KENYA'S DOMESTIC HORTICULTURE SUBSECTOR: WHAT DRIVES COMMERCIALIZATION DECISIONS BY RURAL HOUSEHOLDS?

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ABSTRACT

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Majority of Kenyan smallholder households grow horticultural crops but do not earn a significant portion of their income from the sector. This study uses regional specialization index to estimate commercialization within the regions. The study then looks at the factors driving commercialization by rural households in Kenya. We revisit policy implications of assumptions between simultaneous and sequential usually made to models the decision making process. Does it matter if we model market participation and volume decisions simultaneously or sequentially? Using Tobit, Heckman selection and double hurdle models we compare the two competing hypotheses regarding household-level marketing behavior. A Tobit model assumes that household makes the decision simultaneously. The other two models use two stage procedures where first stage models the household's commercialize choice, and second stage models the intensity. The study concludes that there is a wide variety of Fresh Fruits and Vegetables grown in Kenya and high level of commercialization with low level of regional specialization. Simultaneous and sequential assumptions have non-trivial policy implications. There is evidence of labor and capital constraint among women headed households and younger families. There is need to improve the access to labor saving techniques to female headed households as the top 20% of the growers to increase greater commercialization and specialization.

Dedication

This work is dedicated to my mom (Jenifer) and family. I especially dedicate this work to my mom who took care of me alone when I was young, believed in me, and through her struggles taught me the love of hard work in life. Mom, thank you. To Lilian my dear wife, daughters Kendi and Gakii, I dedicate this work to you, for your love, patience, understanding and support at all times. You allowed me to spend many hours in Cook Hall basement office instead of spending time with you. The completion of this work would not have been possible without your support. Thank you and I dearly love you all. May the face of the Lord shine upon you always!

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CHAPTER 1

Introduction and Problem Statement

The Kenyan economy is heavily dependent on the agricultural sector for foreign exchange earnings, employment, income generation, and food security. The sector contributes 24% of Gross Domestic Product (GDP) and employs over 75% of the population directly or indirectly (CIA, 2008). However, the sector has been in decline in the past two decades.

One of the success stories has been the horticultural industry which has shown a remarkable growth both in the domestic and export markets. Kenya's export horticultural sector grew by 9% per year in the first decade after independence, then 17% per year from 1974-1983 (Minot and Ngigi, 2002). The rapid growth has since slowed, to perhaps 4% per annum over the past decade (Muendo, et al., 2004). Currently the sector ranks second in terms of foreign exchange earnings, displacing the traditional coffee sector.

Despite this remarkable growth, the export sector remains a relatively small part of the overall horticultural system in the country. Over 90% of all fruit and vegetable production is consumed domestically either on the farm or in the domestic markets. The domestic sector accounted for 98% of the total growth in quantity of fruit production and 91% of the total growth in vegetable production between 1992/93 and 2000/01 (Muendo, et al., 2004). For vegetable production in Kenya in 1997-2001 valued at farm gate prices, 36% was retained on the farm, 52% was sold and consumed domestically and 12% was sold for export (Tschirley, et al., 2004) . Domestic shares for fruit are even higher.

The export sector faces major challenges to maintain growth of even 4% per year. New regulations in international horticultural trade and intense competition are redefining the marketing system. Exporters work with fewer small-scale farmers who can meet the stringent health and traceability requirements. Therefore, even if the growth in the export sector was to continue at the current rate or even better there is general agreement among most researchers that the level of exports originating from small-scale farmer will continue to fall. Already there are estimates that the share has fallen from a high of 75% in the early 1990s (Harris, 2001) to 27% for fresh vegetables and 85% for fresh fruits, for an overall 47% share of total exports (Minot and Ngigi, 2002).

The population in Kenya was estimated to be 35.5 million in 2005, with an urban population of 10.4 million. Current population growth rates are about 3.99% and negative 2.29% in urban and rural areas, respectively, with urban population expected to reach 24.1 percent by 2015 from estimates of 20.7% as at 2005 (UNdata, 2008, United-Nations, 2008). The rural:urban population ration will change from about 3.8:1 in 2005 to about 3:1 in 2015. With urbanization rates of 4%, domestic urban demand will grow by at least 4% per year and probably more. Urbanization with growing incomes[1] is associated with more focus on healthy food choices and particularly fruits and vegetables. The high-income elasticity of demand for fruits and some vegetables means that total growth in demand could be large. When this is combined with falling rural populations, then growth in demand *per farmer* could increase by about 50% in the next decade.

Any growth in the domestic horticultural industry is likely to affect poverty in different ways in rural and urban areas, and the impact will vary from one rural area to another. The urban areas will benefit from domestic horticulture mainly by provision of jobs to the low-income earners and particularly the women who are the

[1] Kenya GDP growth rate as per 2007 was 7% per annum.

major retailers of the produce in retail markets, in the streets and the traditional grocery stores. Consumers will also benefit from affordable high quality produce available all the year round, which could lead to better nutrition. We expect the demand in urban areas to increase by at least 50%, which will benefit rural horticultural farmer with increased reliable income, improved food security, and better nutrition for the household. Each rural farmer might be required to feed at least one and half of the individuals they currently feed.

However, for this impact on poverty to be realized then local marketing systems must be improved and smallholder farmers should be assisted to respond to this potential growth. In absence of these improvements in the sector, there is a danger of large scale farmers exploiting all the gains. Therefore there is need to identify the driving forces of commercialization within the sector and possible areas of interventions. We need to understand how declining number of farmers will meet rapidly growing urban demand. Satisfying this demand will require higher productivity throughout the supply chain. This study seeks to empirically determine the level of horticulture commercialization, and the factors associated with a farmer becoming a commercial producer. This study will therefore look at these factors in view to identifying the bottlenecks and how to target improvement policies.

Research objectives

The main objective of this study is to describe the pattern and level of horticultural commercialization in Kenya and identify the impediments to greater commercialization. The specific objectives include:

1. Identify the factors driving horticultural commercialization in the areas of study
2. Investigate regional specialization in horticultural production
3. Identify policy mechanisms and investment strategies to enhance farmers' participation in commercial horticulture
4. Demonstrate the importance of assumptions made in modeling with policy implications

CHAPTER 2

LITERATURE REVIEW

The Impacts of Commercialization

Past studies of commercialization of subsistence agriculture among rural households have had mixed results. Critics of commercialization argued that small farms would be left out of the commercialization process and would be unable to compete with increased market competition and prices falling. One argument has been that in order to grow cash crops for the market, smallholder farmers have to forego growing some traditional food crops. That would lead to increased dependence on purchased foods exposing them to greater food security risk due to volatility in the food prices and uncertain cash crop incomes. The other argument is that men typically grow cash crops and any increased income would be reallocation of resources from women and children to men affecting adversely their nutritional position (Dinham, 1983).

Where cash crop farming has been carried out mainly by large-scale farmers using labor saving, capital-intensive techniques, and where farmers spend much of their additional income on goods produced outside the locality, the impact on poverty and hunger has been less marked. This is well illustrated by the experiences of Brazil and Mexico in the 1990s, when progress in agriculture was typically concentrated amongst farmers with capital to invest who were well placed in the emerging marketing chains. This type of growth did little to reduce hunger and poverty as most smallholders became marginalized (David, 2000).

In a broad review of the literature, Von Braun (1995) argues that the large number of studies claiming that commercialization of agriculture has mainly negative effects on the welfare of the poor were conceptually flawed, relied on potentially biased samples, and ignored confounding factors that influence welfare. Summarizing several studies where households had recently switched from subsistence farming to a more commercialized system, Von Braun found that with few exceptions commercialization of agriculture benefited the poor directly by generating employment and increasing agricultural labor productivity. Both the commercialized households and the households that provide labor to them achieve increased incomes. Where commercialization had negative impacts, it was due to poor property rights polices and not due to the impact of the cash crops.

Evidence from studies in other parts of Africa shows that farm incomes and productivity can benefit from cash-crop farming in conjunction with well-developed input and produce marketing channels (Dione, 1989, Dorward, 1988, Goetz, 1993, Kelly, 1996, Poultron, 1998). Govereh and Jayne (1999) in their study on the effect of cotton commercialization in Zimbabwe found that farmers who participated in commercial cotton farming had higher gross per capita income than non-participating farmers. This finding was consistent with past studies on agricultural commercialization (Strasberg, et al., 1999, Von Braun and Kennedy, 1994). Von Braun (1995) however cautions that, while commercialization by itself rarely has adverse consequences on rural households' welfare, when combined with institutional failure it can be detrimental. There are cases where farmers have invested in cash crops and put most of their land into crops like coffee and tea. If for any reason the cash crop cannot be marketed effectively, this has had negative impacts on the farmers' welfare. In many parts of central and eastern Kenya, farmers have put most of their land into coffee production. Collapse of world coffee markets, coupled with ineffective cooperative societies management, has resulted in many families losing their food and income security resulting in substantial loss of welfare. In these cases, failure of the cash crop to improve welfare is due to failure of other supporting institutional mechanisms.

In general, horticultural producers in the rural areas market their produce in the local domestic markets. Therefore, production of horticultural crops has the potential to contribute to commercialization of the rural economy, characterized by increased trade and marketing. Past studies have found that commercialization stimulates the rural economy and contributes to the growth and development process (Pingali and Rosegrant, 1995, Von Braun, 1995). Commercialization benefits the rural and urban areas by generation of employment and increasing agricultural productivity. However, production of horticultural crops is often more risky, because these crops are much more costly to produce per hectare than traditional crops, and because yields and prices are more volatile than for staple crops (Key and Runsten, 1999). Rural farmers need support by an enabling institutional environment, such as access to credit, technical skills and capital and more important with access to market price information.

Diversification

There is now a widespread recognition that rural smallholder households receive their income from a diverse portfolio of activities. Households pursue a diversification strategy, where diversification is defined as the presence of multiple income-generating activities, both on- and off the farm, within the household's economic portfolio.

Previous literature identifies two sets of determinants of diversification, namely push, and pull factors. Push factors are related to crop risk, where farmers diversify into food crops, cash crops, and non-crop production as well as off-farm activities to protect against weather- or pest-induced falls in cropping income. Returns from non-crop activities are often not strongly correlated with cropping returns, and returns to different crops are not perfectly correlated. Therefore, an income portfolio spread across crops and other sectors mitigates risk (Reardon, et al., 1994).

"Pull factors" leading to commercialization include realization of strategic complementarities between activities, such as crop-livestock integration or milling and hog production, and specialization according to comparative advantage accorded by superior technologies, skills or endowments (Reardon, et al., 2001). Terms of trade between agriculture and non-agriculture, migration opportunities and local non-farm opportunities in backward and forward linkages with agriculture are identified as other important pull factors (Benfica, 1998).

Farm diversification in Africa has been shown to be adjustment to fundamental changes in price relationships. This has been due to declines in price of the traditional export crops like coffee and sugarcane during the 1980s and phasing out of the many traditional subsidies at farm level during structural adjustments (Delgado and Siamwalla, 1997, Hussain, 1994). These forces in an open economy should increase the farmer's tendency to engage in production of non-traditional agricultural cash crops such as horticulture. However, fewer than 15% of African farmers are involved in production of these crops for commercial purposes (Jaffee, 1995 , Little and Watts, 1994).

This tendency towards diversification by smallholder farmers raises the question of why some farmers diversify and commercialize while others diversify but do not commercialize. Part of the explanation could be the proximity to certain infrastructure like water for irrigation, good communication or good markets as well as other non-price incentives (Lele and Christiansen, 1989). Livelihood diversity results in complex interactions with poverty, income distribution, farm productivity, environmental conservation and gender relations. The impact of diversity on a household's welfare brought about by this complex relationship is not straight forward, and can be contradictory between alternative pieces of case study evidence (Ellis, 1999).

Studies conducted in Sub-Saharan Africa have found a strong positive relationship between total household income and the share of off-farm income in total income (Collier and Lal, 1986, Reardon, et al., 1994, Reardon, et al., 1994, Tschirley and Benfica, 2002). This explains the reason that policies in many African countries have focused on promotion of both off-farm activities as well as farm level diversification in tradable non-traditional crops that are at least different from traditional agricultural commodity exports (Delgado and Siamwalla, 1997). In cases where a household relies on an export commodity only, when prices are depressed they have found themselves with very little to fall back to. For instance, the coffee sector in Kenya has been an important income earner for both the government and farmers in the past three decades. At the peak of the industry, many farmers dedicated most of their land to coffee production and relied on the income to buy foodstuffs. Coffee prices have been depressed for the better part of the last decade, causing farmers to search for alternative sources of income. Diversifying into other non-traditional cash crops could reduce their reliance on the unpredictable incomes from these sectors and help mitigate their risk exposure.

In Kenya, the major emphasis in the past has been to promote cash crops for export. From independence, many areas were encouraged to grow crops like coffee, tea, and pyrethrum. However, over the last two decades, smallholder production of non-traditional export crops such as horticultural crops has grown much more rapidly than production of traditional exports. Promotion of domestically marketed non-traditional crops has not received lots of attention, though it has been shown that there is a growing market for most horticultural products, which in some cases cannot be met by local production (Muendo and Tschirley, 2004a, Tschirley and Muendo, 2004b; Muendo and Tschirley, 2004c).

Kenyan Horticulture

The literature on Kenyan horticulture falls into three categories. Treatment of various aspects of the export horticulture success story is by far the largest set of literature. Examination of the current status and likely impacts of Kenyan supermarkets on the domestic system has also received some attention; and third is a broader treatment of the domestic production and marketing system. Each of these sections will be briefly addressed in the next paragraphs.

Export horticulture: Most of the studies conducted in the Kenyan horticultural sector have focused on export horticulture due to its importance as a foreign exchange earner. They have looked at either the supply chain or the effect of the consolidation of European and UK supermarkets on the export production sub-sector (Dolan, et al., 1999, Dolan, 2001, Dolan, 2002, Harris, 2001, Jaffee, 2003, Kamau, 2001). Mculloch and Ota (2002) have looked at the contribution of export horticulture towards poverty reduction in Kenya. The study find linkages between export horticulture and poverty reduction and find that households involved in export horticulture in any way are better off than those not involved. However, they caution interpretation of the results since it is not clear if the higher incomes are due to being involved in horticulture or the households are involved in horticulture because they have characteristics associated with higher incomes.

The need for quality and traceability has led to increased use of contract farming for export horticulture serving primarily the United Kingdom supermarkets. This has dictated much tighter supply chain control and some marginalization of the small-scale farmer from the export market (Hazel, et al., 1999). Hazel *et al*. have investigated the links between UK retailers and Kenyan producers using the concept of the marketing chain. Two major chains are identified, wholesale and supermarket. While these chains have no direct investment in Kenya, the supermarkets control production through intermediaries who ensure that standards of quality and presentation are met. Importers play a crucial role in facilitating this trade, acting as a link between farmers and exporters in Kenya and supermarkets in the UK. The need for quality and traceability dictates that contractual arrangements are made predominantly with large-scale farms.

Minot and Ngigi (2002) in their study of Kenya and Cote D'Ivoire came to a similar conclusion as Hazel *et. al*. (1999). In spite of the rapid growth of the export horticultural sector in Kenya, they see a trend toward consolidation, in which small farmers are gradually being squeezed out. The argument is that increasing concentration in European retail markets and rising concern over environmental and labor conditions at the farm-level are pushing exporters to work with larger farmers, who can more easily document their production practices (Dolan, et al., 1999). Second, it is not clear whether trade liberalization under the World Trade Organization will benefit African horticultural exporters, by further opening European markets, or hurt them by eroding some of the preferential access to the European market that they currently enjoy (Steven and Kennan, 1999). And third, the fact that small farmers produce most of the exported fruits and vegetables certainly suggests a poverty reducing impact, but it is difficult to make any definitive statement without better information on the number of beneficiaries, the characteristics of the growers, and the size of the gains. Stevens and Kennan (1999) in their analysis have found Kenya is most likely going to face greater competition from Egypt, South Africa, Chile, Brazil, and Thailand, if the EU liberalizes imports after the expiry of the current preferential treatment through Lome Convention agreement by 2008. There is indication that Kenya has lost out to Cote d'Ivoire on pineapple exports to Europe and finds it difficult to compete with South Africa on avocados.

