Global Agrifood Supply Chain, EU Food-safety Standards and African Small-scale Producers: The Case of High-value Horticultural Export from Kenya

Von der Wirtschaftswissenschaftlichen Fakultät

der Gottfried Wilhelm Leibniz Universität Hannover

zur Erlangung des akademischen Grades

Doktor der Wirtschaftswissenschaften

– Doctor rerum politicarum –

genehmigte Dissertation

von

Solomon Asfaw (M.Sc.)

geboren am 12.03.1977 in Dambi-Dollo (Ethiopia)

2008

Erstgutachter:	Prof. Dr. Hermann Waibel
	Lehrstuhl Entwicklungs- und Agrarökonomik
	Fachbereich Wirtschaftswissenschaften der Gottfried Wilhelm
	Leibniz Universität Hannover
Zweitgutachter:	Prof. Dr. Ulrike Grote
	Lehrstuhl Umweltökonomik und Welthandel
	Fachbereich Wirtschaftswissenschaften der Gottfried Wilhelm
	Leibniz Universität Hannover

Tag der Promotion: Fritag, 21. November 2008

This thesis is dedicated to the memory of my father, Asfaw Tekle
(circa 1944 – 2005)

Acknowledgements

For undertaking the research and writing the thesis, I am indebted to numerous persons and institutions. I feel blessed, and I am very grateful, for all the support I received throughout my doctoral study at Leibniz University of Hannover.

My foremost appreciation and thanks goes to my first supervisor Prof. Dr. Hermann Waibel, for offering me the opportunity to undertake my Ph.D. research, his constant guidance, invaluable advice, constructive criticisms, and keen interest in the study. I am grateful to him for the encouragement, friendly approach and his moral, intellectual and financial support. I also deeply appreciate his kindness, concern for my well being, and for opening the doors to so many opportunities for me. I am also very grateful to Dr. Dagmar Mithöfer, International Centre of Insect Physiology and Ecology (icipe), for her useful and valuable comments and kind advices starting from the early design of the proposal. I am grateful to her for her constant support and outstanding efficiency in responding to my questions and writings, which made the completion of this work possible. She was very generous with her time and patiently and carefully read several drafts of this dissertation. I would also like to thank her family as a whole for their hospitality during my stay in Kenya.

Without the kind cooperation of those involved in the data collection, this study would not have been possible. The enumerators deserve special thanks for the effort they made to collect reliable data. I would also like to thank the farmers who participated in our study and provided us with all important data through out the survey. I am also indebted to staff in International Centre of Insect Physiology and Ecology for their logistic, material and moral support. My special thanks especially go to Dr. Bernhard Löhr and Mrs. Eddah Nan'gole. The co-operation and technical support by the Kenyan Ministry of Agriculture and export companies also deserve great appreciation.

A unique atmosphere of mutual support and collaboration pervades the Institute of Development and Agricultural Economics community. This invaluable social capital made my graduate studies in Hannover one of the most enjoyable experiences of my life. I particularly want to thank Mrs. Renate Nause and Mr. Florian Heinrichs for their friendship and all the many administrative arrangements they have to make on my behalf.

I would also like to thank my mother, Almaz Bati, for her invaluable impetus and encouragements for successful completion of my study. Without her scarifies during my early school age, I could not have been where I am right now. Sincere thanks are also due to my brother, Getu Asfaw and my sister Alemnesh Asfaw for their unreserved and relentless support and love. My special thanks also go to Anna Jankowski (my fiancée) for her unconditional love and support throughout my study.

I am cordially indebted to the financial support by the German Development Cooperation (BMZ/GTZ) for the field survey. All of these things are made possible through the grace and mercy of the almighty loving God.

Solomon Asfaw

November 2008, Hannover

Abstract

Many sub-Saharan African countries have been diversifying their export portfolios away from primary commodities into non-traditional high-value crops to increase their export earning and as a pro-poor development strategy to reduce poverty. Several studies have documented the positive contribution of the horticultural export sector in reducing poverty. However, there are concerns that the proliferation and enhanced stringency of food-safety standards that are imposed by high-income countries can negatively affect the competitiveness of producers in developing countries and impede actors from entering or even remaining in high-value food markets. In parallel with changes in official standards, supermarket chains in Europe have developed prescriptive, production-oriented standards, e.g. the European Union Retailers Produce Working Group for Good Agricultural Practices (GlobalGAP), and are asking their suppliers for produce to be certified according to food-safety and quality standards.

Compliance to these standards for developing countries small-scale producers necessitate costly investment in variable inputs and long term structures. Thus unlike larger commercialized farms, smallholder farmers are faced with financial constraints and human resources limitations in complying with standards. Consequently, small-scale producers, which are the very target of many agricultural development programs that aim at poverty reduction in line with the first Millennium Development Goal (MDG), could become losers of this development. Yet, in some cases, others argue that such standards can play a positive role, providing the catalyst and incentives for the modernization of export supply and regulatory systems and the adoption of safer and more sustainable production practices. The central item of this research is therefore to test these propositions using data collected from Kenyan small-scale vegetable producers.

Data were collected by means of farm household surveys in five export vegetable producing districts of Kenya from September 2005 to August 2006. Overall, 21 sub-locations were randomly selected from the five districts by Probability Proportional to Size (PPS) sampling technique and a total of 539 vegetable

producer households were selected randomly for the interviews. For each randomly selected household the survey combined a single visit (re-call survey) and a season-long monitoring of production practices.

Different econometric models are applied to address the research questions. First, two-stage standard treatment effect model and propensity score matching techniques are used to investigate small-scale producers' decision to adopt GlobalGAP private production standards and examine whether investment in food-safety standards compliance pays off for small-scale producers. Next, the impact of standards on value of production and pesticide use are investigated by applying three-stage damage control production framework that enables to control for a multiple endogeneity problem. Finally, health and environmental impact of adopting standards are evaluated by making use of a two-stage Poisson regression model.

The results of the study can be summarized into three major categories. First, smallholders as compared to large-scale farmers face difficulties in complying with the standards due to a range of constraints. Results show that access to information, capital, services and availability of labor are major factors influencing the ability of small-scale producers to adopt standards and exploit export opportunities for agricultural and food products in developed country markets. Standards do not however eliminate smallholder farmers as a whole from export markets but they discriminate within the group of smallholder producers. Hence, the results support the findings of studies which submit that resource poor farmers with limited access to information and services face difficulties to comply with certification schemes. On the other hand small-scale farmers who do adopt the standards enjoy a range of benefits including higher net-income and stronger bargaining positions with exporters. The financial internal rate of return on investments in standards compliance at farm level is remarkably high even when pessimistic assumptions are made. Comparing the financial internal rate of return to the medium term lending rate by banks in Kenya, it is reasonable to conclude that investment in standards compliance pays off for small-scale producers in Kenya even in the absence of external support.

Second, there is indication that adoption of standards can induce positive changes in production systems of small-scale farmers. Although there is no significant difference in pesticide expenditures, export producers complying with standards significantly use less toxic pesticides. A shift to less hazardous pesticides as a result of adoption could potentially imply less pesticide intoxication by farmers and farm workers, less adverse impact on the environment as well as enhanced food-safety. Results also show that both domestic and export vegetable farmers use pesticide below the financial optimum. However export vegetable producers use significantly higher quantity of pesticides compared to domestic producers although revenue amongst the two groups does not differ.

Third, results show that adoption of production standards reduces production externalities such as pesticide ascribed incidence of acute poisoning symptoms and its associated cost-of-illness. *Ceteris paribus*, farmers who adopt standards experience 78% lesser incidence of acute illness and spent about 50% less on restoring their health compared to non-adopters. Although the health costs examined in this study are limited to treatments related to a few visible acute health impairments (which could be just a small part of the total health cost), they still account for about 86.4% of the mean household chemical expenditure per cropping season for non-adopters and 39.6% of adopters. Likewise adoption of standards has a significant positive impact on improved crop management practices, for example safer and environmentally more benign pesticide use, which is likely to reduce external costs of production.

Generally the empirical results support the notion that it is the asset-poor with limited access to information and service that may be left out from participating in these high-value export market chains. Small-scale farmers who adopted GlobalGAP standards nevertheless have been enjoying significant financial and non-financial benefits supporting the argumentation that standards can also serve as a catalyst to change and improve the production systems of farmers in developing countries. Thus, institutional arrangements that enhance small-scale farmers' physical, social and human capital are vital to influence farm household decisions towards adoption of emerging standards. Both public and private sector support for small actors in the supply chain is important to adopt a strategic perspective in addressing the challenges presented by high-value agricultural and food markets in the context of evolving food-safety standards. Government could promote awareness of the benefits of good agricultural practices and promote their wider use, improve the necessary infrastructure, develop an enabling legal/regulatory framework to facilitate compliance with standards control points and compliance criteria, provide and strengthen extension services and support private sector activities. It is also important that the government provide support to strengthen well-functioning groups of smallholders and self-help groups as well as using various tools to reduce compliance costs of emerging private standards.

The opportunities for smallholders to remain actively involved in lucrative export market also depend on the strategies chosen by export companies. It is important that companies adopt strategic planning that minimizes the negative impact of enhanced standards in marginalizing the poorest segment of the rural producers. Donors and other private sector actors also have a key role to play in enhancing small-scale producers capacities to comply with private-sector standards

In the light of these challenges, considerations also need to be given to policies that shift small-scale producers away from the most demanding global markets. It's important for smallholders to diversify their product categories, invest on better post-harvest qualities and partake in domestic and south-south trade, the market that might be growing fast in the next two decades. From the standard setter point of view it is also crucial that the emerging private standards are/will be smallholder friendly, which is acceptable to both buyers and producers and could be implemented without a significant donor support.

Key words: adoption, efficiency, environment, export vegetables, farmer's health, food-safety standards, GlobalGAP, Kenya, pesticide, productivity

Zusammenfassung

Viele afrikanische Länder südlich der Sahara haben ihr Exportportfolio von traditionellen primären Nahrungsmitteln hin zu hochwertigen Kulturen diversifiziert. Dies dient zum einen der Erhöhung der Exporterlöse und zum anderen als armutsorientierte Entwicklungsstrategie mit dem Ziel der Armutsreduzierung. Mehrere Studien zeigten bereits die positive Rolle des Gartenbauexportsektors bei der Armutsbekämpfung. Jedoch gibt es Befürchtungen, dass sich die starke Zunahme und erhöhte Stringenz von Lebensmittelstandards, die von einkommensstarken Staaten eingeführt werden, negativ auf die Wettbewerbsfähigkeit der Erzeuger in Entwicklungsländern auswirken. Zudem können die Akteure beim Neuzugang oder sogar beim Verbleiben auf hochwertigen Nahrungsmittelmärkten behindert werden. Neben Änderungen der gesetzlichen Standards haben europäische Supermarktketten produktionsorientierte Standards entwickelt, z.B. die European Union Retailers Produce Working Group for Good Agricultural Practices (GlobalGAP), die ihre Anbieter ersuchen, ihre Produkte entsprechend ihrer Standards für Nahrungsmittelsicherheit und –qualität zu zertifizieren.

Für kleinbäuerliche Produzenten in Entwicklungsländern ist die Einhaltung dieser Standards mit kostenintensiven Investitionen in neue Betriebsmittel und langfristige betriebliche Strukturen verbunden. Im Gegensatz zu größeren kommerzialisierten Landwirten, unterliegen Kleinbauern höheren finanziellen sowie personellen Beschränkungen. Folglich könnten kleine Erzeuger, auf die viele landwirtschaftliche Entwicklungsprogramme zur Armutsbekämpfung im Sinne des ersten Millennium-Entwicklungsziels (MDG) ausgerichtet sind, zu Verlierern dieser Entwicklung werden. Auf der anderen Seite gibt es Behauptungen, dass solche Standards einen positiven Beitrag leisten können, indem sie Anreize für die Modernisierung des Exportangebots und der Regulierungssysteme sowie der Adoption sicherer und nachhaltiger Produktionspraxen setzen. Das Hauptanliegen dieser Arbeit liegt deshalb in der Überprüfung dieser Aussagen unter Verwendung von Daten kenianischer kleinbäuerlicher Gemüseproduzenten.

Die Daten wurden mittels Haushaltsbefragungen in fünf kenianischen Distrikten, in denen Gemüse für den Export angebaut wird, vom September 2005 bis August 2006 erhoben. Insgesamt wurden 21 Bezirke aus den fünf Distrikten durch das 'Probability Proportional to Size' (PPS) Auswahlverfahren zufällig ausgewählt, aus denen insgesamt 539 Gemüse anbauende Haushalte für die Interviews zufällig ausgewählt wurden. Für jeden zufällig ausgewählten Haushalt beinhaltete die Befragung einen einzelnen Besuch ('Recall-survey') und wiederholte Beobachtungen über die gesamte Anbaupriode ('Season-long monitoring survey') zur detaillierten Erfassung der Produktionverfahren des Gemüsebaus.

Verschiedene ökonometrische Modelle wurden angewandt für die Untersuchung der zugrunde liegenden Fragestellung. Eingangs wird mit einem zweistufigen simultanen Mehrgleichungsmodell zur Bewertung des Maßnahmeneffekts ('standard treatment effect model') unter Gebrauch des 'Propensity Score Matching'-Ansatzes die Entscheidung der Kleinbetriebe, gemäß privater EU-Lebensmittelmittelstandards zu produzieren, untersucht, und überprüft ob sich für die Kleinbauern die Investitionen und die Einhaltung der Standards lohnt. Daraufhin wird der Einfluss von Standards auf die Produktivität des Ertrags und den Gebrauch von Schädlingsbekämpfungsmitteln untersucht. Um dem multiplen Endogenitätsproblem gerecht zu werden, wird ein 'dreistufiges Schadensfunktions-/Produktionsfunktions-Modell ('damage control/production function model) verwendet. Abschließend wird der Einfluss der Einhaltung von Standards auf Gesundheit und Umwelt anhand verschiedener Indikatoren bewertet.

Die Ergebnisse der vorliegenden Arbeit können in drei Kategorien zusammengefasst werden. Erstens, wegen einer Reihe von Einschränkungen haben Kleinbauern verglichen mit Großbetrieben Schwierigkeiten in der Erfüllung von Standards. Die Ergebnisse zeigen, dass die Fähigkeit von Kleinbetrieben, Standards zu befolgen und somit die Möglichkeit Nahrungsmittel für Märkte der entwickelter Länder zu produzieren, durch Faktoren wie dem Zugang zu Informationen, Kapital, Dienstleistungen und Verfügbarkeit des

Produktionsfaktors Arbeit beeinflusst werden. Standards verdrängen im Allgemeinen nicht kleinbäuerliche Produzenten von den Exportmärkten. Es findet eher ein Differenzierung innerhalb der Gruppe der Kleinbetriebe statt. Die Befunde stützen Ergebnisse anderer Studien, dass Landwirte, die über weniger Ressourcen verfügen und einen beschränkten Zugang zu Informationen und Dienstleistungen haben, sich Schwierigkeiten gegenübersehen, die Anforderungen zur Zertifizierung zu erfüllen. Andererseits erzielen Kleinbetriebe, die gemäß den Standards anbauen, normalerweise ein höheres Nettoeinkommen und genießen meist eine bessere Verhandlungsposition gegenüber den Exporteuren. Der interne Zinsfuß der Investitionen zur Einhaltung von Standards auf der einzelbetrieblichen Ebene ist bemerkenswert hoch, selbst unter pessimistischen Annahmen. Vergleicht man den internen Zinsfuß mit dem durchschnittlichen Kreditzins, den Banken in Kenia im Zeitraum dieser Studie veranschlagt haben, stellt man fest, dass die Investition sich für kenianische Kleinbetriebe sogar ohne externe Unterstützung lohnt.

Zweitens, die Adoption von Standards kann positive Veränderungen in kleinbäuerlichen Produktionssystemen hervorrufen. Obwohl es keinen signifikanten Unterschied in den Ausgaben für den Schädlingsbekämpfungsmitteleinsatz gibt, verwenden Erzeuger, die die Standards erfüllen, weniger toxische Pestizide und erwirtschaften einen höheren Ertrag als andere. Eine Verschiebung zu weniger gefährlichen Schädlingsbekämpfungsmitteln infolge der Einhaltung von Standards kann zu weniger Pestizidvergiftungen der Bauern und Landarbeiter, zu weniger nachteiligen Auswirkungen auf die Umwelt und zu einer höheren Nahrungsmittelsicherheit führen.

Drittens, die Einhaltung der Produktionsstandards kann dazu beitragen, dass negative externe Effekte reduziert werden, wie z.B. das Auftreten akuter Vergiftungssymptome, bedingt durch den Schädlingsbekämpfungsmitteleinsatz und den damit verbundenen Kosten der Krankheit. So erleiden Bauern, die Standards erfüllen, *ceteris paribus*, 78% weniger akute Krankheiten und geben ca.

50% weniger für die Wiederherstellung ihrer Gesundheit aus, als Bauern, die nicht gemäß den Standards produzieren. Obwohl sich die in dieser Arbeit ermittelten Gesundheitskosten nur auf Behandlungen einiger sichtbarer und akuter Beeinträchtigungen der Gesundheit beschränken (und somit lediglich einen kleinen Teil der Gesamtgesundheitskosten darstellen können), verursachen diese Kosten von 86,4% der durchschnittlichen Haushaltsausgaben für Pestizide in einer Anbauperiode für Bauern, die die Standards erfüllen, und 39,6% bei Produzenten die sich nicht an die Standards halten. Die Erfüllung der erforderlichen Standards weist auch einen signifikant positiven Einfluss auf verbesserte Anbaumethoden auf, zum Beispiel ein sichererer und umweltfreundlicherer Schädlingsbekämpfungsmitteleinsatz, der wahrscheinlich die externen Kosten der Produktion reduzieren wird.

Im Allgemeinen deuten die empirischen Ergebnisse darauf hin, dass arme Bauern mit beschränktem Zugang zu Informationen und Dienstleistungen von der Partizipation an diesen hochwertigen Exportwertschöpfungsketten ausgeschlossen werden könnten. Kleinbauern, die GlobalGAP Standards erfüllten, haben signifikante Vorteile finanzieller sowie nicht-finanzieller Art genossen. Dies zeigt, dass Standards auch als ein Beschleuniger dienen können, um Produktionssysteme in Entwicklungsländern zu verändern und zu verbessern. So können institutionelle Maßnahmen, die das materielle, soziale und das Human-Kapital der Kleinbauern erhöhen, ausschlaggebend bei Haushaltsentscheidungen zur Einhaltung von neu entstehenden Standards sein. Sowohl die öffentliche als auch private Förderung von Kleinbetrieben bzw. Kleinunternehmer in der gesamten Wertschöpfungskette ist strategisch wichtig will man die heutigen Anforderungen der Agrar- und Nahrungsmittelmärkte im Hinblick auf sich entwickelnden Lebensmittelstandards erfüllen. Regierungen könnten das Bewusstsein der Vorteile der Einhaltung der guten fachlichen Praxis und ihren breiteren Gebrauch fördern, die notwendige Infrastruktur verbessern, unterstützende gesetzliche und regulierende Rahmenbedingungen schaffen, um die Einhaltung von Standardkontrollpunkten und Einhaltungs-Kriterien zu erleichtern, sowie Beratungsdienstleistungen verstärkt anbieten und die Tätigkeiten des Privatsektors begleiten. Wichtig ist

darüber hinaus, dass die Regierung Unterstützung für gut funktionierende Gruppen von Kleinbauern und Selbsthilfegruppen zur Verfügung stellt sowie das Verwenden verschiedener Methoden stärkt, um Kosten, die bei der Einhaltung von neu entstehenden Standards entstehen, zu reduzieren.

Die Gelegenheiten für Kleinbauern, auf dem lukrativen Exportmarkt aktiv involviert zu bleiben, hängen auch von den gewählten Strategien der Exportunternehmen ab. Private Unternehmen sollten bei ihrer Strategie berücksichtigen, dass das ärmste Segment der ländlichen Produzenten möglichst weiterhin an den Prozessen teilnehmen kann. Bei der Steigerung der Kapazitäten der Kleinproduzenten, die Standards des privaten Sektors zu erfüllen, kommt den Geldgebern der öffentlichen Entwicklungshilfe und anderen privaten Organisationen eine Schlüsselrolle zu.

Im Hinblick auf diese Herausforderungen sollte vermieden werden, die Kleinproduzenten von den globalen Märkten ganz zu verdrängen. Dabei ist es wichtig, dass Kleinbauern ihr Produktportfolio diversifizieren und Investitionen durchführen, die die Produktqualität auch im besseren Nachernte-Prozess verbessern, um weiterhin am Süd-Süd-Handel teilzunehmen, einem Markt, der in den nächsten zwei Jahrzehnten schnell wachsen könnte. Aus der Sicht der Institutionen die Standards entwickeln, ist entscheidend, dass die Standards die Bedingungen der Kleinbauern ausreichend berücksichtigen und gleichzeitig die Ansprüche der Verbraucher erfüllen sowie langfristig ohne Subventionen von Entwicklungshilfeorganisationen implementiert werden können.

Schlüsselwörter: Adoption, Exportgemüse, Gesundheit, GlobalGAP, Kenia, Pestizide, Nahrungsmittelsicherheitsstandards, Produktivität, Umwelt, Wirtschaftlichkeit

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List of Abbreviations

ACP	African Caribbean Pacific
BCR	Benefit Cost Ratio
BRC	British Retail Consortium
COLEACP	Europe/Africa-Caribbean-Pacific Liaison Committee
ETI	Ethical Trading Initiative
EU	European Union
GlobalGAP	European Retailer Working Group for Good Agricultural Practices
FFV	Fresh Fruit and Vegetables
FIIR	Financial Internal Rate of Return
FIML	Full Information Maximum Likelihood
FPEAK	Fresh Produce Exporters Association
FSC	Forest Stewardship Council
GAP	Good Agricultural Practices
GDP	Gross Domestic Product
GFSI	Global Food Safety Initiative
GHP	Good Hygienic Practices
GMP	Good Manufacturing Practices
GoK	Government of Kenya
HACCP	Hazard Analysis and Critical Control Points systems
HCDA	Horticultural Crop Development Authorities
HDC	Horticulture Development Centre
ICS	Internal Management and Control System
IDS	Institute of Development Studies
IFS	International Food Standard
IPM	Integrated Pest Management
ISO	International Organization for Standardization
JBIC	Japan Bank for International Corporation

Kg	Kilogram
KEBS	Kenya Bureau of Standards
KFC	Kenya Flower Council
KSh	Kenyan Shilling
LIML	Limited Information Maximum Likelihood
MDG	Millennium Development Goal
MEC	Marginal External Cost
MPC	Marginal Private Cost
MRL	Maximum Residue Limit
MWP	Marginal Willingness to Pay
NGO	Non-Governmental Organisation
NPV	Net Present Value
PIP	Pesticide Initiative Program
PVS	Private Voluntary Standards
SPS	Sanitary and Phytosanitary Standards
TRDA	Trade Related Development Assistant
TSC	Technical and Standard Setting Committee
TV	Television
UK	United Kingdom
UNCTAD	United Nations Conference on Trade and Development
US$	United States Dollar
USAID	United State Agency for International Development
VIF	Variance Inflation Factor
WDR	World Development Report
WHO	World Health Organization

Chapter 1

Introduction

1.1 Background and research problem

Today, about 1.1 billion people continue to live in extreme poverty on less than US$ 1 a day. Another 1.6 billion live on between US$ 1–2 per day. Three out of four poor people in developing countries- (83 million people) lived in rural areas in 2002 (WDR 2008). Most depend on agriculture for their livelihoods, directly or indirectly. So a more dynamic and inclusive agriculture is required to accomplish the Millennium Development Goals (MDGs) and to get more people out of poverty. The first MDG goal, to eradicate extreme poverty and hunger, in particular depends on raising the productivity of agriculture. However, in today's more integrated world economy, success in productivity-based agricultural growth crucially depends on the expansion of market opportunities. Improving the competitiveness of developing countries agricultural products in international, regional, and domestic markets is the key to expanding market opportunities.

In recent years, governments and development agencies have sought to promote the diversification of agrifood exports in order to accelerate economic growth, expand employment opportunities, and reduce rural poverty. Particular attention has been given to facilitating the exports of higher value foods-including fruits and vegetables. For these commodities international trade has exhibited considerable growth in recent decades. According to Lambaset (2005), high-value products provide an opportunity for farmers in developing countries to compete for a share of this lucrative export market. Trade in horticultural products is often considered an example of successful exports in some developing countries, with some of them managing to gain access into the horticultural value chains.

Based on the most recent trade statistics (UNCTAD 2008), it is estimated that total sub-Saharan Africa exports of fresh fruit and vegetables (FFV) amounted to some US$2 billion in 2006. South Africa, with FFV exports worth almost US$1.2 billion, accounted for almost two thirds of the regions FFV exports in value terms. Côte d'Ivoire (US$195.2 million in 2006) and Kenya (US$178.2 million in 2004, estimated at US$215 million for 2006 by extrapolating the 2004 figure based on growth in trading partners' imports of FFV from Kenya between 2004 and 2006) are also important exporters, followed by Cameroon, Ethiopia, Ghana, Madagascar, Namibia, Senegal, the United Republic of Tanzania, Zambia and Zimbabwe (each of which exported FFV exceeding US$25 million). In several sub-Saharan Africa countries, the FFV sector contributes significantly to the total exports of agricultural products. For example, FFV exports accounted for 29% of South Africa's agricultural exports in 2006. For all sub-Saharan Africa countries as a group, FFV represented 11.7% of all agricultural exports (UNCTAD 2008).

Domestic markets for high-value crops are also the fastest-growing agricultural markets in most developing countries, expanding up to 6–7% a year, led by livestock products and horticulture (WDR 2008). As incomes rise, supermarkets become more dominant in the domestic retail sales of agricultural products-reaching 60% in some Latin American countries (WDR 2008). The poverty impacts of this growth (both domestic and global market) depend on how the rural population participates in high-value markets, either directly as producers (as in Bangladesh) or through the labor market (as in Chile).

Studies in Kenya have shown that French bean production alone provides half a million people with their main source of income. In a survey of five major bean-growing districts, Anyango and Nabwile (1995) found between 17 and 40% of the growers to be women. In another study comprising beans, tomato and cabbage growers, Michalik (1994) found 21.5% of the farmers being women. In addition to income generation, vegetables are vital for the supply of vitamins and other micronutrients to consumers. In addition, export of exotic vegetable species such as French beans, snow peas and Asian vegetables have contributed about US$ 100 million to the foreign exchange earnings of Kenya in 2002. A study conducted by the Institute of Development Studies (McCulloch and Ota, 2002) on the relevance of export vegetable production for poverty alleviation in Kenya showed a significant positive impact of the industry on producers and the workforce employed in the sector. This is reflected in generation of employment in pack houses in urban areas, in farms owned or under contract by exporters as well as through the direct purchase from small-scale farmers. In addition, export vegetable production in Kenya is concentrated in areas severely affected by absolute poverty and hence is expected to contribute to poverty reduction.

Enhancing smallholder participation needs market infrastructure, upgrading farmers' technical capacity, risk management instruments, and collective action through producer organizations (Lambaste, 2005). Addressing the stringent sanitary and phytosanitary standards in global markets is an even bigger challenge. In the past few years, for Kenyan producers, the challenge of international competitiveness in higher value food trade has become increasingly linked to the development of capacity to manage food-safety. In Kenya's main destination markets, especially, in the European Union (EU), official food-safety requirements are becoming more stringent, while new standards are being applied to address previously unknown or unregulated hazards. In parallel with changes in official standards, public oversight have been accelerated moves by the private sector to address food-safety risks and otherwise address the (environmental and social) concerns and preferences of consumers and civil society organizations. Supermarket chains in Europe have developed prescriptive, production-oriented standards, the EU Retailers Protocols on Good Agricultural Practices (GlobalGAP)[1], which are meant for growers of fresh fruit and vegetables and require certification by an independent internationally accredited certification body.

[1] This study was conducted when EurepGAP, Version 2.1 (October 2004) was relevant. Since then EurepGAP has changed its name and logo to GlobalGAP, arguing that its proclaimed role in promoting the harmonization of good agricultural practices schemes had moved beyond Europe. The name change was announced at the 8th EurepGAP Conference, the EurepGAP Asia Conference, held in Bangkok on 6th and 7th September 2007. Therefore, throughout this thesis consistently the word GlobalGAP is used, which would be synonymous to EurepGAP.

This proliferation and enhanced stringency of food-safety standards represent potential barriers to Kenyan farmers seeking to expand their trade in higher value foods. Yet, they may also represent a catalyst for the upgrading of production operations, and for improved collaboration between the public and private sectors. According to Henson and Jaffee (2006) a major implication of adopting the standards as catalysts for development is the need to view compliance as a strategic issue, so that the opportunities and challenges are managed to competitive advantage.

In this context, it is essential to understand the current status and likely trajectory of agrifood standards, the feasible range of commercial, administrative and technical options available to African farmers, firms, and governments, and the underlying economics of such responses. Therefore, this study analyses the expected impact of private food-safety standards on small-scale producers welfare in particular and the horticultural export sector in Kenya in general, which in turn provide the necessary information basis for identifying further research needs and for developing policy recommendations that can induce change towards more sustainable horticultural production and marketing systems in Eastern Africa.

1.2 Objectives of the study

This study aims at investigating the extent to which food-safety standards imposed by the EU private retailers affect the welfare of small-scale farmers in Kenya. The impact of these standards on smallholder welfare is explored by making comparison between different categories of smallholder participating in the export sector.

The specific objectives of the study are to:

i. Investigate the nature and magnitude of costs of compliance with GlobalGAP standards.
ii. Examine determinants of adoption of GlobalGAP standards and estimate the impact of standards on farm financial performance.
iii. Analyse profitability of investment in GlobalGAP certification.

iv. Examine the impact of GlobalGAP standards on pesticide use and farm-level productivity.
v. Estimate the effect of GlobalGAP standards on pesticide ascribed incidence of acute illness symptoms and its associated cost-of-illness.
vi. Explore the impact of GlobalGAP adoption on improved management practices as proxy for environmental benefits.

1.3 Organization of the thesis

The remaining part of this thesis consists of six chapters and brief descriptions of these chapters are presented as follows. Following these introductory remarks, Chapter two is devoted to a review of trend in Kenyan horticultural industry and the evolving EU food-safety standards. It discusses the regulatory EU public standards in comparison with private voluntary food-safety standards. It specifically summarizes the implications of emerging standards on export growth, structure of agrifood supply chain, overall development and poverty reduction for developing countries. It also present the supply chain for fruit and vegetables in Kenya, the degree of smallholder participation in the vegetable export sector and the driving factors for the development of Kenyan horticultural export sectors.

Chapter three presents the general conceptual framework for assessing the welfare impact of GlobalGAP certification. The chapter starts by discussing the diffusion of innovation and adoption of standards in more general terms and presents the welfare effects of GlobalGAP certification. It ends by presenting the general hypotheses of the study based on the concepts discussed in the previous sections.

Determinants of adoption of GlobalGAP standards and the impact of standards on farm financial performance are analyzed in Chapter four. Specifically, this chapter tries to discuss the magnitude and nature of cost of compliance with GlobalGAP standards and provide answer whether investment in EU safety standards compliance pay-off for small-scale producers. Three alternative econometric models are also presented in detail that helps to answer the research questions.

Chapter five analyzes the role of adoption of production standards on the use of pesticides and value of production among export producers. It also provides some insight on the performance of farmers producing for domestic market in comparison with the export farmers. An extended three-stage damage control production framework that accounts for multiple endogeneity problems is discussed and applied.

Chapter six assesses the effect of GlobalGAP standards on pesticide related acute illness and its corresponding cost-of-illness. It also explores the impact of GlobalGAP adoption on improved management practices as proxy for environmental benefits. To attain the objectives, the chapter presents a theoretical non-separable farm household model as a starting point and develops an empirical model to analyze the data.

Finally, Chapter seven reports a general synthesis and conclusion of the study including policy implications of the research findings. The chapter closes with recommendation for further research.

Chapter 2

Kenyan Fresh Export Production and Emerging Food-safety Standards

The purpose of this chapter is to review the evolution of food-safety standards in EU, compares the public regulatory versus private voluntary standards and discusses their possible implications on export growth, structure of agrifood supply chain, overall development and poverty reduction for developing countries. It also review the supply chain for fruit and vegetables in Kenya, the degree of smallholder participation in vegetable export and the driving factors for the development of Kenyan horticultural export sectors.

2.1 Food-safety standards

Food-safety is a matter of primary importance, because foods which are unsafe can easily affect consumer's health and in addition destroy their trust into the supplier, with significant negative effects on its future sales (Fulponi, 2006). What makes it even more important is the fact that food-safety problems can affect a large number of consumers simultaneously throughout regions, since food is often distributed nationwide. The food-safety scandals of the 1990s have led governments of EU and retailers to enact strict food-safety standards covering four broad areas: pesticide residue limits, worker safety, packer hygiene, and traceability. In order to ensure that the food-safety standards are met, various quality assurance systems have been developed. They can be classified into systems of Good Practices[1], Hazard Analysis and Critical Control Points systems (HACCP)[2] and international standards set by the International Organization for

[1] Good practices are guidelines to ensure minimum standards for food processing and storage. They include Good Manufacturing Practices (GMP), Good Agricultural Practices (GAP) and Good Hygienic Practices (GHP) (Luning *et al.*, 2002).

[2] HACCP was developed in 1959 and deals with the prevention of food-safety failures in the food production. It covers the whole process of food production from growing to the preparation for consumption (Luning *et al.*, 2002).

Standardization (ISO)[3] (Henson and Reardon, 2005). The compliance of food suppliers with these systems is ensured either through first party auditing (suppliers audit themselves), second party auditing (the retailer performs the audit) or through a third party auditing (which is supposed to be independent from the other parties).

Although a matter of public importance, globalization in the food sector with supply chains crossing many national borders, growing product differentiation and new technologies, made it increasingly difficult for national governments to regulate matters of food-safety and quality in detail (Hatanaka *et al.*, 2005). In response to the problems of governmental regulation bodies to keep pace with new developments in the food sector, private food-safety and quality standards emerged during the 1990s. One common formula in the discussion about public and private food standards is that public standards are more concerned with physical product characteristics and to a lesser extent with processes, while private standards are concerned with physical and process attributes, both to ensure a certain product characteristic as well as a certain production process itself.

2.1.1 Regulatory public standards

In the case of the EU the tightening of public product standards has to be seen in the context of various 'food scares' (Table 2.1) that have shattered public trust in food production, as well as in the context of harmonization and rationalization of standards across countries and product areas (Humphrey, 2005). One of the most important changes in public product standards was laid with the EU directive 42/2000/EC on Maximum Residual Levels, which came into force in July 2001 as part of the EU pesticide regulation harmonization program (EU 2000). The program requires safe levels of pesticide use to be established by scientific testing, usually based on data submitted by agrochemical companies. Apart from some

[3] For example ISO/9000 series specify quality system requirements and the ISO/22000, which deal with food-safety management systems and the requirements for any organization in the food chain (Færgemand and Jespersen, 2004).

other important changes (Humphrey, 2005), the new EU regulations also require inspection of all imports of plant products, which creates new costs for developing countries' producers, particularly for producers sending only small batches to the EU.

Table 2.1 Examples of major food scares in industrialized countries

Year	Event	Countries
1987 - 1988	Beef hormone scare	Italy/EU
1988	Poultry salmonella outbreak/scandal	UK
1989	Growth regulator scare for apples	USA
1996 - 1997	Microbiological contamination, berries	USA, Canada
1995 - 1997	Avian flu spreads to humans	Hong Kong, Taiwan
1999	Dioxins in animal feed	Belgium
2000	Large-scale food poisoning, dairy	Japan
2001	Contaminated olive oil	Spain
2001	Foot and Mouth Disease	UK/EU
2007	Foot and Mouth Disease	UK

Source: Jaffee *et al.*, 2005

Furthermore, a significant shift has occurred in the way food production is conceptualized, away from pure product-control to a process-control approach, as it is clearly expressed in regulation (EC) No 178/2002, which came into effect in January 2005. Food-safety is viewed as an outcome of the value chain as a whole, stretching from primary production to the final consumer. This approach largely builds on the UK Food Safety Act of 1990, which shifted the responsibility for safe food to retailers and required them to show 'due diligence', which means they had to show that they employed all reasonable means in the stages of production, transport, storage and preparation of food to prevent health risks. This principle of due diligence has been taken onto the supranational level with the new EU regulation, which stipulates that food operators should have 'primarily responsibility for ensuring food-safety', and therefore must have a system in place to identify and respond to safety problems and are required to ensure the traceability of products. The latter refers to the requirement for food operators to be able to trace products up to the respective exporter in supplying countries, but usually not beyond this point. These process-oriented shifts in food-safety largely follow the Hazard Critical Control Point Analysis. This approach is widely applied as a sector-specific standard in the food and other sectors in order to contain risks at critical points within the production process (Humphrey, 2006). These important shifts in public regulation have had particular influence on the development of private standards.

2.1.2 Private food-safety standards

The line between public and private actors is frequently blurred and private standard setting processes usually involve different actors such as corporations, industry association, NGOs, development organizations, and the public sector operating on at different geographical scales (Humphery, 2006). While producers may have driven food chains in the past, often through spot-markets arrangements, retailers have gained control over supply chains with the ongoing concentration in the market place over the last two decades. For instance, at the end of the 1990s only five supermarket chains accounted for 75% of all grocery sales in the UK (Jaffee *et al.*, 2005). Private retailers have become much more involved in imposing requirements on how food is produced throughout the commodity supply chain, even to the degree of monitoring and controlling production in developing countries (Dolan *et al.*, 1999).

