.00	0.00
	Maximum	6.00	10.00	9.00
	Mean	1.85	1.83	2.15
	Std error	0.06	0.09	0.10
Rearing of livestock (%)	Livestock ownership	88.80	97.80	90.80
Growing of fresh produce for export (%)	Growers	55.60	66.40	70.40
Contractual arrangement for growing the fresh produce for export (%)	Contracted	50.70	55.40	67.10
Type of contractual arrangement (%)	Formal	70.00	68.6	49.00
	Informal	30.00	31.4	51.00
Contracted party for growing the fresh produce for export (%)	Hh head	79.40	89.40	75.00
	Spouse	16.20	8.50	22.90
	Other Hh member	4.40	2.10	2.10
Reason for opting to grow French beans under contract (%)	Assured Markets	57.10	77.80	71.40
	Easier credit access	6.30	11.10	2.00
	Access to quality inputs & information	6.40	4.40	10.20
	Better and stable prices	30.10	6.70	14.30
Awareness with GLOBALGAP standards (%)	Aware	96.00	100.00	97.20
Compliance with compliance standards (%)	Compliant	36.20	43.10	35.20

Source: Survey data, 2010 – 2011

About 97% and above of the sampled respondents keep livestock on their farms either on a subsistence or a commercial basis. Livestock keeping is in particular an important aspect of this study considering manure is more easily available to livestock keeping households. Organic manure provides an appropriate mechanism for replenishing soil nutrients and improving soil structure where a lot of synthetic fertilizer has been applied for a long time. At the same time, a majority of the sampled households were growers of fresh produce for export. However, while a majority of the sampled respondents are aware of the GLOBALGAP standards, it is only a very low proportion of those sampled that were compliant with these standards. When evaluating compliance by study cluster, Buuri had the highest level of compliance at 43% while Mbooni had the lowest rate at 35% of the sampled respondents.

Among the growers of fresh vegetables for export, the study further sought to evaluate the contractual arrangements within which these crops are grown and marketed. From the analysis and as can be seen from table 5, over 50% of the growers of fresh vegetables for export are in some form of contractual arrangement. 70% and 68.6% of the sampled households in Kirinyaga and Buuri respectively are in formal contracts with buyers of their produce while in Mbooni, this figure is much lower at 49% of the respondents. In all the cases, the household Head is the predominant contracted individual at 75% - 85% of the households. The predominant reason that the sampled households cite for being in a contractual engagement for growing of fresh produce is to guarantee markets for their produce. Other reasons were cited as being easier access to credit, access to agro-inputs and extension information and for stable and higher farm gate prices for their produce.

4.1.5 External Support Accessed by the Sampled Households

Farmers operate within a broader economic and policy context and the effectiveness with which the overarching policy under which the farmer operates is highly likely to influence the outcomes of his production activities. Some of the outcomes that will be influenced by the effectiveness of the policy context within which the farmer operates include his access to and use of agricultural inputs including the level of efficiency and timeliness in using them, the safeness of the resultant agricultural produce and whether or not it will be fit for human consumption or for export in this matter. Furthermore, given the extension approach by the relevant provider and indeed the content of the extension advice, the farmer's agricultural production practices will be impacted upon and consequently his environment. Another key external assistance that farmers will usually receive in any production system and this is again influenced by the broader economic and policy environment include access to credit and the rates of interest payable. With access to credit, factors such as the collateral required will influence the ability of farmers to utilize the available credit facilities. Availability and affordability of credit influences use and adoption of better agricultural technologies including use of agro-chemicals and superior seed varieties. With this in mind, this section reviews the external assistance that the sampled households receive.

Access and Utilization of Credit in Agriculture

From Table 6, it is evident that between 43 to 54% of the sampled households have utilized credit in their agricultural activities with a majority of those utilizing credit (between 50 – 76%) using it to finance compliance with GLOBALGAP standards. This in turn is expected to be a determinant in their expectations vis a vis the agricultural productivity and returns on their agricultural enterprises. Obtained credit can either be used to finance components of the agri-enterprises that directly lead to higher productivity e.g. purchase of inputs such as fertilizer and higher yielding seed varieties or, in components that have no direct effect on agricultural productivity such as building grading sheds or purchasing protective clothing. In the face of intangible or indirect benefits that farmers can relate to the credit used in agriculture, then there is a possibility that the use of credit determines the degree of agricultural resource exploitation in an effort to recoup the externally funded investments in the agri-enterprise.

Table 6: Access and Utilization of Credit in Agriculture

Variable	Statistic	Kirinyaga	Buuri	Mbooni
Utilization of credit in agriculture (%)	Credit used for farming	43.50	45.30	54.20
	Credit used for compliance	50.00	75.80	60.50
Major form of credit (%)	Monetary	25.50	55.60	18.20
	Inputs and farming materials	66.30	44.40	79.20
Source of credit (%)	Agricultural Finance Cooperation	0.00	6.30	1.30
	Exporters / buyers	43.40	39.70	70.50
	Commercial banks	9.10	6.30	2.60
	Donors / Micro-finance institutions (MFI)	3.00	6.30	2.60
	Farmer groups	4.00	12.70	6.40
	Family and / friends	16.20	19.00	7.70
	Input dealers	14.10	4.80	2.60
Reason for not using credit in farming (%)	No need for credit	38.70	36.50	29.40
	Lack of collateral	8.00	13.50	5.90
	Not a member of the MFI	1.30	1.90	23.50
	High cost of credit	21.30	13.50	17.60

Source: Survey Data, 2010 – 2011.

Exporters/brokers, friends/family and input dealers are the top most cited sources of agri-credit among the sampled respondents with a big proportion of the credit predominantly being in form of agric-inputs and farming materials. Given that most of the credit received was primarily in form of inputs, it would be expected that the farmers would be realizing higher yields as a result of utilizing productivity increasing inputs. However, there is need to exercise caution in this interpretation due to the fact that since the credit received is mostly non-interest charging sources, farmers do not get to factor in the true costs of obtaining credit into their gross margins. As such, there might be a possibility that with access to relatively cheaper credit, farmers overuse or misuse the agro-inputs resulting in pollution and environmental degradation. For this reason, the effect of access to credit will be a key variable to watch and especially the direction in which it influences the WTP for changes in soil quality.

Access to Agricultural Extension

Between 56 – 68% of the sampled households had benefited from extension contacts for their farming activities thus showing a relatively high coverage of extension service providers in the study area. From Table 7, it can be seen that the government, exporters, and agri-input dealers are the main providers of agricultural extension information in the study area. The three sources collectively account for between 76 – 89% of the extension contacts made in the study area in the past one year. Extension advice received by farmers covered the areas of product handling, pest management, soil and water use, chemical handling, record keeping and field hygiene. From water user groups, farmers received extension advice on water cleaning for irrigation and domestic use, and water analysis.

Table 7: Access to agricultural extension services

Variable	Statistic	Kirinyaga	Buuri	Mbooni
Extension contacts (%)	Hhs that received	56.50	63.50	68.30
Farmer's extension provider (%)	Government	44.50	47.10	50.50
	Exporter / broker	22.70	23.00	16.50
	Input dealers	9.40	18.40	13.30
	NGO/Donor	5.50	6.90	1.00
	Farmer groups and cooperatives	8.60	1.10	5.10
Type of extension advice received (%)	Product handling	9.50	4.60	6.40
	Pest management	11.10	14.90	11.70
	Soil and water use	0.80	6.90	2.10
	Chemical handling	11.10	24.10	1.10
	Record keeping	0.80	-	1.10
	Field hygiene	1.60	1.10	-
Extension services provided by water user groups (%)	Water analysis	6.70	1.70	4.50
	Water cleaning	17.90	19.10	9.10

Source: Survey Data, 2010 - 2011

4.1.6 Soil Nutrient Management

The fertilizers used in Kenya are mostly compound fertilizers reformulated in the country by fertilizer dealers. There are two main groups of Nitrogenous fertilizers that are used in the study area i.e. the acidic fertilizers (DAP & NPK) and the non-acidic fertilizers (CAN). NPK is slightly less acidic compared to DSP / DAP and thus where the soils are highly acidic, it is recommended that either NPK which has a milder acidic effect or CAN be used as sources of Nitrogen for the crop. The importance of Nitrogen to fresh produce for export and for crops in particular will not be reviewed in this study as it is considered to outside the purview of this study. However, it is important to mention that often, Nitrogen has been found to be a deficient mineral element in the country. Furthermore, with continuous cropping, soil nutrients tend to be exhausted over time thus necessitating the supplementation of soil nutrients with chemical fertilizers.Table 8 shows a brief overview of fertilizer use by the sampled respondents.

