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Challenges and Opportunities for Market Integration to Improve Food Security among Smallholder Farming Households in Western Kenya

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Abstract. African smallholder farmers produce food both for home consumption and commercial purposes, but these farmers are often net food buyers in local markets. To what extent do markets play a role in making food available and accessible throughout the year? This study assessed: (a) the extent of smallholder farmers' involvement in market trading networks, and (b) the role of markets in access to food at household level. All plant and animal species grown or reared for food were inventoried on 30 smallholder farms in six villages of Mumias District and Vihiga District, Western Kenya. A survey of available food products was conducted in three markets in Mumias and four markets in Vihiga near the surveyed farms. The market was the main source for cereals in both districts, while in Mumias District, fruits and animal source foods were also mainly sourced from markets. Regarding market trading systems, 15% of the 48 food products were sold by the farmers, 10% were sold by small-scale traders, while 75% were sold by large-scale traders. The study shows that local markets are mainly utilized by market traders who bring produce from outside the study areas. To increase incomes to enable access to diversified foods, organized smallholder farmers can be integrated better in the local market system, in two key ways: (a) by tapping into increasing market demand for 'niche' products uniquely available through on-farm production, and (b) by value addition of farm produce lost at post-harvest to increase year-round availability of diversified foods.

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Introduction

Unlike in the developed countries where close to 15% of total income is devoted to food (Regmi and Meade, 2013), spending on food represents 50–80% of developing country consumers' budgets (Smale et al., 2009). The population of Eastern and Southern Africa is predominantly rural (Barrett, 2008), with 60–80% of the rural households, including a large proportion of smallholder farmers growing food crops, being net food buyers of the same crops they grow (Mehra and Rojas, 2008; Barrett, 2008; Smale et al., 2009). This is mainly because they are unable to meet the subsistence needs of their families through their own production and must purchase the remainder, usually at higher prices (Smale et al., 2009, 2012). Due to dependence of rural households on market purchase for food supply, in some cases making up to 90% of all the food consumed (Baiphethi and Jacobs, 2009), markets play a crucial role in achievement of household food security. With the scarce cash directed towards meeting staple food needs first in rural markets (Smale et al., 2009; Thorne-Lyman et al., 2009), household food transfers (Baiphethi and Jacobs, 2009) and subsistence production (Aliber and Hart, 2009; Baiphethi and Jacobs, 2009) enhance accessibility to affordable foods.

While the majority of smallholder farmers prioritize subsistence production as a household food security strategy, agricultural production that raises household incomes is critical to guarantee longer-term food security and improve well-being (Mehra and Rojas, 2008). To guarantee both household food consumption needs and market demand, surplus agricultural output needs to be generated (Omiti et al., 2009). Surplus smallholder farmers comprise of 20–30% of rural households while an additional 10–15% of rural households are net deficit producers who nevertheless sell a proportion of their crop soon after harvest (Poulton et al., 2006a), when prices are at their lowest. Crop sales by poor households occur straight after harvest because they are desperate for cash, hence these 'distress sales' are driven by short-term survival needs (Leavy and Poulton, 2007) rather than a longer-term focus on farming as a business enterprise.

For smallholder farmers selling their produce in formal markets, there are many steps in the value chain to take the product from producer to consumer (KIT and IIRR, 2008). Smallholder farmers who are unable to supply directly to wholesale or retail markets sell their produce to spot market traders (Rao and Qaim, 2010; Wiggins, 2012), who act as market intermediaries. Travelling traders, including many part-time traders who spend most of their time farming, meet the farmer at their farm to collect and pay for the produce in cash. Until the trader sells the produce to someone else, they must bear all costs and any unpredictable losses that may occur while the produce is under their ownership (KIT and IIRR, 2008). Although traders specialize in marketing the produce (Collier and Dercon, 2014), the majority of smallholder farmers regard them as 'middlemen' who gain profits for themselves along the value chain, while paying farmers poor prices for their produce (Wiggins, 2012). With this suspicion, cooperation between smallholder farmers and traders is relatively underdeveloped and this could be closely related to lack of market access for smallholder farmers (KIT and IIRR, 2008). Lack of formal market access is also associated with poor infrastructure together with long distances to markets and poor access to information on prevailing market produce prices (Delgado, 1999; Leavy and Poulton, 2007; Alene et al., 2008). These poor conditions translate to high exchange costs, which are usually too high for smallholder farmers to enable many transactions to take place (Delgado, 1999; Alene et al., 2008). Households have dif-

ferent abilities to mitigate these market transaction costs, resulting in differential market participation among smallholder farmers (Alene et al., 2008), with a majority of the farmers in low-income rural areas opting out of markets (Barrett, 2008) as market product sellers.

It is acknowledged that in cases when smallholders engage in markets, they only trade in small volumes. However, there exists a knowledge gap on the extent of smallholder farmer involvement in market trading networks, especially in regions with good market access. Secondly, although on-farm food production is insufficient to meet smallholder farming household food needs and markets have been shown to be important for sourcing mainly staple food grains (Jayne et al., 2006), there exists a gap in knowledge of the diversity and amounts of other food groups also sourced from markets, in addition to other food channels. To address these two knowledge gaps, this study addresses two research questions:

1. To what extent are smallholder farmers integrated into the market trading networks for selling their produce in regions with good market access?
2. What is the role of markets in access to food at household level among smallholder farmers?

Methodology

Study Area and Data Collection

Primary market data were collected in September and October 2012, while farm data were collected both in September/October 2012 and November/December 2012 in Mumias and Vihiga districts, Western Kenya. Mumias and Vihiga districts mainly represent the humid Lower Midland (LM1) and Upper Midland (UM1) agroecological zones, respectively (Jaetzold et al., 2005). The selection of Mumias and Vihiga districts as study sites was with an aim to represent different agroecological zones, and thus most likely a different level of agro-biodiversity, with an added advantage of geographical closeness to each other and both regions being close to local markets. Table 1 shows details on geographical, climatic and agricultural characteristics of the two districts.

Smallholder farm sizes in Kenya mainly range from below 0.2 to 3 ha, according to the Government of Kenya's (2010) estimates. The current policy framework governing the Kenyan land sector, in particular the *Sessional Paper No. 3 of 2009 on National Land Policy* (NLP), recognizes three categories of land: community land (previously referred to as trust land), public land (formerly referred to as government land) and private land (Government of Kenya, 2009). The NLP offers a wide array of incentives with the aim of ensuring land tenure security, such as security on community land as well as the acquisition of land rights by inheritance, with or without a will. In our household surveys, various forms of land ownership were reported by smallholder farmers. The majority (97%) owned private land (90% owned inherited land, while 7% had bought their land) while only 3% occupied community land. More than half of the households (63%) possessed land title deeds, which were registered mainly under the name of their in-laws, generally under the name of a member of the family of the head of household (57% of the households) or that of the wife's family (7% of households). Title deeds with the name of the nuclear family's head of household were reported for only 3% of the surveyed households. The remainder of the respondents (33%) did not know the names used in their household's title deeds.

