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Smallholder Horticultural Commercialization: Gender Roles and Implications for Household Well-being in Kenya

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Abstract

Commercialization of agriculture is often associated with decline in women control even for previously women-managed crops such as vegetables. This study utilizes survey data of over 300 smallholder vegetable producers in selected regions in Kenya to assess the gender roles in horticultural commercialization, identify determinants of women participation in vegetable markets and evaluate the impact of women control over production and revenues derived from vegetables on household well-being. Women have limited access to vegetable production and marketing training, extension services, agricultural credit and membership in farmer groups compared to men. Empirical results indicate that female participation in commercialization of vegetables is positively related to their membership in farmer groups, younger age, education, large number of female adults in the household, female ownership of assets and access to business. Female management of vegetable plots relates negatively to households' food, clothing, school fees and health care expenditures.

1. Introduction

The commercialization of agriculture is often associated with new production technologies, marketing opportunities, and profit increases, which may reduce the role of women even if they were the main contributors of farm production before the shift. This is evident from findings of previous studies such as for rice production in Gambia (von Braun et al., 1994), groundnuts in Zambia (Wold, 1997), French beans in Kenya (Dolan, 2001), and leafy vegetables in Uganda (Shiundu and Oniang'o, 2007). Focusing on vegetables, the rapid emergence and spread of high-value modern supply chains may have profound gender implications over the control of resources in rural households (Maertens and Swinnen, 2010). Women are mostly excluded from contracting with large horticultural firms for the delivery of high-value produce (Dolan, 2001; Maertens and Swinnen, 2010). These modern supply chains therefore may aggravate existing rural inequalities by excluding and exploiting the poorest farmers, which are primarily women (Farina and Reardon, 2000; Maertens and Swinnen, 2010; Reardon et al., 2003). Increase in international market regulations also exclude rural poor smallholders (Okello et al., 2007; Muriithi et al., 2010), often women as they lack the capacity to comply with such regulations.

Changes in gender roles due to commercialization may affect the bargaining power of women in intra-household resource allocation and thus directly or indirectly affect them and their families through the loss or diminishment of livelihoods. Fischer and Qaim (2012a) for instance find that male control over banana output and revenues, a crop that prior to commercialization was primarily under the control of women, affected negatively household calorie consumption and dietary diversity. Increases in the resources controlled by women can have greater development impacts than similar increases for men, as women are more likely to apply increased allocations towards children's education, health, and nutrition (Quisumbing et al., 2006).

Past studies on the gender implications of modern vegetable supply chains have paid more attention on the labour market (Barrientos et al., 2005; Tallontire et al., 2005; Maertens, 2009). Employment opportunities in this sub-sector in rural areas are, however, not only limited and thus employ a relatively small proportion of rural labour force, but also make rural



households vulnerable to rapidly changing global market variability, hence the need to pay attention to gender dynamics that contribute to sustainable benefits from the product market.

Recognizing the role of women in agricultural commercialization and the consequent household welfare effects, as well as problems faced by women in agricultural production and marketing, several initiatives have been pursued by both the government and non-governmental organizations to link smallholders including women farmers to markets. Such initiatives include organizing farmers in production and marketing organizations (PMOs), improving access to market information, contract farming, and out-grower schemes (Njuki et al., 2011). Women are thought to have the most to win from these initiatives, for instance, PMOs that facilitate access to productive resources (FAO et al., 2010). While the determinants of farmer participation in these initiatives, and their implication on household commercialization and welfare have been analyzed in past studies (Smartt and Haq, 2008; Barham & Chitemi, 2009; Markelova & Mwangi, 2010; Fischer and Qaim, 2012b), studies on the gender implications of such initiatives are very limited. A few cases include a study by Fischer and Qaim (2012a) that analyze gender implications of the commercialization of banana enterprises through collective action in Kenya. While the case study by Fischer and Qaim (2012a) is based on a domestic fruit supply chain, such an analysis has not been performed in the framework of high-value vegetable production and particularly in the context of rapidly changing agricultural markets.

The role of women's rural livelihoods is also recognized by various policies that focus on agricultural development for instance the Comprehensive Africa Agriculture Development Programme (CAADP) policy on improvement of agricultural productivity. In Kenya, the Agricultural Sector Development Strategy (ASDS), proposes to develop a gender policy for the agricultural sector in order achieve female empowerment and mainstream the needs of women, men and youth in all agricultural sub-sectors (GoK, 2010). The Kenyan National Horticultural policy recognizes existence of gender inequality in distribution of gains derived from horticultural production and gender discrimination in the horticultural labour market (GoK, 2012). However, it highlights limited understanding of gender issues, which have contributed to a lack of enforcement of gender-related labour laws in employment in the industry and lack of facilities to meet specific needs of women (GoK, 2012).

This study assesses different roles of women and men in the production and marketing of vegetables targeting different markets, and in decision-making on resource allocation and sharing of generated benefits. Second, the study evaluates the constraints and determinants that influence female participation in market-led horticultural farming, using female control over income and management of plots allocated to commercial vegetable production as proxies for female market participation. Attention is given to the role of female group membership, female access to extension services and vegetable production and marketing training, and other household and individual characteristics that may influence female market participation. Finally, this study evaluates the impacts of female control over production and revenues generated from horticulture on household well-being. In estimating the impacts of female participation on household well-being, there is an endogeneity problem, which we attempt to address in pursuit of different econometric strategies.

The rest of the chapter is structured as follows. Section 2 provides the theoretical underpinnings on the linkages between gender, intra-household resource allocation and agricultural commercialization and section 3 describes data and presents a comprehensive descriptive analysis that include the roles of gender in the smallholder vegetable production and marketing. Section 4 outlines the empirical strategies and results and the final section concludes.

2. Theoretical underpinnings

Different studies have used different theories to explain intra-household allocation of resources. Using these methods, they assessed whether male and female allocate resources efficiently, and the impact on household welfare outcomes. Most of the analyses of the impacts of horticultural commercialization are based on patriarchal perspectives that assume a unitary household model. This model is characterized by the aggregation of the preferences of all household members into a single joint utility, and assumes that within a household there is pooling of resources so that every household member can enjoy same level of welfare and that the household head is an altruist (Haddad et al., 1994). There is, however, qualitative and empirical evidence that contradicts the premises of this model (Chiappori, 1992).

The critics of the unitary model have provided an alternative theory, the collective model, which provides a more realistic representation of household behaviour (Alderman et al., 1995).

In collective models, different household members may have distinct preferences such that the utility of each household member depends on their own and possibly that of other members (Chiappori, 1992). Collective model can be cooperative or non-cooperative. In non-cooperative models, household members operate as independent sub-economies with each member controlling their income depending on their preferences. Conversely, in cooperative models, individuals have a choice, either to remain individual or to pool all or some of their resources as a household or other sub-group (Chiappori, 1992).

A popular form of cooperative model is the Nash-cooperative bargaining model (Manser and Brown, 1980; McElroy and Horney, 1981). This model is based on the argument that the “threat point” of each household member determines a particular allocation (efficient resource allocation). Under this model, a household is considered as a site for both cooperation and conflict where intra-household resource allocation is the outcome of a bargaining process (Agarwal, 1997). Chichilnisky (2008) describes gender gap as Nash equilibrium of a game with incomplete information about the work at home and in the market place. She concludes that a family produces a “local” public good (household welfare), using common properties or resources (labour hours of man and woman spent working in the home and in market place). Therefore, on the basis of these intra-household resource allocation arguments, defining measures such as poverty and other household level welfare indicators and assuming that all household members enjoy the same well-being outcomes can be misleading (Falkingham and Baschieri, 2009). The Nash-cooperative bargaining models could be related to past studies that have shown differential expenditure patterns from different farm enterprises between men and women. An example of early literature on this subject found that income from commercial crops are primarily controlled by men and used for non-food expenditures (Kennedy & Cogill, 1987). Recent studies include Njuki et al. (2011) who find that men spent only 6 percent of their income on food compared to 23 percent spent on the same item by women, and an empirical analysis by Fischer and Qaim (2012a).

Following the above theoretical understanding, this study uses data from smallholders to analyze the different roles of men and women in vegetable commercialization including production, marketing and resource allocation decisions and the management of sales revenues. The study further focuses on the implications of the roles of women in the control over



production and income on selected household welfare indicators. Differentiation of gender roles follows the household models of Carter and Katz (1997) and Katz (1995) that assume that allocation of resources between household members can be observed and measured. Using this model, Katz (1995) demonstrated how complex processes that characterize domestic allocation of resources can be observed by examining how the resources (labour time, income, land, etc), transfers, and expenditures (food and non-food) flow within a household.

