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Full Length Research Paper

Market participation by vegetable farmers in Kenya: A comparison of rural and peri-urban areas

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Transformations in agri-food systems provide prospects for improving livelihoods of many farmers through enhanced participation in commercial agriculture. Indeed, various studies have been undertaken to establish factors that influence the level of market orientation in different areas. However, those studies do not show appropriate objective criteria to support decisions for either separating or merging data and the subsequent analyses for different sites. Consequently, policy inferences made from such studies may be misleading due to failure to statistically account for site-specific variations in data. This study fills the analytical gap evident in literature by using the Chow test and descriptive measures of statistical difference to compare the intensity of market participation among rural and peri-urban vegetable farmers in Kenya. Results show that there are significant differences in the percentage of output sold, distance from farm to market, and the unit price of sale for output between the Rural and Peri-Urban areas. These findings demonstrate the urgent need for appropriate statistical evidence to improve disaggregated analyses of agricultural market participation in different systems and environments. This would enable targeting of development strategies to effectively address the changing agricultural landscape; particularly enhancing food supply and ensuring better farm incomes. There is need to improve market information provision, develop farmers' business skills, improve roads and or support establishment of high value vegetable market outlets at different scales in Rural and Peri-Urban areas.

Key words: Vegetable farmers, market participation, development policy, Kenya.

INTRODUCTION

Rapid population growth and urbanization in developing countries imply high demand for food and require urgent supply response to prevent widespread famine, especially among low income consumers (Pingali et al., 2006). In Kenya, about 20% of the approximately 38 million national population lives in urban areas. Close to 40% of the urban population reside in the capital city, Nairobi, representing a considerable share of middle income and high income consumers of fresh fruits and vegetables (Nyoro et al., 2004).

Promoting market-orientation among agricultural producers, more so the smallholder farmers, in both the Rural and Peri-Urban areas of developing countries is pivotal for development of effective agribusiness value chains that could supply adequate food. This will involve improving the production and marketing processes for key commodities that have greater potential for supplying more nutritious food, as well as capacity for income generation among resource-poor farmers.

Enhancing market-orientation and growth of agri-business are some of the main policies suggested in the Strategy for Revitalizing Agriculture (SRA) in order to improve economic growth (Republic of Kenya, 2005). Attainment of these requires a more refined and targeted analysis of pertinent issues that critically constrain sustainable development of agri-food systems, especially in Rural areas of low-income countries.

Recent transformations in agri-food systems (particular-

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ly the rise of supermarkets and technological advances in the agricultural sector of many developing countries during the last decade) offer opportunities for smallholder farmers (McCullough et al., 2008). However, these prospects might be countered by population pressure, ongoing global economic downturn and the adverse effects of climate change, if appropriate policies and development strategies are not urgently put in place to reverse the decline in real purchasing power of many households (Food Ethics Council, 2008).

At the empirical level, analysis of agricultural value chains needs to be improved in order to comprehensively capture site-specific dynamics of the agri-food systems. The nature of a value chain depends on the type of market (demand and supply situation), business environment (laws and facilities such as roads, information, electricity), possibility for vertical and horizontal linkages between and among firms/farms, and effectiveness of supporting institutions such as credit provision and technology transfer organizations. Marketing is one of the primary activities and services in the agricultural commodity value chains. In order to effectively market its products, a firm /farm requires relevant infrastructure, labor, technology and coordinated procedures. A firm/farm will derive more benefit from market participation if it minimizes the cost of doing business and or focuses on goods/services in which it enjoys comparative advantage than its competitors (Porter, 1985). This study focuses on a comparison of factors that influence the degree of market participation between rural and Peri-Urban vegetable farmers in Kenya.

In Kenya, horticulture production (especially vegetables) is an important source of income for smallholder farmers, who often account for more than 70% of the output (McCulloch and Ota, 2002). It has higher returns than most other cash crops and is suitable for production on small and marginal farms in varying climatic conditions (Minot and Ngigi, 2004). The horticultural sub-sector is one of the key growth-driving economic sectors since it contributes about 23% of total export earnings for the country (CBS, 2006). Eaton et al. (2007) note that about 3% of the arable land in Kenya is utilized for vegetable production (over 60% of the total land area is unsuitable for agriculture).