Table 1. Overview of geographical, climatic and agricultural characteristics of Mumias and Vihiga districts, Western Kenya

Characteristic	Mumias District	Vihiga District
AEZ	Lower Midland (LM1)	Upper Midland (UM1)
Altitude	1300–1500 metres above sea level	1500–1900 metres above sea level
Annual mean temperature	21.0–22.2°C	18.5–21.0°C
Total annual rainfall	1650–1850 mm	1800–above 2000 mm
Rainfall pattern	Bimodal with long rains from end of February to end of March and short rains from end of July to November/December	Bimodal with long rains from end of February to end of March and short rains from mid-July to November/December
Soil types	Ferrasols	Combination of cambisols and lithosols
Main crops	Cash crops: sugarcane Food crops: sorghum, cassava, sweet potatoes	Cash crops: tea, coffee, sugarcane Food crops: maize, beans, cowpeas

Source: Jaetzold et al., 2005.

This study was conducted in tandem with a larger, cross-sectional research project entitled 'Improving Nutrition through Local Agrobiodiversity'. It purposefully selected six villages in order to cover the above-mentioned different climatic zones, three villages in Mumias and three in Vihiga districts, out of 30 villages from the larger study. The latter were sampled according to district village lists with number of households per village applying a 'probability proportional to size' approach (Magnani, 1997), with larger villages given a greater chance of selection than smaller villages. A total of 30 households, 15 in Mumias and 15 in Vihiga districts, in the six villages (five households per village) were then randomly selected to represent 10% of the 300 households sampled by the larger study. In both September/October 2012 and November/December 2012, the same smallholder farming households were surveyed.

Smallholder farmers participated in the selection of major local markets near the surveyed farms in Mumias and Vihiga districts. The average walking distance to the nearest major local market was 30 minutes (ranging from 5–60 minutes). Seven major local open-air markets, three in Mumias and four in Vihiga districts, were surveyed on seven non-consecutive market days. Simple random sampling was adopted to select market traders to be interviewed (Abukutsa-Onyango, 2002) in all the different market stands with an aim of sampling the whole market. With this, at least 10% of market stands representing each food group were randomly sampled for the market trader interviews. In those cases where the market trader randomly selected was unavailable to answer the questions, a different market trader representing the same stand was purposefully sampled (Abukutsa-Onyango and Onyango, 2005). A total of 65 market traders representing 65 different stands were interviewed. Figure 1 shows a map of the two study areas, indicating the six villages and seven markets where the survey was carried out.

All present food plant and livestock species were inventoried per farm by recording species names and counting individuals of each species. On each farm, the head of household or his/her representative was interviewed using a semi-structured questionnaire to collect data on: (a) basic demographic and socio-economic house-

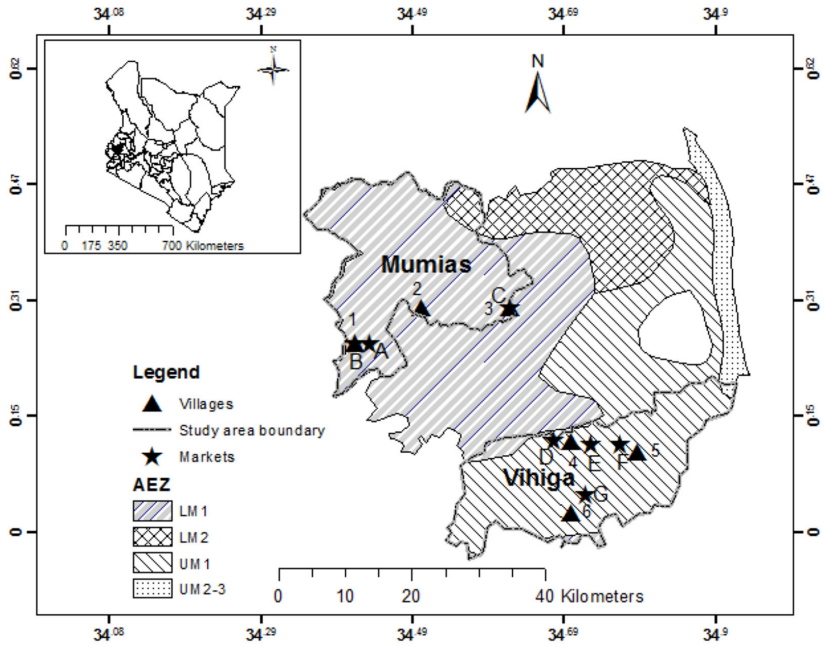

Figure 1. Map of study area in Western Kenya.
Notes: Mumias District is categorized as humid Lower Midland (LM1), Vihiga District is categorized as humid Upper Midland (UM1) agroecological zones; the village (triangle symbols) codes: 1. Khushipari A, 2. Emahanga , 3. Busokho, 4. Hombala, 5. Wambenge, 6. Lodondo; the market (star symbols) codes: A. Buhuru, B. Mumias, C. Makunga, D. Kilingili, E. Mudete , F. Chavakali, G. Majengo.

hold characteristics; (b) names, production, and uses of food plant and livestock species produced on the farm; (c) products of plant and livestock species consumed by households. In addition, during November/December 2012, respondents reported the source of the foods that they consumed within the household for the last five times. This time span ranged from the last 24 hours to the last few months, depending on the food items. During the November/December 2012 survey, farmers also reported specific walking distance approximations to the nearest market and the frequency of nearest market visits in a month. The market survey was utilized to capture market food biodiversity available for purchase by smallholder farmers and sources of the market produce. A semi-structured questionnaire was utilized to collect market data, in September and October 2012, on: (a) edible food species available, (b) sources of produce, (c) prices of different foods, and (d) seasonal availability of these foods.

Data Analysis

All present on-farm and market food plant species were assigned to one out of the seven major FAO-defined food plant groups, according to statements on their main use (FAO, 2011). Simple descriptive statistics such as means, frequency counts and percentages were computed to characterize farms and markets according to species richness and abundance, as well as the proportions of market produce sold by dif-

ferent types of market traders.

There were species identification challenges in the local markets when identifying leaves of the following local vegetables: (a) *Amaranthus cruentus* ssp. *hybridus* and *Amaranthus hybridus* complex (collectively classified as *Amaranthus* species) (b) *Corchorus acuntangulus*, *Corchorus olitorius*, *Corchorus trilocularis* and *Corchorus tridens* (collectively classified as *Corchorus* species) (c) *Cucurbita maxima* and *Cucurbita moschata* (collectively classified as *Cucurbita* species) (d) *Solanum villosum*, *Solanum scabrum* and *Solanum americanum* (collectively classified as *Solanum* species) (e) *Crotalaria ochroleuca* (classified as *Crotalaria* species). Although it was possible to obtain specimens of some unidentified plants for proper identification, plant identification at the species level was in some cases still challenging, especially with the different *Amaranthus* species. In most cases, however, it was possible to identify species while conducting the farm survey, where higher diversity among these species was documented (Maundu et al., 1999). For the sake of consistency and comparability of market and farm species, all the above-mentioned species were taxonomically classified in one of the five respective groups.