Today, the motivation for private food-safety standards is much more strategic. Retailers have moved into domains such as product development, branding/private label development, distribution and supplier selection as corporate strategies in order to increase rents in a highly competitive market. Fierce competition among retailers in Europe not only spurred processes of innovation, but also the need to express social responsibility and accountability as a strategy of corporate benchmarking in times of increased societal reflexivity. The standards help firms to gain access to new markets and to coordinate international production due to a standardization of product requirements across suppliers, therefore helping to reduce their transaction costs (Henson and Reardon, 2005; Hatanaka *et al.*, 2005). Furthermore, they help retailers to protect their reputation and therefore to maintain customers loyalty, which can be easily jeopardized by a food-safety problem (Fulponi, 2006). Achieving these goals required a restructuring of value chains, with most significant impacts on the sourcing of fresh produce. Initially they were aimed at addressing the problem of microbial contaminants in food. They later evolved to cover three broad areas: i) pesticide residue standards, including pesticide usage, handling, and storage as well as disposal of pesticide containers and leftover pesticides, ii) hygiene standards, including sanitation of grading and storage facilities as well as general personal hygiene, and iii) traceability requirements, including documentation of production activities, especially pesticide usage, planting and spraying dates, and labeling of graded produce (Jaffee *et al.*, 2005).

The private food-safety standards that have an international scope and are applied in the fresh produce vegetable and fruit sector are very similar. The reason is that many of them are build around the same principles such as HACCP, ISO, GAP and GMP. Tesco's Nature's Choice (UK), Mark's and Spencer's Field to Fork (UK) or Carrefour's Qualité Superior (France) are prominent examples of company-based standards, which are applied exclusively to value chains governed by these retailers (value chain specific standards). Despite the significant market share of some large retailers, the most profound impact arises from the development of private collective standards being set and enforced by global standard networks. The most prominent of them have been the British Retail Consortium (BRC), Global Food Safety Initiative (GFSI), the Ethical Trading Initiative (ETI), the International Food Standard (IFS), ISO 9000 and 14000, the Forest Stewardship Council (FSC) and GlobalGAP. These are usually applied sector-specifically. Fulponi (2006) refers to these standards as 'private voluntary standards' (PVS). These standards arise on three levels. First, they are a response to public regulatory pressure such as BRC, a standard that governs issues of Good Manufacturing Practices (Processing) and was largely a response to the UK Food Safety Act. Second, they may develop from civil society's pressure or from a development context as in the case of the ETI. Third, they may be regarded as an effort to harmonize standards themselves as it is the case with the GFSI or

GlobalGAP. To enhance credibility and externalize monitoring costs, most of the standards such as GlobalGAP, ISO 9000 and 14000, BRC and ETI are enforced through third party certification, i.e. an independent, accredited certification body, which inspects and audits the respective producers on an annual level.

Although most of these private voluntary standards are relevant for the horticultural sector in Kenya, they are often more stringent than GlobalGAP and primarily adopted by large-scale producers. There were no smallholder groups certified under these standards during the survey period except for GlobalGAP. Hence the study focuses primarily on smallholders producing under GlobalGAP standards.

2.1.3 GlobalGAP standards for fruits and vegetables

The GlobalGAP guidelines reflect a harmonization of the existing safety, quality, and environmental guidelines of the major European retailers, and are a response to increasing consumer interest in food-safety and environmental issues (GlobalGAP 2004). The detailed production protocols were first developed for fruit and vegetables and now also cover flowers and grains. GlobalGAP has a growing membership of retailers, including leading food retailers such as Sainsbury's, Tesco, Safeway, Coop Italia, Belgian Wholesale Markets, Waitrose and Kesko (GlobalGAP 2004).

The Euro-Retailer Produce working group established its own standard for good agricultural practices, GlobalGAP, in 1997 based on retailer needs to reassure consumers that food was being produced in a safe and sustainable manner within context of a globalized food economy. Originally developed with reference to fruits and vegetables, it has expanded to include integrated assurance schemes for farms and aquaculture, as well as protocols for flowers and ornamentals. A protocol for green coffee protocol will soon be completed. Its organization has also evolved from a uniquely retailer dominated to one of partnership with producers and consults regularly with consumer groups, NGOs and governments in the developments of its protocols.

GlobalGAP is flexible and permits benchmarking of local schemes to GlobalGAP, thus extending participation under the scheme. This is seen as important in fulfilling a basic aim of facilitating trade in safe and sustainable farm production. As a business to business scheme the logo is available to accredited farmers when supplying manufacturers or retailers. It may not appear at point of sale to the final consumer since it is understood that all products offered for sale comply with basic implicit requirements.

GlobalGAP is a quality and safety management system, providing tools for verifying best practices in a systematic and consistent way through the use of product protocols and compliance criteria. The GlobalGAP schemes are based on compliance to four main criteria: food-safety, environmental protection, occupational health and safety and animal welfare. The food-safety criteria are based on the application of HACCP principles, while criteria for the environment are designed to minimize negative effects of agricultural production. While a minimal level of occupational health and safety criteria are part of GlobalGAP, these are not to be considered in depth audits of social conditions. All GlobalGAP schemes require compliance with national and international legislation.

Compliance with GlobalGAP is assessed on grounds of the control points, which are classified into three levels of importance, ranging from 'major musts' over 'minor musts' to recommendations. Major musts have to be fulfilled with a compliance of 100% (GlobalGAP 2004). All control points that are viable for food-safety and some points related to occupational safety belong to this category. A compliance of 95% is sufficient for the sum of minor musts. Those major and minor musts that are not fulfilled but were deemed as not being applicable for certain farms do not enter into the calculation of compliance. In contrast, recommendations have no minimum percentage that has to be complied with. Recommendations have therefore mainly the function of raising awareness for the topics in question (the control points for environmental protection belong to this category).

In case of non-compliance to one of the major musts that was not declared to the certification body, the certification is suspended for three month. A second violation of the same control point leads to a withdrawal of the GlobalGAP certificate. Declared violation of major musts compliance leads to a rejection of the produce that was affected by the non-compliance. In case of compliance with less than the required 95% of the minor musts, corrective measures have to be taken by the producer within a month – these corrections are subject to a subsequent inspection by the certification body (GlobalGAP 2004). Repeated violation of more than 5% of the minor musts leads to a suspension of the certificate for up to six months. Within these six months the issues have to be resolved – otherwise the GlobalGAP certificate is withdrawn (GlobalGAP 2004)[4].

Although approximately 66% of certified producers are located within the EU, GlobalGAP also gains in importance all over the world (GlobalGAP 2004). Especially, in North and South America GlobalGAP is already broadly implemented with certified growers in almost every country. Whereas, in Africa certified growers are mainly located on the eastern coast and in Asia GlobalGAP is mainly implemented in south-east Asian countries.

GlobalGAP offers four options to producers who seek to obtain certification under the standard. Under Option 1, an individual farmer applies for certification. The farmer must carry out an internal self-inspection and undergo an external inspection by a certification body, which is a certification enterprise accredited by GlobalGAP. Under Option 2, a group of farmers applies for a group certificate. Under Options 3 and 4, individual farmers or farmer groups that have already implemented another standard can apply for a 'GlobalGAP benchmarked scheme certificate', i.e. GlobalGAP recognizes the existing standards scheme as being equivalent to the GlobalGAP standard (GlobalGAP 2004). The four key elements for group certification are described in the GlobalGAP General Regulations (GlobalGAP 2004).

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[4] For a listing of the specific criteria according to product scheme, see http://www.globalgap.org.

First, the group must have an operating Internal Management and Control System (ICS). This system includes quality control through written protocols and a procedure manual. This is supposed to guarantee that internal inspections are undertaken in a competent way. It also has a traceability system, which allows to separate GlobalGAP certified products from none certified, and also enables to trace back to the farm where the product was obtained. All registered members of the farmer group must be operating under the same management and subject to central management review. Farmers belonging to the farmer group must register for GlobalGAP certification for at least one whole year and all farmer groups must have internal audit procedures that establish a minimum of an annual inspection for each registered farmer.

Second, each registered farmer should complete a farmer internal self inspection and this includes a completed internal self-inspection based on the GlobalGAP checklist, which must be available on each registered farm to be reviewed by either the internal or the external inspector. Internal self-inspection must be carried out at least once a year.

Third, qualified staff must complete an internal inspection of all registered farms i.e. a minimum of one internal inspection per year of each registered farm must be carried out by qualified staff within the farmer group, or subcontracted to an external verification body different from the certification body responsible for the external verification. The annual internal inspection must be based on the GlobalGAP checklist.

Fourth, external verification should be performed by GlobalGAP approved certification body. The external inspection is annual and made by taking a random sample that is, as a minimum, the square root of the total number of GlobalGAP registered farmers within the farmer group.

In Kenya, only the first two GlobalGAP certification options were relevant at the time of this study. In the case of smallholders, an exporter or producer organization determines the type of certificate. The smallholder producer then decides whether or not to implement the standards. To comply with the standards producers have to change their production technology, e.g. switch to less harmful pesticides. The standards also require lumpy investments like a grading shed, charcoal cooler, disposal pit, toilet, and pesticide store. An overview of selected GlobalGAP compliance criteria and investment required by small-scale producers is presented in Table 2.2.

Table 2.2 Selected GlobalGAP compliance criteria and investment required

Compliance criteria	Investments required
Record keeping and internal self inspection	Office construction, office furniture, writing materials, technical staff etc.
Crop protection	Chemical store, use of Integrated Pest Management (IPM), shift to approved chemicals etc.
Worker safety, health and welfare	Construction of toilet and bath room, first aid equipments, protective clothing, disposal pit, potable water etc.
Soil management and quality of water	Soil and water testing etc.
Product handling	Grading shed, charcoal cooler etc.

Source: GlobalGAP, 2004

2.2 Food-safety standards and their implications

Over the past 50 years, progress has been made in lowering the barriers to trade through a removal of quotas, a reduction in tariffs and preferential trade agreements for developing country imports in western economies. This has benefited developing country export performance. Participation in international trade is generally recognized to favor economic growth and especially agricultural exports would promote development in low-income countries due to the link with the rural economy. However, it is argued that the gains from trade liberalization are offset by increasing food standards that are mainly imposed by high-income countries and increasingly dominate the world's food trading system (Augier *et al.*, 2005; Brenton and Manchin, 2002). These standards are argued to act as new barriers to developing country exports. Moreover, others argue that high standards concentrate the benefits of trade with processing and retailing companies and large farms, thereby casting doubt on the development impact of increased agricultural exports from developing countries. Standards would lead to an unequal distribution of the gains from trade and result in the marginalization of poorer farmers and small agrifood businesses.

2.2.1 Food standards role for export growth

Although food standards have first emerged in high-income countries, they are increasingly spreading through developing countries as well, especially in their urban markets, and affect these countries through foreign direct investment (FDI) and agricultural trade. Food processing and retailing companies investing in developing countries require high standards from their suppliers to serve high-standard markets in their home economies, to reduce transaction costs in regional distribution and supply chains, or to harmonize production and processing standards across subsidiaries of multinational holdings. Food standards further affect developing countries because exports to high income countries have to meet the high standards in these countries.

There is uncertainty on how food standards affect developing country exports. Some studies argue that standards are new trade barriers that are offsetting the gains from trade liberalization and diminish the export opportunities for developing countries (Augier *et al.*, 2005; Brenton and Manchin, 2002). Others argue that compliance with food standards can be a catalyst for upgrading and modernization of developing country's food supply systems and for export growth (Jaffe and Henson, 2005; Henson and Jaffee, 2006).

Food standards have the potential to be used as protectionist tools or as a (scientifically-justified) excuse for protectionism by industrial countries. Standards can be set higher for imports than for domestically produced goods or countries could apply discriminatory measures to different importing countries. Standards can be designed to protect national industries rather than consumer health. Increased trade liberalization creates incentives for countries that see quotas removed and tariffs reduced, to indeed (mis)use standards to bar developing country exports and protect domestic farmers and agrifood companies (Neff and Malanovski, 1996). The empirical evidence on this is mixed. Some argue that the protectionist use of standards and trade disputes over food quality and safety issues has increased in the past decade and is likely to increase in the future. For example, Mathews *et al.* (2003) note that several countries effectively discriminate by having zero-tolerance for salmonella on imports of poultry products while not attaining and not monitoring this standard for domestic supplies. Jaffee and Henson (2005) note an example from Australia prohibiting imports of sauces from the Philippines on the basis of containing benzoic acid while permitting imports from New Zealand of similar products containing that additive. No systematic research has been done on this issue and there is only anecdotal evidence on the discriminatory use of food standards. However, Jaffee and Henson (2005) argue that many of these anecdotal cases involve at least partially legitimate food safety and agricultural health issues and that no systematic evidence on the discriminatory use of standards is available.

Apart from the discriminatory use of standards there is another reason why standards may act as barriers to trade for developing countries: the high cost-of compliance with food standards and the low capacity of developing countries in food safety. The compliance cost is likely to be higher for developing countries because they generally have insufficient food safety capacity. Developing countries lack the institutional, technical and scientific capacity for food quality and safety management. Hence adherence to high standards imposed by high-income countries might require substantial investment – from the public sector as well as from the private sector – to realize that capacity. For poor countries, lacking the financial means, the cost of compliance with food standards might be too high and undermine their competitive capacity. Hence, standards could act as barriers to trade for developing countries facing particular weaknesses in food safety capacity.

Some studies have estimated the cost of compliance to food quality and safety standards for specific cases and have demonstrated that these costs are relatively lower than generally assumed. For example Aloui and Kenny (2005) estimate the cost of compliance with sanitary and phytosanitary standards (SPS) to be 3% of total costs of export tomato production in Morocco. Cato *et al.* (2005) have estimated the cost to implement compliance to safety standards to be less than 3% and the cost to maintain this compliance less than 1% of the total value of shrimp exports from Nicaragua. Another reason why compliance costs are high is the lack of harmonization in standards across countries and even across individual importers. It is argued that compliance costs could be substantially reduced if standards would be harmonized across countries and internationally uniform conformity assessment and certification producers adopted (Aloui and Kenny, 2005).

The cost of compliance might be relatively low compared to export earnings but the cost of non-compliance with standards is potentially very high. The inability to comply with food standards can lead to border detentions of produce and trade restrictions such as import bans for specific products. For example, in 1997 the EU banned fish exports from Kenya on grounds of food safety risks (Henson *et al.*, 2000) and from Bangladesh on the basis of incompliance with hygiene norms in processing plants (Unnevehr, 2000). Such detentions and import bans are extremely costly; in the short run in terms of immediate forgone export earnings and the waste these detentions generate; and in the long run in terms of damaging a country's reputation and eroding its export competitiveness. For example the EU ban on fish exports from Kenya decreased export earnings by 37% (Henson *et al.*, 2000) and US border detentions of vegetable shipments from Guatemala made this country lose $ 35 million annually in the period 1995-1997 (Julian *et al.*, 2000).

Some developing countries have been successful in complying with increasing food standards. Among the success stories are Thai and Kenyan horticulture (Jaffee *et al.*, 2005; Jaffee, 2003); Thai and Nicaraguan shrimp (Jaffee *et al.*, 2005); and Indian spices (Jaffee, 2005). Instead of acting as barriers, emerging food safety and quality standard might provide incentives for developing countries for upgrading their export capacity and for gaining access to high value food markets. Jaffee and Henson (2005) note that the most successful countries and/or sectors have used high quality and safety standards to (re)-position themselves in competitive global markets. In fact, standards provide a bridge between producers in developing countries and consumer preferences in high income markets and could be used as catalysts for upgrading and modernization of developing countries' food supply systems and improving their competitive capacity. Food safety standards reduce transaction costs and promote consumer confidence in food product safety, without which the market for these products cannot be maintained or enhanced (Henson and Jaffee, 2006). Food standards provide opportunities that can be utilized by developing countries to their competitive advantage. If standards can be used as catalysts in such a way, they provide a basis for long term export growth. A key element in attaining these benefits is to be proactive in food quality and safety and facilitate business strategic responses (Jaffee and Henson, 2005). Compliance with stringent food quality and safety standards might create positive spillover effects into domestic markets and traditional agricultural supply systems (Henson and Jaffee, 2006). Attention to 'good agricultural practice' and consumer health in export supply chains might spillover to more traditional and domestic agricultural and food markets. This might benefit the local population and domestic producers.

2.2.2 *Food standards and supply chain restructuring*

The way standards affect the structure of food supply chains in developing countries, is crucial for understanding not only the link between standards and export performance but also the link to rural development and poverty (Maertens and Swinnen, 2006b).

Food standards pose specific challenges to small agro-food businesses, exporters and farmers in developing countries to stay in the business in high-standards export markets. These challenges arise from the financial and other constraints these small enterprises face in complying with food standards. They experience difficulties in accessing the necessary information on standards, in translating such information into specific investment needs, and in making the necessary investments for quality and safety upgrading while facing financial, technical and institutional constraints (Maertens and Swinnen, 2006b). Although, in general, the cost of compliance with standards might be low relative to the total export value in a particular sector, this cost might be very high relative to the means of small firms and poor farmers (Reardon *et al.*, 1999). Therefore the increased importance of food standards in global agricultural trade can lead to those weaker players exiting profitable high-standard export markets and hence to consolidation of the supply base. The literature has presented some evidence of ongoing consolidation of agricultural exporting and processing activities in developing countries. Dolan and Humphrey (2000) find that in Kenya and Zimbabwe smaller agro-food businesses increasingly squeezed out of fresh vegetable trade and that the fresh fruit and vegetable export sector is dominated by a few large agro-industrial companies and exporters. Also Jaffee (2003) points to that fact for the case of Kenya fruit and vegetable exports and estimates that 90% of the export volume is controlled by only six companies. There is also evidence of ongoing consolidation at the level of primary production. This is closely related to increased vertical coordination in the export supply chain.

Compliance with increasingly complex and stringent food standards and monitoring of this compliance throughout the supply chain requires tighter vertical coordination at different nodes in the chain. The search for quality and high-standards is a key driving force of increased vertical coordination in global food supply chains (Maertens and Swinnen, 2006b). At the export-import node of the chain; importers in high-standard markets, especially the large retail chains, increasingly procure from a list of preferred suppliers in order to guarantee quality and safety of the produce. Being on this list and attract contract deals with importers becomes increasingly crucial for exporters in developing countries to gain and maintain market access. This is specifically tough for smaller exporters who are disadvantaged in vertically coordinated supply chains because they cannot provide the quantities large multinational food distributing companies demand. This might lead to further consolidation at the level of exporting companies. For example in Kenya, the few large fresh fruit and vegetable exporting companies who dominate the sector all have contracts with supermarket chains in the UK and other European countries (Dolan and Humphrey, 2000).

Upstream the supply chain, vertical coordination between exporters /processors / retailers and primary producers in developing countries is increasing in response to increasing food standards. Traditional spot market trading systems with intermediaries or 'middlemen' are generally not effective in high-standards supply chains. In such trading systems, monitoring compliance with standards is extremely difficult and expensive in terms of transaction costs. Hence, as a result of increasing food standard, the food supply system is moving towards increased vertical coordination where contract-farming and integrated estate farming become increasingly important. In general, two distinct pathways of increased vertical coordination in high-standards food supply chains can be identified.

First, buyers may increasingly rely on contract-farming with suppliers. As to guarantee product quality and assure process conformity with food safety standards, these buyers might choose to contract with larger farmers and / or to apply tighter contract coordination (Maertens and Swinnen, 2006b). Second, increasing standards might lead to a shift from smallholder contract based production towards large-scale vertically integrated estate production. This would be a more radical change of increased vertical coordination and implies exporters and agro-processing companies to start their own primary production on bought or rented land. Such an integrated way of production increases the scope for standardized production and for meeting high safety and traceability standards at low transaction costs. However, such large-scale integrated production entails risks for agro-exporting companies and increases other costs; e.g. supervision costs of labor and the cost of renting or buying land.

2.2.3 Food standards implication for development and poverty reduction

Understanding the link between standards on the one hand and export competitiveness and performance of developing countries on the other hand is crucial in the design of a broader development agenda. Yet, an even more critical issue for policy makers concerned with equitable growth, is to understand the link between food standards, developing country agricultural exports and poverty in those countries. As indicated by the Jaffee *et al.* (2005) the cost and structural changes associated with compliance with food standards can cause significant redistribution of welfare across countries, along the supply chain and in societies. Such redistribution determines the capacity of high-standards agricultural trade to serve not only as a basis for long term export growth and a tool for upgrading and modernizing developing country food supply systems but also as an engine for economic growth and poverty reduction. Some authors argue that high standards agricultural trade may do little for the fate of poor farmers and fishermen as they are likely to be excluded from high-standards supply chains while the rents in the chain are extracted by multinational companies and developing country elites (Dolan and Humphrey, 2000; Farina and Reardon, 2000; Reardon *et al.*, 1999).

The general view in the literature is that small farmers, and especially the poorest ones, are increasingly being squeezed out from high-standards production and trade. Many authors point to the fact that poor farmers do not benefit from agricultural trade because high standards impede their participation in export supply chains (Reardon *et al.*, 2003; Pimbert *et al.*, 2001; Kerallah, 2000; Gibbon, 2003). This exclusion of the smallest farmers is argued to happen either because contract-farming is biased towards large farmers or because large-scale vertically integrated production crowds out small suppliers. First, contract-farming might be biased to larger farmers because of the high transaction costs processing and exporting firms face in sourcing from a large number of (dispersed) small suppliers (Key and Runsten, 1999). Especially monitoring conformity with standards might involve very high transaction costs. Second, smaller and poorer farmers might need more intensified farm extension and additional financial assistance in order to meet quality and safety standards. The burden this brings to exporting companies might lead them to choose to contract only larger farmers.

Participation of small enterprises and poorer farmers in high-standards export production and trade is a necessary but not a sufficient condition for an enhanced welfare effect of high-standards agricultural trade; these agents also need to effectively benefit from this participation (Maertens and Swinnen, 2006b). It has been repeatedly argued in the literate that the gains from high-standards agricultural trade are captured by foreign investors and developing country elites (Dolan and Humphrey, 2000; Farina and Reardon, 2000; Reardon *et al.*, 1999). Contract-farming has been criticized as a tool for agro-industrial firms and food multinationals to exploit unequal power relationship vis-à-vis farmers and to extract rents from the supply chain to the disadvantage of poor farmers (Warning and Key, 2002). Consolidation of the export supply base and vertical coordination in the supply chain can amplify the bargaining power of large exporting companies and displace decision-making authority from the farmers to the downstream agroindustrial companies. This would strengthen the capacity of large companies to extract rents from the chain (Maertens and Swinnen, 2006b).

2.3 Overview of the Kenyan horticultural sector

Horticultural exports have grown dramatically in many sub-Saharan African countries while many other agricultural export commodities have faced stagnation and declining world market prices. The Kenyan horticultural export industry has been most successful and is now by far the largest exporter of vegetables to the European Union (GoK 2006). The exports of vegetables have increased quickly over the last decade, surpassing coffee - historically Kenya's most prosperous export crop - as the nation's second major source of foreign exchange in the agricultural sector next to tea.

The value of horticultural exports raised between 1980 and 2000 from 50 to nearly 250 million US$ (Jaffee, 2003). After the year 2000, this development continued and the value of horticultural produce (in terms of gross market production value) increased to over 550 million US$ in 2005 (GoK 2006). The value share of horticultural products in percent of total export value grew in the same time (2001-2005) from 31 to 41%, underlining the growing importance of horticulture for the Kenyan economy (GoK 2006). As shown from Figure 2.1 the volume of fresh produce exports did not drop since 2003. Besides its high growth, the horticultural industry (both export and domestic) currently contributes about 19% of Kenya's annual Gross Domestic Product (GDP) (GoK 2006). The importance of the horticulture sector is also reflected by the large number of people employed in the sector ranging from 50,000 to 116,000 in 2005 (Dolan, 2005; Humphrey *et al.*, 2004).

The major export vegetable crops are green beans, peas and Asian vegetables (such as karella, chillies, aubergines and okra) with beans and peas mostly being exported to the EU. The main flowers exported include roses, carnations, statice and a variety of summer flowers (voor den Dog, 2003).

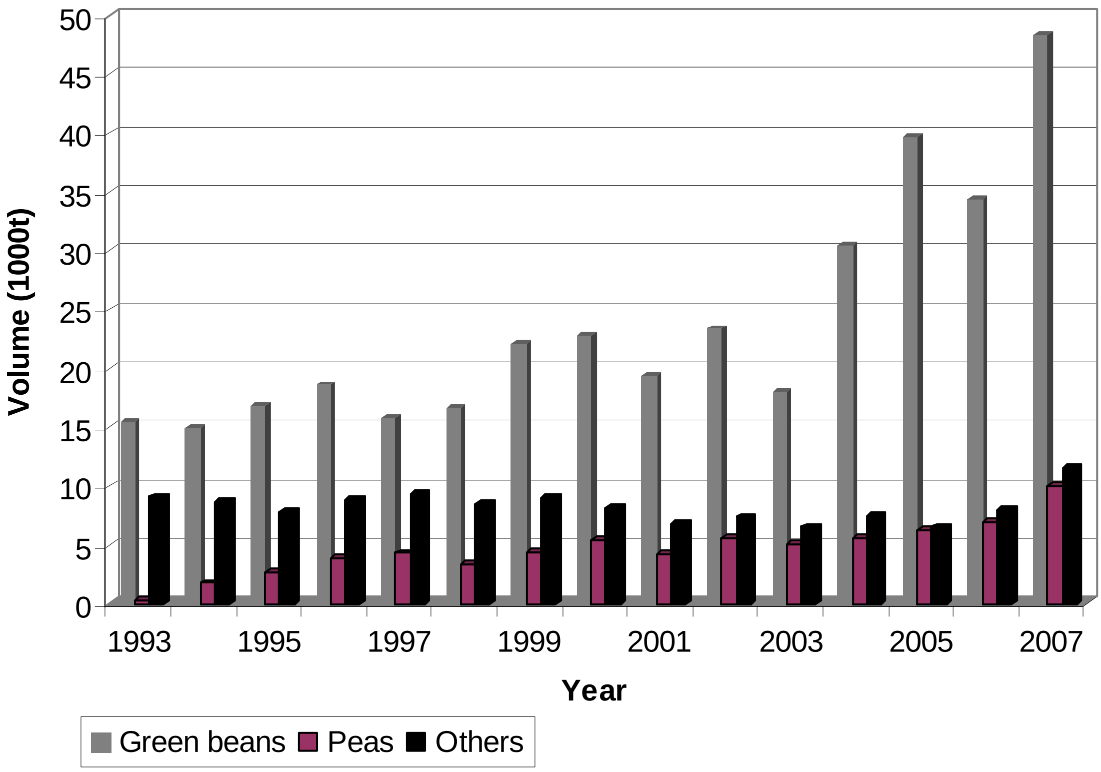

Figure 2.1 Trends in vegetable exports from Kenya.
Source: HCDA, 2008

The vast majority of this produce (89%) is destined for Europe, with the United Kingdom (UK) market absorbing the major share. Kenya also exports Asian vegetables to the Middle East market (Harris *et al.*, 2001). Besides UK most of the Kenyan exports also goes to the Netherlands, France and Germany. This is demonstrated in Table 2.1. For fruits, the picture is more complex with passion fruit mainly going to the UK, avocado mainly going to the Netherlands and France, while mango going almost exclusively to the Middle East.

The concentration of products in a very small number of markets implies that the development in these markets become crucial. In Europe in general and in the UK in particular, large supermarket chains play a dominant role in the retail of fresh produce. In the UK, the supermarkets sell around 70% of total fresh produce while the remaining 30% is channeled through wholesale markets (Barrett *et al.*, 1999). In general, the supermarkets have a similar share of trade in Northern Europe while they are much less dominant in Southern Europe where much fresh produce is still sold on traditional markets and through independent greengroceries. France is somewhere in the middle. Everywhere, though, supermarkets are gaining market shares.

Table 2.3 Markets for Kenyan fresh horticultural exports by crop type and country (% of export volume)

Crop type	UK	Netherlands	France	Germany	Rest of Europe	Middle East	South Africa
Total fresh horticulture	35	33	10	7	3	7	5
Cut flowers	16	65	1	9	3	4	1
Green beans	56	0	29	3	3	0	10
Snow and snap peas	73	9	5	7	3	0	3
Asian vegetables	66	1	4	12	1	0	16
Avocado	1	46	32	9	2	7	3
Mango	4	1	1	1	1	92	1
Passion fruit	49	18	16	6	9	1	0

Source: HDCA, 2004
Note: The percentage may not add up to 100 since it is rounded to the nearest digit.

The growing dependence of Kenyan exporters on the UK market had important consequences for the production and processing of horticultural products. For example, in the 1960s horticultural products were grown by smallholder farmers, sold to a small number of exporters, and channeled through wholesale markets to UK retailers. According to Gray and Kleih (1997), in that period wholesalers controlled 90% of the UK fresh horticultural trade. When the UK supermarkets entered the fresh vegetables trade, they too purchased product from the wholesale market. However, this system could not achieve the quality and quantity that supermarkets required. As a result, by the 1990s, this loose network between the UK importers and an array of exporters became a coordinated value chain dominated by a few UK supermarkets (Dolan and Humphrey, 2000). The strong link to the UK can be seen as an advantage for the export industry, because UK's supermarkets have maintained a product differentiation strategy which allows higher margins (Jaffee, 2003).

Beside the export sector, the domestic market also plays an important role for the economy at large and farmers' welfare in particular. Comparing the two sectors in terms of intensity of production, it is apparent from Figure 2.2 that volumes of vegetables produced for the domestic market by far exceed those of the export market and thus also far more smallholders participate in local than export market production (Mithöfer *et al.*, 2008). The domestic vegetable sector contribution to the total GDP however is lower compared to the export vegetable sector.

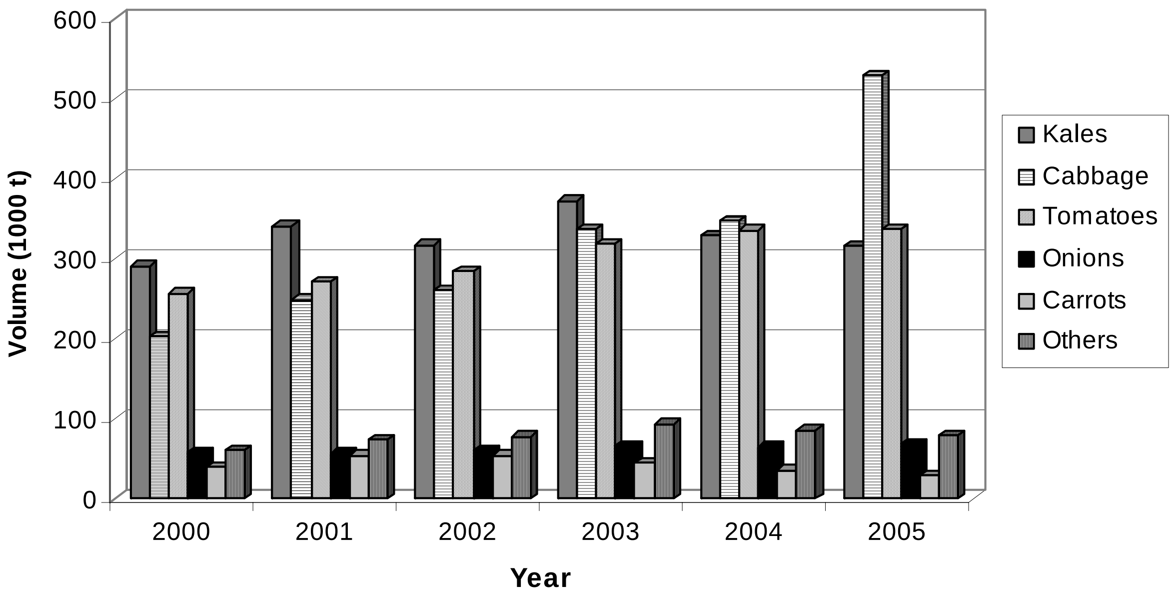

Figure 2.2 Kenya vegetable productions for local market by crop and year.
Source: Mithöfer *et al.*, 2008

Most of the produce for the local market is marketed through the informal sector, i.e. open markets and kiosks, and currently only 5% are sold through supermarkets (Tschirley *et al.*, 2004). So far, their production is not governed by production standards and their enforcement, e.g. on maximum residue levels (MRL), and tests related to food safety issues are rarely done. Within the next years, retail shares of supermarkets are expected to increase to 10-20% (Tschirley *et al.*, 2004) and concerns over food safety issues of vegetables produced for the local markets are growing (Kedera, 2006).

2.3.1 Supply chain for fruit and vegetables in Kenya

The market channels vary widely depending on the market location and on the characteristics of the producers. Domestic produce for rural markets is delivered directly from local farms while urban market chains require transportation. Smallholders rely on wholesalers, retailers or brokers, while larger producers usually have the resources to supply urban markets through own transportation (Minot and Ngigi, 2003). The ongoing spread of supermarkets even in rural areas supports this competitive advantage of larger-scale producers as larger suppliers lower retailer's transaction costs. This tendency can be shown by the supply composition of fresh fruit and vegetable of Uchumi[5] supermarket. The same trends can be observed in the supply chains for the export of fruits and vegetables. However, this trend is not generally observable, as Nakumatt and Mugoya supermarkets sources of fresh fruit and vegetables are focused on small-scale farms (Neven and Reardon, 2005).

Minot and Ngigi (2003) emphasize that smaller producers commonly use longer supply chains. Consequently, the market gets more concentrated. This is typically accompanied by smaller margins for those small-scale farmers who depend on the longer chains. Consequently further vertical integration of the supply chain takes place (Neven *et al.*, 2005).

Currently most of the export horticultural produce is channeled through the supermarket chain, while a smaller part is channeled through the wholesale chain into the European Union. The wholesale chain is mainly supplied by small and

[5] Uchumi, Nakumatt and Mugoya are the biggest supermarkets in Kenya

medium size producers, while in the supermarket chain large growers dominate (Barrett *et al.*, 1999). Small-scale producers often operate as individuals or as a member of out-grower schemes. Figure 2.2 shows the fruit and vegetable supply chain to illustrate the different choices the actors have in selling their produce.

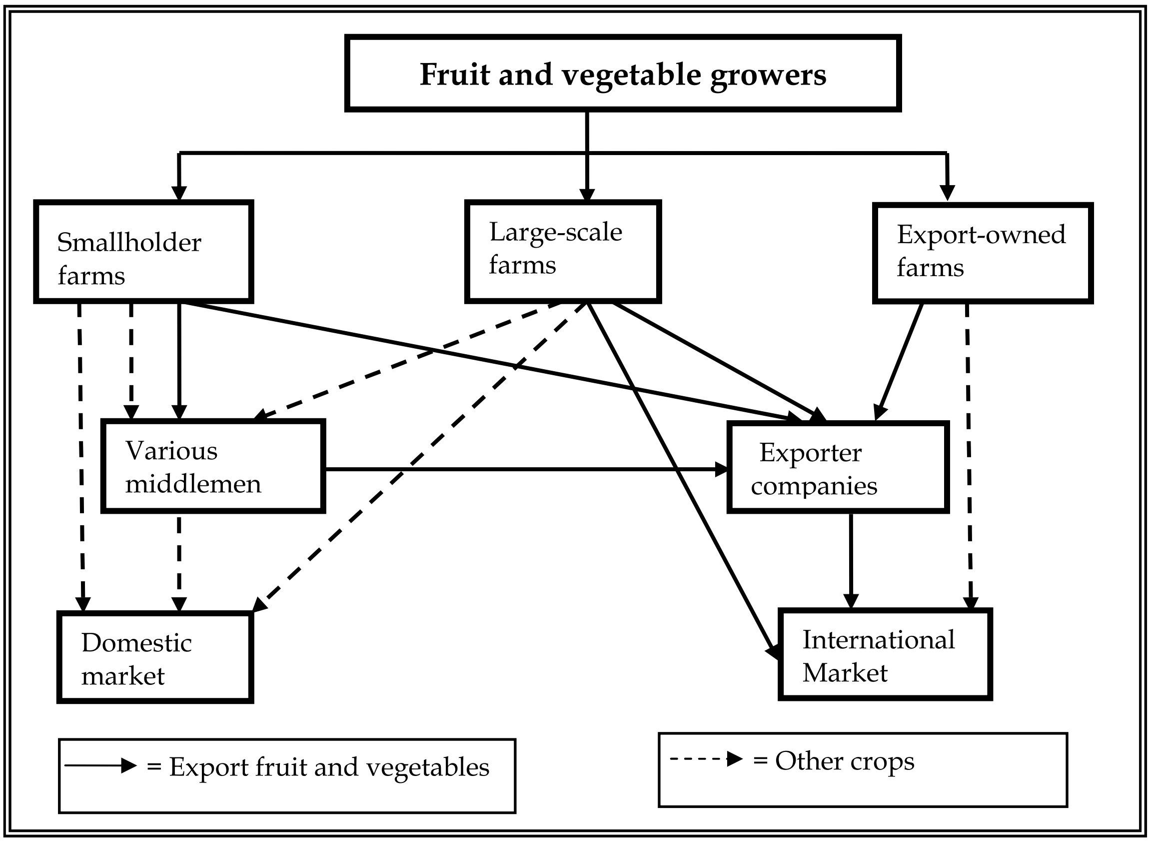

Figure 2.3 Supply chain of fruits and vegetables in Kenya
Source: Own presentation

The concentration of exporters in Kenyan horticulture is quite low compared to horticultural industries in other counties. There are about 400 exporters active, although no more than half of these are active at the same time (Jensen, 2005). About half of the exporters can be said to be so-called 'briefcase exporters', i.e. part-time exporters who go in and out of the market according to the market situation. They are only present at market peaks such as Mother's Day and Christmas for flowers and the European winter months for temperate vegetables. These exporters have no structures in place in the sense that they do not have farms on their own, nor do they have permanent trading structures like lorries and cold stores, but rent transport vehicles and space in cold stores when it is necessary. While the number of these exporters is large, the amount they export is very small, somewhere between 2 to 10% (Jensen, 2005). About 90% of exports are done by constant year round exporters. Most of these have their own farms and supplement the export volume by buying from other farmers either large or small-scale commercial farmers or smallholders. A few exporters do not source from other farms than their own.