The literature review and theoretical foundation discussed here leads to three hypotheses that address the research objectives. 1) the commercialization of vegetables contributes to increased male control over production (management of plot) and revenues. 2) female oriented training and extension services on vegetable production and marketing, as well as membership in PMOs increase their control over production and revenue management and thus enhance participation in the commercialization of horticulture and 3) female control over vegetable production and revenues management has positive effect on household well-being.

3. Data and descriptive statistics

The methods employed in this study are an integration of quantitative and qualitative analyses applied to data collected in five of the major vegetable producing counties in Kenya (namely Nyeri, Kirinyaga, and Murang'a, Meru and Makeni). These counties represent approximately half of the smallholders that produce vegetables for the export market (Mithofer *et al.*, 2008; Asfaw *et al.*, 2009; Asfaw *et al.*, 2010a), and also have the highest levels of horticultural commercialization for locally consumed vegetables (Sindi, 2008). The counties are endowed with a generally favorable climate for horticultural production, but differ in the intensity and type of vegetable crops being produced, in agro-ecological characteristics, and in accessibility (Asfaw *et al.*, 2009; Asfaw *et al.*, 2010a, Asfaw *et al.*, 2010b)

Extensive primary data collection, conducted in 2011, was organized at different levels of supply chains. First, a follow-up survey involving a random sample of 370 of the 539 households that were surveyed in 2005/06 by the International Center for Insect Physiology and Ecology



(ICIPE)¹ was carried out. The second level involved qualitative interviews with agents of horticulture trading companies and focus group discussions with farmer organizations. The focus group discussions were conducted in two stages. The first stage was designed to examine farmer perceptions on change in gender roles as a result of vegetable commercialization. The second stage involved single-gender discussions to elicit further information on gender roles in horticultural commercialization, the dynamics of these roles, and their effects on different community groups. The qualitative interviews covered five focus group discussions (or ten single-gender groups), one in each of the survey counties. The household survey gathered information on household demographics characteristics, asset ownership differentiated by gender, crop enterprises, income and income sources (on-farm, and off-farm). Also collected was data on sources of inputs, access to services (credit, extension services, training), marketing channels, and social capital indicators such as membership in farmer groups, and gender roles in horticultural commercialization such as vegetable plot ownership and management, and income earning and management.

The information on the type of vegetables produced was used to classify households according to commercialization into *export market suppliers* and *domestic market suppliers*. An additional category was provided for households who supplied vegetables jointly to both markets. Owing to the nature of our analysis of comparison between men and women within households, the data utilized in this paper does not include women in female-headed households or men in male-headed household with no female spouse. Table 1 presents a summary of the sample of households utilized for analysis in this study by surveyed county.

[Table 1 here]

3.1. Household and farm characteristics

Table 2 compares selected household and farm characteristics for households producing vegetables exclusively for the export market to those producing for the domestic market. Complete summary statistics for all the different market categories are provided in Table A.1. We begin by looking at the household welfare outcomes of interest in this study: per adult

¹ The survey was a follow-up of a study conducted in 2005/2006 for an ICIPE project on the “Economic Impact Assessment in Horticulture” Asfaw *et al.* (2009), Asfaw *et al.* (2010a), (Asfaw *et al.*, 2010b), (Muriithi and Matz, 2015, 2014) provide further details on the study area and data collection procedure.



equivalent income, per adult equivalent non-land asset index, per adult equivalent food and clothing expenditure and expenditure on school fees and health care. Household income comprises of sales revenue from crops and livestock, business profits, remittances and salaries of all household members. Household non-land asset are measured using an index constructed using Principal Component Analysis (PCA) following Henry et al. (2003), Rutstein and Johnson, (2004), and Zeller et al. (2006). The assets include livestock assets of all types, agricultural assets, productive durables, consumer durables and dwelling assets². None of the differences in income, assets and expenditures between the export and domestic markets suppliers is statistically significant.

Similarly, none of the demographic characteristics seems to be statistically significantly different between the export and domestic market suppliers. More domestic market suppliers receive remittances than export market suppliers. On average, export market suppliers own less land than domestic market suppliers. While the difference in cultivated land is not statistically different, domestic market suppliers have more land allocated to vegetables than export market suppliers. A possible reason is that domestic vegetables are not as land intensive as export vegetables and therefore needs more space to fetch higher value in comparison to export market vegetables. Producers of export market are more likely to own cash crop and fertile land than producers of the domestic market. In addition, producers for the export market are closer to the market town than those of the domestic market.

Social capital is observed as an important determinant of women participation in commercial agriculture (Njuki et al., 2011). In this study, social capital proxies include female membership in a social group, household membership in a producer group (lagged), female extension contract, and female access to training in vegetable production and marketing. While female membership in social groups and household membership in producer group are not significantly different across the two groups, more female members in households producing vegetables for the export market received extension contact and vegetable training in comparison to domestic market producers.

² Livestock assets includes calves, cow, heifers, oxen, bulls, chicken, sheep, goats, rabbit; Agricultural assets includes Spray pump, sprinkler, hose pipes, water pump, watering cans; Productive assets comprise of Milking equipment, solar panels, batteries, store, sewing machines, refrigerators, car, cart, weighing machine, water tank; and consumer assets include TV, radio, furniture, motorcycles, bicycle and cookers ((Muriithi and Matz, 2015)

[Table 2 here]

Weather shocks and weather risks are observed as important determinants of agricultural production and thus farm income (Hertel and Rosch, 2010; Muriithi and Matz, 2015). These variables are included in this study as annual rainfall (*Rainfall*) and during the year prior to the survey and as the variability of rainfall during the year of the survey (*Rainfall CoV*) respectively. (Muriithi and Matz, 2015). Producers for the export vegetable market received statistically significantly higher rainfall than producers for the domestic market, while weather risk is not different between the two groups.

Asset ownership considered as measure of welfare, which reflects the household's long-term capacity to manage risk and meet its consumption requirement (Moser and Felton, 2007). Female asset ownership can thus enhance their participation in commercial farm activities such as vegetable production. Female ownership of non-land assets is significantly higher in households producing vegetables for the export market in comparison to those producing for the domestic market. When we disaggregate specific assets categories by gender of the household member who owns the asset, we find that exclusive female ownership share of most assets across all categories are less than 50 percent, with the highest share being agricultural assets (41%) and the least share consumer assets (4%).

3.2. *Gender roles in the commercialization of vegetable farming*

Understanding how commercialization of small-scale farming activities affects the gender management of labour and land resources, income flows, expenditure patterns, food and nutritional security, and gender relationship is essential for addressing poverty in the rural communities (FAO et al., 2010). This section assesses the role of female and male members of the households in vegetable commercialization. The focus is on ownership and management of vegetable plots, membership in farmer associations, and access to information through trainings or extension services on vegetable production and marketing and access to agricultural credit. Further examined in this section is division of labour resources and control of income generated from vegetable sales.



3.2.1 Ownership and management of vegetable plots

Decisions on utilization land, including selling and leasing, are mainly taken by men across all surveyed counties, together with using land as collateral to obtain loans. Men also dominated in decision making regarding the type of commercial vegetable crops to plant and the size of land to allocate to each farm enterprise. In regions where export vegetables contribute a relatively higher share of household income, men have greater influence on production of such vegetables while women have almost full control over production of vegetables for the domestic market. Figure 1 shows gender composition of intra-household ownership and management of vegetable plots by crop, using two major vegetables produced mainly for the export market and four types of vegetables for the domestic market. On average, men own over 83 percent of the vegetable plots across for both export and domestic markets. Men equally dominate in management of all vegetable plots, although women have a substantial share, especially for vegetables produced for domestic market. Men typically manage production of vegetable with higher average returns, and organized marketing channels, which in our case includes export vegetables and high-value domestic vegetables such as tomatoes and cabbages.

[Figure 1 here]

Household member who manages a plot allocated to specific vegetable makes the decision on the choice of marketing channel to sell the produce. In cases where a plot is jointly owned or/and managed, men consult their wives on the choice of market, but they have a stronger influence on the outcome. This is common where a household had no prior contact with the buyer contrary to the case of contract farming for export vegetable crops.