The main vegetable crops grown by smallholder farmers for both subsistence and commercial purposes in Kenya include cabbages, tomatoes, kales (*sukuma wiki*), onions and indigenous vegetables commonly referred to as African Leafy Vegetables (ALVs) such as *amaranth* (Omiti et al., 2004). Vegetables can be sold in various market outlets ranging from the farm gate, retail open-air markets, to wholesale and supermarket stores. The choice of a particular outlet may depend (among other factors) on the geographic distribution of the channels and the ability of the farmer to meet trading requirements such as quality, food safety standards and consistency in record keeping beyond a single season (traceability).

Tschirley and Ayieko (2008) report that larger supermarkets in Kenya such as *Uchumi* and *Nakumatt* are concentrated in urban areas, and that about 10% of the volume of vegetables traded in the capital city (Nairobi) is sold directly by farmers to supermarkets, while the rest is spread to other outlets. Most farmers who sell to supermarkets produce on relatively large scale, tend to have more capital and are specialized on commercial production than those who sell to other channels (Hernandez et al., 2007).

While the emergence of more supermarkets in Africa from 1990s presents opportunities for better incomes, many smallholder farmers are unable to utilize these markets due to high costs of compliance with standards, inability to deliver regular supplies and lack of branding or reputation arising from the short trading history of many farmers in these markets (Jaffee, 2003; Weatherspoon and Reardon, 2003; Narrod et al., 2009). Despite the tight requirements set by supermarkets, the rapid expansion of the supermarkets into smaller towns increases competetion among various channels and offer a learning opportunity to smallholder farmers on quality improvement and group formation. Ultimately, farmers who are able to adjust their production and marketing strategies accordingly gain access to supply supermarkets (Neven and Reardon, 2008).

Promoting investments in agricultural commercialization, more so in developing marketing channels are critical for poverty reduction (Geda et al., 2001). The potential benefits of higher product prices and lower input prices due to commercialization, improved production efficiency and compliance with quality standards and necessary regulations can be more effectively transmitted to poor households when markets function fairly (IFAD, 2001). In Kenya, recent research suggests that prioritizing infrastructure development for vegetable production and marketing are necessary for improvement of most livelihoods (Omiti et al., 2006).

Previous studies on vegetable marketing in Kenya have been based on single or multiple sites. However, the decision to pool data or perform separate analysis is often subjective. In addition, related studies (for example, Alene et al., 2008, who analysed farmers' participation in maize and fertilizer markets), differentiate sites in terms of geographic features, climatic conditions and socio-economic profiles. Although the findings from such studies might offer useful insights on necessary policies, they do not show rigorous objective criteria to support decisions on whole sample (generalisability) or site-specific analysis and development programmes (specificity weaknesses). It is important to support market analysis with sufficient evidence for site-specific or nation-wide strategies. This would enable implementation of targeted development interventions to address salient challenges that may vary across sub-regions within a country. Indeed, data needs to be tested to confirm similarities or differences in various sites so that appropriate analysis can be

done in order to prioritise and target the right development strategies.

This study contributes to literature on analysis of farm-level market participation through application of the Chow's seminal test (Chow, 1960) and other statistical measures of sample difference. The specific objectives of the study are:

i) To compare the intensity of market participation between rural and peri-urban farmers.
ii) To analyse factors that influence the percentage of vegetables that are sold by farmers.

The study provides insights for policy debate by use of a truncated regression model to analyse factors that influence the percentage of vegetables sold by farmers in Rural and Peri-Urban areas. The approaches used in this study are envisaged to provide an improved analysis of agricultural market issues at the farm-level. Ultimately, this would facilitate implementation of better development programmes that enhance market participation. This is considered as a potential option for enhancing farm incomes and facilitating access to food for farm and non-farm households, thereby contributing towards achievement of the Millennium Development Goal number one (reducing extreme hunger and poverty by half by 2015).