Supermarkets: Increasing attention is being paid to the supermarket sector in Kenya due to its fast growth in urban centers. Research attention on this sector of the economy focuses on the resulting structural transformation they could effect on the food industry. Recent studies estimate that supermarkets chains have a 2% (Tschirley *et. al*. 2004) to 4% (Neven and Reardon, 2004) share of the overall urban market for domestic fresh fruits and vegetables (FFV). In terms of tonnage, supermarkets in 2004 sold about the same volumes as were exported, about 55,000 tons compared to 69,000 tons of export. Estimates indicate the sector is growing at about 5% per annum. This growth is driven by the rapid urbanization in Kenya, which is double the rate of overall population growth. Therefore, as the urban population share increases from the current estimates of 35% to a higher level coupled with the expected growth in the economy due to current economic reforms, the role of supermarkets is likely to grow.

Nevertheless, Tschirley *et al*., (2004) in their report volume II and Tschirley et. al. (2004) policy paper suggest that small-scale farmers will continue to play the most important role in domestic horticultural production and trade up to the near future for the following reasons: i) Their study reveals that "fewer than one shilling in

20 (4%) in Nairobi is spent in supermarket chains, and essentially all of these expenditures come from the wealthiest 20% of consumers; the bottom 80% of consumers spend 99 out of every 100 FFV shillings in open air markets, kiosks, or other traditional outlets" (Tschirley, 2004). ii) Looking at the growth pattern of the supermarkets in Latin America and South Africa where supermarkets have had a similar growth pattern, they conclude that traditional market outlets will maintain a very large market shares in FFV for the foreseeable future. This is based on evidence from these countries with a higher per capita income and much bigger urbanized population. Iii) The other even more compelling reason is that for supermarket to be a strong alternative to the local outlets there must be effective demand for the type of produce they supply at the prices they charge. This can be as a result of rapid income growth in the urban centers. Though incomes might grow, the growth is likely to be at a modest rate. Growth in income must also be accompanied with reliable power supply. Currently even middle-income earners will prefer to buy fresh vegetables regularly because refrigeration is not feasible with frequent power outages. Therefore, although the supermarket-marketing channel is important, Kenyans will continue to rely on other marketing channels for the bulk of their perishable produce for many years to come.

Domestic market: Some recent studies have concentrated on the impact of grades and standards in the food sector in Kenya and how small-scale farmers and large commercial farmers are changing to comply with the new trends in the market (Reardon, et al., 2001). Other studies have looked at the domestic horticulture sector by doing a sub sector analysis. Dijkstra (1997) concludes that the evolution of rural assembly markets for horticultural commodities can be explained in terms of efficiency developments. They evolve in production areas with relatively poor farm accessibility and low supply concentration. Assembly markets reduce transport and/or information costs of suppliers and buyers. The most recent studies are by Kavoi and Tschirley (2004) volume I, Tschirley and Kavoi (2004) volume II and (2004) volume III which are organized in three volumes that focuses on the domestic industry situation and its competitiveness in the East African region. In their first volume Kavoi and Tschirley (2004)*volume I,* find that production and yields of fruits have stagnated over the past decade with the exception of bananas, mangoes, pineapples, avocadoes and passion fruits. Vegetable production level has been mixed with some trending upwards while other being stagnant. They find a high level of concentration in sales, with 15% of rural households accounting for 80% of all horticultural sales. In their second volume, Tschirley and Kavoi *(2004*) concentrate on horticultural marketing and conclude that the domestic market continues to absorb about 4 to 5 times more produce by value than the export market. The third volume Kavoi and Tschirley *(2004*) explores horticultural research and regulatory system for inputs. The report shows that there is room for improvement in terms of horticultural seed improvement regulations in Kenya. They have also shown the relative importance of domestic horticulture to the economy and that Kenya is slowly facing competition from the regional markets on bananas, citrus and onions.

Though the horticultural sector in Kenya is extensively studied, it is clear that the bulk of the studies concentrate on the export sector. Kavoi *et al*. (2004), Tschirley *et al*. (2004) work reveals that more work still needs to be done on the domestic horticultural sector. Their finding that over 90% of the farmers grow some horticulture and 70% sell some of it yet few earn significant amount of their income from horticulture sales is an important finding. Any intervention to improve this sector then has multiplicative effect on other sectors. However, income share of horticulture even from the top 20% of sellers is only 22% compared to 24% for off-farm work (Kavoi and Tschirley, 2004). With such a percentage of rural farmers growing and selling horticultural crops, we would expect it to contribute a bigger share of their household income. This study will attempt to add to the literature addressing the small-scale sector not involved in the export market. If the farmers are to be encouraged to diversify and commercialize further into this fast growing sector then we need to understand factors that drive commercialization for some households while others grow for subsistence use only. This study therefore looks at the nature of horticulture commercialization and factors affecting decisions to commercialize.

CHAPTER 3

Commercialization theory

Under rational expectation theory of the firm, producers choose their production mix with the main objective of maximizing profit (Feder, 1985, McConnell, 1983). The key premise is that changing of relative output prices influences the relative returns to resource activities. These returns influence the type of crops to produce. Therefore, output prices are considered as potentially instrumental as an incentive for a farmer to invest in a particular activity (Reardon and Vosit, 1995, Reardon and Vosit, 1997).

We can represent a farmers' problem as that of profit maximization subject to the constraint of market prices, technology and market size. We describe this problem as follows:

$$\begin{aligned} &Max\ \Pi_{it} = P*Y_{it} - (r*K_t + w*L_t + nM) \\ &s.t. \\ &Y = f(K, L, M) \end{aligned} \qquad (1)$$

Where Y is vector of production, P is vector of prices, M is wealth endowment, K is the capital goods, L is labor, nM is the market size.

In this optimization problem, the profit equation represents the objective function and the production function represents the constraint. The firm must determine the appropriate input output combination as defined by this constraint in the attempt to maximize profits.

However rational expectation approach where a farmer invests in production for the sole purpose of maximizing profit can be considered as a narrow perspective of describing farmers' behavior. A farmer has other objectives apart from maximizing profit. A farmer is both a producer and a consumer (Sadoulet, 1995) and may maximize utility but not necessarily maximize profits at the same time.

With the assumption that utility maximization aptly describes a farmer's decision-making process, we look at a utility maximization framework. Despite its failure to identify the psychological processes that determine preferences, the framework is considered to be less restrictive than profit maximization approach (Lynne, 1988). The perspective of farmer decision based on utility maximization assumes that an individual is able to order practices according to level of preference, subject to the constraints given by the availability of resources. The optimization problem facing the consumer can be stated as:

$$\begin{aligned} &Max\, U(Y_i) \\ &s.t. \\ &P_i Y_i \leq M \end{aligned} \tag{2}$$

where Y now is a vector of consumption goods, P is vector of market prices, and M is the wealth endowment

Paramount in preference-based utility is the notion that individuals are the best judges of what is good for them. This assumption has been criticized, on information grounds, that individuals do not always know what is best for them. Their action may not truly reflect what is in their best interest (Perman, 2003). In view of this, some recent theories on the role of information in adoption of technology have used models in which learning is based on the profitability of the preceding period (Ellison, 1993), and information nearness (Marra, 2001).

Since smallholder horticultural farmer commercialization does not neatly fit into any of the two models, we considered it to fit into the general income, investment, and consumption strategy of the farm household. Then the policy framework under which the household makes a decision influences the decisions. This framework features three key issues for consideration: a farm household is an investor, a consumer, and at the same time is subject to policy and physical factors. This scenario implies that the salient features of utility and profit functions have a place in the incentive and capacity conceptual framework.

Modeling commercialization

Rural households make decisions with a motivation of increasing their income as well as improving their food security among other unobserved driving factors. However, what is observed is their income generating and food security decisions. Therefore, to model the farmer's commercialization decisions the first step is to analyze rural household income sources. If a household has diversified sources of income, their decision to include horticulture in the product mix will depend on the relative profitability of each of the enterprises and its contribution to food security. And if any other competing enterprise has a higher expected return than horticultural crops or is less risky then there is higher likelihood that it will be chosen.

$$E_t[U(horticulture)] \geq E_t[U(challenger)] \tag{3}$$

Equation (3) must hold for a farmer to invest in commercial horticulture.

If we further assume that households make sequential decisions then we can model commercialization as a dynamic process:

$$\begin{aligned} &\underset{C_s, I_s}{Max}\ E_s\left\{\sum_{s=t}^{\infty} B^{s-t} U(C_s) \mid Z_s\right\} \\ &s.t. \\ &W_{s+1} = RW_s + f(Y_s) - C_s - I \\ &K_{s+1} = I + (1-\delta)K_s \end{aligned} \tag{4}$$

where E is the expectation operator, t is time subscript, B is the household discount factor, W is the household wealth, U denotes utility derived by the household, C is consumption decision of the household, R is the rate of returns to investment (1+r), I is the investment in horticultural assets, K is the productive assets allocated to horticultural production. Y is the amount produced whereas *f* is a function denoting the production technology employed and Z are shock factors. Market participation choices are made only in s=0 and sales volume decisions are made only in s = 1. For a simultaneous decision making process, s is only equal to zero.

The farmer is assumed to maximize her/his expected utility and income that are influenced by exogenous factors in resource allocation. A farmer is endowed with capital, labor, and land. To minimize risks and utilize any opportunities available, each individual farmer will then allocate resources depending on her circumstances and prevailing policy framework.

Methods of Analysis

The analysis is divided into several sections as follows:

- Determination of horticultural commercialization index. This is used to understand the extent of commercialization of horticulture in various regions.
- Determination of regional specialization in horticultural production in various districts or ecological zones. This index indicates the potential for interregional trade.
- Econometric models to explain the decision to commercialize and the intensity of commercialization.

DATA USED

The data used in this study is cross-section rural household survey data from Kenya that was conducted for two years (1997 and 2000) on the same households. Egerton University/Tegemeo Institute of Agricultural Policy and Development (TEGEMEO), Nairobi, Kenya and Michigan State University, East Lansing, USA collected the data.

SAMPLE DESIGN AND SELECTION

The sample was based on proportional sampling based on population. Census data was used to find the populations of all non-urban divisions in the country. The populations in all these divisions were assigned to one or more agro-ecological zones (AEZ) based on secondary data and in-house experience. This process resulted in dividing Kenya's rural population into its make up by AEZ. Within each AEZ, two or three divisions were chosen based on their importance (population) within their AEZ. Diversity in cropping patterns was allowed to influence the selection of divisions where it was not clear which divisions to choose. These divisions fell within 24 districts. The divisions were regrouped into the 9 agro-regional zones a hybrid of broad agro-ecological zones, administrative and political boundaries presented in Table 3a.

A team of researchers visited the selected divisions in order to select locations, sub-locations, and villages in which the survey was to be conducted. This was normally done through a blind equal chance ballot where a local official, usually the District Officer or District Agricultural Extension Officer helped choose the location, the Chief helped choose the sub-locations and Assistant chiefs chose the villages. The process of choosing households was a little more tedious but followed a similar pattern. Where a list of all the households was available (e.g. in famine relief areas) this list was used. Where other lists were available, e.g. coffee societies, those were used (but ultimately discarded due to bias, not all households grow coffee, and co-operative members tended to be older members of the community).

Most commonly, the team would get together a group of community members and list all households in the village. Extra care was taken that e.g. households of unmarried mothers and widows were included. The resulting list was divided by the number of households required. This gave us a step between households in the list. Balloting was used to determine at what position in the list the selection would begin, then e.g., every 5th house would be chosen for interview. Appointments were made immediately but followed up through some local link person two weeks in advance of the visit.

Implementing the Survey

The actual administration of a survey of 1,540 households is a major organizational and logistical operation. A team of 25 enumerators organized in 4 teams each led by a supervisor administered the questionnaire. The enumerators were hired from the recently graduated class in Agricultural Economics and Agri-Business Management of Egerton University. The supervisors were Tegemeo research assistants. All undertook a period of training that involved understanding the questionnaire in English, Kiswahili and, where possible, the local language in the areas they would be operating. The enumerators were grouped to reflect the different languages spoken in different regions of the country.

Once the instrument was understood by all in the same way, and each question could be asked to elicit the required response from the respondents, the team went out on a series of pre-tests where all involved had several chances to try out the questionnaire on farmers. The iterative process of pre-test and office based trouble shooting was important to minimizing enumerator based errors in data collection, through misunderstanding the question, asking it in the wrong way, or being misunderstood by the respondent. Each evening the teams and their supervisor would go over the filled questionnaires looking out for such problems. The 4 teams of supervisor, 6 enumerators, driver and 4-wheel drive vehicle averaged about 13 interviews per day over a period of six weeks. Each interview took anywhere from one and a quarter to two and a half hours.

Table 3-a: The Sample

Zone	District	% of Population	Households sampled	Total
Northern Arid	Garissa	2.6	20	40
	Turkana		20	
Coastal Lowlands	Kilifi	5.19	54	80
	Kwale		26	
Eastern Lowlands	Taita Taveta	10.78	11	166
	Kitui		21	
	Machakos		22	
	Makueni		77	
	Mwingi		35	
Western Lowlands	Kisumu	12.21	111	188
	Siaya		77	
Western transition	Bungoma (Kandunyi)		50	172
	Kakamega (Kabras, Mumias)		122	
HP Maize zone	Bungoma (Kimilili, Tonageren)	26.69	39	411
	Kakamega (Lugari)		28	
	Bomet		43	
	Nakuru		114	
	Narok		25	
	Trans-Nzoia		61	
	Uasin-Gichu		101	
Western Highlands	Vihiga	10.3	64	156
	Kisii		92	
Central Highlands	Murang'a	17.4	74	268
	Nyeri		107	
	Meru		87	
Marginal rain shadow	Laikipia	3.83	59	59

Argwings-Kodhek et al (1998)

The same households interviewed in 1997 were interviewed in the 2000 survey with added households due to attrition.

Analytical Modeling

Horticulture Commercialization Index

Horticulture commercialization index (HCI) is defined as the proportion of a household's horticultural production that is marketed:

HCI = [*gross value of horticulture crop sales* *hh i, year j* /*gross value of total horticultural production* *hh i, year j*]* 100. (5)

This index measures the extent to which household horticultural production is oriented toward the market (Strasberg, et. *.al, 1999)*. A value of zero would signify a totally subsistence-oriented household; the closer the index is to 100, the higher the degree of commercialization. The index captures the variation in terms of the intensity of horticulture commercialization across the sample by region (agriculture production zones). Households were divided into four categories: those households not growing horticultural crops, and three groups of equal size according to their HCI.

Regional Specialization in Horticulture Production

Differences in horticulture production across regions were explored further by determining the extent of regional specialization in horticultural production. Following Kalemli-Ozcan et .al.(2001), an index of regional specialization can be defined as:

$$Spec_i = \left[\sum_{s=1}^{S} abs \left(\frac{V_{ij}}{V_j} - \frac{1}{j-1} \sum_{j \neq i} \frac{V_{ik}}{V_k} \right) \right] * \frac{1}{2} \qquad (6)$$

where V_{ij} is the value of horticultural production in category i for region j and V_j is the total value of horticulture production for region j. Similarly, V_{ik} is the value of horticulture production in category i for region k and V_k is the total value of horticulture production for region k.

The index is calculated for each region for 1997 and 2000. The index measures the gap between the vectors of horticultural crops shares in region i, and the vector of shares in the other six regions. If regions horticultural structure is identical to that of the other regions, it is completely unspecialized, and the index is equal to zero. At the other end of the spectrum, if region's structure is entirely different from other regions, the index is equal to 1 (because each share of the category in each region will be counted in full). Therefore, the index is a rough way of quantifying differences in structures and hence regional specialization. More insights are obtained by disaggregating horticulture crops into finer categories. For instance the specialization index can be calculated for the top five most valuable and most widely grown fruits and vegetables.

The index of regional specialization across the years will measure the movement towards regional comparative advantage in horticulture production. Slow movement toward regional specialization may be an indication of interregional barriers that could prevent inter-regional trade. These barriers could be due to high transaction costs, poor information flow between regions and poor infrastructure. Alternatively, there may be direct policy barriers or barriers that arise from rent-seeking behavior by police seeking bribes and excessive local authority taxes.