3.2.2 Participation and registration in producer groups and access to training and extension services

Women in developing countries are often discriminated against in accessing agricultural information (Temu and Temu, 2005). In the current study, access to information was captured through household registration and participation in farmer groups and participation in horticultural trainings and extension contacts over the past 12 months. Among the households registered with a horticultural production and marketing group, only 20 percent of the registered members were female, compared to 68 percent male. Similarly more male members participated

in those groups (i.e. attending meetings and other group activities) in comparison to female members (59% and 33% respectively). Women exclusion from attaining farmer group membership was also confirmed during the focus group discussion where over half of the women participants reported that they had to consult their husbands before joining a group. Unfortunately, the consent is not always granted. However, in contrast to the requirement of land ownership to join a farmer group (which was the case five years ago), PMO membership regulations have been modified to give men and women equal opportunities to join producer groups.³ This has not however been well received by men and has led to family conflicts. In Nyeri county for example, men claimed their spouses were “over-empowered” when they become members in such groups as they receive their proceeds without involving their husbands. A similar observation was also made by in Meru county in a framework of a project that seeks to promote high-value banana varieties through collective action (Miriti et al., 2011). To ensure that registered female members are rewarded for their efforts, most of the PMOs require members to have a bank account through which proceeds are paid. This also provides women the opportunity to operate a bank account, a responsibility that many rural women had not previously embraced. Ownership of bank accounts among rural women can be interpreted as a process empowerment of women as it allows them to control the income generated from their farm enterprises as well as save for future needs. Although the decision to open a bank may sometimes dictated by the PMO requirements or vegetable buyer, men have strong influence over whose bank account the crop proceeds are paid. Lack of market information is a major challenge that contributes to low participation of women in the commercial production of vegetables as was observed in the study area.

Women deprivation to agricultural information was also evident in access to horticultural training and extension services. More male household members attended trainings (62%) and received extension contact (63%) in comparison to female members (34% for both case). Men mainly rely on formal information sources, whereas women mostly rely on informal sources.

³ In the early 2000s when PMO were reorganized to comply with GlobalGap standards, the registered PMO members had to be the owner of the farm where vegetables are produced, which is typically the man. Equally, the registered member received proceeds from sales. This arrangement denied women the opportunity to directly control income derived from high-value markets. Currently women are not required to provide proof of legal ownership of land to register with a PMO, implying that they can rent land for this purpose. This is an evolving concept which in some communities is highly contested.

This is demonstrated from the survey where more men (63%) received extension contact in comparison to women (34%). In addition to formal information channels, men exchange information informally while socializing with their friends, especially in social joints where they meet after work. Women on the other hand access information mainly through informal sources, such as neighbors, and community women's groups and friends, which sometime provide incomplete information.

3.2.3 Access to inputs and agricultural credit

Limited access to productive resources such as land presents a barrier to women for acquiring credit through the formal channels. The qualitative work of this study revealed that men take the lead role in accessing agricultural inputs. Men typically determine the type and amount of fertilizers, pesticides and other farm inputs to be purchased, except in the few cases where women are more skilled in the utilization of those inputs. Men also typically control water for irrigation and credit access. Out of 37 percent of the households that reported to have received credit for agricultural activities for the last 12 months, more men (54%) received the credit compared to women (44%). However, over 80 percent of this credit was provided by produce buyers, in the form of inputs and the cost deducted from sales.

Generally, financial credit is very low given the current abundance of micro-finance institutions in rural areas of Kenya. Traders and PMOs were mentioned as the most important sources of financial credit for smallholder vegetable producers in the survey areas. The widespread lack of the collateral - legal land titles- was observed as an important constraint of women's ability to access credit through commercial banks. Generally, men and women cited the fear of being unable to pay loans as the reason for not negotiating loans through banks or micro-finance organizations. The issue of being unable to pay was mainly attributed to uncertainty inherent to production of vegetables, as they are biologically sensitive to adverse environmental conditions such as drought, pests and diseases, as well as commercial vulnerability to erratic market prices. In addition, most farmers perceived that credit from commercial banks was too expensive. It was also clear during the focus group discussions that women lacked information on existing loans. Lack of capital to purchase farm inputs results to reduced productivity of women's labour in horticultural farming.

3.2.4 Division of labour in vegetable production

Vegetable production is a labour intensive activity and requires extra effort during peak periods, especially in seasons when production of vegetables and other cash crops overlaps. Past studies have observed that men usually decide when and who to hire during those peak labour requirement periods (Dolan, 2001). In so doing, they often allot more labour to their own plots (Udry, 1996; Ndiritu et al., 2014). In this study, it was observed that despite the fact that both men and women are capable of participating in any of the production and harvesting activities for vegetables, cultural constructs determine the gender division of labor. Men are usually responsible for manual tasks that require greater physical exertion, such as tilling. They also usually take responsibility for irrigating crops and application of fertilizers and pesticides. Some of these activities require knowledge and skills, which men gain from trainings and extension contacts. Men are also in charge of seeking for market information. Although women support their husbands in some of these tasks, they are particularly responsible for activities that require deftness and attention such as planting, weeding, and harvesting as well as transporting produce to collection centers. Figure 2 shows the gender contributions to family labour inputs in the production and marketing of commercialized vegetables.

[Figure 2 here]

Female household members spend more time on commercial vegetable crops than male members as demonstrated by significant differences in the number of labour hours spent in production of export market vegetables between female and male household members (28 and 21 hours per week respectively). However, labour input sharing between male and female household members is evident among farmers specializing in production of domestic market vegetables and those supplying both the domestic and export markets. With respect to the total sample, there is no difference between female labour input in vegetable production and marketing (25 hours per week), compared to male labour input (22 hours per week). Generally, the results of this study agree with previous studies that female household members are likely to spend more time on commercial vegetable crops than male household members (Dolan, 2001)).

Across the survey districts, households grow other cash crops such as tea, coffee and rice, which demand significant labour inputs during peak periods such as harvesting. Women however mainly perform such tasks. The same applies to vegetable harvesting, a task that is culturally

constructed to be a female job. The alternative to family labour is hired labor, whose cost has doubled over the last five years due to wages increases (Muriithi and Matz, 2014). Women lack of economic resources to hire extra effort to substitute some of their work needs. Women indicated that health problems related to irrigating their plots and spraying chemicals, which constrained them from participating in horticultural commercialization. Excess use of chemicals among export market households has significant health implications as discussed by Asfaw et al. (2010a). During the dry seasons when water is rationed, crops must be irrigated at dawn. Cold temperatures occurring during the morning hours are unfavorable to women. Women also face labour constraints, which as well limit women from attending agricultural training or participating in other community development activities.

3.2.5 Participation in vegetable marketing and control of the benefits

Control of income from vegetables sales is a critical factor in women's ability to empower themselves and improve their family welfare. Although workloads are shared between men and women, women have limited access and control over the benefits. This reflects gender inequality in production of vegetables and benefit sharing, as we will illustrate below. The nature of market orientation differs between women and men. Access to market information through formal sources enables men to negotiate for higher prices for their produce, while women often take prices offered at farm gate. In some cases, men travel to secure higher prices for their produce or contact traders from distance places who offer them better prices, while women prefer selling to traders and consumers whom they can reach on foot or at farm gate.

The analysis shows significant differences in the proportion of households in which women received money from sales across different types of vegetables (Figure 3). Generally, men received most income from export market vegetables. In 35 percent of the households that produced French beans for example, women exclusively received money from sales, while men received the money in 59percent of the households. Similarly, male household members received money from vegetables that fetch higher returns in the domestic market such as Irish potatoes, cabbages and tomatoes. On the other hand, the percentage of households in which women exclusively received money from kale sales was higher (71%) compared to men (25%). Kales however generated lower average returns compared to other vegetables. The results support previous research findings that women are likely to receive and control income from



commodities that generate lower average revenues, whereas men dominate commodities with higher revenues and that are often sold in formal markets (Njuki et al., 2011).

[Figure 3 here]

In terms of the management of vegetable income, men autonomously manage a bigger share of income from both export market vegetables (26%) and domestic market vegetables (28%). The qualitative information collected during the survey revealed that in most cases, while men do not disclose to their wives the amount of income they receive from the sale of vegetables, women are required to reveal their earnings and together they decide how it is spent. As a result, women sometimes choose to sell smaller quantities in secret, for example selling part of their export vegetable crops to brokers, while the household has a contractual arrangement with an exporter. This is often referred to as side selling, a common practice among smallholders which threatens the sustainability of existing contractual relationships with exporters. Like in many parts of Kenya, majority of women in the study area do not have the legal rights to household land. Instead, they receive usufruct rights which limit them to perform certain transactions. These land-use rights given to women are withdrawn if women contest their husband's demands of joint-management of income generated by women. As noted by Dolan, (2001) among vegetable growers in Meru district, and recently by Miriti et al. (2011) among banana growers in the same region, horticultural commercialization has in this region brought about matrimonial conflicts. While men claim returns from their land, women claim for returns from their labour. Such disagreements may result in negative social and economic implications ((Dolan, 2001; Miriti et al., 2011). Miriti et al. (2011) observe that in some cases where women have successfully been able to retain income from banana enterprises, their husbands have withdrawn their contribution to the household budget, resulting to breakdown of marriages as men resent the fact that women are withholding their banana proceeds.

