THE ROLE OF THE SWEET POTATO IN THE CROP DIVERSIFICATION OF SMALL-SCALE FARMERS IN SOUTHERN PROVINCE, ZAMBIA

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ABSTRACT Stable maize production and increased productivity are important for improved food security in Zambia. Because most farmers cultivate maize under rain-fed agriculture, a maize monoculture is vulnerable to drought or excessive rainfall. Therefore, increasing the diversification of crops and crop varieties is important to achieve food security in the face of a changing climate. The sweet potato (*Ipomoea batatas*) has great potential as a crop for consumption and as a source of income. The aim of this study was to determine farmers' familiarity with sweet potato varieties and their features, and to clarify production and consumption patterns in a rural area in Southern Province, Zambia. Field studies were conducted at three sites. Farmers in the study area planted sweet potatoes in both the rainy and dry seasons. As a group, farmers were able to identify a total of 22 sweet potato varieties, but all varieties that were identified were not actually cultivated. Sweet potato production was much greater at one site. Further study of some households at this site indicated that sweet potato tubers were consumed about twice per week. Consumption was highest during and immediately after the harvest, and then decreased gradually. Annual sweet potato sales per person generated sufficient income.

Key Words: Food security; Food consumption; Cash income; Tuber crop.

INTRODUCTION

About 75% of farmers in Zambia engage in small-scale farming, with an average farm size of 2 ha (VAM Steering Committee Zambia, 1998). Most of these farmers cultivate maize, which is a staple food in Zambia. Consequently, stable maize production and increased productivity are important for food security. Because small-scale agriculture is predominantly dependent on rain-fed cultivation, a maize monoculture is vulnerable to factors such as flooding and drought. Increasing diversification of crops and crop varieties is, therefore, important to achieve food security in the face of a changing climate (Cotter & Tirado, 2008). As a result of structural adjustments and economic liberalization carried out in the early 1990s, crop diversification has improved. Zulu et al. (2000) reported that the cultivated area of crops excluding maize increased from 1993 to 1998, including production areas for cotton, groundnuts, cassava, and sweet potatoes. Production of groundnuts,

cassava, sweet potatoes, and tobacco also increased during this period. Jayne et al. (2007) found that cassava, groundnut, and sweet potato production all increased with the introduction of improved varieties in the early to mid-1990s, indicating that crop varieties should also be considered when undertaking crop diversification.

Average sweet potato production in Zambia was calculated for 5-year periods from 1965 to 2009 using FAO STAT 2013 data (FAO, 2013). The reason for taking a 5-year average was to clarify long-term trends by removing short-term fluctuations. The growth rate of sweet potato production was maintained at 10% from 1965 to 2004, with the exception of the 1995 to 1999 period. Sweet potato production from 2005 to 2009 was twice as high as production in the 2000 to 2004 period. Thus, it is thought that the importance of the sweet potato has increased in recent years.

The sweet potato is an important secondary food in Zambia and other countries in southern Africa (Kapinga et al., 2005). In addition to its important role as a food crop for self-consumption, it has great potential as an income source for farmers (Rees et al., 2001). Therefore, it is important to understand the production and consumption of sweet potatoes in rural Zambia. Currently, there is little published information on the area under cultivation, or how the crop is utilized at the household level. The aim of this study was to determine farmers' familiarity with sweet potato varieties, the features of these varieties, and to clarify production and consumption patterns of sweet potatoes in several rural villages in Southern Province, Zambia.

STUDY AREA AND METHODS

The study sites were located in Southern Province, Zambia (Fig. 1), which is in the semiarid tropics and has an average annual precipitation that ranges from about 600 to 900 mm (Yatagai, 2011). The rainy season occurs from November to April, and small-scale farmers in the area commonly cultivate maize under rain-fed conditions. The elevation increases gradually from the Lake Kariba shore to the highlands. The three sites used in this study were located in the lower terrace near Lake Kariba (Site A), the middle of the escarpment (Site B), and the upper terrace of the escarpment (Site C). Sites A and B each consisted of two villages, and Site C had one. The sites' agro-ecosystems were different because of rainfall, temperature, and vegetation. All residents of the sites were of Tonga ethnicity; Site A and B residents belong to the Gwembe Tonga, and Site C residents to the Plateau Tonga.

Group discussions using open-ended questions were conducted to produce crop calendars at each site in October of 2007. More than five adult participants were arbitrarily chosen for these discussions. To determine the cultivation area for each crop, all of the cultivated fields were measured at the three sites in the 2008/09 rainy season and the 2008/09 dry season using hand-held GPS units. Rainy season fields were measured from March to April in 2009 and dry season fields were measured from August to October in 2009. In cases in which other crops were planted with maize in the same field, the entire planted area was considered as the