MATERIALS AND METHODS

Study area

This study was conducted in the East African highlands. It was carried out in one Rural and one Peri-Urban area in Kisii and Kiambu districts of Kenya, respectively. The two sites were chosen through stakeholder consultations with district (local) and provincial (sub-national) agricultural officers from sixteen (16) districts that are considered to be typically representative of Kenya's agricultural production and marketing systems.

Kiambu district covers an area of 1458.3 km^2, 97% of which is arable. About 90% of the arable land is under smallholdings (less than 2 ha) while the rest is under large farms. The district has reddish brown volcanic soils and natural water supply from a few springs. Altitude ranges from 1500 to 2591 m above sea level, while the average temperature is 26°C (Republic of Kenya, 2001a). The average annual rainfall is 1239.6 mm occurring in a bimodal pattern; long rains in April–May and short rains from October to November. The average population density was estimated at 526 persons per km^2 in 1999 (CBS, 2003). Kiambu district in Central Province was selected mainly because of its proximity to the capital city, that is, Nairobi, where there is potentially huge lucrative urban market for maize, dairy and horticultural products, amongst other consumer items.

Generally, food production systems in Kiambu are relatively more commercialized; considering its comparative advantage in most physical infrastructure (roads, water, electricity, *etc.*) compared to other parts of the country. Kisii district has a highland equatorial climate, red fertile soils, some rivers and streams that drain into Lake Victoria. Its total land area is 1200 km^2. The altitude ranges from 1000 to 1800 m above sea level, with a mean temperature of 22°C. There are two rainfall seasons; long rains in April–June and short rains in September–November, recording an average annual rainfall of 1500mm. About 78% of the land is arable; 58% of which is cropped (Republic of Kenya, 2001b). The average population density was approximately 647 persons per km^2 in 1999. Kisii district, about 400 km from Nairobi in south-western Kenya, is characterized by modest level of commercialization and relatively modest status of basic socio-economic infrastructure.

Data and sampling

The study is based on primary data from a household survey. A purposive sample of 77 vegetable (Kales) producers, who were selling different proportions of their output to specific channels were interviewed (37 in the rural area and 40 in the Peri-Urban area). Prior to the household survey, Focus Group Discussions (FGDs) were held in the selected districts (Kiambu and Kisii) in order to identify Peri-Urban and Rural villages (based on proximity to Nairobi and local municipalities), and to understand the distribution of farmers who sell vegetables from those villages. In Kiambu district, villages located within the municipality were classified as Peri-Urban areas. On the other hand, villages located outside Kisii municipality were considered as rural areas.

The Peri-Urban sample was obtained from four villages in Kiambu (that is, Kamung'aria, Ndiuni, Gachie and Kabae), while the rural sample was selected from an equal number of villages in Kisii district (that is, Obosando, Bonyunyu, Kionganyo and Mwogeto). Farmers in these villages were randomly visited during the household survey and interviewed. The sample is considered representative because of involvement of key informants (such as agricultural officers) in identification of the sites and the relative distribution of farmers who sell output in these villages. With a more favorable budget, a larger sample would have been ideal.

The data captured total quantity of vegetable produced in a moderate season (July – September, which represents a transition period between the wet and dry seasons in the country), percentage of the vegetable sold, household socio-economic variables and farm characteristics. The quantities of vegetable produced and sold were both measured in gunny bags typically used by farmers (then converted into kilogrammes and percentages respectively for analysis). A structured questionnaire was used to collect the data.