The share of income managed by women is mainly spent on food and children requirements such as clothes. A significant share of income managed by men is used to purchase adult goods such as beer and other expenditures that do not benefit the family. Women's responsibility for household food security and childcare was also highlighted during the focus group discussions in which women ranked food and clothing as their first and second expenditure priorities for income received from vegetable sales. Income managed jointly by men

and women is mainly spent on common household expenditures such as school fees, house improvements and other household investments.

Generally, control over income between men and women depend on the level of production and income earned. Women are less likely to control high-value vegetables, especially when vegetables that contribute a significant proportion to the total household income. High levels of vegetable commercialization contribute to male control over vegetable production and revenues. Qualitative information gathered in the field revealed that with vegetables and other horticultural enterprises (such as bananas in Meru) enduring to be key source of household income due to improved and efficient marketing systems (increased number of traders and organized marketing arrangements), the control of horticultural produce income has changed from women to men. Vegetables income has increased quickly surpassing the traditional cash crops, often under the domain of men, such as coffee, tea and pyrethrum.

4. Empirical approaches and results

The descriptive statistics revealed that expenditure patterns of men differ from those of women as well as other gender roles related to intra-household resource allocation and management of vegetable revenues. As elaborated in the introduction section of this study, previous studies suggest that income earned and controlled by women has different effects on household expenditure patterns compared to income earned by men. In this section, the implications of female participation in the commercialization of vegetables on selected household welfare outcomes and the determinants of female participation in the commercialization of vegetables are explored.

Assume a regression model that relates household welfare outcome, Y , for household, i , and female participation in the commercialization of vegetables given as follows,

$$Y_i = \mathbf{X}_i' \boldsymbol{\beta} + \alpha_{1i} WP_{ji} + \alpha_{2i} WI_{ji} + \varepsilon_i \quad i=1, \dots, N; j=\text{export market, domestic market} \quad (1)$$

where \mathbf{X} is a vector of exogenous household and village variables that are likely to affect household welfare outcome Y for household i , WP_{ji} is a dummy variable given as 1 if a female member of household i is the manager of a market vegetable plot j . WI_{ji} , is the share of vegetable

income derived from vegetable plot j that is managed by a female household member and ε is the error term that contains unobserved factors that influence the outcome Y . In order to get a better understanding of the implications of female participation in commercialization, a range of household welfare outcomes are considered. These include; per adult equivalent income, per adult equivalent non-land assets, per adult equivalent food and clothing expenditures and household expenditures on school fees and health.

In this analysis, we are confronted with endogeneity problem due to simultaneity bias. This implies that there could be factors that influence Y through WP and WI , rendering them endogenous in Equation (1). Estimating the above model using OLS therefore may result to biased estimates of α_1 and α_2 . The endogenous variables can be expressed as follows:

$$WP_{ji} = \theta_i Z_i + \mu_{1i} \quad (2)$$

$$WI_{ji} = \theta_i Z_i + \mu_{2i} \quad (3)$$

where Z_i is a vector of variables that affect women's production decisions and management of revenues generated from the sale of vegetables. Z_i contains X and other variables that are correlated with female participation in the commercialization of vegetables, but not with household welfare outcomes. In this case, the assumption is that the covariance of error terms for the participation Equations. (2) and (3) are correlated with error term of the household welfare outcome. A possible solution is to use an instrumental variable approach. This involves using two-stage least squares (2SLS) where Equations. (2) and (3) are estimated in the first stage using a linear or non-linear model and then Equation (1) is estimated in the second stage. The two-stage least square model relies on the central limit theorem and is considered robust, even with dummy endogenous variables conditional on the identification of valid instruments (Wooldridge, 2002). In this regard, because WP is a dummy variable, it can be estimated using an IV approach. However, WI is a functional form model, which is censored at zero since only some female household members manage a certain proportion of income generated from sale of vegetables. In this case, an IV approach may not be suitable. An alternative approach is the Control Function approach. Similarly, to the IV approach, this method involves two stages where the exclusion restriction applies in the first stage. The first stage is estimated using a Probit

model for dummy dependent variables to obtain probit residues ($\hat{\mu}_{1j}$) and using the Tobit model for censored dependent variables to obtain tobit residues ($\hat{\mu}_{2j}$). Unlike the IV approach, in the second stage, the structural model (Equation (1)) is estimated with the observed endogenous variables and the residuals from the first stage as explanatory variables. Equation (1) is therefore estimated as;⁴

$$Y_{ik} = \mathbf{X}\beta + \alpha_{1i}WP_{ji} + \alpha_{2i}WI_{ji} + \psi_1 \hat{\mu}_{1j} + \psi_2 \hat{\mu}_{2j} + \varepsilon_i \quad (4)$$

The control variable approach in this context is superior to the IV approach as it also accounts for omitted variables, which may influence female participation but not household welfare outcome. The test for endogeneity is the statistical significance test of the coefficient of the residuals estimated using bootstrapped standard errors (Heckman and Robb, 1985). Control variable approach will be utilized for the analysis in this study.

4.1. Identification of the female participation equations

After establishing the appropriate regression method, the next step is to establish the variables that correlate with female participation in the commercialization of vegetables but not with household welfare outcome in order identify Equations. (2) and (3). Such variables can also be viewed as instrumental variables (IVs) for female participation. Identification of instruments for female participation in agriculture is difficult and particularly so in the context of rural Africa where most production and marketing decisions are dominated by household heads who are usually male household members. Considering the two indicators used in this study as measures for female bargaining power in horticultural commercialization, they can be related to different instrumental variables used by other authors to measure female bargaining power in rural contexts. It is important to note that these instruments are selected based on the context of the study which may vary from one location to another depending on cultural, social and economic activities as well as geographical and agro-ecological conditions (Quisumbing and de La Brière,

⁴ Addressing endogeneity in health econometric modeling, (Terza et al., 2008) find two-stage residual inclusion, which follows same procedure as control function approach consistent, while the two-stage predictor substitution, whose procedure is similar to that of the 2SLS, inconsistent.



2000). The instruments are also based on the measure of bargaining power being considered.⁵ Rainfall patterns for example have been used as instruments for individual household member agricultural income on household expenditure patterns, for example by Doss (2001) in Ghana and Duflo and Udry (2004) in Cote d'Ivoire. Osmani (2007) uses the size of labour, number of dependents, and principal occupation of the household head to instrument female participation in a micro-credit program focused on land ownership and non-land assets in Bangladesh. To establish the relationship between women's assets and shares of household expenditures on children's clothing and education in Bangladesh, Quisumbing and de La Brière (2000) instrument their current assets along with assets owned at the time of marriage. Further, the authors use various household characteristics such as education and age of the husband and wife, number of siblings, and land holdings of the wife's parents as instruments for women assets at the time of marriage.

Based on these past studies and on the context of this study, various potential instrumental variables are identified. These instruments are related to the production and marketing decisions and various indicators of intra-household resource allocation. For example, women are labour constrained due to multiple responsibilities at home and on the farm. As such, we use the size of labour measured as the number of adult females in the household and number of children less than five years old. A large female labour size is expected to have positive influence female participation in vegetable plot management and revenue.

Second, we relate market decisions to infrastructure, which is reflected by type of road, distance to the nearest market town and the square of it and division level prices for two important domestic market vegetables and two important export market vegetables. These variables are directly related to market opportunities for farm enterprises, which may directly affect women position in the production and marketing decisions relative to men. This is based on past studies observations that new market opportunities reduce the role of women in the commercialization of farm enterprises. Maize prices and the size of cultivated land allocated to maize are also included to account for food sufficiency. The inclusion of maize variables, a

⁵ Measures or indicators of bargaining power include income, employment, assets, human capital, decision-making, altitude, and other measures such as participation in projects (Doss, 2001). In our analysis, the two measures of women's participation in the commercialization of vegetables represent their bargaining power in the commercialization of vegetables.



staple crop in Kenya, is based on the presumption that women's participation in market activities is likely to have negative effects on food security and nutrition at household level.

In addition, indicators of human capital that could influence women's bargaining power, are included in the analysis. These include education of the female spouse and female membership in social groups. Education and membership in social groups may enhance information access, and thus improve female participation in vegetable commercialization. Age of the female spouse may also influence bargaining power and thus included in the estimation. The primary activity of the household head may have an influence on female participation in horticultural activities. Since the current primary activity may be correlated with the household welfare outcome, we use the primary activity five years prior to this survey, which we easily obtain from the dataset collected from the same households in 2005/2006. For export market households, a lagged group membership of the household in a producer and marketing group is also included.