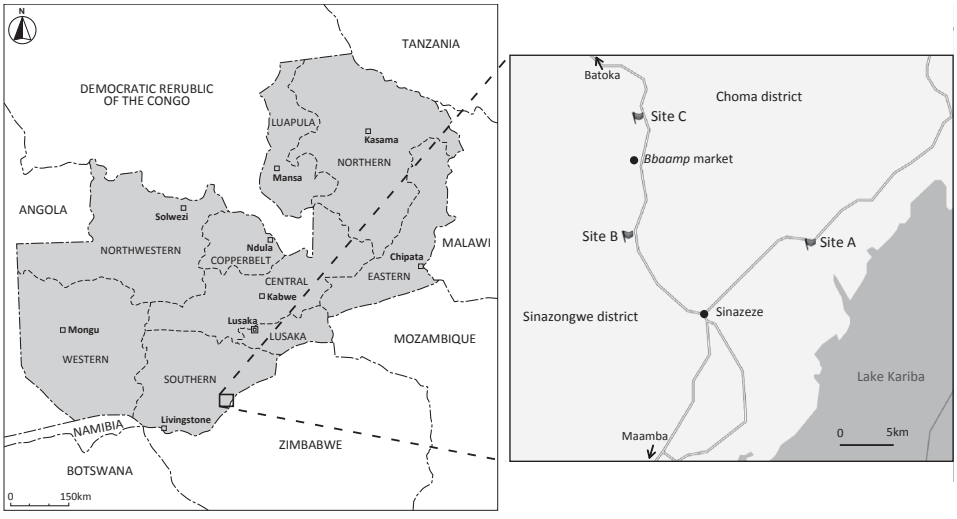

Fig. 1. Study sites in Southern Province, Zambia.

primary crop, which was determined by the field's owner.

We were not only interested in the types of crops grown, but also in the varieties of sweet potatoes that were grown. To clarify the farmers' familiarity with sweet potato varieties, we interviewed the household head or the spouse at all households at each of the three sites from August to September in 2009. Field assistants conducted semi-structured interviews using questionnaires. Field assistants visited all households and conducted each interview one by one. Interviewees were asked about the number of varieties they were familiar with, including familiarity with variety features such as time to maturity, tuber size, color of the tuber skin, taste, pest tolerance, and drought tolerance. A total of 77 households were interviewed at Site A, 38 at Site B, and 82 at Site C.

Information on cooking method was obtained through observations by the first author and through group discussions conducted by field assistants using a semi-structured questionnaire in December of 2010. Five adults participated and reported their knowledge on how to cook sweet potatoes. Semi-structured questionnaires were conducted to determine sweet potato home consumption and sales. Six households were selected for home consumption, and 12 households, including the six households that were selected for home consumption, were selected for sales from 95 households. Those households were also selected from different expanded households. Selected households kept semi-structured papers in their homes to record their consumption and sales of sweet potatoes from May of 2009 to April in 2010. A field assistant inspected and collected these papers every 2 weeks.

CROP DISTRIBUTION

I. Crop Calendar

Farmers planted maize at the beginning of the rainy season in November, either by dry planting, in which they started planting by hoe after the first rain, or by using an animal-drawn plow after the first several rains (Fig. 2). Other crops (e.g., pumpkin, sorghum, pearl millet, and beans) were typically planted in the same field along with the maize at the same time. When they finished planting maize, they began to plant other crops in other fields. Some "green" maize was harvested in March, and the remaining maize was harvested after it dried in the fields. The dried maize was used to make maize flour, usually beginning in the end of April. The typical sowing time for dry season maize differed between Sites A, B, and C. At Site A, planting took place from the end of February to the beginning of March, but at Sites B and C, maize was planted from the end of August to October. Other crops were also grown during the dry season. The dominant dry season crop was okra at Site A and sweet potatoes at Site C. Vegetables such as cabbage, tomatoes, and rape were planted in gardens at all of the sites. Vegetable crops were planted in March or April by farmers with suitable fields, such those near riverbanks or *dambo* (seasonal wetlands). Some of the farmers continuously grew and harvested vegetables to sell, particularly at Site C.

II. Spatial Distribution

Maize was the dominant crop grown during the rainy season, but there were many other types of crops planted, ranging from 9 other crops at Site C, to 11

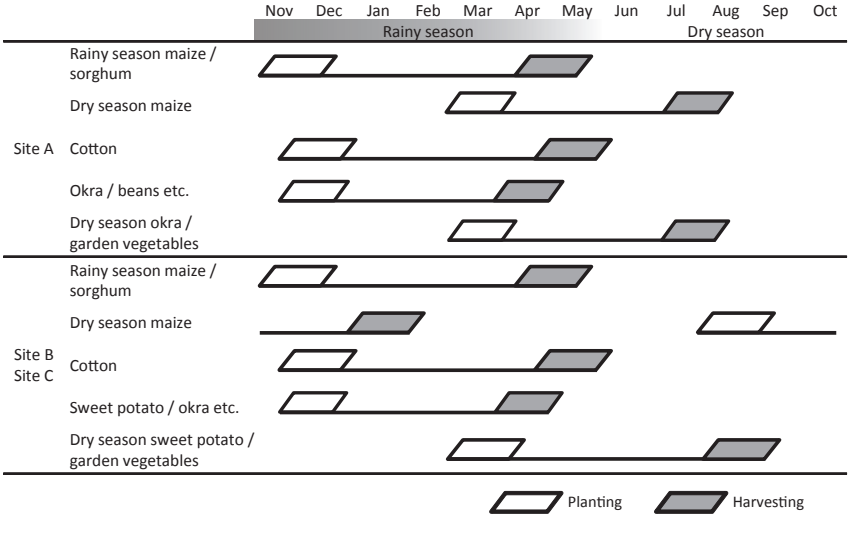

Fig. 2. Crop calendars for the study sites.