2.3.2 *The role of small-scale producers*

Although solid quantitative evidence concerning the actual number of small-scale farmers involved in export fresh vegetable production in Kenya is controversial, there is a general consensus that smallholder farmer participation in export markets has been significant. Estimates from the early 1990s suggest that smallholders supplied over half of the export vegetable production (Kimenye, 1993; Jaffee, 1995). More recently, the Horticultural Crops Development Authority (HCDA) estimated that 70% of exported vegetables are produced by smallholders (Harris *et al.*, 2001). According to interviews with four leading exporters, Dolan and Humphrey (2000) conclude that just 18% of vegetables for export come from smallholders. They also found that smallholders are unable to comply with food-safety and quality requirements imposed by supermarkets and other buyers. They argue that these requirements are leading exporters to grow their own produce or purchase from large-scale commercial farms. On the other hand, exporters may wish to under-report the share of production that comes from smallholders to satisfy European buyers who are suspicious of smallholder quality control (Harris *et al.*, 2001). Jaffee (2003) interviewed several exporters and estimated that smallholders account for 27% of exported fresh vegetables. A recent census estimated the current number at about 12,000 smallholders producing for the vegetable export market in nine districts of Kenya in the end of 2005 (Mithöfer *et al.*, 2008). The data from the 2000 Rural Household Survey suggest that almost all farmers, large and small, rich and poor, participate in some form of horticultural production.

One of the difficulties in estimating the number of participating smallholders is the definition of the small-scale producers. With an exception of Mithöfer *et al.* (2008), in most of these estimate small-scale producers are defined as farmers with less than 10 acres of land while medium-scale and large-scale producers are farmers with between 10 to 20 and larger than 20 acres respectively (Harris *et al.*, 2001). However recent discussions with experts from Kenya reveal that these classifications do not reflect the reality on the ground. The experts instead define small-scale horticultural producers as farmers with less than 5 acres of land under horticulture, whereas farmers with 5 to 10 acres of land and greater than 10 acres under horticultural production as medium- and large-scale producers, respectively (Mithöfer *et al.*, 2008). Thus, this definition is applied throughout the thesis instead of the former classifications.

2.3.3 Development of Kenyan horticultural export sector

The horticultural sector in Kenya can be considered a successful case of export diversification. Minot and Ngigi (2003) identified the reasons for such a success. First, Nairobi's location as a centre of air transport between Europe and the East and Southern African region, and Kenya's role as a major tourist destination, ensure that there is sufficient northbound air cargo to transport exports. Second, preferential treatment under the Lomé Convention between African Caribbean Pacific (ACP) countries and the EU provides concessionary access for Kenyan flowers and vegetables to the European market. Third, the sustained demand for horticultural products as a result of high and growing incomes in Europe provides a stable and growing market for Kenyan producers. Fourth, close co-operation with the supermarket chains in Europe and a smooth adaptation to the new criteria defined in the various labels by supermarkets and other market sources. Finally, the presence of ample local and international investors, particularly in the cut-flower business, provides Kenya with an added advantage (Markandya *et al.*, 1999; voor den Dog, 2003).

There were also a number of trade related development assistant (TRDA) activities that contributed significantly to the development of the Kenyan horticultural industry. By far the most ambitious TRDA undertaken in Kenyan horticulture ever is a project sponsored by the Japan Bank for International Corporation (JBIC) entitled 'the Horticultural Produce Handling Facilities project'. The project aimed at establishing seven local satellite depots located in the main growing areas and linked to a large auction house facility in Nairobi managed by the HCDA. The original idea was that the HCDA should source supply from smallholders organized in farmers' groups, process the produce at the satellite depots and auction it off to exporters in the auction in Nairobi. The whole approach soon showed to be infeasible due to the requirements of the major companies for assured and traceable supplies.

The Fresh Produce Exporters Association (FPEAK) is another main association representing fruit and vegetable exporters. Historically, it has mainly served the interests of small and medium-sized exporters, while the largest have either preferred to lobby on their own or worked their influence through the Kenyan Flower Council as most of the largest exporters produce flowers too. FPEAK's main source of finance has until recently been United State Agency for International Development (USAID). It has undertaken traditional industry coordination functions as well as provided extension services and run traditional development projects mainly focused on linking smallholders to exporters by establishing farmer groups. The support to farmers' groups have consistent in solving their input and credit problems and more recently to assure compliance with MRLs and secure traceability. While the assistance to smallholders and exporters are generally viewed favorably, the organization itself has failed to develop in a sustainable way (ECI 2001).

The Pesticide Initiative Program (PIP) was launched in 2001 under the auspices of the COLEACP, an EU funded organization that promotes horticultural trade from ACP countries. One component of PIP, the 'Good Company Practices' component, involves the provision of assistance to individual companies within a number of ACP countries in order to design or improve food-safety control and risk management systems and to provide technical assistance and training to company staff and smallholder out growers. The initiative is demand-driven with sub-projects being negotiated with individual export companies with the support tailored to the specific conditions, goals, and capacities of each company.

Finally, the Horticulture Development Centre (HDC) is another USAID-funded program managed by the agribusiness firm Fintrac Inc. and was established in October 2003. The objective is to increase smallholders' income through crop diversification, improvements in production, post harvest technologies and market linkages. The project currently targets smallholder production for both the export and the local market of passion fruit, vanilla, spices, flowers, fruit and local market vegetables. It also trains smallholders in various standards such as limits on pesticide residues and the private standard GlobalGAP.

2.3.4 *Kenya Good Agricultural Practices (GAP) initiatives*

There have been efforts in Kenya to benchmark national Good Agricultural Practice (GAP) schemes for horticultural products to GlobalGAP. First in June 2005 the GlobalGAP Technical and Standard Setting Committee (TSC) approved equivalent status for the seventh edition of the Kenya Flower Council (KFC) standard. This completed the process of benchmarking against the GlobalGAP cut flower and ornamentals standard. Second, in August 2007, the GlobalGAP TSC approved equivalent status for the KenyaGAP standard, developed by the Fresh Produce Exporters Association of Kenya for fruit, vegetables and flowers, successfully completing a benchmarking process initiated in 2005 (UNCTD, 2008).

The Kenya Bureau of Standards (KEBS) first developed the national horticultural code of practice through its multi-stakeholder national food-safety committee. The purpose was to develop a national baseline that would provide guidance to all producers on basic GAP principles, workers' health and safety and environmental conservation. In 1977, FPEAK established its own code of practice for FFV, which was revised in 1999, and again in 2003 to develop it into KenyaGAP. The visit of chairman of GlobalGAP to Kenya in 2005 provided an opportunity for clarification and deeper understanding of GlobalGAP benchmarking procedures, with a focus on how smallholders could be accommodated into a national scheme benchmarked to GlobalGAP (UNCTD, 2008). As a result, the national GlobalGAP TSC was commissioned to establish interpretation guidelines for the GlobalGAP fruit and vegetables standard for Kenyan smallholders with a view to facilitating cost-effective and sustainable certification of small-scale growers. The launch of the GlobalGAP benchmarked Kenyan equivalent standard, KenyaGAP, has been cited as a role model for the region in pushing towards global harmonization of GAP in Africa and demonstrates how it is possible to incorporate smallholder needs into emerging private standards like GlobalGAP.

2.4 Summary

Over the past five decades, production and trade of agricultural commodities have played a major economic role in many developing countries, especially in the small and least developed ones. This progress is partially attributed to the lowering of the barriers to trade through a removal of quotas, a reduction in tariffs and preferential trade agreements for developing country imports in western economies. As a result many sub-Saharan African countries have been diversifying their export portfolios away from primary commodities into non-traditional exports with more auspicious market trends. In particular, horticultural production has been indicated as a sector that can provide real opportunities for enhancing farm incomes and reducing poverty and since export of vegetables involves a much higher rate of labor inclusion than traditional export crops, it also suits donor’s support of labor-intensive trade.

However, it is argued that the gains from trade liberalization are offset by increasing food standards that are mainly imposed by high-income countries and increasingly dominate the world’s food trading system. Exporters are required to conform to increasingly stringent regulations and in many cases, private-sector standards. There has been increasing awareness of health risks related to food consumption in many developed countries and as a result it has become a clear objective of governments and private sector in these countries to maintain a low level of these risks. Developing countries at large and Kenya in particular are generally more concerned with food security (i.e. there being sufficient nutrients available for the population) than food-safety for consumers. However, from the developing country perspective, food-safety issues have important implications for export opportunities to countries with a low risk tolerance. To reduce the risk intrinsic in the global trading of food and other agricultural products, these products are confronted with stringent technical requirements at the country and business level.

Thus, there are concerns that the enhanced stringency of food-safety standards that are imposed by high-income countries can negatively affect the competitiveness of producers of developing countries. First, small-scale producers may be squeezed out of the vegetables value chains because exporters prefer to work with larger farmers who can be coordinated more easily. Second, private standards may contribute to a shift away from procurement from independent producers through contract farming towards increased agro-industrial production in estates. Yet, in some cases, contrary to the these hypothesis others argue that such standards can play an important and positive role, providing the catalyst and incentives for the modernization of export supply and regulatory systems and the adoption of safer and more sustainable production practices. By certifying the quality of their products through standards schemes, developing countries' farmers can add value to their products, differentiate them and climb up the value chain. This study tries to test these propositions from an illustrative cases study on vegetable exports from Kenya.

Chapter 3

Conceptual Framework

3.1 Introduction

The production of food products in developing countries for export markets to industrialized countries is constrained primarily by lack of information. Producers are often unaware of consumer preferences and regulatory standards of the importing country. Policies to enhance higher environmental and health standards of food production are rarely existing because of weak institutions and poor capacities of regulatory enforcement. Likewise consumers in importing countries are often misinformed about the actual production conditions in the developing countries. Their perception can be heavily influenced, for example, by reports of misuse of outdated pesticides, child labor, or otherwise poor labor conditions etc. Nobel laureate Spence (1974) suggests, that a mechanism is needed that will solve the problem of asymmetric information. Certification is a means of providing information to the buyer that the product conforms to clearly defined standards. At the same time certification can be a vehicle to induce producers to adopt safer and environmentally more benign crop management practices. In this chapter an attempt is made to highlight the general conceptual framework for understanding the adoption process from the producer perspective and at the same time the potential impact of GlobalGAP certification on both producers and consumer welfare. Nevertheless specific theoretical model relevant to specific research questions are presented in the subsequent chapters.

3.2 Innovation and adoption of standards

Adoption and diffusion of innovations theory (David, 1969; Rogers, 1995; Sunding and Zilberman, 2001; Zilberman and Waibel, 2007) has been widely used to identify factors that influence an individual's decision to adopt or reject an innovation. "An innovation is an idea, practice or object that is perceived as new by individual or other unit of adoption. The perceived newness of the idea for the individual determines his or her reaction to it" (Rogers, 1995). Rogers identifies five characteristics of an innovation that affect an individual's adoption decision. These are (i) relative advantage, which is the degree to which an innovation is perceived as being better than the idea it supersedes; (ii) compatibility, or to the degree to which an innovation is perceived as consistent with the existing values and beliefs, past experiences and the needs of potential adopters; (iii) complexity, which is the degree to which an innovation is perceived as relatively difficult to understand and use; (iv) trialability, or the degree to which an innovation may be used experimentally on a limited basis; and (v) observability, which is the degree to which the results of an innovation are visible to others. The relative advantage and observability of an innovation describe the immediate and long-term economic benefits from using it whereas compatibility, complexity, and trialability indicate the ease with which a potential adopter can learn about and use an innovation (Rogers, 1995). Although this concept is relatively old, it is relevant for most current adoption studies. However it is important to note that it may not altogether be applicable for the case of adoption of standards.

For the purpose of this study, GlobalGAP is considered as an innovation. The adoption and certification of this standard cannot be seen as a single event that takes places on a farm. It rather must be described as a process over time with different stages from the first knowledge of the standard until its implementation. The process of compliance can be described as a process, which consists of at least three stages: 1) information, 2) decision and 3) implementation. At the first stage, the information stage, the producer obtains information and knowledge on the standard. He or she becomes aware of the existence of the standard and gains knowledge on how the standard works. The information stage is essential to pass to the subsequent steps of the compliance process, as certain knowledge on the standard is necessary to form an attitude toward the standard and to make a decision. It is vital to emphasize the critical importance of this stage in developing countries like Kenya. In such countries the largest number of producers faces great difficulties in accessing information, due to limitations including the lack of formal education and poor infrastructure. These limitations create obstacles to information access. At the second stage, the decision stage, the producer makes a decision on the implementation of the standard. Once the decision to implement the standard is made, the producer enters the implementation stage. The implementation stage consists of the actual adoption of the standard and the introduction of the standard's requirements on the farm.

The decision to adopt safety standards is also an investment decision. This decision may involve sizeable fixed costs (e.g. grading shed, pesticide store, office etc), while the benefits realized over time. The choice of whether or not to adopt emerging standards will, therefore, be based on a careful assessment of a large number of technical, economic and social factors. The technical feature of the standards may have a direct consequence on the decision making process. The potential capability of the standards, in terms of enhancing yield, reducing cost of production and giving rise to higher profit, are also substantially important. The problem, however, is that when a technology first introduced, uncertainty with respect to its functioning under local settings is often high. Also, it is difficult to tell its economic outcome with certainty. However, over time, as farmers adopt and become familiar with the new technology, the uncertainty and the cost associated with it will fall. Some farmers may fail to adopt the standards totally if they think that it simply doesn't function well under their circumstances, or if the size or type of their farm operation is not suited to the technology in question.

The economic theory of adoption is generally based on the assumption that the potential adopter makes a choice based on the maximization of expected utility subject to different constraints. Faced with high cost of compliance and complexity of the standard, farmers generally examine the perceived benefit vis-à-vis the expected cost before making any kind of decision to adopt the standard.

3.3 Welfare effects of GlobalGAP certification

The analysis of the economic consequences of GlobalGAP certification in welfare terms can be illustrated by considering some simplified assumption. Considering the case where there is no certified vegetable market at the beginning, partial equilibrium implications are apparent on the right hand side of Figure 3.1 that shows the non-certified quantity demanded, MWP, which represent the marginal willingness to pay and quantity supplied, MPC, which represent the marginal private cost of fresh vegetables, where a* and q_o* are the pre-certification equilibrium price and quantity of vegetables, respectively. However, every unit of production is associated with negative health and environmental externalities as represented by MEC, which represent marginal external cost. A certification scheme like GlobalGAP is introduced, and a portion of the vegetable producers changes their practices to meet the new requirements. Two markets are now relevant, the one for certified vegetables and the other for uncertified ones, assuming that there exist producers and consumers which maintain the new market. The certified and uncertified markets are denoted by sub-scripts c and u, respectively.

If indeed a market for certified vegetables appears and consolidates, where agents participate voluntarily, it is because both suppliers and consumer of this market obtain some benefits. However, although it might be likely that they will be better off than with only the non-certified products market situation, this is not necessarily the case. It will depend on the specific market conditions. Assuming they were better off, both producers and consumers of this market would incur welfare gains. The externals benefiting from the certified market would gain, since now the negative externalities are smaller per unit of vegetables provided. The net result would be an improvement in welfare, depending on what is the effect of the certification on the consumers and producers of uncertified vegetables.

The existence of a certified market affects the outcome in the uncertified one. There is likely to be a decrease in the demand for uncertified vegetables, represented in Figure 3.1 with a shift of the marginal willingness to pay curve to the left, from MWP to MWP_u. For the case that the marginal private cost in the non-certified market remain unchanged, the equilibrium quantity and the marginal price is represented by b* and q_u*. It is also assumed that the marginal external cost (MEC_u) in the non-certified market segment remain the same with the original one (MEC). In terms of welfare, consumers' surplus refers to A, producers' surplus to B, and externalities refer to C.

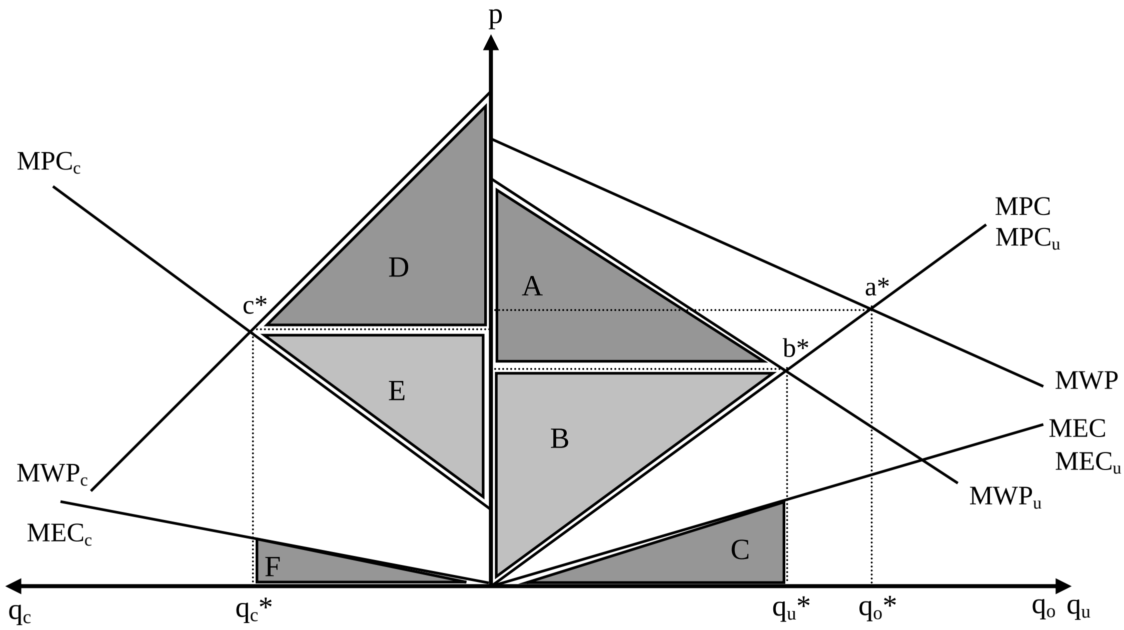

Figure 3.1 The theoretical welfare effects of GlobalGAP certification
Source: Own presentation

The certified vegetable market is represented on the left hand side of Figure 3.1. The marginal private cost for certified market (MPC_c) intersects the vertical axis above MPC_u, showing additional costs producers would have to incur when following certification standards. Similarly the marginal willingness to pay for certified market (MWP_c) intersects the vertical axis at a higher value than MWP_u, which captures the idea that willingness to pay for the first unit is higher when the product is certified. To simplify the presentation, the marginal private cost functions are represented with the same slope in certified and uncertified markets, even if in general they could be different. It is plausible to assume that negative externalities of certified production are lower than under conventional production schemes as represented by MEC_c. In this situation, the price in the uncertified market (b*) is lower than its counterpart in the certified market (c*). The welfare surplus for consumers, producers and externals in the certified market are represented by areas D, E and F, respectively.

The segmentation of the market, caused by the introduction of certification policy, generated a surplus equivalent to area A+B+D+E-C-F to be compared with the surplus before the market segmentation. The comparison can also be broken down by type of agents. Thus sum of the producers surpluses B and E can be compared to the original producer surplus. Likewise, consumers surpluses A and D can be weighted against the producer surplus before the market segmentation, and C and F compared to the original external costs.

This general framework for assessing the welfare impact of GlobalGAP certification illustrates the societal gains that in principle can be expected from certification. In reality of course the welfare analysis of the economic consequences of certification can be more complex as pointed out by Sedjo and Swallow (2002), for instance if the assumptions presented above are relaxed. However, it is important to note that this general framework helps to identify the major research questions emerging from such interventions. For this study it is not possible to estimate the overall welfare impact of standards on producers and consumers at the national level but an attempt is made to estimate on different components of producers' welfare.

3.4 Research hypotheses

A summarized schematic presentation of the link between standards and household welfare is shown in Figure 3.2. Adoption of production standards like GlobalGAP can improve human and social capital, thus increasing farmers' efficiency and improving the efficiency in the use of production inputs. Improvements in human and social capital result from learning new input use techniques via extension or technology transfer between farmers and from export companies. Improved farmer efficiency leads to enhanced productivity which in turn increases household income. Adoption of GlobalGAP also offers a set of opportunities in which conventional inputs especially agrochemicals can be used more effectively and environmental friendly.

Standards, if adopted could reduce exposure of farmers to highly toxic pesticides and hence their cost of pesticide-related illnesses. In this way farmers are likely to have an improved health status. It also offers an opportunity for conservation of natural resource capital, such as biodiversity especially due to the proper use of agrochemicals. Finally, measures taken to meet export market requirements for food-safety usually have spill-over benefits for other (non-export oriented) local producers or for domestic consumers.

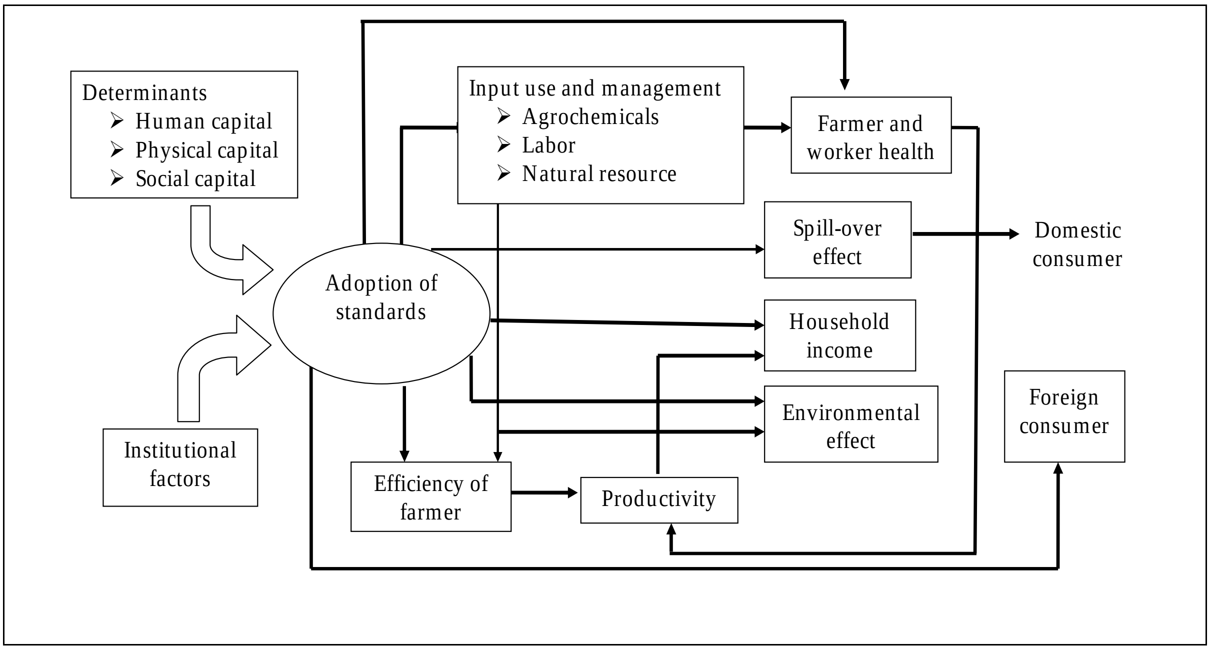

Figure 3.2 Schematic presentation of the link between standards and household welfare
Source: Own presentation

Thus, it is of interest to determine which factors facilitate the adoption of the standards, and which factors bring about productivity and, therefore, lead to an improved income. A two-stage framework is used for impact assessment of food-safety standards in Kenyan small-scale export vegetable producers. Stage one identify which technical, socio-economic, institutional and policy factors influence adoption of standards. In stage two, the effect of standards adoption on household income, pesticide use, household health and environment is assessed. The respective impact indicators are listed in the respective chapters. In addition, the financial internal rate of return of investment in standards compliance is also estimated. In general the study rests on the overall hypothesis that adoption of EU private food-safety standards by small-scale producers leads to improved household income, better farmer health and improved environment.

Chapter 4

Investment in EU Private Food-safety Standards: Does it Pay Off for Small-scale Producers in Kenya? [1]

4.1 Introduction

One strategy employed by Kenya and other sub-Saharan African countries to achieve higher rates of growth in agriculture and to reduce poverty is diversification of export portfolios away from primary commodities into non-traditional exports with more auspicious market trends (Harris *et al.*, 2001). Participation in international trade is generally recognized to favor economic growth and especially agricultural exports would promote development in low-income countries due to the link with the rural economy (Aksoy, 2005). Smallholders participating in export vegetables, whether as producers or the workforce employed in the sector, are better off than non-export smallholders, with average annual household incomes being almost five times higher (McCulloch and Ota, 2002). However, there is a concern that the emerging food-safety standards imposed by industrialized countries can lower the competitiveness of developing countries and impede actors from these countries from entering or remaining in high-value food markets (Augier *et al.*, 2005).

Several authors have found that smallholders, especially the poorest ones, are increasingly being squeezed out from high-standards export production (Barrett *et al.*, 1999; Dolan and Humphrey, 2000; Farina and Reardon, 2000; Reardon *et al.*, 2003; Weatherpoon and Reardon, 2003; Jensen, 2004; Okello, 2006a; Humphrey, 2006). Comparing large-scale and small-scale export producers in Kenya, Mausch *et al.* (2007) also demonstrated that Kenyan large-scale export vegetable producers easily cope with EU standards, as the investments are relatively low compared to the net revenues these farms generate. However, for small-scale producers it takes

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[1] An adapted version of this chapter is forthcoming in Journal of International Food and Agribusiness Marketing.

much longer to "break even" (Mausch *et al.*, 2007), which supports the 'barrier' hypothesis. On the contrary, Henson and Jaffee (2006) and Maertens and Swinnen (2006) argue that compliance with food-safety standards can be a catalyst for upgrading and modernization of developing countries food supply systems.

As stated in chapter two, from a development perspective the increase of food-safety standards by the importing countries generally reflect the preferences of developed country consumers. Production standards focus on high quality produce and place importance on traceability of the produce through the entire production chain to ensure strict adherence to total quality management (Jenson, 2004). In theory, adoption of food-safety standards provides a broad spectrum of potential direct and indirect benefits to the farmers including positive health and environmental impacts stemming from changes in pesticide use and hygiene practices (Okello, 2006b). In addition widespread adoption of standards by export producers may induce some spill-over effects of the good agricultural practices to domestic production and thus benefit domestic consumers. On the other hand stringent food-safety standards may impose severe restrictions for those smallholder producers whose production conditions are still rudimentary. Thus unlike larger commercialized farms, smallholder farmers are faced with financial constraints and human resources limitations in complying with standards. Consequently, small-scale producers, which are the very target of many agricultural development programs that aim at poverty reduction in line with the first Millennium Development Goal (MDG), could become losers of this development.

The smallholders' ability to maintain and strengthen their role in horticultural exports will depend on their capacity to adapt to these changes and fully comply with the emerging standards. Compliance to these standards entails costly investments in inputs, particularly the switch to approved pesticides, and long-term structures like a grading shed, charcoal cooler, disposal pit, toilet, and pesticide store. These investments are "lumpy" and mostly specific to the fresh export vegetable business.

While much research addressed impacts of standards on developing countries at the macro level (Henson and Loader, 2001; Jaffee *et al.*, 2005; Henson and Jaffee, 2005; Aloui and Kenny, 2005; Manarungsan *et al.*, 2005; Henson and Jaffee, 2006), less attention has been given at the level of small-scale producers. Among the studies which looked at small-scale producers are the study by Okello (2006b), who investigated the impact of compliance with international food-safety standards on Kenyan green bean producers, the studies by Maertens and Swinnen (2006) and Minten *et al.* (2006) that focused on the export vegetable industry of Senegal and Madagascar, respectively.

The specific objectives of this chapter are: (1) to investigate the nature and magnitude of costs of compliance with GlobalGAP standards, (2) to examine determinants of adoption of GlobalGAP standards, (3) to estimate the impact of standards on farm financial performance and (4) to analyze profitability of investment in GlobalGAP certification.

In addressing these four objectives, this chapter contributes to the previous studies in two major areas, namely with regard to micro-econometric modeling and with regard to empirical data on smallholders in this sector. In much of the previous literature on private standards, self-selectivity (or endogeneity of adoption of standards) is usually ignored. This chapter addresses this issue using a two-stage standard treatment effect model complemented by propensity score methods and matching techniques. With regard to the data, the chapter draws upon a relatively large sample data set, which is collected via re-call and season-long monitoring survey. Although some prior studies have tried to estimate the income effect of standards, none of them has tried to answer whether investment in food-safety standards compliance pays off for small-scale producers using net-income as proxy.

The organization of the chapter is as follows. Section 4.2 presents the theoretical framework. The data collection methodology and the analytical model are presented in section 4.3 and 4.4, respectively. Section 4.5 presents the results and in section 4.6 some conclusions are drawn and the policy implications are pointed.

4.2 Theoretical framework

The manner in which agricultural households respond to interventions is a critical factor in determining the relative merits or demerits of alternative option. In economic theory, the problem of production, consumption and labor supply decisions are usually analyzed separately through the behavior of the three classes of agents (Sadoulet and de Janvry, 1995). The first one is producers who maximize net revenue with respect to levels of products and factors, subject to constraints determined by market forces and technology, secondly consumers who try to maximize utility with respect to the quantities of goods consumed, subject to constraints determined by market forces, income, household characteristics and tastes and thirdly the workers who try to maximize utility with respect to income and leisure subject to constraints determined by the market wages and total time available and worker characteristics.

The agricultural household model recognizes that the household decision maker is often engaged simultaneously in production, consumption and work decisions. The household has a dual role of producer and consumer, and makes production, labor allocation, and consumption decisions that may be interdependent of one another depending on market forces. By consuming all or part of its own output, which could alternatively be sold at a given market price, the household implicitly purchases goods from itself. By demanding leisure or allocating its time to household production activities, it implicitly buys time, valued at the market wage, from itself (Singh et al., 1986). This household behavior has necessitated the integration of the three decision problems into a single household problem. Since first developed by Singh et al. (1986), farm household models were used frequently to address research questions related to the complex behavior of farm households and it is based on the assumption that for any production cycle, the household maximizes a utility function:

$$U = u(c_m, r_m, l_i; z_m) \tag{4.1}$$

It is assumed that households derive utility from consumption of on-farm goods (c_m), market goods (r_m), leisure (home time) (l_i) and vector of other factors that shift the utility function (z_m). The household maximizes utility subject to a set of constraints, namely cash income constraints, (Equation 4.2), time constraints (Equation 4.3) and technology constraint (Equation 4.4).

$$\sum_{i=1}^{N}\left[p_i(Q_i - c_m) - w\sum x_i + E\right] \geq \sum_{m=1}^{N}\left[p_m r_m\right] \tag{4.2}$$

$$D \geq l_i + l_a(G) \tag{4.3}$$

$$Q_i \leq Q_i(l_a(G), x_i(G), G; Z_u) \tag{4.4}$$

Where Q_i and $p_{i,m}$ denote the quantity and price of farm output respectively; w and x_i represent the price and a vector of inputs used for farm production activities respectively, D and l_a are total household labor endowment and labor devoted to own farm activities, respectively; Z_u denotes a vector of exogenous farm and community level characteristics that shift the production function whereas E and G represent unearned income and adoption of GlobalGAP, respectively. As mentioned in the previous chapters, it is assumed that the adoption GlobalGAP code of practices will increase complexity and reduce flexibility that translate into increased amount of labor allocated for farm production activities. In this case, the amount of labor devoted to own farm activities l_a and possibly the use of other farm inputs x_i are a function of G, the adoption of GlobalGAP standard.

A technology-constrained measure of household income is obtained by substituting Equation (4.4) into Equation (4.2) (Huffman, 1991; Fernandez-Cornejo *et al.*, 2005).

$$\sum_{i=1}^{N}\left[p_i(Q_i(l_a(G), x_i(G), G; Z_u) - c_m) - w\sum x_i + E\right] \geq \sum_{m=1}^{N}\left[p_m r_m\right] \tag{4.5}$$

The Lagrangian technique is used to solve the household utility maximization problem. The Lagrangian solution to the household constrained maximization problems yields a system of first order conditions, which constitute the structural form of the model. The structural form of the model can then be solved for the reduced form that gives the endogenous variables as a function of exogenous variables. The first-order conditions for optimality can be obtained by maximizing the Lagrangian expression L over a set of choice variables.

$$L = U(c_m, r_m, l_i; z_m) + \lambda \left\langle \sum_{i=1}^{N} [p_i \{Q_i(l_a(G), x_i(G), G; Z_u)\} - c_m] - w\sum_{i=1}^{N} x_i(G) + E - \sum_{m=1}^{N} p_m r_m \right\rangle + \mu((D - l_i - l_a(G))) \tag{4.6}$$

The GlobalGAP adoption decision may be obtained from the following Kuhn-Tucker conditions:

$$\partial L / \partial l_a = \lambda [P_i(\partial Q / \partial l_a)] - \mu = 0 \tag{4.7}$$

$$\partial L / \partial G = \lambda [p_i((\partial Q / \partial l_a)(\partial l_a / \partial Q)' + (\partial Q / \partial x_i)(\partial x_i / \partial Q)' + \partial Q / \partial G) - w(\partial xi / \partial G)'] - \mu(\partial l_a / \partial G)' = 0 \tag{4.8}$$

$$\partial L / \partial x_i = \lambda [p_i(\partial Q / \partial x_i) - w] = 0 \tag{4.9}$$

$$\partial L / \partial c_m = U_c - \lambda p_i = 0 \tag{4.10}$$

$$\partial L / \partial r_m = U_r - \lambda p_m = 0 \tag{4.11}$$

$$\partial L / \partial l_i = U_l - \mu = 0 \tag{4.12}$$

where U_c, U_r and U_l are the partial derivatives of the function U. It is assumed that the production function is concave and G and $l_a \geq 0$. The GlobalGAP adoption decision condition is obtained from the optimality conditions, Equation

(4.8) and Equation (4.7) and Equation (4.11), noting that the expression in brackets in Equation (4.8) is the total derivative dQ/dG.

$$p_i(dQ/dG) - w(dx_i/dG)' - (\mu/\lambda)(dl_a/dG)' = 0 \tag{4.13}$$

But from Equation (4.11) and Equation (4.12), $\mu/\lambda = p_m(U_l/U_r)$, then

$$p_i(dQ/dG) - w(dx_i/dG)' - (p_m(U_l/U_r)(dl_a/dG)' = 0 \tag{4.14}$$

The left-hand side of this expression may be interpreted as the marginal benefit of adoption of GlobalGAP, $p_i(dQ/dG)$ minus the marginal cost of adoption, which includes the marginal cost of the production inputs, $w(dx_i/dG)'$, and the marginal cost of labor $(p_m(U_l/U_r)(dl_a/dG)'$, brought about by adoption of GlobalGAP. It will not be optimal to adopt if the marginal benefit of adoption falls short of the marginal cost of adoption.

4.3 Data

To generate the empirical basis for this study, data collection was conducted at vegetable grower level. A multi-stage sampling procedure was used to select districts, sub-locations[2] and small-scale vegetable producers, respectively. The first stage was to select five districts purposively from the two major vegetable producing provinces (namely Nyeri, Kirinyaga, and Murang'a Districts in Central Province and Meru Central and Makueni Districts in Eastern Province). Selection was based on the intensity of export vegetable production, agro-ecology, types of crop produced and accessibility. Meru District is located at higher altitude primarily producing French beans while Nyeri, Kirinyaga, and Murang'a Districts are situated at middle altitude producing a range of green beans and peas. Makueni District is located at lower altitude mainly producing Asian vegetables. These districts represent approximately 50% of smallholders producing for the

[2] Sub-location is a set of villages and represents the lowest administrative unit in Kenya.

vegetable export market (Mithöfer *et al.*, 2008). Since the size of export vegetable producers among the districts vary and to ensure that every element in the target population has an equal chance of being included in the sample, Probability Proportional to Size (PPS) sampling technique is used. Lists of all smallholders in export production, which were compiled as an update on smallholders participation in export production at the sub-location level (Mithöfer *et al.*, 2008), served as a sampling frame for this study. Overall, 21 sub-locations were randomly selected from the five districts by PPS sampling procedure and a total of 439 export vegetables producer households were chosen randomly for the interviews.

Table 4.1 Description of sample size by district

Province	District	Households producing vegetable for export	Number of samples sub- location	Number of households surveyed
Central	Nyeri	1584	6	122
	Kirinyaga	3073	7	116
	Muranga	472	2	44
Eastern	Meru Central	1480	4	120
	Makueni	650	2	37
Total	5	7259	21	439

Source: Own survey

Data collection took place during the 2005/2006 cropping season. For each randomly selected farmer the survey combined a single visit (re-call survey) and a season-long monitoring of household production practices. The data were collected by trained enumerators supervised by the researcher using structured questionnaires. The re-call survey questionnaire covered specific information on the characteristics of household members, household income (both farm and off-farm), household assets such as land size, livestock ownership, farm machinery and household equipments and access to different services like credit, irrigation, formal contract and group membership. The respondents were also asked for their perception of the costs and benefits associated with compliance with GlobalGAP standard. The season-long monitoring survey form was used to record inputs and outputs related to export vegetable production. Besides personal interviews, a series of formal and informal farmer group discussions were also conducted to complement the household survey.