4.2 Determinants of women's participation in the commercialization of horticulture

Before discussing household well-being implications of female participation in commercialization of vegetables, we report the results from the first stage of the control function approach (Equations. (2) and (3)) for each market pathway. In the first stage, we use all of the variables, including those hypothesized to influence household well-being outcomes and the instruments used to identify participation equations. The results are given in Table 3. The table presents the Probit model estimates of the determinants of female participation in production decisions: management of export vegetable plots (model [1]), and the management of domestic vegetable plots (model [2]). In addition, Table 3 presents the Tobit regression estimates of the determinants of the share of revenue generated from export and domestic market vegetable sales that is managed by female members of the household; export market vegetables (model [3]) and domestic market vegetables (model [4]).⁶

Table 3 shows that female management of export vegetable plots is positively related to the size of land cultivated, the share of cultivated land allocated to vegetables, and distance to

⁶ Prior to running the models, a test is conducted to detect the problem of multicollinearity between the variables included in the analysis. The results depict no strong correlation since the values of Variance Inflation Factor (VIF) are by far less than 10.

market town (model [1]). Furthermore, the results support the expectation of this study that female access to extension services and training on vegetable production are positive and significantly related to female management of export vegetable plots. (World Bank et al., 2009) observe that in countries where agriculture is a major source of employment for women, like in Sub-Saharan countries, capacity building, vocational training and extension services addressing relevant skills and knowledge gaps have been found to be pertinent. The lagged household group membership variable also shows a positive relationship to female management of export vegetable plots. The probability of female member to manage an export vegetable plot decreases with increase in age of the male head, increase in size of land owned, and increase area allocated to maize and potato prices. Increase in size of cultivated land allocated to maize, a staple food in Kenya, may draw away women from commercial vegetable production as they seek to provide food security to their families with little resources left for production of commercial crops.

[Table 3 here]

Female participation in the management of domestic vegetable plots is positively related to the availability of remittances (model [2]), which can be interpreted as a source of capital for the commercialization of vegetables. As expected, a female household member is likely to manage vegetable plots where the household head's major activity is non-farm. In agreement with the descriptive statistics, female household members are likely to manage vegetable plots if the household is engaged in the production of other cash crops like coffee and tea, which in most cases are under the domain of the male household members. The amount of labour given in the analysis as the number of female adults in the household is also positively related to female participation in the management of domestic vegetable plots, as well as the share of cultivated land allocated to vegetables. This is plausible since vegetables are labour intensive and women as demonstrated earlier in Figure 2 carry out most of the activities.

The share of revenues from the sale of export market vegetables managed by female members of the household is positively related to the number of children attending school, total land cultivated, total number of female adults in the household, and female access to extension services (model [3]). The positive association between the size of land cultivated and the share of export market revenues controlled by a female household member could be an indication of women's compensation for their labour input in production of vegetables and other crops.

Female access to extension services is expected to equip women with production and marketing skills that could influence management of vegetable sales. On the other hand, the share of revenues from the sale of export market vegetables is a decreasing function of household size, total land owned, and maize prices. This finding agrees with Fischer and Qaim (2012a) who find farm size to be negatively related to the share of banana income that is managed by female household members. Increase in maize prices could be negatively related to the share of revenue managed by females in two ways. On one hand, increase in maize prices may enhance the opportunity cost of vegetable production inducing a household to shift labour and land resources to production of maize and thus reducing income from the commercialization of vegetables. From a different perspective, a bigger share of the jointly managed income could be directed to the purchase of food thus reducing the share of income managed by different members of the household. This later argument however holds if the unitary intra-household model is assumed.

The share of revenues from domestic market vegetable sales are positively and statistically significantly related to household access to unearned income (remittances), the share of cultivated land allocated to vegetable production and the number of female adults in the household (model [4]). The positive relationship between land allocated to commercial crop production and female control over revenues agrees with the findings of Fischer and Qaim (2012a). Larger land area cultivated could be related to high female labour input, which may translate into a bigger share of vegetable income controlled by women. As expected, the price of cabbage, one of the important domestic vegetables is negatively related to the share of revenues from sale of domestic vegetables managed by women. This agrees with our expectation that increase in the profitability of farm enterprises may reduce the role of women even if they were the main contributors of farm production before the change. Female participation in social groups such as village women's groups decreases their share of domestic vegetable sales. Participation in social groups provides women with potential source of income for example ROSCAs (Rotating Savings and Credit Associations). Consequently, such groups may provide incentives for less demand of the income generated from crop sales among women.

4.3 Female participation in commercial horticulture and household well-being

Table 4 provides the second stage regression estimates of the control variable approach (Equation (4)). The estimates provided relate female participation in the commercialization of

vegetables and household well-being outcomes. The results are provided for the four categories of household welfare outcomes measured at per adult equivalent level: non-land assets (model (1)), income (model (2)), and food and clothing expenditure (model (3)). The fourth category of household well-being is monthly household expenditures on school fees and health care (model (4)).

[Table 4 here]

Non-land assets are an index calculated as explained in Section 3.1, while the rest of the household welfare outcomes are calculated in monetary values. The coefficients of some of the residual variables are statistically significant implying that female participation is endogenous and therefore it is important to address them. The residuals utilized from the first stage are from all the four models presented in Table 3.

From the above regression analysis, all of the estimates indicate that female participation in the commercialization of horticulture, both in plot management and revenue do not appear to influence per adult equivalent non-land assets and income. Although not statistically significant, the share of female managed revenue from both export and domestic vegetable markets is positively related to expenditures on children school fees and health care, which agrees with past studies, which observe that women invest in food and child needs before they can make any investment in physical assets (Njuki et al., 2011). On the other hand, female management of both export and domestic markets vegetable plots show a negative relationship on expenditure on food and clothing, but statistically significant only for management of export vegetable plot. Similarly, management of both plots for export and domestic vegetable plots depicts negative relationship with expenditure on fees and health care, however statistically significant only for management of plots for domestic market vegetables. The above findings give an indication of the limited economic returns generated from women-managed enterprises that perhaps could be attributed to low access to inputs and market information as discussed in the descriptive analysis section.

5. Conclusions and policy implications

This study discusses gender roles and constraints in smallholder commercialization of horticultural farming through both the export and domestic market supply chains. Further, motivated by the hypothetical collective household model, the study has applied empirical

models to determine factors that influence female participation in the commercialization of horticulture and implications on household well-being.

Generally, control over income between men and women depend on the level of production and income earned. Women are more likely to control income from less profitable vegetable enterprises. These are vegetables produced primarily for the domestic market, while men have more control over vegetables supplied to the export market. Persistent gender disparities constrain women from accessing productive resources as demonstrated using patterns of gender roles in commercialization of horticulture. Women are deprived of access to land, irrigation water, agricultural credit, production and marketing information, and extension services.

Empirical results confirm the hypothesis of this study that female training on vegetable production and marketing, extension services and membership in farmer groups contribute positively to management of export vegetable plots by women. This underlies the importance of skill building in women to ensure that they do not lose control of those agricultural commodities that are traditionally under their domain once they become commercialized. Female participation in production and revenue control did not seem to have any influence on the ownership of non-land assets and per adult equivalent income, while female management of vegetable plots depicts negative relationship with household expenditure on food and clothing, and school fees and health care. This could suggest that women generate limited economic returns from enterprises left under their responsibility to create impact perhaps due to the lack of access to resources such as capital and market information. The implications for commercialization-led development of these findings are that gender considerations should be incorporated in the selection of agricultural commodities. This involves identifying commodity preferences and the role of men and women at different stages of the supply chains of these commodities, as well as identifying constraints and opportunities for men and women as relates to intra-household relations. Both men and women should be integrated into vegetable supply chains, and provided with gender training, to prevent negative intra-household effects of market development and commercialization programmes. Organizing mixed gender farmer groups as opposed to single-gender groups that result in intra-household conflicts in the management of resources and income for example should be encouraged. Membership rules of farmer groups and associations



should allow multiple members of households to register instead of just one member per household. Commercialization-related projects need to ensure that women do not lose control of crops and income to reduce negative market–household welfare trade-offs as observed during the field survey.

The empirical model applied in this study has tried to address the endogeneity problems that are likely to give biased results. However, as with many cross-section data sets and with a limited sample size, the findings are only limited to the study area and broad generalization should be discouraged because the results are case specific. Moreover, heterogeneity between regions in terms of the types of marketing channels, socioeconomic conditions, and culture may differ considerably from one situation to another. Further research should therefore explore gender dynamics using panel data, and focus on different types of crops and supply chains to provide better understanding on gender roles and their implications on household wellbeing.