Table 8: Soil Nutrient Management Strategies by the Sampled Households

Variable	Statistic	Kirinyaga	Buuri	Mbooni
Fertilizers used (%)	DAP	17.00	46.70	7.00
	NPK	57.40	41.60	46.50
	CAN	59.20	63.50	53.50
	Manure	41.70	24.80	37.30
Average fertilizer amount used (kgs)	DAP / DSP	30.82	39.65	26.11
	NPK	26.46	28.75	17.67
	CAN	29.32	31.33	19.35
Average fertilizer price per Kg (Kshs)	DAP / DSP	56.20	61.05	62.78
	NPK	53.17	55.60	57.77
	CAN	43.22	49.17	47.26

Source: Survey Data, 2010 – 2011.

From Table 8, it can be seen that of the three fertilizer types outlined above, a majority of farmers in Kirinyaga and Mbooni use NPK while slightly the same proportion of farmers in Buuri use DAP and NPK i.e. at about 46% for DAP and 41% for NPK. On the other hand, a majority of farmers reported using CAN in their farming practices and this is thought to be due to not only the need to replace lost Nitrogen and calcium but to also be gentler on the soil ph condition so that it does not become more acidic even as lost nutrients are replenished in the soil.

On average, the sampled households used about 32 Kgs of DAP, 24Kgs of NPK and 25 Kgs of CAN for farming of fresh vegetables for export. The highest application rates were observed in Buuri, followed by Kirinyaga and Mbooni. Given the observed low fertilizer application rates, it means that the farmers purchase low quantities of fertilizer and use them for all their cropping requirements. Thus, the fertilizer application rates are somewhat low in the study area. For every kilogram of DAP, the farmers incurred an average cost of about Kshs 60 as purchase costs while for NPK and CAN, the average costs were Kshs 55 and 46 respectively.

4.1.6 Soil Nutrient Levels in Kirinyaga

As has been indicated elsewhere in this write-up, the soil analysis data was collected in the greater Kirinyaga District which basically comprises Kirinyaga East, Kirinyaga South and Kirinyaga West. Further, the soil (chemical element) parameters that were analyzed in computing the replacement costs were; the total N% as a proxy for available N% in the soil, the organic C%, the Phosphorus level in parts per million, the Potassium, Calcium and Magnesium levels in milli-equivalent %. While the Sodium levels were also evaluated, they were found to occur in trace amounts and thus they were not used in computing the replacement costs. Further, for the PH computations, the exchangeable acidity levels in milli-equivalent % were used to compute the liming requirements and thus the contribution of liming costs to the replacement costs.

For all the sampled farms, the soils were found to be moderately acidic with the average ph being 5.67. However, when analyzed by divisions and by compliance status, the non-growers soils were found to be slightly less acidic compared to those of fresh export vegetable growers followed by the compliant farmers and thus the non-compliant farmers' soils were found to be the most acidic across all divisions. However, the soils in Kirinyaga East were found to be the most acidic followed by those of Kirinyaga West and thus those of Kirinyaga South were found to be the least acidic. This is shown in Table 9. However it should be noted that just a cursory glance at this figures does not portray the true picture as at the end of the day we need to ask whether this differences in soil quality attributes are significantly different.

Table 9: Cross-Tabulations of the Average Parameter Levels by Location and by Compliance Category

Category	Average of pH	Average of Total N %	Average of Organic C %	Average of P ppm	Average of K me %	Average of Ca me %	Average of Mg me %
Kirinyaga East	5.3752	0.1743	1.7774	5.6905	0.6350	8.2762	4.6429
Compliant	5.3805	0.1714	1.7157	111.0952	0.7095	7.8762	4.9576
Non-compliant	5.3523	0.1738	1.8485	70.2308	0.5377	8.8154	4.7731
Non-grower	5.3988	0.1825	1.8238	96.6250	0.5975	8.4500	3.6050
Kirinyaga South	5.8811	0.1611	1.7686	100.7200	1.4720	7.8768	4.6774
Compliant	5.8726	0.1661	1.8578	126.6304	1.7287	8.1478	5.1483
Non-compliant	5.8297	0.1568	1.7237	92.1905	1.3178	7.4698	4.6351
Non-grower	5.9692	0.1651	1.7885	99.2179	1.5697	8.3744	4.4682
Kirinyaga West	5.4756	0.1629	1.5651	95.5714	0.6140	7.8778	4.3895
Compliant	5.4747	0.1713	1.5847	95.0000	0.6481	8.6375	4.3931
Non-compliant	5.4245	0.1400	1.4845	92.3636	0.3982	5.2000	4.0436
Non-grower	5.5050	0.1620	1.5780	98.2500	0.6780	8.1350	4.5740
All	5.6777	0.1640	1.7144	98.3913	1.0841	7.9500	4.5923
Compliant	5.5691	0.1697	1.7036	109.0197	0.9921	8.2789	4.7776

Non-compliant	5.7735	0.1591	1.7320	89.9651	1.0976	7.4698	4.6342
Non-grower	5.7625	0.1663	1.7299	98.6194	1.1875	8.3119	4.3967

Source: Author, 2013; Mnyambo, 2012.

Towards this, the soil quality attributes were analyzed for differences in their mean / average values by categories i.e. growers vs non growers and the compliant vs the non-compliant farmers. As can be seen from Table 10, when this comparison is made between growers and non-growers, none of the evaluated soil quality attributes are significantly different between these two groups. However, when the same attributes are compared between the compliant and compliant farmers, the soil ph level, Nitrogen level and the phosphorus are found to be significantly different while the other attributes are not.

Table 10: Mean Difference Test for Soil Quality Attributes

Soil quality attributes	Growers vs Non-growers		Compliance vs Non-compliance	
	T statistic	Mean Difference	T statistic	Mean Difference
PH level	(1.4805)	(0.1198)	(2.0846)**	(0.1622)
Total Nitrogen %	(0.6317)	(0.0032)	1.7606*	0.0086
Organic Carbon %	(0.3751)	(0.0218)	(0.2901)	(0.0163)
Phosphorus (ppm)	(0.0368)	(0.3219)	1.8937*	15.8736
Potassium (me %)	(1.2368)	(0.1458)	(1.2067)	(0.1374)
Calcium (me %)	(0.7202)	(0.5107)	0.7733	0.4913
Magnesium (me %)	1.2138	0.2759	1.2612	0.2769

*** - Significant at the 1% level of significance

** - Significant at the 5% level of significance

* - Significant at the 10% level of significance

Source: Author, 2013

For the other soil parameters, results were mixed across the various categories depending on division and on compliance status. However, for purposes of computing the replacement cost estimates, the baseline category will be the non-growers and thus the estimates so obtained will be either negative or positive depending on the category's mean for the parameter relative to the non-growers average level.

4.2 Direct Economic Value of Changes in Soil Quality

In computing the replacement cost estimates, various assumptions had to be made. These are:

- The soil parameter estimates for the non-growers represents the status quo. As such, the observed variation of the non-compliant farmers and the compliant farmers is due to the variation in agricultural practices occasioned by growing fresh vegetables for export and by compliance with GLOBALGAP standards. Consequently, the resultant replacement costs will either be positive or negative given the influence of the two factors on the farmers' soil nutrient management practices. However, only the positive differences (where the soil quality attributes show lower levels compared to the non-growers) will be considered in computing the replacement as we only replace what is lacking and not that which is in excess.
- The soil nutrient and by extension the fertilizer requirements are computed based on the assumption of one hectare of land with a soil depth of 15 centimeters and thus about 2,000 tonnes or 2,000,000 kgs of soil. This is very important in computing the soil nutrient restoration rates for the farmers' soils.

Based on the second assumption, various formulae were applied in determining the replacement costs for the restoring the soils of the non-compliant and the compliant farmers to the same status as that of the fresh export vegetables non-growers.

➢ The first of these was applied with a view to computing the differences in parts per million among the various categories to give the basis for determining the replacement quantities. For the reported values (in milli-equivalents %) of Potassium, Calcium and Magnesium the formula applied was as follows:

$$Z\ ppm = Z\ me\ \% \ * Atomic\ Weight * 10 \tag{12}$$

with$Z$ being the reported elemental quantity in milli-equivalent % (Jacobsen and Lorbeer, 1998).