4.4 Analytical models

The purpose of the estimation that follows is to identify the determinants of adoption of GlobalGAP standards and to measure the impact of adoption on income of those who adopt standards. Using the estimation results a financial cost-benefit analysis is further conducted to examine whether investment in food-safety standards compliance pays off for small-scale producers. The major question is what would the income of GlobalGAP adopters have been if they had not adopted standards? To answer this question a suitable comparison group of non-adopters whose outcomes, on average, provide an unbiased estimate of the outcomes that the adopters would have had in the absence of standards needs to be identified. Finding a valid counterfactual is necessary because adopters are not placed randomly and the decision to adopt depends on individual, household, community characteristics and other exogenous factors.

To account for self-selection as a source of endogeneity, and to investigate the robustness of the econometric estimates, three alternative models are applied in this analysis by drawing upon findings in the literature that deals with treatment effects models (Rosenbaum, 1983; Heckmann, 1988; Green, 1997; Angrist, 2001; Wooldrige, 2002). The first model is a two-stage standard treatment effect model in which determinants of adoption and the income effect are estimated simultaneously. The second one is a regression model based on propensity scores and the third model applies a matching techniques. Propensity score matching estimators are not consistent estimators in the presence of hidden bias, however instrumental variables estimation can provide consistent estimation of causal effects even in the presence of hidden bias. It is apparent that if selection is based on unobservable variables, then the estimation of the last two models is not efficient. At this point no stand is taken on what is the correct assumption regarding the presence of hidden bias. The chapter presents all three sets of estimates as a benchmark to compare the results and confirm the robustness of the results to different assumption. In the following section the model specifications are described.

Two-stage Standard Treatment Effect Model

Unlike the conventional selectivity model in which the effects of adoption are calculated using the sub-samples of adopters and non-adopters separately, the standard treatment effect model uses all the observations. In this model, the observed indicator variable, G_i, indicates the presence or absence of treatment, which in this case refers to adoption of GlobalGAP standards by household *i*. Formally, given the unobserved or latent variable, G_i^* , and its observed counterpart, G_i (dummy for adoption of GlobalGAP), the treatment-effect equation can be expressed as:

$$G_i^* = \beta X_i + u_i \tag{4.15}$$

$$Y_i = \alpha V_i + \gamma G_i + e_i \tag{4.16}$$

$$G_i = 1 \text{ if } G_i^* > 0 \text{, otherwise } G_i = 0 \tag{4.17}$$

where X_i is a non-stochastic vector of observed farm and non-farm characteristics determining adoption, Y_i denotes the vegetable export production net-income, V_i is a vector of exogenous variables thought to affect farm financial performance and u_i and e_i are random disturbances associated with the adoption of GlobalGAP and the impact model. Note that it is not possible to simply estimate Equation (4.16) because the decision to adopt may be determined by unobservable variables that may also affect net income from vegetable export production. If this is the case, the error terms in Equations (4.15) and (4.16) are correlated, leading to biased estimates of γ, which is the income effect of adopting GlobalGAP. The selection bias is corrected by assuming a joint normal error distribution, and using a two-stage procedure. In the first stage a probit model is used to estimate determinants of GlobalGAP adoption. The predicted probability of adoption, obtained from the adoption decision model, is used as an instrument for estimating the effect of adopting GlobalGAP in the second stage impact model. However whether or not the effect of a treatment (GlobalGAP adoption) can be correctly estimated using a two-stage regression importantly depends on the validity of the exclusion restriction. Hence for identification purpose, the analyses follow the usual order condition that X_i contains at least one element not in V_i imposing an exclusion restriction in Equation (4.16)[3]. The general form of the first stage adoption model is expressed as:

ADOP = f [AGEH, AGSQ, EDU1, EDU2, FEMA, LIVE, FERT, FACI, MACH, RADI, TVUS, MOBI, TRAI, EXTE, CONT, GROU, IRRI, EXPO, OFFF]

The dependent variable adoption of GlobalGAP standards (ADOP) equals one, if the household has commenced to comply with GlobalGAP code of practices during interview period in the 2005 cropping season, and zero otherwise. It is generally assumed that the household's aim to maximize its expected utility subject to various constraints determines the decision to adopt emerging standards. Based on this assumption, the following observable factors are hypothesized to affect the adoption decision.

First, the household's endowment with family labor is expected to positively affect the probability of adoption, given the added labor requirements for certified export vegetable production. In the model the number of adult females (FEMA) is used as a proxy. Human capital is another factor that can influence the decision to participate in a certification scheme. Age of household head (AGEH), age square (*AGSQ)*, his or her educational attainment (EDU1) and the level of education of that household member who had the highest educational attainment (EDU2) are taken as proxies. While for education the relationship is assumed to be positive, the opposite may be the case for age as young farmers may show a higher tendency to adopt innovations.

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[3] Instrument such as year's of group membership is considered as variable that causally affect adoption of GlobalGAP but do not have a direct causal effect on the outcome and thus satisfy the exclusion restriction..

Ability to undertake additional investments as required by the GlobalGAP food-safety standards suggests a positive link to farm resource endowment variables, thus the value of livestock (LIVE), the value of farm machinery (MACH) and facility index[4] (FACI) are included. However asset variables may be endogenous as the decision to buy livestock, machinery and other assets might be jointly determined with the decision to adopt GlobalGAP standards. To correct for an endogeneity problem related to these variables assets purchased after the adoption period were excluded[5]. Communication and information related variables include level of agricultural training (TRAI) prior to adoption, total hours spent on listening to radio per week (RADI), total hours spent on watching television per week (TVUS), use of mobile phone prior to adoption (MOBI) and contact to extension service (EXTE). It is expected that these variables enhance the ability of farmers to quickly acquire, synthesize and respond to changes, thereby increasing the probability of adoption of GlobalGAP.

Access related variables include access to formal contract (CONT), duration of group membership (GROU), use of irrigation (IRRI) and participation in off-farm activities (OFFF). Note that these variables are measured prior to the adoption period. To undertake the necessary investment to comply with GlobalGAP requirements farmers usually organize themselves in a group, which is one of the certification options.

In the estimation of the second-stage impact model, net-income from export vegetables (NETI) is the dependent variable. Net-income is computed as total revenue from all export vegetables minus all variable costs including family labor

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[4] Facility index: $D_h = \Sigma D_{ih} (1-P_i)$ $P_i = n_i/n$

where D_{ih} = 1 if household h has access to facility i ; the facilities are having cemented floor, number of rooms, access to pipe water, and being less than 100 meter from water source; P_i is the probability of having facility i; n_i = number of households which have a facility i; and n = total number of households (McCulloch and Ota, 2002).

[5] The first small-scale producers in Kenya started to adopt GlobalGAP in 2003/04 and to clearly establish the causal relationship the exogenous variables used in the adoption model are measured in a way that reflects the situation prior to the adoption period.

per cropping season. The value of family labor was approximated by the existing wage rate in the nearest village. The primary interest is to analyze whether adoption of GlobalGAP (ADOP) has an effect on the net-income of the household[6]. The general form of the income effect model is given as:

NETI = f [AGEH, AGSQ, EDUC1, LAEX, LIVE, OFFF, ADOP, IRRI, DISTDUM]

Some of the exogenous variables of the adoption model are also used in the second stage income model considering the exclusion restriction imposed on the income equation. These are age of the household head (AGEH), age square (AGSQ) as a proxy for experience, educational attainment of household head (EDU1) to capture the managerial ability of the farmers. The value of livestock (LIVE) owned by household is expected to have a positive impact on net-income from export vegetables since households with more livestock have more manure, which can have positive impact on productivity and further livestock can be used as collateral to obtain credits. Additional variables included in the model are land allocated under export vegetables (LAEX)[7], participation in off-farm activities (OFFF) and access to irrigation water (IRRI). Heterogeneity in agro-ecology usually is a strong factor explaining the variation in the net-income thus a series of district dummies (DISTDUM) is included to capture the environmental factors. A descriptive summary of the variables used in both models is presented in Table 4.2.

Propensity score methods and matching techniques

The other methods used in the literature to correct for selectivity bias are propensity score methods and matching techniques. These methods are applied for the analysis to complement the results of the two-stage estimates. For these

[6] The fixed costs are not included in the computation of net-income, however they are taken into account in later section of cost-benefit analysis.

[7] Variables MACH & FACI are excluded from the second stage model since they are highly correlated with LAEX.

techniques to be valid, the fundamental assumption is ignorable treatment assignment (Rosenbaum and Rubin, 1983) and can formally be represented by:

$$(Y_1, Y_2) \perp G_i / X \tag{4.18}$$

where Y_1 and Y_2 are net-income from export vegetables for adopters and non-adopters, respectively. This assumption states that, conditional on a set of observables *X*, the respective treatment outcome is independent of actual treatment status (adoption of GlobalGAP).

Considering the underlying assumption of ignorability of treatment, the propensity score is used as control function in the second model to overcome the endogeneity problem of adoption variable. The propensity score is estimated using probit or logit model and indicates the conditional probability of adoption given observable regressors X.

The structural equation then is expressed as:

$$Y_i = \alpha V_i + \gamma G_i + \mu Pscore + e_i \tag{4.19}$$

where:

$$Pscore(X) = \Pr(G_i = 1 / X) \tag{4.20}$$

The third model bases on matching techniques, which have to deal with the challenge of defining an observationally similar group of non-adopters to that of adopters. Smith and Todd (2005) demonstrate that impact estimates calculated using matching methods are highly sensitive to matching method itself, but robustness can be improved by restricting matches only to those adopters and non-adopters who have a common support in the distribution of propensity scores. Therefore, the impact is estimated by applying the common support condition and further checking for robustness by using four different methods for selecting matched non-adopters namely stratification matching, nearest neighbor matching, radius matching and Kernel matching.

Table 4.2 Summary of variables used in estimations (N = 439)

Variables	Unit	Mean	Std. Dev.
Household characteristics			
Age of the household head (**AGEH**)	years	45.657	12.66
Age square (**AGSQ**)	years	2266	1249.01
Female household member (**FEMA**)	numbers	2.663	1.67
Highest grade attained by household head only (**EDU1**)	years	8.595	3.47
Highest grade attained by other adult household members (**EDU2**)	years	8.925	4.47
Asset holding and household wealth			
Total land size (**LAND**)	acres	2.711	2.57
Land size under export vegetables (**LAEX**)	acres	0.287	0.22
Proportion of land that is fertile in percentage (**FERL**)	%	95.009	19.84
Value of livestock (**LIVE**)	'000 KSh	21.379	14931.93
Value of farm machinery (**MACH**)	'000 KSh	17.540	49359.44
Facility index (**FACI**)		1.199	0.85
Income variables			
Net-income from export vegetables per cropping season (**NETI**)	*'000 KSh*	5.941	15201.38
Total revenue from export vegetables per cropping season (**EXIN**)	*'000 KSh*	33.864	43102.97
Total annual crop income (**CRIN**)	*'000 KSh*	79.941	81372.2
Communication behavior variables			
Television use per week (**TVUS**)	hours	8.399	11.41
Radio use per week (**RADI**)	hours	27.018	16.08
Number of major agricultural training (excluding GlobalGAP) attended in the past three years prior 2005 (**TRAI**)	number	5.493	3.82
Use mobile phone prior to adoption dummy (**MOBI**)	1/0	0.877	0.33
Contact with extension service dummy (**EXTE**)	1/0	0.777	0.416
Access related variables			
Participation in off-farm activities dummy (**OFFF**)	1/0	0.141	0.35
Number of years the head has been involved in formal contract (**CONT**)	years	2.330	2.64
Number of years the head has been a group member (**GROU**)	years	1.927	2.53
Irrigation use prior to adoption dummy (**IRRI**)	1/0	0.945	0.23

Notes: The exchange rate at the time of the survey was approximately 72 Kenyan Shilling (KSh)/US$.
[a] Statistical significance at the 0.01 (***), 0.05 (**) and 0.1 (*) level of probability.
Source: Own survey

4.5 Results and discussion

The data analysis is performed in three steps. First, a description of the socioeconomic characteristics of the sample of export vegetable producers comparing adopters and non-adopters is presented. Second, the results of the regression are discussed and, third, using the estimation results the financial internal rate of return (FIIR) of smallholder's investment to meet GlobalGAP compliance is computed.

Descriptive statistics

As a starting point to compare GlobalGAP adopter categories, chi-square and t-test procedures are used for those variables, which are hypothesized to influence adoption are presented (see Table 4.3 and 4.4). In Table 4.3, the differences between the adopter categories in terms of access and communication related variables, such as participation in off-farm activities, access to credit service, participation in agricultural training, use of television, reading printed materials, access to mobile phone, duration of group membership and opinion leadership are significantly different below the 0.1 level of probability. Adopters of GlobalGAP have higher levels of access to credit, training, reading printed materials and use of television than non-adopters. Adopters also consider themselves as opinion leaders, have higher levels of access to mobile phone and a higher share of them are a members of grower groups.

Table 4.3 Chi-square analysis of GlobalGAP adopters by some selected variables

	Adopters (N = 149)		Non-adopters (N = 290)		Chi-square [a]
Variable	N	%	N	%	
Gender of household head					
Male	132	88.59	239	82.41	2.868*
Female	17	11.41	51	17.59	
Participation in off-farm activities					
Yes	14	9.40	47	16.21	3.069*
No	135	90.60	243	82.79	
Use of television					
Yes	90	64.29	127	44.56	14.616***
No	50	35.71	158	55.44	
Reading printed materials					
Yes	112	80.00	199	69.82	4.952**
No	28	20.00	86	30.18	
Access to credit service					
Yes	48	32.21	51	17.59	12.059***
No	101	67.79	239	82.41	
Participated in agricultural training					
Yes	87	58.39	125	43.10	9.210***
No	62	41.61	165	56.90	
Access to mobile phone					
Yes	141	94.63	244	84.14	10.045***
No	8	5.37	46	15.86	
Group member					
Yes	144	96.64	196	67.59	47.584***
No	5	3.36	94	32.41	
Opinion leadership					
Yes	89	63.57	134	47.02	10.315***
No	51	36.43	151	52.98	

[a] Statistical significance at the 0.01 (***), 0.05 (**) and 0.1 (*) level of probability.
Source: Own survey

From Table 4.4 the wealth-related variables such as value of livestock owned, facility index and value of farm machinery owned, and the household characteristics variables such as education level of the head and other adult household members are statistically significant different below 0.1 level of probability between the two groups. Moreover, access and communication related variables such as access to mobile phone, television use, access to extension service, duration of group membership access to irrigation water and number of major agricultural training subjects attended differ significantly below 10% level of probability. However, there is no significant difference between the two groups in terms of some household characteristics variables such as age and number of female household members.

Table 4.4 Analysis of t-test for selected variables (N = 439)

Variables	Adopters (N = 149)	Non-adopters (N = 290)	t-stat[a]
Age of the household head (years)	45.38	46.18	-0.53
Age square (years)	2,212	2,297	-0.57
Female household member	2.80	2.62	0.85
Highest grade attained by household head only	9.42	8.07	3.28***
Highest grade attained by other adult household members	9.77	8.89	1.67*
Total land size (acres)	2.97	2.66	0.99
Land size under export vegetables (acres)	0.34	0.27	2.42**
Proportion of land that is fertile in percentage (%)	97.80	97.24	0.33
Value of livestock ('000 KSh)	26.92	19.45	4.33***
Value of farm machinery ('000 KSh)	37.43	13.39	2.19**
Facility index	1.59	1.03	5.68***
Net-income from export vegetables per cropping season *('000 KSh)*	13.54	2.71	5.26***
Total revenue from export vegetables per cropping season *('000 KSh)*	21.18	8.56	5.39***
Total annual crop income *('000 KSh)*	101.07	67.85	3.49***
Television use per week (hours)	11.43	7.93	2.58**
Radio use per week (hours)	27.82	25.36	1.42
Number of major agricultural training subjects attended	6.81	5.26	3.61***
Number of years the head has been involved in formal contract	2.66	2.30	1.18
Number of years the head has been a group member	3.15	1.33	5.83***

[a] Statistical significance at the 0.01 (***), 0.05 (**) and 0.1 (*) level of probability.
Source: Own survey

The results suggest that GlobalGAP adopters have a higher level of household members' education, more livestock, higher number of farm machinery, and higher level of facility indexes than the non-adopters. The length of membership in grower groups, level of training, intensity of television use, contact with extension personnel, access to irrigation water and use of mobile phone are also significantly higher for GlobalGAP adopters compared to their counterparts. As shown in Table 4.4, total annual crop income, total revenue from export vegetables per cropping season and actual mean net-income from export vegetables is also significantly higher for GlobalGAP adopters than for non-adopters.

This simple comparison of the two groups of smallholders suggests that adopters and non-adopters differ significantly in some proxies of physical, human and social capital prior to the adoption period. For those farmers who adopt standards, the descriptive analysis depicts a substantial amount of income benefit compared to non-adopters. In the subsequent part of the chapter, a rigorous analytical model is estimated to verify whether these differences in mean household income remains unchanged after controlling for all confounding factors. To measure the financial benefit of adopting standards, it is necessary to take into account the fact that individuals who adopt GlobalGAP might have achieved a higher level of economic performance even if they had not adopted.

Costs and benefits of compliance with GlobalGAP standards

Implementation of GlobalGAP necessitates changes of production practices and investment in infrastructure. This can impose substantial costs on smallholder export farmers and may be a constraint to adoption. Table 4.5 presents estimated costs of compliance with GlobalGAP standards incurred by individual farmers and donor and/or exporters contracting the farmers. Estimates for the expenses at household level for the adopters are obtained from the household survey whereas the total certification cost including the share covered by exporters as well as donors is acquired from AfriCert[8]. The estimates show that the costs of compliance

[8] AfriCert is one of the few certification companies operating in Kenya to carry out certification services for mainly agricultural production and processing systems.

with GlobalGAP standards for small-scale export vegetable producers operating under option two certification scheme is about 36,600 KSh per individual member of the group and about 8,390 KSh per group member by the exporters and/or donors. The investment cost borne by individual farmers' accounts for approximately 30% of their total annual crop income.

The bulk of costs incurred by individual farmers (about 90%) are for investment in infrastructure and equipment that farmers must have as a pre-condition for implementing standards. These represent the non-recurring costs and are primarily meant for record keeping and in support of internal self-inspection (e.g. office construction and furniture), crop protection (e.g. chemical store, pesticide disposal pit), worker safety, health and welfare (e.g. waste disposal pit, toilet and bathroom) and product handling (e.g. grading shed and charcoal cooler). Some of these structures like grading shed, office and charcoal cooler are established at the farmer group level and hence the costs incurred per individual is relatively low compared to the costs incurred for other structures. Such investments are more of a constraint for small-scale farmers as compared to large-scale farms, which generally face less financial restrictions to purchase equipment and build facilities. This is also reflected in the respective pay off periods for such investments. Mausch (2007) calculated static break even points for the returns of investments related to certification, which for a typical large-scale producer is reached one year after attaining certification status, while a typical smallholder needs more than two years to break even.

Table 4.5 Cost of compliance with GlobalGAP standards

Cost incurred by individual farmer			Cost incurred by exporter per farmer	
Requirement	Cost (KSh)	Life span	Requirement	Cost (KSh/year)
Application as a legal business (group)	100	Annual	Internal audits	530
Application for water permit	1,500	Annual	Pre audits (paid once)	1,250
Toilet	9,000	5-10 years	Certification audits	1,650
Bathroom	3,500	5-10 years	Training	2,333
Grading shed	1,500	5-10 years	MRLs testing	875
Fertilizer store	3,000	5-10 years	Water analysis	28
Chemical store	4,500	5-10 years	Soil analysis	28
Waste disposal pit	750	3 years	Organic fertilizer test	33
Pesticide disposal	2,500	3 years	Quality controller salary	417
Charcoal cooler	1,500	5-10 years	Technical assistant salary	1,250
Office	667	5-10 years		
First aid kit	900	3 years		
Protective clothing	4,000	3 years		
Knapsack sprayer	2,575	3 years		
Harvesting buckets	195	3 years		
Record keeping	420	Annual		
Total	36,607			8,394

Source: Own calculation based on data of AfriCert

The cost incurred by exporters and/or donors is primarily for auditing, training, testing for maximum residue levels of toxic substances (MRLs), soil and water analysis, salary for technical assistants and staff in charge of quality control. These constitute the recurring costs and largely accrue annually. Exporters, who received support from donors to subsidize the certification for smallholders mostly pay for these costs.

Figure 4.1 highlights a number of wider benefits from compliance with GlobalGAP as perceived by the survey respondents. Smallholder growers who adopted the protocol appreciated to be part of a group going through the GlobalGAP compliance process. They also perceived that adoption would assure them of markets and higher price as well as timely payment by the exporters. Many also perceived that implementation of GlobalGAP at the farm level increased quality of production and reduced the amount of reject by the buyer. Under GlobalGAP, agrochemicals are stored and handled by trained individuals and many growers felt that their health is better protected. Likewise the installation of disposal pits for the waste generated on the farm, clean toilets, baths and hand-washing facilities was perceived by the respondents as a reason for better hygienic conditions. In addition GlobalGAP adopters expressed pride in the neatness of their farms compared to the situation before compliance. Finally, another perceived benefit of the farmers is improved bargaining power with their buyers, which enable them to more easily switch from one buyer to another. The question remains whether these benefits are large enough to offset the investments associated with GlobalGAP compliance, which is going to be addressed in the following section.

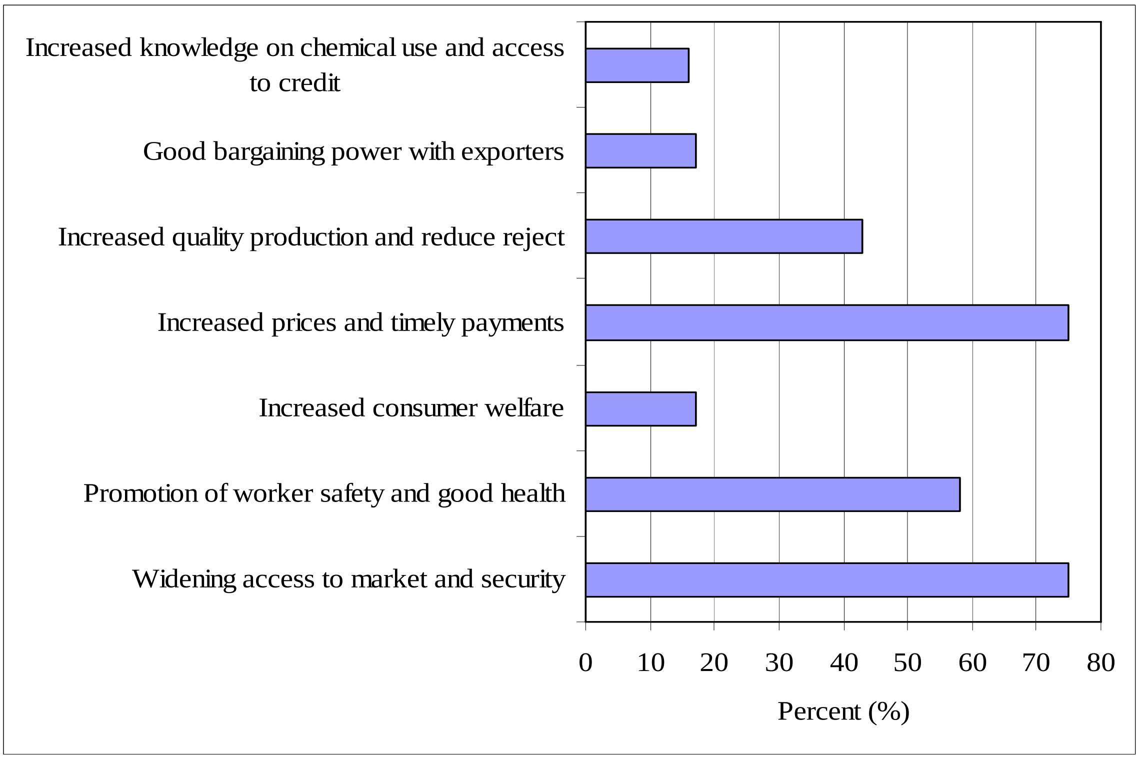

Figure 4.1 Adopters' perception of benefits of GlobalGAP protocol (N= 149)
Source: Own survey

Factors influencing GlobalGAP adoption

The stage one of the treatment effect model provides the predicted probabilities of adoption. The null-hypothesis that all variables can be dropped is rejected at less than the 1% level of significance and the Wald Chi-square is 67.65 (Table 4.6).

Among the statistically significant variables in the adoption model, the coefficient that captures education of the household member and the educational status of the household head takes a positive sign corroborating the hypotheses. It is reasonable to assume that the decision to adopt GlobalGAP is not only made by the head of the household alone but also by other educated adult members of the household. The adoption model results support this notion. This observation is in line with the thought that an educated member of the household confers a positive externality on the illiterate agents in the household by sharing the benefits of his or her literacy (Basu *et al.*, 2000; Asfaw and Admassie 2002). The household decision to adopt GlobalGAP is also positively and strongly related to the level of agricultural training received prior to GlobalGAP adoption, which once again indicates the importance of knowledge in the adoption decision.

As expected, the household wealth proxies such as value of livestock, facility index and value of farm machinery owned prior to adoption take a positive sign[9] all suggesting the positive role of household wealth in the adoption decision. This could imply that the higher the capacity of the household to absorb risk and finance an investment in additional activities, the greater the likelihood of adopting standards.

Among the communication variables, there is no evidence that access to government extension service increases the likelihood of adoption of standards. As expected radio use and television use increase the likelihood of positive adoption decision. Radio is extensively used in the research area and the primary

[9] Prior to running the model, a technique of Variance Inflation Factor (VIF) was employed to detect the problem of multicollinearity among some wealth related regressors. The results show that there is no strong correlation among the variables since the values of VIF are by far less than 10.

features listened to are the news and entertainment. However, there are agricultural programs on television and radio, which increase awareness of emerging standards and influence the adoption decision. The more a farmer listens to the radio or watches TV, the more likely h/she is to learn of GlobalGAP contribution. Access to mobile phone by the household is also positively and strongly related with the adoption decision pointing to the positive role of information technologies in bridging the gap between farmers and information source, which is primarily the exporter companies in Kenya.

As expected, the coefficients of most access related variables have their hypothesized signs. The variable group membership takes a positive sign, which implies that farmers who have been a group member for many years prior to the adoption period are more likely to adopt standards vis-à-vis farmers with few years of group membership. Since one precondition of GlobalGAP certification for small-scale farmers is that they organize themselves in a group, the dynamics and cohesiveness of the group plays a crucial role for the implementation of the protocol and the group's successful certification. Grower groups often provide some of the services farmers require for meeting standards. In this study, most smallholders affiliated with a group depended on a technical assistant either hired by the group or the buyer (exporter) to meet technical requirements of standards. Such tasks include pest scouting, record keeping, pesticide application, etc. The present results confirm the findings of Okello (2006a), who also pointed out that the future of smallholders to maintain their position in the export market lies in banding together into groups that collectively invest in fixed and specific assets. The results further show that the experience in contract farming, measured by the time period a farmer has produced under contract with an exporter prior to adoption is positively associated with the adoption decision. This result is reasonable when considering the role of exporter in the supply chain especially in provision of technical service and information. The majority of the exporters in Kenya have trained technical personnel who provide services for the smallholders producing export crops for them.

Table 4.6 Two-stage treatment effect model results

	Two-stage treatment effect (model 1)			
	Adoption Model		Income Effect Model	
Variables	Estimated [a] Coefficient	Rob. Stand. [b] Error	Estimated [a] Coefficient	Rob. Stand. [b] Error
AGEH	-0.009	0.004	478	463
AGSQ	0.001	0.000	-5	4
EDU1	0.020**	0.008	279	303
EDU2	0.037*	0.019		
FEMA	0.056	0.051		
LIVE	0.001***	0.000	0.12*	0.07
LAEX			17,793***	4,705
FERL	0.008	0.006		
FACI	0.434***	0.119		
MACH	0.001*	0.000		
TVUS	0.010*	0.007		
RADI	0.016**	0.006		
MOBI	0.343*	0.182		
TRAI	0.043*	0.024		
EXTE	0.315	0.222		
CONT	0.080**	0.035		
GROU	0.240***	0.050		
IRRI	0.599*	0.358	1,648	3,391
OFFF	-0.555**	0.270	-2,962	2,719
MERU (Base)				
KIRINYAGA			1,386	2,643
MURANGA			4,268	3,857
NYERI			9,608***	2,677
MAKUENI			-769	6,216
ADOP			9,707**	4,804
CONSTANT	-4.131***	1.458	-22,348*	12,052
Log pseudo-likelihood		-3,312.03		
Wald Chi-square		67.65		
Prob > Chi-square		0.0000		

[a] Statistical significance at the 0.01 (***), 0.05 (**) and 0.1 (*) level of probability.
[b] Standard errors are computed with clustering at the smallholder group level since farmers are organized into groups to get the certificate.
Source: Own survey

Besides farmer involved in contract schemes have high probability to obtain credit either in cash or kind from exporters, which can facilitate the adoption decision. Given the required investment to establish the necessary infrastructure to comply with standards, access to credit from exporter companies plays a crucial role in mitigating the financial constraints faced by many smallholders.

The likelihood of adopting standards also increases significantly with the access to irrigation. Most export crops are susceptible to water stress, which can seriously affect crop quality and most buyers that enforce GlobalGAP reject such quality. Participation in off-farm activities is strongly and negatively correlated with the adoption decision. This indicates a time constraint and underlines the fact that if farmers engage in certified export production they must specialize.

The impact of GlobalGAP on smallholder income

The comparison of mean income between adopters and non adopters demonstrate that adopters of standards earn a higher net-income from export vegetable production. To verify whether this difference can be attributed to adoption of standards, the income effect model is estimated using different econometric procedures (Table 4.6 and 4.7).

Adoption of GlobalGAP standards is strongly and positively associated with household net-income in all the econometric models showing the robustness of the result. *Ceteris paribus*, adoption of GlobalGAP protocol results in an increase in net-income from export vegetables of 9,707 KSh in the treatment effect model. In the case of the regression based on propensity score (model 2), two alternative specifications are estimated. First only the propensity score and the adoption variables are included in the equation and in the second part other control variables in addition to the propensity score are included. Both estimation results show a positive and strong effect of adoption of standards on net-income from export vegetables. Keeping other variables constant, adoption of GlobalGAP standards result in an increase of the export vegetables net-income of 8,127 KSh and 7,481 KSh in the first and second specification, respectively.

Table 4.7 Estimation results based on propensity-score

Variables	Regression based on propensity-score (model 2)			
	Without Control Variables		With Control Variables	
	Estimated [a] Coefficient	Rob. Stand. [b] Error	Estimated [a] Coefficient	Rob. Stand. [b] Error
AGEH			513	496
AGSQ			-6	5
EDU1			294	318
EDU2				
FEMA				
LIVE			0.12*	0.07
LAEX			17,792***	4,787
FERL				
FACI				
MACH				
TVUS				
RADI				
MOBI				
TRAI				
EXTE				
CONT				
GROU				
IRRI			1,952	3,543
OFFF			-2,912	2,801
MERU (Base)				
KIRINYAGA			8,93	2,671
MURANGA			4,197	3,931
NYERI			9,454***	2,785
MAKUENI			-849	6,404
ADOP	8,127***	2,358	7,481***	2,276
Propensity score	9,059**	4,522	2,062	5,906
CONSTANT	152	1,674	-21,745*	11,894
Log pseudo-likelihood	15.79		6.27	
Wald Chi-square	0.000		0.000	
Prob > Chi-square	0.14/ 0.12		0.32/ 0.28	

[a] Statistical significance at the 0.01 (***), 0.05 (**) and 0.1 (*) level of probability.
[b] Standard errors are computed with clustering at the smallholder group level.
Source: Own survey

Table 4.8 reports estimates of the impact of GlobalGAP adoption based on the propensity score matching technique. The average difference in net-income between adopters and their matches provides an estimate of the average treatment effect on the treated. The first column of Table 4.8 gives mean outcomes among treatment cases (i.e. export vegetables net-income of adopters), while the second column gives the mean outcomes among the set of matched controls (i.e. export vegetables net-income of non-adopters). The difference between these two is the estimate of the unconditional average treatment effect, corrected for the possibly confounding effects of observed covariates. The impact estimates are robust to the different estimation methods: the four methods give remarkably similar estimates and show a significant difference between the groups of adopters and non-adopters. Among the four matching methods used the stratification technique gives the highest net-income differentials of 10,279 KSh whereas the radius matching method gives the lowest value of 8,839 KSh (Table 4.8).

Table 4.8 Net-income differentials using PPS matching methods (model 3)

Variable	Adopters	Non-adopters	Difference = average treatment effect on the treated	t-stat [a]
Method 1: Stratification matching	Stratification with 5 blocks under common support			
Number of observation	149	288		
Net-income from export vegetables	-	-	10,279	3.452***
				(2,977.56)[b]
Method 2: Nearest neighbor matching	Only 59 non-adopters have bee matched to the 149 adopters under common support			
Number of observation	149	59		
Net-income from export vegetables	13,073	3,763	9,310	2.876***
				(3,237.32)
Method 3: Radius matching	Non-adopters within 0.1 PPS under common support			
Number of observation	139	281		
Net-income from export vegetables	11,741	2,902	8,839	3.93***
				(2,244.76)
Method 4: Kernel matching	Kernel-weighted average of all control farmers under common support			
Number of observation	129	256		
Net-income from export vegetables	13,073	3,130	9,943	4.060***
				(2,449.23)

[a] Statistical significance at the 0.01 (***), 0.05 (**) and 0.1 (*) level of probability.
[b] The number in brackets shows bootstrapped standard errors with 100 replication samples.
Source: Own survey

As shown in Table 4.6 and 4.7, there are other variables other than adoption that affect net-income of export vegetables. The coefficient of the area under export vegetables is positive and strongly correlated with net-income. Keeping all other factors constant, an increase in area under export vegetables by an acre results in an increase in household net-income of 17,793 KSh. The coefficient of livestock value is positive and significant in both models, which suggest that farmers with more livestock tend to have higher net-income from export vegetables. Perhaps due to the availability of more manure, which can have positive impact on productivity and further livestock can be used as collateral to get credits. Although the coefficients are not significant at the 10% level, participation in off-farm activities is negatively associated with the net-income, whereas a higher education level of the household head and access to irrigation contribute positively to net-income. Agro-ecological and location variations also affect the household net-income from export vegetables as revealed by the significant coefficient of the district dummy.

In summary, results of all econometric models are robust and support the notion of financial benefits from introducing food-safety standards to small-scale farmers in Kenya. In the next section these findings are used to examine if the estimated additional benefits are large enough to payback the initial investment in the implementation of standards.

Profitability of investment in standards compliance

In the previous section the incremental financial benefit from investment in GlobalGAP certification, were estimated. This section addresses the question whether these benefits are sufficiently large to cover non-recurring and recurring costs of obtaining and maintaining the certification standard and render the investment profitable. This is analyzed by considering two scenarios taking into account the planting schedule of smallholders in Kenya. Scenario one assumes that smallholders plant three export crops per year, which is the most frequent case in Kenya and scenario two considers the worst case situation of two cropping season only. Assuming a constant impact of GlobalGAP on net-income in all cropping seasons, of 8,727 KSh[10], the annual net-income attributable to GlobalGAP adoption is approximately to 22,443 KSh under the three-cropping season scenario and 14,962 KSh under the two-cropping season scenario. Using cost data presented in Table 4.4, the Financial Internal Rate of Return (FIRR), Net Present Value (NPV), Benefit-Cost Ratio (BCR) and pay off period are computed and presented in Table 4.9[11].

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[10] Average estimated income across all econometric models is used.

[11] The life span of most of the investments is assumed to range from five to ten years and hence the cost-benefit analysis is conducted considering five, seven and ten year life span of the investment.

First, it is assumed that farmers pay all the costs including auditing, training and the tests. Considering three-cropping season per year and a constant net-income over the life span of the investment, the estimated FIRR is 33% for the conservative five years and 42% for upper limit ten years life span of the investment. However when two- cropping season per year are considered the IRR declines to minus 1% for five year and 15% for ten year life span of the investment.

In the second scenario it is assumed that external agencies (donors or exporters) cover the annual audit fees, training and the tests as it has been the case for small-scale farmers in Kenya (see Table 4.5). Under all the scenarios, the FIRR is high ranging from 30% from two-cropping season up to 66% for the three-cropping season scenario (see Table 4.9 for detail). The pay off period analysis demonstrates that smallholders can recover their investment cost in two to three years under three-cropping season scenario. However if two-cropping season without any donor/ exporter support scenario is considered, it takes up to seven years to recoup their initial investment cost.