After getting some insights from the two indexes, we turn now to econometric analysis techniques that have more powerful statistical power. In this section then we will use four different tools: linear, tobit, Heckman sample selection, and double hurdle models. We use these tools to test for robustness of our model and to emphasize the impact of different assumptions usually made in tool choice about producer decision-making processes.

Estimation Strategies

Linear model

If households are assumed to maximize their overall returns from all activities then it is possible to characterize their horticultural income as being derived from an aggregate production function in which household characteristics as well as environment are the key factors of production. Therefore it is possible to specify a reduced form expression for income as a function of these explanatory variables in a traditional Mincerian wage equation (McCulloch and Ota, 2002). The aim of the model is to explain the reported value of sales of different households taking into account all the possible differences in household characteristics, location factors, and infrastructure availability.

A linear model is formulated as:

$$y = f(D, A, G, CC, FS, S) \tag{7}$$

Where: *y,* is household horticultural sales and other dependent variables defined in models for participation in horticulture commercialization decisions. D is all demographic characteristics used in the study. A, are the assets both general and for irrigation. G, are local geographical characteristics. CC, are cash crops grown by the households. FS are food security variables used in the models to measure the extent of food security. S, are the government services provided like extension services and infrastructure in any locality in the study.

Initially a linear regression analysis was used to account for the variations in the amount of sales each household sells to the market. Using a linear regression preserves all the variations in the model and acts as a basis for comparison with other models used. We use robust regression due to the inherent nature of biasness introduced by the presence of outliers in sales data. As mentioned earlier horticulture sales are highly concentrated with 24% of all the growers not selling anything whereas 20% of all the sellers contribute nearly 80% of the total sales (Kavoi and Tschirley, 2004).

There are cases of some household with very high sales volumes while others have negligible amounts. These outliers then affect the results of the linear regression. Therefore following work done by Berk (1990), Rousseeuw and Leroy (1987), Hamilton (1992), Huber (1964) and Beaton and Tukey (1974) iterative regression is used where weights are calculated based on absolute residuals and regression using those weights. Weights based on one of two weights functions, Huber weights, and biweights, are used until convergence and then based on that results biweights are used until convergence. Both weights are used because Huber weights have problems dealing with severe outliers, while biweights sometimes fail to converge or have multiple solutions. The initial Huber weights improve the behavior of the biweight estimator (Manual, 2003).

Tobit Model

The standard ordinary least squares regression model may not be appropriate to use in our case since we have 526 zeros (24%) in the sales variables which is the dependent variable. Zero arises when a farmer who grows horticultural crops does not report any sales. This could be due to a number of reasons. An individual may have grown very little and so used it only for home consumption, while another household is due to thin markets.

One approach to model the problem is to use the well-known Tobit model. However, Tobit interprets all the zero observations as corner solution. That is, the household is assumed a seller of horticulture with a zero outcome. Tobit model also assumes that both the decision to commercialize and the level of commercialization are determined by the same variables and those variables that increase the probability of commercialization also increases the amount of sales. In other words, the decision to commercialize and the intensity of commercialization are jointly determined. Because one of our objectives is to illustrate the impact of assumptions made before choice of estimation model, the study will employ Tobit model as one of the commonly used models. In this case, the assumptions will be that the decisions are jointly made.

The Fundamental Equation as found in Wooldridge (2002):

$$\begin{aligned} y_i^* &= x_i\beta + \mu_i, \quad \mu_i \sim N(0,\sigma^2), \\ y_i &= y_i^*, \qquad\quad if \quad y_i^* > 0, \\ y_i &= 0, \qquad\quad\; if \quad y_i^* \le 0. \end{aligned} \tag{8}$$

where: y_i^* is the observed value of horticultural sales which can take the value of zero or a continuous value above zero, x_i is a vector of factors explaining the value of the dependent variable.

The log-likelihood function for the Tobit model is

$$\ln L = \sum_0 \ln \Phi(-x_i\beta/\sigma) + \sum_+ \ln\left\{\sigma^{-1}\phi((y_i - x_i\beta)/\sigma)\right\} \tag{9}$$

Heckman's sample selection model

The decision to commercialize and the intensity may not necessarily be jointly determined. Horticultural farming is widespread in Kenya and many households could make the decision to grow for food security and sell surplus. Therefore, the decision to sell some output could precede that of the intensity depending on many factors. There is high likelihood that household will only intensify their sales if there is a good market for their products. In this case, factors that determine decision to commercialize and the decision on intensity could be different. Therefore, we could alternatively model the decisions as two separate processes. First is whether to commercialize or not then second is if commercialized how much to sell. The Heckman correction model is widely used to model this two-step decision process. The observed sales are nonrandom and conditional on the decision to participate in commercialization. This then introduces incidental sample selection problem. We assume that a vector of variables X and Z affect commercialization and the intensity respectively. Two-step procedures are used to model the process. First a Probit model for commercialization or selection equation is estimated.

$$C_i = \delta Z_i + \varepsilon_i, \quad E(\varepsilon_i \mid Z) = 0 \tag{10}$$

In this equation C_i is a dummy for participation in commercialization whereas Z_i is a vector of variables that affect commercialization decision. The next equation is to explain the levels of sales.

$$Y_i = \beta X_i + \mu_i, \quad E(\mu \mid X) = 0 \tag{11}$$

Y_i indicates the level of sales and X_i is a vector of variables that explain the levels of sales, ε_i and μ_i are the error terms.

For this model to work we have to assume that Z and X are observable variables, exogenous and X is a subset of Z. The correlation between ε_i and μ_i is not zero that then causes the selection bias. After estimating equation (10) a non selection bias is computed using $E(\varepsilon_i | c_i, z_i)$ which is called Inverse Mills Ratio (IMR) $\lambda(\delta Z_i)$ when C_i =1 (Wooldridge, 2002). Then the new lambda is used in equation (11) as an explanatory variable. The new equation for the second stage regression is therefore:

$$E\left(Y_i = Z_i, C_i = 1\right) = \beta X_i + \rho\lambda\left(\delta Z_i\right) \qquad (12)$$

Equation (12) gives the expected level of sales Y_i given vectors of observable factors Z_i and given that the household has already made the decision to sell. This can be explained by vector of observable characteristics X_i and the Inverse Mills Ratio evaluated at λ (δZ_i). If ρ=0 then there is no evidence of the selection bias and the regression reverts to OLS. But if $\rho \neq 0$ then there were omitted variables in the initial model correlated with X_i, which is corrected by including IMR in the second regression. The drawback to this estimation approach is the assumption that a variable affecting the decision to commercialize can sequentially lead to reduced intensity of sales to zero sales. This is like assuming that there is a reserve sales price and that, if it is not met, the agent will not sell. As stated earlier we will also use this method for estimation and compare the results with double hurdle models and their implications. These two models are based on different assumptions and the next section explores double hurdle specification.

Double hurdle model

The double hurdle estimation procedure involves running a probit regression on the decision to commercialize using all the variables in the first stage. Then followed by a truncated regression model on the commercialized households (Cragg, 1971). Double hurdle is used in situation where an event may occur or not and when it does then takes continuous positive values (Gebremedhin, 2003). The producer is faced with hurdles in her decision making process. The decision to commercialize is made first and then the decision to intensify[2] (how much of horticultural crops marketed). The decision to commercialize can be modeled as a probit regression as was modeled by Cragg (1971):

Suppose that the latent variable y_i^* follows

$$y_i^* = x_i\beta + e_i \tag{13}$$

where e_i is independent of x_i which is a 1 by K vector of factors affecting the decision to commercialization for all households (i), β is a 1 by K vector of parameters, and e_i ~Normal(0,1). Instead of observing y_i^* we observe only a binary variable indicating the sign of y_i^*

$$y_i = \begin{Bmatrix} 1 \, if \;\; y_i^* > 0 \\ 0 \, if \;\; y_i^* \le 0 \end{Bmatrix} \tag{14}$$

[2] A producer has to make the decision on how much to produce for the market at period S=1

The decision to intensify commercialization is modeled as a regression truncated at zero:

$$Z_i^* = X_i\beta + \mu_i, \quad \mu_i \sim N\left(0, \sigma^2\right)$$
$$Z_i = \begin{cases} Z_i^* \ if \ Z_i^* > 0 \ and \ y_i = 1 \\ 0 \quad Otherwise \end{cases} \tag{15}$$

where z_i is the intensification level of commercialization which depends on latent variable z_i^* being greater than zero and conditional to the decision to commercialize y_i .

The likelihood of not commercializing is given by:

$$\Phi\left(-x_{1i}\beta/\sigma\right) + \Phi\left(-x_{2i}\gamma\right)\Phi\left(x_{1i}\beta/\sigma\right) \tag{16}$$

and the likelihood for positive sales

$$\Phi(x_{2i}\gamma)\sigma^{-1}\phi((y_i - x_{1i}\beta)/\sigma) \tag{17}$$

The log-likelihood function of the double hurdle model is

$$\ln L = \sum_0 \ln\left\{1 - \Phi(x_{2i}\gamma)\Phi(x_{1i}\beta/\sigma)\right\} - (n_+/2)\ln\sigma^2 + \sum_+ \ln\Phi(x_{2i}\gamma) + \sum_+ \ln\phi\left\{(y_i - x_{1i}\beta)/\sigma\right\}. \tag{18}$$

Variables used in the models

Demographic characteristics: We include household size, age and gender of the head of the household are used in the models. The size of the nuclear family will have a direct impact on the decision to engage in horticulture. Large household size indicates availability of labor that is crucial in commercial horticulture production, which is labor intensive. The age of the household head could have a positive effect on participating in horticulture production; it is a proxy measure of experience and availability of resources. Commercial horticultural production is a risky venture and ability to take risks may be different across gender. Male-headed households are expected to be more likely to engage in commercial horticultural production since cash crops are considered a “male domain” crop. Highest educational level attained by the household head is used in the study.

Assets

In circumstances in which financial markets are imperfect or non-existent, asset ownership represents a common form of savings and investment among households in rural communities. The ownership of durable goods may be a good indicator when locating wealthier households although at times it may be indicative only of lumpiness in household income. These goods also can be a factor in creation of wealth and can be used as factors of production. A household’s tractors, oxen, ploughs, livestock, fixed assets, and landholdings are a good indicator of its wealth and productive potential. Land ownership in particular is important when it comes to the decision by a farmer to invest into specific assets like irrigation equipments that could involve substantial initial investment. General assets as well as the irrigation equipments are divided into quartiles to capture the influence of wealth differential in adoption decision.

Irrigation equipments

Commercial horticulture is more successful where there is irrigation water. The data set used did not have a variable indicating water availability so we proxy ability to irrigate by using ownership of irrigation equipments. We also use the value of the equipment so that we could capture the investment threshold necessary for commercialization.

Other economic activities

Smallholder farms in Kenya are generally diversified. It is common in central highlands of Kenya to have a single farmer having dairy animals, coffee, and tea with some horticultural crops on the side. This is a form of risk mitigation strategy. Later in the study, a specialization index is computed showing to what extent there is evidence of regional specialization in the top five crops within agro-ecological zones. Some of the enterprises in the household either can be in direct competition with horticultural farming as a source of income or can be a complement. Farmers could invest in commercial horticulture with the income from other crops like coffee or tea. Commercial horticulture requires capital-intensive irrigation equipment. Without a good source of income then it will be difficult for households to invest in investments with many competing alternatives that could be less risky.

Regions with many cash crops like coffee, tea pyrethrum, cut flowers, and sugarcane face periods of acute labor shortage when picking or harvesting of the crops is at its peak. Availability of extra labor is crucial when investing in labor-intensive enterprise such as commercial horticulture production. In regions with high competition for farm labor then horticultural production might lose out to other traditional cash crops like tea.

Off-farm employment

Rain-fed agriculture is highly seasonal, carries some inherent risk, and is characterized by lumpy cash flows. In the absence of well-developed markets coupled with lack of formal farm insurance, farmers will tend to self-insure. One form of self-insurance is engaging in off farm employment. In poor countries where agriculture marketing is in the initial stages of development, other sources of income like salaries and transfer payments are very significant. However, the way they affect agricultural commercialization is very ambiguous. The extra income could be used as an important source of income when it comes to investment in farm enterprises. In other cases where the investment is labor intensive with close management required then they will be negatively correlated with commercial crops. Then non-farm income could play an important role in enterprises choices and investments decisions.

Availability of credit

Availability of credit and the associated cost of credit are crucial in the success of the agricultural industry. Credit could be used to purchase inputs (planting material, fertilizer and crop protection), pay wages, invest in machinery, or to smooth consumption. The availability of credit is expected to lead to increased agricultural productivity and greater commercialization. We use the variable indicating if the household received any form of credit not necessarily for horticulture. This is important since credit for smallholder horticultural farming is very rare in Kenya and we need to capture any access to credit for future investments.

Production region usually dictates the type of agricultural activities that can be carried out. The hypothesis is that households in the higher potential areas will be more likely to engage in horticulture production or shift into commercial production. If they do not have other labor intensive competing crops. They also have similar unobserved characteristics.

Food security

The choice by a smallholder household of any particular cropping mix is based on satisfaction of home consumption first and second provision of cash surplus. Consequently, the effects of commercialization on food production are important to farm households. Smallholders in lower rainfall regions may not be self sufficient in food crop production and will use revenues from commercial cash crops to buy food in times of shortages. Elamin *et al*. (2002) indicate that smallholder farmers who produce more cash crops for the market are those who are able to use purchased inputs to produce food grain. Therefore there is possibility of synergy between food crop production and cash crop production which we investigate in our models latter. We use 1997 bags of maize in stock at the time of harvest as the proxy for food security.

Distant to services

Access to good infrastructure can form a backbone for rural household commercialization. Farmers will grow perishable crops for markets only when they are assured that they can market them easily. “Distance to fertilizer shop” in the last cropping season was used to proxy access to market. Majorities of Kenyan farmers use some fertilizer and the location of the shop where they bought the fertilizer is a good proxy for horticultural market access. Distance to the nearest road is used as a proxy for the cost of taking the produce to the market. The hypothesis is that good infrastructure has a positive impact on the decision to engage in commercial horticulture production or a shift from subsistence horticulture farming to a more commercial orientation. The problems of market access may be usefully considered in three dimensions: the physical (the distance of the households from markets); the political (their inability to influence the terms upon which they participate in the market); and the structural (the lack of market intermediaries). This study will only look at the physical dimension of market accessibility as a dummy for all the other dimensions. Proximity to a major town gives a farmer a better flow of market information regarding the demand, supply, and prices of various commodities in the major market. It also signals an effective demand of horticultural produce within a farmer's reach.

CHAPTER 4

DESCRIPTIVE STATISTICS AND REGIONAL SPECIALIZATION INDEX

Introduction

This chapter presents a descriptive overview of horticultural production and sales in Kenya. We first examine the most important horticultural crops in the country, comparing data from the Ministry of Agriculture with results from the 2000 Tampa household survey. Next, we examine regional patterns in horticultural production and sales, before ending with an examination of the characteristics of horticultural farmers by their level of commercialization.

Most important horticultural crops

Due to its agro-ecological diversity, Kenya produces a wide range of fresh produce, with over 60 individual items recorded in smallholder household surveys. Nonetheless, a relatively restricted number of crops dominate production and sales. Table 4-a uses data from MoALRD to show area and production shares of the seven top horticultural crops in 1992 and 2001; data are sorted based on production shares in 2001, and incorporate production from all farms, not just smallholders.

Three key patterns can be seen in the fruit sub-sector are. First, banana, and pineapple dominate, with about three quarters of the value of production between them. Bananas far outweigh any other fruit in terms of area and production shares. This is likely to remain the case with introduction of clean planting materials through tissue culture to the farmers. There is also a major push in the industry to have quality bananas in the up-market supermarkets. More small-scale and medium-scale farmers have put land into production of new varieties of banana plants in the hope of tapping into this market. Pineapples also show a large production share, though the area share is far below citrus and mangoes. This can be explained by large-scale production of pineapples by Delmonte group based in Thika with corresponding high yields due to the intensive nature of their production. The second main pattern is that relative rankings among fruit changed very little between the two years, especially in production shares. Finally, banana and (to a lesser extent) citrus shares fell slightly in the study period. This has been attributed to the onset of disease in both crops due to lack of clean planting materials and farm hygiene practices for bananas and citrus greening virus for the citrus fruits (Kahangi, 1996 and Kavoi and Tschirley, 2004 Vol. III). Kenya imports a sweet variety banana (Bogoya) from Uganda due to its popularity in the market although the overall imports likely account for only 7% of the market share. Citrus greening disease affects the mid-altitude because the carrier vector is found in the highlands. That explains why Tanzania citrus orchards have not been affected because they are in the coastal regions where the vector is not widespread. Citrus imports account for as much as 21% of the market (Tschirley et. al. vol II, 2004).