Analytical approach

The Chow test

In order to determine whether it was more appropriate to estimate a pooled sample model or separate site-specific models, the study used the Chow test to establish any significant differences in the data from both areas (Johnston and DiNardo, 1997). The Chow test consists of assumptions on equality of error variances in two linear regression models (Ghilagaber, 2004). In this study, two models can be illustrated for the Rural and Peri-Urban sub-samples (Equation 1 and 2):

$$Y_r = X_r \beta_r + \varepsilon_r = X_r b_r + e_r \quad (1)$$

$$Y_u = X_u \beta_u + \varepsilon_u = X_u b_u + e_u \quad (2)$$

Where X_i, ($i = r, u$ for rural and peri-urban sub-samples respectively) are non-singular matrices of explanatory variables, β_i are column

vectors of the K regression coefficients and Y_i are column vec-

tors for the dependent variable. The null hypothesis to be tested is that the coefficients are equal for the rural and peri-urban sub-samples (Equation 3):

$$H_0 : \beta_r - \beta_u = 0 \quad (3)$$

Three separate linear regressions were estimated to constitute the Chow test; one model for the pooled data (whole sample from Rural and Peri-Urban areas) and separate regressions for the Rural and Peri-Urban datasets. The Chow test statistic was set up as follows:

$$F^* = \frac{RSS_w - (RSS_r + RSS_u)}{(RSS_r + RSS_u)} * \frac{(T - 2K)}{K} \quad (4)$$

Where F* is the test statistic.
RSS_w = residual sum of squares for the whole sample.
RSS_r = Residual sum of squares for the rural sub-sample.
RSS_u = Residual sum of squares for the peri-urban sub-sample.
T = Total number of observations in the whole sample.
K = Number of regressors (including the intercept term) in each unrestricted sub- sample regression.
2*K* = Number of regressors in both unrestricted sub sample regressions (whole sample).

Because the test statistic (F*) was greater than the respective F-statistic at 5% level of significance for this study, the null hypothesis was rejected and it was concluded that the sub-samples were significantly different (Table 1). Therefore, separate models were estimated for the rural and peri-urban data. A whole sample regression was also estimated to compare coefficients with those derived from the sub samples.

Descriptive measurement

Tests of sample difference were performed to establish any significant differences between means and frequencies (Moore, 2006), for important variables that explain the intensity of market participation among vegetable farmers.

To establish difference in means of variables analysed, the relevant hypothesis test was developed as in Equation 5.

$$H_0 : m_r - m_u = 0 \quad (5)$$

From Equation (5), m_r is the mean for rural sub-sample while m_u represents the mean for Peri-Urban sub-sample.

The test statistic for means is given by:

$$z = \frac{m_x}{\sigma_x} \quad (6)$$

Where m_x is the difference between the means of variables in the Rural and Peri-Urban sub-samples $(m_x = m_r - m_u)$ and σ_x is the joint standard deviation of both sub-samples.
For the percentage frequencies, the test statistic for comparisons was calculated as:

$$z = \frac{(p_r - p_u)}{\sqrt{f_r + f_u}} . f_r = \frac{pq}{n_r} \; f_u = \frac{pq}{n_u} \quad (7)$$

Where p_r and p_u are percentages for variables in the Rural and Peri-Urban sub-samples respectively, p is the percentage frequency in the whole sample, and q=1-p.

Truncated regression estimation

A truncated regression model was used to analyze determinants of percentage of vegetables sold by farmers. Observations on households who do not sell their produce were excluded; therefore typical selectivity models are inappropriate for this study. The truncated model follows normal distribution with a homoscedastic error component (Greene, 2007).

$$Y_i^* = \beta_i X_i + \mu_i \quad (8)$$

Where Y_i^* is the percentage of output that is sold by the individual, β_i is the vector of parameters to be estimated, X_i is the set of explanatory variables and μ_i is the disturbance term. An observation of zero value for Y_i^* is made when a household does not sell any output, while Y_i^* = 100 if a household sells all output. The specific variables hypothesized to influence vegetable sales are described in Table 2.

Some of the above variables have been found to affect market participation differently for various commodities in previous studies (Alene et al., 2008; Cunningham et al., 2008; Vance and Geoghegan, 2004; Key et al., 2000). For example, although unit price is expected to have a positive influence on output sale, the magnitude of its effect depends on the type of market outlet where the farmer sells the output. Papzan et al. (2008) also noted that the degree of innovation, market access and bureaucracy affect Rural entrepreneurship. In order to control for endogeneity, farm size and labour are excluded from the market sales equation because both variables are partly the key factors in the production function where output is determined.