Results

Profile of the Local Markets and Market Traders

The seven open-air markets have at least one market trading day. There are two daily markets (Makunga and Majengo markets), one biweekly market (Mumias market) and four weekly markets (Buhuru, Mudete, Kilingili and Chavakali markets). Four of the seven markets (Chavakali, Majengo and Mudete markets in Vihiga District and Mumias market in Mumias District) are municipal council markets, centrally located in rural town centres where local administrative offices are based while the others are rural markets (Table 2). Trading in all the seven local markets is subject to daily market trading fees and taxes, ranging from US$0.3 to US$1, mainly depending on the quantity of produce to be traded. Buhuru rural market in Mumias District had the highest number of different produce (30) mainly because it is a mixed market trading in live animals, animal source foods and a variety of farm produce (Table 2).

All the seven markets in the two districts are readily accessible by tarmac roads, except Buhuru rural market, which is accessible by gravel road. This makes it inaccessible during wet weather due to the slippery nature of the road, yet it had the highest number of different types of produce out of the seven markets surveyed. In Mumias District, the average walking distance to the nearest market is 37 minutes, with an average of 10 market visits per month for each household. In Vihiga District, it takes an average of 32 minutes to walk to the nearest market, with an average of eight market visits per month per household.

Out of the 65 market traders interviewed, 40% were male and 60% were female traders. A majority (97%) of the female traders, with an average age of 39 years, were owners of the stands while 62% of the male traders, with an average age of 32 years, owned the stands. Both female and male traders had been in the market trading business for an average of at least 10 years. Slightly more than half of the female traders (51%) and 31% of male traders sold a variety of produce on one stand, ranging from two to seven different food groups. Vegetables, followed by fruits, were the most popular combinations in the mixed market stands. The rest of the market trad-

Table 2. Frequency of products in seven markets in Mumias and Vihiga districts, Western Kenya, September/October 2012.

Food group	Frequency of food products in Mumias markets						Frequency of food products in Vihiga markets								Overall frequencies
	Buhuru Rural		Mumias Municipal		Makunga Rural		Mudete Municipal		Majengo Municipal		Kilingili Rural		Chavakali Municipal		
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	%
Animal source foods	7	23	1	4	3	13	3	11	3	11	3	12	3	11	12
Cereals	3	10	0	0	3	13	3	11	2	7	4	15	2	7	9
Fruits	3	10	6	25	3	13	3	11	2	7	3	12	6	22	14
Pulses/nuts/seeds	5	17	1	4	5	21	2	7	2	7	3	12	2	7	11
Starchy roots/ tubers/green bananas	2	7	1	4	2	8	2	7	2	7	3	12	2	7	8
Vegetables	10	33	15	63	8	33	12	44	14	50	7	27	10	37	41
Spices/condiments	0	0	0	0	0	0	2	7	3	11	3	12	2	7	5
Total produce	30	100	24	100	24	100	27	100	28	100	26	100	27	100	100

ers specialized in particular market products, mainly selling animal source foods. Among female traders, chicken-only and fish-only stands were most popular while cattle-only stands were the most popular among male traders. Sixty different plant and animal species were documented on the surveyed farms while 48 different food products were available in the local markets (Table A1).

There was an overlap of 58% of on-farm products that were also available in the markets. 'Niche' products unavailable in the local markets but uniquely available through on-farm production comprised of one animal source food, 12 fruits, three pulses/nuts/seeds, three starchy roots/tubers/green bananas and three vegetables (Table 3).

Main Foods Available in Markets and for Household Food Consumption

The different food types available in all the markets and farms were grouped into eight of the major FAO-defined (2011) food groups, namely: (i) cereals, (ii) fruits, (iii) pulses/nuts/seeds, (iv) starchy roots/tubers/green bananas, (v) vegetables, (vi) spices/condiments, (vii) animal source foods, and (viii) high-sugar foods. In the context of this study, the high-sugar food refers to sugarcane (*Saccharum officinarum*), found on farms but not in the local markets surveyed. During the September/October 2012 market survey, vegetables had the highest availability in all the markets, with a frequency of 41%, followed by fruits (14%), animal source foods (12%), pulses/nuts/seeds (11%), cereals (9%), starchy roots/tubers/green bananas (8%), and spices/condiments (5%) (Table 2). The vegetable food products available in all the markets were bulb onions (*Allium cepa*), white cabbages (*Brassica oleracea* var. *capitata*), African kale (*Brassica oleracea* var. *acephala*) and tomatoes (*Solanum lycopersicum*). *Amaranthus* species, *Solanum* species and cowpea leaves (*Vigna unguiculata*) were available in six out of the seven markets.

Markets also play a role in contributing to household food consumption of smallholder farmers throughout the year. During the last five times a certain food group had been consumed at the household level, the market was the main food source for cereals in both Mumias and Vihiga districts while in Mumias District, fruits and animal source foods were also mainly sourced from markets. In Vihiga District, a considerable proportion of fruits, animal source foods, starchy roots/tubers/green bananas and spices/condiments were sourced from family and friends. In both districts, the four key food groups sourced from farms were vegetables, spices/condiments, pulses/nuts/seeds, and starchy roots/tubers/green bananas (Figure 2).

On-farm food production by smallholder farmers is mainly for home consumption, though some proportion is also utilized for commercial purposes. This is through both formal and informal market channels (Figure 3), with the latter mainly through barter within the community. Formal market channels are mainly utilized for selling cash crops, mainly tea (*Camellia sinensis*) in Vihiga District and sugarcane (*Saccharum officinarum*) in Mumias District, classified as spices/condiments and a high-sugar food, respectively. The proportion of pulses/nuts/seeds that are sold through in-kind exchange is equal or higher, compared to those sold through formal market channels in Mumias and Vihiga districts (Figure 3).