Table 1. Cultivated crop area in the 2008/09 rainy season for Sites A, B and C

Crop			Site A		Site B		Site C	
English	Scientific name	Local name	(ha)	(%)	(ha)	(%)	(ha)	(%)
Maize	*Zea mays*	*Mapopwe*	51.14	45.73	56.25	87.54	74.89	69.61
Cotton	*Gossypium* spp.	*Buluba*	49.42	44.19	0.82	1.28	6.39	5.94
Sorghum	*Sorghum bicolor*	*Maila*	4.75	4.25	1.44	2.24	0.89	0.83
Sunflower	*Helianthus annuus*	*Malangazuba*	-	-	1.31	2.04	-	-
Groundnut	*Arachis hypogaea*	*Indongwe*	-	-	0.25	0.39	1.59	1.48
Cowpea	*Vigna unguiculate*	*Nyangu*	0.49	0.44	0.30	0.47	1.35	1.25
Sweet potato	*Ipomoea batatas*	*Chimbwali*	0.51	0.46	0.92	1.43	22.03	20.48
Cassava	*Maniot esculenta*	*Mwaanja*	-	-	-	-	0.20	0.19
Sugar cane	*Sorghum saccharatum*	*Munsale*	1.58	1.41	0.01	0.02	-	-
Banana	*Musa* spp.	*Ibbanana*	-	-	0.27	0.42	-	-
Okra	*Hibiscus esculentus*	*Mudelele*	3.62	3.24	2.47	3.84	-	-
Green beans	*Phaseolus* spp.	*Cimbamba*	0.08	0.07	-	-	-	-
Garden vegetables			0.15	0.13	0.22	0.34	0.09	0.08
Orchard			-	-	-	-	0.16	0.15
Others			0.09	0.08	-	-	-	-
Total			111.83	100.00	64.26	100.00	107.59	100.00

A "-" means that the crop is not planted.

crops at Site B (Table 1). The percentage of area under maize cultivation exceeded 70% at Sites B and C, and was more than 45% at Site A, which also had a large amount of cotton production (44%). Site C had the largest percentage of land devoted to sweet potato cultivation (20%). Other crops included sorghum, cowpeas, sugar cane, sunflower, and groundnuts, but none of these crops were grown on more than 5% of the total area at any site. Clearly, maize dominated the planted area, but the farmers planted a variety of crops.

At Site A, the predominant crop was okra in the dry season, followed by maize and garden vegetables (Table 2). At Site B, maize predominated, but sweet potatoes and vegetables each had a 25% share of the production area. At Site C, maize was planted on 90% of the total area and garden vegetables on the remaining 10%.

Table 2. Cultivated crop area in the 2008/09 dry season for Sites A, B and C

Crop	Site A		Site B		Site C	
	(ha)	(%)	(ha)	(%)	(ha)	(%)
Maize	1.69	35.81	0.86	41.15	17.33	89.42
Sweet potato	-	-	0.53	25.36	0.13	0.67
Banana	-	-	0.06	2.87	-	-
Okra	2.64	55.93	0.01	0.48	-	-
Green beans	-	-	0.01	0.48	-	-
Garden vegetables	0.39	8.26	0.52	24.88	1.92	9.91
Others	-	-	0.10	4.78	-	-
Total	4.72	100.00	2.09	100.00	19.38	100.00

A "-" means that the crop is not planted.

Table 3. Sweet potato production by area and number of households who planted sweet potato at the three study sites

Site	Rainy season				Dry season				Total season	
	Area		Number of households		Area		Number of households		Area	
	(ha)	(%)		(%)	(ha)	(%)		(%)	(ha)	(%)
Site A	0.51	0.46	1	1.30	-	-	-	-	0.51	0.44
Site B	0.92	1.43	5	12.82	0.53	25.36	7	17.95	1.45	2.19
Site C	22.03	20.48	59	62.11	0.13	0.67	1	1.05	22.16	17.45
Total	23.46	8.27	65	30.81	0.66	2.52	8	3.79	24.12	7.78

A "-" means that the crop is not planted.

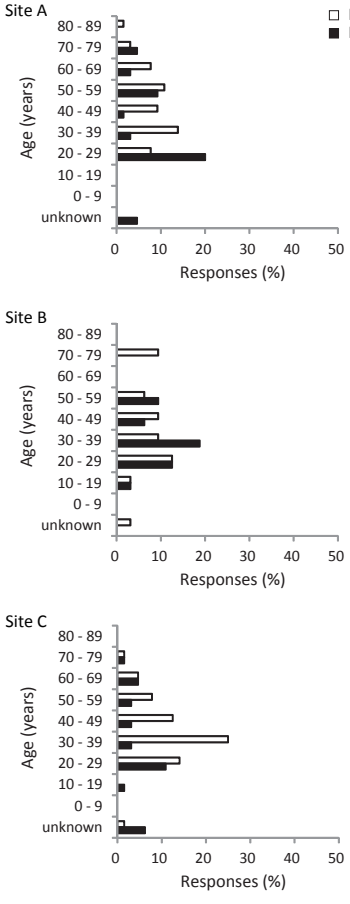

Fig. 3. Demographic characteristics (age and sex) of interviewees at Sites A, B, and C.