In addition, although Narrod et al. (2009) show that group membership (collective action) significantly enhances farmers' ability to access inputs cheaply and to bargain for better prices, it is not included in this study due to data limitation. Nonetheless, we concur with previous studies on the importance of group organization as a strategic institutional arrangement that serves to strengthen participation in commodity value chains.

RESULTS AND DISCUSSION

The rural sample (Kisii) consisted of farmers selling vegetables mostly in open-air retail markets (61%) and neighbouring districts such as Nyando, Rachuonyo and Kisumu. Other farmers in the rural area sold vegetable to schools, hospitals, hotels and mini-wholesales/mini-super-

Table 1. Chow test outcome.

RSS_w	RSS_r	RSS_u	F*	*F(K, T-K) at 5% significance level*	Decision
15251.69	8032.20	770.33	4.18	1.99	Separate Rural and Peri-urban data

Source: Computed from survey data (2007).

Table 2. Independent variables used in the regression model.

Variable	Description	Measurement	Expected sign
Age	Age of the household head	Number of years	+
Gender	Gender of the household head (binary)	0 = Female 1 = Male	±
Education	Education level of the household head (binary)	0 = Not completed secondary education 1 = Completed secondary education	+
Household size	Number of people in the household	Number	±
Non-farm income	Proportion of non-farm income in total monthly household income	Ratio	±
Output	Total quantity of vegetable produced per season	Kilograms (Kg)	+
Distance	Average distance from farm to main point of sale	Kilometres (Km)	-
Market information	Market information source (binary)	0 = Informal 1 = Formal	±
Unit price	Average price per Kg	Kenya Shillings (Kshs)	+

Table 3. Means and standard deviations for some factors influencing vegetable marketing in Kenya.

Variable	Rural farmers (n=37)		Peri-Urban farmers (n=40)		Whole sample of farmers (n=77)		Test statistic
	Mean	σ	Mean	σ	Mean	σ	*z*
Output sold (%)	62.91	17.42	94.95	5.7	79.56	20.49	10.68***
Age of household head (years)	45.27	16.35	43.33	13.37	44.26	14.81	0.57
Household size (number)	6.30	2.87	5.90	3.67	6.09	3.29	0.53
Per capita land (acres)	0.70	0.52	0.70	0.83	0.70	0.69	0.00
Nonfarm Income	0.16	0.28	0.12	0.23	0.14	0.25	0.68
Output (Kg)	3232.43	3252.87	1869.75	2961.23	2524.55	3159.36	1.75
Distance (Km)	8.68	7.12	2.82	2.83	5.63	6.07	3.71**
Unit price (Kshs)	14.24	3.52	19.98	8.13	17.22	6.93	4.07***

***p<0.01, **p<0.05.
Source: Computed from survey data (2007).

markets. On the other hand, the peri-urban sample (Kiambu) had many farmers selling mainly (70%) to wholesale markets (such as Wakulima, Kangemi and Gikomba) and supermarkets such as *Uchumi* and *Tuskys* in Nairobi, while the rest sold in open-air retail outlets such as *kiosks* and on the roadsides within Kiambu.

A relatively higher percentage of total vegetable output is sold by farmers in Peri-Urban areas compared to those in Rural areas (Table 3). Generally, the intensity of market participation for vegetable is higher in Peri-Urban areas than in the Rural areas. This reflects the growing Urban consumer preference for fresh vegetables, which is necessitated by rapid rise in urban population, emerging consumer preference for nutritious vegetables and the desire for convenience foods by a large proportion of the middle-income households. Lower vegetable sales by rural farmers show that they contribute directly towards reducing extreme hunger by consuming more of the output. This is an important step in ensuring household food self sufficiency.

Table 4. Percentage frequency distributions for some factors influencing vegetable marketing in Kenya.