- For the reported values of the total Nitrogen levels, the following computations were used. For Nitrogen, it was assumed that of the total N content of the soil, only approximately 3% of it is in a form that would be available to a crop for uptake while the rest would exist in form of organic matter. Since the amount of Carbon is the proxy for the organic matter content of the soil, then the objective was to only restore the available N to the levels of the non-growers. The computations were:

$$\text{Avail N\%} = 3\% * \text{Tot N\%} \tag{13}$$

The Nitrogen requirement in parts per million was consequently computed as:

$$X = \frac{1{,}000{,}000 * AvailN}{100} \tag{14}$$

where, X is the Nitrogen requirement in parts per million.

With the one hectare of land at a soil depth of 15 cm that is assumed in this study, the Nitrogen requirement per ha of farm land would thus be the figure *X* obtained above multiplied by two.

- Since the values for phosphorus had been reported in parts per million, the differential figures were multiplied by two to obtain the replacement quantity requirements for one hectare of farm land.
- For ph restoration, the following formula from Hoskins, (1997) was used:

$$Limingrequirement(poundsperacre) = ExchangeableAcidity * 1000 \quad (14)$$

To obtain the liming requirement in Kgs / ha, the liming requirement obtained above in pounds per acre should then be multiplied by 1.0214 and thus the formula above can be modified as shown in equation 15:

$$Liming\ Requirement\ (kgs/\ ha) = Exchangeable\ Acidity * 1000 * 1.0214 \quad (15)$$

Using these formulas, the amounts of replacement materials for the compliant and non-compliant farmers were computed with a view to restoring the quality of these soils to those of the non-growers, the studies comparative group. Further, the associated costs of the identified replacement materials was also computed based on an assumption of a uniform price for a 50 kg bag of fertilizer at Kshs 2,000/=. Table11shows the figures subsequently obtained for replacing the soil nutrient levels to the status of the non-growers soils per acre of land owned by the farmer.

Table11: Soil Nutrient Replacement Quantities and Costs

Soil Quality Replacement Parameter	Replacement Quantities (Kgs) / Acre of Farm Land[10]		Replacement Costs (Kshs) / Acre of Farm Land	
	Non-compliant Farmers	Compliant Farmers	Non-Compliant Farmers	Compliant Farmers
Agricultural Lime ($CaCO_3$Eqvlts)	(93.97)*	81.71	-	1,123.60
Nitrogen (N)	1.73	(0.83)*	358.80	-
Organic C%	(17.01)*	210.38	-	28,051.20
Phosphorus (P)	6.92	(8.32)*	1,384.80	-
Potassium (K)	28.05	60.95	2,337.60	5,079.20
Calcium (Ca)	134.75	5.28	35,291.20	1,382.40
Magnesium (Mg)	(22.80)*	(36.57)*	-	-

[10] Where we have a *, the soil parameter levels were higher for the particular compliance category and thus there is no need for replacement of that particular soil element for the compliance category in mind.

Total Costs	**39,372.40**	**35,636.40**

Source: Author, 2013

Besides the replacement materials purchase costs, the farmer will also incur additional costs associated with transportation of such materials to the farm from the purchase point. Further, the farmer will also incur costs associated with the application of such replacement / restoration materials into the respective farmer's farmland. Table 12 shows the transportation and application cost approximations based on the mean transport cost of 100 kshs/50kg bag (102.47Kshs but we use 100 kshs for farmers in Kirinyaga County), and a mean daily income levels of 313 kshs / full day worked but we assume that the application of 50Kgs of fertilizer takes about a quarter of a day thus approximately 80 Kshs/50 kg bag of fertilizer.

Table 12: Replacement Material Associated Transport and Labor Costs

Replacement Material	Transport Costs		Labor Costs	
	Non-Compliant (kshs)	Compliant (kshs)	Non-Compliant (Kshs)	Compliant (Kshs)
Liming Materials	-	163.42	-	130.74
Nitrogen	3.46	-	2.76	-
Organic Carbon	-	420.77	-	336.61
Phosphorous	13.85	-	11.08	-
Potassium	56.10	121.90	44.88	97.52
Calcium	269.50	10.56	215.60	8.45
Total	**342.90**	**716.66**	**274.32**	**573.32**

Source: Author, 2013

The total direct economic costs of the changes in soil quality were obtained by aggregating these costs and thus, the total direct economic costs for the non-compliant and compliant farmers areKshs39, 989.62/acre and Kshs 36, 926.38/acre respectively. For both the compliant and non-compliant farmers, a bulk of the direct economic value of soil quality are attributed to the cost of the soil quality replacement materials as a result of the high prices of inorganic fertilizers in Kenya.

However, for the non-compliant farmers, a major portion of their replacement materials cost arises from the costs required for replacing calcium in the soils. On the other hand, a major portion of the costs for the replacement materials costs for the compliant farmers is attributed to the costs that would be incurred in restoring the organic matter / Carbon content of the soil.

Table 13: Total Replacement Costs

Cost Stream	Non – Compliant Farmers (Acre)	Compliant Farmers (Acre)
Replacement Materials	39,372.40	35,636.40
Transportation	342.90	716.66
Labor	274.32	573.32
Total Costs	**39,989.62**	**36,926.38**

Source: Author, 2013

An important angle of this study and for most environmental valuation studies is the fact that changes in soil quality as any other changes in the quality of an environmental resource have a time aspect to them. This is attributed to the fact that changes in soil quality due to compliance with the GLOBALGAP standards has occurred over time. Further, the use of soil nutrients by plants takes place over time and if not replenished, the soil is degraded. Thus degradation of soil nutrients can be slowed or reversed with the application of soil nutrients gradually. Where an intervention is made to reverse changes that have occurred over a longer time span, there is need to compute the time aspect of the intervention e.g. the cost that would be incurred if the intervention was taken on an annual basis as is the case with most fertilizer application practices.

In incorporating the time dimension in the computed replacement costs, the knowledge of the existence of these standards, compliance with the standards and the period that the farmer has been growing French vegetables for export are important determinants. From the socio-economic baseline survey undertaken a year before this study was undertaken, the farmer who has the earliest knowledge of the existence of standards in fresh vegetables for exports, professes to have first heard of them 20 years ago. However, the farmer who has complied longest with GLOBALGAP standards has complied with the standards for a maximum of 16 years. Indeed, studies show that compliance with international standards may have started in the 1980s in Kenya. Further, the earliest growers of fresh vegetables of export are reported to have been growing the fresh vegetables for a period of between 25 – 30 years.

Due to lack of uniformity in the compliance period, or even in the awareness of the existence of these standards as well as in the period of growing fresh vegetables for exports coupled with non-continuity in growing fresh vegetables for exports, a subjective time horizon has to be adopted in determining the annual replacement costs. However, at the end of the day, adopting shorter time horizons will result in higher annual replacement costs while longer time horizons will result in lower annual replacement costs. Adopting a time horizon of 15 years during which it is assumed that the changes in soil conditions have occurred, the annual replacement costs for the compliant farmers and non-compliant farmers becomes Kshs 2,461.76 and Kshs 2,665.97 respectively.

4.3 Total Economic Value of Changes in Soil Quality

4.3.1 Estimated Mean Willingness to Pay

The open ended iterative bidding approach to contingent valuation was used to elicit individual WTP values from which the mean willingness to pay for all the sampled farmers and for the various farmers categories sampled was computed. From table14, it can be seen that the estimated mean willingness to pay for all the sampled respondents stands at Kshs 2,166.15 per acre per year. It can also be seen that generally, the compliant farmers have a higher estimated mean willingness to pay (estimated at Kshs 2,523.63 per acre per year) compared to the non-compliant farmers (estimated at Kshs 1,953.26 per acre per year).