We also see three main patterns for vegetables. First, three crops (kales, tomatoes, and cabbage) account for about three-quarters of all production. Second, cabbage shares in both area and production fell sharply during the period, from first to third place, while sukuma wiki (kale) rose; otherwise, there was very little change in rankings. Finally, shares of traditional vegetables and “other vegetables”, both of which are groupings of several vegetables, rose; this may reflect some diversification in vegetable production over the period. The decline in cabbage production and area shares needs to be understood in further studies. Nevertheless, one reason could be that cabbage is very easy to grow and during the rainy period many farmers are able to produce the crop. Large inflows to the market at the same time lead to gluts which cause drastic decreases in price. Some large-scale farmers are now growing the crop under irrigation only in the dry period when there is a general shortage and prices are high. Mathenge and Tschirley (2006) show that cabbage tends to have higher seasonal price movements than most other horticultural crops, though not in Nairobi.

Table 4-a: Area and production shares of seven of fruit and vegetable crops in Kenya, in 1992 and 2001

Fruits	Area Shares		Production Shares	
	FRUITS			
	1992	2001	1992	2001
Bananas	63	55	58	49
Pineapples	6	10	22	28
Mangoes	10	12	5	8
Citrus Fruits	13	11	7	6
Pawpaw	4	5	4	4
Passion Fruits	1	2	1	4
Avocadoes	1	3	1	2
Other Fruits	2	2	2	1
	VEGETABLE CROPS			
Kales (sukuma wiki)	21	25	25	31
Tomatoes	17	18	22	24
Cabbages	25	17	32	22
Carrots	6	4	6	5
Onions	6	6	5	5
Traditional Vegetables	5	10	3	5
Other Vegetables	4	7	3	4
French beans	8	6	2	2
Garden peas	8	7	2	2

Data Source MoALRD[3]

Table 4-a was based on MoALRD data, which included all production in the country, regardless of the size of farm. Table 4-b now focuses on the smallholder sector, using the TAMPA household data set from 2000. Production shares in Table

[3] This table is quoted from Kavoi and Tschirley (2004 vol. 1). Shares are based on value of production.

4-b are based on all fruits and vegetables together, and so are not directly comparable to those in Table 4-a. Nonetheless, common patterns are discerned. The two tables tell a similar story regarding the importance of bananas, with the crop accounting for 23% of total sales among smallholders. Within the vegetables sub-sector, the three most important crops in table 4-a also dominate the sub-sector in table 4-b, though they appear in reverse order in Table 4-b (cabbage, tomato, and sukuma wiki). The major difference is that avocado appears much more important in the TAMPA data set, while pineapple, mango, citrus, pawpaw, and passion fall out of the top group. Pineapples, citrus and passion require high capital investment to produce and are usually grown by relatively more endowed farmers and big multinational farms. Since the TAMPA dataset targeted smallholder farmers, these larger farms were not captured in the study. Mangoes on the other hand are divided into export variety grown by larger farms and local varieties grown by smallholder farms. This account for the difference in the two tables with the first table capturing total mangoes production while the second table accounts only smallholder production

Table-4b also presents information on the level of commercialization of horticultural crops. Three patterns are worth mentioning. First, generally high shares of production are sold for all crops, with banana the least commercialized at 44% of production sold, and all others at 50% or higher. Banana's relatively low share can be explained by the fact that in many communities, households use it as a staple food and will only sell the surplus. Second, cabbage shows the largest value in both production and sales (as shown especially by the median sales value being much higher than any other crop). This is consistent with our earlier explanation that it is an easy crop to produce and many smallholder farmers grow it for extra incomes.

Table 4-b: The five most valuable crops in production sales in Kenya (2000) by zones

	Production				Sales				
Crop	Share of crop pdn value to FV total pdn	Value of HH production among producers (Kshs)		Top 3 producing zones (%)	Share of crop sales to total FV sales	Value of HH sales among sellers (Kshs)		Top 3 selling zones (%)	% of total production sold
	Mean	Mean	Median		Mean	Mean	Median		Mean
Bananas	.29	6662	2000	Western H. (28) Central H. (20) Western T. (18)	.23	6582	1850	Western H. (34) Western T. (17) Central H. (15)	.44
Cabbage	.12	7119	2399	Central H. (56) High P.M.Z. (16) Eastern (14)	.18	7733	3000	Central H. (61) High P.M.Z. (13) Eastern L. (12)	.82
Tomatoes	.08	4163	1199	H.P.M.Z (33) Eastern (15) Marginal R. S. (14)	.11	5182	1712	High P. M.Z. (35) Marginal R.S. (16) Western H. (15)	.74
Sukuma wiki	.07	1629	720	High P.M.Z. (31) Central H. (18) Western H. (16)	.08	1692	675	High P.M.Z. (29) Western H. (19) Central H. (16)	.59
Avocado	.06	2693	833	Eastern L. (44) Central H. (30) Western H. (12)	.05	2424	656	Eastern (47) Central H. (31) Western H. (10)	.50

Third, as in the previous table, both production and sales are concentrated among a small number of crops; in the 2000-production year the top two crops accounted for 41% of total production and sales, while the top five accounted for 63% of production and 65% of all sales.

There are 29 different vegetables produced in our sample, and nearly 2/3 of all of that is commercialized (See table 4 (c) below). This shows the sub-sector is highly commercialized which is unusual to have such a diverse crop grouping to be heavily commercialized. Comparing the horticultural sub-sector with vegetables at 64% and fruits 48% with "other cereals", which is more commercialized with 71% share of sales, but the group is very small (only 9 crops) and the result is driven largely by wheat.

Table 4-c. Share of total production sold in Kenya, by crop type (2000)

Crop Type	Number of Crops	Total Production in Sample	Total Sales in Sample	Share Sold
Other cereals (primarily wheat)	9	624,736	443,506	0.71
Vegetables	29	2,200,020	1,407,047	0.64
Fruits	25	2,548,433	1,212,265	0.48
Maize	1	2,433,292	1,151,134	0.47
Tubers and Pulses	14	1,466,409	567,416	0.39

Regional Patterns in Horticultural Production and Sales

This section focuses on regional patterns of production and sales, including the location of commercialized and less commercialized horticultural producers. Table 4-d shows in each zone the percentage of households growing and selling horticultural crops, their mean and median values for 2000, and the share of the region in national production and sales. With the exception of Western lowlands, nearly all households produce horticultural crops. Mean production value per producing household is highest, at Kshs 28,000 (US $389)[4], in Eastern lowlands and lowest in Western lowland Kshs at 4,000 (US $56). Four agro-ecological zones dominated production and sales in 2000: central highlands, eastern lowlands, western transitional and high potential maize zone.

Table 4-d: Percent of households growing and selling horticultural crops (2000)

Zone	% of households growing	Value of production among producers		Zonal share of national FV prod'n (%)	% of households selling	Mean value of sales among those selling		Zonal share of total FV sales (%)
		Mean	Median			Mean	Median	
Central Highlands	100	23486	10050	26	83	16148	4177	30
Eastern Lowlands	99	28424	10347	20	81	18577	4913	21
High Potential Maize Zone	98	11503	4608	20	71	7778	1833	19
Western Highlands	100	20699	9800	14	90	12673	3650	15
Western Transitional	100	14840	8372	11	87	7328	2647	9
Coastal Lowlands	96	18639	8667	6	66	10386	1675	5
Western Lowlands	83	4326	1375	3	51	3879	1333	3

Location and incidences of commercialization

To examine how the level of commercialization of farmers varies over regions, we define non-commercial producers as those who either did not sell fresh produce, or who sold less than Kshs 1,000 per year, semi-commercial as those having sales between Kshs 1,000 and 11,000 per year and commercial producers with sales above 11,000 per year. These figures are based roughly on sales quartiles, where non-sellers and the first quartile of sellers are defined as non-commercial, the second and third quartiles of sellers are semi-commercial, and the fourth quartile of sellers is commercial

[4] Exchange rate used is US $ 1 = Kshs. 72 as per July 13, 2006 rate

Table 4-e addresses two related questions: where are commercialized farmers located? In addition, where is a farmer most likely to be a commercial farmer? The first question reflects both the likelihood of being a commercial farmer *and* the region's population, while the latter eliminates the effects of population. The table shows that despite demand for FFV from rural households, domestic urban markets (primarily Mombasa), and the tourism sector, Coastal lowlands have a low commercialization rate with 62% of growers being non-commercial and only 8% classified as commercial under our definition. In contrast, a producer in Central Highlands has a 31% probability of being commercialized, followed by Eastern Lowlands (27%); both of these lie close to Nairobi, the country's main urban market for horticultural produce. Consistent with results from Table 4-d, farmers in the Western Lowlands are the most likely (73%) to be subsistence (or nearly subsistence) producers of fresh produce. The next chapter investigates factors determining commercialization as a whole though we do not disaggregate to according to the regions.

Concentration of Horticultural Sales

Table 4-f shows concentration of horticultural sales in the sample divided into 5 categories. Two other categories are included of those who do not grow fruits and vegetables, and those who produce but have no sales. From Table (4-f) below we notice only 3.2 % of the household's do not produce horticultural produce. This is a very small proportion of the population, which underscores the importance of FFV production in the country. Of those growing, only 21% have no sales at all which is in accordance with table (4-c) above.

Table 4-e: Location and incidence of commercial FV farmers (2000)

Where are commercial FFV farmers located? (Distribution of farmers types by zones)				Where is a farmer most likely to be a commercial FFV producer? (Share of farmers types in each zone)			
Zone	Non commercial (%)	Semi-commercial (%)	Commercial (%)	Zone	Non commercial (%)	Semi-commercial (%)	Commercial (%)
Coastal Lowlands	7.7	4.7	2.4	Coastal Lowlands	62.0	30.4	7.6
Eastern Lowlands	9.0	11.9	17.6	Eastern Lowlands	35.4	37.3	27.3
Western Lowlands	20.2	8.3	2.4	Western Lowlands	72.7	23.9	3.4
Western Transitional	8.5	17.0	10.4	Western Transitional	32.5	51.8	15.7
High Potential Maize Zone	32.4	27.9	20.8	High Potential Maize Zone	51.6	35.3	13.0
Western Highlands	7.1	13.6	14.8	Western Highlands	29.8	45.7	24.5
Central Highlands	15.1	16.6	31.6	Central Highlands	37.1	32.4	30.5

Table 4-f Concentration of horticultural sales: percent of total sales by quintiles

Sales category	% of farmers	Average value of horticultural production per hh (Ksh)	% of total prodn in sample	Average value of horticultural sales per hh (Ksh)	% of total sales in sample	Median # of FFV items sold	Share of bananas in total sales	Share of cabbage and tomato in total sales
No production	3.2	—	—	—	---	---	---	---
Production, no sales	21.2	3,911	5%	0	0%	0	---	---
1 Lowest sales	15.1	3,475	3%	234	0%	1	.15	.07
2	15.1	5,927	6%	1,112	2%	2	.20	.15
3	15.2	8,953	9%	2,807	5%	3	.25	.13
4	15.1	15,496	15%	7,850	14%	4	.26	.23
5 Highest sales	15.1	61,995	61%	43,980	79%	6	.23	.32

Source: Muendo and Tschirley, 2004

Table (4-f) breaks all FFV producers into quintiles (20% each), the top group has mean sales of about Kshs 44,000 (US $ 611) and account for about 80% of total sales in the sample out of which bananas, cabbage and tomatoes contribute about 55% of the total sales. The median number of crops grown in each of the quintiles also increases from 1 to 6 from the lowest to the highest. This indicates the interest on horticultural crops implying that the commercialized households have diversified FFV crop mix.

Regional specialization

An additional way to characterize regional patterns is to explore the extent to which production of particular items is concentrated in certain geographic areas; put another way, how different is each region, in terms of its mix of production, from other regions. As an economy grows and urbanizes and improves its infrastructure, trade increases and households and regions in a country shift from self-sufficiency towards a more commercial orientation. Commercialization, while leading to an increase in the diversity of products at national level (responding to a more diverse consumer demand) leads to increased specialization among households and regions.

The Regional Specialization Index attempts to capture the degree to which regions have specialized in the production of different horticultural products. Viewed another way, it measures the region's revealed comparative advantage in production and exports to other regions[5]. As we have calculated it, a value of 1.0 for a given region indicates that, for whatever horticultural products that region produces, it produces 100% of the national supply; a value of zero means that the region's horticultural crop mix is identical to the average crop mix in the rest of the country. For this reason, the measure is also referred to as the *dissimilarity index*.

We present the specialization index by year and zone as a clustered bar graph (Figure 1) for the top five crops. From the graph, the following are the key conclusions: 1) specialization is very low in both years, suggesting a tendency to grow a similar mix of produce throughout the country. 2) There is evidence of more specialization in 1997 than in 2000. However, specialization is not high during either year. In addition, the change we do see is driven by the lowland and transitional areas and changes in the highland areas (including HPMZ) are too small to even note. 3) The general conclusion from this graph is that there is no clear pattern across years in relative specialization of regions. This is all consistent with a low-income economy with poor infrastructure with rainfall pattern driving production.

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[5] For more information on how it is calculated and interpreted see chapter three the section on regional specialization.

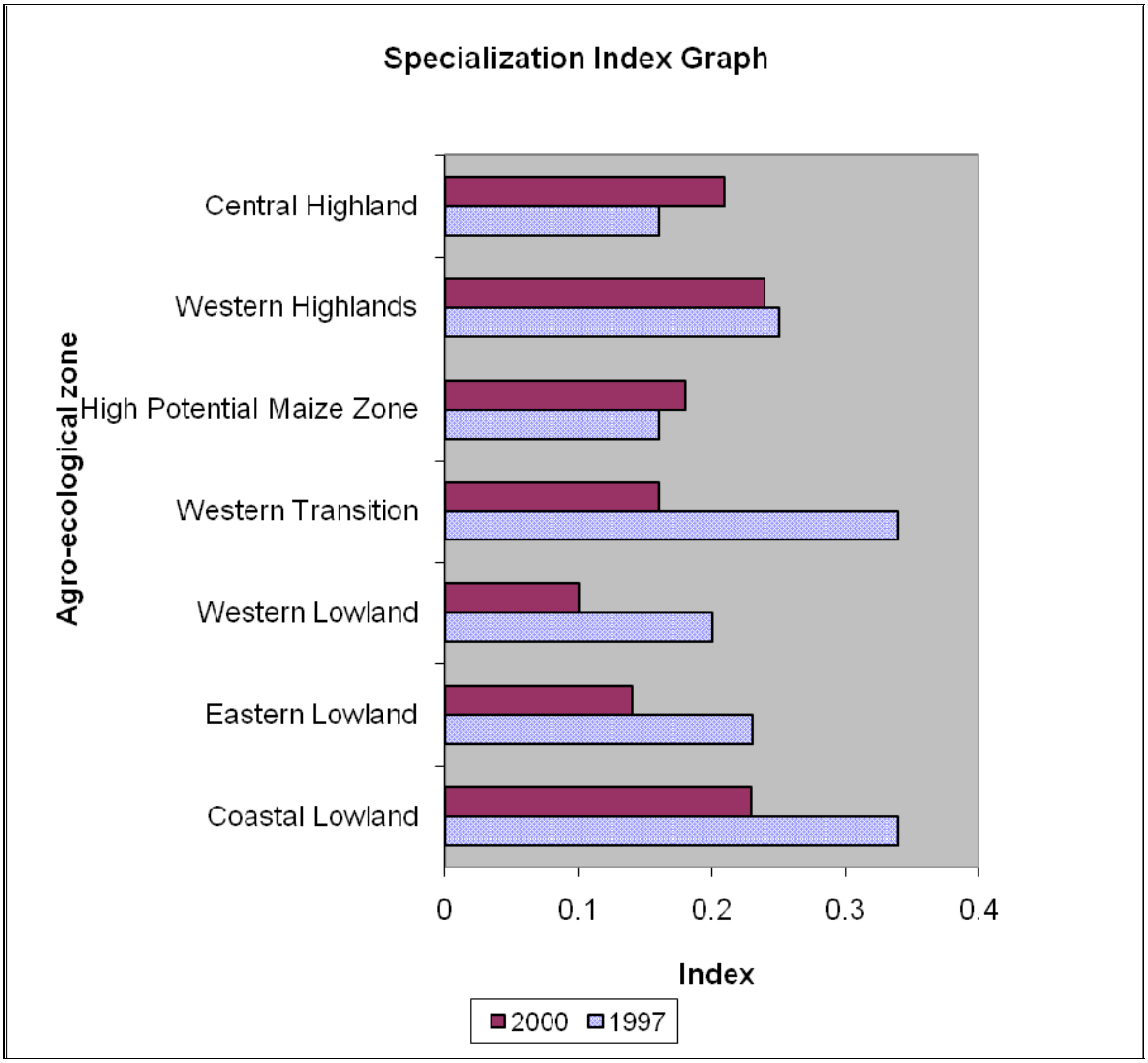
The lack of regional specialization could be explained by the smallholder producer often striving to maintain subsistence food production along with commercial production despite the apparent higher returns to land from horticultural crops. Then it could be interpreted as an attempt by the households to have an insurance policy against the fluctuating market prices of the horticultural crops and sometimes lack of market due to over-production during the growing season. It could be seen as a second best solution as opposed to full market integration and the related economic benefit of full commercialization is foregone (Von Braun, 1995).