Variable		Rural farmers (n=37)	Peri-Urban farmers (n=40)	Whole sample of farmers (n=77)	Test statistic *z*
Gender	Male	62.20	92.50	77.90	3.20**
	Female	37.80	7.50	22.10	
Education	Completed secondary	51.40	57.50	54.50	0.54
	No secondary	48.60	42.50	45.50	
Security of land tenure	Has title deed	62.20	45.00	53.20	1.51
	No title deed	37.80	55.00	46.80	
Market information source	Formal	40.50	35.00	37.70	0.50
	Informal	59.50	65.00	62.30	

**p<0.05.
Source: Computed from survey data (2007).

Distances to markets and unit price vary significantly between the Rural and Peri-Urban farmers. Specifically, Rural farmers travel longer distances to the nearest points of sale, and sell their vegetables at relatively lower prices compared to the Peri-Urban farmers. This finding is consistent with the observation by Oluwasola et al. (2008) that indeed, geographical distance imposes higher transport costs on Rural farmers, thereby reducing their ability to sell in better but far-away markets such as large supermarkets in big cities. Consequently, weak Rural-Urban linkages often contribute to lower farm incomes, especially among households in remote rural localities.

Peri-Urban farmers obtain relatively higher prices because they sell, through a variety of arrangements, mostly to wholesale markets and supermarkets, which target middle-income and wealthier consumers who consider product convenience attributes such as quality and packaging. In the rural areas, however, prices are lower due to somewhat less preference for product differentiation.

There are no significant differences between Rural and Peri-Urban farmers in terms of average age of the household head, household size, per capita farm size, proportion of non-farm income in total income, and the total vegetable output. However, the effects of these variables on percentage of vegetable sold may be different due to the influence of other exogenous factors such as access to education and employment opportunities, which are not equally distributed between Rural and Peri-Urban households. The similarity in total output could be possibly explained by possession of nearly the same average per capita land sizes in both sites. In addition, whereas most farmers in the Peri-Urban area may have considerable access to non-farm employment and business opportunities in the capital city (Nairobi), some of the rural farmers supplement their livelihoods with earnings from wage employment in tea plantations in the vast Rift Valley province and remittances from relatives employed elsewhere.

Gender of household heads in Rural and Peri-Urban areas is significantly different. Over 60% of farmers sampled in both sites have male household heads (Table 4). However, most Peri-Urban household heads were male; 93% compared to 63% in the Rural areas. There were no significant differences in education, security of land tenure and main source of market information between the Rural and Peri-Urban farmers. Provision of timely market information (e.g., on buyer characteristics, price and product standards) enables farmers to deliver the right quantity and quality desired by a particular outlet (Narrod et al., 2009). In this study, formal market information sources include all institution-based sources or formal channels such as radio, television, newspapers and conferences. On the hand, non-institutional sources like neighbours and friends are regarded as informal.

The results obtained in this study demonstrated that the unit price significantly motivates farmers to increase the percentage of vegetable sold in both Rural and Peri-Urban areas (Table 5). The total amount of output produced per season and being a male head of a household also significantly increase the percentage of vegetables that are sold. This study confirmed the observation by Alene et al. (2008) that price and amount of output are key determinants of the percentage of farm produce that is sold.

As noted by Cunningam et al. (2008), male household heads generally have a tendency to sell more output than female household heads, irrespective of the type of crop. In most patrilineal African societies, income sources are often controlled by men, while women are generally concerned with household food self-sufficiency (hence storage of more farm output). Male-headed households also tend to have more access to resources (e.g. land). In addition, men have less social inhibitions and tend to have greater institutional networks, which facilitate interaction and information flow.

The results also show that geographical distance reduces percentage of vegetable marketed in Rural areas and for the whole sample. Although not quantified in this study, it was noted that farmers do incur some losses due to perishability of vegetables and transportation costs associated with long distances to the markets, more so if the roads are in bad state. This observation is consistent with

Table 5. Factors that influence the percentage of kales sold by farmers in Kenya.