Pre- and Post-harvest Losses

Some of the on-farm produce for either home consumption or for selling in both

Table 3. Overlaps and gaps in products available in seven markets and on 30 farms in Western Kenya, between September and October 2012

Food group	Overlaps in products available in markets and farms	Products available only in markets or farms	
		Market-only products	Farm-only ('niche') products
Animal source foods	Cattle	Fish	Rabbit
	Chicken		
	Goat		
	Sheep		
	Pig		
Cereals	*Sorghum bicolor*	*Eleusine coracana*	
	Zea mays	*Oryza sativa*	
		Triticum aestivum	
Fruits	*Ananas comosus*	*Citrullus lanatus*	*Annona muricata*
	Citrus limon	*Citrullus sinensis*	*Carica papaya*
	Mangifera indica		*Dovyalis caffra*
	Musa sapientum		*Eriobotrya japonica*
	Persea americana		*Morus alba*
			Passiflora species
			Passiflora edulis
			Physalis peruviana
			Psidium guajava
			Solanum betaceum
			Syzygium cuminii
			Vitex doniana
Pulses/nuts/seeds	*Arachis hypogaea*		*Cajanus cajan*
	Glycine max		*Lens culinaris*
	Phaseolus vulgaris		*Vigna subterranea*
	Sesamum indicum		
	Vigna radiata		
Spices/condiments	*Capsicum annuum*	*Allium sativum*	*Camellia sinensis* (sold in other markets)
		Coriandrum sativum	*Coffea arabica* (sold in other markets)
		Zinziger officinale	
		Starchy roots/tubers/ green bananas	
	Ipomoea batatas		*Colocasia esculenta*
	Manihot esculenta		*Dioscorea bulbifera*
	Solanum tuberosum		*Musa paradisiaca*
Vegetables	*Allium cepa*	*Brassica oleracea* var. *capitata*	*Cleome hirta*
	Allium fistulosum	*Spinacia oleracea*	*Basella alba*
	Amaranthus species		*Erythrococca bongensis*
	Brassica carinata		
	Brassica oleracea var. *acephala*		
	Cleome gynandra		

Table 3 *cont.*

Food group	Overlaps in products available in markets and farms	Products available only in markets or farms	
		Market-only products	**Farm-only ('niche') products**
Vegetables	*Corchorus* species *Crotalaria* species *Cucurbita* species *Daucus carota* *Solanum lycopersicum* *Solanum melongena* *Solanum* species *Vigna unguiculata*		
High-sugar foods			*Saccharum officinarum* (sold in other markets)

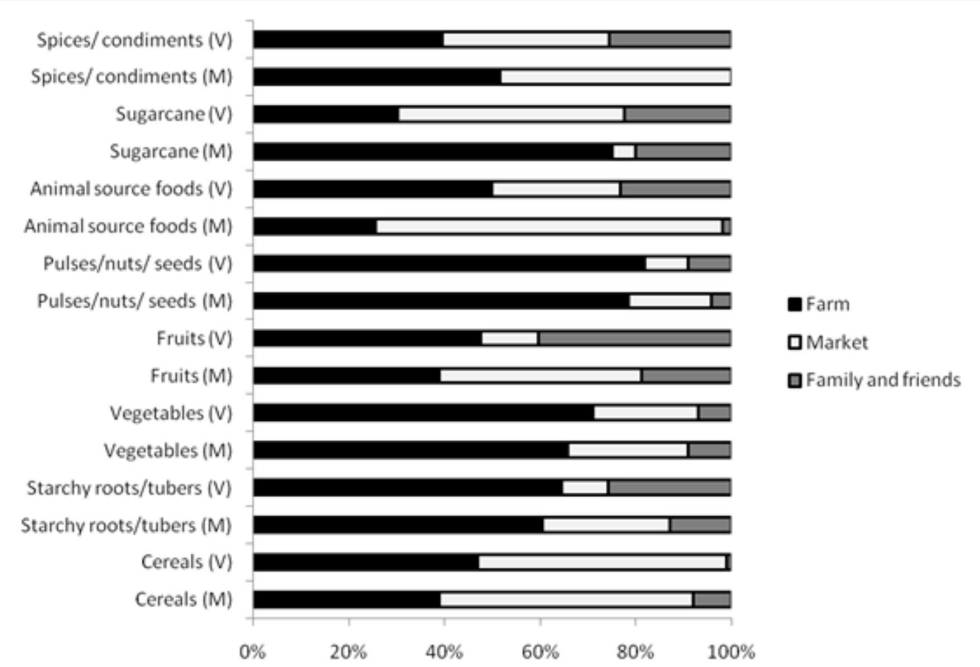

Figure 2. Food sources for the different food groups given as the last five consumptions among households in Mumias (M) and Vihiga (V) districts, November/December 2012, N = 30 (15 per district).

formal and informal markets is lost through pre- and post-harvest losses. Between January and December 2012, 10% of the smallholder farmers had experienced pre-harvest food losses while 37% had experienced post-harvest food losses. Although negatively affecting a small proportion of smallholder farmers, these farmers men-

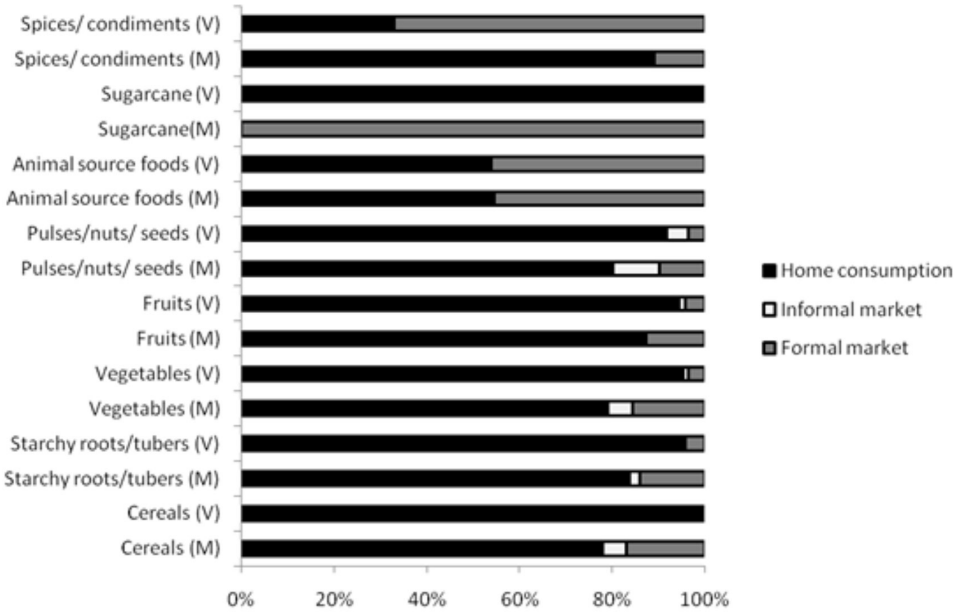

Figure 3. Main food uses of on-farm products among households in Mumias (M) and Vihiga (V) districts, September/October 2012, N=30 (15 per district).

tioned that 'hail stones' are mainly responsible for pre-harvest food losses of a diversity of on-farm crops in Vihiga District, a more humid region. In both Vihiga and Mumias districts, post-harvest food losses are mainly due to poor markets for surplus fruits and vegetables, followed by poor storage conditions of cereals.

