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Solomon Asfaw, Dagmar Mithöfer, Hermann Waibel

Institutions: International Crops Research Institute for the Semi-Arid Tropics, Leibniz University of Hanover

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Solomon Asfaw, Dagmar Mithöfer, Hermann Waibel
University of Hanover, Germany

solomon@ifgb.uni-hannover.de

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What Impact Are EU Supermarket Standards Having on Developing Countries Export of High-Value Horticultural Products? Evidence from Kenya

Solomon Asfaw[1], Dagmar Mithöfer[2], Hermann Waibel[3]
[1, 3] Leibniz University of Hanover, Germany,
[2] International Centre of Insect Physiology and Ecology (ICIPE), Kenya.
solomon@ifgb.uni-hannover.de

Summary

European Union (EU) retailers are setting global benchmarks for the production of fresh food, 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 entail costly investment in variable inputs and long term structures. Limited empirical evidence exists either to refute or confirm the concern that the proliferation and enhanced stringency of these standards marginalize smallholders from global market. This article therefore explores the costs of compliance, factors explaining the smallholder decision to adopt EU private quality standard and the impacts of the standard on farm financial performance. We develop a two-stage standard treatment effect model to account for self-selection as a source of endogeneity. Analysis is based on a random cross section sample of 439 small-scale export vegetable producers in Kenya whose production was monitored in 2005/2006. We demonstrate that adopters and non-adopters are distinguishable by their asset holding and household wealth, access to services, labor endowment and level of education. Once we control for endogeneity problem, we found that small-scale producers can benefit substantially from adopting the standard at the farm level.

KEY WORDS: Kenya, export vegetables, adoption, EurepGAP standard, impact assessment

1. Introduction

One way that Kenya and other sub-Saharan African countries have attempted to reduce poverty and achieve higher rates of growth is by diversifying their export portfolio 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). Extensive household surveys have shown that 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; and Humphrey et al., 2004). However, there is a concern 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 in particular smallholders and impede actors from these countries from entering high-value food markets (Augier et al., 2005). An alternative and less pessimistic view emphasize that compliance with food-safety standards can be a catalyst for upgrading and modernization of developing country's food supply systems (Jaffee and Henson, 2004; Maertens and Swinnen, 2006).

The challenge especially for small-scale producers is the fact that horticultural export is becoming increasingly competitive and sophisticated. Consumers require high quality produce and this has to be traced back to the producer to ensure strict adherence to total quality management (Jenson, 2004). The smallholders' ability to maintain and strengthen their role in horticultural exports will depend on their capacity to adapt to these changes and comply fully with the emerging standards. Compliance to these standards entails costly investments in such as variable inputs (in particular, the switch to approved pesticides) and long-term structures (e.g., grading shed, charcoal cooler, disposal pit, toilet, and pesticide store). These investments are "lumpy" in nature and mostly specific to the fresh export vegetable business. The general view in the literature is that smallholders, especially the poorest ones, are increasingly being squeezed out from high-standards export production (Barrett et al., 1999; Dolan and Hamphrey, 2000; Farina and Reardon, 2000; Reardon et al., 2003; Weatherpoon and Reardon, 2003; Jeffee, 2003; Jensen, 2004; Okello, 2005).

Participation of small-scale producers in high-standards export production is a necessary but not a sufficient condition for an enhanced welfare effect of high-standards agricultural trade (Maertens, 2006). Faced with high cost of compliance and complexity of the standard, farmers examine the perceived benefit vis-à-vis the expected cost before making a decision to adopt the standard. Theoretically, complying with food-safety standards provides a broad spectrum of potential direct and indirect benefits to the farmers. Small-scale producers complying with the standard are expected to have high productivity and good quality produce which reduce the level of rejection by the buyers and increase the return. The health and environmental impacts stemming from changes in pesticide use and hygiene practices associated with adoption are another important benefit. Adopters are expected to have better market access and stable income over time compared to the non-adopters and in addition spill-over effects to domestic production could benefit the domestic consumers (Henson and Jaffee, 2004).

Much research addressed impacts of standards on developing countries at a policy level (Henson and Loader, 2001; Beghin and Burea, 2001; Jaffee et al., 2005; Henson and Jaffee, 2005; Aloui and Kenny, 2005; Manarungsan et al., 2005), however less attention has focused at the level of small-scale producers. The few exceptions, to the best of our knowledge, are the study by Okello (2005), who investigated on compliance with international food-safety standards for Kenyan green beans producers on case study basis. He found that resource poor farmers are likely to be marginalized by international food-safety standards. However, they can overcome the capital barrier by banding together into cooperative groups and then jointly investing in costly facilities. The study by Maertens (2006) and Minten et al. (2006) focused on Senegal and Madagascar export vegetable industry respectively and found a positive impact of high standard export contract on smallholder welfare, income stability and shorter lean periods.

In this paper we undertake an empirical study of the impact of complying with a most widely known EU private food-safety standard on small-scale producers in Kenya. We addresses three main objectives: (1) to investigate the nature, magnitude and significance of cost of compliance with EU private standards, (2) to examine factors explaining the smallholder decision to adopt EU private standard and (3) to estimate the impacts of standard on farm financial performance.

The organization of the rest of the paper is as follows. Section 2 is devoted to a review of trend in Kenyan horticultural industry and the evolving EU food-safety standards. The methodology and empirical model is presented in section 3. Section 4 presents and discusses the empirical findings and section 5 reports the conclusions and policy implications of the study.

2. Kenyan Fresh Export Production

2.1. Overview of the Horticultural Sector

Compared to many African countries, the horticultural export industry of Kenya is now by far the largest exporter of vegetables to the EU and has been for about a decade the country's second most important foreign exchange earner in the agricultural sector, after tea (Jaffe et al., 2005). 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). The vast majority of this produce (89.4%) is destined for Europe, with the UK market absorbing the major share 71% in 1999. Kenya also exports Asian vegetables to the Middle East market (Harris et al., 2001).

There are various players active in the export market channels of fresh fruits and vegetables in Kenya. Small-scale producers often operate as individuals or as a member of out-grower schemes. Figure 1 shows the high-value vegetable supply chain to illustrate the different choices the actors have in selling their produce.

Figure 1 Here

The strength of the horticulture export sector can be attributed to several factors. 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 (APC) 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).