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Tables

Table 1: Description of the survey sample by county

County of survey	Total Sample	Domestic market suppliers	Export market suppliers	Both domestic and export market suppliers	Non-sellers
Kirinyaga	76	24	12	21	19
Makueni	23	15	0	2	6
Meru	68	22	17	12	17
Murang'a	24	7	7	6	4
Nyeri	74	42	5	25	2
Total	265	110	41	66	48

Source: 2011 field survey data

Table 2: Selected household and farm characteristics of survey participants

		Domestic market participants (n=110)		Export market participants (n=41)		Difference (domestic – export)
		Mean	SD	Mean	SD	Diff
Per AE income	Per adult equivalent income (\$ per day)	1.819	4.612	1.823	2.218	-0.004
Per AE asset index	Per adult equivalent non-land asset index	0.928	0.777	0.749	0.380	0.1786
Per AE food & clothing	Per adult equivalent food & clothing expenditure (US\$ monthly)	18.7	36.7	12.7	7.3	6.076
Per AE fees & health care	Per adult equivalent expenditure on fees and health care (US \$ monthly)	24.1	120.8	10.5	14.6	13.630
Female export revenue	Female controlled export vegetables revenue (%)			20.4	36.9	
Female domestic revenue	Female controlled domestic vegetables revenue (%)	18.6	33.5			
Female export plot manager	Female export plot manager (binary: 1=yes)			0.4	0.5	
Female domestic plot manager	Female domestic plot manager (binary: 1=yes)	0.3	0.5			
Remittances	Remittances (1=Yes)	0.4	0.5	0.2	0.4	0.238***
Male head age	Age of male household head (years)	50.2	11.7	47.2	11.6	2.971
Female spouse age	Age of the female spouse (years)	43.4	12.2	41.6	10.4	1.836
Household size	Household size (adult equivalent)	5.6	2.3	5.7	2.0	-0.148
Dependency	Dependency ratio	1.3	0.8	1.4	0.6	-0.012
School children	School going children (count)	1.6	1.3	2.0	1.2	-0.382
Below five children	Children below 5 years (count)	0.3	0.5	0.4	0.5	-0.102
Female adults	Female adults (count)	1.3	0.8	1.4	0.7	-0.048
Male head education	Years of schooling of male household head	9.5	3.7	8.7	2.4	0.734
Female spouse education	Years of schooling of female spouse	8.4	3.1	9.0	2.8	-0.624
Head major activity in 2010	Head major activity in 2010 (1=Non-farm)	0.4	0.5	0.3	0.4	0.113
Owned land	Land owned (acres)	3.0	3.2	1.9	2.0	1.115**
Cultivated land	Land cultivated (acres)	2.2	2.1	1.8	2.0	0.436
Vegetable area	Vegetable area (% cultivated land)	44.0	28.6	35.6	24.5	8.379*
Cash crop	Cash crop (binary: 1=yes)	0.3	0.5	0.5	0.5	-0.176*
Fertile land	Fertile land (binary: 1=yes)	0.3	0.5	0.4	0.5	-0.148*
Shock	Experienced economic shock in past year (binary: 1=yes)	0.5	0.5	0.3	0.5	0.122
Market distance	Distant to market town (km)	3.7	3.8	2.0	1.5	1.727***
Road type	Road type (1=good)	0.7	0.5	0.5	0.5	0.182**
Female social group	Female member social groups (binary: 1=yes)	0.90	0.99	0.51	0.64	0.388
Head major activity in 2005	Head major activity in 2005 (binary: 1=Non-farm)	0.2	0.4	0.0	0.2	0.139**
Group member 2005	Producer group member 2005 (binary: 1=yes)	0.5	0.5	0.6	0.5	-0.089
Female extension contact	Female extension contact (binary: 1=yes)	0.1	0.3	0.2	0.4	-0.162***
Female vegetable training	Female vegetable training (binary: 1=yes)	0.1	0.2	0.2	0.4	-0.180***
Female non-land assets	Female non-land assets (%)	17.81	10.10	21.74	14.75	-3.929*
Jointly owned assets	Jointly owned assets (%)	35.46	32.77	31.35	32.49	4.114
Rainfall	Total annual rainfall (mm, lagged)	1007.7	102.8	1034.8	23.8	-321.8***
Rainfall CoV	Covariance of variation of rainfall (%)	54.27	6.79	56.11	5.81	-1.838
French beans price	French beans price (US \$/Kg)	0.64	0.39	0.56	0.26	0.077
Snow peas price	Snow peas price (US \$/Kg)	0.73	0.17	0.82	0.21	-0.087**
Potato price	Potato price (US\$/Kg)	0.25	0.06	0.27	0.05	-0.016
Cabbage price	Cabbage price (US \$/Kg)	0.14	0.07	0.14	0.04	-0.003
Maize area	Maize area (% cultivated land)	23.16	17.50	19.69	18.16	3.468
Maize price	Maize price (US \$/Kg)	0.28	0.10	0.30	0.08	-0.022

Notes: Tests for equality of means based on unpaired data with unequal variances and on households involved in the production of either the domestic or the domestic market exclusively. * p < 0.10, ** p < 0.05, *** p < 0.01.

Table 3: Determinants of female participation in the commercialization of horticulture

	<i>Probit regression estimates</i>		<i>Tobit regression estimates</i>	
	<i>Female export plot manager (dummy)</i>	<i>Female domestic plot manager (dummy)</i>	<i>Female export revenue (%)</i>	<i>Female domestic revenue (%)</i>
	[1]	[2]	[3]	[4]
Remittances	-0.674* (0.448)	0.564** (0.248)	22.5 (19.8)	34.53** (17.1)
Male head age	-0.256* (0.165)	-0.089 (0.088)	-3.39 (7.55)	2.41 (6.9)
Male head age squared	0.002* (0.001)	0.001 (0.001)	0.024 (0.07)	-0.03 (0.1)
Household size	0.054 (0.244)	-0.226 (0.158)	-20.39* (12.7)	-28.2** (11.6)
Dependency	0.643 (0.519)	0.145 (0.349)	-5.89 (26.9)	10.39 (29.1)
School children	-0.357 (0.390)	0.106 (0.240)	27.67* (18.8)	1.00 (17.5)
Male head education	0.022 (0.072)	0.057 (0.041)	2.89 (3.36)	2.09 (3.0)
Household major activity in 2010	1.80*** (0.516)	1.68*** (0.261)	8.21 (20.6)	2.64 (17.3)
Land owned	-1.44** (0.727)	0.027 (0.139)	-38.08* (25.9)	3.67 (9.5)
Cultivated land	1.512** (0.751)	-0.040 (0.170)	41.64* (27.2)	-0.91 (11.0)
Vegetable area	0.018** (0.009)	0.008* (0.005)	0.37 (0.39)	0.57* (0.3)
Cash crop	0.169 (0.461)	0.670** (0.286)	-11.43 (22.0)	-10.56 (20.2)
Fertile land	0.105 (0.432)	0.000 (0.260)	40.83** (19.8)	16.39 (17.7)
Rainfall	-0.006 (0.005)	0.000 (0.004)	0.13 (0.23)	-0.12 (0.2)
Rainfall CoV	-0.029 (0.049)	0.037 (0.039)	-0.50 (2.83)	1.04 (2.2)
Shock	0.258 (0.435)	0.247 (0.243)	20.21 (18.5)	4.60 (16.0)
Market distance	0.405** (0.191)	0.038 (0.102)	6.68 (7.42)	-0.02 (6.7)
Market distance (sq)	-1.66** (0.955)	-0.171 (0.503)	-33.30 (37.5)	12.30 (32.8)
Road type	0.108 (0.483)	-0.101 (0.274)	7.83 (21.4)	-31.20* (20.4)
Female adults	0.681 (0.680)	0.893** (0.410)	61.55** (32.3)	59.35** (29.8)
Female spouse age	0.127 (0.222)	0.104 (0.105)	9.65 (9.28)	4.77 (8.1)
Female spouse age (sq)	-0.001 (0.002)	-0.001 (0.001)	-0.08 (0.10)	-0.08 (0.1)
Female spouse education	-0.051 (0.080)	-0.078* (0.046)	-0.21 (3.66)	-3.01 (3.4)
Below five children	0.027 (0.542)	0.186 (0.249)	-24.19 (20.6)	16.23 (16.2)
French beans price (log)	-0.206 (0.570)	-0.107 (0.325)	-12.94 (22.6)	32.34 (23.0)
Snow peas price (log)	-0.632 (0.978)	-0.497 (0.553)	51.11 (40.0)	-35.79 (33.1)
Potatoes price (log)	-2.38** (1.032)	-0.128 (0.543)	12.09 (49.3)	15.65 (38.0)
Cabbage price (log)	-0.205 (0.680)	0.092 (0.351)	37.27 (28.3)	-51.29** (24.2)
Maize area	-0.023* (0.013)	-0.009 (0.008)	0.49 (0.55)	-0.36 (0.5)
Maize price (US \$/Kg)	-0.161 (0.626)	-0.096 (0.313)	-75.5*** (27.7)	-90.9*** (24.0)
Female social group	-0.162 (0.238)	0.093 (0.135)	-13.61 (11.7)	5.49 (9.0)
Head major activity in 2005	-1.697* (1.046)	-0.256 (0.385)	-11.27 (34.6)	15.85 (28.2)
Group member in 2005	0.964* (0.528)		-21.51 (19.3)	
Female extension contact	1.74*** (0.639)		57.8** (27.4)	
Female vegetable training	3.07*** (0.809)		6.99 (28.8)	
District fixed effects	Yes	Yes	Yes	Yes
Constant	4.481 (7.11)	-4.389 (4.36)	-382.4 (329)	-291.6 (296)
Number of observations	242	242	242	242
LR chi2(38) (export); LR chi2(35) (domestic)	145 ***	92.1***	50.4*	68.0***
Pseudo R2	0.65	0.32	0.07	0.08
Log likelihood	-38.9	-97.8	-331.3	-391.686