Variable	Rural farmers (n=37)		Peri-Urban farmers (n=40)		Whole sample of farmers (n=77)	
	β	t-ratio	β	t-ratio	β	t-ratio
Constant	34.62	1.70	90.46	23.18***	63.39	8.13***
Age	0.23	1.14	0.09	1.28	0.14	1.01
Gender	7.34	2.42*	-0.21	-0.07	13.07	3.24**
Education	-2.96	-0.40	3.53	2.18*	-0.01	-0.44
Household size	-0.98	-3.91***	-0.23	-0.90	-1.00	-1.64
Non-farm income	4.86	0.48	-9.15	-2.80**	-5.06	-0.76
Output	0.16	2.15*	0.03	1.05	0.18	2.60**
Distance	-0.49	-2.42*	-0.52	-1.87	-1.44	-4.85***
Market information	-8.83	-1.21	1.77	1.97*	-7.32	-1.98**
Unit price	0.04	1.96*	0.13	1.99*	1.14	4.48***
	Log likelihood ratio = -152.03		Log likelihood ratio = -115.92		Log likelihood ratio = -312.87	
	Pseudo R^2 =19.22		Pseudo R^2 =21.02		Pseudo R^2 =45.80	

***p<0.01, **p<0.05.
Source: Computed from survey data (2007).

findings by Chianu et al. (2008), which found that long distance and poor road infrastructure make farm inputs inaccessible to most rural farmers in Kenya. The household size also contributes to significant reduction in the percentage of vegetable sold by Rural farmers. Larger households imply higher consumption needs and low labor supply for production (if a greater proportion of the household consists of children). This leaves little or, in some cases, no surplus output for sale.

For Peri-Urban farmers, the intensity of market participation is significantly increased by the household head's education level and access to formal market information channels. Non-farm income, on the other hand, significantly reduces amount of vegetable sold. Informal market information sources contribute to significant increments in percentage of vegetable marketed by the whole sample. These findings demonstrate the need for certain site-specific strategies, as well as nation-wide interventions to facilitate increased production and marketing of vegetables.

Partial correlation analysis

Although a few variables in the analysis are correlated, the strength of the correlations is weak (partial correlation coefficients are smaller than 0.5) and significant at 5%. These imply that there is association between the variables, but there is no evidence for multicollinearity; which occurs if partial correlation coefficients are greater than 0.5 and are significant. In the rural household data, there is a significant negative correlation (-0.436) between male gender and unit price of output.

This is consistent with the findings by Cunningam et al. (2008), that male household heads sell output soon after harvest (early in the season when prices are much lower due to oversupply in the market) compared to female household heads who tend to hold stocks for internal food security. In addition, there is a negative correlation between price and total output (-0.415). This reflects the general trend in most rural areas where output prices fall sharply during bumper harvests, due to thin markets.

In the Peri-Urban areas, the household head's formal education is positively correlated with proportion of non-farm income in the total household income (0.375). This is plausible, considering that most off-farm opportunities in the Urban areas require high levels of formal literacy. Access to formal market information is also associated with ability to sell output at higher prices in the Peri-Urban areas (partial correlation coefficient is 0.385).

The whole sample data has three pairs of correlated variables compared to only two sets in both Rural and Peri-Urban sub-samples (Table 6). This further supports the need for disaggregation of the analysis in terms of rural and peri-urban sites in this study. There is a negative correlation between formal information source and amount of output produced. This level of association (-0.283) possibly explains that if formal information provided to farmers is of poor quality and delivered at the wrong time (for example too late in the season), it may either hinder appropriate supply response or trigger false farm response to market conditions. Distance from farm to main market and sources of formal market information are also positively correlated (0.267). This reaffirms the fact that most farmers in remote localities in Kenya are isolated from the usually urban-based formal information providers, through long distances.

Thus, farmers have to travel to distant markets in order to obtain information from institutional sources such as government and private bureaus, which are mainly located in towns. In addition, as expected, access to formal information positively associated with higher prices of output. These partial correlation coefficients emphasize variables that require priority in the various policy proces-

Table 6. Partial correlation coefficients for the data on vegetable marketing in Kenya.