2.2. Role of Small-scale Producers

The figures on the number of small-scale farmers involved in export fresh fruit and vegetable production in Kenya vary depending on the source and year of estimation. Estimates from the early 1990s suggest that smallholders supplied over half of the export fruit and vegetable production (Kimenye, 1993; Jaffee, 1995). More recently, the Horticultural Crops Development Authority (HCDA) estimated that 40% of exported fruit and 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 further make the case that smallholders are being squeezed out of export production because of the difficulty of ensuring compliance 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 their 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 estimates that smallholders account for 27% of exported fresh vegetables and 85% of exported fresh fruit, for an average of 47% of fresh fruit and vegetable exports. A recent review and update estimated the current number at about 12,000 smallholders producing for the vegetable export market in nine districts of Kenya (Mithöfer et al., 2006). Previous estimates range from 13-16,000 (Jaffee,

1995) to 80,000 smallholders producing vegetables and fruits for the export market (Karuga and Masbayi, 2004)

One of the difficulties in estimating the number of participating smallholders is the definition of the same. With an exception of Mithöfer et al. (2006), 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). This definition was re-discussed with experts from Kenya, and majority of the experts concluded that this definition does not reflect the reality on the ground. The experts instead defined 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. This is the definition applied throughout the paper.

2.3. European Private Food-safety Standards

European consumers are increasingly concerned about possible health consequences of pesticide residues. Even consumers who are not part of the growing "organic food" movement are increasingly wary of agricultural chemicals (Dolan et al., 1999). In 1990, the U.K passed the Food Safety Act which obliged food retailers to demonstrate "due diligence" to ensure that the food they sell is safe and the resultant supermarkets developed codes of practice. In practice, this means that supermarkets 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 horticultural production in developing countries (Dolan et al., 1999). These changes were initially 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 and 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).

Many of the individual quality and food-safety standards of retailers in EU have been harmonized, with two prominent common standards being the British Retail Consortium (BRC) standard and European Retailer Produce Working Group for Good Agricultural Practices (EurepGAP). Companies supplying branded fresh and processed food products use BRC, which has been in operation since 1996 and it covers basic safety and quality requirements, including HACCP (Hazard Analysis Critical Control Point). EurepGAP is the most widely known example of a common EU private standard. It is a model of on-farm assurance that is being promoted to growers of fresh food as a mandatory standard and it is regarded as a condition of entry to EU markets and is unlikely to provide price premium.

The EurepGAP 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 (EurepGAP 2003). The detailed production protocols were first developed for fruit and vegetables and now also cover flowers and grains. EurepGAP has a growing membership of retailers, including leading food retailers such as Sainsbury's, Tesco, Safeway, Coop Italia, Belgian Wholesale Markets, Waitrose and Kesko. It hopes to become the global player in agricultural production standards and verification frameworks. The main focus is food-safety, but the protocols also addresses a number of issues concerning the environment (soil, water, and wildlife conservation), occupational health and safety, complaint procedures and internal audits (EurepGAP 2003).

EurepGAP 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 EurepGAP. Under Option 2, a group of farmers applies for a group certificate. Farmers must establish an internal management and control system, perform individual self inspections and group internal inspections before receiving an external verification by a certification body. Under Options 3 and 4, individual farmers or farmer groups that have already implemented another standard can apply for a "EurepGAP benchmarked scheme certificate", i.e. EurepGAP recognizes the existing standards scheme as being equivalent to the EurepGAP standard (EurepGAP 2003).

3. The Theoretical Framework

Adoption and diffusion of innovations theory (David, 1969; Rogers, 1995; Sunding and Zilberman, 2001) has been widely used to identify factor that influence an individual's decision to adopt or reject an innovation. An innovation is defined as 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 (1) relative advantage, which is the degree to which an innovation is perceived as being better than the idea it supersedes; (2) 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; (3) complexity, which is the degree to which an innovation is perceived as relatively difficult to understand and use; (4) trialability, or the degree to which an innovation may be used experimentally on a limited basis; and (5) 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).

For the purpose of this study, EurepGAP food safety standard 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 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 labour supply decisions are usually analysed separately through the behaviour 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, labour 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 behaviour has necessitated the integration of the three decision problems into a single household problem.

The basic structure of the agricultural household model (Singh et al., 1986) also known as the household farm model is based on the assumption that for any production cycle, the household maximizes a utility function:

$$U = u(c_m, r_m, l_i; T_u) \qquad (1)$$

We assume 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 (T_u). The household maximizes utility subject to a set of constraints, namely cash income constraints, (equation 2), time constraints (equation 3) and technology constraint (equation 4).

$$\sum_{i=1}^{N} \left[p_i (Q_i - c_m) - w \sum x_i + E \right] \geq \sum_{m=1}^{N} \left[p_m r_m \right] \qquad (2)$$

$$D \geq l_i + l_a(G) \qquad (3)$$

$$Q_i \leq Q_i(l_a(G), x_i(G), G; Z_u) \qquad (4)$$

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 EurepGAP code of practices, respectively. As its mentioned in the previous chapters, its considered that the adoption EurepGAP code of practices will increase complexity and reduce flexibility that translate into increased 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 EurepGAP standard.

A technology-constrained measure of household income is obtained by substituting Equation (4) into Equation (2) (Huffman, 1991; Fernandez-Cornejo et al., 2005).

$$\sum_{i=1}^{N}\left[p_i(Q_i(l_a(G), x_i(G), G; Z_u) - c_m) - w\sum x_i + E\right] \geq \sum_{m=1}^{N}\left[p_m r_m\right] \quad (5)$$

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 of the model 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.

$$L = U(c_m, r_m, l_i; T_u) + \lambda\left\langle \sum_{i=1}^{N}\left[p_i\{Q_i(l_a(G), x_i(G), G; Z_u)\} - c_m\right] - w\sum_{i=1}^{N} x_i(G) + E - \sum_{m=1}^{N} p_m r_m \right\rangle + \mu\left(D - l_i - l_a(G)\right) \quad (6)$$

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

$$\partial L / \partial l_a = \lambda\left[P_i(\partial Q / \partial l_a)\right] - \mu = 0 \quad (7)$$

$$\partial L / \partial G = \lambda\left[p_i\left((\partial Q / \partial l_a)(\partial l_a / \partial Q)' + (\partial Q / \partial x_i)(\partial x_i / \partial Q)' + \partial Q / \partial G\right) - w(\partial xi / \partial G)'\right] - \mu(\partial l_a / \partial G)' = 0 \quad (8)$$

$$\partial L / \partial x_i = \lambda\left[p_i(\partial Q / \partial x_i) - w\right] = 0 \quad (9)$$

$$\partial L / \partial c_m = U_c - \lambda p_i = 0 \quad (10)$$

$$\partial L / \partial r_m = U_r - \lambda p_m = 0 \quad (11)$$

$$\partial L / \partial l_i = U_l - \mu = 0 \quad (12)$$

where U_c, U_r and U_l are the partial derivatives of the function U. We assume the production function is concave and that G and $l_a \geq 0$. The EurepGAP adoption decision condition is obtained from the optimality conditions, Equation (8) and Equation (7) and Equation (11), nothing that the expression in brackets in Equation (8) is the total derivative dQ/dG. Thus we obtain

$$p_i(dQ / dG) - w(dx_i / dG)' - (\mu / \lambda)(dl_a / dG)' = 0 \quad (13)$$

But from Equation (11) and Equation (12), $\mu / \lambda = p_m(U_l / U_r)$, then

$$p_i(dQ / dG) - w(dx_i / dG)' - (p_m(U_l / U_r)(dl_a / dG)' = 0 \quad (14)$$

The left-hand side of this expression may be interpreted as the marginal benefit of adoption of EurepGAP, $p_i(dQ/dG)$ 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 EurepGAP. It will not be optimal to adopt if the marginal benefit of adoption falls short of the marginal cost of adoption.