Note: Standard errors are presented in parenthesis. The prices of vegetables are taken at the divisional level

* p < 0.10, ** p < 0.05, *** p < 0.01.

Source: 2011 field data

Table 4: Second stage estimates for the control function model

	Per adult equivalent non- land assets (log) (1)	Per adult equivalent income (log) (2)	Per adult equivalent food and clothing expenditure (log) (3)	Expenditure on fees and health care (log) (4)
<i>Female export revenue</i>	0.0000 (0.0004)	-0.001 (0.002)	0.0001 (0.001)	0.001 (0.003)
<i>Female domestic revenue</i>	-0.0002 (0.0004)	-0.0005 (0.001)	-0.001 (0.001)	0.004 (0.003)
<i>Female export plot manager</i>	-0.033 (0.059)	-0.089 (0.168)	-0.092* (0.138)	-0.403 (0.365)
<i>Female domestic plot manager</i>	-0.032 (0.135)	-0.271 (0.352)	-0.614 (0.452)	-1.615* (0.916)
Remittances	-0.010 (0.034)	0.018 (0.100)	-0.077 (0.099)	-0.101 (0.233)
Male head age	-0.017* (0.012)	0.003 (0.031)	-0.062** (0.029)	-0.003 (0.056)
Male head age (squared)	0.0002* (0.0001)	-0.0001 (0.000)	0.001** (0.000)	0.000 (0.001)
Household size	-0.17*** (0.012)	-0.094*** (0.031)	-0.057* (0.036)	0.272*** (0.077)
Dependency	0.043 (0.045)	0.189* (0.103)	0.083 (0.114)	0.229 (0.268)
School children	-0.045* (0.028)	-0.173*** (0.066)	-0.050 (0.074)	-0.158 (0.178)
Male head education	0.006 (0.005)	0.025** (0.013)	0.038*** (0.013)	0.062* (0.033)
Head major activity in 2010	0.015 (0.065)	0.381** (0.181)	0.358* (0.226)	0.841* (0.466)
Owned land	0.077** (0.032)	0.097 (0.070)	0.154* (0.082)	0.483*** (0.134)
Cultivated land	-0.047 (0.035)	0.140* (0.079)	-0.113 (0.083)	-0.43*** (0.153)
Vegetable area	0.001 (0.001)	0.004** (0.002)	-0.0003 (0.002)	0.008** (0.004)
Cash crop	-0.008 (0.043)	0.144 (0.119)	0.153 (0.127)	0.205 (0.222)
Fertile land	0.042* (0.025)	0.196* (0.111)	-0.224** (0.093)	-0.50*** (0.202)
Rainfall	0.000 (0.001)	0.000 (0.002)	0.000 (0.003)	-0.002 (0.002)
Rainfall CoV	0.002 (0.006)	0.006 (0.017)	0.013 (0.024)	-0.034 (0.029)
Shock	-0.016 (0.027)	0.186* (0.099)	0.054 (0.086)	0.508*** (0.186)
ψ (female export revenue)	-0.0002 (0.0004)	-0.001 (0.001)	-0.001 (0.001)	-0.01*** (0.002)
ψ (female domestic revenue)	-0.0004 (0.0004)	-0.0004 (0.001)	-0.001 (0.001)	0.002 (0.002)
ψ (female export plot management)	-0.017 (0.044)	0.104 (0.114)	-0.039 (0.092)	0.099 (0.270)
ψ (female domestic plot management)	0.016 (0.073)	0.100 (0.213)	0.363 (0.260)	0.909* (0.550)
District fixed effects	Yes	Yes	Yes	Yes
Constant	1.143* (0.657)	5.765*** (1.887)	3.686* (2.163)	5.573* (3.415)
Number of observations	242	242	242	240
Wald chi2(27)	2837***	442***	141***	270***
R-squared	0.85	0.52	0.24	0.35

Note: probability levels; Bootstrapped standard errors are presented in parenthesis.

* p < 0.10, ** p < 0.05, *** p < 0.01.

Table A. 1 Selected household and farm characteristics of survey participants

	Domestic market participants (n=110)		Export market participants (n=41)		Both export and domestic market participants (n=66)		Non-sellers (n=48)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
<i>Per AE income</i>	1.819	4.612	1.823	2.218	1.801	3.572	1.270	1.535
<i>Per AE asset index</i>	0.928	0.777	0.749	0.380	0.747	0.327	0.773	0.398
<i>Per AE food & clothing</i>	18.7	36.7	12.7	7.3	14.2	9.4	14.9	16.7
<i>Per AE fees & health care</i>	24.1	120.8	10.5	14.6	9.1	9.9	12.5	24.7
<i>Female export revenue</i>			20.4	36.9	16.2	32.8		
<i>Female domestic revenue</i>	18.6	33.5			24.1	39.8		
<i>Female domestic plot manager</i>	0.3	0.5			0.4	0.5		
<i>Female export plot manager</i>			0.4	0.5	0.3	0.5		
<i>Remittances</i>	0.4	0.5	0.2	0.4	0.3	0.4	0.4	0.5
<i>Male head age</i>	50.2	11.7	47.2	11.6	47.9	11.1	54.3	13.1
<i>Female spouse age</i>	43.4	12.2	41.6	10.4	41.5	9.4	46.3	11.9
<i>Household size</i>	5.6	2.3	5.7	2.0	6.0	2.3	5.4	2.0
<i>Dependency</i>	1.3	0.8	1.4	0.6	1.1	0.5	1.3	0.9
<i>School children</i>	1.6	1.3	2.0	1.2	1.7	1.2	1.6	1.4
<i>Below five children</i>	0.3	0.5	0.4	0.5	0.3	0.6	0.3	0.5
<i>Female adults</i>	1.3	0.8	1.4	0.7	1.6	0.8	1.4	0.7
<i>Male head education</i>	9.5	3.7	8.7	2.4	9.6	2.9	8.9	3.5
<i>Female spouse education</i>	8.4	3.1	9.0	2.8	9.0	2.9	7.7	3.6
<i>Head major activity in 2010</i>	0.4	0.5	0.3	0.4	0.3	0.5	0.3	0.5
<i>Owned land</i>	3.0	3.2	1.9	2.0	2.6	2.3	3.1	3.0
<i>Cultivated land</i>	2.2	2.1	1.8	2.0	2.3	2.1	2.6	2.0
<i>Vegetable area</i>	44.0	28.6	35.6	24.5	60.2	30.2	7.6	12.3
<i>Cash crop</i>	0.3	0.5	0.5	0.5	0.4	0.5	0.3	0.5
<i>Fertile land</i>	0.3	0.5	0.4	0.5	0.3	0.5	0.2	0.4
<i>Shock</i>	0.5	0.5	0.3	0.5	0.4	0.5	0.5	0.5
<i>Market distance</i>	3.7	3.8	2.0	1.5	5.0	6.3	2.0	2.7
<i>Road type</i>	0.7	0.5	0.5	0.5	0.8	0.4	0.7	0.5
<i>Female social group</i>	0.90	0.99	0.51	0.64	0.64	0.78	0.75	0.84
<i>Head major activity in 2005</i>	0.2	0.4	0.0	0.2	0.1	0.3	0.1	0.2
<i>Group member 2005</i>	0.5	0.5	0.6	0.5	0.7	0.5	0.5	0.5
<i>Female extension contact</i>	0.1	0.3	0.2	0.4	0.2	0.4	0.0	0.0
<i>Female vegetable training</i>	0.1	0.2	0.2	0.4	0.2	0.4	0.0	0.0
<i>Female non-land assets</i>	17.81	10.10	21.74	14.75	19.23	14.78	23.11	13.44
<i>Jointly owned assets</i>	35.46	32.77	31.35	32.49	29.88	29.49	33.89	34.91
<i>Rainfall</i>	1007.7	102.8	1034.8	23.8	1041.1	85.2	982.6	129.1
<i>Rainfall CoV</i>	54.27	6.79	56.11	5.81	54.22	8.40	58.59	5.86
<i>French beans price</i>	0.64	0.39	0.56	0.26	0.49	0.19	0.46	0.18
<i>Snow peas price</i>	0.73	0.17	0.82	0.21	0.79	0.26	0.77	0.13
<i>Potato price</i>	0.25	0.06	0.27	0.05	0.25	0.06	0.26	0.04
<i>Cabbage price</i>	0.14	0.07	0.14	0.04	0.14	0.06	0.14	0.04
<i>Maize area</i>	23.16	17.50	19.69	18.16	18.66	15.76	30.20	21.62
<i>Maize price</i>	0.28	0.10	0.30	0.08	0.30	0.11	0.34	0.16

The exchange rate used is approximately KSh. 79 per US \$. Vegetable prices are taken at district level.