Given the risky economic environment in Kenya at the time of the study and virtually no other insurance market the household, tend to maintain own food production and grow a wide variety of crops as food security first strategy. It has also been documented that farmers are willing to pay a price to maintain household food security based on own production of food crops as well as a wide range of horticultural crops (Von Braun and Immink, 1994).

Dynamics of households among commercialization categories

In the study, we investigated the dynamics of the various levels of commercialization. Though the period of study spans only three years we were interested in finding out if more households are moving towards some form of commercialization. We now see that there was a substantial move towards more commercial growing in 2000, with 51% (see table 4-h below) being commercial or semi-commercial in that year, compared to only 35% in 1997. These results are consistent with past studies that have shown that horticultural crops are generally more profitable than other food crops.

Figure 1: Specialization Index Graph



However, we should not interpret these results without considering that in 1997/98 season there was an El-Nino phenomenon which greatly decreased the amount of crops harvested in general. As indicated in the introduction of the study there is a high movement of rural population to the urban centers increasing demand for horticultural produce. Clearly, there is a movement towards fulfilling the increased demand. However, the table shows that there is room for improvement since 62% of the households that were not commercialized in 1997 remained at subsistence level[6]. In the same period, 58% of the commercialized in 1997 remained commercialized.

Table 4-g: Mobility among horticultural farmer types from 1997 to 2000 in Kenya

Commercialization level in 1997	Commercialization level in 2000			**Total, 1997**
	Non commercial	Semi-commercial	Commercial	
Non commercial	62%	31%	7%	**65%**
Semi-commercial	31%	45%	24%	**22%**
Commercial	12%	30%	58%	**13%**
Total, 2000	**49%**	**34%**	**17%**	

Characteristics of Commercial Horticultural farmers

This section examines demographic, asset, and locational characteristics of households based on their horticultural commercialization status. Household demographic characteristics are very similar between commercialization classes. Some highlights of the results from table 4-i are; 1) the only sharp difference is the evidence that female headed households are much less likely than others to be classed as commercial horticultural farmers, 2) there is also some evidence that more commercial farmers are more educated (based on the median), but the relationship is not strong.

Fresh produce production generally requires a higher capital outlay, and is more labor intensive than the production of many other crops. The hypothesis we tested was that households with higher income base are more likely to afford commercial

[6] The larger absolute number of non-commercialized farmers relative to commercialized farmers means that any % movement out of the former group will have a larger percentage effect on the other two.

horticultural production. The results shown below in table 4-j show that, across a wide range of indicators of economic wellbeing, the more commercial farmers is better off than non-commercial farmers are. For instance, the type of house the household have indicates their overall assets ownership. In this case, we find that better houses with iron sheet roof, brick/stone walls and cement floor are more common among commercialized farmers than among others.

Table 4-h: Demographic characteristics by horticultural commercialization level

	Age of the head of the household		Gender (%)		Years of schooling of household head		Number of household members	
	Mean	Median	Male	Female	Mean	Median	Mean	Median
Non commercial	54	52	84	16	9	9	6.5	6.0
Semi-commercial	53	53	85	15	9	10	6.5	6.0
Commercial	52	51	92	8	10	11	6.6	6.0

Table 4-i Share of households owning selected assets

Asset		Commercialization level in 2000		
		Non commercial	Semi-commercial	Commercial
Value of FFV production (Kshs)	Median	2033	9054	37727
Value of FFV sales (Ksh)	Median	.00	3400	24764
House has iron sheet roof	Col %	65.9	72.0	81.0
House has brick/stone wall	Col %	21.7	27.4	31.9
House has cement floor	Col %	25.7	29.9	48.7
Land is owned with title deed	Col %	47.6	57.2	58.1
Total acres cultivated	Median	2.7	3.5	5.0
Total value of assets (Kshs)	Median	20250	24800	40720
Total household income in 2000 (Kshs)	Median	79817	106820	193200

For the locational characteristics (Table: 4-k), there is strong evidence from the first three variables that commercial producers live closer to centers of economic activity. The mean distance to where a household buys their fertilizer is 10 km for a non-commercial horticultural farmer, while the distance for the commercial households is less than seven km. This variable was used as a proxy for the distance to the main trading center where farmers could access a market for their produce. The other infrastructure availability seems to be very similar. This finding is according to the theoretical framework at the beginning of the study that households nearer a major market will be more likely to be commercialized than those that are further away due to availability of market.

Table 4-j: Location characteristics and commercialization (2000)

		Commercialization level in 2000		
		Non commercial	Semi-commercial	Commercial
Distance from a	Mean	2.4	2.2	1.8
matatu/bustop	Median	1.7	1.5	1.0
Distance to where	Mean	10.1	8.0	6.7
fertilizer is bought	Median	6.0	4.0	3.0
Distance to fertilizer seller	Mean	11.3	5.2	3.4
	Median	4.0	2.0	2.0
Distance from a	Mean	1.5	1.2	1.3
motorable road (KM)	Median	0.5	0.5	0.5
Distance to a tarmac road	Mean	8.6	7.6	7.8
(KM)	Median	5.0	6.2	8.0

Conclusion

We find that there is a high level of sales of horticultural produce among households in the study, but just a few crops dominate them. Some regions mainly the coastal and western lowlands have the least commercialized households whereas, central highlands, and eastern lowlands – located close to Nairobi -- are the most commercialized. However, there is very little evidence of regional specialization among the different ecological zones in terms of horticultural production mix. This is consistent with a low-income economy with poor infrastructures. Therefore, households tend to take a second best strategy to mitigate production and price risks by growing most of their crops for food security before they produce for the market. Overall, we find evidence of movement towards commercialization of horticultural production. More wealthy households also seem to be more commercialized.

Chapter 5

Model Results and Discussion

This section presents the results of the econometric analysis first outlined in Chapter Three. After presenting summary statistics for all right hand side variables, regression results are presented in two steps. Table 5-b focuses on the decision of households to commercialize, presenting probit model results for each year and pooled. Table's 5-c and 5-d then focus on factors associated with the level of commercialization, presenting and comparing results from all four methods we used to address this question: OLS on the full sample, Tobit on the full sample, and the second stages of the Heckman and Double Hurdle methods, each applied only to sellers. In each case, we present results separately by year and pooled.

Summary statistics for variables in the regressions are presented in table 5-a below. The main highlights are: 1) The age of head of the household has a big spread from 21 to 110 years; 2) The mean number of members per rural household is stood at 6.56; 3) Landholding has a mean of 5.5 acres with a big spread from zero to 204 acres; 4) The average distance to the fertilizer shop is 6 km with the furthest distance being 230 kilometers to get fertilizer.

Commercialization Decision

From table 5-b the results of the probit analysis indicate that demographic characteristics had little consistent association with the decision by a household to commercialize its horticultural production. In 2000, female-headed households had a 20 percent lower probability of being commercialized. However, this result was not obtained in 1997 nor did we find it in the pooled regression.

Table 5-a Summary statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Demographics					
HH head is a female	2231	0.12	0.33	0	1
HH head age	2230	52	14	21	110
HH head years of schooling	2257	6.1	5.3	0	18
No. of HH members	2231	6.6	2.6	1	14
Assets					
Horticulture land is owned by hh	2257	0.8	0.4	0	1
No. of acres owned and used	2226	5.5	9.4	0	204
Quartile 1 value of assets (Kshs)	2231	2,271	2,745	0	8,500
Quartile 2 value of assets (Kshs)	2231	18,125	5,554	8,600	28,400
Quartile 3 value of assets (Kshs)	2231	46,636	12,593	28,500	72,600
Quartile 4 value of assets (Kshs)	2231	247,809	547,990	72,700	8,290,000
with no irrigation equipment (Kshs)	2231	0	0	0	0
Quartile 1 irrigation equipment (Kshs)	2231	373	228	30	860
Quartile 2 irrigation equipment (Kshs)	2231	1,234	255	900	1,800
Quartile 3 irrigation equipment (Kshs)	2231	2,639	582	1900	3,900
Quartile 4 irrigation equipment (Kshs)	2231	14,896	16,115	4000	82,000
Other economic activities					
HH member has a formal job (0,1)	2231	0.5	0.5	0	1
HH grows coffee	2230	0.3	0.4	0	1
HH grows tea	2230	0.2	0.4	0	1
HH grows sugar cane	2230	0.1	0.3	0	1
Maize Policy Effects					
Household sold maize to NCPB (0,1)	2231	0.01	0.09	0	1
Median district maize prices (Ksh/90 kg bag)	2161	1015.9	135.7	700	1350
Food Security Status					
Not food secure	2231	0.56	0.50	0	1
Barely food secure	2231	0.10	0.31	0	1
Food secure	2231	0.20	0.40	0	1
very food secure	2231	0.12	0.33	0	1
Distance to services					
Distance to fertilizer shop (km)	2231	6.1	10.9	0	230
Distance to motorable road (km)	2231	1.1	2.1	0	37
Distant to extension services (km)	2231	5.2	5.4	0	62
Received credit (0,1)	2231	0.5	0.5	0	1
Annual precipitation (mm)	2231	1196.1	260.5	705	1641
Year	2231			0	1

Household ownership of irrigation assets shows a clear threshold effect at the third quartile, with no effect prior to that point and with the fourth quartile effect being comparable to that of the third quartile. This is not surprising since irrigation equipment is expensive and specific to horticultural production often not used for food crop production. Therefore, a higher investment must be in view to turning in some profit. The value of non-irrigation assets, which is a better indicator of household wealth, does not seem to have any effect. This is counterintuitive to the expectation that wealthier household will invest in a higher income generating enterprise. But considering that the survey was spread across rural areas and not focused on intensive horticultural growing areas, the results are more representative of the general rural households. We expect that wealthier household to invest more into very capital-intensive horticultural production units mainly geared for export in more intensive horticultural zones.

Production of coffee was not associated with commercial horticultural production in 1997, whereas it became positively associated in 2000 as well as in the pooled model. This pattern of results is consistent with expectations based on temporal coffee price patterns (Figure 2). Coffee as a crop is interesting because for a long time it was a crop protected by law: a farmer could not cut down coffee bushes even when prices are too low. Therefore, when coffee prices are low, farmers prune their bushes and grow other crops, especially horticultural[7] crops, under them; when prices are good, they let the bushes grow and stop plantings of other crops. After reaching a historic low in 1993, prices increased nearly six times through 1997, creating an incentive to maximize coffee production and thus to reduce inter-planting of horticultural crops. From 1997 to 2000, prices fell by more than 60%, prompting household to shift their production mix towards other cash crops.

[7] Horticultural crops have higher income and can substitute for the lost coffee income and besides most are very short term hence would not be a problem if the field was inspected by the coffee field inspectors

Table 5-b Decision to commercialize (Probit analysis)

Variables	1997	2000	Pooled	Significant in 2/3
Demographics				
HH head is female	0.084	-0.209*	-0.104	
HH head age	-0.002	-0.005	-0.003	
HH head years of schooling	0.025	0.003	0.01	
# of HH members	0.014	0.003	0.002	
Assets				
Hort land is owned by HH (0,1)	0.138	0.101	0.074	
# acres owned and used	0.003	0.004	0.005	
Quartile 1, value of assets (excl.)				
Quartile 2, value of assets	0.242	-0.074	0.067	
Quartile 3, value of assets	0.192	-0.258*	-0.022	
Quartile 4, value of assets	0.208	0.017	0.123	
No irrigation equipment (excl.)				
Quantile 1 irrigation equipt	0.488	0.145	0.281	
Quantile 2 irrigation equipt	0.39	0.292	0.219	
Quantile 3 irrigation equipt	1.194***		0.915**	X
Quantile 4 irrigation equipt	1.017**	0.712	0.769**	X
Other Economic Activities				
HH member has a formal job (0,1)	-0.163	0.057	-0.055	
HH grows coffee (0,1)	0.225	0.413**	0.312***	X
HH grows tea (0,1)	-0.362*	-0.383*	-0.343**	X
HH grows sugarcane (0,1)	-0.103	-0.17	-0.186	
HH has interest in growing FFV	0.217*	0.501***	0.268***	X
Maize Policy Effects				
HH sold maize to NCPB (0,1)	-0.82	0.432	-0.094	
Median district maize price Ksh/kg)	0.001	-0.001*	-0.001	
Food Security Status				
Not Food secure	-0.498**	-0.197	-0.314***	X
Barely food secure	0.332	-0.019	0.116	
Food secure	-0.129	-0.034	-0.051	
Distance to services				
Distance to fertilizer shop (km)	-0.007	0.003	0.001	
Distance to motorable road (km)	0.056	0.043*	0.029	
Distance to extension service (km)	-0.021	-0.011	-0.012	
Received credit (0,1)	0.123	-0.112	0.017	
Annual precipitation (mm)	0.002***	0.002***	0.002***	X
Year			0.523***	
Constant	-2.532	-0.414	-1.461**	
# of Observations	776	1316	2106	

* Significant at 10%; ** significant at 5%; *** significant at 1%;

X indicates that a the variable is significant in at least two of the models.

Horticultural production saw an increase into production for commercial purposes in this period. This behavior is consistent with the theory that farmers will only grow a crop for commercial purposes if the returns are greater than those of a challenger.

In contrast to coffee, tea has a negative relationship to horticultural commercialization. Tea crop prices in Kenya have been fairly stable and it is a relatively well managed sector, unlike coffee. Farmers get a monthly payment based on the production for the previous month and a bonus lump-sum payment once a year. Households growing tea are therefore assured a monthly cash-inflow that is unlike any other crop in Kenya. Therefore, tea production in conditions where it is possible to grow is a very attractive crop. The downside of tea production is that it is very labor intensive, demanding daily picking for most farms. In households with labor constraints, there will not be any motivation to invest in another labor-intensive enterprise such as commercial horticultural production[8].

For the variable "interest in growing horticulture", the households were asked what they would do if the prices of maize would fall and to what crops they would allocate their freed up area of land. A value of 1.0 for this variable means that the household indicated it would allocate the land to horticultural production. This variable thus shows the orientation of the household and we can argue that it shows their motivation to grow horticultural crops, which is not typically an observed variable. Therefore, the variable also captures some unobserved variables which otherwise are difficult to control for.