In January and December 2012, the main foods lost were fruits and vegetables but also pulses and cereals. The key fruits affected were guavas (*Psidium guajava*), avocados (*Persea americana*) and mangoes (*Mangifera indica*). During high harvest seasons, the quantity of fruits is too much for household food consumption and they would sometimes be left to rot and also birds would eat and spoil the ripe fruits. This post-harvest loss is mainly because there is low market demand for seasonal fruits in high supply. One farmer reported that when fruits are available in high quantities, the market price for a 50 kg bag of avocados can be as low as US$0.4. Within one month of high vegetable harvest, a different farmer experienced losses of cowpea leaves (*Vigna unguiculata*), African kale (*Brassica oleracea* var. *acephala*), Jew's mallow (*Corchorus* species) and slender leaf (*Crotalaria* species), due to poor market prices as they were too much for both household and livestock consumption. The main cereal affected by post-harvest loss is maize, due to aflatoxin contamination as a result of storage of the cereal in damp conditions. According to the farmers, a main cause of pre-harvest food loss in Vihiga District is excessively cold conditions resulting in 'hail stones' that destroy on-farm crops. For example, in September and November 2012, a diversity of on-farm crops, including cowpea leaves (*Vigna unguiculata*), fruit bananas (*Musa sapientum*), avocados (*Persea americana*) and guavas (*Psidium guajava*),

had been destroyed.

Participation in Local Market Trading System

While the geographical and sociocultural settings in formal markets are of trading between smallholder farmers and interested buyers (whether known or unknown) in open-air markets, informal markets are characterized by in-kind exchange of farm produce by smallholder farming households (mainly to known buyers, such as family and friends) away from designated market places. Although smallholder farmers have surplus on-farm produce and engage mainly in informal market channels, their involvement in formal market channels is minimal. The only market produce smallholder farmers were selling directly were milk, *Amaranthus* species, African kale (*Brassica oleracea* var. *acephala*), sweet potatoes (*Ipomoea batatas*), avocados (*Persea americana*), groundnuts (*Arachis hypogaea*) and common beans (*Phaseolus vulgaris*), the latter three being a produce from only one smallholder farmer (who was selling their on-farm produce at the market). Fifteen per cent of the 48 food products were sold by smallholder farmers (who were also part-time market traders), 10% were sold by small-scale/travelling traders (who directly sourced their products from local smallholder farmers), and 75% of the products were sold by large-scale traders/wholesalers, who did not directly source their products from smallholder farmers but rather sourced their products from small-scale traders, large-scale farmers from within the district, other districts and from neighbouring countries. The food groups 'fruits', 'pulses/nuts/seeds' and 'starchy roots/tubers' were mainly sourced from neighbouring countries such as Uganda (Table 4).

Discussion

Smallholder Farming Households Rely on Multiple Food Sources

This study shows that smallholder farmers rely on farms, markets and existing social networks such as family and friends in meeting household food consumption needs. This finding corroborates with a study in the Amhara region of Ethiopia where the three most common ways of food acquisition among rural households are on-farm production, purchase from markets and gifts (Negatu, 2004). There is a general consensus that rural households mainly access food through subsistence production, markets and household transfers (Baiphethi and Jacobs, 2009), yet never through only one source.

On-farm Production as a Food Source

In the study sites, smallholder farms are essential in meeting household food needs for a number of food groups that are also highly available in markets. While reducing reliance on markets for most household food consumption needs, these foods also affordably provide diverse nutritional value. The main strategy employed by the smallholder farmers to reduce unnecessary market visits is by consumption of alternative foods available through on-farm production, such as seasonally available fruits and starchy roots/tubers/green bananas. In this study, though oranges (*Citrus sinensis*) were the most highly available fruits at the local markets, fruits that

Table 4. Types of market traders and origin of products in the seven markets in Mumias and Vihiga districts, September/October 2012.

Food group	Type of market trader	Origin	
Animal source foods	A, B	A	Market trader's farm
		B	Within district, Other districts (Kakamega, Kisumu, Busia, Luanda, Lodwar, Nandi)
Cereals	B, C	B	Within district, Other districts (Busia ,Kitale, Nandi, Eldoret, Busia, Kapsabet, Kisumu)
		C	Someone's farm
Fats and oils	B	B	Within district
Fruits	A, B, C	A	Mumias
		B	Other districts (Kakamega, Kisumu, Bungoma, Siaya, Machakos and Kitui, Marakwet, Mombasa), neighbouring countries (Uganda, Tanzania)
		C	Chavakali (Someone's farm), Mumias (Someone's farm)
Pulses/nuts/seeds	A, B	A	Buhuru
		B	Other districts (Busia, Kakamega, Kisumu, Luanda, Nairobi), neighbouring countries: Uganda
Spices/condiments	B	B	Within district (Mumias, Majengo), Other districts (Bungoma, Kakamega, Kisumu, Mombasa, Nairobi)
Starchy roots/tubers/green bananas	A, B	A	Kisumu, Mumias
		B	Within district (Chavakali, Majengo), Other districts (Busia, Bungoma, Kakamega, Mount Elgon area, Kiambu, Marakwet, Nairobi, South Nyanza, Timboroa), neighbouring country (Uganda)
Vegetables	A, B, C	A	Mumias (market trader's farm)
		B	Within district (Mumias, Majengo, Makunga), Other districts (Kakamega, Kapsabet, Nandi, Mount Elgon area, Kisumu, Kitale, Luanda Mwea, Nairobi, Narok)
		C	Makunga (someone's farm), Kilingili (someone's farm)

were widely consumed by smallholder farming households were guavas (*Psidium guajava*), mangoes (*Mangifera indica*), avocados (*Persea americana*) and fruit bananas (*Musa sapientum*). With regard to starchy roots/tubers/green bananas, though potatoes (*Solanum tuberosum*) were widely available in local markets, they were not consumed by smallholder farming households. In the two study sites, smallholder farmers plant and consume more than one variety of cassava (*Manihot esculenta*) and sweet potatoes (*Ipomoea batatas*). The popularity of sweet potatoes and cassava (*Manihot esculenta*) for home consumption could be a survival strategy to acquire a cheap source of starchy roots and tubers. This finding on the popularity of the three cassava varieties, MM95/0183 ('Migyera'), 'SS4' and MM96/1872, for on-farm production corroborates with a study conducted among a cassava consuming community in Nambale, Western Kenya, reiterating the popularity of 'SS4' and 'Migyera', with the latter the most preferred variety for cooking (Nungo et al., 2012).

Although vegetables were the most frequently available food items in the local markets, smallholder farmers in both districts mainly relied on vegetables sourced from their farms during the November/December short rainy season. The high availability of vegetables in markets could be explained by a Western Kenya market study suggesting that market availability of a particular kind of vegetable is

associated with its high demand (Ekesa et al., 2009). Although smallholder farmers endeavoured to increase their vegetable self-sufficiency through farm production, adequate vegetable yields depend on many factors, including seasonality, implying that markets remain essential for year-round vegetable supply. At the same time, it is common to cook different vegetables together in one meal in Western Kenya, for example cowpea leaves (*Vigna unguiculata*) are mostly cooked together with Jew's mallow (*Corchorus* species) (Ekesa et al., 2009). Despite high-volume farm harvests of a local favourite vegetable during one season, crop losses may deplete a household's vegetable reserve. For example, one smallholder farmer growing Jew's mallow lost the entire crop within one month post-harvest, which could necessitate sourcing the vegetable elsewhere when desired for home consumption. In addition, farmers may not always grow all the different types of vegetables they consume in a meal themselves, necessitating them to access the other vegetables from alternative sources, including markets.