Source: 2011 field survey data

Figures

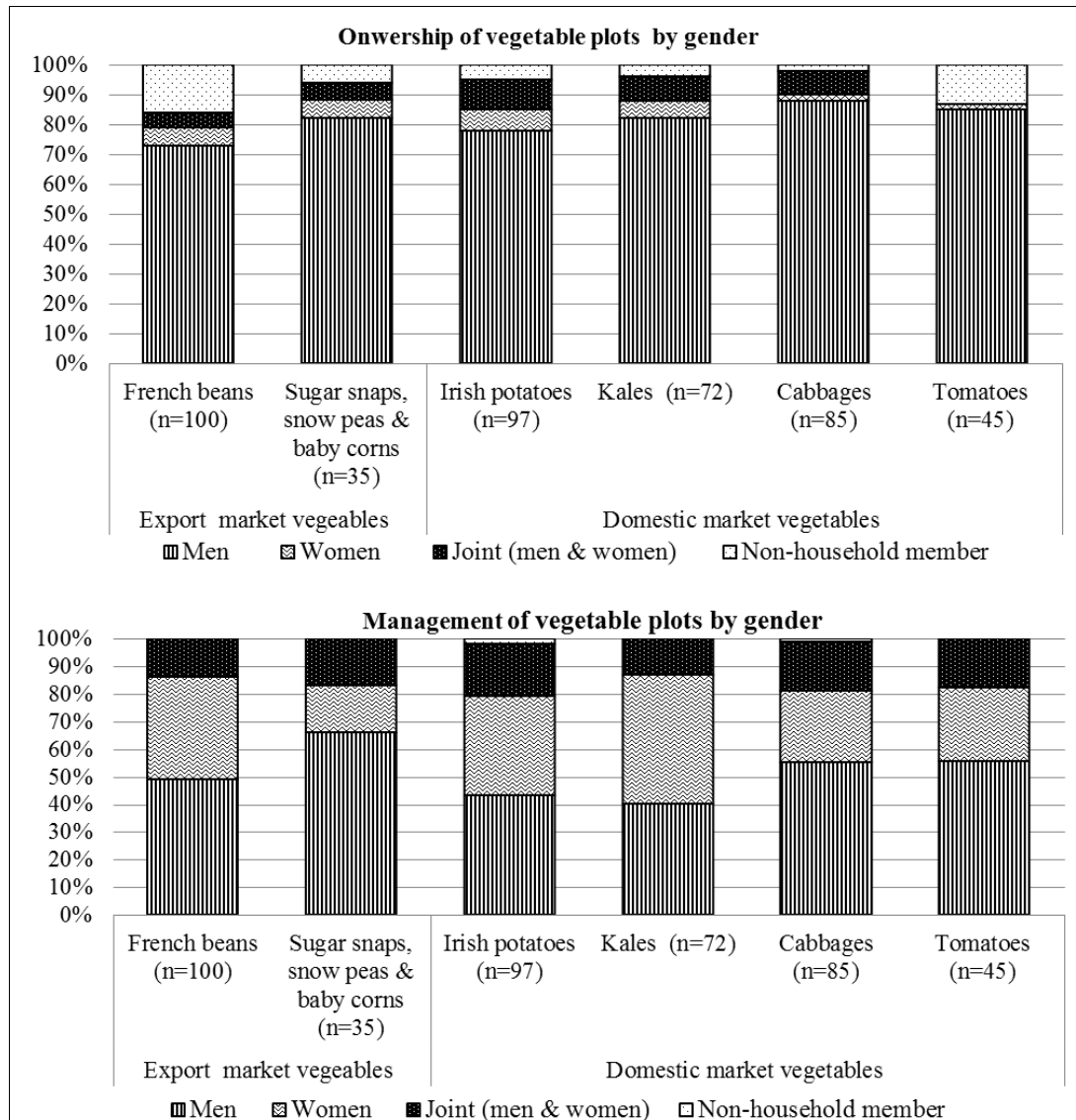


Figure 1: Intra-household ownership and management of vegetable plots by gender (% of households)

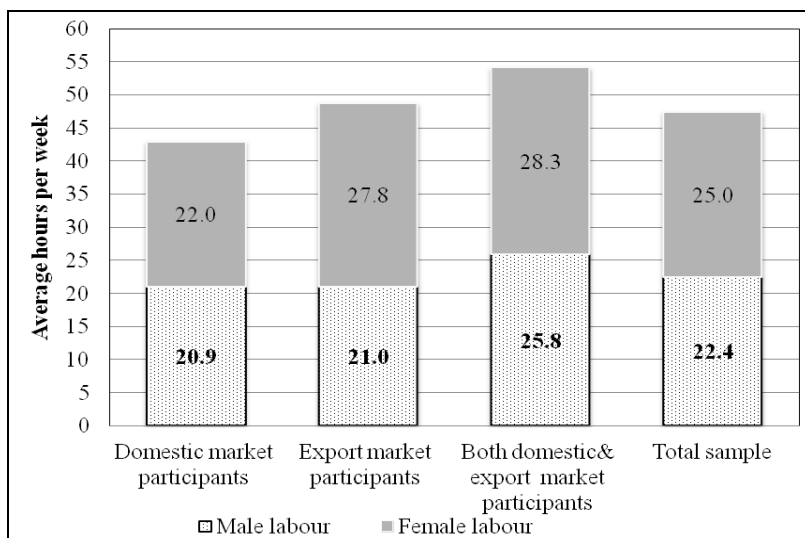


Figure 2: Gender division of labour input (hours/week) in commercial vegetable production

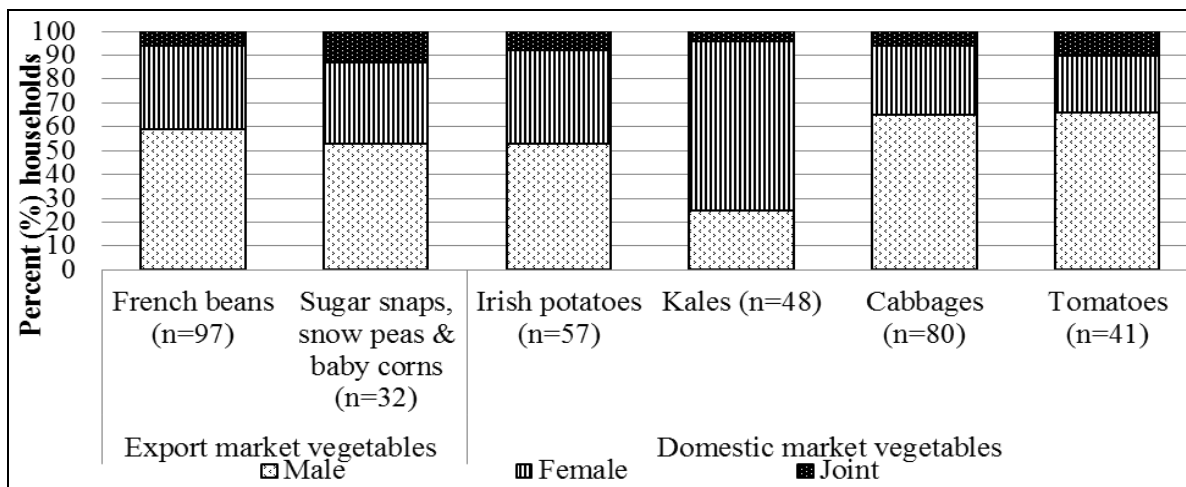


Figure 3: Income recipient by gender for different vegetable crops (% of households)