Table 14: Estimated Mean Willingness to Pay

Study Area	Compliance Status	Estimated Mean Max WTP (/acre/year)	Std. Deviation	Max Stated WTP (/acre/year)
Kirinyaga	Compliant	2,621.69	1,819.04	1,1760.00
	Non-compliant	1,993.15	1,700.31	1,1408.00
Buuri	Compliant	2,611.69	2,432.32	10,000.00
	Non-compliant	2,066.64	1,588.49	6,000.00
Mbooni	Compliant	2,743.29	1,813.84	6,000.00
	Non-compliant	2,216.00	1,689.85	6,000.00

Source: Author, 2013

When evaluated across compliance categories, the non-compliant farmers had the lowest mean willingness to pay for changes in soil quality followed by the GLOBALGAP compliant farmers. This indeed confirms the apriori expectations that GLOBALGAP standards compliant farmers not only practice different agronomic practices but also have different income levels from the non-compliant farmers. Further, this variation can also be attributed to the compliant farmers perhaps receiving a different extension package compared to the non-compliant farmers or practicing somewhat different agricultural practices from the non-compliant farmers. Further, the requirement for them to use more environmental friendly agro-chemicals as part of the compliance regime might have resulted in them appreciating the economic value of their environment.

When evaluated across locations, the farmers (both compliant and non-compliant) show some variation in their stated maximum WTP with the farmers in Mbooni having the highest Mean Maximum WTP responses followed by those in Buuri and those in Kirinyaga. Considering that Mbooni's agro-climatic conditions are harsher compared to those of Kirinyaga, it is probable that agro-climatic conditions have an influence on the stated maximum WTP.

A fundamental question that then arises is whether there exist statistically significant differences between farmers who are either compliant or non-compliant with the global gap standards. The same question can be asked with regard to farmers who are either growers or non-growers of fresh vegetable produce for export in Kenya. To address this question, the study went a step further and evaluated the statistical differences between these two sets of populations i.e. the compliant vs non-compliant farmers and the growers vs non-growers of fresh vegetable produce for export. As can be seen in Table 15 below, various factors were found to be significantly different between the two sets of populations. Most importantly, the mean stated willingness to pay was found to be statistically significant between the compliant and non-compliant farmers and between the growers and non-growers of fresh vegetable produce for export.

Table 15: Mean Difference Test by Compliance Status and Whether the Farmer Grows Fresh Produce for Export

	Compliant vs Non-compliant Farmers			**Growers vs Non-growers of Fresh Vegetables for Export**		
Attribute	***T - statistic***	***Significance - 2 tailed***	***Mean Difference***	***T – statistic***	***Significance - 2 tailed***	***Mean Difference***
Tot-land	.185	.854	.050	1.023	.307	.283
Manure-use	1.091	.276	.049	-.062	.951	-.003
Aware Soil-lab	1.125	.261	.035	.015	.988	.000
HH_Size	3.016	.003	.582	-2.772	.006	-.536
HH_hd_age	-1.842	.066	-2.352	4.128	.000	5.391
HHeadOccup	-1.786	.075	-.064	.372	.710	.014
HHead_Sex	-1.199	.231	-.040	.922	.357	.033

HH-income	1.404	.162	299.889	-1.652	.010	-213.421
Membr-Grp	3.137	.002	.055	-2.163	.031	-.049
HHead-Exp	-.843	.310	-.929	2.217	.027	2.660
Livestock	2.334	.020	.054	-1.510	.132	-.040
Totl-Laborers	2.441	.015	.805	-3.899	.000	-1.094
DistInptshp	-1.260	.208	-.474	1.223	.222	.461
Transpt-costs	.603	.547	5.011	-4.765	.000	-35.325
RoadType	-1.933	.054	-.131	-2.155	.032	-.146
Extensncntact	9.232	.000	.372	-1.971	.049	-.090
TakeCrdt	15.581	.000	.575	-6.011	.000	-.263
Importance	-3.596	.000	-.281	4.082	.000	.318
Stated WTP Value (final bid)	3.287	.001	556.941	-2.774	.006	-471.869

Source: Author 2013

4.4.1Factors Influencing the Total Economic Value of Changes in Soil Conditions

In analyzing factors that influence the total economic value of changes in soil conditions, the OLS regression model was applied. Both economic and non-economic factors are thought to influence the WTP values of individuals with no particular indication of the factors to watch out for except the economic factors. The expected sign refers to the direction in which these factors are expected to influence the WTP estimates and ultimately the total economic value depending on their impact on household income and environmental quality. Indeed, the effect/ influence will interact highly with the respondents' utilization of the environmental resource in question and their ability to perceive changes in environmental quality. The variables as used in this study and their anticipated influence on the total economic value of changes in soil quality (based on past studies) are shown in Table 16.

Table 16: Variables Used in the OLS Regression Model and their Expected Signs

Variable code	Description	Expected sign
Tot-land	Total household Land - the control of the household both owned and rented in excluding what is rented out in acres	-
Manure-use	Use of Manure by the household in their farming activities (0 do not use, 1 use manure in farming)	-

Aware Soil-lab	Awareness of nearby soil testing labs (0 not aware, 1 aware)	+
Grow	Growing of fresh vegetables for export (0 non growers, 1 growers)	+ / -
HH_Size	The size of the household in terms of the number of members that make up the household	+/-
HH_hd_age	Age of household Head in years	-
HHeadOccup	Occupation of household Head (0 farming, 1 not farming)	+
Comstatus	Global gap compliance status (0 non-compliant. 1 compliant)	-/+
OrgMbr	Membership to water users group (0 no, 1 yes)	-/+
HHead_sex	Respondents gender (0 male, 1 female)	-
HH-Income	Annual Household income (in Kenya shillings	+
Membr-Grp	Household membership to a farming group (0 no, 1 yes)	-/+
HHead-Exp	Farming experience of the household head in years	-
Livestock	Household ownership of livestock (0 does not own, 1 owns)	-
Totl-Laborers	No of farm laborers	+
DistInptshp	Distance to the nearest input shop in kilometers	+
Transpt-costs	Transport costs to nearest major urban center in Kenya shillings	+
RoadType	Type of road to nearest market center (0 seasonal, 1 all-weather road)	+
Extensncntact	Household contact with extension service providers (0 no, 1 yes)	-
TakeCrdt	Use of credit in farming (0 no, 1 yes)	+
Importance	Importance of the SQCIMP (0 not important (important)	+
Buuri	Respondent from Buuri (0 no, 1 yes)	N/a
Mbooni	Respondent from Mbooni (0 no, 1 yes)	N/a

Source: Author, 2013

The size of the farm holding under the direct control of the household affects the household's risk and income diversification strategies. With bigger land sizes, households are likelier to practice crop rotation and thus alternating between crops with high nutrient requirements with those that can be used to recycle soil nutrients. Land size is thus expected to have a negative influence on the households' WTP values. Other resource endowments such as livestock will also have the same effect as land on the WTP due to the fact that they present an income stream away from crops for the farmer.

At the same time, the use of manure by the household in cropping activities is supposed to have a negative effect on the stated maximum WTP values as this represents efforts by households to take better care of their soils. As such, since they are already doing it, households are likely to have a lower stated maximum WTP since the hypothetical scenario posed is premised on the soil conservation advice given to households. Closely associated with farming practices is household head's farming experience since it is expected that farmers who have been farming for longer periods of time know and appreciate the value of the soil resource and are thus taking better care of their soils. Furthermore, they have with time mastered the art of taking care of their soils and have benefited from years and years of extension advice. They are thus likely to have a negative WTP for an externally driven mechanism for something that they have already mastered. The age of the household is expected to have the same influence. The number of laborers are engaged by the household in farming activities whether from within or outside the household is expected to positively influence the stated maximum WTP values due to the fact that they are indicative of more intensive agricultural practices and thus efforts towards maintaining the quality of soil and by extension its productivity will be welcome.

Consistent with past CVM studies, this study anticipated apriori that the income earned by the household will positively influence the value estimates from each households. Closely linked to household income is the primary occupation of the household head. In cases where the household head is primarily engaged off-farm, the stated economic value of changes in soil quality are expected to be higher as the household has relatively higher disposable and more assured incomes. Furthermore, the importance that the respondent attaches to the hypothetical scenario will have a positive influence on the total economic value for changes in soil quality. On the other hand, use of credit in agriculture will have a positive influence on the total economic value of changes in soil quality as the availability of external sources of money whether at a fee or not is usually interpreted by most households as an increase in their disposable income. Furthermore, since the credit was obtained for farming, the households would feel less guilty about using it to pay for the changes in soil quality through the hypothetical scenario posed to them.

Factors relating to external farm support to the household such as extension contacts are expected to have a negative effect on the economic value of changes in soil quality since by precedence, the farmers are being shown how to conserve their soils. As such, farmers who have received extension contacts are likely to have lower economic values for the resource in question. However, the principle assumption in the apriori expectation is that soil management practices are a component of the extension package. The more the distance to agro-input shops the higher is the expected economic value of changes in soil quality as better soils in such a case represent a cost reduction strategy as less fertilizer would be required for well-maintained soils. Simply put, the possibilities for risk and income diversification are lower for those farmers who are further away from agro-input shops and indeed from urban centers. For the same reason the transport costs to the major urban centre will positively influence the economic value of changes in soil quality.