Markets and Social Networks as a Food Source

While farms are more important for sourcing a diversity of nutrient-rich food groups, markets play an important role in the provision of foods inadequately available through on-farm production, especially cereals. The importance of cereals is backed up by a study suggesting that staples are one of the main ingredients of most of the food that is consumed by rural households, and they rely on such staples for a large share of their daily calories (Smale et al., 2009). In Mumias and Vihiga districts, as in the rest of Western Kenya, dry maize grain is milled to produce a fine maize flour, which is used to make a cooked paste known as *ugali* (Mwololo, 2010), considered a staple and a delicacy among the Luhya community, the predominant community in the two study sites.

The importance of working social networks for food access is exemplified by sourcing of starchy roots/tubers/green bananas and fruits from family and friends in Vihiga District, though the percentages exchanged and consumed are lower than those sourced from on-farm production. Family and friends, who in most cases were also farmers, shared their produce with the smallholder farmers, whether the family and friends' produce was in surplus or not. Seasonally available fruits that were in high supply for smallholder farming household consumption, but in low demand at the local markets, were also shared among family and friends. A study conducted among smallholder farmers in Embu District of Eastern Kenya found that most (76%) of the farmers grow crops for home consumption rather than for the market, due to poor market prices (Stocking et al., 2003). This could be the case with green bananas (*Musa paradisiaca*), which were readily available through on-farm production and for smallholder farming household consumption, but were unavailable in local markets.

Smallholder Farming Households Rarely Sell Their Surplus On-farm Produce in the Formal Markets

Smallholder farmers grow on-farm produce for both home consumption and for commercial purposes. With the exception of sugarcane and spices/condiments, the highest proportion of a majority of the food groups were utilized for home con-

sumption, with the remainder sold. Apart from sugarcane in Mumias District and tea in Vihiga District, animal source foods are also sold in formal markets in addition to their utilization for home consumption. Animal source foods sold in formal markets are mainly cattle but also goats, sheep, rabbits and pigs, while chickens are reared by smallholder farming households mainly for their eggs. Though it has been suggested that poor smallholder farming households tend to sell rather than consume the animal source foods they produce (Allen, 2003; Dror and Allen, 2011; Smith et al., 2013), this applies mainly to large livestock, such as cattle, where sale could also contribute to household food security by providing income that can be used to purchase staple foods (Smith et al., 2013) or pay for non-food items such as school fees, household goods and repairs.

Though studies suggest that poor infrastructure leads to high transaction costs, which in turn limit the extent of smallholder farmer engagement in formal market exchanges (Omamo, 1998; Nagarajan et al., 2007; Dury et al., 2011), physical access to formal markets is not necessarily a limiting factor in this study. This is because both study sites are well connected to local markets mainly by tarmac roads, with the nearest local urban or rural market relatively close to the smallholder farming households. However, the smallholder farmers in this study still do not participate in formal market trading network as sellers, suggesting that it takes more than good infrastructure for rural households to engage and participate in formal markets (Omiti et al., 2009). While trading smallholder farm produce between households and relatives strengthens family relationships (Maroyi, 2009), informal market channels in this study were probably selected depending more on the type of market information a farmer has access to and the need to reduce market transaction costs. As in this study, though formal sources of market information such as newspapers and mobile phones are available in the rural areas, they are inaccessible to the majority of smallholder farmers who do not purchase or read newspapers on a regular basis (Omiti et al., 2009). While all smallholder farmers in this study either own or have access to a mobile phone, these phones are mainly for socializing and less frequently for communicating with potential buyers and discovering market prices (Mutabazi et al., 2013). Though travelling traders could serve as more accessible contacts on prevailing market prices, limited repeated transactions with these traders hamper long-lasting business relationships that facilitate insightful market information dialogues. Therefore, optimal use of the existing mobile phone technology could facilitate the building of relationships with market traders to improve smallholders' market access. However, the underdeveloped cooperation between market traders and smallholder farmers could also be because market traders seem more interested in having regular and consistently high-quality supplies (KIT and IIRR, 2008) whereas smallholder farmers trade mostly in small volumes of variable quality (Hazell, 2005).

Secondly, informal markets are characterized by lower transaction costs, as all trading of food crops and livestock in formal rural markets attracts fees and taxes (Ellis and Bahiigwa, 2003; Ellis and Mdoe, 2003). In addition to this, surplus pulses/nuts/seeds, a less perishable produce, was sold in both formal and informal markets in this study, with a preference for informal markets due to the flexibility of products and services that the produce could be traded for. For example, a farmer exchanged surplus soya beans (*Glycine max*) and groundnuts (*Arachis hypogaea*) for payment of their children's school fees. Informal selling of surplus on-farm produce, while offering flexibility in the mode of payment, incurs little or no transaction costs as compared to transporting and selling produce in formal markets. Barrett et al. (2000)

suggest that when smallholder farmers participate in markets, they are engaged in low-return market activities, such as petty trading at weekly rural markets, mainly because they have little financial choice, which also applied to the situation in Western Kenya.

Market Traders Mainly Source Produce from Distant Areas

This study shows that the majority of the market produce is not sourced from within the region, which is confirmed by a Western Kenya study showing that most market products come from neighbouring districts, not from within the same area (Abukutsa-Onyango, 2002). This is partly because some produce, such as lemons (*Citrus limon*), oranges (*Citrus sinensis*) and animal source foods such as fish, are not produced in the local area, necessitating market traders to purchase such produce from neighbouring areas.

For locally available produce, three main observations explain why traders least source their market produce from local smallholder farmers, based on informal discussions with market traders. They concern quantity, price and quality. Firstly, while smallholder farmers are unable to consistently supply market traders with high quantities of produce, traders acquire sufficient quantities of plant produce from other readily accessible sources, which saves both time and money. Among smallholder farmers, surplus on-farm produce for selling is highly available immediately (one to two weeks) after the harvest season, after which the remaining quantities are reserved for home consumption. It could also be that as a result of many traders in search of the (same) produce, smallholder farmers run out of surplus stock for selling soon after harvesting. With high quantities unavailable for selling, traders in search of market produce would be required to search for produce from many different farmers to get desired quantities, which is time consuming. The same applies for animal source foods, where one trader remarked that in most cases, a trader can only get five chickens from five different local smallholder farmers while in other neighbouring districts where chicken rearing is common (such as Nandi district), they can get a hundred chickens from one source. Secondly, in cases where the produce is available in high quantities for a longer time span, for example sweet pepper (*Capsicum annuum*), few of the smallholder farmers will have the produce, and most likely having incurred high production costs, the produce can be quite expensive for traders to buy. In those cases, it is more profitable for market traders to buy such produce in places of high availability, even if in different districts or even countries. Thirdly, where the produce is highly available and affordable, it may be unsuitable for local markets. For example, many smallholder farmers harvest maize when it is too young, which is good for selling as roasted or boiled maize, but not suitable for selling as grain, as it is not preferred for grinding into maize flour. The low frequency of sourcing of produce from smallholder farmers further agrees with studies suggesting that smallholder farmers are rarely integrated in local markets (Rietbergen et al., 2002; Kruijssen et al., 2009) generally due to variability in the quantity and quality of their produce.