4. Empirical Model And Data

Following Greene (1997) and Fernandez-Cornejo et al. (2005), a two-stage standard empirical model is developed to account for self-selection as a source of endogeneity. The first stage consists of the adoption decision model for identifying determinants of EurepGAP adoption and the second stage is the impact model that provides estimates of the impact of adopting EurepGAP protocol on household income.

4.1 The Adoption Decision Model

Equation (14), implied by the Kuhn-Tucker conditions, is the central for the EurepGAP adoption decision. Considering a first-order approximation and adding a disturbance terms, the adoption decision can be empirically represented by:

$$G_i = \beta_i \mathrm{X}_i + u_i \qquad (15)$$

where, X_i are non-stochastic vectors of observed farm and non-farm characteristics and u_i is random disturbances associated with the adoption of the new technology. Assuming that the disturbances are independently and identically normally distributed, the probit transformation can be used to model the adoption decision. The probit model assumes that the error term of the model follows a normal distribution between $-\infty$ and the value βX_i such that the area under the curve represents the probability that EurepGAP protocol is adopted. Hence, the larger the area under the curve, the higher is the probability of adoption. The functional form of for a probit model F (cumulative distribution function) may be defined as follows:

$$F(\beta X_i) = \int_{-\infty}^{\beta X_i} \frac{1}{\sqrt{2\pi}} \exp\left(-\frac{t^2}{2}\right) dt \qquad (16)$$

The parameters of the probit model were estimated by maximizing the likelihood function K in equation (17). The likelihood function is specified as the product of the probabilities of adopting D_i and not adopting $(1 - D_i)$ and its log is maximized with the respect to the unknown parameter.

$$K = \prod_{G_i = 1} G_i \prod_{G_i = 0} (1 - G_i) \qquad (17)$$

4.2 The Impact Model

An econometric impact model is specified, which statistically controls for factors considered relevant, and for which there are data, by holding them constant, so that the effect of adoption can be estimated. The model developed takes into consideration that unobservable factors may cause farmers complying with food-safety standards to earn higher incomes than non-compliant farmers, resulting in an overestimation of the adoption effect and use instrumental variable techniques to purge the dependence of adoption. The predicted probability of adoption, obtained from the adoption decision model, is used as an instrument for estimating the effect of adopting EurepGAP in the impact model.

Unlike the traditional selectivity model in which the effects are calculated using the sub-samples of adopters and non-adopters separately, the impact model uses all the observations and is known as a "standard treatment effects model," used by Fernandez-Cornejo et al. (2005). In this model the observed indicator variable, G_i, indicates the presence or absence of some treatment, which in this case adoption of EurepGAP standard (Greene, 1997). Formally, given the unobserved or latent variable and its observed counterpart, the treatment-effect equation, which is the basis for our impact model can be expressed as:

$$G_i^* = \beta X_i + u_i \quad \textbf{(18)}$$

$$Y_i = \alpha V_i + \gamma G_i + e_i \quad \textbf{(19)}$$

$$G_i = 1 \; if \; , G_i^* > 0 \, , otherwise \quad ; G_i = 0 \quad (20)$$

G_i^* is the unobservable or latent variable for EurepGAP adoption, G_i is its observable counterpart (dummy for adoption of EurepGAP), Y_i is a vector denoting the farm net-income[1], V_i is a matrix of exogenous variables thought to affect farm financial performance 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 impact model and the adoption of EurepGAP.

Note that we cannot simply estimate (2) because the decision to adopt may be determined by unobservable variables that may also affect income. If this is the case, the error terms in (1) and (2) will be correlated, leading to biased estimates of γ, the impact of adopting EurepGAP. We can correct for the selection bias by assuming a joint normal error distribution, and using a two-step procedure. In the first step we use a probit model to estimate adoption. Using the probit results, we compute the inverse Mill's ratio for each observation. In the second step, we linearly regress income on the explanatory variables and the inverse Mill's ratio (Greene, 1997). The reduced form of the first stage adoption model is

> *ADOPTION = f [(household characteristics (AGEH, GEND, EDU1, EDU2, FEMA, CHIL), asset holding and household wealth (LIVE, LAND, FERT, FACI, MACH), communication behavior (RADI, TVUS, TRAI, MOBI, EXTE) and access to services (CRED, CONT, GROU, DIST, IRRI, EXPO, OFFF)]*

Where the dependent variable adoption of EurepGAP standard (ADOPTION) equals one, if the household has commenced to comply with EurepGAP code of practices during 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 an innovation. 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 labor-intensive nature of export vegetable production. Labor variable in the model include the number of adult females (FEMA) and children

[1] Net-income is computed as total revenue from all export vegetables minus all variable cost including family labor per cropping season. The value of family labor was approximated by the existing wage rate in the nearest village.

under 15 years of age (CHIL). The age of household head (AGEH) and his or her educational attainment (EDU1) as well as that of other household members (EDU2) capture differences in the quality of management. We expect education of household head and members to positively influence EurepGAP adoption although the direction of the age effect might be ambiguous. Age is usually taken as a proxy for experience and is expected to have a positive impact on adoption of an innovation. However, it is argued that there is a certain threshold of age beyond which the ability of farmers to take risk and adopt innovations decreases. This means that young farmers are more likely to face the risks associated with innovations, e.g. uncertainty in return and unfamiliarity of the technology and to adopt them than their old counterparts. Also, the direction of the gender (GEND) effect is not clear a priori.