Table 4.9 Profitability of investment in GlobalGAP compliance

		Three-cropping seasons		Two-cropping seasons	
Life span of the investment	Decision criteria [a]	Farmer pays all the costs	Donor or exporter pays some the cost [b]	Farmer pays all the costs	Donor or exporter pays some the cost
5 years	FIRR	35	60	-1	30
	NPV	28,721	59,181	-7,062	23,398
	BCR	1.37	2.23	0.91	1.49
7 years	FIRR	41	65	10	37
	NPV	47,343	90,327	3,624	43,294
	BCR	1.56	2.78	1.04	1.85
10 years	FIRR	44	66	15	40
	NPV	74,528	125,873	13,232	64,577
	BCR	1.68	3.17	1.12	2.11
	Pay off period	3 years	2 years	7 years	3 years

[a] Discount rate used for the computation of NPV and BCR is 7%.
[b] Exporter/ donor pays about 8,394 KSh per group member for auditing, training, MRLs testing, soil and water analysis, salary for technical assistants and staff in charge of quality control (see Table 4.5).
Source: Own survey

This analysis did not incorporate the risk inherent to the investment and compare the findings against alternative investment option that are available to smallholder due to lack of information. However when comparing the FIRR to the medium term lending rate by banks in Kenya, which is about 12%, investment in EU private food-safety standards compliance pays off for small-scale producers in Kenya even in the absence of external support. Yet, the question remains whether many small-scale farmers in Kenya can finance the initial cost of about 37,000 KSh in year zero to start up the implementation of the protocol and at the same time the donor/ exporter continue their financial and technical support.

4.6 Conclusions

Results of this study show that that GlobalGAP adopters are statistically distinguishable from non-adopters in the principle measures of household wealth (value of livestock, value of farm machineries and facility index), access to information (use of television and radio, use of mobile phone and level of training), access to services (group membership, use of irrigation and access to formal contract) and household characteristics (educational level). This implies that access to information, capital and services are major factors influencing the ability of small-scale producers to adopt standards and exploit export opportunities for agricultural and food products to developed country markets. These results empirically demonstrate the general argument in the literature (Dolan and Humphrey, 2000; Weatherpoon and Reardon, 2003; Okello, 2006a) that resource poor farmers with limited access to information and services face difficulties in complying the emerging standards.

On the other hand the econometric model results also show that those who adopt standards enjoy a substantial income benefit. The FIRR, computed for different cost and benefit scenarios display that investment in EU private food-safety standards pays off for small-scale producers in Kenya. The foregoing analysis has dealt only with the direct financial benefit from adoption of standards, nevertheless as noted earlier, adoption of standards have indirect benefits such as potential spill over effects on domestic production, stronger bargaining positions with exporters, domestic food-safety, farmers' health and the environment. Thus the economic internal rate of return which could not be calculated here would be higher if positive externalities are accounted for.

The above discussion has one major message for policy: it is the asset-poor with limited access to information and service that may be left out from participating in these supermarket chains. Implication for policy is that smallholders need to be focused for building their physical, social and human capital. The government and the private sector can help farmers expand and upgrade their range of assets and practices to meet the new requirements of supermarkets and other coordinated supply chains. The options include public investments in increasing farmers' productivity and connectivity to markets, and public-private partnerships to promote collective action and build the technical capacity of farmers to meet the new standards. Up to now, the role of the public sector in this development was rather limited compared to the private sector. Nevertheless if it is the policy goal of the Kenyan government to keep as many smallholders as possible in the export market by helping them to get certified with the emerging standards, the question is at what costs this can be achieved. So far the donors have picked up some of the bill for supporting the smallholder in attaining standards and some exporters have also helped farmers overcome their asset constraints and improve their business image by providing technical assistance. There is no simple answer to these challenges. It is very important to consider alternative strategies that can integrate the marginalized farmers into less demanding global market with less rigid standards such as Middle East and Asian countries and at the same time invest in connecting them to the domestic market.

Chapter 5

Do EU Private-sector Standards in Kenya Reduce Pesticide Overuse and Raise Productivity?[1]

5.1 Introduction

The increase in demand for high-value horticultural produce by developed countries consumers' has encouraged farmers in developing countries to diversify their traditional food crop based cropping system into fruits and vegetables. This change was accompanied by the increased use of external inputs like fertilizers and chemical pesticides. In horticultural crops agrochemical inputs such as pesticides play an important role to meet the quality requirements of wholesale and retail agents, i.e. to deliver produce with specific physical attributes, such as color, shape, size and spotlessness (Thrupp *et al.*, 1995). While agrochemical inputs contributed to increased production, high levels of pesticide use have been associated with negative externalities. In the developing countries short-and-long-term human health effects resulting in significant health costs of rural households were reported (Wilson and Tisdell, 2001; Antle and Pingali, 1994; Pingali *et al.*, 1994; Ajayi, 2000; Antle and Capalbo, 1994). However also ecological effects on non-target plants and animals (Thrupp *et al.*, 1995; Pimentel and Greiner, 1997) and damage to the soil and water quality of the agro-ecosystem (Pimentel and Greiner, 1997) were shown to occur in agriculture worldwide.

Increasingly, pesticide residues above maximum residue limit (MRL)[2] have resulted in food-safety concerns for both domestic and foreign consumers. Retailers and consumers in the importing European countries have become increasingly concerned about the prevailing production methods in the exporting countries. Various rules and regulations have been put in place to protect consumers and farm workers from pesticide intoxication and restore consumer

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[1] A paper based on this chapter is under review for the Journal of Agricultural Economics.

[2] MRL means the maximum concentration of a pesticide residue that is legally permitted or recognized as acceptable in or on a food or agricultural commodity.

confidence. At present, over 250 control points have been identified in GlobalGAP for fresh fruit and vegetables, of which over 50% define criteria for the correct use of chemicals for pre-and post-harvest treatment (GlobalGAP, 2004). To comply with these standards producers have to change their production technology, e.g. switch to less harmful pesticides and invest in structures like grading shed, charcoal cooler, disposal pit, toilet and washing facilities, pesticide store etc.

Some argue that such stringent food-safety standards pose major challenges for small-scale producers' and may drive them out of international markets for high-value food products (Augier *et al.*, 2004). Yet, in some cases, others argue that such standards can play a positive role, providing the catalyst and incentives for the modernization of export supply and regulatory systems and the adoption of safer and more sustainable production and processing practices (Jaffee and Henson, 2004; Maertens and Swinnen, 2006). In the previous chapter it is shown that adoption of standards has a positive effect on income although for smallholders it takes longer to recover their investment. In addition to the direct financial effect one might consider the positive external effects stemming from changes in pesticide use and various hygiene practices associated with adoption as a major non-financial benefit. However, no empirical evidence exists either to confirm or refute the hypotheses that food-safety standards generate positive external effects for farmers adopting it. This chapter extends the analysis to capture pest management issues and hereby assess the potential impact of standards on productivity and changes in pesticide use.

Using cross-section farm-level data, collected from a random sample of 539 Kenyan small-scale vegetable producers, this chapter deals with the following questions: (i) how do smallholder export vegetable producers differ with domestic vegetable producers in terms of pesticide use and yield? ii) Does the adoption of production standards affect the overall use of pesticides among export producers? And (iii) does the adoption of production standards affect the yield of export producers? To answer these questions an econometric model was applied taking into account potential problems of endogeneity and/or selectivity with respect to pesticide use, choice to produce for export market and the adoption of standards.

The remainder of this chapter is organized as follows. Section 5.2 discusses the data and sampling design. The analytical model and the specification of the reduced form equations are presented in section 5.3. Section 5.4 presents empirical results and in section 5.5 some conclusions and implications are pointed out.

5.2 Sampling design and data

A multi-stage sampling procedure was used to select districts, sub-locations and small-scale vegetable producers, respectively. As discussed in chapter 4, at the first stage five districts were purposively selected from the two major vegetable producing provinces (namely Nyeri, Kirinyaga, and Murang'a Districts in Central Province and Meru Central and Makueni Districts in Eastern Province) based on the intensity of export vegetable production, agro-ecology, types of crop produced and accessibility. Meru District is located at higher altitude primarily producing French beans while Nyeri, Kirinyaga, and Murang'a Districts are situated at middle altitude producing a range of green beans and peas. Makueni District is located at lower altitude mainly producing Asian vegetables such as okra, chilies and aubergines. These districts represent the major export vegetable producing areas, which cover approximately half of all smallholder vegetable export producers (Mithöfer *et al.*, 2008). Since the number of export vegetable producers among the districts varies and to ensure that every element in the target population has an equal chance of being included in the sample, Probability Proportional to Size (PPS) sampling technique is used. Overall, 21 sub-locations were randomly selected from the five districts by PPS sampling procedures and a total of 539 vegetable producer households (both export and domestic market vegetable producers) were selected randomly for the interviews. Of these 149 are GlobalGAP adopter export farmers, 290 are non-adopter export farmers and 100 are domestic vegetable producers. GlobalGAP adopters in this case is defined as small-scale export producers who have either already obtained GlobalGAP certificate or are in the process of obtaining the certificate under Option 2.

Data collection took place during the 2005/2006 cropping season. For each randomly selected farmer the survey combined a single visit (re-call survey) and a season-long monitoring of household production practices. The season-long monitoring data was collected for both dry (November 2005 to February 2006) and rainy seasons (May 2006 to August 2006). However the data collected during the first monitoring survey (i.e. dry season) was incomplete due to prevalent drought in the survey areas. Thus, the analysis excludes the dry season data set and uses only the data collected during rainy season as well as the re-recall survey data.

The data were collected by trained enumerators supervised by the researcher using structured questionnaires. The re-call survey questionnaire covered specific information on the characteristics of household members, household income (both farm and off-farm), household assets such as land and livestock ownership, farm machinery and household equipments as well as access to different services like credit, irrigation, formal contract and group membership. The season-long monitoring survey form was used to record inputs and outputs related to vegetable production. Besides personal interviews, a series of formal and informal farmer group discussions were also conducted to complement the household survey.

5.3 Analytical model

Following the works of Shankar and Thirtle (2005), Ajayi (2000), Hung *et al.* (2002), Pemsl (2005), Qaim (2003) and Qaim and Zilberman (2003), Lichtenberg and Zilberman (1986), this study takes a damage control approach to establish pesticide productivity and computing economic optima for pesticide use. The Cobb Douglas production function with logistic damage control function can be represented as:

$$Ln(Q) = Ln(a) + \sum_{i=1}^{n} \beta_i Ln(W_i) + \gamma G_i + Ln(1 + \exp(\lambda - \alpha x_p))^{-1} + \varepsilon \qquad (5.1)$$

where Q denotes total revenue per acre from vegetables[3], the vector W_i includes labor, fertilizer, seed, number of vegetable crops grown, choice to produce for export, price of vegetable output, types of vegetables produced, access to irrigation, distance to market, quality of soil, age of the household head and G_i denote adoption of GlobalGAP standards. A series of district dummy variables are also introduced in the model to capture the heterogeneity in location specific factors.[4] The β_i's are the respective coefficients to be estimated, λ is constant and α is the parameter to be estimated for pesticides in the logistic damage function framework.

Weather or not the effect of GlobalGAP adoption can be correctly estimated using regression analysis depends on the proper specification of the model. It is obvious that the introduction of a variable representing vegetable type in the model is crucial since price of output, yield and cost of inputs can potentially be confounded with the type of vegetable produced. However as mentioned earlier export vegetables production among smallholders are mostly district specific i.e. Meru farmers primarily produce French beans, Makueni farmers produce Asian vegetables and farmers in the other districts produce peas and French beans. The inclusion of vegetable type variable together with the district dummies can potentially create multicollinearity problem. However to check the robustness of the results to different specification, a sensitivity analysis is performed with and without variable representing vegetable type.

Another long-standing problem with direct estimation of the production function is that the inputs are treated as exogenous, when the farmers decide their levels. Although this problem applies to all inputs, it is especially true of pesticides, since they are often applied in response to pest pressure (Huang *et al.*, 2002). Hence, it is

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[3] We used total revenue instead of total yield to capture the variation in the quality of the produce and at the same time avoid the potential problem of aggregation error. Unlike other crops, for vegetables physical yield is meaningless.

[4] Average annual precipitation is not included in the model due to lack of data, nevertheless the variation in rainfall is expected to be captured by the district dummies.

possible that the covariance of x_p and the residuals of the revenue function is non-zero, a condition that would bias parameter estimates of the impact of pesticides on output. In other words, pesticides used by farmers may be endogenous to yields and a systematic relationship may exist among pests, pesticide use and vegetable yields. Equation (5.1) does not account for the possible selection bias of production of export vegetables and once participated in the export market, the adoption of GlobalGAP in the production function equation. The decision (a) to participate in export market and (b) to adopt standards may be determined by unobservable variables that may also affect productivity. If this is the case, it leads to biased estimates of the impact of adopting GlobalGAP.

Table 5.1 gives an overview of model specification for revenue and pesticide use function (without consideration of potential endogeneity problem) and definition of variables included in the model.

Table 5.1 Model specification and definition of variables

Model specification without considering potential endogeneity problems
TRVG = f [SEED, FERT, LABO, PRES, CRNU, PEST, CRTY, ADOP, AGEH, PRPR, MARK, FERL, IRRI, vegetable type dummies, district dummies]
PEST = f [CRTY, ADOP, PEPR, FEPR, PRES, HHSI, CONT, AGEH, DIST, GROU, SYPT, FACI, TRAI, CRED, APPL, FERL, vegetable type dummies, district dummies]

Variable	Definition
TRVG	Total revenue of vegetables per acre per cropping season (KSh)
PEST	Total cost of pesticide use per acre per cropping season (KSh)
AGEH	Age of the household head (years)
EDU1	Highest grade attained by household head (year)
EDU2	Highest grade attained by other adult household members (years)
HHSI	Household size (adult equivalent)
LITU	Number of Tropical Livestock Unit owned
SEED	Seed cost per acre per cropping season (KSh)
FERT	Fertilizer cost per acre per cropping season (KSh)
LABO	Labor cost per acre per cropping season (KSh)
LAEX	Land size under export vegetables (acres)
CRTY	Choice to produce for export (1, if export market, 0 domestic market)
CRNU	Number of vegetable crops grown per cropping season
PRPR	Average vegetable output price (KSh/kg)
PRES	Pressure of pest (scores from 1 to 9)
ADOP	Adoption of GlobalGAP dummy
PEPR	Price of pesticide (KSh/g)
FEPR	Price of fertilizer (KSh/kg)
SYPT	Pesticide poisoning cases one year prior to the survey
FACI	Facility index
TRAI	Number of major agricultural training subjects attended in the past three years prior 2005
GROU	Number of years the household head has been a group member
CONT	Number of years the household had a formal contract
DIST	Distance to extension service (km)
CRED	Amount of credit used for the past three years prior 2005 (‘000 KSh)
APPL	Primary applicator of pesticide (1, if household member, 0 casual labor)
MARK	Distance to nearest local market (km)
FERL	Proportion of land that is fertile in percentage (%)
IRRI	Access to irrigation dummy

Source: Own survey

A Wu-Hausman specification test (Hausman, 1978) is performed to test the null hypotheses that (a) pesticide use, GlobalGAP adoption and choice to produce for export market are exogenous in the revenue function; and (b) GlobalGAP adoption and choice to produce for export market are exogenous in pesticide use function before further econometric analysis. The estimated Wu-Hausman chi-square statistics are reported in Table 5.2.

Table 5.2 Results of Wu-Hausman specification tests

Null hypothesis	Wu-Hausman F-test statistics	P-value
Exogeneity of GlobalGAP adoption discrete choice in revenue function	3.78	0.053*
Exogeneity of pesticide inputs use in revenue function	1.55	0.138+
Exogeneity of choice to produce for export market in revenue function	1.48	0.145+
Exogeneity of GlobalGAP adoption discrete choice in pesticide use function	4.15	0.043**
Exogeneity of choice to produce for export market in pesticide use function	1.60	0.114+

[a] Statistical significance at the 0.05 (**) , 0.1 (*) and 0.15(+) level of probability
Source: Own survey

The P-values of the estimated F-test statistics show that the exogeneity hypothesis is rejected in the revenue function for GlobalGAP adoption, pesticide use and choice to produce for export market at the 5% and 15% level of significance, respectively. The exogeneity hypothesis for GlobalGAP adoption and choice to produce for export market in pesticide use function is rejected at 5% and 15% level of significance, respectively. The results of the Wu-Hausman specification test suggest that farmers decision to produce export crops, adopt GlobalGAP and pesticide input use are endogenous in the revenue production function model and need to be accounted for to get efficient and consistent estimation. It is most likely that the destination markets and compliance with standards affect product prices received as well as input costs incurred. If this is the case, prices are not exogenous of the dependent variable revenues and costs. So it could be the case that due to the specification used, these equations will exhibit right hand side endogeneity. Yet endogeneity would remain a problem for the decision sequence in question with a different specification that did not conflate price with the dependent variable i.e. total yield and pesticide quantity as a dependent variable instead of total revenue and pesticide cost.

To empirically account for this multiple endogeneity and/or selectivity problem in the production function, a model that consists of three stages is used and looks as follows (Arendt and Holm, 2006; Wooldridge, 2002; Rivers and Vuong, 1988):

Stage one: Adoption equation

$$G_i^* = \beta X_i + u_i \tag{5.2}$$

Stage two: Reduced form regression

$$Y_i^* = \alpha V_i + \gamma G_i + e_i \tag{5.3}$$

$$G_i = \begin{cases} 1 & if\ G_i^* > 1 \\ 0 & otherwise \end{cases} \tag{5.4}$$

Stage three: Structural equation

$$Q_i = \alpha W_i + \gamma G_i + \beta Y_i + v_i \tag{5.5}$$

where G_i^* is the unobservable or latent variable for GlobalGAP adoption, X_i is a non-stochastic vector of observed farm and non-farm characteristics determining adoption[5], Y_i^* denotes the expenditure on chemical pesticides, V_i is a vector of exogenous variables thought to affect pesticide use, G_i is the predicted value of GlobalGAP adoption from stage one, Q_i denotes total revenue per acre from export vegetables, W_i represent covariates expected to influence structural revenue equation, Y_i denotes predicted value of pesticide use from stage two, and

[5] Exogenous variables used in the first stage adoption equation are identical with what is presented in chapter four and thus it is not discussed in this chapter.

u_i, e_i and v_i are random disturbances associated with the adoption of GlobalGAP, pesticide use and the revenue model.

The purpose of stage one and two is to eliminate the problem of endogeneity of GlobalGAP adoption and pesticide use in the structural model. To solve this problem, the endogenous variable is first regressed on the instruments and then the estimated value of the endogenous variable is included in the structural equation instead of the endogenous variable itself (Greene, 1997; Wooldridge, 2002). So in stage one, the probability of adopting GlobalGAP standards in function of a number of variables that explain the adoption decision using probit model is estimated. From this model, an estimate of predicted value of GlobalGAP adoption is constructed, which is then included in stage two and three of the model. In stage two of pesticide use is estimated based on the reduced form equation, which contains the instruments, the predicted value of GlobalGAP adoption from stage one, and a number of control variables. In stage three the structural equation is then estimated. In this stage, the dependent variable of interest, in this case total revenue per acre from vegetable production, is regressed on the estimated values of the endogenous variables from stage one and two. In doing so, the endogeneity problem of both variables is controlled at the same time in the structural model and estimates the impact of GlobalGAP adoption on total revenue.

To examine the impact of participation of smallholders in export versus domestic market channels on pesticide use and total revenue, the same procedures are applied. At the first stage the determinants of participation in export market is estimated using the total sample (which includes both domestic and export farmers) to obtain the predicted value of participation then this variable is included in the second pesticide use function as discussed above. In the third stage the revenue function is estimated by including the predicted value of choice to produce for export market, which is obtained from the first stage and predicted value of pesticide use that is estimated from the second stage pesticide use function. Hence, pesticide use function and revenue function are estimated for each stratum i.e. total sample that encompass domestic and export farmers and a sub-sample that include export farmers only.

5.4 Results and discussion

Descriptive analysis

The most frequently grown export vegetable is French beans, whereas the most prevalent crop for the domestic market includes cabbage, tomatoes and kales. As shown in Table 5.3, of the total sample households in the five districts, 55.3% of them grow French beans on an average plot size of 0.35 acres per household. Peas and Asian vegetables are grown by 23.9% and 7.4% of the sample households respectively, on an average plot size of 0.28 and 0.38 acres. Among vegetables produced for domestic market, cabbage is produced by about 14.3% of the sampled households whereas kale and tomatoes are produced by 8.7% and 5.6% of the sample households respectively. Table 5.3 gives the number of growers, area allocated to each type of vegetable crop per household, total yield per acre and the average price received per kg of output.

Table 5.3 Number of growers and farm size allocated to each type of vegetable (N=539)[6]

Vegetable types	Count	Percent	Farm size (acres)	Yield (kg/acre)	Price (KSh/kg)
French beans	298	55.3	0.35	1,732	33
Peas	129	23.9	0.28	2,240	42
Asian vegetables	40	7.4	0.38	1,416	25
Cabbage	77	14.3	0.29	2,960	14
Kale	47	8.7	0.22	3,968	12
Tomatoes	31	5.6	0.25	2,232	18

Source: Own survey

[6] Vegetables produced solely for home consumption are not considered. The list includes only vegetables produced for commercial purpose either for domestic or export market. Asian vegetables category includes okra, chilies, karalla and aubergines.

Table 5.4 presents the t-test comparison of means of selected production variables between export and domestic vegetable producers and GlobalGAP adopters' categories. The total yield is significantly higher for domestic vegetable producer. However total revenue and net-revenue per acre for export vegetable producers is not significantly higher than those of domestic producers in contrary to other findings (McCulloch and Ota, 2002). The data only captures revenue and net-revenue of the rainy season and if year-round production is considered, export farmers are likely to have higher income compared to those who produce for the domestic market.

With the exception of labor cost and land use, export and domestic vegetable producers are distinguishable by other input costs such as fertilizer, seeds and pesticides. The cost of fertilizer is significantly higher for export vegetable producers whereas the cost of seeds is lower compared to their domestic counterparts. It is also clear from the descriptive statistics that domestic vegetable producers use less quantity of pesticides and spend less money on them than export vegetable producers. Results also show that domestic-oriented farmers use less herbicide than export-oriented farmers, but both use similar amounts of insecticide. For example, farmers producing for domestic market on average applied 0.87 kg of pesticides per acre, whereas export vegetable farmers used 1.1 kg/acre. The lower pesticide quantities also translate into cost savings for farmers. Domestic vegetable producers spent 1,093 KSh/acre on pesticides; on average export farmers spent 1,730 KSh/acre.

Table 5.4 Comparison of export and domestic market vegetable producers in Kenya

Variables	Export vegetable producers (N= 439)				Domestic vegetable producers (N= 100)	t-stat[a]
	GlobalGAP Adopters	Non-adopters	All exporters	t-stat[a]		
Net-income (KSh/acre)	39273	14290	23382	3.69***	18156	0.99
Total revenue (KSh/acre)	67325	40576	50311	3.47***	45017	0.90
Total yield (kg/acre)	1996	1449	1572	2.99***	3215	-3.22***
Seed cost (KSh/acre)	7432	4036	5272	3.76***	7320	-2.48**
Fertilizer cost (KSh/acre)	8462	8931	8760	-0.58	6471	3.77***
Labor cost (KSh/acre)	9922	10800	10481	-0.75	10116	0.39
Land size (acre)	0.34	0.27	0.30	2.42**	0.27	1.15
Pesticide cost (KSh/acre)	1503	1860	1730	1.77*	1093	3.29***
Pesticide use (kg/acre)	1.13	1.07	1.09	0.40	0.872	1.97**
Hazard Category I pesticide (kg/acre)	0.09	0.06	0.08	1.08	0.01	3.33***
Hazard Category II pesticide (kg/acre)	0.23	0.40	0.34	-2.69***	0.53	-3.19**
Hazard Category III pesticide (kg/acre)	0.09	0.13	0.12	1.92*	0.03	4.96***
Hazard Category IV pesticide (kg/acre)	0.68	0.48	0.55	1.65*	0.28	2.89***
Insecticide (kg/acre)	0.52	0.61	0.58	1.00	0.59	-0.13
Herbicide (kg/acre)	0.58	0.40	0.47	2.24**	0.25	3.44***
Insecticide cost (KSh/acre)	827	861	848	0.21	779	0.59
Herbicide cost (KSh/acre)	452	441	445	0.13	278	2.53**
Vegetable output price (KSh/kg)	35	28	34	2.22**	14	2.55***
Distance to nearest local market (km)	1.63	1.54	1.58	0.65	1.62	0.82
Proportion of land that is fertile (%)	97.80	97.24	97.44	0.11	91.05	-3.29***
Access to irrigation dummy	0.96	0.86	0.92	7.64***	0.90	0.44
Number of crops grown per season	1.19	1.09	1.13	2.01**	1.18	-1.16

[a] Statistical significance at the 0.01 (***), 0.05 (**) and 0.1 (*) level of probability
Source: Own survey

GlobalGAP adopters and non-adopters only differ significantly with respect to quantity of seed used and number of crops grown per cropping season. GlobalGAP adopters incur significantly higher seed costs, which partially might be attributed to high price for good quality seed that is demanded by exporters who pursue GlobalGAP standards. It is observed that the groups are indistinguishable with respect to total quantity of pesticide use per acre although the associated costs are significantly higher for non-adopters. Besides, the types of pesticides used among the categories are compared, non-adopters uses significantly higher amount of Hazard Category II and III pesticides, which WHO classifies as highly toxic and toxic respectively, whereas the adopters use higher amount of Hazard Category IV, which WHO classifies as moderately toxic. The results also reveal that the adopters use significantly higher amount of herbicide per acre than the non-adopters even though the high herbicide quantity does not translate into higher cost. Total yield, total revenue and the net-revenue per acre are significantly higher for GlobalGAP adopters compared to the non-adopters.

Stage two: pesticide use model results

The results of pesticide use functions demonstrate that the model performed well in explaining pesticide use with reasonable explanatory power (adjusted R-squared between 0.3 and 0.4)

Most importantly, the regression model results demonstrate the effect of the choice to produce for export market (CRTY) and the adoption of GlobalGAP standards (ADOP) on expenditures of pesticide use. The positive and highly significant coefficient on the CRTY variable means that export vegetable producers spend higher cost for pesticides when compared to domestic vegetable producers. Ceteris paribus, farmers producing export crops spend 28% more on pesticides than farmers producing domestic crops[7].

However, with regard to the pesticide use function estimated for export farmers, no significant difference between the adopter categories is observed in terms of the value of pesticide use. This indicates that GlobalGAP adoption has no significant reduction effect of pesticide expenditures of smallholder export

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[7] When dummy variables are used in a model with a log-transformed dependent variable, the coefficient of the dummy variable multiplied by 100 is not the usual percentage effect of that variable on the dependent variable (Kennedy, 1981). Instead it should be calculated as: $h = 100 * \left[\exp(\beta_i - 1/2v(\beta_i)) - 1\right]$ where h is the percentage change in the level of the dependent variable, β_i is the estimated coefficient of the dummy variable and $v(\beta_i)$ is the estimated variance of β_i, which is applied in this study.

producers[8]. This might be attributed to three factors. First, exporters who monitor and enforce compliance with GlobalGAP give much emphasis on physical appearance of the produce (e.g. spotless), which implicitly encourages chemical control of pests and diseases. Second, although GlobalGAP requirements advocate the use of alternative pest control strategies like Integrated Pest Management (IPM), export farmers rarely resort to this alternative due to the risk associated with outbreak and rapid multiplication of pests, the challenge that is exacerbated by the tropical climate (Okello, 2006b). Third, export companies that enforce GlobalGAP also indirectly promote the use of chemical control by handing farmers a weekly spray program and sometime involving in direct spraying by their technical personnel. These chemicals are often expensive compared to some chemicals available in the market. The same observation was made by Okello (2006b). In his study he did not find any significant difference between compliant and non-compliant green bean growers in terms of types and quantities of pesticides used.

To examine if adoption of standards affects types of pesticide used, an alternative function is estimated by using the ratio of WHO Hazard Category I and II pesticides to the total pesticides as a dependent variable. Contrary to findings of Okello, the estimation results demonstrate that the adopter categories are distinguishable in types of pesticide used i.e. non-adopters uses significantly higher amount of WHO Hazard Category I and II pesticides compared to non-adopters (see Table 5.6 below). These findings support the descriptive results presented earlier.

The coefficients on variable FEPR is negative and statistically significant for both pesticide use functions whereas the price of pesticide (PEPR) is positively associated. This suggests that the expenditure on pesticide use is inversely related with the price of fertilizer and directly related with pesticide price which is in line with expectations. This depicts that farmers at the same time adjust their total

[8] An alternative function is also estimated using quantity of pesticide used as dependent variable, however no significant difference between adopter categories is observed.

expenditures on pesticide use depending on the change in price of other inputs. On the other hand farmers having access to credit services (CRED) spend significantly higher amount on pesticides, which reveals that financial constraints are one impediment for pesticide use among export farmers. As expected the coefficients on pest pressure (PRES) is positive although it is not significant for the pesticide use function for export farmers. This indicates that farmers base their spray decisions on the actual prevalence of insect and diseases outbreak.

Table 5.5 Results of pesticide use function estimation

	Amount of pesticide use: Ln-total cost (KSh/acre)					
	Domestic and export vegetable producers			Export vegetable producers only		
Variable	Estimated [a] coefficient	Standard error	t-value	Estimated [a] coefficient	Standard error	t-value
Constant	6.832***	0.488	14.01	7.627***	0.525	14.52
ADOP estimated				-0.051	0.158	-0.32
CRTY estimated	0.319**	0.141	2.27			
PEPR	0.148***	0.037	3.97	0.128***	0.035	3.57
FEPR	-0.025***	0.007	-3.37	-0.028***	0.007	-3.76
AGEH	-0.005	0.005	-1.02	-0.010*	0.006	-1.74
HHSI	-0.038*	0.025	-1.51	-0.041*	0.027	-1.61
PRES	0.062*	0.033	1.86	0.052	0.036	1.42
CONT	0.029	0.030	0.93	0.051	0.034	1.50
GROU	0.178	0.028	0.61	0.042	0.028	1.48
SYPT	0.059	0.038	1.56	0.048	0.041	1.17
FACI	-0.119	0.096	-1.23	-0.242**	0.107	-2.27
TRAI	-0.031*	0.018	-1.71	-0.027	0.021	-1.32
DIST	0.087***	0.022	3.93	0.074***	0.023	3.11
CRED	0.001*	0.000	1.81	0.001*	0.000	1.68
APPL	0.335**	0.157	2.14	0.382**	0.180	2.12
FERL	-0.011	0.019	0.67	0.032	0.022	1.11
DISTRICTS						
MERU (Base)						
KIRINYAGA	-0.232	0.212	-1.09	-0.229	0.253	-0.91
MURANGA	0.089	0.323	0.28	0.848**	0.401	2.12
NYERI	-0.017	0.202	-0.08	0.157	0.231	0.68
MAKUENI	-0.940***	0.307	-3.07	-1.009**	0.404	-2.50
Number of observation	539			439		
R-square	0.282			0.383		
Adjusted R-square	0.248			0.336		

[a] Statistical significance at the 0.01 (***), 0.05 (**) and 0.1 (*) level of probability
Source: Own survey

The parameter estimate for the level of training (TRAI) is negative and significant for the pesticide use function pointing to a positive effect of agricultural training on reduction of pesticide use. As expected the coefficient of distance to extension service (DIST), which is used as a proxy for access to information and advice, is positively and significantly associated with the expenditure on chemical pesticide. This coefficient suggests that farmers who reside near the extension service can make use of the information and consultancy service, which have a negative impact on their decision of spending on chemical pesticide. Access to effective government extension service can help the farmers in Kenya to resort to more environmental friendly pest control strategies rather than relying on chemical pesticides.

Household size (HHSI) in both functions is negatively correlated with pesticide use. This suggests that the more members the household has the more labor available for activities like weeding, which leads to low quantity of herbicides use. Age of the household head also seem to play a role in how much farmers expend for pesticides, i.e. younger vegetable farmers spend less than older farmers. This result is plausible as younger farmers are more likely to adopt integrated methods of pest control. The most interesting result is the coefficient that captures pesticide application (APPL). It had been expected that the more the household relied on hired casual labor to spray chemicals, the higher quantity (high spending) s/he would use because of the shift of risk associated with pesticide spraying to another party. However the result depicts a positive and significant correlation between the household head as primary applicator of pesticide and the spending on pesticides. Possibly farmers who spray themselves have a higher chance to use the money, which otherwise would have been spent on casual laborers for purchase of chemical pesticides.

Table 5.6 Results of pesticide use function for export vegetable producers

Dependent variable: ratio of WHO Hazard Category I and II pesticides to the total pesticides

	Estimated coefficient	[a]Standard error	t-value
Constant	0.519***	0.137	3.77
ADOP estimated	-0.056*	0.044	-1.62
PEPR	-0.019*	0.010	-1.85
FEPR	-0.004*	0.007	-1.87
AGEH	0.001	0.002	0.367
HHSI	-0.009	0.009	-1.07
PRES	0.020*	0.015	1.64
CONT	0.006	0.009	0.72
GROU	-0.023	0.008	-0.29
SYPT	-0.002*	0.001	1.67
FACI	-0.009	0.030	0.33
TRAI	-0.0045	0.006	-0.86
DIST	-0.014**	0.006	2.17
CRED	0.078*	0.046	1.70
APPL	-0.059	0.048	-1.24
FERL	-0.016	0.013	0.87
DISTRICTS			
MERU (Base)			
KIRINYAGA	0.100	0.071	1.42
MURANGA	-0.058	0.108	-0.54
NYERI	0.016	0.061	0.26
MAKUENI	-0.237**	0.120	-1.97
Number of observation	439		
R-square	0.291		
Adjusted R-square	0.246		

[a] Statistical significance at the 0.01 (***), 0.05 (**) and 0.1 (*) level of probability
Source: Own survey

Stage three: structural revenue model results

The estimation of production functions are aimed to investigate potential differences in the productivity of pesticides and total output revenue between farmers producing for domestic market versus export market and GlobalGAP adopters versus non-adopters. The results of the parameter estimates of both production functions are presented in Table 5.7. The models have a satisfactory explanatory power with adjusted R-square ranging from 0.3 and 0.4, which are reasonable for cross-sectional data set.

The results of the revenue function estimated for all vegetable producers indicate that although there is a positive correlation between choice to produce for export market (CRTY) and value of the crop yield, the coefficient is not significant. This result suggests that export farmers and domestic farmers are indistinguishable in terms of total revenue they earn from producing vegetables per acre during the long rainy season. However if one considers the total annual revenue per acre, export farmers earn significantly higher than the domestic farmers for three basic reasons. First the volume of sale for export producers is higher due to year round production unlike most domestic farmers which are seasonal. Second, the price of the export produce is relatively higher during the dry season due to high demand in most European countries, which perhaps could lead to higher return. Third, exporter-oriented farmers have year-round access to markets, whereas domestic ones have a narrower marketing window. On the other hand the coefficient of GlobalGAP adoption (ADOP) is positive and significant in the revenue function estimated for export farmers, which indicates the positive impact of GlobalGAP adoption on total revenue per acre. *Ceteris paribus*, GlobalGAP adopters get 24% higher crop revenue than the non-adopters.

The results show that for both production functions, the expenditure on seed, pesticide, and labor are the most important determinants of the final output obtained in vegetable fields. All these variables have the expected sign. The coefficient of fertilizer is not significant in both production functions. The coefficient of pesticide (PEST) shows that a 1% increase in pesticide expenditure in vegetable fields will increase the value of vegetable output proportionally by 0.002% for the first model and 0.003% for the second model. As expected product price (PRPR) have a positive impact on total revenue for both functions. The coefficients of seed (SEED) and labor (LABO) are positive and significant in both models pointing to the positive impact of these inputs on the output. The expenditure in seed captures variety specifics such as the potential yield for a variety and is a quality indicator, for instance in terms of germination rate. Theoretically, it would be expected that farm output would increase significantly as the management ability (measured in terms of farmer's age) of farmer increases. However the results demonstrate that farmer's age (AGEH) has a negative impact on the output of vegetables. Perhaps young farmers are more likely to face the risks associated with innovations, which could lead to high output. Two of the four district dummy coefficients (KIRINYAGA and MURANGA) have a negative sign whereas the coefficient of one district (MAKUENI) has positive sign. These indicate that farmers in Meru District have significantly higher revenue from vegetable production compared to Kirinyaga and Muranga Districts but less compared to farmers in Makueni Districts. Meru District is located at higher altitude, which has favorable climatic condition for most export and domestic vegetable crops. This entails high productivity, high quality and high price for the produce. On the other hand farmers in Makueni District have the advantage of using irrigation water since it's situated at lower altitude. Farmers producing vegetable for domestic market have also the advantage of delivering their produce to Nairobi or Mombassa market, which could boost the price they receive compared to farmers in other districts[9].

[9] In an alternative model specification, which includes set of dummies for types of vegetables produced instead of district dummies, there is no significant change in the sign and level of significance of the interest variables although the significance level is changed by small percentage for two variables (LABO and AGEH).