Control (dependent) variable	Site	Independent variables	Age	Gender	Education	Household size	Non-farm income	Out-put	Distance	Market information	Unit price
Percentage of output sold	Rural	Age	1.000								
	Peri-urban		1.000								
	Whole sample		1.000								
	Rural	Gender	0.246	1.000							
	Peri-urban		0.007	1.000							
	Whole sample		0.131	1.000							
	Rural	Education	-0.323	-0.313	1.000						
	Peri-urban		-0.191	0.341	1.000						
	Whole sample		-0.247	-0.072	1.000						
	Rural	Household size	0.526*	0.061	-0.184	1.000					
	Peri-urban		0.652	0.045	-0.168	1.000					
	Whole sample		0.578	0.036	-0.172	1.000					
	Rural	Non-farm income	-0.267	-0.070	0.303	-0.145	1.000				
	Peri-urban		-0.030	0.161	0.375*	-0.071	1.000				
	Whole sample		-0.177	0.009	0.292	-0.101	1.000				
	Rural	Output	0.180	-0.057	0.104	0.140	-0.063	1.000			
	Peri-urban		-0.167	0.164	0.172	-0.088	-0.064	1.000			
	Whole sample		0.033	-0.004	0.111	0.020	-0.036	1.000			
	Rural	Distance	0.089	0.139	-0.209	-0.164	-0.066	-0.308	1.000		
	Peri-urban		0.199	0.164	-0.005	0.111	-0.157	0.003	1.000		
	Whole sample		0.133	0.100	-0.132	-0.046	-0.088	-0.185	1.000		
	Rural	Market information	0.044	0.216	0.146	-0.224	0.032	-0.344	0.415	1.000	
	Peri-urban		0.053	0.224	0.137	0.098	0.027	-.0149	0.101	1.000	
	Whole sample		0.051	0.209	0.184	-0.043	-0.034	-0.283*	0.267*	1.000	
	Rural	Unit price	-0.202	-0.436*	0.382	-0.075	-0.047	-0.415*	0.110	-0.067	1.000
	Peri-urban		0.213	0.000	-0.002	0.230	-0.114	-0.109	0.425	0.385*	1.000
	Whole sample		0.059	-0.111	0.135	0.138	-0.118	-0.221	0.161	0.295*	1.000

*$p<0.05$.
Source: Computed from Survey data (2007).

ses for agricultural production and marketing interventions in different localities.

Policy implications

There is need to deliberately improve the intensity of market participation in Rural areas in order to facilitate stable incomes and sustainable livelihoods. Priority issues for Rural development should include establishment of more market outlets (e.g., assembly or bulking facilities, cold storage) closer to farms in order to minimize transportation difficulties and wastage. This option has cost implications, which would require feasibility analysis and adequate stakeholder consultations on resource mobilization strategies including exploring the possibility of cost-sharing

In addition, improving rural infrastructure (e.g., access roads) would facilitate faster delivery of farm produce (especially perishable commodities such as vegetables) to urban consumers. Also, provision of rural employment opportunities is essential to reduce high dependence by households on farm output. This is a critical step in generating more marketable surplus.

In the Peri-Urban areas, the already high level of commercialization should be sustained to ensure stable food supply for the rising Urban population. This will require enhanced provision of new production skills and specific market information. One option would be to intensify mobile phones in linking consumers with suppliers; for instance, to promote door-to-door delivery of fresh vegetables in the urbanising residential areas.

At the national level, agricultural policies ought to be refined to encourage increased vegetable production (through better production practices and adoption of high yielding varieties) in order to ensure stable supply and better farm incomes in all seasons. It is also imperative to enhance farmers' business skills, for instance by training and encouraging them to produce and sell vegetable in organized groups. This would provide them with economies of scale for better market search and bargain, as well as enable them to reduce operational costs (especially on inputs and transport). Future research should extend the application of Chow test and measures of sample difference to the analysis of how multiple input sources and product market channels influence the degree of market penetration for different agricultural commodities in various agro-ecological zones.

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