Farm resource endowment variables such as the value of livestock (LIVE), value of farm machinery (MACH) and facility index (FACI[2]) are expected to have a positive impact on adoption of EurepGAP since these variables are a good proxy for measuring the capacity of households to invest in new infrastructure necessary for the compliance and take risks. The coefficient of land size (LAND) can take either sign depending on alternative form of land use, thus representing opportunity cost of land. Communication and information related variables include level of agricultural training (TRAI), total hours spent on listening to radio per week (RADI), total hours spent on watching television per week (TVUS), access to mobile phone (MOBI) and distance to extension service (EXTE). We expect these variables to enhance the ability of farmers to quickly acquire, synthesize and respond to changes, thereby increasing the probability of adoption of EurepGAP adoption.

Access related variables cover access to credit (CRED), access to formal contract (CONT), duration of group membership (GROU), use of irrigation (IRRI), participation in off-farm activities (OFFF), distance to input seller (DIST) and number of years the household has been producing export vegetables (EXPO). Smallholders in Kenya can hardly afford to make the necessary investment to comply with EurepGAP code of practices individually and hence seek to get a certificate under Option 2, which requires farmers to organize themselves in a group. Thus, the stronger and more cohesive the group is, the higher the probability to acquire and analyze information and to implement the protocol.

For the second stage, the impact model, household net-income from export vegetables is taken as a dependent variable. The primary interest is to analyze whether EurepGAP has an effect on the income of the households. Description and descriptive summary of the explanatory variables used in the model are presented in Table 1 below.

Table 1 Here

4.3. Data Source and Sample

To generate the empirical basis for answering the research questions, data collection was conducted at vegetable grower level. A multi-stage sampling procedure was used to select districts, sub-locations and small-scale vegetable producers, respectively. The first stage was to select five districts purposively from two major vegetable producing provinces (namely Nyeri, Kirinyaga, and Murang'a Districts in Central Province and Meru Central

[2] Facility index: $D_{ht} = \Sigma D_{ih} (1-P_i)$ $P_i = n_i/n$
where $G_{ih} = 1$ 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)
Durable goods index: $G_h = \Sigma G_{ih} (1-P_i)$ $P_i = n_i/n$
where $G_{ih} = 1$ if household h possesses durable i; P_i is the probability of having durable good i; n_i = number o households which have durable i; and n = total number of households. The items used to compute the index are refrigerator, sofa set, swing machine, radio, television, bicycle, motorcycle and car. (McCulloch and Ota, 2002)

and Makueni Districts in Eastern Province) based on the intensity of export vegetable production, agro-ecology, types of crop produced and accessibility. These districts represent the major export vegetable producing areas, which according to the current update on the number of smallholders producing for the vegetable export market (Mithöfer et al., 2006), cover approximately half of the share of all smallholder vegetable export producers. Overall, 21 sub-locations[3] were randomly selected from the five districts based on proportional to export vegetable producers size. Lists of all smallholders in export production, which were compiled for that update at the sub-location level (Mithöfer et al., 2006), served as a sampling frame for this study. A total of 439 export vegetables producer households were selected randomly for the interview.

Data collection took place during the 2005/2006 cropping season. The survey was conducted through single visits (re-call survey) and season-long monitoring of household production practices. The data were collected by trained enumerators supervised by the researcher using structured questionnaires, which covered a broad range of socio-economic aspects of the rural life from household composition and asset position to agricultural production and input use. 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 a host of questions related to costs and benefits associated with compliance with EurepGAP standard. The season-long monitoring survey questionnaire primarily focused on inputs and outputs related to export vegetable production. Besides personal interviews, a series of formal and informal farmer group discussions have been conducted to understand the export supply chain and to get more information on the intangible benefits of compliance with the standard.

5. Results

The data analysis is performed in two steps. First a description of the socioeconomic characteristics of the sample of export vegetable producers comparing adopters and non-adopters is presented. Secondly, the results of the regression are discussed.

5.1. Descriptive Statistics

As presented in Table 1 the average age of the farm households in the research area is 45.7 years. The majority of the sampled households are male headed (85%) and on average the household size measured in adult equivalents is 4.36. The average number of female household members of the sample is 2.8 whereas adult members between 14-60 years and children less than 14 years make 3.6 and 1.7, respectively. The highest grade attained by household head is 8.6 and other adult household members except the head 9.6. The average farm size and number of plots owned by households are 3.01 acres and 2.04, respectively and 95% of the total land area owned by the respondents is perceived as fertile land. The average number of tropical livestock units owned is 2.06 and its equivalent monetary value is estimated at 20,884 KSh. The average durable goods index and facility index is 0.86 and 1.21, respectively. Fourteen percent of the respondents participate in off-farm activities, 73% have access to reading printed materials, 87% have access to mobile phone, 95% have access to irrigation water, 34% have adopted EurepGAP protocol and only 17% are EurepGAP certified. The average gross annual income from export vegetables amounts to

[3] Sub-location is the lowest administrative unit in Kenya

33,864 KSh. On average the sample households spent 8.2 hours per week watching their own or neighbors' television and 27.3 hours per week listing a radio. Majority of the sampled households are grower group member with the average years of group membership 2.04 and participation in export production business 4.33 years.

Chi-square and t-test procedures are used for some selected variables as a starting point to compare EurepGAP adopter categories and results are presented in Table 2 and 3. From Table 2 the 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, group member and opinion leadership are statistically significant below the 0.1 level of probability. However, there is no significant difference between the two-adopter categories in terms of use of irrigation water. The result depicts that adopters of EurepGAP have higher levels of access to credit, training, reading printed materials and use of television than the non-adopters. The adopters also consider themselves as opinion leaders, have higher levels of access to mobile phones and are to a higher share a member of grower groups than their counterparts. Those who are a member of a group are 96% EurepGAP adopters and 67% non-adopters while 32% of the adopters and 17% of the non-adopters have access to credit services. Those who had participated in agricultural training are 58% adopters and 43% non-adopters whereas 63% adopters and 47% non-adopters consider themselves as opinion leaders. Those who use television are 64% adopters and 44% non-adopters while 94% of adopters and 84% of the non-adopters have access to mobile phone.

Table 2 Here

From Table 3 the wealth related variables such as land size, tropical livestock units owned, durable goods index, facility index, number of farm machinery owned, and the household characteristics' variables such as education level of the head and other adult household members, dependency ratio, children below 14 years of age and adults between 15-60 years of age 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 use, television use, duration of group membership, number of major training subjects and amount of credit used differ significantly below 0.1 level of probability. However, there is no significant difference between the two groups in terms of some household characteristics variables such as age, number of female household members and household size.