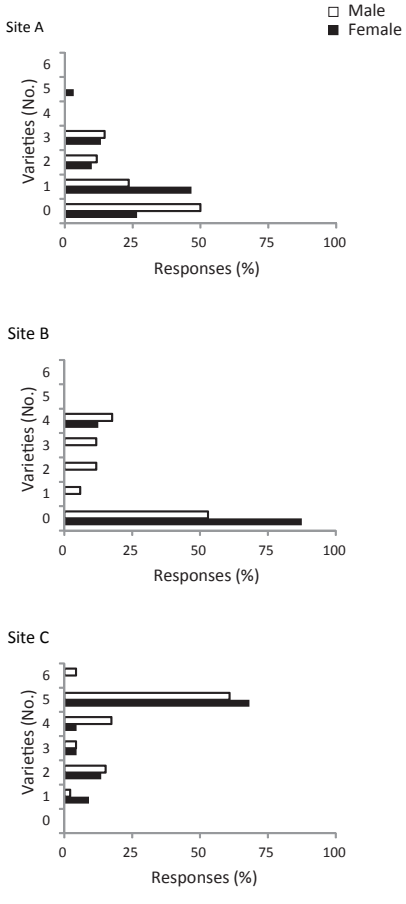

Fig. 4. Distribution of the number of sweet potato varieties identified by farmers at each site.
A "0" means one of two things: the farmer knew there were different varieties but was unable to name them, or the farmer was totally unfamiliar with any sweet potato varieties.

III. Sweet Potato Production

Sweet potatoes were planted in both the rainy and dry seasons in this area. In the rainy season, 20% of the cultivated area at Site C was planted with sweet potatoes, but the amounts were much smaller (< 2% at Sites A and B) (Table 3). Similarly, a larger percentage of households planted sweet potatoes at Site C than at the other two sites. In the dry season, Site B had the greatest percentage of land used to cultivate sweet potatoes (25.4%), as well as the highest percentage of households growing sweet potatoes (17.9%). There was almost no sweet potato production at the other sites during the dry season. These trends show that sweet potato production varied by both site and growing season. On average, 31% of households planted sweet potatoes on 8.3% of total cultivated land during the rainy season. As sweet potato cultivation area in Southern Province was 1.9% in 2002/03 (Suman, 2007), the average values of the study sites were high. Although Site C had a particularly high percentage of cultivated land for sweet potatoes, Sites A and B were slightly lower.

FARMER FAMILIARITY WITH SWEET POTATO VARIETIES

The male to female ratio for respondents who reported their age was 35 to 30, 17 to 16, and 43 to 22 at Sites A, B, and C, respectively (Fig. 3). The numbers do not match the total number of households because we were unable to obtain age information for a few households at each site.

I. Number of Varieties Identified

Farmers at Site C consistently identified the most varieties, whereas the majority of farmers at Site B could not identify a single variety and many could not do so at Site A as well (Fig. 4). In fact, every farmer at Site C could identify at least one variety. The average number of sweet potato varieties identified by males was 0.9 at Site A, 1.4 at Site B, and 4.5 at Site C. A similar trend was observed for females (1.2 at Site A, 0.5 at Site B, and 4.1 at Site C). The overall site averages were 1.1 at Site A, 0.9 at Site B, and 4.4 at Site C. There were significant differences between Sites A and B and Site C ($p < 0.01$).

II. Varieties and Features

1. Identified varieties

A total of 22 varieties were identified (Table 4). Other than the major varieties, there was a large number of minor sweet potato varieties at each site; *Kalyabalumi* (Fig. 5), *Kalembula*, and *Mandala* at Site A, *Kalyabalumi* and *Mandala* at Site B and *Kalyabalumi*, *Kalembula*, *Muvuba Chacha*, *Simpa Ubone* and *Fwaka* at Site C. Twelve varieties were identified by farmers at Site A, 13 at Site B, and 6 varieties at Site C. Although farmers at Site A and B could identify more varieties than those at Site C as a whole, on a per household basis, site C's farmers still

Table 4. Sweet potato varieties known by farmer

	Site A		Site B		Site C	
	Number of households	Percentage (%)	Number of households	Percentage (%)	Number of households	Percentage (%)
Kalyabalumi	15	19	9	24	82	100
Kalembula	12	16	2	5	59	72
Muvuba Chacha	1	1	3	8	61	74
Mandala	19	25	7	18		
Kapiri	9	12	2	5		
Ndindinkuni	7	9	1	3		
Sikamamba	7	9				
Kayuwi Yuwi	3	4				
Chilima Boofu	2	3				
Bbwaki Bbwari	1	1				
Kacharn	1	1				
Libingi	1	1				
Carrot			1	3		
Kabikkagoko			1	3		
Katukatu			1	3		
Kayuyu			1	3		
Lukkanga			1	3		
Lutembwe			1	3		
Namukkolo			1	3		
Simpa Ubone					78	95
Fwaka					62	76
Kasimpa Bayanga					1	1
Total	78	101	31	82	343	418

Number of households does not equal the total number of households because some households identified more than one variety. The percentages do not equal 100% for the same reason.

Fig. 5. *Kalyabalumi*: One of the most popular sweet potato varieties in the study area.

had greater knowledge of sweet potato varieties. The varieties identified by farmers differed among the three sites. Only three varieties, *Kalyabalumi*, *Kalembula*, and *Muvuba Chacha*, were known at all three sites. *Mandala*, *Kapiri*, and *Ndindinkuni* were identified at Sites A and B. The remaining 16 varieties were identified at only one site. Two of the varieties commonly noted at Site C (i.e., *Simpa Ubone* and *Fwaka*) were not mentioned at Sites A or B. The Ministry of Agriculture, Zambia, recommends the following improved sweet potato varieties: *Lukulu*, *Lukusashi*, *Lunga*, *Mulungushi*, and *Kalungwashi* (FoDiS, 2009); however, none of these varieties were mentioned at any of the sites. It is not clear whether these improved sweet potato varieties have not yet been introduced in this area, or if they were known locally under different names.