This study did not have any apriori expectations on the influence of the compliance status and on whether the households grows or does not grow French beans. This is principally attributed to the fact that it is not concretely known what the impacts of being compliant with GLOBALGAP standards is, in terms of the environmental and specifically soil quality effects. Thus while compliance has been reported to have a positive effect on farmer health, we posited at the beginning of this stage that the benefits of compliance with GLOBALGAP standards may not stretch to the farmer's environment. Indeed, this aspect was a key study objective and thus the results will be contextualized accordingly. Other factors for which no apriori expectations existed were; membership to water user groups and farming groups as well as the dummy variable capturing the location of the respondent.

In evaluating the influence of the various factors on the farmers' total economic value of soil quality, this study took cognizant of the fact that farmers in the surveyed areas might be inherently different owing to their location. To probe the locational related differences between the three groups of respondents, an independent sample t-test (mean difference test was undertaken whereby the various farmer and household specific attributes were compared. As can be seen in Table 17, various factors were found to be significantly different given the geographical location of the responded.

Table 17: Mean Difference Tests by Study Area

Attribute	**BuurivsMbooni**			**KirinyagavsBuuri**			**KirinyagavsMbooni**		
	T - statistic	*Significance - 2 tailed*	*Mean Difference*	*T - statistic*	*Significance - 2 tailed*	*Mean Difference*	*T - statistic*	*Significance - 2 tailed*	*Mean Difference*
Tot-land	3.040	.003	.935	-3.779	.000	-1.025	-.263	.793	-.090
Manure-use	2.232	.026	.123	-2.913	.004	-.145	-.408	.684	-.021
Aware Soil-lab	-2.743	.007	-.117	3.229	.001	.128	.361	.718	.011
Grow	1.894	.059	.110	-.929	.353	-.050	1.174	.241	.060
HH_Size	3.212	.001	.792	-3.934	.000	-.822	-.129	.898	-.030
HH_hd_age	-.409	.683	-.696	.358	.721	.520	-.112	.911	-.176
HHeadOccup	1.893	.059	.086	-2.681	.008	-.110	-.524	.600	-.024
HHeadSexs	-3.088	.002	-.131	.491	.623	.022	-3.096	.002	-.109
HH-income	.504	.615	24.195	-.717	.474	-166.160	-.629	.529	-141.965
Membr-Grp	-.874	.383	-.021	1.477	.140	.033	.452	.652	.012
HHead-Exp	-.829	.408	-1.272	1.336	.182	1.806	.402	.688	.535
Livestock	-.096	.923	-.003	-.564	.573	-.016	-.681	.497	-.020
Totl-Laborers	-1.490	.138	-.683	1.899	.059	.887	.626	.532	.205
DistInptshp	3.186	.002	1.454	-3.975	.000	-1.167	.569	.569	.287
Transpt-costs	7.582	.000	68.335	-9.520	.000	-75.111	-.716	.475	-6.776
RoadType	5.725	.000	.537	-6.695	.000	-.592	-1.023	.307	-.055
Extensncntact	.014	.989	.001	1.004	.316	.055	1.076	.283	.056
TakeCrdt	.601	.549	.036	.792	.429	.043	1.477	.140	.079
Importance	-.442	.659	-.043	-.805	.421	-.075	-1.224	.222	-.118
Stated WTP Value (final bid)	1.594	.112	374.014	-.244	.807	-48.090	1.674	.095	325.924

Source: Author, 2013

In view of the observed statistical differences, four sets of regression models were analyzed i.e. one for each study area and a fourth regression model which combined the entire sample data but had two locational dummy variables to capture the effect of the households' location on the stated willingness to pay.

4.4.2 Regression Analysis

Table 19 shows the estimated coefficients of the OLS regression while in Table 18 the model's statistics and indicators as reported by STATA version 9 are reported. Four models were estimated with the first three being fitted for the three study clusters individually, and the fourth one fitted for the entire data set. All the models were significant at the 1% level of significance and had satisfactory explanatory power on the stated WTP values. The models for the three study clusters showed lower numbers of variables significantly influencing the households' stated WTP. This is primarily attributed to the fact that CVM studies seem to obtain some gains in efficiency with larger sample sizes (Carson and Haneman, 2005). For this reason, results of the model that utilizes the entire dataset will be discussed here with reference being made to the other three location models where appropriate.

Table 18: Indicators for the Estimated OLS Regression Models

Indicator		Kirinyaga	Buuri	Mbooni	Combined
F Statistic		27.710	12.760	29.290	55.830
Prob>F		0.000	0.000	0.000	0.000
R^2		0.705	0.636	0.795	0.689
Adjusted R^2		0.679	0.586	0.768	0.677
Observations		202	133	137	472
Degrees of Freedom	**Model**	16	16	16	18
	Residual	186	117	121	454
	Total	202	133	137	472

Source: Author, 2013

Consistent with past CVM studies, this study found that income has a significant and positive influence on the total economic value of changes in soil quality. All the other models which were applied for each of the three clusters also showed positive influence of income on the total economic value of changes in soil quality except for in the Buuri one which was not significant. The direct inference that can be made out of this result is that with higher incomes, the buy-in for externally driven farmer funded soil conservation strategies / programmes becomes more viable as the farmers place a higher premium on the quality of their soils if they have higher farm based incomes.

At the beginning of this write-up, we posed that GLOBALGAP compliant households either receive a different extension package compared to the non-compliant farmers and / or have higher incomes compared to the non-compliant and non-growing households. Indeed, in the regression analysis undertaken, compliance was found to have a positive effect on the Stated WTP value. However, the influence of compliance on the stated WTP was not significant when analyzed by the study sub-clusters of Mbooni, Kirinyaga and Buuri. At the same time, the effect of extension contacts was evaluated by a distinct dummy variable on reception of extension contact by the farm households. The results in the table above show that households that had received extension contacts had lower economic values for changes in soil quality though the effect of this is not significant for all models.

Table 19: Regression Results – Combined and by Study Area

Variable	Kirinyaga		Buuri		Mbooni		Combined	
	Co-efficient	**t statistic**	**Co-efficient**	**t statistic**	**Co-efficient**	**t statistic**	**Co-efficient**	**t statistic**
Tot-land	(105.772)**	(1.980)	38.745	0.670	(140.544)***	(2.710)	(43.416)	(1.500)
Manure-use	190.406	0.770	23.370	0.050	(267.613)	(0.860)	(6.149)	(0.040)
Aware Soil-lab	744.294**	2.400	14.074	0.020	841.937	1.470	672.467***	2.680
HH_Size	23.335	0.340	(26.357)	(0.250)	(4.815)	(0.080)	2.736	0.070
HHeadOccup	60.230	0.180	441.038	0.820	218.675	0.720	99.806	0.490
Comstatus	373.196	1.400	531.506	1.350	152.125	0.440	325.387*	1.840
OrgMbr	(94.946)	(0.220)	62.676	0.090	819.606*	1.740	185.582	0.660
HHead_sex	(445.333)**	(1.950)	(528.552)	(1.420)	(194.444)	(0.690)	(367.644)**	(2.320)
HH-Income	188.793**	2.460	155.030	0.940	208.326***	2.490	170.730***	3.130
HHead-Exp	(3.491)	(0.380)	(11.182)	(0.670)	(7.428)	(0.680)	(5.334)	(0.840)
Livestock	198.016	0.530	578.479	0.590	695.646*	1.720	345.326	1.280
DistInptshp	116.862**	2.600	54.245	0.560	(24.942)	(1.290)	(1.493)	(0.080)
Transpt-costs	0.756	0.410	(0.307)	(0.170)	(5.435)***	(3.410)	(2.065)**	(2.150)
RoadType	65.826	0.240	(562.930)	(1.060)	(118.464)	(0.240)	(259.703)	(1.240)
Extensncntact	(83.823)	(0.350)	(578.332)	(1.420)	180.868	0.550	(198.174)	(1.150)
Importance	1,324.335***	4.100	1,739.598***	3.140	2,056.917***	7.480	1,672.577***	8.460
Buuri#	N/A	N/A	N/A	N/A	N/A	N/A	320.896	1.520
Mbooni#	N/A	N/A	N/A	N/A	N/A	N/A	688.829***	3.150

Note: * - significant at the 10% level; ** - significant at the 5% level and *** - significant at the 1% level of significance

Dummy variables for the location of the respondent which were only included in the combined model that analyzed the whole data set.