While smallholder farmers dealing in food crops and livestock in this study have poor access to markets, smallholder farmers growing the two main cash crops, sugarcane and tea, are well connected to domestic and regional markets. In Mumias, sugarcane smallholder farmers are offered institutional support through out-grower schemes, with farmers accessing a ready market, among other benefits (Govereh et

al., 1999). Similar producer support is mirrored by smallholder tea farmers in Vihiga District. In this study, though the smallholder farmers dealing in food crops and livestock lack formal institutional support, they also rarely organize themselves (formally or informally) to market existing produce or develop better markets for their produce. Organized farmers have the potential to enhance the quantity and quality of their produce, which in turn facilitates better cooperation with market traders, with traders offering higher prices and a loyal business relationship lasting years (KIT and IIRR, 2008).

Organized Smallholder Farmers Stand to Benefit by Filling in Market Gaps

Despite their current minor involvement as sellers in local market trading networks, smallholder farmers who get organized in the study sites could potentially benefit from better market integration, in two key ways: by filling in the local market gaps and by local product value addition. In the first instance, smallholder farmers have the capacity to fill in the market gaps by diversifying their on-farm produce to match produce available and in demand in the local markets. In this study, smallholder farmers do not currently produce in-demand food items uniquely available in local markets such as spices/condiments (*Allium sativum*, *Coriandrum sativum* and *Zinziger officinale*) and animal source foods. With changing tastes increasing rural and urban demand for some food products such as indigenous vegetables (Gotor and Irungu, 2010; Muhanji et al., 2011; Chege et al., 2015), organized smallholder farmers can also tap into these markets by introducing 'niche' products unavailable in markets but uniquely available through on-farm production, for example rabbits (Table 3). While rabbit-breeding was not practised commercially in the Western Kenya study sites during the survey period, smallholder farmers in some other parts of the country have established market linkages based on this niche product. While many Kenyans are unaware that rabbit meat can adequately substitute other protein sources (Borter and Mwanza, 2011), in 2009 a smallholder-run organization based in Central Kenya, the Rabbit Breeders Association of Kenya (RABAK), started their enterprise by addressing the misconceptions around rabbit meat consumption. They did so by educating community members on the nutritional and economic value of rabbit meat through extensive campaigns in annual national agricultural fairs, monthly local farmers' meetings and ad hoc media coverage. RABAK received a boost from one of the leading regional supermarket chains, supplying it with about two tonnes of rabbit meat every month to date, thus substantially increasing the farmers' market share. RABAK has also partnered with about six other collaborators offering many forms of support, including procurement of RABAK's rabbit fur, thus establishing the smallholder farmers' rabbit market niche (RABAK, 2014). Thus, while there is a need for various stakeholders to stimulate education on nutrition to help build market integration for smallholders based on their niche products, it is also likely that when organized smallholder farmers initiate such ventures, other interested stakeholders may eventually partner with them. This collaboration may in turn result in sustainable support schemes, such as food cooperatives (Jaklin et al., 2015). In addition, some of these food groups, including small ruminants and starchy roots, are subject to relatively few transaction costs (Delgado, 1999). Moreover, with diversification in early-maturing and late-maturing produce, some of these niche products unavailable on every farm around the same time could be sold for a good price and the profits utilized to meet household food needs. Further, when

vegetables, fruits and livestock products become more plentiful and cheaper, they could improve the nutritional status of households (Poulton et al., 2006b). However, there are still many risks associated with building markets for niche products. For instance, institutional support schemes depend not only on the product in question but also on the contrasting interests and power dynamics of these producer organizations (Varga, 2015).

In the second instance, preservation and value addition of surplus perishable products is a strategic market entry point for organized smallholder farmers, not only to increase farmers' incomes, but also to bridge hunger gaps during out-of-season periods. In this study, surplus fruits, vegetables and cereals are mainly lost through post-harvest losses. This is because most smallholder farmers produce their food items at the same time, resulting in high seasonal supply and low demand (Omiti et al., 2009). In this study, though few farmers (37%) are affected by post-harvest foods losses, the surplus seasonal produce that eventually makes it to the market fetches low prices, resulting from the limited ability of producers to store surplus produce (Weinberger and Lumpkin, 2007) especially in seasons of high availability. The issue may be more complex than limited storage facilities, as farmers often have little choice but to sell their produce immediately so as to meet their short-term cash needs (Godfray et al., 2010). However, through pooling of resources, seasonal surplus supply can be processed at different levels (factory, village, household, individual) and to different degrees (minimal, culinary, 'ultra-processing') (Monteiro and Cannon, 2010) into higher value produce with a longer shelf life, such as dried fruits and vegetables, which can fetch higher prices and meet food demands during seasons of food deficiency. For example, organized smallholder farmers in the Mgeta region in Tanzania market local goat's milk yoghurt through a semi-formal local goat farmers cooperative, which has a greater impact on improving their livelihoods than selling highly perishable surplus milk (Lie et al., 2012). Thus, reduction of food waste by value addition could contribute to increased food availability (Kader, 2003; Sagar and Kumar, 2010) as well as to rural development and poverty reduction by improving agribusiness livelihoods (Hodges et al., 2011).

Although this study is limited by identification of morphologically similar local vegetables in the local markets as well as by market and farm species identification down to variety level, the findings provide insights to addressing the challenges that smallholder farmers face in market participation, with an aim of increasing market integration for improved household food security.

Conclusions

Smallholder farmers with different farm and environmental settings utilize multiple channels of continuous food supply. Markets are more important for sourcing cereals, a staple food inadequately available through on-farm production, while their own farms are more important for sourcing a diversity of nutrient-rich food groups, with working social networks playing a supporting role. Although surplus on-farm produce for selling is seasonally available, smallholder farmers prefer to sell such produce in informal markets as they are associated with lower transaction costs. At the same time, market traders in formal markets mainly source their produce from distant areas, including other countries, due to the small and inconsistent volumes that smallholder farmers trade in. As a consequence, smallholder farmers are least integrated in formal markets. Improving smallholder farmer access to formal mar-

kets in general and to market traders in particular goes hand in hand with efforts in organizing smallholder farmers to fill in the local market gaps and to add value to surplus perishable products. This in turn holds the potential to increase food incomes and close out-of-season food and nutrition gaps. The increased incomes could enable access to diversified foods and reduce the need for food self-sufficiency, with an overall impact on improving household food security.

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Appendix

Table A1. List of food plant species (sorted by food-use groups), their scientific and common names, and their availability in seven markets and 30 farms surveyed in Mumias and Vihiga districts, Western Kenya, September/October 2012.