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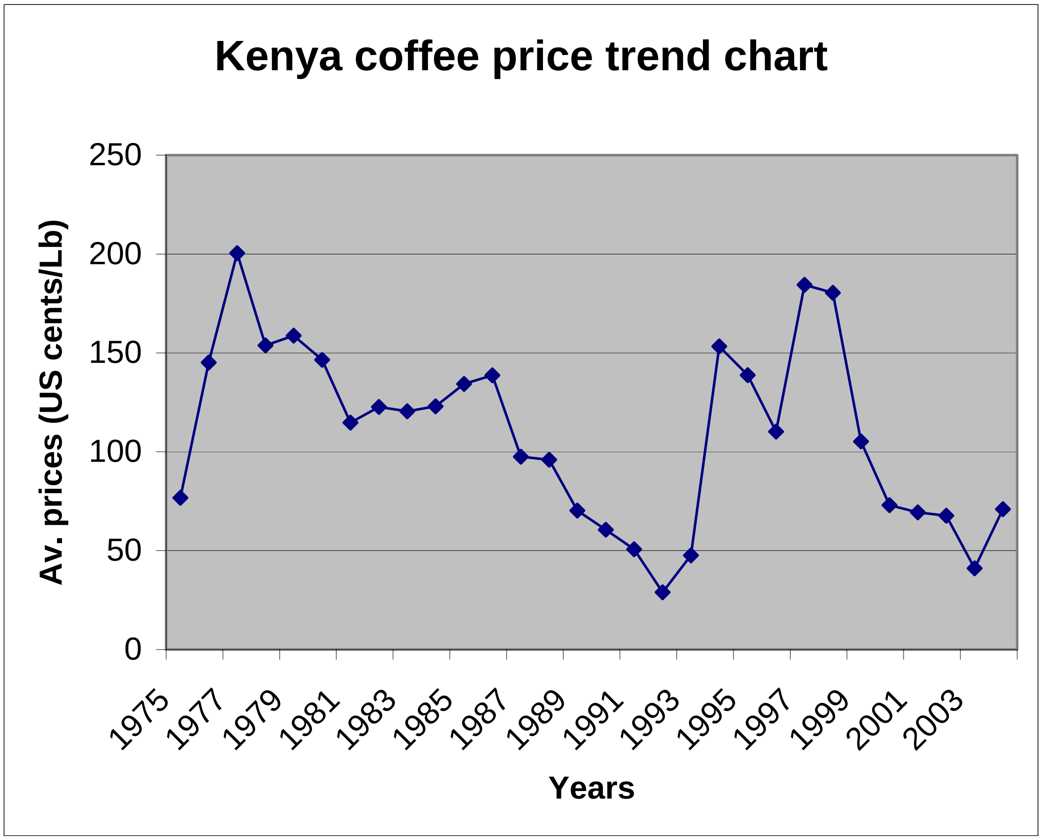
[8] Note that crop dummies variable used can be argued to be endogenous. Therefore, we do not argue here any causality except for association we find. However, running a model without these variables did not change significantly the other independent variables. It is then safe to assume that their inclusion did not decrease our models efficiency whereas we still benefit from the insight we get from the relationships (see table A-2 in the appendix for models without these variables.

Figure 2: Kenya coffee price chart



Data source: International Coffee Organization (2006)[9]

This variable also captures the perception on possible benefits of horticulture within a certain locality. Interest in growing horticulture for commercial purposes has a strongly positive relationship to horticulture commercialization. With caution, we could also, conclude that a positive attitude towards a certain enterprise is important if policies have to be encouraged to promote it. However, because this variable is also capturing some other unobserved effects we cannot read too much into it.

[9] The graph uses nominal prices paid to growers in Kenya in US cents per lb for Arabica coffee

Maize is considered to be a staple crop in Kenya with majority of the households using it in their meals almost every day. Hence, there are many policies the government articulates geared towards the crop with little regards to the effects they have, negative or positive, on other crops in the farmers' enterprise. We used two variables to control for this effect; the first one was to gauge the access to NCPB, the government marketing board. Government policies have been to use the board price to influence overall producer market prices. It turns out that access to the NCPB market has no significant effect on horticultural commercialization.

The next variable was the district median price of maize. This variable was to capture the effect of maize price support policies articulated by the government in Kenya. The only effect here is captured in 2000, which shows that higher maize prices lead to decreased horticultural commercialization. The 1997 and the pooled models also capture a negative relationship even though they are not significant.

This is a very important result because the implications are that when policies distort the relative output prices of different crops, farmers respond by allocating their resources accordingly. The net result is that the less favored crops with no established lobby lose. There is a danger of skewing our policies towards crops with strong political lobby and reduce the potential to develop other potentially profitable crops which could diversify rural household income. Such polices might leave the farmer open to potential price and yield risks associated with a single crop.

It was also important to find out the effect of food security[10] situation of a family to the decision to commercialize. Some researchers have argued that if households turn to cash crops it is to the detriment of food crops. To test this hypothesis we used a series of dummy variables relating to the amount of maize in stock before they harvested their new crop. The omitted dummy was the quartile of greatest maize stocks -- "very food secure" households. The results indicate that compared to the households who are very secure, the not food secure household are less likely to engage in commercialized horticultural production. The implication is that they prioritize growing crops to meet their food security needs before growing for the market. This makes sense and does not support the assertion that food crops suffer when a household commercializes since they are able to make decision to take care of their food security first.

Most horticultural crops in rural areas in Kenya are grown by rain-fed agriculture. However, these crops generally require more water than other food crops. Therefore, areas endowed with more rainfall will tend to grow more horticultural crops for commercial purposes. Results indicate that the decision to engage in commercialized horticultural production is positively associated with rainfall, as expected.

Distance to a good road is positively associated with commercialization. This result is counterintuitive, but may be explained by the fact that places with good conditions for growing horticultural crops also have heavy rainfall as shown above. Therefore, rural access roads deteriorate very fast unless there is a good maintenance program which is often lacking. There is need to improve roads in these areas to promote growth in this sector.

[10] There was concern that food security variables were endogenous. However, after running the models without these variables the results remained largely unchanged. We therefore decided to leave the variables in the results since they provide important insights without the cost of biasing the results.

Commercialization Level

As mentioned earlier, the assumptions that researchers make guide their choice of the model on the level of commercialization. There are several options based on the assumptions on the decision sequence of the household. If we assume that, a household makes a simultaneous decision to participate in the market, and how much to grow for sale. Then we could model this decision using Tobit or Heckman selection model. As explained in chapter three, tobit assumes the outcome of zero sales is a result of a decision to sell zero, and treats zero observations as valid sales as much as any other sales value.

The decision to model the process as Tobit ignoring the two-step nature of decision may hamper understanding of true behavioral patterns, leading to erroneous conclusions, and generating incorrect policy recommendations. If the number of zero observations is sizable often the Tobit procedure breaks down, i.e. it is not possible to maximize the likelihood function, and the procedure reverts to OLS.

The Heckman selection model is appropriate if we assume that there is a censoring process in measuring the intensity of sales. That is, the Heckman procedure assumes there are some potential sales that are not observed. It therefore uses a two-step procedure and in the second step takes into account those who have sold their produce, ignoring the zeros.

Table 5-c Decision to intensify commercialization (two year models)

Variables	1997				2000			
	Log sales (OLS)	Tobit	Double-hurdle (2nd stage)	Heckman (2nd stage)	Log sales (OLS)	Tobit	Double-hurdle (2nd stage)	Heckman (2nd stage)
Demographics								
HH is female headed	-0.022	0.081	-0.29	-0.309	-0.615**	-0.791**	-0.308**	-0.213
	(0.05)	(0.14)	(1.54)	(1.59)	(2.35)	(2.4)	(2.27)	(1.34)
HH Head Age	0.001	0	0.009**	0.009**	-0.007	-0.01	0.003	0.005
	(0.09)	(0.03)	(2.02)	(2.02)	(1.04)	(1.14)	(0.75)	(1.17)
HH Head years of schooling	0.088	0.122	-0.003	-0.004	-0.007	-0.003	-0.02	-0.021
	(0.77)	(0.81)	(0.05)	(0.09)	(0.11)	(0.04)	(0.64)	(0.59)
# of HH members	0.038	0.052	0.018	0.015	0.027	0.032	0.031**	0.030*
	(0.68)	(0.7)	(0.69)	(0.58)	(0.91)	(0.85)	(2.06)	(1.81)
Assets								
Hort land is owned by HH (0,1)	0.241	0.288			0.175	0.218		
	(0.63)	(0.57)			(0.68)	(0.68)		
# acres owned and used	0.021	0.023	0.018**	0.017*	0.038**	0.040**	0.042***	0.040***
	(1.03)	(0.86)	(1.99)	(1.82)	(2.56)	(2.16)	(5.66)	(4.82)
Quartile 2, value of assets	0.623	0.842	0.186	0.126	-0.049	-0.09	0.15	0.194
	(1.55)	(1.59)	(1.03)	(0.61)	(0.19)	(0.28)	(1.16)	(1.34)
Quartile 3, value of assets	0.735*	0.920*	0.414**	0.360*	-0.36	-0.533	0.267*	0.404**
	(1.8)	(1.71)	(2.24)	(1.76)	(1.25)	(1.48)	(1.85)	(2.26)
Quartile 4, value of assets	0.903*	1.134*	0.705***	0.645***	0.223	0.248	0.304**	0.314*
	(1.81)	(1.73)	(3.16)	(2.64)	(0.73)	(0.65)	(2.00)	(1.87)
Quartile 1 irrigation equipt	1.466*	1.789*	0.503	0.42	0.502	0.556	0.301	0.241
	(1.88)	(1.78)	(1.58)	(1.2)	(0.89)	(0.8)	(1.13)	(0.8)
Quartile 2 irrigation equipt	0.794	1.102	0.289	0.211	1.099	1.259	0.586*	0.467
	(1.04)	(1.11)	(0.93)	(0.62)	(1.43)	(1.34)	(1.68)	(1.16)
Quartile 3 irrigation equipt	2.625***	3.151***	1.066***	0.894**	0.739	0.82	0.14	-0.045
	(3.44)	(3.22)	(3.53)	(2.22)	(0.81)	(0.74)	(0.34)	(0.1)
Quartile 4 irrigation equipt	2.640***	3.162***	1.064***	0.905**	1.540**	1.661**	0.975***	0.832**
	(3.5)	(3.25)	(3.47)	(2.29)	(2.24)	(1.97)	(3.1)	(2.26)

Table 5-c Decision to intensify commercialization (two-year models) cont'd..

	1997				2000			
Variables	Log sales (OLS)	Tobit	Double-hurdle (2nd stage)	Heckman (2nd stage)	Log sales (OLS)	Tobit	Double-hurdle (2nd stage)	Heckman (2nd stage)
Other Economic Activities								
HH member has a formal job (0,1)	-0.620**	-0.746*			0.047	0.06		
	(2.09)	(1.9)			(0.25)	(0.25)		
HH grows coffee (0,1)	0.318	0.584	-0.258	-0.294	0.790**	1.009**	0.096	-0.076
	(0.79)	(1.11)	(1.47)	(1.57)	(2.46)	(2.54)	(0.63)	(0.38)
HH grows tea (0,1)	-1.144**	-1.375**	-0.785***	-0.713***	-0.922**	-1.070**	-0.473***	-0.34
	(2.47)	(2.28)	(3.93)	(3.09)	(2.56)	(2.4)	(2.76)	(1.64)
HH grows sugarcane (0,1)	-0.688	-0.763	-0.753**	-0.738**	-0.628	-0.792	-0.396*	-0.299
	(0.96)	(0.81)	(2.24)	(2.16)	(1.38)	(1.38)	(1.66)	(1.13)
HH has interest in growing FFV	0.828***	1.028***	0.421***	0.380***	1.11***	1.29***	0.510***	0.339*
	(2.84)	(2.7)	(3.3)	(2.65)	(3.85)	(3.62)	(3.72)	(1.83)
Maize Policy Effects								
HH sold maize to NCPB (0,1)	-2.399*	-3.626*	-0.41	-0.19	0.573	0.865	-0.196	-0.443
	(1.71)	(1.83)	(0.48)	(0.21)	(0.59)	(0.72)	(0.41)	(0.81)
Median district maize price Ksh/kg)	0.004	0.004	0.003	0.003	-0.004**	-0.005**	0	0.001
	(0.6)	(0.52)	(1.09)	(0.97)	(2.1)	(2.22)	(0.27)	(0.51)
Food Security Status								
Not Food secure	-1.234**	-1.646**	-0.207	-0.097	-0.93***	-1.08***	-0.65***	-0.54***
	(2.47)	(2.52)	(0.95)	(0.35)	(3.21)	(2.98)	(4.53)	(3.2)
Barely food secure	0.331	0.411	-0.191	-0.233	-0.253	-0.262	-0.23	-0.215
	(0.55)	(0.53)	(0.75)	(0.87)	(0.64)	(0.53)	(1.17)	(0.99)
Food secure	-0.338	-0.458	-0.077	-0.05	-0.116	-0.166	0.023	0.055
	(0.63)	(0.66)	(0.33)	(0.2)	(0.38)	(0.43)	(0.15)	(0.32)

Table 5-c Decision to intensify commercialization (two-year models) cont'd

Variables	1997				2000			
	Log sales (OLS)	Tobit	Double-hurdle (2nd stage)	Heckman (2nd stage)	Log sales (OLS)	Tobit	Double-hurdle (2nd stage)	Heckman (2nd stage)
Distance to services								
Distance to fertilizer shop (km)	-0.004	-0.009	0.015*	0.016*	0.007	0.009	0.001	0
	(0.2)	(0.39)	(1.74)	(1.82)	(0.94)	(0.99)	(0.38)	(0.05)
Distance to motorable road (km)	0.142*	0.204*	0.02	0.005	0.075	0.098	-0.014	-0.034
	(1.72)	(1.9)	(0.55)	(0.12)	(1.49)	(1.53)	(0.48)	(1.04)
Distance to extension service (km)	-0.060*	-0.086*	-0.008	-0.003	-0.023	-0.033	0.005	0.011
	(1.76)	(1.92)	(0.54)	(0.15)	(0.97)	(1.09)	(0.36)	(0.78)
Received credit (0,1)	0.28	0.315	0.15	0.137	-0.163	-0.219	0.011	0.049
	(0.88)	(0.76)	(1.08)	(0.95)	(0.77)	(0.83)	(0.1)	(0.41)
Annual precipitation (mm)	0.007***	0.009***	0.002*	0.001	.007***	.009***	0.002***	0.001
	(3.42)	(3.29)	(1.73)	(0.92)				
Year								
Constant	-5.23	-8.359	2.544	3.541	2.177	1.125	5.541***	6.596***
	(0.9)	(1.1)	(0.99)	(1.17)	(1.04)	(0.43)	(5.12)	(4.98)
# of Observations	776	776	569	569	1330	1330	1042	1042
R-squared	0.24				0.25			
Mills Ratio				-0.54				-1.37
Mills se				(0.8)				(0.8)
Wald			225.97				434.97	
Pseudo R-squared		0.05				0.05		

Absolute value of z statistics in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%

Table 5-d Summarized results of decision to intensify commercial horticultural

Variables	1997			2000			Pooled			Sign of significant variables**
	Significant in OLS and Tobit	Sig. in Double Hurdle & Heckman	Significant in 3/4	Significant in OLS and Tobit	Sig. in Double Hurdle & Heckman	Significant in 3/4	Significant in OLS and Tobit	Sig. in Double Hurdle & Heckman	Significant in 3/4	
Demographics										
HH head is female				X	X *	X	X	X	X	-
HH Head Age		X						X		+
HH Head years of schooling										
# of HH members					X			X		+
Assets										
Hort land is owned by HH (0,1)										
# acres owned and used		X		X	X	X	X	X	X	+
Quartile 1, value of assets (excluded)										
Quartile 2, value of assets								X *		+
Quartile 3, value of assets	X	X	X		X			X		+
Quartile 4, value of assets	X	X	X		X		X	X	X	+
No irrigation equipment (excluded)										
Quantile 1 irrigation equipt	X						X	X *	X	+
Quantile 2 irrigation equipt					X *					+
Quantile 3 irrigation equipt	X	X	X				X	X	X	+
Quantile 4 irrigation equipt	X	X	X	X	X	X	X	X	X	+
Other Economic Activities										
HH member has a formal job (0,1)	X									-
HH grows coffee (0,1)				X			X			+
HH grows tea (0,1)	X	X	X	X	X *	X	X	X	X	-
HH grows sugarcane (0,1)		X			X *		X	X	X	-
HH has interest in growing FFV	X	X	X	X	X	X	X	X	X	+
Maize Policy Effects										
HH sold maize to NCPB (0,1)	X									-
Median district maize price Ksh/kg)				X						-
Food Security Status										
Not Food secure	X			X	X	X	X	X	X	-
Barely food secure								X		-
Food secure										
Very food secure (excluded)										
Distance to services										
Distance to fertilizer shop (km)		X								+
Distance to motorable road (km)	X									+
Distance to extension service (km)	X						X			-
Received credit (0,1)										
Annual precipitation (mm)	X	X *	X	X	X *	X	X	X *	X	+
Year							X			+
Constant					X			X *		

* Significant only in double hurdle, not Heckman; ** Signs on significant variables were uniformly the same across all years and estimation procedures

On the other hand, the double hurdle model assumes a two-stage process but takes the second stage as a truncated model. It assumes that there are two distinct hurdles in the decision, the first being to participate or not in the market and the second being how much to produce for the market. It is a generalization of the Tobit model, making Tobit a special case of the double hurdle model.