Source: Author, 2013

The effect of the importance attached by the respondent to the proposed SQCIMP was also positive and highly significant as expected apriori. This basically goes to show that for those households who thought that an intervention in terms of an externally driven and conceptualized soil conservation mechanism was important were willing to contribute more. Further, it shows the hypothetical and conceptual validity of the proposed strategy to the respondents and thus underpinning the need to construct viable scenarios that will impact on the resource being valued in CVM studies. Closely associated with this aspect is the knowledge of the existence of soil testing facilities which is found to have a positive effect on the economic value of changes in soil quality.

Farmers over time perceive deterioration in the quality of their soils due to their farming activities. To counter the deterioration in soil quality, various strategies are used by the farmers to reduce the rate of the decline in soil quality with the application of manure to supplement inorganic fertilizer being one of the most natural ways of doing this. The effect of the application of manure on the estimated economic value of changes in soil quality was negative (though insignificant) as expected apriori as this effectively represents a soil quality enhancement for the farmer and thus some reluctance to contribute to externally initiated soil quality improvement programs. Closely associated with the application of manure is the ownership of livestock by the household which contrary to apriori expectations, was found to have a positive influence on the economic value of changes in soil quality (it was however only significant for the Mbooni study cluster). Thus, it seems that the effect of this variable is derived from its income provision aspect and not as a source of manure for the farmer. The ownership of livestock by the farm household offers a broader income base and thus the family has the ability to attach higher monetary value to the environmental resource under consideration.

The gender of the respondent had a negative and significant influence on the stated economic value of changes in soil conditions. This is attributed to the ability of the respondent to take control of the household's income, and make decisions concerning its use and appropriation. On the other hand, the farming experience of the household head had a negative though insignificant effect on the economic value of changes in soil condition consistent with the study by Kakumanu et al., (2012) on farmers' WTP for insurance premiums. It is expected that the more a farmer has been into farming the more value they would attach to the soil resource. Consistent with this was the expectation too that when more experienced, farmers take better care of their soils and thus do not think it is necessary to have or pay for external interventions on the quality of their soils. Consistent with past studies (e.g. Abu, Taangahar and Ekpebu, 2011), the primary occupation of the farmer whether farmer or non-farmer had a positive though insignificant effect on the economic value of changes in soil conditions mainly due to the fact that off-farm employment offers more constant and diversified sources of income. As such, it can be inferred that those households for which the household heads derive their incomes from non-farm sources have slightly higher incomes and thus they are willing to contribute more for externally driven soil quality conservation mechanisms.

Transport costs, type of road connecting the household to the nearest market centre and the distance to the nearest agro-input shop were all found to negatively influence the stated economic value of changes in soil conditions. However, it is only transport cost whose influence was significant. This basically implies that the higher the costs of transport to the nearest major urban centre, the lower the economic value they attach to changes in the quality of their soils. For the type of road linking the road to the nearest market centre, households linked to the nearest market by an all season road had lower stated economic values of changes in soil quality. Closely linked to the transport costs to major urban centers and the type of roads connecting the household to nearest urban centers are the location dummy variables. The two location dummy variables were both significant and had a positive influence on the stated economic value of changes in soil quality.

6.0 CONCLUSIONS

Initial compliance with GLOBALGAP standards posed a challenge to developing country smallholder farmers such as those in Kenya. Over time, smallholder farmers in Kenya have come up with innovative approaches aimed at reducing the transaction costs associated with compliance with these standards. Despite perceived market access benefits associated with compliance with GLOBALGAP standards, a significant number of farmers growing fresh produce for export are still not complying with these standards. Over time, studies have sought to thrash out the producer end benefits of compliance with the GLOBALGAP standards.

In particular, the issue of non-market benefits in the context of compliance with the GLOBALGAP standards has over time drawn considerable interest from researchers. This study was thus framed in the context of possible environmental benefits of compliance with GLOBALGAP standards, a form of agri-regulation. In quantifying the environmental benefits associated with compliance with GLOBALGAP standards, this study uses an innovative approach by combines two environmental valuation methodologies i.e. the replacement cost and the contingent valuation method to estimate the direct and total economic value of changes in soil quality. In particular, this study sought to evaluate the economic value of changes in soil quality among smallholder growers of fresh produce given their compliance or lack thereof with the GLOBALGAP standards.

Results of the replacement cost show that the compliant farmers would require lower costs for their soils to be restored to the same quality as that of the non-growers of fresh vegetables for export compared to the non-compliant farmers. The direct interpretation of this is that the soils of the compliant farmers are of superior quality compared to those of the non-compliant farmers. In the evaluation of the direct economic value of changes in soil quality, the study found that there exist significant differences between the soil chemical attributes between compliant and non-compliant farmers. In the same vein, no statistical differences were found between growers and non-growers of fresh vegetables for export. Results of the replacement cost approach used in the estimation of the direct economic values of changes in soil quality show that the non-compliant farmers have a higher replacement costs estimates than the compliant farmers. As such, the soils of the non-compliant farmers are more degraded, and it can thus be concluded that there exist direct environmental benefits of compliance.

In estimating the total economic value of changes in soil quality, this study applied the open ended iterative bidding approach to contingent valuation. The estimates of the total economic value of changes in soil quality are consistent with the estimates of the direct economic value of changes in soil quality. It is found that the compliant farmers have higher total economic values of changes in soil quality. The study goes further and proves that the estimated total economic values of the compliant and non-compliant farmers are statistically different from each other. Indeed, an independent sample t-test undertaken on the means of various variables analyzed in the study shows that their means are significantly different between compliant and non-compliant farmers and between growers and non-growers of fresh produce for export. A similar analysis by study area also shows that several of the various farmer and household specific attributes are significantly different in their means when compared by the study area of the sampled farmer.

Through regression analysis, it is evident that compliance with GLOBALGAP standards as well as a few other factors (such as the household's income level, the household's land size, the household being located in Mbooni, the ownership of livestock and application of manure by the household to its farm, the transport costs to the nearest urban centre as well as the importance the household attached to the SQCIMP) has an impact on the total economic value of changes in soil conditions.

From the results of the estimated replacement costs, estimated mean WTP, and from the results of the regression analysis, it can be concluded that compliance with GLOBALGAP standards has empirically quantifiable environmental benefits which accrue to farmers growing fresh produce for export in Kenya and other developing countries. From the results of this study and the conclusions that have been made here, several policy relevant recommendations can be drawn from this study as indicated in the section below.

7.0 POLICY RECOMMENDATIONS

While the need for safe agricultural commodities for human consumption is emphasized the world over leading to various food safety protocols in the world, their application in developing countries remains limited to usually markets that cater for the highly affluent in society. However, the level of affluence in the population is on the increase in low income countries such as Kenya thus resulting in increased pressure for safe food and consequently agricultural regulation in low income and developing countries such as Kenya. Indeed, in Kenya, there already exists agricultural regulation standards for the local market i.e. KenyaGAP standards. The results of this study show that compliance with GLOBALGAP standards results in quantifiable environmental benefits to the producers. Taken in the context of results of past studies showing that there is quantifiable health benefits associated with the GLOBALGAP standards, this study recommends that in terms of government policies, measures should be taken to encourage compliance with agricultural regulation as besides benefitting consumers, farmers will also benefit in terms of health and their environment. Indeed, a move towards greater agricultural regulation and compliance with such standards will result in an increasing number of farmers practicing safer agricultural practices.

Given the positive influence of income and income enhancing factors on the households' stated total economic value of changes in soil quality, income enhancing strategies enables households to set aside funds for environmental conservation efforts that are externally driven. Thus, with higher incomes, agricultural households are more amenable to accept and participate in externally driven agri-environmental resource conservation programmes. This study thus recommends that more efforts should be put to critically identify these factors and ways of re-enforcing their levels so as to stimulate greater sustainability in agricultural practices in the context of agricultural regulation.

Finally, given that mechanisms which enable households to undertake the conservation efforts on their own e.g. use of manure, extension contacts etc lead to lower stated economic value of changes in soil quality, it would then seem that empowering agri-households to conserve the environmental resource on their own without external actors leads to lower costs for donor and government driven environmental conservation strategies. This study thus recommends that efforts should be made to empower farmers to undertake environmental conservation on their own so as to lower the societal costs of the externally driven environmental conservation efforts.