2. Features of the varieties

Responses for the features of the six main sweet potato varieties are summarized in Fig. 6. Those six features include maturation time, tuber size, color of tuber skin, taste, pest tolerance, and drought tolerance. Features of the other varieties are presented in the Appendix.

(a) Maturation time

There were great differences between Sites A and C for *Kalyabalumi*, *Kalembula*, and *Muvuba Chacha*; Site B was intermediate between the two sites for these varieties. There were also differences between Sites A and B for *Mandala*, *Kapiri*, and *Ndindinkuni*. The identified maturation times increased from Site A to B to C. These differences may be the result of differences in the agro-ecosystems of the sites, such as temperature or rainfall.

(b) Tuber size

Sites A and C again showed notable differences, and Site B was intermediate between the two sites for the first three varieties. There were also smaller differences between Sites A and B for the last three varieties. Except for *Kalyabalumi*, tuber size increased from Sites A to B to C.

(c) Color of tuber skin

Except for *Muvuba Chacha* and *Ndindinkuni*, the identified tuber skin colors of each variety were similar. *Kalyabalumi*, *Kalembula*, and *Kapiri* ranged from white to yellow and *Mandala* from white to orange. See Fig. 6 for the color variations for *Muvuba Chacha* and *Ndindinkuni*.

(d) Taste

Mandala, *Kapiri*, and *Ndindinkuni* each generated consistently negative taste comments (a normal taste comment for these varieties). *Kapiri* generated contradictory comments, ranging from tasteless to sweet. The other varieties generated only positive comments, such as good, sweet, and soft.

(e) Pest tolerance

Pest tolerance comments were inconsistent among sites and varieties. Overall, 40% of responses indicated the varieties had a low pest tolerance, and 36% of the responses indicated that they were tolerant.

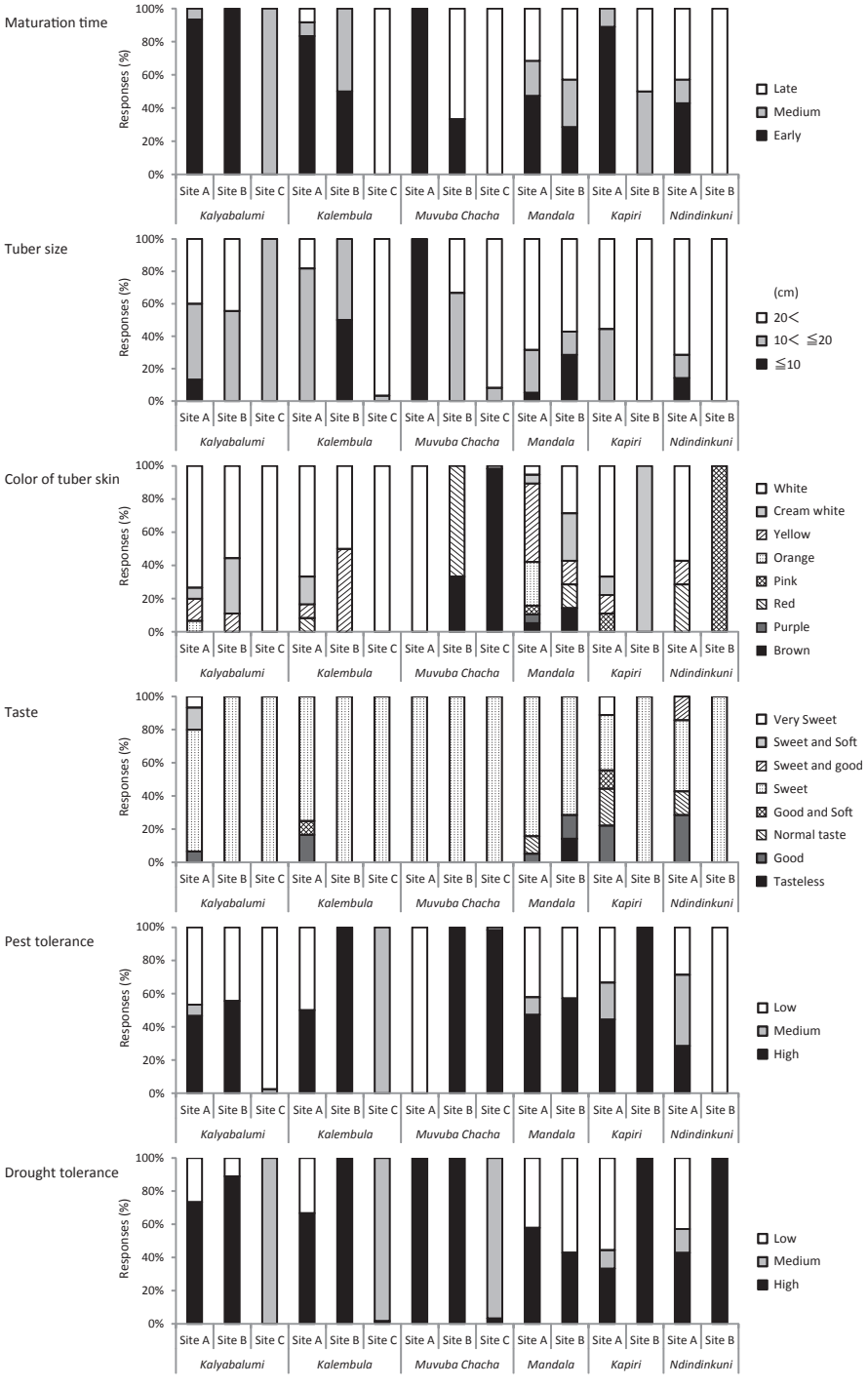

Fig. 6. The features of the six main sweet potato varieties identified by farmers at each site: (a) maturation time, (b) tuber size, (c) color of tuber skin, (d) taste, (e) pest tolerance, and (f) drought tolerance.