Table 3 Here

The results suggest that EurepGAP adopters have higher level of household members' education, larger land size, more livestock, higher number of farm machinery, higher level of durable good and facility indexes than the non-adopters. The level of participation in grower groups member, amount of credit received, level of training, intensity of television use and duration of mobile use are also significantly higher for EurepGAP adopters compared to their counterpart. As shown in the Table 3, actual mean household net-income from export vegetables is also significantly higher for EurepGAP adopters than for non-adopters.

5.2. Costs and Benefits of EurepGAP Compliance

Implementation of EurepGAP necessitates changes of production practices and/ or investment in infrastructure. This imposes substantial costs on smallholder export farmers. These costs are a major hurdle that has to be overcome especially for small-scale producers in order to achieve the certificate. Our survey estimates approximately 37,000KSh per group member to implement EurepGAP and achieve the certificate, which is approximately 30% of the total annual crop income of the adopters. The main costs (30300 KSh) are for the buildings and facilities that farmers must establish as a pre-condition of implementing the standard. These two cost elements comprise represent the nonrecurring costs: a one-

time investment to set up the implementation. The other 18% (6,700) are the recurring costs of compliance (protective clothing, record keeping, salary for the grader etc). The costs for external auditing, certification, training and soil analysis are not included in the cost calculations since they have so far been met by others, e.g. NGO's and exporter companies. Unlike large-scale farms who can purchase all of the required equipment and facilities within six or seven months (a maximum of one year), small-scale farms cannot afford these costs all at once and hence they tend to prepare for the requirement in two or three years. Indeed many of the smaller producers who decide to adopt the protocol are forced to rely on loans and external support even though some rely on their own financial resources. This result is also supported by Mausch (2007) findings where he found that contracted large-scale farm reaches its break-even point after a year while the contracted smallholder farm needs more than two years to break even.

Beyond the costs, Figure 2 highlights a number of wider benefits from compliance with EurepGAP perceived by the farmers. Smallholder growers who adopted the protocol appreciated highly to be part of a group going through the EurepGAP compliance process. They were assured of markets with buyers who offered the best price as well as timely payment. Many also perceived that implementation of EurepGAP at the farm level increased quality of production and reduced the amount of reject by the buyer. Under EurepGAP, 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 had clearly brought better hygienic conditions at the farm. Growers complying with EurepGAP are proud of the neatness of their farms compared to before compliance. Another perceived benefit is improved bargaining power with their major buyers. Prior to EurepGAP, growers were often price takers and hardly negotiated with their buyers on different marketing arrangements but many farmers confirmed that by complying with EurepGAP they will be in a better position to bargain with their buyers especially on price.

Figure 2 Here

5.3. The Adoption Decision Model Results

To further investigate if the above observed disparity between the adopters' categories affects a farmer's decision to adopt EurepGAP protocol at the farm level, we estimate a probit regression (Table 4) that estimates the predicted probabilities of adoption of EurepGAP protocol by smallholder export vegetable farmers. 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 99.53.

Table 4 Here

Among the statistically significant variables in the adoption model, the coefficient of female household members takes positive sign corroborating our hypothesis. However the number of children below the age of fourteen is negatively associated with the probability of adoption. The status of women in the study area is intimately linked to their labor but also responsibility for the cultivation and preparation of food. Predominantly women are responsible for labor intensive task of planting, weeding and harvesting of the crop, e.g. picking of French beans, thus provide most labor for export vegetable production. Therefore households with more female household members tend more likely to adopt the standard than their counterparts. Even though the coefficient is not significant, young farmers seem more likely to adopt the protocol and take the risk associated with the technology than the older farmers.

Education is a very important determinant of the adoption of new technologies. We hypothesized that the decision whether to adopt EurepGAP or not is not necessarily made by the head of the household alone but also by other educated adult members of the household. Our findings also support this notion. As shown in Table 4, the coefficient value

of education level of the head and other adult household member except the head takes a positive sign and significant indicating the positive effect of intra-household literacy on the adoption decision of EurepGAP. This result shows that, even if the household head is illiterate, the presence of an adult literate person in the family plays a crucial role in increasing the probability of the household to adopt the protocol. This 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 EurepGAP is also positively and strongly related to the level of agricultural training received prior to EurepGAP adoption, which once again indicates the importance of knowledge in the adoption decision.

Land size is negatively associated with EurepGAP adoption, which implies that having less land size has not been a serious constraint to the adoption of practices in the sampled areas. However households with more fertile land seem more likely to adopt the practices compared to their counterparts. Households with relatively big land size in the study area tend to focus more on production of cash crops such as coffee and tea, which requires bigger areas unlike export vegetable crops. As expected, the number of farm machinery and value of livestock variables takes positive sign corroborating our hypothesis. This implies that the higher the capacity of the household to absorb risk and make an investment on additional activities, the greater the likelihood of adopting the protocol. Facility index is another crucial variable that substantially explains the household decision to adopt the protocol. It shows a strong and positive association with the adoption decision.

Contrary to the findings of Okello (2005), we find no evidence that access to extension service increase the likelihood of adoption of the standard. This result sounds counter-intuitive at first sight. Nevertheless, they make more sense if we closely consider the information channels in the export supply chain. Unlike other agricultural innovation, the private sector such as exporter companies and NGOs play a crucial role in disseminating the information concerning EurepGAP. Majority of the exporters in Kenya have got trained technical personnel at the grass root level who provides technical services for the smallholders producing export crops for them. The technical personnel visit the farmers on frequent basis and provide the necessary information and services and hence the role of government extension personnel is very limited related to export crops. However other communication related variables such as radio use and television use increase the likelihood of a farmer adoption decision. Radio is extensively used in the research area and the primary purposes of listening are the news and entertainment features. However there are agricultural programs on television and radio, which could increase awareness about new emerging standards and influence the adoption decision and the more a farmer listens to the radio or watches TV, the more likely h/she is to learn of EurepGAP contribution.

As expected, the coefficients of many access related variables have their hypothesized signs. The variable group membership takes positive sign in line with our hypothesis. This implies that farmers who have been a group member for long years are more likely to adopt EurepGAP standard vis-à-vis farmers with few years of group membership. As discussed in the background, smallholders participating in export vegetable business often organize themselves in a group to deliver their produce to their buyer and apply for EurepGAP certificate. Often, grower groups provide some of the services farmers require to meet the standard and most export farmers affiliated with farmer groups depended on a technical assistant either hired by the group or the buyer (exporter) to meet technical requirement of the standard (e.g. pest scouting, record keeping, pesticide application etc) and hence the dynamics and cohesiveness of the group plays a very crucial role for the implementation of the protocol. In his study Okello (2005) also presented similar results.