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ANNEX

Annex 1: CVM Questionnaire[11]

1.0 Introductory section

1.1 Have you noticed any changes in the quality of soils over time in your farm? Yes [1] No [2]

1.2 What is the nature of these changes? Improvement in quality [1] Decline in quality [2]

1.3 Do you know is there exist any soil testing lab near you? Yes [1] No [2] If yes, go to 2.1.4 below

1.4 How far is the nearest soil testing lab? …………………. Kms

2.0 Context

Different farming practices have different effects on the conditions of soil quality in which crops are grown. Depending on how farming is carries out, these effects may either be positive or negative in which case the soil quality either improves or deteriorates. This happens because the soils of an area have specific characteristics and attributes that make them ideal for the production of some crops. Further, the characteristics of a soil are determined by the climatic and geologic conditions specific to that area.

To prevent the deterioration in soil conditions due to agricultural practices, farmers should periodically manage their soil resources in a manner that is not only productive but also sustainable. Where soil quality has already deteriorated, measures should be taken to ameliorate this by use of professional and sometimes expensive services.

Scenario i): Status Quo

Farmers continue to carry out agricultural practices like they have been doing in the past without any concerns on their effects on the soil resource. Damage to the farmers' soils continues unabated and there is a gradual and continuous decline in crop productivity. Once the soils have been damaged completely, the farmers are forced to either abandon agricultural activities or experience a decline in agricultural productivity.

[11] This part of the questionnaire captures only the WTP related to questions while the socio-economic data and agricultural practices data was collected in a different survey earlier on as part of the broader research program.

Scenario ii): Hypothetical

The government of Kenya through the Ministry of Agriculture (MoA) intends to start a Soil Quality Improvement, Conservation and Management Program (SQICMP) aimed at arresting and reversing the deterioration in farmer's soil quality/conditions. This basically involves establishing a professional soil testing program that uses trained soil scientists who will be offering soil testing services to farmers before planting on the appropriate soil management practices given the crops that they intend to plant.

To raise the money required to finance this program, farmers will be required to pay a mandatory annual soil testing fee payable to the MoA. Given that transparent and accountable systems will be put in place, would you be willing to contribute xxx Kshs towards this program considering that the soil testing and advice will only be available to contributors?

In answering this question, consider that making this contribution will increase the costs associated with land preparation and planting to you and thus reducing the proceeds from a given season's crop.

WTP Question - The responses to this question are to be entered in table 2.

2.1 Would you vote in favor of the Soil Quality Improvement, Conservation and Management Program (SQICMP)? The SQICMP would mean that you and your fellow farmers would have to contribute xxx Kshs at the beginning of every season so as to finance this program? Yes [ ] No [ ] ***(if yes, go to 2 below; if no, go to 3 below.)***

NB: Depending on the answer given to the first question, the enumerator should raise or lower the follow up bids at the predetermined criteria with the follow up bid that results in a change in response e.g. from yes to no, where the follow up bids were higher, or from no to yes where the follow up bides are lower, being recorded in sections 2 and 3 below.

2.2 Would you vote for the SQICMP if you and your fellow farmers were obligated to contribute xxx Kshs (higher than the value asked in 1 above) so as to finance this program? Yes [ ] No [ ] Final bid value {KShs_________}

2.3 Would you vote for the SQICMP if you and your fellow farmers were obligated to contribute xxx Kshs (lower than the value asked in 1 above) so as to finance this program? Yes [ ] No [ ] Final bid Value {KShs_________}

Table 2: Iterative bidding figures

Initial Bid	2nd Bid	3rd Bid	4th Bid	5th Bid	6th Bid	7th Bid	8th Bid	9th Bid	Final Bid

3.0 Debriefing Section

3.1 Would you opt to finance the SQICMP through another mechanism e.g. taxes? Yes [ ] No [ ] ***(if yes, go to 2 below)***

3.2 Which would be the most ideal financing mechanism to you?

…………………………………………………………………………………………………
…………………………………………………………………

3.3 Rate the importance to which you attach to having the SQICMP?......................................

[1] Very important [2] Important [3] Neutral [4] Not important [5] Should not even be considered

Annex 2: Correlation Analysis Matrix for the OLS Regression Variables

	Totlandagrc	Manure-use	Awaresoil-lab	Grow	HH_Size	Hh_head_age	Primryoccup
Totlandagrc	1.000						
Manure-use	0.030	1.000					
Awaresoil-lab	0.049	(0.020)	1.000				
Grow	(0.003)	0.209	0.008	1.000			
HH_Size	0.085	0.034	(0.015)	0.117	1.000		
Hh_head_age	0.205	(0.085)	(0.037)	(0.196)	0.002	1.000	
Primryoccup	(0.049)	(0.068)	0.060	(0.015)	0.052	(0.159)	1.000
Comstatus	0.062	0.193	0.046	0.251	0.133	(0.065)	(0.081)
MembrGrp-wtr	0.039	0.088	0.013	0.070	0.111	0.047	(0.119)
Resp_postn	(0.024)	(0.005)	(0.105)	0.048	0.112	(0.087)	0.064
HHead_sex	(0.088)	(0.111)	(0.158)	(0.004)	0.073	(0.044)	0.064
OrgMbr-farm	0.104	(0.015)	0.087	0.071	(0.018)	0.105	(0.087)
HHead-exp	0.216	(0.009)	0.003	(0.076)	0.027	0.713	(0.180)
Livestock	0.135	0.088	(0.091)	0.072	0.112	(0.018)	(0.043)
Totland	0.213	0.144	0.115	0.154	0.128	(0.024)	(0.038)
DistInptshp	0.020	(0.038)	(0.034)	(0.064)	0.045	(0.008)	0.027
Transpt-costs	0.014	(0.052)	(0.051)	0.175	0.124	(0.058)	(0.034)
RoadType	(0.098)	0.058	0.105	(0.122)	(0.100)	(0.045)	(0.047)
Extensncntact	0.113	0.159	(0.008)	0.093	0.175	(0.017)	(0.096)
TakeCrdt	0.076	0.270	0.006	0.260	0.165	(0.027)	(0.113)
Importance	0.020	0.093	0.079	0.171	0.008	(0.072)	(0.169)
Buuri	0.091	(0.137)	(0.095)	0.025	(0.027)	0.030	(0.073)
Mbooni	(0.029)	0.035	(0.130)	0.087	0.347	(0.079)	0.172
	Comstatus	**MembrGrp-wtr**	**Resp_postn**	**HHead_sex**	**OrgMbr-farm**	**HHead-exp**	**Livestock**
Comstatus	1.000						
MembrGrp-wtr	0.047	1.000					
Resp_postn	0.066	0.000	1.000				
HHead_sex	(0.086)	(0.054)	0.512	1.000			
OrgMbr-farm	0.086	0.243	(0.125)	(0.134)	1.000		
HHead-exp	(0.011)	0.084	(0.061)	(0.020)	0.071	1.000	
Livestock	0.085	0.110	0.034	0.030	0.130	0.006	1.000
Totland	0.102	0.003	0.021	(0.084)	0.056	(0.014)	0.079
DistInptshp	(0.057)	0.047	0.049	0.041	(0.006)	0.040	(0.041)
Transpt-costs	0.023	(0.028)	(0.067)	0.032	0.104	(0.061)	0.076
RoadType	0.012	0.035	(0.005)	(0.023)	(0.054)	(0.052)	0.037
Extensncntact	0.368	0.078	0.113	0.061	0.040	(0.010)	0.078
TakeCrdt	0.543	0.119	0.075	0.004	0.036	0.045	0.114

Importance	0.114	(0.031)	0.024	(0.053)	0.114	(0.069)	(0.012)
Buuri	0.077	(0.024)	(0.077)	0.012	0.328	(0.036)	0.133
Mbooni	(0.034)	(0.000)	0.103	0.141	(0.367)	0.024	(0.034)
	Totland	**DistInptshp**	**Transpt-costs**	**RoadType**	**Extensncntact**	**TakeCrdt**	**Importance**
Totland	1.000						
DistInptshp	(0.036)	1.000					
Transpt-costs	0.055	0.057	1.000				
RoadType	(0.024)	(0.038)	(0.251)	1.000			
Extensncntact	0.077	(0.086)	0.012	0.027	1.000		
TakeCrdt	(0.031)	(0.026)	0.049	(0.022)	0.327	1.000	
Importance	0.107	(0.056)	0.021	(0.062)	0.075	0.107	1.000
Buuri	(0.029)	0.016	0.322	(0.060)	0.021	(0.020)	0.088
Mbooni	(0.105)	0.133	0.088	(0.178)	0.082	0.084	(0.175)
	Buuri	**Mbooni**					
Buuri	1.000						
Mbooni	(0.399)	1.000					