The results in table 5-c indicate that the linear and tobit models have very comparable results in both years as well as in the pooled model (see table 5-e): looking at the pooled results, the same set of variables is significant in each model, signs are the same, and magnitudes are comparable. The reason could be due to the sizable number of zeros, therefore the maximum likelihood maximization is very similar to a linear model. The Heckman and Double hurdle second stage models also have very similar results in the pooled sample, with only three variables significant in one and not in the other. Comparing across the OLS/Tobit and Heckman/Double hurdle results, we find that the latter generated more significant variables, but that every variable significant in OLS/Tobit was significant in at least one of the second stage models, and that signs agreed in all cases. Thus, for all the assumptions outlined below, the general results are very similar.

We present the two approaches of modeling in table 5-c and 5-e that is a) linear and Tobit b) Heckman and double hurdle. Overall, the two approaches have similar outcomes. However, there are some variables that are significant in the latter models, which are not in the former models. That indicates that for policy purposes one could make different recommendations based on the choice of either of the two approaches. Based on the linear and Tobit models we can conclude that individual characteristics have no role in the decision on amount to produce for the market with the exception of the gender of the household head. However, this is contradicted by the double hurdle and heckman model results, which show that households with older heads and those with more members sell more horticultural produce. We could miss the crucial evidence that labor is a constraint in horticultural intensification. Age of the household is also a proxy to access to productive assets as well as experience that give different results.

Households with older heads may sell more fresh produce which can be explained by the fact that commercial horticultural is both labor and capital intensive. Younger households have to allocate their time between taking care of children as well as engaging in productive activities in the farm, whereas old household may be freer to focus on farm activities. This result also indicates that younger households could be capital constrained. Perhaps surprisingly, we find no effect of schooling of the household head on sales. At the same time, this result is consistent with much research across Africa that suggests that households that are more educated preferentially invest in off-farm activities, not agricultural intensification. Households with more members are no more likely to sell, but do sell more; this is consistent with the labor-intensive nature of horticultural production and more members in the household relaxes the constraint.

Table 5-e **Decision to intensify commercialization**

Variables	Pooled			
	Log sales (OLS)	Tobit	Double-hurdle (2nd stage)	Heckman (2nd stage)
Demographics				
HH is female headed	-0.425*	-0.528*	-0.305***	-0.275**
	(1.88)	(1.8)	(2.76)	(2.31)
HH Head Age	-0.003	-0.005	0.005*	0.006**
	(0.44)	(0.61)	(1.89)	(2.00)
HH Head years of schooling	0.026	0.038	-0.011	0.001
	(0.46)	(0.53)	(0.43)	(0.04)
# of HH members	0.023	0.028	0.027**	0.023*
	(0.85)	(0.81)	(2.13)	(1.7)
Assets				
Hort land is owned by HH (0,1)	0.12	0.146		
	(0.56)	(0.53)		
# acres owned and used	0.036***	0.040***	0.034***	0.031***
	(3.09)	(2.66)	(5.98)	(4.99)
Quartile 2, value of assets	0.264	0.32	0.189*	0.173
	(1.21)	(1.14)	(1.79)	(1.55)
Quartile 3, value of assets	0.184	0.159	0.338***	0.360***
	(0.79)	(0.53)	(2.99)	(3.00)
Quartile 4, value of assets	0.560**	0.663**	0.434***	0.400***
	(2.15)	(1.98)	(3.46)	(2.95)
Quartile 1 irrigation equipt	0.876*	1.011*	0.381*	0.283
	(1.93)	(1.76)	(1.86)	(1.21)
Quartile 2 irrigation equipt	0.757	0.964	0.361	0.323
	(1.47)	(1.48)	(1.57)	(1.3)
Quartile 3 irrigation equipt	1.856***	2.186***	0.700***	0.539*
	(3.44)	(3.21)	(2.98)	(1.87)
Quartile 4 irrigation equipt	2.028***	2.300***	1.019***	0.855***
	(4.07)	(3.66)	(4.64)	(3.12)
Other Economic Activities				
HH member has a formal job (0,1)	-0.25	-0.299		
	(1.59)	(1.47)		
HH grows coffee (0,1)	0.555**	0.781**	-0.078	-0.184
	(2.23)	(2.46)	(0.68)	(1.22)
HH grows tea (0,1)	-1.074***	-1.277***	-0.595***	-0.483***
	(3.79)	(3.53)	(4.52)	(2.89)
HH grows sugarcane (0,1)	-0.750*	-0.920*	-0.517***	-0.443**
	(1.96)	(1.85)	(2.69)	(2.11)
HH has interest in growing FFV	0.899***	1.062***	0.488***	0.407***
	(4.54)	(4.2)	(5.29)	(3.43)

Table 5-e Decision to intensify commercialization (cont'd)

Variables	Pooled			
	Log sales (OLS)	Tobit	Double-hurdle (2nd stage)	Heckman (2nd stage)
Maize Policy Effects				
HH sold maize to NCPB (0,1)	-0.465	-0.587	-0.17	-0.119
	(0.58)	(0.57)	(0.41)	(0.28)
Median district maize price Ksh/kg)	-0.002	-0.002	0	-0.001
	(1.02)	(0.94)	(0.22)	(1.36)
Food Security Status				
Not Food secure	-1.059***	-1.281***	-0.520***	-0.391**
	(4.23)	(3.99)	(4.38)	(2.41)
Barely food secure	-0.053	-0.013	-0.262*	-0.279*
	(0.16)	(0.03)	(1.72)	(1.72)
Food secure	-0.154	-0.213	0.011	0.038
	(0.57)	(0.62)	(0.08)	(0.27)
Distance to services				
Distance to fertilizer shop (km)	0.004	0.005	0.002	0.002
	(0.63)	(0.63)	(0.75)	(0.56)
Distance to motorable road (km)	0.057	0.076	-0.007	-0.017
	(1.37)	(1.4)	(0.31)	(0.72)
Distance to extension service (km)	-0.033*	-0.048*	0	0.006
	(1.71)	(1.94)	0	(0.53)
Received credit (0,1)	0.064	0.052	0.073	0.057
	(0.37)	(0.23)	(0.87)	(0.65)
Annual precipitation (mm)	0.007***	0.009***	0.002***	0.001
	(6.55)	(6.39)	(3.71)	(1.12)
Year	1.090***	1.413***	-0.069	
	(3.21)	(3.23)	(0.42)	
Constant	-0.879	-3.215	5.198***	6.980***
	(0.53)	(1.5)	(6.27)	(4.49)
# of Observations	2106	2106	1611	1611
R-squared	0.22			
Mills Ratio				-0.97
Mills se				(0.79)
Wald			611.66	
Pseudo R-squared		0.04		

Absolute value of z statistics in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%

We find no evidence that ownership of land, as opposed to renting, has any effect on the level of commercialization. More land holdings, however, are clearly associated with greater sales of fresh produce. Ownership of some minimum level of irrigation equipment is a clear determinant of both the decision to commercialize and the value sold. Households in the bottom half of irrigation equipment ownership are no more likely to sell fresh produce -- and do not sell any more when they do sell – than those with no irrigation equipment do.

However, households in the top half of irrigation equipment ownership are more likely than all others to commercialize. In addition, sell substantially more. Note that for level of sales, the threshold starts only in the fourth quartile (top 25%) in 2000, but starts in the third quartile (top 50%) in 1997 (table 5-c) and in the pooled regression (see table 5-e). We believe that the significance of the first quartile can be ignored because a) the second quartile is never significant, and b) the first quartile is not significant in the pooled Heckman. Therefore, while these results are slightly anomalous, they still lead to the conclusion that the threshold starts around the 50th percentile.

The implication of this finding is that for commercial fresh produce to play a greater role in improving rural farmers' income, irrigation equipment must be made more readily accessible. This can be done through promotion of low cost irrigation equipment and better access to credit facilities targeting the sector. Ownership of assets other than irrigation equipment is also associated with higher fresh produce sales. Again with a threshold starting around the 50th percentile (the significance of the second quartile in the pooled double hurdle is weak in light of the fact that it is not significant in the double hurdle during any individual year, nor in the Heckman in any of the years or the pooled).

The asset variable in this case may not be affecting horticultural production and sales directly, but rather as a proxy for general household resource endowment and, perhaps, level of economic motivation.

Coffee growers are significantly more likely to sell more and as explained earlier it is due to the low returns from coffee production due to low world prices and poor management of coffee cooperatives. Growers of tea are substantially less likely to be commercial horticultural producers. Growers of sugarcane may or may not be less likely to sell horticultural produce (signs in the probit are all negative but not significant), but both types of farmers sell substantially less fresh produce than do other farmers. Tea has consistently given better returns over the last decade and the crop is very labor intensive. Therefore, for intensity these two crops compete for the already constrained labor resources in the household. The factors driving sugarcane results could be different but very similar to returns on investment to factors of production. Sugarcane prices could be low but the way its production is organized makes its very attractive to farmers. Traditionally farmers provide the land and labor to the sugar company. The firm provides all the inputs as well as some labor. Therefore, sugarcane production draws very little from farmers' resources other than land, and a substitute crop must have very high returns to replace it.

Households that expressed a desire to expand area in fruits or vegetables are more likely to grow and participate in the market than other households. This variable is likely to proxy for indicators of both duration and quality of past-experience with horticultural production and marketing.

As expected, the least food secure households, even controlling for other factors, are less likely to intensify their sales of fresh produce than others, and sell less when they do sell. Note that the significance of the "barely food secure" group in the pooled Heckman and double hurdle of the levels regressions can be considered weak, since it is not significant in any other specifications. However, the results underscore the need to have a holistic approach into promotion of fresh produce commercialization. To overcome poverty through commercialization there is need for promotion of other strategies to increase food security.

Results on the distance variables are anomalous. None is consistently significant, but when they are, two take on positive signs, and one takes on a negative sign. In 1997, distance to fertilizer shop is positive and significant. This is a proxy for the nearest big market where farmers can sell their produce. The further away from a market the more the sales which at first might seem to contradict theoretical assumptions. Yet many suitable areas to grow these crops have high rainfall and are found in the highlands (e.g. Kinangop area), and are likely to be further away from major markets. These farmers are then further away from traditional fertilizer sellers except for the occasional dealer who only sells during the peak selling season. The variable could have captured the traditional shops dealing with agrochemical and veterinary products, which are found in bigger markets because they require large capital investments to stock. Distance to extension service is negative in linear and Tobit models for 1997 and pooled. Though the significance can be considered weak, it is worth mentioning since it may show that technical expertise is important in growth of this sector. Therefore, more extension service is required.

Our credit variable is not significant. This is not surprising since credit to farmers in Kenya is targeted to a particular crop. The major crops that have credit facilities are coffee, tea, sugarcane and maize. It is only in export geared fresh produce that credit is given to farmers and this is only limited to very few regions in the country. The implications are that there is need for credit targeted to the domestic horticultural sector.

Annual precipitation is strongly and positively associated with the probability and level of sales in all OLS, Tobit, and Double Hurdle estimations. Anomalously, it is never significant in the Heckmans. Nevertheless, overall these results suggest that the variable is significant. The variable is a proxy for the climatic condition of the area as discussed earlier.

District dummies were also included in the models (see appendix 1 table A-2). The district could capture unobserved effects in the regions as well as distant away from the main market centers. Fresh fruits and vegetables main commercial markets are the five major markets in Kenya namely: Nairobi, Mombasa, Kisumu, Nakuru, and Eldoret. Proximity to these markets indicates that producers will have a ready market for their produce and unless the road network is very bad. Therefore, we expected that districts near these markets would have a positive correlation to commercialization. In comparison to Kilifi district, proximity to the capital city has in general a positive effect on the intensity of commercialization. Kitui, Machakos, Makueni, Meru, and Murang'a all have a positive effect of intensity of commercialization, although the effect on commercialization is ambiguous. In contrast, almost all the other district near to the other major cities seems to have the opposite effect on both commercialization and intensity.

Therefore, we may not read too much into the results on district because they do not show a coherent similar story.

CHAPTER 6

Conclusions and policy implications

In this chapter, we will review important findings from the last two chapters. First, we will enumerate the findings and the implications, then the key policy recommendations and finally briefly state some future research areas.

Key findings

Kenya's horticultural sector is highly diverse, both in terms of the number of crops grown and sold, and the percentage of households involved. For example, nearly all household grew fresh produce in 2000, over 70% sold, and together they produced at least 29 different vegetables and 25 fruits. This finding suggests that the sector is or could be capable of satisfying a wide range of consumer demand for fresh produce. However, only a few horticultural crops dominate the domestic market in terms of sales due to strong consumer preferences for those products. Though there is great variety of produce grown in Kenya there is an obvious lack of diversity in terms of the areas of production and value of sales. The bulk of production is concentrated in a few geographical and ecological zones. Though we need to point out that this level of concentration is not very high and is mainly due to proximity to the big markets like Nairobi. The specialization index indicates low level of specialization within the zones, which indicates that there is room for improvement for each zone to capture its competitive advantage. This has a net effect of improving productivity and hence rural incomes.

This study finds that overall horticultural production in Kenya is more commercialized compared to other crops grown by the rural households. The findings are a surprise considering the diversity in terms of the types of the crops grown in each group as shown in table (4-c). This again emphasizes the role this sub-sector could play if harnessed to alleviate poverty in rural areas in a country where almost half of the rural population live on under a dollar a day. However, despite widespread commercialization of fresh produce, sales values tend to be very low. For example, in Central Highlands (the most commercialized area), median household sales value of all fresh produce is only about Kshs 4,200, or about US$58; in Western Lowlands (least commercialized), the median value is about Kshs 1,300, or US$18. Spread over an average family of six, these are very low sales values.

These low median figures mask the fact that the top selling households sell quite a lot of fresh produce and account for the bulk of sales. We find that the top 20% of sellers sell an average of about Kshs 44,000 (US$611) in fresh produce per annum, and account for about 80% of national sales from the smallholder sector. Nevertheless, as noted above most of these farmers are located in Central Highlands, Western Highlands, and Eastern Lowlands, i.e., near population centers that demand larger quantities of fresh produce. They tend to sell a broad range of FFV items (median of 6 items sold) that are concentrated on cabbage and tomatoes. So, farmers who decide to take a strong commercial orientation tend to do so in these two crops, along with banana, which is important for nearly all groups

This study in addition to the need to identify in a more rigorous fashion the drivers of commercialization in fresh produce, wanted to examine the effect of different analytical techniques (reflecting differing assumptions about farmer decision processes), on the results. OLS and Tobit models both assume a simultaneous decision process, while Heckman and Double Hurdle assume a sequential process. In the last two models, Heckman further assumes sample selection, while double hurdle assumes two-part models in participating in commercial horticulture or the amount to sell. The model also allows for the factors affecting commercialization to be the same as those that affect intensity but affecting each differently. The comparison could be carried out on two grounds: theoretical (which approach was most appropriate for what we were trying to model), practical (the existence of valid exclusion restrictions).We did not perform formal tests to select the appropriate assumptions to satisfy the theoretical basis but investigated the impact each assumptions have on regression results and thereby policy implication.