(f) Drought tolerance

At Sites A and B, *Kalyabalumi*, *Kalembula*, and *Muvuba Chacha* were thought to be tolerant to drought, but these varieties were not considered to be drought tolerant at Site C.

Farmers preferred drought tolerant sweet potato varieties because sweet potatoes are sensitive to dry conditions during the planting period, as vines (planting material) are transplanted in the fields (Shiwachi, 2010). Nevertheless, at Site C, all varieties of sweet potato were stated to have a medium drought tolerance. As Site C has higher average precipitation, and a lower drought risk compared with Site A and B (Sakurai, 2008), farmers at Site C were not as concerned about drought tolerance. Farmers also preferred sweet varieties at Site C because sweet potatoes were grown primarily for selling and home consumption. In contrast, at the Sites A and B, most of the farmers mentioned that cultivation was only for home consumption.

III. Planted Varieties of Sweet Potato

Eleven households (14% of all households interviewed) planted sweet potatoes at Site A, 11 (29%) at Site B, and 54 (66%) at Site C. These numbers include farmers with inter-cropped and mixed-cropped fields. The varieties that were planted at each site are presented in Table 5. Only 10 of the 22 identified sweet potato varieties were cultivated, five at Site A, six at Site B, and five at Site C. The numbers of varieties planted differed among the sites. Most households planted only one variety at Site A, whereas about 90% of households at Site C planted multiple varieties, and 20% of them planted five varieties.

Although Gwembe Tonga began planting sweet potatoes in this area in 1956 (Scudder, 1962), farmers stated that they started cultivating sweet potatoes in the

Table 5. Varieties of sweet potato planted at the study sites

	Site A		Site B		Site C	
	Number of households	Percentage (%)	Number of households	Percentage (%)	Number of households	Percentage (%)
Kalyabalumi	3	27	8	73	54	100
Kalembula			1	9	11	20
Muvuba Chacha					17	31
Mandala	4	36	3	27		
Kapiri	3	27	1	9		
Ndindinkuni	2	18	1	9		
Chilima Boofu	1	9				
Kabikkagoko			1	9		
Simpa Ubone					48	89
Fwaka					17	31
Not known	1	9	2	18		
Total	14	127	17	155	147	272

Number of households does not equal the total number of households because some households planted more than one variety. The percentages do not equal 100% for the same reason.

mid-2000s at Sites A and B. However, they did have some knowledge about sweet potato varieties, indicating they could have been cultivated by former generations at these sites. Most of them did not continue cultivating sweet potatoes for several years. In contrast, farmers at Site C had planted sweet potatoes for many years. The earliest year of cultivation at this site was in 1968, and planting continued to the 2008/09 cropping season with the number of farmers cultivating sweet potatoes steadily increasing since the 1990s.

It was important for farmers to have easy access to sweet potato vines. Vines are usually recycled and traded between farmers, because they are difficult to obtain at markets in these areas. It is also difficult for farmers to nurse vines in dry season at Sites A and B, because there are not enough riverbanks or *dambo*. The difficulty of obtaining vines at Sites A and B was likely a contributing factor to the small number of households that cultivated sweet potatoes at these sites.

HOME CONSUMPTION AND SALES

In this section, we examined household consumption of sweet potatoes and their use as a cash crop, both of which can enhance food security. Because Site C farmers were more familiar with sweet potatoes, we focused on selected households at Site C.

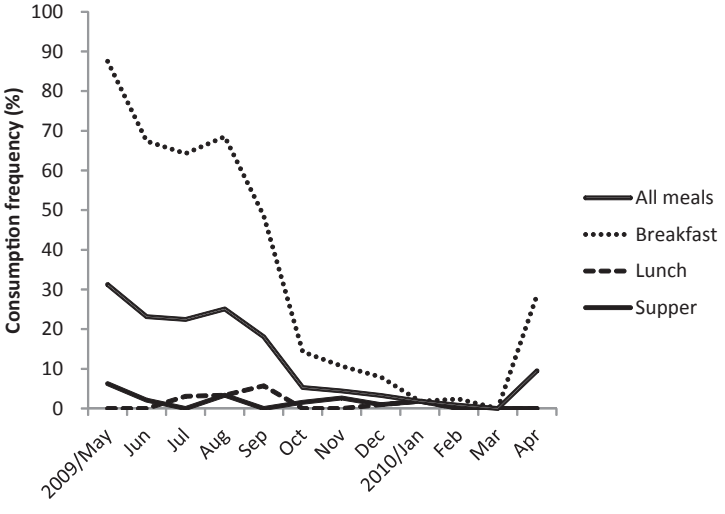

Fig. 7. Monthly household frequency of consumption of sweet potatoes for selected households at Site C. The values are the monthly average percentages of meals and sweet potatoes consumed.

I. Household Consumption

Boiling sweet potato tubers in a small volume of water is the most common cooking method in this area. The boiled tubers are sometimes dried for storage and later rehydrated and mashed to make a dish called *bupapa*. Sweet potato leaves are also boiled with little water and used as a side dish accompanying *nshima*, which is a staple food in Zambia made from maize flour called *mealie-meal* (a local staple food). Only two sweet potato varieties are used for this purpose, most commonly *Kalembula* and occasionally *Kalyabalumi*. *Kalyabalumi* leaves are said to have a slightly more bitter taste than *Kalembula* leaves.