Table 5.7 Estimates of the revenue function

	Revenue function: Ln-total revenue (KSh/acre)					
	Domestic and export vegetable producers			Export vegetable producers only		
Variable	Estimated [a] coefficient	Standard error	t-value	Estimated [a] coefficient	Standard error	t-value
Constant	8.194***	0.830	9.87	5.603***	1.053	5.32
CRTY estimated	0.379	0.096	0.94			
ADOP estimated				0.273**	0.118	2.30
SEED	0.138***	0.039	3.54	0.222***	0.062	3.54
FERT	0.034	0.039	0.88	0.073	0.071	1.02
LABO	0.285***	0.063	4.50	0.368***	0.082	4.49
AGEH	-0.379**	0.161	-2.35	-0.276	0.197	-1.40
CRNU	0.089	0.115	0.77	0.231*	0.149	1.64
PRPR	0.231***	0.073	2.89	0.198***	0.045	2.45
IRRI	0.052	0.034	0.54	0.039	0.029	0.42
MARK	-0.142	0.097	1.32	-0.132	0.076	1.45
FERL	0.021	0.006	0.87	0.033	0.024	0.61
DISTRICTS						
MERU (Base)						
KIRINYAGA	-0.533***	0.125	-4.26	-0.495***	0.151	-3.27
MURANGA	-0.713***	0.183	-3.89	-0.417*	0.245	-1.70
NYERI	0.094	0.142	0.66	-0.007	0.174	-0.04
MAKUENI	0.484**	0.223	2.17	0.649*	0.119	2.30
Damage control function						
Constant (λ)	0.685***	0.257	2.66	0.679*	0.392	1.73
PEST estimated	0.002***	0.000	3.29	0.003**	0.001	2.46
Number of observation	539			439		
R-square	0.372			0.335		
Adjusted R-square	0.353			0.308		

[a] Statistical significance at the 0.01 (***), 0.05 (**) and 0.1 (*) level of probability
Source: Own survey

Using the estimated coefficients presented in Table 5.7, the associated marginal value products (MVPs), actual and optimal amount of pesticides for GlobalGAP adopters, non-adopters and domestic farmers are computed and presented in

Table 5.8. These computations are based on the assumption of all other inputs being constant at the sample average values while only varying the pesticide value. For the logistic damage function specification, the derivation of the marginal value products of pesticide (x_p) is obtained in as follows[10]:

$$\frac{\partial Q}{\partial x_p} = \frac{Q}{1-\exp^{(\lambda-\alpha_1 x_p)}} * \alpha_1 \exp^{(\mu-\alpha_1 x_p)} \tag{5.6}$$

The result demonstrate that the production function model integrating damage control function generate marginal value products per unit cost of pesticide greater than unity for all the cases suggesting that both export farmers either GlobalGAP adopters or non-adopters and domestic vegetable producers use pesticides below the financial optimum. Results of the t-tests compared to null hypothesis that MVP = 1 are all statistically significant below 10% significance level (see table 5.8)[11]. Especially for the case of domestic vegetables, farmers are using pesticides below their optimal levels. For example GlobalGAP adopters spend 630 KSh/acre on pesticides below the optimal level; non-adopters use nearly 185 KSh/acre less and the domestic farmers spend almost 1,485 KSh/acre less than optimal. This under use may have several reasons including financial constraints, the perceived risk of detectable pesticide residues leading to product rejection by exporters, the high variation in crop prices and other non-pest yield risks. Pesticides use below the financial optimum level has been reported for conventional cotton in West Africa (Ajayi, 2000) and Bt cotton in South Africa (Shankar and Thirtle, 2005). However in China, Huang *et al.* (2002) demonstrated the over-use of pesticide in cotton production.

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[10] The mathematical derivation of marginal value product of damage control inputs is presented in the appendix.

[11] MVP analysis might have shortcomings when applied to pesticide use in general since a marginal decision rule is predicated upon the assumption of a divisible input. Pesticide labels clearly state that they are to be treated like medicines and applied at standard rates for reasons of safety and efficacy. However for most developing countries at large and Kenya in particular this may not be the case since farmers decision rule is determine by a number of constraints. Thus MVP analysis is expected to be informative on the decision of pesticide use.

Table 5.8 Estimated marginal value product of chemical pesticides in [KSh]

Variables	Export market producers (N= 439)			Domestic market producers (N= 100)
	GlobalGAP Adopters	Non-adopters	Total	
Marginal value products (KSh)	5.61 (2.43***)[a]	1.64 (1.96*)	5.84 (2.64***)	21.04 8 (3.77***)
Actual pesticide use (KSh/acre)	1503	1860	1730	1093
Optimal pesticide use (KSh/acre)	2135	2045	2595	2575

[a]Number in bracket shows a t-test compared to null hypothesis that MVP =1. Statistical significance at the 0.01 (***), 0.05 (**) and 0.1 (*) level of probability
Source: Own survey

Figure 5.1 shows the marginal value of pesticides use for different input levels of pesticides, which demonstrates the usual patterns of diminishing marginal returns. Increase in the monetary value of an additional vegetables output approach zero as expenditure on pesticide use increases to a level above 2,000 KSh/acre for all the cases.

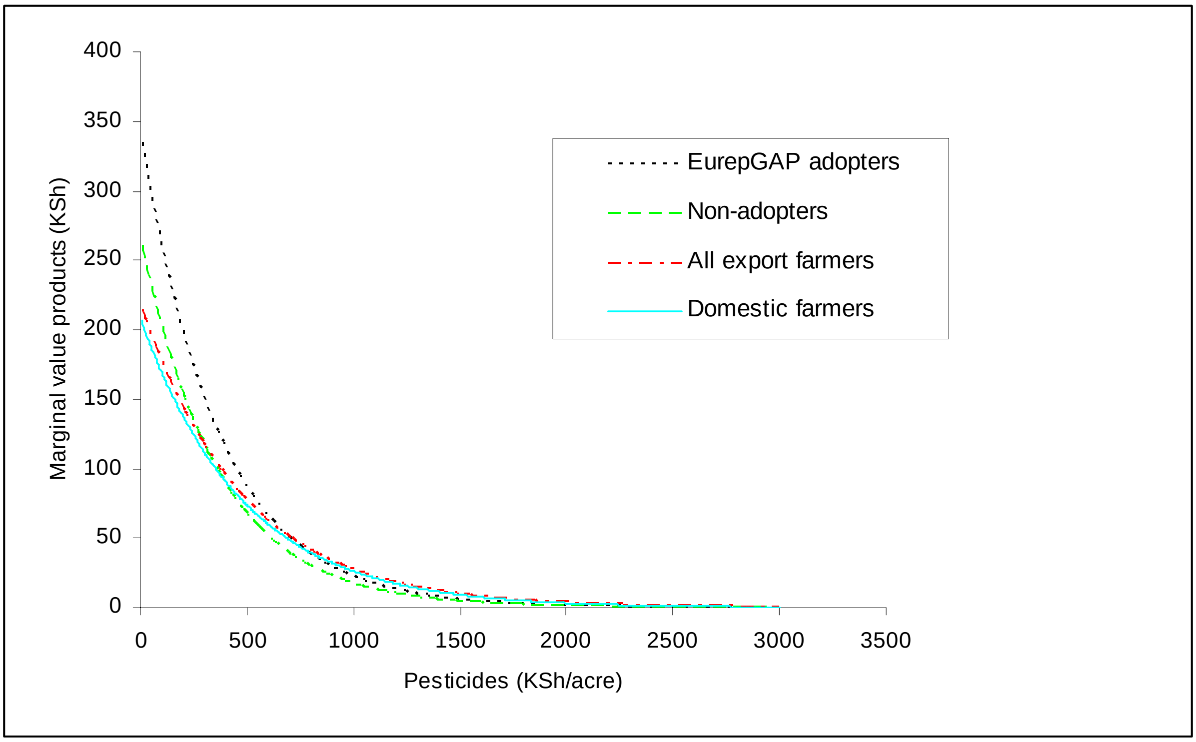

Figure 5.1 Marginal value products of pesticide use in vegetable production
Source: Own survey

It is important to note that the calculated optimal pesticide use levels do not take into account any environmental and health cost of pesticide use. If a ratio of 1:1 is assumed for health costs alone (see Rola and Pingali, 1994), under use would no longer exist.

5.5 Conclusions

This chapter contributes to the growing literature on the implications of introducing food-safety standards in developing countries for farmers' production system using the case of Kenyan vegetable producers. Results show that farmers producing vegetables for the domestic market use significantly less pesticides in terms of expenditure vis-à-vis export farmers. Ceteris paribus, farmers producing export vegetables spend 28% more on pesticides than farmers producing domestic crops. This study also showed that the adoption of standards by the export farmers does not have any significant impact on the total expenditures for pesticides. However, in export vegetables adopters and non-adopters of standards still use pesticides below the private economic optimum. On the other hand the adopter categories are distinguishable in terms of types of pesticide used i.e. adopters use safer pesticides based on WHO classification. The third stage structural revenue model results demonstrate a positive and significant effect of standards adoption on revenue of vegetable production. Nevertheless, export and domestic farmers are indistinguishable in terms of total revenue they earned from producing vegetables per acre during the long rainy season.

While food-safety and quality standards can be barriers for resource poor smallholders to maintain their position in the lucrative export markets, they can also induce positive changes in production systems of small-scale farmers who adopt it as shown by the results presented. A shift to less hazardous pesticides as a result of GlobalGAP adoption implies less pesticide intoxication by farmers and farm workers, less adverse impact on the environment as well as enhanced food-safety.

Generally, the empirical results presented in this chapter support the notion that the adoption of emerging food-safety standards can play a positive role by serving as a catalyst of transforming the production systems towards safer and more sustainable production. Hence these standards can have health and environmental benefits aside from the benefits that accrue for industrial country consumer. Nevertheless to extrapolate these results to the whole vegetable sector in Kenya, it is crucial to look closely at the scale of adoption of standards nationwide. According to a separate survey by Mithöfer *et al.* (2008), the scale of adoption among export vegetable producers seems to be rather low (i.e. the scale of adoption among export vegetable producers is below 20%) for achieving a direct significant impact within the smallholder vegetable export sector.

Chapter 6

Health and Environmental Impact of EU Private-sector Standards in Kenyan's Export Vegetable Growers[1]

6.1 Introduction

In recent years, governments and development agencies have sought to promote the diversification of African agro-food exports in order to accelerate economic growth, expand employment opportunities, and reduce rural poverty (Harris *et al.*, 2001). Particular attention has been given to facilitating the export of high-value horticultural products, which have grown steadily to become the single largest category in world agricultural trade, accounting for over 20% of such trade in recent years (Humphrey, 2006). A number of African countries have had some notable success in such export diversification amongst them Kenya is leading. Small-scale farmers have proven to be effective suppliers of horticultural products when satisfactory contracting arrangements are established with an exporter or processing firm (Dolan and Humphrey, 2000). However, there are problems in horizon for export horticulture in Kenya – and may be equally applicable elsewhere in Africa and these problems will have a profound impact on small-scale farmers. Increased intensity in export market production has led to the use of relatively large quantities of pesticides often not for the purpose of preventing yield loss but in order to satisfy export markets' demand for aesthetic appeal. This intense use of chemicals has been associated with a high risk to human health (chronic and acute illness) and intolerable environmental pollution (Mwanthi and Kimani, 1990; Okello and Swinton, 2006b; Ohayo-Mitoko, 1997; Thrupp, et al, 1995; Macharia, 2002; Rola and Pingali, 1993; Crissman *et al.*, 1988 and Maumbe and Swinton, 2003; Garming and Waibel, 2008).

In spite of the growing recognition of the hidden costs related to the environmental and health effects due to pesticide use and the potential of adoption of production standards such as GlobalGAP to reduce them, there is lack

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[1] A paper based on this chapter is under review for Environment and Development economics.

of empirical evidence to support these prepositions. Theoretically adopting food-safety standards like GlobalGAP provides potential health and environmental benefits stemming from changes in pesticide use and hygienic practices. Standards, if adopted could reduce exposure of developing country farmers to highly toxic pesticides and hence cost of pesticide-related illnesses. Measures taken to meet export market requirements for food-safety usually have spill-over benefits for other (non-export oriented) local producers or for domestic consumers. Referring to these potential direct and indirect benefits, some argue that standards can play a positive role, providing the catalyst and incentives for the modernization of export supply and regulatory systems and the adoption of safer and more sustainable production practices in developing countries (Henson and Jaffee, 2006 and Maertens and Swinnen, 2006).

Limited empirical evidence exists either to confirm or refute the hypotheses that food-safety standards generate a positive external on farmers adopting it. Incorporating these environmental and health effects in the analysis could help to improve understanding of the true impact of emerging production standards on developing countries farmers. Therefore this chapter addresses two major objectives: (1) to estimate the effect of standards on pesticide ascribed incidence of acute poisoning symptoms and its associated cost-of-illness and (2) to explore impact of standards on improved crop management practices as proxy for environmental benefits. Given time and resource constraint, this study focuses on self-reported health symptoms associated with pesticide use and its corresponding cost ignoring other potential health effects such as genetic and reproductive disorders as well as cancers.

To attain the above-mentioned objectives, a theoretical non-separable farm household model is used as a starting point. This model gives a detailed explanation of households demand for health. Based on the health demand functions derived from the model's first-order condition, an empirical model is formulated and estimated. In addressing these two objectives, the contribution of this chapter to the literature is threefold. First, there is limited empirical evidence on the link between private-sector standards, farmers' health and crop management practices. Thus, it is important to empirically document the argumentation and hypotheses build up in the literature. Second, unlike previous studies this chapter addresses the potential self-selectivity (or endogeneity of adoption of standards) problems using two-stage econometric model techniques. Third, the chapter also draws upon a relatively large sample data set, which is collected via re-call and season-long monitoring survey, which was not the case in previous literatures.

The remainder of the chapter is structured as follows. Section 6.2 presents the theoretical concept of a non-separable household model. Section 6.3 shows the data collection methodology. The econometric model used for estimation is presented in section 6.4. Section 6.5 presents the estimation results and some conclusions and policy implications are pointed out in section 6.6.

6.2 Theoretical model

In order to assess the impact of production standards like GlobalGAP on households production decision and pesticide ascribed health and environmental effect, a household production model (Singh *et al.*, 1986) is used as a framework. Given that production and consumption decision of rural households are non-separable (Sadoulet and de Janvry, 1995), households would be maximizing the following utility function:

$$U = U(c_m, r_m, l_i, h; z_m) \tag{6.1}$$

Each household derives utility from consumption of on-farm goods c_m, gain revenue from sale of its on-farm output to purchase other market goods r_m, leisure (home time) (l_i), household health (h) and vector of other factors that shift the utility function (z_m). The household maximizes utility subject to a set of constraints, namely production constraint (Equation 6.2), cash income constraints (Equation 6.4) and health constraint (Equation 6.5).

$$Q_i = Q_i(V_i(h), D(P, x_p(G)), W, M(G), T(G)); z_u) \quad (6.2)$$

where:

$$G = G(S, W, H / z_h) \quad (6.3)$$

The level of on crop production (Q_i) depends on the availability of family and hired labor (V_i), the occurrence of pests as represented by damage control function (D), non-pesticide inputs such as fertilizer (M), household asset, (W) environmental factors (T) and household characteristics and other shifters (z_u). The damage control function represents potential damage that pest and diseases can cause to farm production and depends on the pest pressure (P) and the use of pesticide inputs (x_p). In addition the use of pesticide and non-pesticide input use is determined by adoption of GlobalGAP production standards (G) and in turn the adoption of GlobalGAP standards is influenced by social capital (S), household asset (W), human capital (H) and household characteristics (z_h).

The second set of restriction is the cash income constraint, which can be expressed as:

$$\sum_{i=1}^{N} \left[p_i (Q_i - c_m) \right] - wV_i - p_x x_p - p_n M - p_k k_i + E \geq \sum_{m=1}^{N} \left[p_m r_m \right] \quad (6.4)$$

where p_i, w, p_x, p_n, p_k and p_m denote the exogenous prices for agricultural outputs, labor, pesticide inputs, non-pesticide inputs, health inputs and purchased output. E is net transfer received including remittances.

The household utility maximization problem is completed by incorporating the household health constraint:

$$h = h(c_m, r_m, k_i, x_p(G), b_h; z_h) \quad (6.5)$$

The health status of the farmer (h) can be influenced by consumption of own farm goods (c_m), market goods (r_m), behavioral factors such as smoking and alcohol consumption (b_h), health inputs (k_i) like health care services and protective devices, and occupational hazards from the use of chemical inputs ($h(x_p) \leq 0$) (Crissman *et al.*, 1988). An environmental factor (T) which is represented by improved pesticide management practices is influenced by adoption of GlobalGAP production standards, human capital, household asset and household characteristics.

$$T = T(G, H, W / z_h) \tag{6.6}$$

The adoption of standards is expected to influence farmers' health and environment via changing exposure to and management of chemical pesticides in three major ways. First, quantity of pesticide use under GlobalGAP is expected to be lower, as to ensure compliance with residue limits and partly may be replaced by non-chemical crop management practices. Second, change in type of pesticide used is more likely i.e. farmers complying with GlobalGAP standards are expected to shift to less hazardous type of chemicals compared to the non-compliant farmers. Third, adoption of GlobalGAP is also expected to affect farmers' pesticide management practices such as scouting pest before spraying, using protective clothing, bathing after spray, having chemical store and disposal pit etc.

The Lagrangian associated with the constrained maximization problem is given as:

$$\begin{aligned} L = U(c_m, r_m, l_i, h; z_m) + \lambda \left\langle \sum_{i=1}^{N} \left[p_i (Q_i - c_m) \right] - wV_i - p_x x_p - p_n M - p_k k_i + E - \sum_{m=1}^{N} \left[p_m r_m \right] \right\rangle \\ + \sum_i \phi \left[Q_i (V_i(h), D(P, x_p(G)), W, M(G), T(G, H); z_{u,}) \right] + \mu \left(\left(h(c_m, r_m, k_i, x_p(G), b_h; z_h) \right) \right) \end{aligned} \tag{6.7}$$

Note that λ, ϕ and μ are the Lagrange multipliers for the cash income constraint, the production constraints and the health constraints, respectively. Solving the household utility maximization problem subject to the constraints, reduced form of factor demand for pesticide inputs (x_p) and non-pesticide inputs

(M) as well as household demand for health (h) can be derived based on some set of explanatory variables.

$$F = f(p_x, p_n, p_k, w, W, G; z_h) \qquad (6.8)$$

where F is a vector representing x_p, M and h.

The main task in this chapter is to measure econometrically the coefficients of the G vector, which contains the estimated impacts of GlobalGAP adoption on the farmer health.

6.3 Survey design and data

Farm level data were collected for this study between August 2005 and September 2006 via a cross-sectional survey of 449 households of Kenyan export vegetable producers. The sampling design followed a multi-stage procedure to select districts, sub-locations and small-scale vegetable producers, respectively. First, five districts were selected purposively from the two major vegetable producing provinces (namely Nyeri, Kirinyaga, and Murang'a Districts in Central Province and Meru Central and Makueni Districts in Eastern Province). The five study districts were selected intentionally because of the intensity of export vegetable production and differences in agro-ecology and types of crop produced. Meru District is located at higher altitude primarily producing French beans while Nyeri, Kirinyaga, and Murang'a Districts are situated at middle altitude producing a range of green beans and peas. Makueni District is located at lower altitude mainly producing Asian vegetables. These districts represent approximately 50% of smallholders producing vegetables for the export market (Mithöfer *et al.*, 2008). Second, 21 sub-locations were randomly selected from the five districts based on Probability Proportional to Size (PPS) sampling technique. Overall, a total of 439 farm households were randomly selected from the export crop producing households living in the selected sub-locations of which 149 of them are GlobalGAP adopters export farmers and 290 non-adopter export farmers[2]. GlobalGAP adopters in this case are defined as small-scale export producers who have either already obtained GlobalGAP certificate or are in the process of obtaining the certificate under Option 2.

For each randomly selected farmer the survey combined a single visit (re-call survey) and a season-long monitoring of household production practices. The data were collected by trained enumerators supervised by the researcher using structured questionnaires. Prior to commencing the survey the questionnaire was pre-tested on non-sampled farmers separately for validation. The re-call survey questionnaire covered specific information on the characteristics of household members, household income (both farm and off-farm), household assets such as land size, livestock ownership, farm machinery and household equipments and access to different services like credit, irrigation, formal contract and group membership. The respondents were also asked to re-call incidence of intoxication after applying pesticides on export vegetables during the past three years. Nevertheless while conducting the survey it was realized that using health information collected via recall survey could lead to misleading conclusion since most farmers could hardly remember the pesticide ascribed health problems in prior years. Hence it is decided to collect health information together with production inputs and outputs related to export vegetable production by means of a season-long monitoring survey.

The monitoring questionnaire was administered exclusively to the household head every three weeks throughout the cropping season. A health symptom that the respondents reported is regarded to be associated with pesticide spraying if the symptom only began during the spraying operation or within 24 hours after spraying. If the household members experienced any sort of pesticide intoxication, then he/she was asked to report for each symptom, the number of times the symptom occurred, the number of work-days lost partially or completely due to the health symptoms and the type of medication taken by victims. Other data

[2] Unlike chapter 5 that compares domestic versus export producers, this chapter uses only 439 households producing for export market since the primary objective is to compare GlobalGAP adopter categories.

collected include direct costs of the symptoms, i.e. pharmacy cost and consulting fees, and indirect costs such as travel expenses to and from health centers. Beside health economics information, data were also collected on type of pesticides sprayed, the quantity sprayed, duration of spraying, and other pesticide management practices indicators such as whether protective clothing was used by the person who sprayed, precautionary measures taken against wind, condition of spraying equipment used etc.

Evaluation of health costs of pesticides

An estimate of pesticide related health cost is computed as the sum of farmer-reported medical treatment costs to clinics and private physicians, the opportunity cost of work days lost to illness, travel costs to and from health facility, time spent in traveling and the cost of home-based health care. This estimate can be expected to be the lower bound estimate of the true cost-of-illness since other costs such as loss of labor by family members nursing the victim, work efficiency loss in farm due to illness, the value of leisure forgone due to illness, cost of defensive expenditure and the cost of traditional healing strategies are not included in the computation due to lack of information.

Contingent valuation methods, which measure the respondents' willingness to pay for hypothetical health improvements could have been used as an alternative procedure to estimate cost-of- illness, as used in some other studies (Atreya, 2005; Kenkel *et al.*, 1994; Garming and Waibel, 2008). However, these methods are often expensive to design properly (Diamond and Hausman, 1994; Maumbe and Swinton, 2003). Beside the hypothetical nature of this procedure introduces some sources of potential inaccuracy and imprecision since the choice constrains imposed by true market conditions are not truly binding on respondents. In this respect, the cost-of-illness approach has the advantage that it is based upon real market condition (Maumbe and Swinton, 2003). The contingency valuation method on the other hand has the advantage of taking into account other costs such as pain, suffering, discomfort and other intangible costs, which cannot be captured via cost-of-illness method. As a result often the estimation based on contingency valuation method exceeds the cost-of-illness estimate (Atreya, 2005; Kenkel *et al.*, 1994).

6.4 Empirical models

This chapter specifies three empirical models to explain the principal factors affecting farmer's health and improved management practices. The first model involves the estimation of the cost-of-illness and the primary interest is to estimate the impact of standards on the pesticide ascribed health cost. The second and third models involve the estimation of determinants of acute symptoms of pesticide poisoning and improved pesticide management practices, respectively. Following Angrist (2001), Fernandez-Cornejo *et al.* (2005), Green (1997), Rosenbaum (1983) and Wooldrige (2002), different econometric techniques is applied to correct for potential selection bias in estimating the impact of adoption of GlobalGAP standards on farmers' health and improved management practices.

Treatment effect model and propensity score methods

In the first regression model an attempt is made to control for potential endogeneity problem using a two-stage standard treatment effect model. The major question is what would the cost-of-illness of GlobalGAP adopters have been if they had not adopted standards? To answer this question a suitable comparison group of non-adopters whose outcomes, on average, provide an unbiased estimate of the outcomes that the adopters would have had in the absence of standards needs to be identified. The choice of counterfactual is crucial because adopters are not placed randomly and the decision to adopt depends on individual, household, community characteristics and other exogenous factors. Formally, given the unobserved variable and its observed counterpart, the treatment-effect equation can be expressed as:

$$G_i^* = \beta X_i + u_i \tag{6.9}$$

$$H_i = \alpha V_i + \gamma G_i + e_i \tag{6.10}$$

$$G_i = \begin{cases} 1 & if\ G_i^* > 1 \\ 0 & otherwise \end{cases} \tag{6.11}$$

where G_i^* is the unobservable or latent variable for GlobalGAP adoption, G_i is its observable counterpart (dummy for adoption of GlobalGAP), H_i is a vector denoting the cost-of-illness, V_i are vectors of exogenous variables thought to affect health cost and X_i are non-stochastic vectors of observed farm and non-farm characteristics determining adoption. e_i and u_i is random disturbances associated with the cost-of-illness model and the adoption of GlobalGAP.

Note that it is not possible to simply estimate (Equation 6.10) because the decision to adopt may be determined by unobservable variables that may also affect health cost. If this is the case, the error terms in (Equation 6.9) and (Equation 6.10) will be correlated, leading to biased estimates of γ, the impact of adopting GlobalGAP. The selection bias can be corrected by assuming a joint normal error distribution, and using a two-step procedure. In the first step a probit model is used to estimate adoption. Using the probit results, the predicted probability of adoption is computed for each observation. In the second stage, cost-of-illness is regressed on the explanatory variables and the predicted probability of the probit model (Greene, 1997). However whether or not the effect of a treatment (GlobalGAP adoption) can be correctly estimated using a two-stage regression importantly depends on the validity of the exclusion restriction. Hence for identification purpose, the usual order condition that X_i contains at least one element not in V_i is followed imposing an exclusion restriction in Equation 6.10.

To assess the robustness of these results, an alternative propensity scores is used as control functions in case the adoption variable interact with unobserved heterogeneity (Wooldridge, 2004) – a method pioneered by Rosenbaum (1983):

$$H_i = \alpha V_i + \gamma G_i + \mu Pscore + e_i \tag{6.12}$$

where:

$$Pscore\ (X) = \Pr(G_i = 1 / X) \tag{6.13}$$

The propensity score (*Pscore*) is the conditional probability of adoption given observed covariates X_i and can be estimated by a probit model. The estimated propensity scores are used in the structural equation as a control function for selection bias. A key assumption underlying this method is ignorability of treatment, which implies that the potential outcomes are independent of participation conditional on the set covariates (Wooldridge, 2004; Rosenbaum, 1983).

$$(H_1, H_2) \perp G_i / X \tag{6.14}$$

where H_1 and H_2 are the outcomes of interest (cost of illness) for adopters and non-adopters, respectively.

Two-stage Poisson regression model

The second and third regression models involve the estimation of determinants of acute symptom incidence of pesticide poisoning and improved pesticide management practices, respectively. Acute symptom incidences refer to short-term illness episodes experienced by the farmers and these include both the dermal and oral (ingestion) symptoms. Thus, the total incidence model aggregates skin irritation, diarrhea, sneezing, headache, dizziness, vomiting, stomach poisoning, blurred vision, eye irritation and backache episodes incurred by the household members during and/or soon after spraying pesticides. Counts of improved pesticide management practices include owning pesticide store, full protective clothing, disposal pit, special pesticide mixing container, pest scouting before spraying, observing pre-harvest interval, inspecting sprayer before spraying, calibrating nozzle of the sprayer regularly, record keeping of inputs and observing wind direction before spraying.

The response variable in both situations is a quantitative variable, but has the property that it is discrete, taking on only integer values. These dependent variables are addressed via Poisson regression model. The basic idea for this model is that the predictor information is related to the rate or susceptibility of the response to increase or decrease in counts. Econometric model of count data give consistent estimate only when the regressors are exogenous. In the present study, however, the main regressor of interest is adoption of standards, which is likely to be endogenous. Hence to account for potential endogeneity problem of adoption of standards, a two-stage estimation procedure is applied.

The estimation of linear models with endogeneity is to some extent straightforward, but a situation in which a count dependent variable depends on a binary endogenous variable is more complex because a simple reduced form does not exist. There are two standard approaches to estimation. The first approach is a full information maximum likelihood, FIML, model in which the joint distribution is specified and the joint log-likelihood function is maximized. Alternatively, a limited information maximum likelihood, LIML, two-step procedure can also be adopted. In this approach, the first model is estimated, since it does not involve the second parameter vector. Subsequently, the second parameter vector is estimated conditional on the results of the first step estimation. Consider the following two equations:

$$\begin{aligned} M_{1i} &= \exp(\alpha_i Z_i + \gamma_1 G_i + u_i) = \exp(\alpha_i Z_i + \gamma_1 G_i)\exp(u_i) \\ &= \exp(\alpha_i Z_i + \gamma_1 G_i)\varepsilon_i \end{aligned} \tag{6.15}$$

$$G_i^* = \beta X_i + u_i \tag{6.16}$$

where M_{1i} is a count endogenous variable, G_i is a binary endogenous variable, Z_i and X_i are exogenous variables, ε_i and u_i are disturbance terms that follow a gamma distribution and a logistic distribution, respectively and G_i^* is an unobservable variable. From the viewpoint of model estimation, however, the model described above cannot be estimated using fully simultaneous estimation due to logical consistency (Winkelmann, 2003; Windmeijer and Santos Silva, 1997; Cameron and Trivedi, 1998; Mullahy, 1997). As a result, the parameters are estimated by maximizing the log-likelihood function using limited information maximum likelihood estimation[3]. The *matrix accum* and *matrix vecaccum* stata commands are used as provided by Hardin (2002) for estimation and the standard errors are also adjusted to account for the two-step procedure.

Choice of explanatory variables

The explanatory factors for the models explaining health costs and acute symptoms incidence incorporate four broad classes of variables namely those related to household characteristics, household wealth, household health and pesticide exposure and institutional settings. Age (and its square) of household head (AGEH & AGSQ), his or her educational attainment (EDU1) and the level of education of that household member who had the highest educational attainment (EDU2) are taken as proxies to measure the human capital. While for education the relationship is assumed to be negative the opposite may be the case for age as young farmers may show a higher tendency to adopt innovations and protect against pesticide intoxication. Gender of household head (GEND) is also expected to affect pesticide ascribed health symptoms and its associated cost although the direction of the effect is not clear a priori.

Household wealth variables such as total income earned during 2005 (INCO) and facility index (FACI) are included in the cost-of-illness model to capture the ability of the households spending on health service. Pesticide exposure indicators include quantity of pesticide used by classes of toxicity based on WHO classification (from Hazard Category I, which is highly toxic up to moderately toxic Hazard Category IV), whether the farmer used cocktail of chemical (COCK), total number of hours sprayed (HRSP), eat in the vegetable field while spraying (EATE), wash the protective gear after use (WASH), take bath after spraying chemicals (BATH), knowledge of label meaning (LABE), maintained sprayer ever (MAIN) and the family members are a primary applicator (APPL). Health related variables include the duration in years of smoking (SMOK) and drinking alcohol

[3]An exclusion restriction is imposed in equation (6.15) i.e. X_i contains at least one element not in Z_i.

(ALCH) by the household head. Another set of variables incorporate institutional and access related variables such as major agricultural training attended (TRAI) and contact with extension service (EXTE). A set of district dummies are also included to capture the heterogeneity in the ecological and service provision. A variable of interest is adoption of GlobalGAP standards (ADOP), which is hypothesized to influence the health symptoms and cost negatively[4].

For the third model, count of improved pesticide management practices is used as the left-hand variable. The right hand variables in the regressions include (a) household characteristics including gender and age (and its square) of the head and level of education (categorized into education level of the head and highest education level attained by other adult household members); b) household wealth: annual total household income and facility index; c) access to different services: amount of credit used in the past three years (CRED), years of group membership (GROU), years of participation in formal contract (CONT), radio use per week (RADI) and contact with extension personnel's; d) adoption of GlobalGAP standards and e) the geographical location of the household (in this case dummies for districts). Descriptions of the variables used in the analyses and basic statistics are provided in Table 6.1.

[4]Four major variables namely number of protective clothing used, owning chemical store, owning special mixing container and observing wind direction when spraying are excluded from the health model since they are highly correlated with the adoption variable. Their presence in the model obscures the effect of standards on the farmers' health due to multicollinearity problem. A test is also performed to check the multicollinearity problem between variables WASH and FACI, BATH & FACI.

Table 6.1 Descriptive summary of variables used in estimations (N = 439)

Variables	Unit	Adopters (N = 149)	Non-adopters (N = 290)	t-stat[a] (chi-square)
Dependent variables				
Acute pesticide poisoning cases (**ACUT**)	count	1.61	2.21	1.74*
Health cost-of-illness (**COST**)	KSh	165.54	324.33	2.42**
Improved pesticide management practices (**MANA**)	count	8.27	6.40	-6.70***
Household characteristics variables				
Age of the household head (**AGEH**)	years	45.38	46.18	0.53
Age square (**AGSQ**)	years	2,212.41	2,297.23	0.57
Male household head dummy (**GEND**)	1/0	0.89	0.81	3.57*
Highest grade attained by household head only (**EDU1**)	years	9.42	8.07	-3.28***
Highest grade attained by other adult household members (**EDU2**)	years	9.77	8.89	-1.67*
Household wealth variables				
Total annual income (**INCO**)	KSh	144,141	148,100	0.11
Total land size (**LAND**)	acres	2.97	2.66	-0.99
Facility index (**FACI**)	-	1.59	1.03	-5.68***
Pesticide exposure and health related variables				
Hazard Category I pesticide (**PES1**)	gram	13.06	29.64	2.32**
Hazard Category II pesticide (**PES2**)	gram	64.21	74.32	1.06
Hazard Category III pesticide (**PES3**)	gram	105.41	100.42	-0.17
Hazard Category IV pesticide (**PES4**)	gram	156.26	99.96	-2.96***
Use cocktail of chemicals dummy (**COCK**)	1/0	0.59	0.77	10.89***
Wash the gear after use dummy (**WASH**)	1/0	0.92	0.69	20.67***
Bath after spraying dummy (**BATH**)	1/0	0.99	0.93	5.49**
Eat while spraying dummy (**EATE**)	1/0	0.12	0.02	14.67***
Knowledge on the label of pesticide dummy (**LABE**)	1/0	0.96	0.89	4.47**
Number of hours sprayed (**HRSP**)	hours	4.68	4.91	0.38
Maintained sprayer ever dummy (**MAIN**)	1/0	0.46	0.43	0.64
Primary applicator of pesticide dummy (**PRIM**)	1/0	0.81	0.61	12.75***
Smoking duration (**SMOK**)	years	2.34	3.89	1.62*
Alcohol intake duration (**ALCO**)	years	1.32	2.42	1.44
Institutional and access related variables				
Radio use per week **(RADI)**	hours	27.82	25.36	-1.42
Number of major agricultural training subjects attended (**TRAI**)	count	6.81	5.26	-3.61***
Contact with extension service dummy (**EXTE**)	1/0	0.86	0.73	6.25**
Amount of credit used for the past three years prior 2005 (**CRED**)	KSh	5,535	4,459	-0.55
Number of years the head has been a group member (**GROU**)	years	3.15	1.33	-5.83***
Number of years the head has been involved in formal contract (**CONT**)	years	2.66	2.30	-1.18

[a] Statistical significance at the 0.01 (***), 0.05 (**) and 0.1 (*) level of probability. Categorical variables are analyzed using chi-square test.
Source: Own survey

6.5 Results and discussion

Descriptive analysis

Table 6.1 presents the t-test and chi-square comparison of means of selected variables between GlobalGAP adopters' categories. Level of education of the household head and other household members is significantly higher for GlobalGAP adopters. No significant difference is observable in the age of the household head. Adopters seem to have more access to facilities as indicated by facility index however there is no significant difference in total annual income and total land size. As far as pesticide exposure and health related variables are concerned, non-adopters use significantly high quantity of Hazard Category I pesticide, which WHO classifies as highly toxic, whereas the adopters use higher amount of Hazard Category IV, which WHO classifies as moderately toxic. The result also depicts that the adopter categories are distinguishable in terms of knowledge on the label of pesticides. Non-adopters have a tendency to use of cocktail of chemicals and eat in the vegetable fields while spraying compared to adopters. The adopters more often take a bath after spraying chemicals and wash the protective gear used than their counterparts. The primary applicator of pesticide is more often the household head in adopters group than non-adopters. The duration in years of smoking is significantly higher for non-adopters although there is no significant difference in years of alcohol intake. Moreover the length of membership in grower groups, level of agricultural training and contact with extension personnel are also significantly higher for GlobalGAP adopters compared to their counterparts.

Incidence of pesticide-related acute illness symptoms and its associated health cost are significantly higher for non-adopters as shown by t-test comparison. For the 2005 cropping season, the estimated average cost of pesticide-related health risks is 165 KSh and 324 KSh for adopters and non-adopters, respectively. These costs equal 86.4% of the mean household pesticide expenditure per cropping season for non-adopters and 39.6% of those adopters. Table 6.2 underscore that non-adopters reported more cases of acute health symptoms ascribed to pesticide compared to their adopter counterpart.

Table 6.2 Pesticide related health symptoms among export vegetable producers

Symptoms	GlobalGAP Adopters (N=149)		Non-adopters (N=290)		Total (N=439)	
	Frequency	%	Frequency	%	Frequency	%
Skin irritations	18	29.0	44	71.0	62	100
Eye irritations	9	17.3	43	82.7	52	100
Headache	11	18.6	48	81.4	59	100
Sneezing	28	29.5	67	70.5	95	100
Stomach poisoning	7	28.0	18	72.0	25	100
Backache	4	16.0	21	84.0	25	100
Dizziness	16	29.6	38	70.4	54	100
Blurred vision	7	20.6	27	79.4	34	100
Diarrhea	1	6.3	15	93.8	16	100
Vomiting	2	15.4	11	84.6	13	100

Source: Own survey

Table 6.3 presents the list of proxies used to measure improved pesticide management practices and compares degree of practices between the adopter categories. The chi-square test results depict that a higher proportion of GlobalGAP adopters own pesticide store, full protective clothing, disposal pit and special pesticide mixing container. The groups are also significantly distinguishable in terms of practices such as pest scouting before spraying, observing pre-harvest interval, inspecting sprayer before spraying, calibrating nozzle of the sprayer regularly, record keeping of inputs and observing wind direction before spraying.