The general results are robust and very similar for all the models. However, there are non-trivial differences on the impact of individual specific characteristics and labor constraints on the decision to intensify sales. The results also shows that older household head relaxes the labor and capital constraints increasing sales. An important result from the simultaneous assumption that is not found in the sequential assumption is that extension services have a positive impact on commercialization and intensity of the horticultural production. The results show little difference between Heckman selection model and double hurdle model. They gave very similar results in terms of direction and level of statistical significance. This can be explained by the difficulty in getting a valid exclusion instrument, which correlates with the decision to participate in commercialization but does not affect intensity.

On the main results that are common to most specifications, gender was found to have impact on the level of sales where women sold less of the horticultural crops in comparison to the men. Labor saving technologies are crucial if horticulture has to grow to full commercial levels. The results show that having more labor in the household's increases intensity whereas having another labor-intensive enterprise reduces the intensity of sales.

The results show that horticultural production can be used as a poverty reduction vehicle for poor female-headed households. FFV enterprises can generate very high production value per unit area, which is appropriate for female-headed households that tend to have little land. However, labor constraints will have to be overcomed through a more intensive production system raising yields and increasing value of production per unit of labor.

General assets as well as irrigation assets are very important in the intensity decision and there is evidence that they have a thresh-hold at 50^{th} percentile. The implication is that for horticultural crop or any other cash crop to be commercial in rural areas effort needs to be made to have the complimentary asset affordable to the adopters of the new crop. To improve rural household market participation then accessibility to irrigation assets is crucial. This could have a big impact in the push for rural household's participation in horticultural commercialization to diversify their incomes.

The results show that producers above the thresh-hold correspond also to the top producers. Intensification of commercialization at this level would improve the overall production of horticulture in the country. For this to be possible then special emphasis needs to be put on relaxing labor and credit constraints to enable purchase of irrigation and other equipments geared to intensifying production and increase specialization.

Access to credit was not significant in all the models that were a reflection that agricultural credit in Kenya is crop or enterprise specific. In addition, since domestic horticultural market is deemed a risky sector in terms of poor markets, very little credit is targeted to this sector. More effort could be done to streamline the marketing aspect of the crops to attract credit services into the sector.

Distance to the market was expected to be important since proximity to a big market was expected to be important. However, our results do not show a significant correlation. The reason could be that the measure we used to proxy for distant was not good enough and did not capture what was intended. Proximity to market question was not asked directly and distant to where they bought their fertilizer was used as a proxy.

Policy recommendation

We have shown that horticultural production is widely practiced in the rural areas in Kenya. And there is strong orientation towards commercial production particularly for the top 20% of the seller. For areas producing other high value cash crops, only horticultural crops that compliment the already established crops should be introduced for successful adoption.

Irrigation equipments have a high threshold at 50th percentile with the implication that heavy investment is needed to have greater impact on commercialization. For this to be possible there is need for cheap and affordable equipment in the rural areas. This is only possible if credit facilities are also available targeting this sector.

With better marketing channels and information, the horticultural sub-sector could be used as a way out of poverty, especially for female-headed households. Quality marketing information tied to wholesale markets, and improvement in the logistical efficiency of wholesale markets along with programs to link producers with these markets would greatly improve their incomes (Tschirley et al. (2004).

Horticultural production is a high value crop and female-headed households with little land can use it to increase their incomes. However, these households together with younger families suffer from at least two disadvantages. They tend to have labor and capital constraints and are less likely to own irrigation equipment. Since women and younger households are less commercialized, then special programs are needed tailored to their needs. Subsequently, programs focused on low income, land constrained households (many of whom will be female-headed) would need to emphasize access to insecticides and herbicides, along with low interest loans to access irrigation equipment. All of this should be done in an integrated way that ties these households to market outlets. Two possible avenues are; (i) use of innovative technology which relaxes labor constraints; and (ii) microfinance targeting the women head of households to relax capital constraints and enable women access to inputs and irrigation equipments.

Lack of regional specialization could be an indication of presence of trade barriers[11] preventing trade between the regions. If horticultural production in Kenya was to be truly commercialized then, these barriers must be minimized. Each production zone will exploit their comparative advantage in producing crops based on their climatic and soils conditions. As mentioned earlier targeting the top 20% producers to increase commercialization would also improve the level of production of various products since they contribute 80% of the national sales.

Future research

- More disaggregated models on gender could capture the special factors hindering women from participating more in the market.

[11] Trade barriers could be as a result of very poor roads or road blocks by the police who may require some bribe before a vehicle carrying produce passes through.

- Longer panel data set could also be used to investigate carefully on the issue of regional specialization as well as the movement towards commercialization.
- More research is needed to quantify the welfare impact of greater commercialization of horticultural crops in the rural areas.
- Rigorous test should be used to identify the correct models to apply where policy implications are concerned.

APPENDIX A

Table A 1 Decision to commercialize (probit model)

Variables	1997	2000	Pooled
Demographics			
HH is female headed	0.084	-0.209*	-0.104
	(0.44)	(1.72)	(1.04)
HH Head Age	-0.002	-0.005	-0.003
	(0.39)	(1.56)	(1.32)
HH Head years of schooling	0.025	0.003	0.01
	(0.53)	(0.12)	(0.39)
# of HH members	0.014	0.003	0.002
	(0.65)	(0.19)	(0.14)
Assets			
Hort land is owned by HH (0,1)	0.138	0.101	0.074
	(0.89)	(0.81)	(0.79)
# acres owned and used	0.003	0.004	0.005
	(0.31)	(0.53)	(1.07)
Quartile 2, value of assets	0.242	-0.074	0.067
	(1.5)	(0.6)	(0.7)
Quartile 3, value of assets	0.192	-0.258*	-0.022
	(1.16)	(1.88)	(0.22)
Quartile 4, value of assets	0.208	0.017	0.123
	(1.02)	(0.11)	(1.07)
Quartile 1 irrigation equipt	0.488	0.145	0.281
	(1.3)	(0.44)	(1.18)
Quartile 2 irrigation equipt	0.39	0.292	0.219
	(1.09)	(0.58)	(0.84)
Quartile 3 irrigation equipt	1.194***		0.915**
	(2.59)		(2.43)
Quartile 4 irrigation equipt	1.017**	0.712	0.769**
	(2.4)	(1.25)	(2.4)
Other Economic Activities			
HH member has a formal job (0,1)	-0.163	0.057	-0.055
	(1.32)	(0.64)	(0.8)
HH grows coffee (0,1)	0.225	0.413**	0.312***
	(1.28)	(2.34)	(2.6)
HH grows tea (0,1)	-0.362*	-0.383*	-0.343**
	(1.85)	(1.92)	(2.56)
HH grows sugarcane (0,1)	-0.103	-0.17	-0.186
	-0.36	-0.78	-1.1
HH has interest in growing FFV	0.217*	0.501***	0.268***
	(1.75)	(2.93)	(2.84)

Absolute value of t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table A 1 (cont'd)

Variables	1997	2000	Pooled
Maize Policy Effects			
HH sold maize to NCPB (0,1)	-0.82	0.432	-0.094
	(1.53)	(0.94)	(0.29)
Median district maize price Ksh/kg)	0.001	-0.001*	-0.001
	(0.23)	(1.82)	(0.99)
Food Security Status			
Not Food secure	-0.498**	-0.197	-0.314***
	(2.33)	(1.4)	(2.8)
Barely food secure	0.332	-0.019	0.116
	(1.19)	(0.1)	(0.76)
Food secure	-0.129	-0.034	-0.051
	(0.56)	(0.22)	(0.42)
Distance to services			
Distance to fertilizer shop (km)	-0.007	0.003	0.001
	(0.97)	(0.69)	(0.17)
Distance to motorable road (km)	0.056	0.043*	0.029
	(1.6)	(1.85)	(1.59)
Distance to extension service (km)	-0.021	-0.011	-0.012
	(1.54)	(0.99)	(1.5)
Received credit (0,1)	0.123	-0.112	0.017
	(0.9)	(1.09)	(0.22)
Annual precipitation (mm)	0.002***	0.002***	0.002***
	(2.89)		(5.17)
Year			0.523***
			(3.53)
Constant	-2.532	-0.414	-1.461**
	(1.05)	(0.44)	(2.04)
# of Observations	776	1316	2106

Absolute value of z statistics in parentheses, * significant at 10%; ** significant at 5%; *** significant at 1%

Table A 2 Decision to intensify commercialization without crop and food security

	log OLS	Tobit	Probit	Double-hurdle	Heckman (1st Stage)	Heckman (2nd Stage)
HH head Gender	-0.266**	-0.266**	-0.061	-0.270**	-0.042	-0.280**
	(2.33)	(2.36)	(0.61)	(2.40)	(0.42)	(2.41)
HH Head Age	0.005	0.005	-0.003	0.004	-0.002	0.004
	(1.57)	(1.59)	(1.01)	(1.52)	(0.77)	(1.38)
Years of schooling	-0.013	-0.013	0.004	-0.013	-0.026	-0.018
	(0.50)	(0.50)	(0.17)	(0.50)	(1.17)	(0.69)
# of HH members	0.021	0.021	-0.003	0.021	0.006	0.022*
	(1.57)	(1.59)	(0.22)	(1.60)	(0.58)	(1.70)
Own land	-0.049	-0.049	0.064		0.065	
	(0.46)	(0.47)	(0.70)		(0.71)	
Acres owned and used	0.037***	0.037***	0.006	0.036***	0.006	0.037***
	(6.21)	(6.30)	(1.27)	(6.36)	(1.28)	(5.71)
Quartile 2, value of asset	0.198*	0.198*	0.081	0.196*	0.066	0.209*
	(1.83)	(1.85)	(0.85)	(1.84)	(0.70)	(1.87)
Quartile 3 value of asset	0.411***	0.411***	0.031	0.409***	0.012	0.410***
	(3.55)	(3.60)	(0.32)	(3.59)	(0.12)	(3.55)
Quartile 4 value of asset	0.534***	0.534***	0.193*	0.534***	0.184*	0.568***
	(4.20)	(4.26)	(1.74)	(4.26)	(1.66)	(3.88)
Quantile 1 irrigation equipt	0.443**	0.443**	0.339	0.438**	0.355	0.502**
	(2.09)	(2.12)	(1.46)	(2.10)	(1.54)	(2.01)
Quantile 2 irrigation equipt	0.370	0.370	0.177	0.367	0.083	0.386
	(1.56)	(1.58)	(0.69)	(1.57)	(0.33)	(1.60)
Quantile 3 irrigation equipt	0.787***	0.787***	0.837**	0.784***	0.709**	0.876***
	(3.26)	(3.30)	(2.33)	(3.29)	(2.03)	(2.82)
Quantile 4 irrigation equipt	1.162***	1.162***	0.783**	1.164***	0.739**	1.260***
	(5.15)	(5.22)	(2.49)	(5.23)	(2.35)	(4.15)
HH has interest in growing FFV	0.522***	0.522***	0.272***	0.522***	0.252***	0.566***
	(5.49)	(5.57)	(2.92)	(5.57)	(2.73)	(4.27)
HH sold maize to NCPB	-0.084	-0.084	-0.056	-0.089	-0.103	-0.103
	(0.20)	(0.20)	(0.17)	(0.21)	(0.32)	(0.24)
Median district maize price	-0.000	-0.000	-0.000	-0.000	0.001***	0.000
	(0.29)	(0.29)	(0.74)	(0.29)	(3.10)	(0.14)
Distance to fertilizer shop	0.003	0.003	0.001	0.003	0.002	0.004
	(1.01)	(1.02)	(0.42)	(1.02)	(0.56)	(1.09)
Distance to motorable road	0.001	0.001	0.029	0.001	0.026	0.006
	(0.05)	(0.06)	(1.58)	(0.03)	(1.46)	(0.26)
Distance to extension service	0.003	0.003	-0.011	0.003	-0.013*	-0.000
	(0.26)	(0.26)	(1.45)	(0.28)	(1.71)	(0.02)
Received credit	-0.034	-0.034	-0.035	-0.032	-0.008	-0.035
	(0.41)	(0.41)	(0.47)	(0.40)	(0.11)	(0.43)

Absolute value of t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table A-2 Decision to intensify commercialization without crop and food security variables (Cont'd)

	log OLS	Tobit	Probit	Double-hurdle	Heckman (1st Stage)	Heckman (2nd Stage)
Annual precipitation	0.001**	0.001**	0.002***	0.001**	0.002***	0.001
	(2.13)	(2.16)	(4.12)	(2.15)	(4.11)	(1.57)
Year	0.015	0.015	0.511***	0.017		
	(0.09)	(0.09)	(3.53)	(0.10)		
Kwale	0.279	0.279	-0.335	0.275	-0.929**	0.034
	(0.51)	(0.51)	(0.82)	(0.51)	(2.49)	(0.05)
Taita Taveta	0.704	0.704	-0.581	0.716	-1.232***	0.385
	(0.98)	(0.99)	(1.22)	(1.01)	(2.81)	(0.42)
Kitui	0.814*	0.814*	-0.116	0.807*	-0.332	0.698
	(1.73)	(1.75)	(0.36)	(1.74)	(1.06)	(1.39)
Machakos	-0.333	-0.333	0.660**	-0.338	0.488*	-0.232
	(0.93)	(0.95)	(2.23)	(0.96)	(1.67)	(0.55)
Makueni	1.245***	1.245***	1.105***	1.240***	0.597**	1.331***
	(3.49)	(3.54)	(3.67)	(3.53)	(2.25)	(3.53)
Meru	0.791**	0.791**	-0.125	0.791**	-0.403	0.676
	(2.11)	(2.14)	(0.37)	(2.14)	(1.25)	(1.60)
Mwingi	0.100	0.100	0.141	0.094	-0.075	0.066
	(0.27)	(0.28)	(0.52)	(0.26)	(0.28)	(0.18)
Kisii	0.582	0.582	-0.116	0.582	-0.645*	0.412
	(1.30)	(1.31)	(0.32)	(1.32)	(1.92)	(0.81)
Kisumu	-0.571	-0.571	-0.947***	-0.571	-1.347***	-0.915
	(1.44)	(1.46)	(3.28)	(1.46)	(5.07)	(1.19)
Siaya	-0.393	-0.393	-0.411	-0.396	-0.605**	-0.532
	(1.13)	(1.14)	(1.48)	(1.15)	(2.22)	(1.24)
Bungoma	0.283	0.283	0.057	0.286	-0.173	0.222
	(0.83)	(0.84)	(0.20)	(0.85)	(0.62)	(0.64)
Kakamega	-0.216	-0.216	-0.450*	-0.213	-0.645***	-0.359
	(0.66)	(0.67)	(1.80)	(0.66)	(2.64)	(0.84)
Vihiga	-0.398	-0.398	-0.534	-0.396	-1.066***	-0.646
	(0.81)	(0.82)	(1.34)	(0.82)	(2.89)	(0.98)
Murang'a	0.496	0.496	0.241	0.494	-0.119	0.456
	(1.59)	(1.61)	(0.95)	(1.60)	(0.51)	(1.60)
Nyeri	-0.309	-0.309	-0.281	-0.317	-0.799***	-0.514
	(0.85)	(0.86)	(1.00)	(0.89)	(3.32)	(1.08)
Bomet	-0.595	-0.595	-0.723*	-0.592	-1.317***	-0.893
	(1.18)	(1.20)	(1.79)	(1.19)	(3.58)	(1.22)
Nakuru	0.029	0.029	-0.135	0.025	-0.349*	-0.058
	(0.10)	(0.10)	(0.62)	(0.09)	(1.67)	(0.19)
Narok	-0.570	-0.570	-0.255	-0.573	-0.540*	-0.708
	(1.39)	(1.41)	(0.85)	(1.41)	(1.86)	(1.53)
Trans Nzoia	0.101	0.101	-0.166	0.097	-0.311	0.029
	(0.35)	(0.35)	(0.74)	(0.34)	(1.41)	(0.09)
Uasin Gishu	-0.404	-0.404	-0.422*	-0.400	-0.717***	-0.569
	(1.23)	(1.24)	(1.67)	(1.23)	(3.01)	(1.28)
Constant	5.882***	5.882***	-1.097*	5.867***	-2.178***	4.988***
	(7.28)	(7.38)	(1.65)	(7.36)	(3.70)	(2.65)
Observations	1611	1611	2107	1611	2107	2107
R-squared	0.25					

Absolute value of t statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

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