Surprisingly, the experience in export production measured by the time period a farmer has produced for export market, has negatively associated with the adoption decision in contrary to our expectation. However, the length of time the farmer has produced with a

formal contract increases the probability of adoption of EurepGAP. The likelihood of adopting the protocol does also seem to increase significantly with use of irrigation. Most export crops are susceptible to water stress especially during pod filling, which results in wrinkles and spots on the pods. Such quality is rejected by most buyers that enforce EurepGAP. The amount of credit does seem to have a positive impact on adoption decision behavior though not significant. Given the required investment to establish the necessary infrastructure to comply with the standard, access to credit service plays a very crucial role in mitigating the financial constraints faced by many smallholders. Participation in off-farm activities is strong and negatively correlated with the adoption decision. This underlines the important role of the opportunity costs of labor for a technology that is labor demanding.

5.4. The Impact Model Results

Net-income from export vegetables significantly differs for adopters and non-adopters of EurepGAP standard. However, while illustrative, a comparison of means can only lead to a definite conclusion in an ideal experimental setting. Unlike controlled experiments, conditions other than the treatment are not equal in farm surveys. Thus, these differences in mean household income cannot necessarily be attributed to adoption of EurepGAP. To measure the financial benefit of adopting the standard, it is necessary to take into account the fact that individuals that adopt EurepGAP might have earned a higher income even if they had not adopted. Hence, to control for this sample selection bias we estimated a separate impact model. Thus, the model examines whether the differences in income between the adopter categories disappear when one takes into account other differences between the households. The results presented in table 5 show that this is not the case.

Table 5 Here

Explanatory variables in the impact model include a dummy for EurepGAP adoption, several indicators of household characteristics (such as age and household size), household assets (such as land size, number of farm machinery, value of livestock, and durable goods index), and participation in off-farm activities. A series of dummy variables for different districts is also included to represent heterogeneity in agro-ecological conditions. Results show that the coefficient associated with the inverse Mill's ratio is not significant, indicating that the correction for selectivity bias is insignificant in this model.

Adoption of EurepGAP standard is strongly and positively associated with household net-income. All other things kept equal adopting EurepGAP protocol results in an increase in net export vegetable income of 5,271 KSh. However, the fact that some small-scale producers benefit significantly from adopting the standard does not necessarily imply the whole sector is better off. The standard's positive impact on poverty and pro-poor development depends on the scale of adoption. According to data from FoodPlus secretariat, the legal body of EurepGAP, by June 2006 about 33 large-scale producers and 10 smallholder farmer groups with 267 members were certified for EurepGAP standard for fruit and vegetables under Option 1 and 2, respectively. The survey on the number of export smallholders conducted in preparation for this survey arrived at about 3,400 smallholders who in September 2005, were in the process of EurepGAP certification in the nine districts surveyed from Central and Eastern Province of Kenya (Mithöfer, 2006). This implies that from September 2005 to June 2006 not much progress was made in terms of increasing smallholder certification and further, taken the approximately 12,000 smallholders in export production, the scale of adoption seems to be rather low for achieving a direct significant impact on whole sector. If we compare this figure with the total number of stallholders involved in export production, the scale of adoption seems to be much lower to bring significant impact on pro-poor rural development.

The age of household head is negatively and strongly associated with the net-income, which suggests that the age of the head poses considerable constraints upon a household's ability to obtain higher income from export vegetables. Age is usually taken as a proxy for

experience and is expected to have a positive impact on income however it is argued that there is a certain threshold of age beyond which the ability of the farmers to take risk and implement new ideas decrease, which might have a negative impact on income. The size of household is positively associated even though the coefficient is not statistically significant. The coefficient of number of crops grown by the household shows that net-income significantly is an increasing function of the diversity of the export crop portfolio. All other things kept equal, an increase of crop number grown by one results in an increase in net export vegetable income of 7,658 KSh. This shows the first highest positive impact on the net-income followed by EurepGAP adoption. The more assets a household owns the higher its net-income could expected to be, but with an exception of the number of farm machinery, other asset related variables such as land size under export vegetables, livestock value and durable goods index are neither strongly nor statistically significantly associated with higher net income. Conversely, participation in off-farm activities is negatively and strongly associated with the net-income. This may be due to the high labor demand required for export vegetable production, which is shared by other off-farm activities and affect the net-income from export vegetables negatively. We also found evidence that agro-ecological and location variation does affect the household net-income from export vegetables. Households from Meru District do earn significant higher net-income than households from other districts with an exception of Makueni. Meru District is situated at higher altitude, which has a favorable environment for beans and peas, i.e. higher productivity, better quality and higher price for their produce compared to the other districts. Makueni District is at a lower altitude and therefore primarily involved in producing Asian vegetables.

6. Conclusions and Policy Implications

The study detailed in this paper indicates that EurepGAP adopters are statistically distinguishable from non-adopters in the principle measures of asset holding and household wealth (quality of land, farm machinery, value of livestock and facility index), access to services (group membership, use of irrigation, access to contract and credit) and household characteristics (labor endowment, educational level and training). This implies that access to information, capital, services and availability of labor are major factors influencing the ability of small-scale producers to adopt the standard and exploit export opportunities for agricultural and food products in developed country markets. These results empirically demonstrate the general argument in the literature that resource poor farmers with limited access to information and services hardly comply with the emerging food-safety standards (Dolan and Humphrey; 2000; Weatherpoon and Reardon, 2003; Okello, 2005).

The results of the impact model indicate that small-scale producers complying with the EurepGAP protocol obtain a significant higher net-income from export vegetable production than non-adopters. Besides the significant improvement in the financial performance, farmers implementing EurepGAP regulation are aware of the non-financial benefits such as more secure and long-term relation with their buyer, continued participation in potentially lucrative export markets, increased awareness of agrochemical handling practices and improvements in general conditions of hygiene and cleanliness at the farm. With respect to benefits from potential spillover effects on domestic production, domestic food safety, farmers' health and the environment no conclusions can so far be drawn and this area requires further research.

Despite the standard's positive impact on the financial performance of the adopters, the impact on the development of the sector depends on its successful adoption by a broad number of producers, which is so far not yet the case in Kenya. The primary message is that poor small-scale producers on themselves are unable to comply with the emerging food-safety standards under the current existing condition. This implies that a significant proportion of the smallholder is likely to be excluded from the lucrative export market.

If it is the policy goal of the Kenyan government to keep smallholders in the export market, the question is at what costs can this be achieved? So far the donors have picked up much of the bill of initial investment for supporting the smallholder in attaining the standards. It is not clear, however, whether they would continue to do so in the future? There is thus a need to assess 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.