Table 6.3 Improved management practices in export vegetable production

Variables	GlobalGAP Adopters (N=149)	Non-adopters (N=290)	Total (N=439)	Chi-square [a]
Own pesticide store (0,1)	0.93	0.62	0.74	33.22***
Own disposal pit (0, 1)	0.92	0.60	0.72	34.52***
Pest scouting (0, 1)	0.98	0.86	0.90	12.22***
Observe pre-harvest interval (0,1)	0.98	0.87	0.91	10.26***
Inspect sprayer before spraying (0, 1)	0.82	0.71	0.75	4.65**
Maintained sprayer ever (0, 1)	0.46	0.43	0.44	0.21
Own special mixing container (0,1)	0.59	0.33	0.43	18.31***
Calibrates nozzle (0,1)	0.68	0.44	0.53	16:54***
Record keeping (0, 1)	0.99	0.81	0.87	21.64***
Observe wind direction (0,1)	0.93	0.78	0.84	10.98***

[a] Statistical significance at the 0.01 (***), 0.05 (**) and 0.1 (*) level of probability
Source: Own survey

In the subsequent part of the chapter, a rigorous analytical model is estimated to investigate whether these and other variables influence household's health and environment using pesticide related acute illness, the corresponding costs of illness and counts of improved management practice as dependent variables.

Results of pesticide-ascribed acute illness model

The results of a two-stage Poisson regression model used to estimate determinants of self-reported acute symptoms of pesticide poisoning are presented in Table 6.4.

Pesticide use significantly affects farmer's health impairments. The statistically significant and positive coefficient for categories I and II pesticides indicates the incidence of farmer's health impairments rises with the increase in highly toxic pesticide use. Although the coefficients are insignificant, categories III pesticide types are positively correlated with incidence of acute poisoning whereas negative correlation is observed with category IV pesticide type. It is hypothesized that using pesticide cocktails can increase incidence of symptoms in the household due to the possible interaction between pesticides that can lead to unknown chemical reactions (Yánez *et al.*, 2002). The results do not support this notion since the coefficient is not significant below 10%. It is interesting to note the significant negative coefficient for age, which indicates the older the farmer, the more experience in pesticide use resulting in better health. However as displayed with the positive and significant coefficient of age square, the ability of farmers to appropriately use pesticides decreases after a certain threshold of age resulting in health problems. The regression results also depicts that incidence of health impairment is higher among male farmers than females, which is consistent with the researchers' observation during the field survey. Pesticide applicators in the study area are primarily male farmers whereas the female farmers engage in other farming activities such as weeding and harvesting.

Previous studies have shown that the higher the level of training or education of the household head or members, the more likely to report pesticide-related health symptoms simply because of the awareness of negative effects on health. However the findings show that participation in agricultural trainings tends to decrease the number of reported pesticide-related acute illness. Likewise the incidence of acute illness symptoms is also mitigated by knowledge of pesticide labels as indicated by negative and significant coefficient of the variable.

Other human capital variables such as education level of the head and other household members and contact with extension service also have a negative sign as expected although the coefficients are statistically insignificant. The implication is that households with higher education level and trained farmers have more knowledge on crop management and input use and thus are more likely to handle pesticides with more caution. In line with our expectation, households with higher access to facilities experience significantly less incidence of acute illness as indicated by the negative coefficient of facility index[5].

[5]A test is conducted to detect the problem of multicollinearity between variables WASH and FACI, BATH & FACI using a technique of Variance Inflation Factor (VIF). The results show that there is no strong correlation among the variables since the values of VIF are by far less than 10.

Table 6.4 Determinants of self reported acute symptoms of pesticide poisoning – two-stage Poisson regression results (N = 439)

Dependent variable: Count of total acute pesticide symptoms per cropping season

Variable	Estimated [a] Coefficient	Murphy-Topel Standard Error	t-value
Constant	4.250	2.681	1.59
AGEH	-0.175*	0.093	-1.86
AGSQ	0.002**	0.000	2.03
GEND	0.912**	0.401	2.27
EDU1	0.047	0.050	0.95
EDU2	-0.045	0.036	-1.24
FACI	-0.464*	0.243	-1.91
PES1	0.007*	0.004	1.88
PES2	0.003*	0.002	1.85
PES3	0.005	0.004	1.39
PES4	-0.001	0.001	-0.83
COCK	0.723	0.555	1.30
WASH	-1.022***	0.593	-2.68
BATH	-0.765	1.022	-0.75
EATE	1.022***	0.454	3.65
LABE	-0.878***	0.338	-2.59
HRSP	0.025	0.029	0.85
MAIN	-0.852**	0.347	-2.45
PRIM	0.807	0.517	1.56
SMOK	0.036*	0.020	1.83
ALCO	-0.171**	0.073	-2.33
TRAI	-0.125**	0.058	-2.13
EXTE	-0.289	0.335	-0.86
MERU (Base)			
KIRINYAGA	-0.793	0.435	1.62
MURANGA	3.247***	1.136	5.17
NYERI	0.975**	0.461	2.12
MAKUENI	1.000*	0.512	1.95
ADOP	-0.784**	0.313	2.50
Log pseudo-likelihood		-153.929	
Pseudo R2		0.361	
Wald Chi2		198.35	
Prob > Chi2		0.000	

[a] Statistical significance at the 0.01 (***), 0.05 (**) and 0.1 (*) level of probability
Source: Own survey

Most importantly, the regression analyses demonstrate the substantial role of adoption of EU private standards in reducing incidence of acute illness associated with pesticide use. With all other factors in the model held constant, farmer who adopt GlobalGAP standards experience about 78% lesser incidence of acute illness compared to non-adopters farmers. The results demonstrate that the adoption of emerging standards confer a positive externality effect on adopters and may serve as a means to transform the production systems that contribute to better health for the producers in developing countries.

Eating in the vegetable field while spraying tend to increase substantially the incidence of acute illness perhaps due to the fact that there might be no availability of water in the field to wash hands and food before eating, which will increase the direct contact with pesticides. Contrary to the findings of Okello and Swinton (2006b) taking a bath after spraying chemicals does not significantly reduce the impact of poisoning. Hiring a laborer for pesticide application tend to substantially reduce the incidence of health symptoms within the household. This is perhaps due the fact that household members are less likely to experience direct pesticide exposure and shift the risk associated with pesticide spraying to another party. Likewise the incidence of acute pesticide related illness symptoms is mitigated by maintaining the sprayer and washing the protective gear after use. The safe use of pesticides has often been considered a pivotal aspect in mitigating episodes of pesticide poisoning (Cropper 1994; Atkin *et al.*, 2000). Studies conducted by Ajayi (2000), Murphy (1999) and Mancini (2005) have demonstrated that farmers from developing countries use pesticide in unsafe and hazardous manner, describing mixing pesticides with bare hands, lack of protective clothing, using leaking backpack sprayers and storing pesticides in kitchens or bedrooms, which enhanced the health risk of pesticides. The four district dummies controlling for agro-ecology and differences in institutional settings are significant in three instances. Export farmers in Muranga, Nyeri and Makueni districts experience significantly high cases of pesticide ascribed health symptoms compared to the base district, which is Meru district.

Results of cost-of-illness model

Table 6.5 presents results of factors determining cost-of-illness among export vegetable producers in Kenya. Test results of the model show that the assumptions of normality and homoskedasticity of the error terms are violated. Thus robust standard errors are estimated using White's heteroskedasticity consistent standard errors. Standard errors are also computed with clustering at the smallholder group level since farmers are organized into growers groups.

The pesticide health costs are determined overwhelmingly by adoption of GlobalGAP standards as indicated by the negative and significant coefficient of adoption variable (ADOP) in the three econometric models pointing to the robustness of the results. Adoption of GlobalGAP standards decreases cost-of-illness by about 60% compared to non-adopters in the two-stage treatment effect model whereas about 50% on average in the regression based on propensity score. This result corroborates with the pervious findings on the negative correlation between adoption of standards and the incidence of acute health symptoms. Cost-of-illness seems to decrease with age of the household head although at an increasing rate as can be seen from the coefficient of the age squared. Female-headed households incur significantly lower health costs compared to their male-headed counterparts perhaps due to their limited role in pesticide handling.

Contrary to the expectation the effect of facility index is negative and statistically significant (at 5%). This could perhaps be explained by the fact that farmers with better access to facilities have experienced lower incidence of acute illness as presented before and this is translated to lower cost. However total income of the household during 2005 cropping season is not significant[6]

[6] Prior to running the model, a test is conducted to detect the problem of multicollinearity between facility index and total annual household income. The test result depicts no strong correlation between the variables. The model is also estimated excluding the income variable but the signs and significance level of other variables didn't change.

Table 6.5 Estimates of cost-of-illness associated with pesticide poisoning

Dependent variable: Natural log of farmer's health cost of pesticide intoxication in KSh (N=439)

Variable	Two-stage standard treatment effect model		Regression based on propensity-score			
			without control variables		with control variables	
	Estimated [a] Coefficient	Rob. Stand. Error	Estimated [a] Coefficient	Rob. Stand. Error	Estimated [a] Coefficient	Rob. Stand. Error
Constant	1.996**	0.800	-0.047	0.097	2.051**	0.812
AGEH	-0.056*	0.032			-0.058*	0.031
AGSQ	0.001*	0.000			0.001*	0.000
GEND	0.181*	0.101			0.195*	0.117
EDU1	-0.016	0.017			-0.006	0.016
EDU2	-0.005	0.014			-0.012	0.013
INCO	0.001	0.000			0.000	0.000
FACI	-0.236**	0.092			-0.154*	0.099
PES1	0.002***	0.000			0.002***	0.000
PES2	0.001*	0.000			0.001*	0.000
PES3	0.002	0.002			0.002	0.002
PES4	-0.001	0.000			-0.000	0.000
WASH	-0.485***	0.168			-0.474**	0.194
EATE	0.871***	0.287			0.984***	0.332
HRSP	0.008	0.015			0.006	0.018
MAIN	-0.216*	0.113			-0143	0.130
PRIM	0.202	0.129			0.176	0.148
SMOK	0.012	0.008			0.011	0.009
ALCO	-0.019**	0.009			-0.018*	0.009
TRAI	-0.031*	0.017			-0.024*	0.019
EXTE	-0.222*	0.141			-0.156	0.143
MERU (Base)						
KIRINYAGA	-0.149	0.172			-0.218	0.183
MURANGA	0.889***	0.303			0.954***	0.306
NYERI	0.124	0.185			0.242	0.195
MAKUENI	0.850**	0.416			0.794*	0.453
ADOP	-0.630***	0.124	0.442**	0.138	0.563**	0.120
Pscore			0.269*	0.257	0.319*	0.249
Log pseudo-likelihood	-481.234					
Wald Chi2	209.39					
Prob > Chi2	0.000					
F-test			3.65		6.33	
Prob > F			0.000		0.000	
R-squared / adj. R-squared			0.13/0.11		0.33/0.26	

[a] Statistical significance at the 0.01 (***), 0.05 (**) and 0.1 (*) level of probability

Source: Own survey

More educated and highly skilled households are expected to experience lower cost-of-illness and the result supports this notion. Human capital related variables such as education status of the head and other household members, level of agricultural training and number of contacts with extension personnel's all have a negative impact on health cost attributed to pesticide use although the coefficients is not significant for the former. In line with the expectation, pesticide exposure related variables have their expected signs. Households who eat in the vegetable field while spraying chemicals incur significantly higher health cost however the coefficient of the number of hours sprayed is not significant in the model. Another set of variables that explain significantly the variation in the health cost among export producers is whether the farmers has maintained their sprayer ever and they wash the protective gear after use, both indicating a negative sign. Household who maintain their sprayers and wash the protective gear after use display significantly lower health cost-of-illness. Alcohol intake is not significant however household heads with long year of smoking experience significantly high cost-of-illness.

With respect to the quantity of different class of pesticide use, hazard category pesticide type I and II are found to be significantly explaining the cost-of-illness among export producers, which is not surprising given that they are classified as highly toxic. Out of the four district dummies included in the model to control for agro-ecology and other institutional settings, two of them are found to be significantly explaining the variation in cost-of-illness. The results display that farmers in Meru district experience significantly low cost-of-illness compared to farmers in Nyeri and Muranga districts.

Determinants of improved pesticide management practices

As illustrated in the theoretical model the adoption of production standards like GlobalGAP may also affects the way farmers manage agricultural inputs. This question was addressed using a two-stage Poisson regression model using data collected from export vegetable producers in Kenya. Results are presented in Table 6.6.

Table 6.6 Determinants of improved pesticide management practices – two-stage Poisson regression results (N = 439)

Dependent variable: count of improved pesticide management practices

Variable	Estimated [a] Coefficient	Murphy-Topel Standard Error	t-value
Constant	1.779***	0.203	8.76
AGEH	0.006	0.008	0.68
AGSQ	-0.001	0.000	-1.01
GEND	0.078*	0.047	1.65
EDU1	0.011**	0.004	2.49
EDU2	0.010***	0.002	3.90
INCO	0.000***	0.000	3.23
FACI	0.059**	0.023	2.50
GROU	0.013*	0.006	1.88
RADI	0.002	0.001	1.57
CRED	0.000	0.000	1.42
CONT	0.015*	0.007	1.93
EXTE	0.042	0.032	-1.28
ADOP	0.227**	0.106	2.13
MERU (Base)			
KIRINYAGA	-0.052	0.046	-1.12
MURANGA	-1.506***	0.123	-12.23
NYERI	-0.131***	0.040	-3.25
MAKUENI	-0.219***	0.061	-3.58
Log pseudo-likelihood		-587.022	
Pseudo R2		0.240	
Wald Chi2		347.45	
Prob > Chi2		0.000	

[a] Statistical significance at the 0.01 (***), 0.05 (**) and 0.1 (*) level of probability
Source: Own survey

As hypothesized, the adoption of GlobalGAP standards (ADOP) does have a significant and positive effect on pesticide management practices. Other factors being equal, adopting GlobalGAP production standards at the farm level increases the level of good pesticide management practice by about 22% compared to the non-adopter export farmers. It is hypothesized that the decision on different pesticide management practices is not necessarily made by the head of the household alone but also by other educated adult members of the household. The results also support this notion. As shown in Table 6.6, the coefficients of education level of the head and other household member take a positive sign and are significant indicating the positive effect of intra-household literacy on the decisions on pesticide management practices. Contact with extension service and frequency of radio use also play a positive role in the way farmers manage pesticide although the coefficient is insignificant. This indicates the importance of knowledge on the management practices.

Another important variable that significantly explains the variation in pesticide management practices among export farmers is the number of years the farmer has been involved in formal contract with the exporters and the number of years they have been member of growers group. Results also show strong and positive effect of participating in formal contract and group membership on good pesticide management practices. It also demonstrates the positive role household income and access to facilities on improved management practices. Likewise access to credit service measured by the amount of credit received for the past three years prior 2005 play a positive role on safe pesticide management practices although the coefficient is insignificant. Given the required financial resources to invest in pesticide store and purchase protective gear, access to financial resources play a crucial role in improving the way farmers manage pesticides use. As shown by significant coefficients of district dummies, agro-ecology and location variations affect management of pesticides among export farmers.

6.6 Conclusions

The primary aim of this chapter is to empirically investigate whether adoption of EU private food-safety standards confer positive externalities in terms of improved health and environment. Two-stage econometric approaches are applied to estimate factors determining pesticide related acute poisoning, cost-of-illness and improved pesticide management practices among export vegetable producers.

Results show the average costs of pesticide-related health risks are about 165 KSh and 324 KSh per cropping season for GlobalGAP adopters and non-adopters export producers, respectively. These costs equal 86.4% of the mean household chemical expenditure per cropping season for non-adopters and 39.6% of those adopters. Compared to the results obtained in other studies (Rola and Pingali, 1993) the ratio of health cost to pesticide cost presented in this chapter is conservative since the computation of health costs is based on the actual market cost of direct short term health impairments and it does not refer to the costs to restore farmers' health status completely as followed by Rola and Pingali (1993) and Garming and Waibel (2008). Estimation results also show that adoption of GlobalGAP standards has a positive and significant impact on farmer's health both in terms of reduction of pesticide related acute poisonings and its associated cost-of-illness. Farmer's who adopt standards experience 78% lesser incidence of acute illness and spent about 50% less on restoring the damaged health compared to non-adopters. On the other hand incidence of pesticide-related acute illness symptoms and its associated health cost increase significantly with the use of highly toxic pesticides. Maintaining the spraying equipment and washing the protective gear after spraying significantly mitigate the incidence and its related cost whereas eating in the vegetable field while spraying substantially increase the pesticide poisoning. Human capital proxies such as education level of the head and other household members, knowledge of pesticide labels, level of agricultural training and contact with extension service also tend to decrease the incidence of acute illness although the coefficients are statistically insignificant for the education variables. These indicate the need for farmer education in exposure averting strategies.

Results also depict that the negative environmental impact is minimized by adoption of the GlobalGAP corroborating the view that standards induce changes in farm production systems in developing countries. *Ceteris paribus*, adopting GlobalGAP production standards at the farm level increases the degree of improved pesticide management practice by about 22% compared to the non-adopter export farmers. Improved pesticide management practices entail less pesticide intoxication by farmers and farm workers, improved environment and potential efficiency gain.

Although there are concerns that the enhanced stringency of food-safety standards that are imposed by high-income countries can negatively affect the competitiveness of producers in developing countries, this study strongly indicate that adoption of such standards can play a positive role, providing the catalyst and incentives for the adoption of safer and more sustainable production practice. Thus, one can conclude that adoption of safety standards can have significant health and environmental benefits for small-scale farmers in Kenya, which are in addition to the financial gains reported earlier.

Chapter 7

Conclusions and Recommendations

7.1 Synthesis and conclusions

The overall objective of this study is to investigate the impact of the most widely known private standards, GlobalGAP standards, on small-scale vegetable producers' welfare in Kenya. GlobalGAP is a private sector standard, which exceeds the requirements of the EU regulatory standards. It has been developed by supermarket chains in Europe. The standards are prescriptive, production-oriented guidelines for fresh fruit and vegetables and they require certification by an independent internationally accredited certification body. To comply with these standards producers have to change their production technology, e.g. switch to less harmful pesticides and invest in structures like grading shed, charcoal cooler, disposal pit, toilet, pesticide store etc.

From the general objective, five specific objectives are defined and analyzed in separate chapters. These includes i) investigate the nature and magnitude of costs of compliance with GlobalGAP standards, ii) examine determinants of adoption of GlobalGAP standards and estimate its impact on farm financial performance, iii) examine the impact of GlobalGAP standards on pesticide use and farm-level productivity; iv) estimate the effect of GlobalGAP standards on pesticide ascribed incidence of acute illness symptoms and its associated cost-of-illness and, v) explore impact of GlobalGAP adoption on improved management practices as proxy for environmental benefits.

This study has addressed these objectives using data collected from a random cross-section sample of small-scale vegetable producers in Kenya. Overall, 21 sub-locations were randomly selected from the five districts by Probability Proportional to Size (PPS) sampling technique and a total of 539 vegetables producer households were chosen randomly for the interviews. For each respondent the survey combined a re-call survey and season-long monitoring of crop production practices. The season-long monitoring data were collected for both dry (November 2005 to February 2006) and rainy season (May 2006 to August 2006). However the data collected during the first round monitoring survey (i.e. dry season) were incomplete due to prevalent drought in the survey areas. Thus, the dry season data set was excluded from the analysis and only the data collected during rainy season as well as the re-recall survey data were used for the analysis.

Chapter four uses a two-stage standard treatment effect model and propensity score matching techniques to explore factors that explain the decision of small-scale producers to adopt private standards and examine whether investments in private standards compliance pays off for small-scale producers. Results show that adopters and non-adopters are distinguishable by their wealth status, access to services and level of education. It is shown that resource-poor farmers with limited access to information and services are less likely to adopt standards and could potentially be marginalized from the lucrative export market. Nevertheless, farmers who adopt standards enjoy a substantial income benefit. The financial internal rate of return, computed for different cost and benefit scenarios display that investment in EU private food-safety standards pays off for small-scale producers in Kenya. The pay off period analysis demonstrates that smallholders can recover their investment cost in two to three years if they plant three crops a year and up to seven years for two cropping seasons.

Chapter five provides an empirical analysis of GlobalGAP impact on pesticides use and farm-level productivity among smallholder vegetable producers in Kenya. An extended three-stage damage control production framework that accounts for multiple endogeneity problems is applied. Results show that export producers complying with standards significantly use less toxic pesticides; however, there is no significant difference on the total quantity of pesticides used. Contrary to findings in Asia, the econometric evidences show that both domestic and export vegetable farmers in Kenya use pesticide below the economic optimum. However export vegetable producers use significantly higher quantity of pesticides compared to domestic producers and enjoy higher level of revenue.

The third stage structural revenue model results demonstrate a positive and significant impact of standards adoption on revenue of vegetable production.

The sixth chapter evaluates the impact of EU retailer food-safety standards on producers' health and environment. To attain the objective, a theoretical non-separable farm household model is used as a starting point. Based on the optimal health demand functions derived from the model's first-order condition, an empirical model is formulated and estimated. Using different econometric approaches it is shown that pesticide ascribed incidence of acute illness symptoms and its associated cost-of-illness significantly decrease with adoption of standards. *Ceteris paribus*, farmers who adopt standards experience 78% lesser incidence of acute illness and spent about 50% less on restoring their health compared to non-adopter farmers. Likewise adoption of standards has a significant positive impact on improved crop management for example safer and environmentally more benign pesticide use, which is likely to reduce external costs of production. Generally the results support the notion that standards reduce externalities from vegetable production if adopted in large-scale corroborating the view that it may serve as a catalyst to transform the farm production systems in developing countries.

In the following recommendations are developed for policy suggesting alternative measures for a pro-poor development strategy in Africa in general and in Kenya in particular. In addition further research topics are suggested related to the impact of emerging food-safety standards on small-scale producers. These topics could not be addressed to greater detail in this thesis.

7.2 Recommendations

This research has provided some insights into what the determinants of adoption of emerging EU food-safety standards and their impact on smallholder producers' welfare. It also provides policy implications on possible support schemes in the supply chain.

Given the ability to invest in required structures, the results of this study generally support the notion that smallholders can enjoy substantial financial and non-financial benefits from adopting emerging private standards. Adoption of emerging food-safety standards can serve as a catalyst in transforming the production systems of developing countries towards safer and more sustainable production. However, the question is whether many small-scale farmers in developing countries at large and in Kenya in particular can finance the initial investment cost in year zero to start up the implementation of the protocol and at the same time the donor/ exporter continue their financial and technical support. There is no question that by raising the bar for new entrants and placing a premium on effective safety management and logistical coordination, higher private standards can weaken the competitive position of the poorest among smallholders to remain active and profitable in export supply chains. But food-safety standards are here to stay, and there is no slowing down their rate of change or applying for special and differential treatment from export market. However as the GlobalGAP secretariat in 2007 has benchmarked Kenya's standards, KenyaGAP, against GlobalGAP that could help the smallholders to get certificate under option 3 and 4.

The government and private sector can help farmers expand and upgrade their range of assets and practices to meet the new requirements of supermarkets and other coordinated supply chains. The options include public investments in increasing farmers' productivity and connectivity to markets, and public-private partnerships to promote collective action and build the technical capacity of farmers to meet the new standards. This would not only address the problem associated with standards rather it addresses the bigger question of linking smallholders to emerging markets either domestic or export. In short developing countries need institutional frameworks to help them overcome the problems associated with being poor or small. Out grower programs for smallholder farmers and systems of training could be effective instruments. So far the role of donors tends to be significant in providing the necessary training and subsidizing the overall certification schemes.

The challenge of new risk of exclusion of smallholders was recognized by numerous donor agencies and for many of them the immediate challenge was to ensure that the implementation of GlobalGAP in Kenya did not undermine their broader goals of reducing poverty and delivering pro-poor growth through promoting a vibrant small-scale farmer sector. According to Humphrey (2006), the goal of many donors was not in many cases framed in terms of integrating small-scale farmers and farmer groups into those horticultural export value chains that required GlobalGAP certification. Rather, it was framed in terms of making the compliance of GlobalGAP easier for small-scale farmer and particularly farmer groups, to achieve the certification.

Although the financial support by donors or private companies was crucial for smallholders to achieve certification as also presented chapter four, subsidizing GlobalGAP certification among smallholders may not be justified from a development perspective for a number of reasons. Firstly, donor support may be insufficient to offset increased smallholder disadvantage and there is a danger that farmers do not maintain their level of certification once donor support ends rendering smallholders' involvement in GlobalGAP production unsustainable. Most of the donor funds are limited to short-term issues towards certification and ignore the long-term perspectives. Second, the stipulated period of donor funds utilizations is too short and does not allow enough time to exclude the kind of farmers who eventually pull out after having spent substantial amounts of funds. Third, large farms growing vegetables employ large numbers of laborers, who are often poorer segments of rural population than the farmers adopting GlobalGAP. Thus, subsidies for smallholders can have a digressive impact on income distribution among the rural poor. Fourth, as mentioned earlier a majority of the largest fresh produce export companies are involved directly or indirectly with donor-funded schemes for farmer certification. However, it is not yet clear who is benefiting most from the subsidies in the supply chain. Therefore it is possible that farmers are indirectly paying for the subsidy through lower product prices.

This does not mean that financial and technical support for small-scale producers is unjustifiable, but it requires further research that assesses the costs of helping a larger part of the smallholder population to achieve food-safety standards and compare these with alternative options for attaining poverty alleviation and rural development. For development agencies, first it's crucial not to only define the challenge in terms of the certification process but also the management systems that lay behind it. Certification is not the end in itself, but rather verification that a quality system has been put in place. Second, both the costs of certification and the costs of maintaining the quality system need to be emphasized. Third, the focus of donors should not be only on farmers and farmer groups rather the value chain linkages in the export horticulture business and the critical role played by exporters in securing access to those buyers that required GlobalGAP certification. There is no simple answer to these challenges. What is clear, however, is that as the requirements of export markets become more sophisticated exporters will play a critical role. There is merit in donors working with private companies and try to determine when their support provides genuine increase in aggregate output. The opportunities of smallholders to remain viable in lucrative export market also grossly depend on the strategies chosen by export companies. It is apparent from the results that smallholders not well supported or contracted by their exporter have low probability of adopting GlobalGAP and that most either fail to certify or drop out of the compliance system within short period time. Therefore it is important that companies adopt strategic planning in their contract farming schemes to minimize the negative impact of enhanced standards on the poorest segment of the rural producers. Private companies may not have financial incentives to do so but there is the corporate social responsibility that implicitly binds them to act.

From the standard setters point of view it is also important that the emerging private standards like GlobalGAP be smallholder friendly, which is acceptable to both buyers and producers and could be implemented without a significant donor support. To produce a truly smallholder friendly standards that small-scale growers could operate cost effectively without external support is probably impossible. In order to make the compliance content requirements specifically address the needs of smallholders would undermine the integrity of the standards thus making the modifications unacceptable to the buyer of the end product. Rather, a balance is required between the desire of the production end of the supply chain for simplicity and reduced compliance cost and the buyers' desire for high levels of control and guarantees of integrity. For this to happen, an extensive dialogue among all stakeholders in the horticulture sector including exporters, smallholders, donors, standard setters and public representatives is highly recommendable. Any discussion of how to achieve improvements and sustainability in the system is also linked to the question of who actually need to pay for compliance to private standards such as GlobalGAP. The main beneficiaries of these standards are the end consumers and out of fairness they should contribute to the cost of compliance by offering a higher price for certified produce rather than pushing them down the chain to the suppliers.

It is also mandatory to consider alternative strategies that can complement or replace participation of small-scale producers in the most demanding, competitive and fast developing global markets. Rather than exclusively focusing on keeping smallholders participating in export markets, alternatives need to be assessed including opportunities in regional as well as domestic markets. There may be scope for expanding exports to export markets with less rigid standards such as Middle East and Asian countries. These may be the rapidly growing markets of the future.

It is important for smallholders to diversify their product categories and invest in post-harvest technologies. It is possible that not all smallholders will be able to qualify to produce for the fresh export market. The dynamics of the fresh produce export market will be getting more complex as the trend of private standards is moving from supermarket-only export markets into traditional wholesale and food-service markets and smallholders without support and good linkages to the market may not be able to keep up with them. Besides the export market may not be large enough to accommodate every producer. It is therefore important for a sustainable development of Kenya's agriculture to improve production and market access for producers, without necessarily focusing on a particular fresh export market. For example, the development of value-adding at the production level could avoid high-season waste (e.g. drying fruit, tomatoes etc.), as well as provide access to different segments of the market. Domestic markets are often poorly developed in Africa at large and in Kenya in particular and this is an area of development that is often overlooked. Despite the limited size of the fresh produce export market, a lot of attention, effort and resources have been put into it, often at the expense of developing and growing local domestic markets. Such markets could provide an important outlet for smaller producers excluded from the export market. Results reported in chapter five supports the notion that farmers involved in domestic vegetable production can benefit as much as those involved in export crops if the domestic markets structures would function more effectively and efficiently. Thus the question of a supportive institutional environment, improved service provision and linkages of smallholder farmers has an equal relevance for the development of domestic or regional markets

Finally, it is also worth considering integrating the marginalized asset-poor farmers to large-scale farms via wage employment as a possibility for an effective poverty reduction strategy. Some researchers have argued that for achieving the overall policy goal of poverty reduction as a component of agricultural development policy, then a strategy of allowing smallholders to decline and focus instead on improving conditions for waged employees might serve the purpose as well (Maertens and Swinnen, 2006b; Humphrey, 2006; McCulloch and Ota, 2002). One should not hold on to a target number of small holders to remain in export market for purely sector policy reasons.

7.3 Further research

A follow up study is recommended in order to assess the impact of compliance with GlobalGAP on fresh produce traded in developing countries' domestic markets. During the survey, it is observed that adoption of standards do not only have direct impact but further results in positive externalities in terms of enhanced food-safety at the domestic market and the non-certified export market, which are mostly attributable to more judicious use of pest control strategies. Such spillover effects may affect the production as well as the policy level, with both levels being interlinked. Thus, there are some research questions that need to be answered in future study both at the policy level and production level. It is not clear how the international debate influenced awareness on food-safety issues and standards of Kenyan policy makers and whether the increased awareness has been translated in adoption of new strategies/ policies. It is also important to investigate to what extent the certified export producers apply their new knowledge to domestic production and it's impact in the production system. Another question is wheather the non-certified smallholder export producers adopted production technologies from certified farmers and it's impact on their production. Future research should also investigate whether there is a significant shift from smallholder contract-farming towards estate farm worker, induced by increasing food-safety standards. Despite the recognition of emerging private standards as an entry barrier for asset-poor smallholder farmers, it is not yet clear what farmers who are drop out of the export markets are doing. Thus further research should also investigate what alternative livelihood-strategies are available for drop-out farmers in Kenya and other countries.

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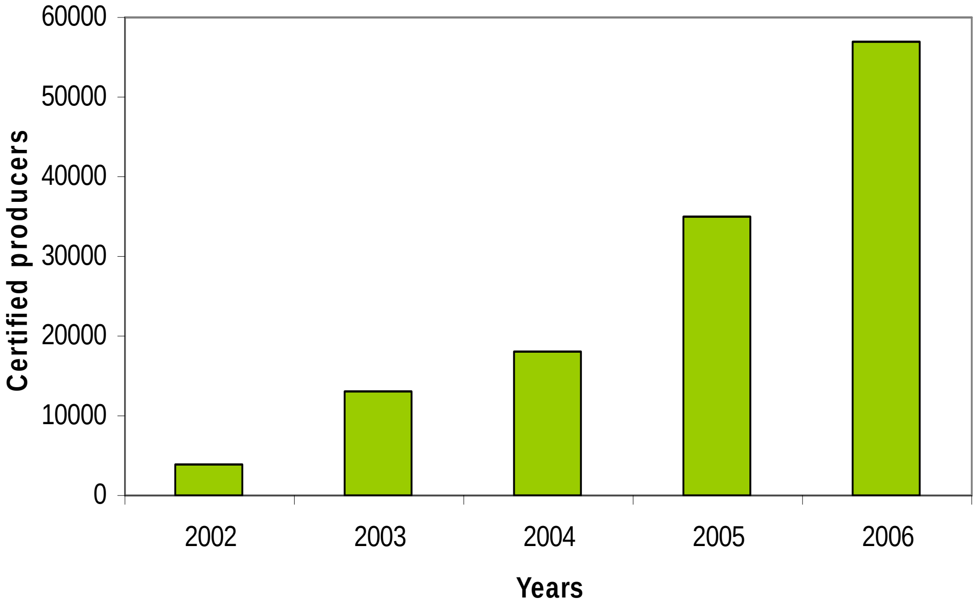
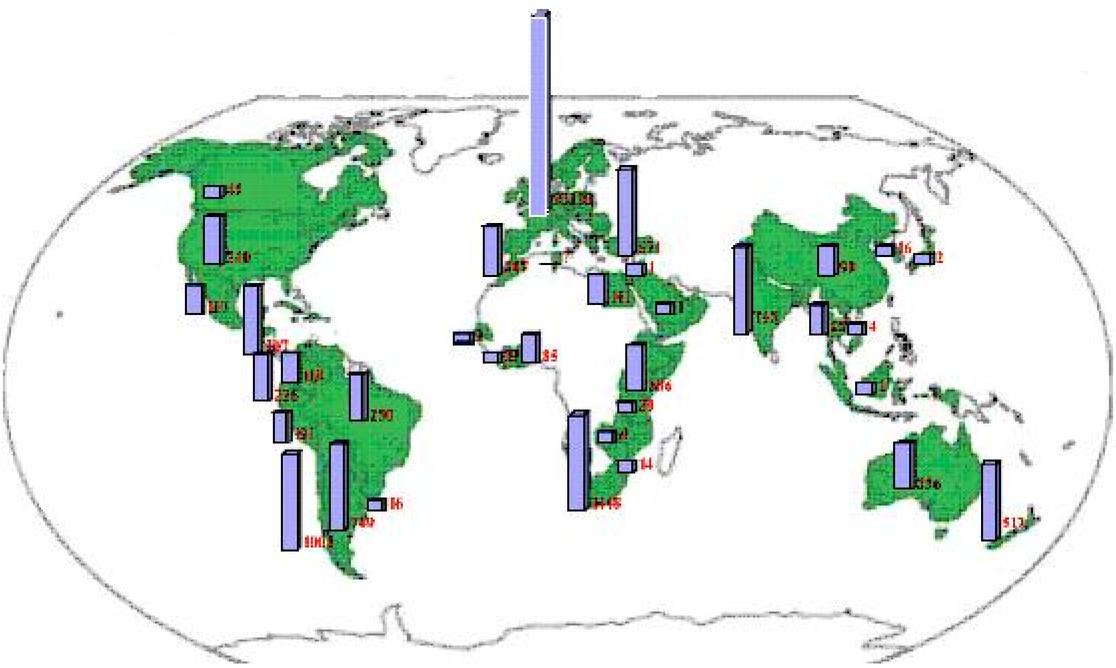
Appendices

Appendix 1 GlobalGAP certified growers' worldwide (option 1 and 2)



Source: Moeller, 2006

Appendix 2 Countries with GlobalGAP certified growers



Source: Moeller, 2006

Appendix 3 GlobalGAP and other private food-safety standards logo

Source: Various internet sources[1]

[1] www.ethicaltrade.org; www.msc.org; www.brc.org.uk; www.transfair.oeg; www.carrefour.ch; www.plus.de/www.eurep.org; www.food-care.info; nationalzoo.si.edu; www.tescocorporate.com.

Appendix 4 Locations of the surveyed small-scale farmers

Source: United Nations, 2006

Appendix 5 Mathematical derivation of marginal productivity of damage control inputs

Let us consider that the observed crop yield, Q_i, can be specified as a function of both standard production inputs, x_i and damage control measures, x_p, as:

$$Q = \left[\prod_{i}^{n} (W_i)^{\beta_i} \right] * D(x_p)^{\alpha} \tag{A1}$$

Integrating the simple logistic form of damage control function, we obtain

$$\ln Q = \beta_0 + \sum_{i}^{n} \beta_i \ln(W_i) + \ln\left[(1 - \exp(-\alpha x_p))\right] \tag{A2}$$

where W_i is the vector of 'conventional' production inputs (labor, fertilizer, seed), farm-specific factors (i.e. farm household characteristics) etc. The β_i are the respective coefficients to be estimated. The term $D(x_p)$, is the damage abatement function that is a function of the level of control agents, x_p (in our case the pesticide used by the farmer to control pests during outbreaks).[2]

By definition, the marginal productivity is the increase in output arising from a marginal increase of a certain input. It can be computed by taking the first derivative of the production function with respect to that input. In the Cobb-Douglas specification, the coefficient β_i estimates the output elasticity of the productive input W_i in the Equation (A2) from which the marginal productivity of the inputs is derived.

$$\beta_i = \frac{\partial Q}{Q} * \frac{W_i}{\partial W_i} \tag{A3}$$

The marginal productivity of W_i using appropriate derivation can be expressed as:

$$\frac{\partial Q}{\partial W_i} = \beta_i * \frac{Q}{W_i} \tag{A4}$$

[2] Following Babcock et al (1992) and Carrasco-Tauber and Moffit (1992) the parameter restriction $\alpha = 1$ was imposed on equation (1) to facilitate the estimation.