Source: Author, 2012

Annex 3: Stata Output for the OLS Model Regression for the Mbooni Cluster

Source	**SS**	**df**	**MS**	**Number of obs**	=	137.000
Model	957078702.00	16.00	59817418.90	**F(16, 186)**	=	29.290
Residual	247122854.00	121.00	2042337.64	**Prob> F**	=	0.000
Total	1204200000.00	137.00	8789792.38	**R-squared**	=	0.795
				Adj R-squared	=	0.768
				Root MSE	=	1,429.100

Final_Bid	**Coef.**	**Std. Err.**	**t**	**P>|t|**	**[95% Conf. Interval]**	
Tot-land	(140.544)	51.824	(2.710)	0.008	(243.143)	(37.944)
Manure-use	(267.613)	311.773	(0.860)	0.392	(884.850)	349.623
Aware Soil-lab	841.937	571.624	1.470	0.143	(289.744)	1,973.617
HH_Size	(4.815)	56.982	(0.080)	0.933	(117.625)	107.995
HHeadOccup	218.675	302.626	0.720	0.471	(380.453)	817.803
Comstatus	152.125	343.608	0.440	0.659	(528.138)	832.387
OrgMbr	819.606	470.843	1.740	0.084	(112.552)	1,751.764
HHead_sex	(194.444)	283.596	(0.690)	0.494	(755.896)	367.009
HH-Income	208.326	83.686	2.490	0.014	42.648	374.004
HHead-Exp	(7.428)	10.991	(0.680)	0.500	(29.188)	14.332
Livestock	695.646	403.708	1.720	0.087	(103.602)	1,494.893
DistInptshp	(24.942)	19.287	(1.290)	0.198	(63.125)	13.240
Transpt-costs	(5.435)	1.594	(3.410)	0.001	(8.592)	(2.279)
RoadType	(118.464)	488.074	(0.240)	0.809	(1,084.735)	847.808
Extensncntact	180.868	330.675	0.550	0.585	(473.790)	835.526
Importance	2,056.917	274.850	7.480	0.000	1,512.779	2,601.054

Annex 4: Stata Output for the OLS Model Regression for the Buuri Cluster

Source	**SS**	**df**	**MS**	**Number of obs**	=	133.000
Model	788095575.00	16.00	49255973.40	**F(16, 186)**	=	12.760
Residual	451788953.00	117.00	3861444.04	**Prob> F**	=	0.000
Total	1239900000.00	133.00	9322440.06	**R-squared**	=	0.636
				Adj R-squared	=	0.586
				Root MSE	=	1,965.100

Final_Bid	**Coef.**	**Std. Err.**	**t**	**P>|t|**	**[95% Conf. Interval]**	
Tot-land	38.745	58.112	0.670	0.506	(76.342)	153.833
Manure-use	23.370	426.751	0.050	0.956	(821.788)	868.528
Aware Soil-lab	14.074	717.884	0.020	0.984	(1,407.657)	1,435.806
HH_Size	(26.357)	105.923	(0.250)	0.804	(236.133)	183.418
HHeadOccup	441.038	538.009	0.820	0.414	(624.461)	1,506.537
Comstatus	531.506	394.791	1.350	0.181	(250.358)	1,313.369
OrgMbr	62.676	703.848	0.090	0.929	(1,331.258)	1,456.610
HHead_sex	(528.552)	372.628	(1.420)	0.159	(1,266.521)	209.418
HH-Income	155.030	164.157	0.940	0.347	(170.074)	480.134
HHead-Exp	(11.182)	16.732	(0.670)	0.505	(44.318)	21.955
Livestock	578.479	978.025	0.590	0.555	(1,358.449)	2,515.407
DistInptshp	54.245	96.070	0.560	0.573	(136.016)	244.506
Transpt-costs	(0.307)	1.786	(0.170)	0.864	(3.844)	3.230
RoadType	(562.930)	531.100	(1.060)	0.291	(1,614.746)	488.887
Extensncntact	(578.332)	407.139	(1.420)	0.158	(1,384.650)	227.986
Importance	1,739.598	554.681	3.140	0.002	641.082	2,838.115

Annex 5:Stata Output for the OLS Model Regression for the Kirinyaga Cluster

Source	SS	df	MS	Number of obs	=	202.000
Model	1122400000.00	16	70152126	F(16, 186)	=	27.710
Residual	470907500	186	2531761	Prob> F	=	0.00
Total	1593300000.00	202	7887829	R-squared	=	0.705
				Adj R-squared	=	0.679
				Root MSE	=	1,591.200

Final_Bid	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
Tot-land	(105.772)	53.312	(1.980)	0.049	(210.946)	(0.598)
Manure-use	190.406	246.940	0.770	0.442	(296.757)	677.568
Aware Soil-lab	744.294	309.617	2.400	0.017	133.481	1,355.107
HH_Size	23.335	68.869	0.340	0.735	(112.530)	159.199
HHeadOccup	60.230	329.741	0.180	0.855	(590.283)	710.743
Comstatus	373.196	265.927	1.400	0.162	(151.424)	897.817
OrgMbr	(94.946)	428.076	(0.220)	0.825	(939.455)	749.563
HHead_sex	(445.333)	228.096	(1.950)	0.052	(895.321)	4.655
HH-Income	188.793	76.857	2.460	0.015	37.169	340.417
HHead-Exp	(3.491)	9.140	(0.380)	0.703	(21.522)	14.539
Livestock	198.016	373.051	0.530	0.596	(537.939)	933.972
DistInptshp	116.862	44.919	2.600	0.010	28.246	205.478
Transpt-costs	0.756	1.848	0.410	0.683	(2.891)	4.402
RoadType	65.826	277.506	0.240	0.813	(481.639)	613.290
Extensncntact	(83.823)	240.181	(0.350)	0.727	(557.653)	390.006
Importance	1,324.335	323.059	4.100	0.000	687.005	1,961.666

Annex 6: Stata Output for the OLS Model Regression for the Combined Data Set

Source	SS	df	MS	No of obs	=	472.000
Model	2781000000.00	18	154500195	**F(18, 454)**	=	55.830
Residual	1256400000.00	454	2767454	**Prob> F**	=	0.000
Total	4037400000.00	472	8553872	**R^2**	=	0.689
				Adj R^2	=	0.677
				Root MSE	=	1,663.600

Final_Bid	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
Tot-land	(43.416)	29.018	(1.500)	0.135	(100.443)	13.611
Manure-use	(6.149)	171.222	(0.040)	0.971	(342.635)	330.337
Aware Soil-lab	672.467	250.974	2.680	0.008	179.252	1,165.681
HH_Size	2.736	41.133	0.070	0.947	(78.099)	83.570
HHeadOccup	99.806	203.130	0.490	0.623	(299.385)	498.997
Comstatus	325.387	176.808	1.840	0.066	(22.077)	672.851
OrgMbr	185.582	280.091	0.660	0.508	(364.854)	736.019
HHead_sex	(367.644)	158.435	(2.320)	0.021	(679.001)	(56.286)
HH-Income	170.730	54.493	3.130	0.002	63.640	277.820
HHead-Exp	(5.334)	6.326	(0.840)	0.400	(17.767)	7.099
Livestock	345.326	270.770	1.280	0.203	(186.792)	877.443
DistInptshp	(1.493)	18.972	(0.080)	0.937	(38.777)	35.790
Transpt-costs	(2.065)	0.960	(2.150)	0.032	(3.952)	(0.179)
RoadType	(259.703)	209.864	(1.240)	0.217	(672.128)	152.722
Extensncntact	(198.174)	172.244	(1.150)	0.251	(536.667)	140.320
Importance	1,672.577	197.609	8.460	0.000	1,284.236	2,060.918
Buuri	320.896	211.693	1.520	0.130	(95.123)	736.914
Mbooni	688.829	218.389	3.150	0.002	259.650	1,118.009

Source: Author, 2012