We collected self-reported data on household consumption of sweet potato tubers. The respondents noted the number of times they ate the tubers for breakfast, lunch, or supper in two consecutive weeks each month during this period. From these data, we calculated the average monthly frequency of consumption (Fig. 7). On average, sweet potato tubers were consumed about once every 3 days, but as can be seen in the Figure, the frequency of consumption peaked in May 2009 and decreased to almost zero in March 2010. Sweet potatoes were most commonly served at breakfast as a main dish, and they were almost always boiled. When they were served at lunch and supper, they were served with *nshima* or other side dishes. In total, sweet potato tubers were consumed at 12% of all meals during the study period. Sweet potato leaves were consumed at 0.4% of all meals throughout the study period, possibly because the varieties grown in the area, primarily *Kalyabalumi* and *Simpaubone*, have leaves that are not considered to be suitable for consumption.

II. Sweet Potato Sales

Vegetables and other commodities are sold by farmers at a roadside market near Site C. The *Bbaamp* market opened in the mid-1990s after economic liberalization and is located on the main road between Batoka and Maamba. Many farmers sell products, including sweet potatoes, to passengers on buses and other vehicles. The respondents reported the frequency and monetary value of sweet potato sales in 2 consecutive weeks each month. From these data, we estimated the average monthly sales frequencies and average monthly income per household (Fig. 8). The sweet potato harvest began in March, and the tubers were sold from March to September. The frequency of average monthly sales peaked in July at 9 days per person. The average monetary value of the monthly sales fluctuated from 0 to 270,000 kwacha (ZKW) per person, and peaked in August. The average annual income was ZKW 1,140,000 per person, which is equivalent to USD 248 (USD 1 = ZKW 4,600 as of September 2009). The weekly average price of a 25-kg bag of *mealie-meal* from May 2009 to April 2010 was ZKW 50,000 at the nearest town, Sinazeze. Therefore, sweet potato sales were equivalent to 22.8 bags per person. Using the FAO (1992) estimated *mealie-meal* consumption rate of 418.6 g per person, per day, we calculated that the average yearly sales of sweet potatoes per person was sufficient to purchase enough *mealie-meal* to feed 7.4 adults for one year.

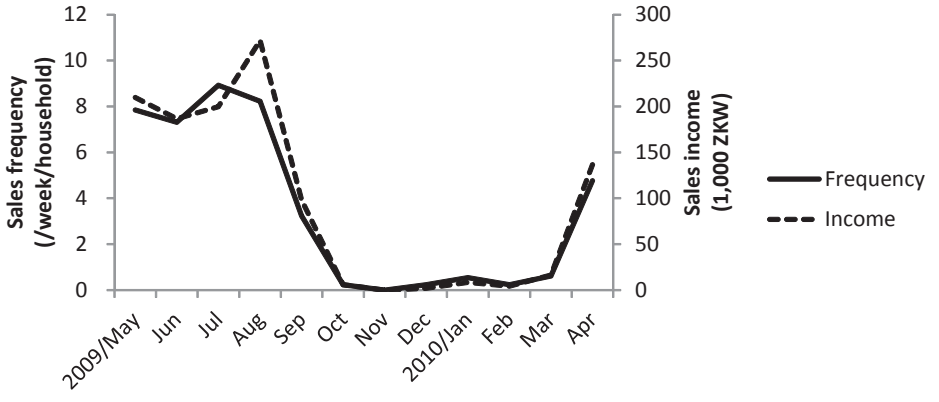

Fig. 8. Average monthly frequency and income of sales of sweet potatoes for the selected households at Site C.

Kitsuki & Sakurai (2012) estimated that the average consumption level per week per adult equivalent for the five consumption categories was ZKW 25,613 at the Site C. The five consumption categories were staple foods, vegetables and fruit (including those collected from the bush), animal and fish products (including those caught in the bush and water), processed food excluding staple food, and non-food goods and services. We also calculated that the average yearly sale of sweet potatoes per person was equal to the total consumption of 0.85 adults for one year.

CONCLUSION

In Zambia, most farmers that cultivate maize as a food or cash crop do so using rain-fed agriculture (Jayne et al., 2007). Following the economic liberalization, a shift from maize to other food and cash crops can be identified, mainly cotton and cassava (Zulu et al., 2000). However, in the study area, cotton was not widely planted, with the exception of Site A (Table 1), and cassava was not planted at any of the sites (Table 1). We determined two reasons for this during the interview process. The first reason is that cotton cultivation requires more family labor than maize, a point that has also been raised by Tschirley & Kabwe (2007). The second reason is that the market price for cotton has decreased over the last several years (Tschirley & Kabwe, 2007; Sakurai, 2008).

This study shows that farmers planted sweet potatoes in both the rainy and dry seasons in the study area, but production varied between the seasons and the sites. Many farmers at Site C planted sweet potatoes in the rainy season, and the cultivated area was the largest at this site. Dry season plantings were most common at Site B, but the dry season fields were much smaller than the rainy season fields. Overall, farmers could identify many sweet potato varieties,

but they did not plant all of the varieties identified. Sweet potatoes were not a primary crop at Sites A and B, but were important at Site C.