No.	Scientific name	Common English name	Local Swahili name	Availability in markets (where applicable, animal part/product available)	Availability on farms (where applicable, animal part/product available)
Cereals					
1.	*Zea mays*	Maize	Mahindi	Available	Available
2.	*Eleusine corocana*	Finger millet	Mtama	Available	Unavailable
3.	*Oryza sativa*	Rice	Mchele	Available	Unavailable
4.	*Sorghum bicolor*	Sorghum	Mawele	Available	Available
5.	*Triticum aestivum*	Wheat	Wimbi	Available	Unavailable
Fruits					
6.	*Ananas comosus*	Pineapple	Nanasi	Available	Available

Table A1 *cont.*

No.	Scientific name	Common English name	Local Swahili name	Availability in markets (where applicable, animal part/product available)	Availability on farms (where applicable, animal part/product available)
Fruits					
7.	*Annona muricata*	Soursop	Mtomoko	Unavailable	Available
8.	*Carica papaya*	Papaya	Paipai	Unavailable	Available
9.	*Citrus limon*	Lemon	Ndimu	Available	Available
10.	*Citrullus lanatus*	Watermelon	-	Available	Unavailable
11.	*Citrus sinensis*	Orange	Chungwa	Available	Unavailable
12.	*Dovyalis caffra*	Kei apple	–	Unavailable	Available
13.	*Eriobotrya japonica*	Loquat	Zabibu	Unavailable	Available
14	*Mangifera indica*	Mango	Embe	Available	Available
15	*Morus alba*	White mulberry	Mfurusadi	Unavailable	Available
16	*Musa sapientum*	Dessert banana	Ndizi ya kuivisha	Available	Available
17	*Passiflora* species	Granadilla	-	Unavailable	Available
18	*Passiflora edulis*	Passion fruit	Marakucha	Unavailable	Available
19	*Persea americana*	Avocado	Parachichi	Available	Available
20	*Physalis peruviana*	Cape gooseberry	-	Unavailable	Available
21	*Psidium guajava*	Guava	Pera	Unavailable	Available
22	*Solanum betaceum*	Tree tomato	Gogwe	Unavailable	Available
23	*Syzygium cuminii*	Java plum	Zambarau	Unavailable	Available
24	*Vitex doniana*	Black plum	Fudu	Unavailable	Available
Pulses/nuts/seeds					
25	*Arachis hypogaea*	Groundnut	Njugu karanga	Available	Available
26	*Cajanus cajan*	Pigeon pea	Mbaazi	Unavailable	Available
27	*Glycine max*	Soy bean	Soya	Available	Available
28	*Lens culinaris*	Lentil	Kamande	Unavailable	Available
29	*Phaseolus vulgaris*	Common bean	Maharagwe	Available	Available
30	*Sesamum indicum*	Sesame	Simsim	Available	Available
31	*Vigna radiata*	Mung bean / greengram	Ndengu	Available	Available
32	*Vigna subterranea*	Bambara nut	Njugu mawe	Unavailable	Available
Spices/condiments					
33	*Allium sativum*	Garlic	Kitunguu saumu	Available	Unavailable
34	*Camellia sinensis*	Tea	Chai	Unavailable	Available
35	*Capsicum annuum*	Chilli pepper	Pilipili	Available	Available
36	*Coffea arabica*	Coffee	Kahawa	Unavailable	Available
37	*Coriandrum sativum*	Coriander	Dhania	Available	Unavailable
38	*Zinziger officinale*	Ginger	Tangawizi	Available	Unavailable
Starchy roots/tubers/green bananas					
39	*Colocasia esculenta*	Taro	Nduma	Unavailable	Available

Table A1 *cont.*

No.	Scientific name	Common English name	Local Swahili name	Availability in markets (where applicable, animal part/product available)	Availability on farms (where applicable, animal part/product available)
Starchy roots/tubers/green bananas					
40	*Dioscorea bulbifera*	Air potato	-	Unavailable	Available
41	*Ipomoea batatas*	Sweet potato	Kiazi kitamu	Available	Available
42	*Manihot esculenta*	Cassava	Mhogo	Available	Available
43	*Musa paradisiaca*	Cooking banana	Ndizi ya kupika	Unavailable	Available
44	*Solanum tuberosum*	Irish potato	Kiazi	Available	Available
Vegetables					
45.	*Allium cepa*	Bulb onion	Kitunguu	Available	Available
46	*Allium fistulosum*	Spring onion	Kitunguu cha kijiti	Available	Available
47	*Amaranthus* species	Amaranth	Mchicha	Available	Available
48	*Basella alba*	Indian spinach	Nderema	Unavailable	Available
49	*Brassica carinata*	Ethiopian cabbage	Kanzira	Available	Available
50	*Brassica oleracea* var. *acephala*	African kale	Sukuma wiki	Available	Available
51	*Brassica oleracea* var. *acephala*	(White) cabbage	Kabichi	Available	Unavailable
52	*Cleome gynandra*	Spider plant	Mkabili	Available	Available
53	*Cleome hirta*	Spider plant	Mkabili	Unavailable	Available
54	*Corchorus* species	Jew's mallow	Mlenda	Available	Available
55	*Crotalaria* species	Slender leaf	Mito	Available	Available
56	*Cucurbita* species	Pumpkin	Malenge	Available	Available
57	*Daucus carota*	Carrot	Karoti	Available	Available
58	*Erythrococca bongensis*	–	Shirieto	Unavailable	Available
59	*Solanum lycopersicum*	Tomato	Nyanya	Available	Available
60	*Solanum melongena*	Egg plant	Biringanya	Available	Available
61	*Solanum* species	Black nighshade	Mnavu	Available	Available
62	*Spinacia oleracea*	Spinach	-	Available	Unavailable
63	*Vigna unguiculata*	Cowpea	Kunde	Available	Available
High-sugar foods					
64	*Saccharum officinarum*	Sugarcane	Miwa	Unavailable	Available
Animal source foods					
65	*Bos taurus*	Cattle	Ng'ombe	Available (whole animal, milk, meat)	Available (whole animal, milk)
66	*Gallus gallus domesticus*	Chicken	Kuku	Available (whole animal, egg)	Available (whole animal, egg)

Table A1 *cont.*

No.	Scientific name	Common English name	Local Swahili name	Availability in markets (where applicable, animal part/product available)	Availability on farms (where applicable, animal part/product available)
Animal source foods					
67	*Tilapia* species	Tilapia fish	Samaki ya tilapia	Available	Unavailable
68	*Capra aegagrus hircus*	Goat	Mbuzi	Available (whole animal)	Available (whole animal, milk)
69	*Ovis aries*	Sheep	Kondoo	Available (whole animal)	Available (whole animal)
70	*Sus scrofa domesticus*	Pig	Nguruwe	Available (meat)	Available (whole animal)
71	*Oryctolagus cuniculus*	Rabbit	Sungura	Unavailable	Available (whole animal)