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Table 1. Definition of selected variables used in the model (N = 439)

Variable name	Variable definition
Dependent variables	
ADOPTION	EurepGAP adoption dummy
NETINCOME	Net-income from export vegetables (‘000 KSh)
Household characteristics	
AGEH	Age of the household head (yrs)
GEND	Male household head dummy
HHSI	Size of the household (Adult Equivalent)
FEMA	Female household member (numbers)
CHIL	Household members less than 15 years of age
ADUL	Household members between 15-60 years of age
EDU1	Highest grade attained by household head only (yrs)
EDU2	Highest grade attained by other adult household members (yrs)
Asset holding and household wealth	
LAND	Total land size (acres)
LAEX	Land size under export vegetables (acres)
CRNU	Number of export vegetable crops grown
FERT	Proportion of land that is fertile in percentage
LITU	Number of Tropical Livestock Unit owned
LIVES	Value of livestock (‘000 KSh)
MACH	Number of farm machinery owned
FACI	Facility index
DURA	Durable goods index
Communication behavior variables	
TVUS	Television use per week (hrs)
RADI	Radio use per week (hrs)
PRIN	Reading printed materials dummy
TRAI	Number of major training subjects (excluding EurepGAP training) attended in the past three years prior 2005
MOBI	Access to mobile phone use dummy
EXTE	Distance to extension service (km)
Access related variables	
OFFF	Participation in off-farm activities dummy
CERT	Proportion of households who have EurepGAP certificate
CRED	Amount of credit used for the past three years prior 2005 (‘000 KSh)
DIST	Distance to input seller (km)
CONT	Number of years the household has been involved in formal contract
GROU	Number of years the head has been a group member
EXPO	Number of years the head has been participating in export production
IRRI	Irrigation use dummy

Table 2. Chi-square analysis of EurepGAP adopters by some selected variables

	Adopters (N = 149)		Non-adopters (N = 290)		Chi-square [a]	P-value
Variable	**N**	**%**	**N**	**%**		
Gender of household head						
Male	132	88.59	239	82.41	2.868*	0.090
Female	17	11.41	51	17.59		
Participation in off-farm activities						
Yes	14	9.40	47	16.21	3.069*	0.080
No	135	90.60	243	82.79		
Use of television						
Yes	90	64.29	127	44.56	14.616***	0.000
No	50	35.71	158	55.44		
Reading printed materials						
Yes	112	80.00	199	69.82	4.952**	0.026
No	28	20.00	86	30.18		
Access to credit service						
Yes	48	32.21	51	17.59	12.059***	0.001
No	101	67.79	239	82.41		
Participated in agricultural training						
Yes	87	58.39	125	43.10	9.210***	0.000
No	62	41.61	165	56.90		
Access to mobile phone use						
Yes	141	94.63	244	84.14	10.045***	0.002
No	8	5.37	46	15.86		
Group member						
Yes	144	96.64	196	67.59	47.584***	0.000
No	5	3.36	94	32.41		
Opinion leadership						
Yes	89	63.57	134	47.02	10.315***	0.001
No	51	36.43	151	52.98		

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

Table 3. Analysis of t-test for selected variables

Variable	Adopters (N = 149)	Non-adopters (N = 290)	t-stat[a]	P-value
Age of household head (yrs)	45.145	45.883	-0.525	0.599
Dependency ratio	0.591	0.763	-2.371**	0.018
Highest grade attained by household head only (yrs)	9.418	8.231	3.117***	0.002
Highest grade attained by other adult household members (yrs)	9.715	8.136	1.700*	0.094
Size of the household (Adult Equivalent)	4.526	4.291	1.064	0.287
Female household members (number)	2.778	2.612	0.887	0.375
Household members less than 15 years of age	1.316	1.827	-3.017***	0.002
Household members between 15-60 years of age	3.854	3.304	2.286**	0.022
Total land size (acres)	2.702	2.716	-0.964**	0.045
Proportion of land that is fertile (%)	96.929	94.042	1.409	0.159
Number of tropical livestock unit owned	2.262	1.936	1.706*	0.088
Number of farm machinery owned	14.336	8.403	4.805***	0.000
Durable goods index	1.015	0.825	2.476**	0.014
Facility index	1.549	1.044	5.556***	0.000
Net-income from export vegetables (‘000 KSh)	12.275	3.155	5.619***	0.000
Total annual crop income (‘000 KSh)	101.981	70.707	3.700***	0.000
Duration of mobile phone use (yrs)	1.252	0.940	1.779*	0.076
TV use per week (hrs)	11.078	7.220	3.055***	0.002
Radio use per week (hrs)	27.861	26.648	0.672	0.501
Amount of credit used (‘000 KSh)	5.268	3.419	1.134	0.257
Group membership (yrs)	3.258	1.345	7.229***	0.000
Major training subjects (number)	6.871	4.882	4.830***	0.000
Distance to extension service (km)	3.146	2.750	1.209	0.227
Formal contract (yrs)	2.679	2.187	1.677*	0.094

Notes: Dependency ratio = the number of individuals aged below 15 or above 60 divided by the number of individuals aged 15 to 64
The exchange rate at the time of the survey was approximately 72 KSh/$US.
[a] Statistical significance at the 0.01 (***), 0.05 (**) and 0.1 (*) level of probability.

Table 4. Probit estimation of the adoption decision model

Dependent Variable: Dummy for EurepGAP Adoption (ADOPTION)

Variable	Estimated [a] Coefficient	Robust Standard Error	t-value
Household characteristics			
AGEH	-0.0086685	0.007776	-1.11
GEND	0.3807204	0.281860	1.35
EDU1	0.0590389*	0.0310199	1.90
EDU2	0.0418688**	0.0204017	2.05
FEMA	0.1845052***	0.064532	2.86
CHIL	-0.3165243***	0.0730512	-4.11
Asset holding and household wealth			
LIVE	0.0000179***	0.00000662	2.71
LAND	-0.0834754*	0.0505795	-1.65
FERT	0.0106348**	0.0044329	2.40
FACI	0.2778661**	0.1293365	2.15
MACH	0.0261786***	0.0099379	2.63
Communication behavior variables			
TVUS	0.0156500*	0.0085651	1.83
RADI	0.0141094***	0.005164	2.73
TRAI	0.0715265***	0.0247873	2.89
MOBI	0.2741820	0.2080225	1.32
EXTE	0.0565071	0.0352104	1.60
Access related variables			
CRED	7.3100001	0.00000580	1.26
CONT	0.0688753*	0.0355304	1.94
GROU	0.2402460***	0.0508226	4.73
DIST	-0.0874578**	0.0375335	-2.33
IRRI	0.8999331*	0.4811122	1.87
EXPO	-0.0784233***	0.028974	-2.71
OFFF	-0.6982502**	0.2994148	-2.33
CONSTANT	-4.393365***	0.9985857	-4.40
Number of observations	439		
Log pseudo-likelihood	-3947.7521		
Prob > Chi-square	0.0000		
Wald Chi-square	99.53		