The derivation of the marginal value product of the damage control inputs x_p is obtained in an indirect manner. It can be expressed as follows:

$$\frac{\partial Q}{\partial x_p} = \frac{\partial Q}{\partial D(x_p)} * \frac{\partial D(x_p)}{\partial x_p} \tag{A5}$$

The marginal value product of $D(x_p)$ is:

$$\frac{\partial Q}{\partial D(x_p)} = \alpha * \frac{Q}{\partial D(x_p)} \tag{A6}$$

By substituting $\frac{\partial Q}{\partial D(x_p)}$, the marginal value product of the damage control x_p can be expressed as follows:

$$\frac{\partial Q}{\partial x_p} = \frac{Q}{\partial D(x_p)} * \frac{\partial D(x_p)}{\partial (x_p)} \tag{A7}$$

Substituting for $D(x_p)$ in the functional form of damage control function (logistic) Equation (A2), the marginal value product of a specific damage control input x_p is expressed as follows:

$$\frac{\partial Q}{\partial x_p} = \frac{Q}{1 - \exp^{(\lambda - \alpha x_p)}} * \alpha \exp^{(\mu - \alpha x_p)} \tag{A8}$$

Appendix 6 Survey questionnaire used for data collection

SECTION 1: HOUSEHOLD DEMOGRAPHY

1 Gender of the household head
1) Male
2) Female

2 What is your age? (Years)

3 Can you describe the composition of your household in terms of age, gender and those living here or away?

Age	Resident		Non-resident	
	Male	Female	Male	Female
0 – 14	a	d	g	j
15 - 60	b	e	h	k
60+	c	f	i	l

4 Relation to the household head?
(1) Head of household (2) Spouse
(3) Offspring (4) Mother/father
(5) Son/daughter in law (6) Mother/father in law (7) Relative

5a Education status of HHH: 1) Literate 2) Illiterate

5b Highest class/grade attained by the household head?

6 Marital status of the head of household
(1) Married (one spouse) (2) Married (more than one spouse)
(3) Single (4) Divorced (5) Widowed (6) Separated

7 Which ethnic group do you belong to?
(1) Kikuyu (2) Luo (3) Luhya
(4) Kamba (5) Meru (9) Others

8 What is the head of HH major (8a) & minor (8b) occupation/activities?
(1) Horticultural production (2) Cereal production
(3) Livestock production (4) Artisan (off-farm activities)
(5) Casual labour (6) Employee
(7) Not applicable (9) Others:________________

9a At what age did children b/n 0-14 years of your HH start participating in farm activities for the first time?

9b In which year did the household start farming in this area?

9c Did you attended a training on farming? 1) Yes 2) No

SECTION 2: OFF-FARM INCOME & BUSINESS ACTIVITIES

10 Did you or any other members of the household work off the household's land either on someone else's land or in some other employment, against payment in cash or in kind? 1) Yes 2) No **If No go to Q16**

11 **If yes**, how many household members were involved in such activities in the last 12 months (2005)?

12 What kind of work were they involved in? (1st & 2nd)
(1) Farm worker (2) Professional worker
(3) Skilled Labourer (4) Unskilled worker
(5) Food-for-work (9) Others

13 **If yes**, what is the total number of days worked during the last 12 months by HH members? (For payment)

14 **If yes**, total amount earned in the last 12 months by HH members. (in Ksh)

15 Who are the employers?
(1) Smaller farmers (2) Commercial farmers
(3) Government organisation (4) NGO
(5) Urban dwellers
(9) Other,____________

16 Did your HH members participate in crafts or other business activities in the last 12 months?
1) Yes 2) No **If No, go to Q20**

17 **If yes**, how many of your HH member were involved in such kind of activities (e.g. weaving, milling, selling of charcoal, trade in grain or livestock, pottery, etc)

18 **If yes**, how much has the household earned (net of costs) from these activities in the last 12 months? (Ksh)

19 **If yes**, what is the income usually used for? (the most important two)
(1) HH consumption (2) Investment in business
(3) Education/Training expenditures (4) Saving
(5) Investment in farm/land (6) Pay back debts
(7) Non-education support for children (8) Not applicable 9) Others: ________________

20	Did your household receive any kind of remittances (gifts from relative, food aid etc), transfers (such as pension) and other source of income during the last 12 months? 1) Yes 2) No	20
21	**If yes**, how much income did you get or drive from them? (Ksh)	21

SECTION 3: HOUSEHOLD ASSET, LAND USE AND OUTPUT

22 At present (2005), how much/many of the following does this household own that are usable/repairable? **(For value per unit, ask for the resale price for asset or the current market value of the asset as it is).**

Item	Quantity	Value per unit (Ksh)	If value/unit not known ask for total value
Large/small tractor	a	b	C
Machine/animal pulled plough	d	e	F
Motorized/hand thresher	g	h	I
Mechanical water pump	j	k	L
Sprinkler	m	n	O
Mill	p	q	R
Motorized/hand insecticide pump	s	t	U
Chemical store	v y	w z	X A
Small cart pulled by person	B	C	D
Wheel barrows	E	F	G
Horse pipes/irrigation	H	I	J
Watering canes	K	L	M

23 At present (2005), how much/many of the following does this household own that are usable/repairable? **(For value per unit, ask for the resale price for asset or the current market value of the asset as it is).**

Item	Quan tity	Value per unit (Ksh)	If value/unit not known ask for total value
Refrigerator	a	b	c
Sofa set	d	e	f
Sewing machine	g	h	i
Radio	j	k	l
Television	m	n	o
Bicycle	o	p	q
Motor bicycle	r	s	t
Car/truck	u	v	w

24 Would you please give us information about your housing conditions and access to facilities?

24a	Iron sheet roofing 1) Yes 2) No	24a
24b	Cemented floor 1) Yes 2) No	24b
24c	Types of wall 1) Stone 2) Mud 3) Timber 4) Iron sheet 5) Bricks	24c
24d	Number of rooms	24d
24e	Does your household own the home or do you rent it? 1) Own 2) Rent	24e
24f	What is the main source of water for domestic use? 1) River 2) Well 3) Protected spring 4) Unprotected Spring 5) Bore hole 6) Piped 9) Other source	24f 24g
24h	What is the distance to this source? (Km)	24h 2
24i	How far are you from piped water? (Km)	24i

25. We would like to ask some questions about all the land used by your household during the last 12 months. Please include land you are cultivating that belongs to other households, or land left fallow or used for grazing.

	Own cultivable land	Own land left fallow	Total agricultural cultivated land		Land given to other family		Grazing land			Home stead land
			Own land	Rented-in (Hired)	Rented out land	Gift/ lent-out	Own	Rented-in (Hired)	Obtained as a gift	
Acres	a	b	c	d	e	f	g	h	i	j
25k) **If you rented out land**, how much did you earn? ____________Ksh										

26. Give details about the plots cultivated and harvested during the last 12 months or 2005. First mention the plots cultivated during the last rainy season. Then mention all plot cultivated during the dry season. Plot with permanent crops are recorded as rainy season crops. A plot is a contiguous area that is not separated by a natural obstacle or by land from another plot. It may be planted with different crops or with one crop only. Two plots are physically separated and may be planted with the same or different crops. If the land s inter-cropped then the total area should be divided by the number of crops grown on the plot (if 2 crops, by 2; if 3 crops, by 3, etc).

A	B	C	D	E	F	G	H	I	J	K	L
									Crop output		
Season 1) Rainy 2) Dry	Plot	Crop code (a)	Area (acre)	Average distance from home i.e one round (Km)	Land quality Code (b)	Slope Code (c)	Was the land irrigated? 1) Yes 2) No	**If yes,** percentage of the land irrigated?	Quantity in Kg	Estimated cash income per crop	Market price (per Kg)

Code (a)
(1) Maize (2) Vegetables for export (3) Vegetables for domestic market (4) Fruit
(5) Sorghum (6) Tea (7) Flowers (8) Linseed
(9) Lintels (10) Coffee (11) Barley (12) Wheat
(13) Yam (14) Chick pea (15) Sweet potatoes (16) Cow Peas
(17) Beans (18) Cassava (19) Cotton (20) Tobacco
(21) Arrow roots (22) Macadomia nuts (23) Pyrethrum (24) Rice
(25) Sun flower (26) Irish potato

Code (b)
(1) Fertile
(2) Moderately fertile
(3) Infertile

Code (c)
(1) Plain (0-12%)
(2) Moderately slope (12 –35%)
(3) Steep slope (> 35%)

SECTION 4: LIVESTOCK OWNERSHIP

27 Can you tell us about your herd of livestock at present (2005)? **(For value per unit, ask for the resale price for asset or the current market value of the asset as it is).**

Type	Number owned and present at your farm	Value per unit (Ksh)
Calves	a	M
Bulls	b	N
Oxen	c	O
Heifer	d	P
Cows	e	Q
Sheep	f	R
Goats	g	S
Horses	h	T
Donkeys	i	U
Mules	j	V
Chicken	k	W
Bee hive	l	x

28

Type	Do you sell the following product? 1) Yes 2) No	Total revenue from the sell of the type in the past 12 months? (Ksh)
Meat	a	j
Hides/skins	b	k
Milk/cream	c	l
Chicken & egg	d	m
Honey	e	n
Live animals	f	o
Transport service	g	p

29 Did you get any income from hiring out oxen (bulls) during the last two cropping season (2005)? 29

1) Yes 2) No

30 **If yes**, how much did you earn? (Ksh) 30

31 Did you fatten livestock to make money (business) in the last 12 months? 1) Yes 2) No 31

32 **If yes**, indicate the profit earned? (Ksh) 32

33 In the last 12 months, how much did you spent on livestock (labour for herding, purchased feed, veterinary services, medicine, vaccination)? (Ksh) 33

SECTION 5: MARKETING AND CONTRACT FARMING

34

	Types of vegetables produced during the last 12 months	For which mkt 1) Domestic 2) Export 3) Home consumption 4) 1 & 2 5) 1 & 3	Share from the total area vegetable produced (acres)
A	a	i	q
B	b	j	r
C	c	k	s
D	d	l	t
E	e	M	u
F	f	N	v
G	g	O	w
H	h	P	x

35 **If you produce for export, answer from 35 –71**

If you produce for export market, to whom do you sell your produce?
(1) Exporter (2) Middleman (3) Both 35

36 **If you sell to both exporter and middleman**, what % is sold for the exporters? 36

37 **If you produce for export market**, how long have you been in this business? (years) 37

38 Do you have any contractual agreement with your buyers (exporters or middlemen)? 38
1) Yes 2) No **If No go to Q 41**

39 **If yes**, what kinds of arrangement do you have? 39
1) Formal contract 2) Informal verbal contract

4

40 **If you have contractual agreement (either formal or informal),** does your buyer provide any of this input or services?

Inputs or services	**1) Yes 2) No**	
Seeds		a
Fertilizer		b
Chemicals		c
Technical advice		d
Service of spraying chemicals		e
Cash credit		f

41 Do you have one or several buyers?
1) One buyer 2) Two buyer 3) Several buyer (>2)

42 **If one buyer**, for how many years have you been selling to him?

43 Do you have made the agreements regarding the quantity that you should deliver? 1) Yes 2) No

44 **If yes**, are these agreements written down formally? 1) Yes 2) No

45a Do you have made agreement regarding the quality that you should deliver? 1) Yes 2) No

45b **If yes**, are these agreements written down formally? 1) Yes 2) No

46a Do you have made agreement regarding the price? 1) Yes 2) No

46b **If yes**, are these agreements written down formally? 1) Yes 2) No

47 Could you discuss the price or did your buyer set it without negotiation?
(1) Buyer set the price (2) We negotiate (3) Negotiate sometime
(9) Other: ____________________

48a Do you have made agreement regarding the amount and type of pesticide used? 1) Yes 2) No

48b **If yes**, are these agreements written down formally? 1) Yes 2) No

49a Do you have agreement on the delivery date? 1) Yes 2) No

49b **If yes**, are these agreements written down formally? 1) Yes 2) No

50 When do you receive your revenue (money) ?
1) Cash on delivering
2) Late payment
3) Depends on the arrangement
9) Other: ____________________

51 **If you receive your payment late**, how long does it take after the agreed date?
1) 1-3 days 2) A week 3) Two week
4) Three weeks 5) A month 6) After a season
7) I am never sure when I will get paid

52 What percentage of the harvest does your buyer reject to buy because of different reasons?

53 **If there is reject**, do you think your buyer gives you enough information regarding reasons for reject?
1) Yes 2) No

54 Do the rejection rate vary from season to season or almost similar? 1) It varies 2) Similar

55 **If rejection rate varies across seasons**, which time of the year is the rejection rate higher?
1) Sep – Nov 2) Dec –Feb 3) March – May
4) June –Aug

56 Do you believe what your buyer told you about the reasons of rejection? 1) Yes 2) No 3) Partly

57 When do you know exactly what amount of your produce is rejected?
1) At point of sale 2) After sometime 3) Both

58 Do the buyer returns back the amount rejected?
1) Yes 2) No 3) Sometimes

59a **If yes**, what do you do with the rejected amount of your produce?
1) ____________________
2) ____________________

60a **If you sell to exporters**, who are they specifically?
1) ____________________
2) ____________________
3) ____________________

5

60d	Do you think there is transparency between you and the buyer about the overall marketing and production systems? 1) Yes 2) No 3) Partly	60d
61	**If you have agreements (either formal or informal),** is there a case when your buyer fails to keep his agreement? 1) Yes 2) No	61
62	**If yes,** how often? 1) Often 2) Sometime 3) Few times	62
63	**If you have agreement (formal or informal),** is there a case when you sell all or part of your produce to another buyer? 1) Yes 2) No	63
64	**If yes,** how often? 1) Often 2) Sometime 3) Few times	64
65	**If yes,** two major reasons for default (or selling to another buyer). 1) ______ 2) ______	65a 65b
66	Do you plan to continue producing for export market in the future? 1) Yes 2) No	66
67	**If no,** two major reasons why? 1) ______ 2) ______	67a 67b
68	**If no** , what alternative option do you plan to follow? 1) Produce for domestic market 2) Shift to cereal production 3) Search for other job 4) Livestock production 5) Business 9) Others: ______	68b 68b
69	**If you plan to produce for domestic market (if answer for Q68 is 1),** which particular crops do you want to produce? (Major two) 1) ______ 2) ______	69a 69b
70	i) How much % of the job for export vegetable is done by. ii) How much % of the income earned from export vegetables is accessed by:	

	Number	Q i)	Q ii)
Husband	A	F	k
Wife	B	G	L
Male HH member	C	H	M
Female HH member	d	i	N
Hired labour	e	j	o

71	**If you produce for domestic mkt (i.e either domestic market only or both market), answer 71-79** If you produce for domestic market, who is the first and second major buyer? (1) Consumer at local market (2) Middleman (3) Restaurants (4) Local industry (5) Supermarket (6) Hospitals (7) Schools (9) Others: ______	71a 71b
72	Do you have formal or informal agreement with your buyer about the price, quality, quantity delivered etc 1) Yes 2) No	73
73	How long have you been producing vegetable for domestic market? (years)	73
74	**(Answer this question if he/she produce for domestic market only)** Have you ever produced vegetables for export market? 1) Yes 2) No	74
75	**If yes,** how many years back?	75
76	**If no,** two major reasons why you did not try? 1) ______ 2) ______	76a 76b
77	**(Answer this question if he/she produce for domestic market only)** Do you plan to produce for export market in the future? 1) Yes 2) No	77
78	**If yes,** two major reasons why? 1) ______ 2) ______	78a 78b
79	**If you produce only for domestic market,** what are the major constraints for entering into export market?	

Major constraints for entering into export market	1) Yes 2) No	1) Very severe 2) Medium 3) Less severe
Inability to find best price	a	j
Capital	b	k
Insect pest & diseases	c	l
Obtaining access to existing export market	d	m

6

	Inability to comply with the quality standards	E	n	
	Knowledge	F	o	
	Water	G	p	
	Farm size	H	q	
	Labour	I	r	
80	How far are you from public telephone services? (Km)			80
81	How far are you from the nearest fertilizer seller? (Km)			81
82	How far are you from the nearest chemical pesticide seller? (Km)			82
83	How far are you from the nearest town? (Km)			83
84	How far are you form your production point to the delivery or market point? (Km)			84
85	How do you evaluate the road condition from your home to nearby town or market? 1) Good 2) poor 3) Very poor			85
86	Average walking time to your vegetable field? (Km)			86
87	Have you got any credit (in cash or kind) during the past 12 months? 1) Yes 2) No			87
88	Did you have contact with extension agent to get advices in the past 12 months? 1) Yes 2) No			88
89	How far are you from extension advice? (Km)			89

SECTION 6: HEALTH EFFECT OF CHEMICAL USE

01 Have you or the family members or farm worker experienced intoxication from pesticide in the past three years? 1) Yes 2) No — 1 [ ]

02 (i) **If yes**, in which year did you experience the intoxication and what were the symptoms you or family member suffered from?
1) Yes 2) No

(ii) **If you get sick in 2005**, which specific pesticide did you apply?

1) Dimethoate 2) Karate 3) Decis
4) Fastac 5) Bulldock 6) Pencozeb
7) Plantvax 20 EC 8) Wetsurf 9) Dithane M 45

Types of symptoms	Years (Q i) 1) Yes 2) No			Q ii)
	2005	2004	2003	
Headache				
Sneezing				
Vomiting				
Stomach ache				
Backache				
Skin rash				
Dizziness				
Blurred vision				
Diarrhea				
Eye irritation				
Other				

03 **If intoxication in year 2005**, what is the total number of people worked in your farm intoxicated in the year 2005? — 3 [ ]

04 How much did you spend on purchase of pesticides in the year 2005? — 4 [ ]

05 Have you or your household member or worker who handle and apply crop protection products trained? 1) Yes 2) No — 5 [ ]

06 Who is making the decisions about pesticide use on your farm? 1) Husband 2) Wife 3) Both 4) Eldest son 5) Exporter 6) Daughter 9) Others: ____________ — 6a [ ] 6b [ ]

07 Where do you receive your information about quality and quantity of pesticide to be used? (major three)
1) Extension service 2) Neighbors
3) Pesticide retailers 4) Salesman from pesticide company 5) Pesticide labels 6) TV & radio
7) Experience 8) Exporters 9) Other sources — 7a [ ] 77b [ ] 7c [ ]

08 How often do you receive new information about chemical use?
1) Once per year 2) Once per cropping season
3) Twice per cropping season 4) More often
5) None at all — 8 [ ]

09 Is your crop protection practices different in the dry and rainy season? 1) Yes 2) No — 9 [ ]

10 Do you use any other method than chemicals to protect your crop from pest and diseases? 1) Yes 2) No — 10 [ ]

11 **If other methods than chemical control are used**, what are they? 1) Bio pesticide 2) Plant extract 3) Concoctions 4) Handpicking 5) Physical killing 9) Others:____________ — 11a [ ] 11b [ ]

12 **If no other methods than chemical controls are used**, why are they not used? (Major two)
1. ____________
2. ____________ — 12a [X] 12b [X]

17 Do you have any separate storage place for chemicals & its equipment? 1) Yes 2) No — 17 [ ]

18 How do you evaluate the expenditure on purchase of pesticides during the 2005 compared to the past year 1) Increased 2) The same 3) Decreased — 18 [ ]

19 Do you understand the meanings or instructions of label on how to use pesticide? 1) Yes 2) No — 19 [ ]

20 Are HH member or workers equipped with suitable protective clothing in accordance with label instructions when handling and applying chemicals? 1) Yes 2) No

21 **If no**, what are the reasons for not using protective clothing? (major two reasons)
1. ____________
2. ____________

22 How far is health centre far from your home? (km)

23 **If you got sick in 2005**, have you or HH member ever visited health service due to pesticide related problems? 1) Yes 2) No

24 **If yes**, how much did you spend totally? (ksh)

25 Have you or anybody in your household trained in First Aid?
1) Yes 2) No

26 Do you think it is important for the pickers to wash their hands before they start picking? 1) Yes 2) No

27 **If yes**, why? (Major two)
1. ____________
2. ____________

28 What do the pickers do to promote the cleanliness of the produce? (major two)
1) They wash their hands before they start picking 2) They wear caps
3) They avoid smoking in the field during harvest
4) They wash their hands after visiting the toilet
5) They put on clean clothes before they start picking
6) They do not use any make-up or perfume when picking
7) They wash the produce after picking
8) They do not do anything at all to promote the cleanliness of the
9) Other, namely: ____________

29 Why do you think trace ability is important for the supermarkets in Europe?
1) They like to know more about the personal situation of each farmer (from which piece of land the vegetables come from etc.)
2) They want to know which farmer grew which vegetable in case of problems concerning the consumers' health
3) To avoid farmers to use other seed like Samantha
9) Other reason: ____________

30 Do you think trace ability is important for you?
1) Yes 2) No

31 **If yes**, why?
1) It makes sure that other farmers are not able to lower my revenue (by grading badly)
2) I can improve my quality control; to avoid making the same mistake twice.
3) Now I know exactly which percentage of my harvest is rejected and the reason why.
9) Other reason: ____________

32 Do you apply crop protection products, which are not officially registered? 1) Yes 2) No

33 Do you take alcohol regularly? 1) Yes 2) No

34 **If yes**, how long? (years)

35 Do you smoke regularly? 1) Yes 2) No

36 **If yes**, how long? (years)

37 Does anyone living in this household own a mobile telephone? 1) Yes 2) No

38 If yes, how long have you (or member) been using? yr

39 If the household does not own a mobile phone does it have **access** to one it can use? 1) Yes 2) No

40 **If yes**, through who? 1) Friends 2) Neighbours
3) Family 9) Others: ____________

41 Has any household member used the **sms** service to access commodity prices information in the last one year? 1) Yes 2) No

42 **If yes,** how often has the household used sms service to access commodity price information?
1) Week 2) Month 3) 6 months
4) Year 9) Others: ____________

SECTION 7: EUREPGAP STANDARDS

01	Are you a grower group member? 1) Yes 2) No		01	
02	If yes, how old is the group since its formation? (years)		02	
03	How long have you been a member? (years)		03	
04	How many members do you have in your group?	Male	04a	
		Female	04b	
05	Is the group legally registered 1) Yes 2) No		05	
06	Have you ever been dismissed from the group for any reason? 1) Yes 2) No		06	

07	Are you a member of any other agricultural organisation i.e cooperative? 1) Yes 2) No	07	
08	Have you heard about the Good Agricultural Practices Protocol (EurepGAP) that the supermarkets in Europe have set up? 1) Yes 2) No **If No go to Q27a**	08	
09	**If yes**, from whom did you hear? 1) Exporter 2) Middleman 3) Extension agent 4) Neighbour 5) Friends and relative 6) Radio & TV 7) Church 8) News paper 99) Others: ________________	09a	
		09b	
10	Are you trained on EurepGAP? 1) Yes 2) No	10	
11	**If you took EurepGAP training**, who organised it for you? 1) Exporters 2) MoA 3) ICIPE 4) KARI 5) JICA 6) HCDA 9) Others: ________________-	11a	
		11b	
		11c	
12	**If you heard/trained about EurepGAP**, have you alone or in-group started to comply with EurepGAP to get the certificate? 1) Yes 2) No	12	
13	**If no**, reasons for not starting compliance with EurepGAP? (two major reasons) 1. ________________ 2. ________________	13a	
		13b	
14	**If you started the compliance**, for which vegetables does the grower group/you seek certification? 1) ________ 2)________ 3)________ 4) ________	14a	
		14b	
		14c	
15	**If you started the compliance**, have you succeeded in getting the certificate for some or all of the crops? 1) Yes 2) No	15	
16	**If you got the certificate**, for which crop did you get the certificate? 1. ________ 2. ________ 3. ________	16a	
		16b	
		16c	
17	**If you did not get the certificate (i.e. if answer for Q 18 is No),** reasons for not getting the certificate? (two reasons) 1. ________________ 2. ________________	17a	
		17b	
18	**If you take the certificate,** how long did it take from the start to get the certificate? (Months)	18	

19 **If not started the compliance,** do you have the plan to go for the certification in the future? 1) Yes 2) No [19]

20 If you get the certificate or on the process of certification, what are the additional major cost categories? (major investment categories)

Major cost items	Individual cost (Ksh)	Support from external source (Ksh)
Building infrastructure	a	h
Labour cost for record keeping	b	i
Labour cost for grading	c	j
First aid kit	d	k
Protective clothing	e	l
Expense for writing materials	f	m
Other: ____________	g	n

21 Who supported you in covering the part or total of the major costs? [21a] [21b]
1) Exporter 2) MoA 3) NGOs
9) Other: ____________

22 **If you get the certificate or on the process**, which part of the compliance criteria is very challenging for you to implement? (major two) [22a] [22b]
1. ____________
2. ____________

23 **If you get the certificate or on the process**, do you apply the code of practices for other crops produced for domestic market? [23]
1) Yes 2) No 3) Partly

24 **If no**, give us two major reasons why you don't apply? [24a] [24b]
1. ____________
2. ____________

25 **If yes or partly**, what are the major three practices you apply to other crops? [25a] [25b] [25a]
1. ____________
2. ____________
3. ____________

26 **If you get the certificate or on the process,** what are the major benefits you expect to earn from complying with this EurepGAP standards? (major three) [26a] [26b] [26c]
1. ____________
2. ____________
3. ____________

27 Do you keep records of the amount of inputs (fertilizers and pesticides) used and different production practices? [27]
1) Yes 2) No

28 **If yes**, for how long do you keep these records (yrs)? [28]

29 Did the water used for washing the final produce or water used for irrigation, manure, soil fertility ever been analyzed to check for its safety? [29]
1) Yes 2) No

30 How do you want the spraying to be done currently or in the future? [30]
1) By people from the exporter?
2) By a few people of my own group who will receive training
3) I want to spray myself after being trained
9) Other: ____________

31 Do you think it is important to be trained before you are allowed to spray? 1) Yes 2) No [31]

32 Do you think it might be important to wear special clothes while you're spraying? [32]
1) Yes 2) No

33 **If yes**, why? (two major reasons) [33a] [33b]
1. ____________
2. ____________

34 Why do you think it is important that you do not spray too much chemical? (three major reasons) [34a] [34b] [34c]
1. ____________
2. ____________
3. ____________

35 Do you feel informed enough? Do you think you get enough information regarding chemical use from the exporter? 1) Yes 2) No [35]

36 Why do you think it is important for the exporter to know which chemicals you spray and the amount being sprayed? (two major reasons) [36a] [36b]
1) ____________

SECTION 1: MONITORING OF VEGETABLE CROPS

1. Could you please tell us how much seeds and seedling do you use in vegetable production? **(All vegetables produced for export and domestic market)**

Crop code (a)	Total land size cultivated for each crop (acres) **Monitoring land size only**	Total land size cultivated for each crop (acres) **Monit + Non-monitoring land**	Quantity (Kg) of seed			Costs (Ksh)			Do you produce/ purchase seedlings? 1) Yes 2) No	If yes, how much (No)	Costs of seedlings (Ksh)	
			Saved from previous harvest	Purchased	Obtained from exporter/middlemen	Saved	Purchased	Obtained from exporter		Purchased	Produced	Purchased

Crop code (a):

(01) French beans	(02) Fine beans	(03) Carrots	(04) Leeks	(05) Snaps	(06) Peas	(07) Baby corn	(08) Tomatoes
(09) Kales	(10) Onions	(11) Capsicums	(12) Okra	(13) Chillies	(14) Karalla	(15) Aubergines	(16) Dudhi
(17) Valore	(18) Tuwer	(19) Turia	(20) Tindori	(21) Cabbage	(22) Spinach	(23) Butternuts	(99) Others: _____

2. Please indicate all types of labour (family, hired, help, exchange, etc) used for the various activities for the vegetable crops during this cropping season? (Child labor refers to those below the age of 15 for this section). Please give us the total labour separately for male (M), female (F) and children (C).
What is the length of one working day (person day) and wage rate in your village? ____________ hours ___________Ksh

3. If you produce seedlings, indicate the amount of labour used (i.e. include labour for seed bed preparation, sowing, irrigation, weeding and others).

Crop code (a)	Total number of people			Number of days			hrs/day			Number of hired labour			Cost of hired labour			No of family labour		
	M	F	C	M	F	C	M	F	C	M	F	C	M	F	C	M	F	C

4. Indicate the amount of labour used for **land (field) preparation**

1	2			3			4			5			6			7		
	Total number of people			Number of days			Hrs/day			Number of hired labour			Cost of hired labour			No of family labour		
Crop code (a)	M	F	C	M	F	C	M	F	C	M	F	C	M	F	C	M	F	C

5a. What types of technology is used for field preparation? (1) Hand (2) Oxen (3) Tractor (4) Hand and oxen (5) Herbicides ____________

5b. If oxen or tractor or herbicides is used, what is the estimate costs of hiring oxen or tractor even if it belongs to you: ____________Ksh

6. Indicate the amount of labour used for **planting**

2	3			4			5			6			7			8		
	Total number of people			Number of days			hrs/day			Number of hired labour			Cost of hired labour			No of family labour		
Crop code (a)	M	F	C	M	F	C	M	F	C	M	F	C	M	F	C	M	F	C

7. Please indicate the **quantity of fertilizer inputs used**?

Crop code (a)	DAP		NPK		CAN		UREA		TSP		Mavno		Folia feeds		Manure		Compost 1) Yes 2) No
	Quantity (Kg)	Cost (Ksh)	Quantity (Kg)	Cost (Ksh)	Quantity (Kg)	Cost (Ksh)	Quantity (Kg)	Cost (Ksh)	Quantity (Kg)	Cost (Ksh)	Quantity (Kg)	Cost (Ksh)	Quantity (Kg)	Cost (Kg)	Quantity (Kg)	Cost (Ksh)	

8. Indicate the amount of labour used for **application of fertilizer and manure**

2	3			4			5			6			7			8		
Crop code (a)	Total number of people			Number of days			hrs/day			Number of hired labour			Cost of hired labour			No of family labour		
	M	F	C	M	F	C	M	F	C	M	F	C	M	F	C	M	F	C

9. What types of irrigation system do you use for your vegetable production?
(1) Sprinkler (2) Drip irrigation (3) Farrow (4) Sprinkler and drip irrigation (5) Basin and furrow irrigation (6) Bucket ________

10) If you use irrigation, where does the water come?
1) From the river 2) From the dam 3) Streams 4) Shallow wells ________
9) From other sources, namely: ____________________

10. Please give us the detail information about **irrigation practices and variable cost for use of machinery** for the same purpose (e.g. fuel, oil etc)

Crop code (a)	Number of weeks	Times per week	How long (hr) at a time	Costs for use of machineries (Ksh)

11. Indicate the amount of **labour used for irrigation**

Crop code (a)	Total number of people			Number of days			hrs/day			Number of hired labour			Cost of hired labour			No of family labour		
	M	F	C	M	F	C	M	F	C	M	F	C	M	F	C	M	F	C

12. List the main weed, pest (damage by insect) and disease (fungal, bacterial, viral) problems for the crop and indicate the pressure (damage) level?

Crop code (a)	Weed problem				Pest or disease problem			
	Type of weed (code b)		Pressure: (1) Low, (2) Normal, (3) High		Type(code c)		Damage: (1) Low, (2) Normal, (3) High	
	1st	2nd	1st weed	2nd weed	1st	2nd	1st pest/disease	2nd pest/disease

Code (b):
(1) Black jack (2) Mexican Marigold
(3) Pig weed (4) Kikuyu grass
(5) Oxaris (6) Weathering Jew
(7) Garant Soja (8) Nut grass
(9) Star grass (10) Coach grass

Code (c):
(1) Cutworm (2) Thrips (3) Vegetable weevil
(4) Baragad bug (5) Saw fly (6) Black-rot
(7) Head-Rot (8) Alternaria Leafspot (9) Powdery Mildew
(10) Anthracnose (11) Club root (12) Ring spot
(13) White rust (14) Aphids (15) Bean rust
(16) Bean fly

13. Indicate the amount of labour used for **weeding**

Crop code (a)	Total number of people			Number of days			hrs/day			Number of hired labour			Cost of hired labour			No of family labour		
	M	F	C	M	F	C	M	F	C	M	F	C	M	F	C	M	F	C

SECTION 2: CHEMICAL INPUT USE

1. Do you use chemicals to protect your crop? 1) Yes 2) No ____________ (if yes, go to the next question)

2. Please give us detail on the types and quantity of chemicals (pesticides, fungicides, herbicides) used?

Crop code (code a)	Product name (code b)	Who applied the chemicals? (code c)	ml or g / pump	Size of the pump (lt)	Cost (if done by hired labour) Ksh	No of pumps	Price per package		Source: (1) Old stock, (2) Friends, (3) Market, (4) Shop, (5) Exporter	How long did it take? (hrs)	Were the pumps leaking when you spray? 1) Yes 2) No
							Package size	Price (Ksh)			

Code (b):
(1) Dimethoate (2) Karate (3) Decis (4) Bulldock
(5) Pencozeb (6) Plantvax 20 EC (7) Dithane M 45 (8) Wetsurf
(9) Thiovit 80W (99) Others:______________________

Code c:
(1) Household head (2) Spouse (3) Son (4) Daughter
(5) Hired labour (7) Technician/agronomist
(9) Others: ______________

3. Use of chemicals (continued . . .)

	11	12	13	14	15	16	17	18
Crop type	Do you use cocktails/mixture of chemicals? 1) Yes, 2) No	If mixtures, which product with? (code b)	Time of day 1) Morning, 2) Lunchtime 3) Afternoon	Weather during & 1 hour after application 1) Raining 2) Sunny 3) Cloudy	Which types of protective clothing were used? (list all)	How did you apply the chemically? (code e)	Did you wash your hands after spraying? 1) Yes, 2) No	Did you eat in the field while or after spraying? 1) Yes 2) No

Code d:
(1) None (2) Mask (3) Gloves (4) Long sleeved coat
(5) Long protective trousers (6) Boots (7) Home made protective clothing
(8) Others: ______________________________

Code (e): (1) Motorized sprayer (2) Hand operated (3) Knapsack
(9) Others: ______________

SECTION 3: HEALTH EFFECTS OF CHEMICAL USE

1. Have you (or the family member who sprays) experienced intoxication from pesticide? 1) Yes 2) No if yes, fill the table. ________

Who exactly? 1) You (HHH) 2) Wife 3) Son 4) Daughter 5) Other member	What are the symptoms you/family members suffered from? (Code a)	How sever were the symptoms? 1) Mild 2) Severe 3) Very severe	How long did the symptoms prevail? (Days)	Which medical treatment did you use? (Code b)	Did the treatment work? 1) Yes 2) No	How much did the treatment cost (including transport)?	Were you able to work during this time? 1) Yes 2) No	If No, how many days you did not work?

Code (a)

1) Headache 2) Sneezing 3) Vomiting 4) Stomach ache
5) Backache 6) Skin rash 7) Dizziness 8) Blurred vision
9) Diarrhea 10) Eye irritation 11) Fever 12) Shortage of breath
13) Heart trouble 14) Other (fatigue, trouble sleeping etc)

Code (b):

1) Clinic 2) Health center 3) Hospital
4) Use of tablets from the shops 5) Traditional
9) Other: ____________________

2	Do you use any other method than chemicals to protect your crop from pest and diseases? 1) yes 2) No	2	
3	If other methods than chemical control are used, what are they? (major three) (1) Bio pesticide (2) Plant extract (3) Concoctions (4) Handpicking (5) Physical killing (6) More than one of this type (9) Others	3a	
		3b	
		3c	
4	Please tell us how much did it cost you to get these materials for pest control?	4	
5	How many protective clothing items do you have? (number)?	5	
6	What is the estimated cost of the items in total? (Ksh)	6	

7	How do you evaluate the total rainfall from planting until harvesting? 1) Excess 2) Good 3) Shortage	7	
8	**If excess or shortage,** do you evaluate the degree of the hazard? 1) Light 2) Medium 3) Heavy 4) None	8	
9	Does the rain come on time of your expectation? 1) Yes 2) No	9	
10	Have you experienced natural hazard like hail, storm, flood etc that damage your crop? 1) Yes 2) No	10	
11	If yes, how do you evaluate the degree of the hazard? 1) Light 2) Medium 3) Heavy 4) None	11	

SECTION 4: OUTPUT

	Crop 1							
Date	**1st week**	**2nd week**	**3rd week**	**4th week**	**5th week**	**6th week**	**7th week**	**8th week**
Yield (kg or head)								
Quantity sold (kg / head)								
Costs related to marketing[1]								
Price received (Ksh/kg or Ksh/head)								
Own consumption (kg/ head)								
Price of home consumed (Ksh/kg)								
Given away (Kg/ head)								
Price for given away (Ksh/kg)								
Livestock feed (kg/head)								
Potential price for livestock feed								
Thrown away (wastage)								

[1] Cost related to marketing includes cost fro transport of produce from the field to marketing place (or collection centre), cost related to harvesting (picking) including family labour value and any cost related to marketing (cost for calling or sms etc)

	Crop 2							
Date	**1st week**	**2nd week**	**3rd week**	**4th week**	**5th week**	**6th week**	**7th week**	**8th week**
Yield (kg or head)								
Quantity sold (kg / head)								
Costs related to marketing								
Price received (Ksh/kg or Ksh/head)								
Own consumption (kg/ head)								
Price of home consumed (Ksh/kg)								
Given away (Kg/ head)								
Price for given away (Ksh/kg)								
Livestock feed (kg/head)								
Potential price for livestock feed								
Thrown away (wastage)								
	Crop 3							
Date	**1st week**	**2nd week**	**3rd week**	**4th week**	**5th week**	**6th week**	**7th week**	**8th week**
Yield (kg or head)								
Quantity sold (kg / head)								
Costs related to marketing								
Price received (Ksh/kg or Ksh/head)								
Own consumption (kg/ head)								
Price of home consumed (Ksh/kg)								
Given away (Kg/ head)								
Price for given away (Ksh/kg)								
Livestock feed (kg/head)								
Potential price for livestock feed								
Thrown away (wastage)								