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

Table 5. Parameter estimates of the financial impact model

Dependent variable: Net- income from export vegetable production (NETINCOME)

Variable	Estimated [a] Coefficient	Robust Standard Error	t-value
AGEH	-134.4842***	50.38352	-2.67
HHSI	317.8607	347.1996	0.92
LAEX	2257.678	5660.1992	0.48
LIVE	0.0356174	0.0411154	0.87
MACH	89.62331*	54.07188	1.66
CRNU	7658.305***	2918.619	2.62
DURA	-135.58	1220.621	-0.11
OFFF	-2869.691*	1473.968	-1.82
DISTRICT			
MERU (Base)			
KIRINYAGA	-5521.866***	1732.185	-3.19
MURANGA	-4264.873***	1522.137	-2.80
NYERI	2879.357	2083.477	1.38
MAKUENI	4332.62*	2492.018	1.74
ADOPTION	5271.258**	2615.297	2.02
INVERSE MILLS RATIO (IMR)	1409.859	1443.771	1.91
CONSTANT	508.4128	4519.101	0.11

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

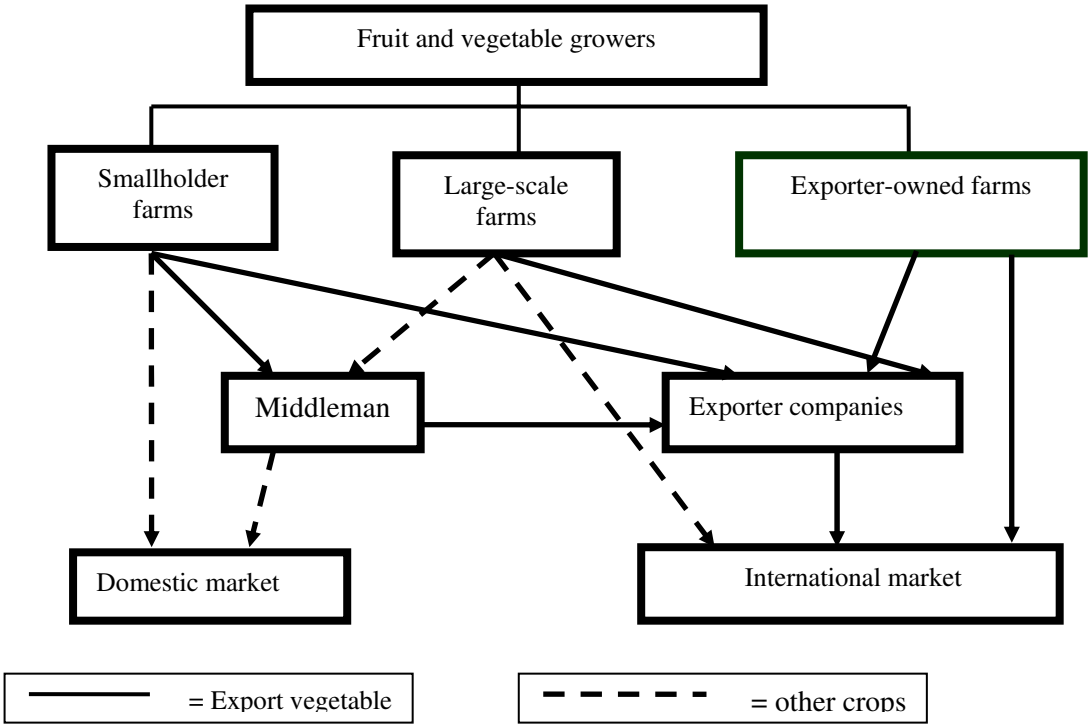

Figure 1: Supply chain of fruits and vegetables in Kenya

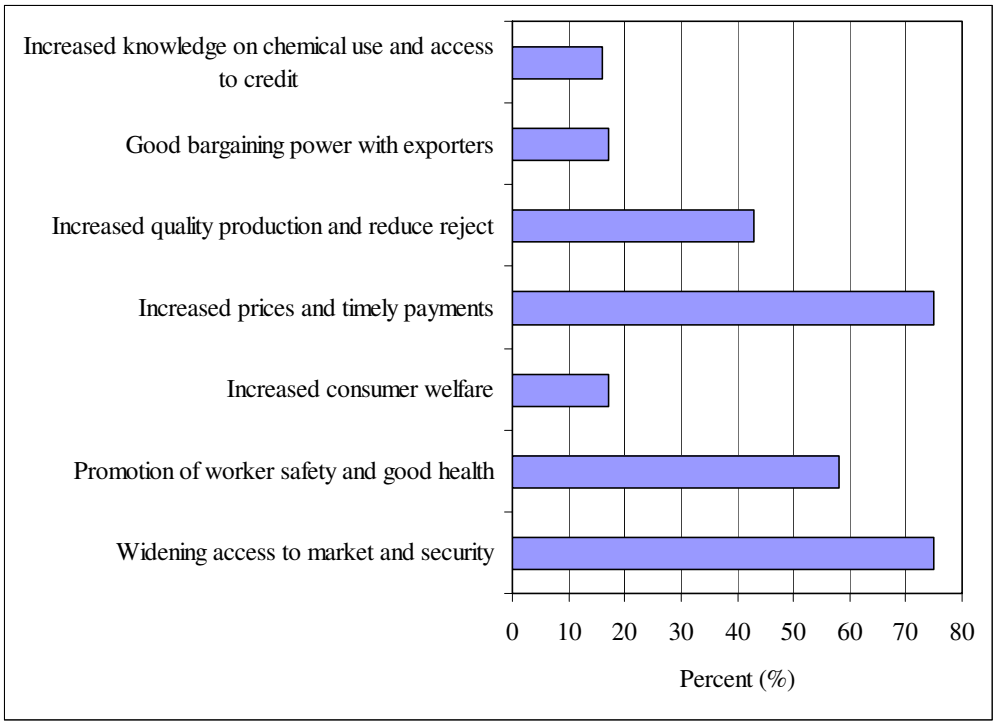

Figure 2: Adopters' perception of benefits of EurepGAP protocol (N=149)

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Contact information

Solomon Asfaw
Leibniz University of Hanover
Faculty of Economics and Management
Königsworther Platz 1, 30167 Hanover, Germany,
E-mail: solomon@ifgb.uni-hannover.de
Tel: +49-511-762-3669
Fax: +49-511-762-2667