After the economic liberalization, some types of crops and vegetables were sold for cash income along the main roads in rural areas of Zambia (Hanzawa, 2010). Similarly, farmers at site C sold many types of cash crops, including sweet potatoes, at the road side market, resulting in an increasing number of farmers cultivating sweet potatoes in this site. As a result, the percentage of sweet potato cropping areas was significantly higher at Site C compared with that of the Southern Province.

Further study at Site C indicated that boiled sweet potato tubers were consumed about twice per week on average, and were most commonly eaten for breakfast. This consumption decreases maize consumption in the dry season. There may be a reduced demand for sweet potatoes when maize yields are high, but when maize yield decreases, cultivation of sweet potatoes will become increasingly more important, especially in the case of a crop failure as mentioned by Low et al. (2007). In other words, sweet potatoes are one of several monoculture risk dispersions. In the central Zambia, cassava plays the same role (Barratt et al., 2006). Oyama (2010) reported that sweet potato leaf consumption accounted for 1.5% of all meals during the pre-harvest season, and 2.7% of all meals in the harvesting season in Northwestern Province. However, the leaves were rarely eaten at this site.

Sweet potato sales generated sufficient income at this site to purchase enough *mealie-meal* to feed 7.4 adults or 0.85 adults total consumption for one year. This cash income reduces the need to sell maize immediately after the harvest when prices are the lowest. This would help with purchases of both small-scale necessities, such as daily living needs, and also pay for large-scale necessities such as school fees, maize seed, and fertilizer for next season.

From these results, we conclude that the sweet potato can play a large role, not only in household consumption, but also in enhancing food security by providing a source of income.

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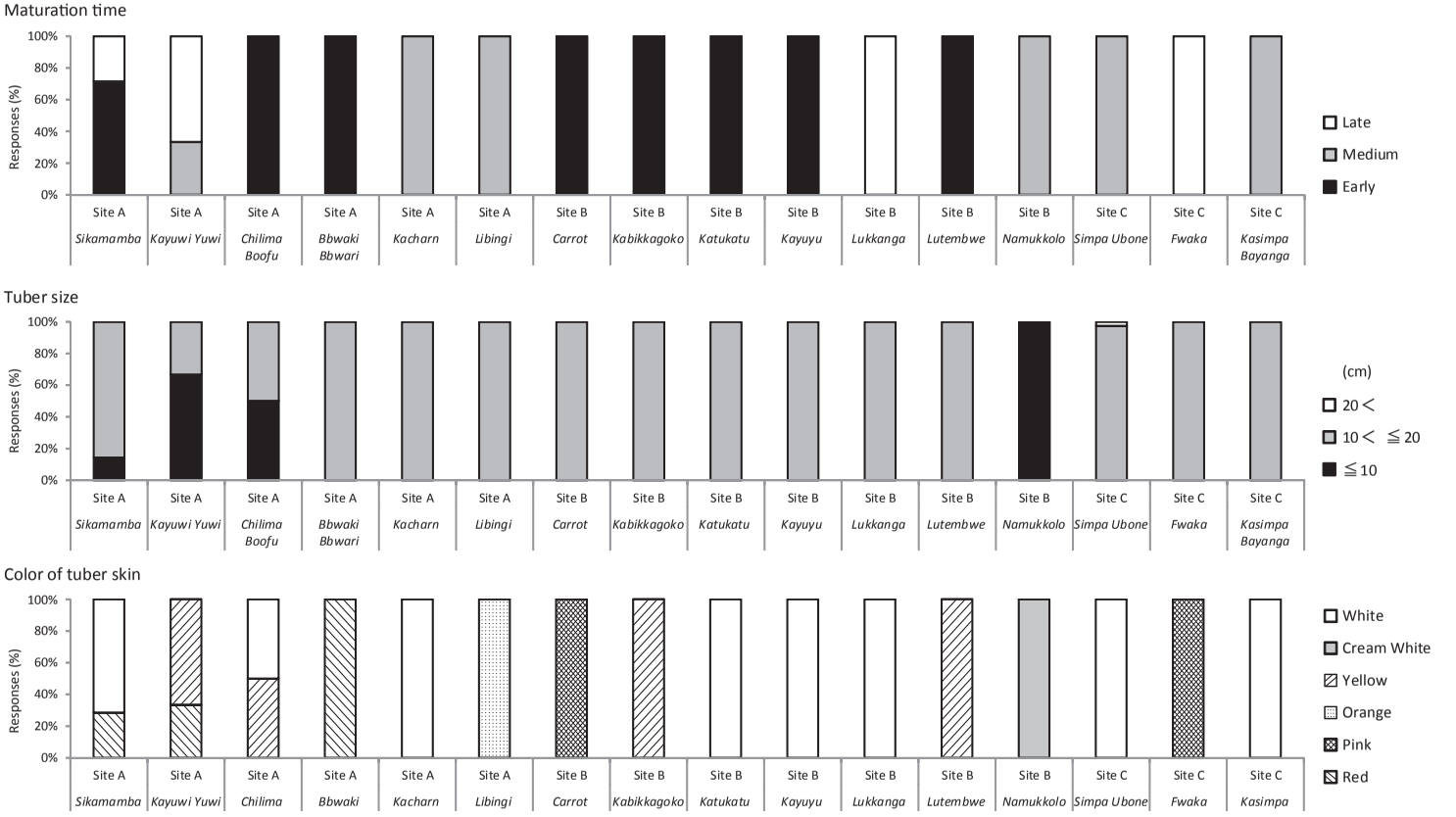
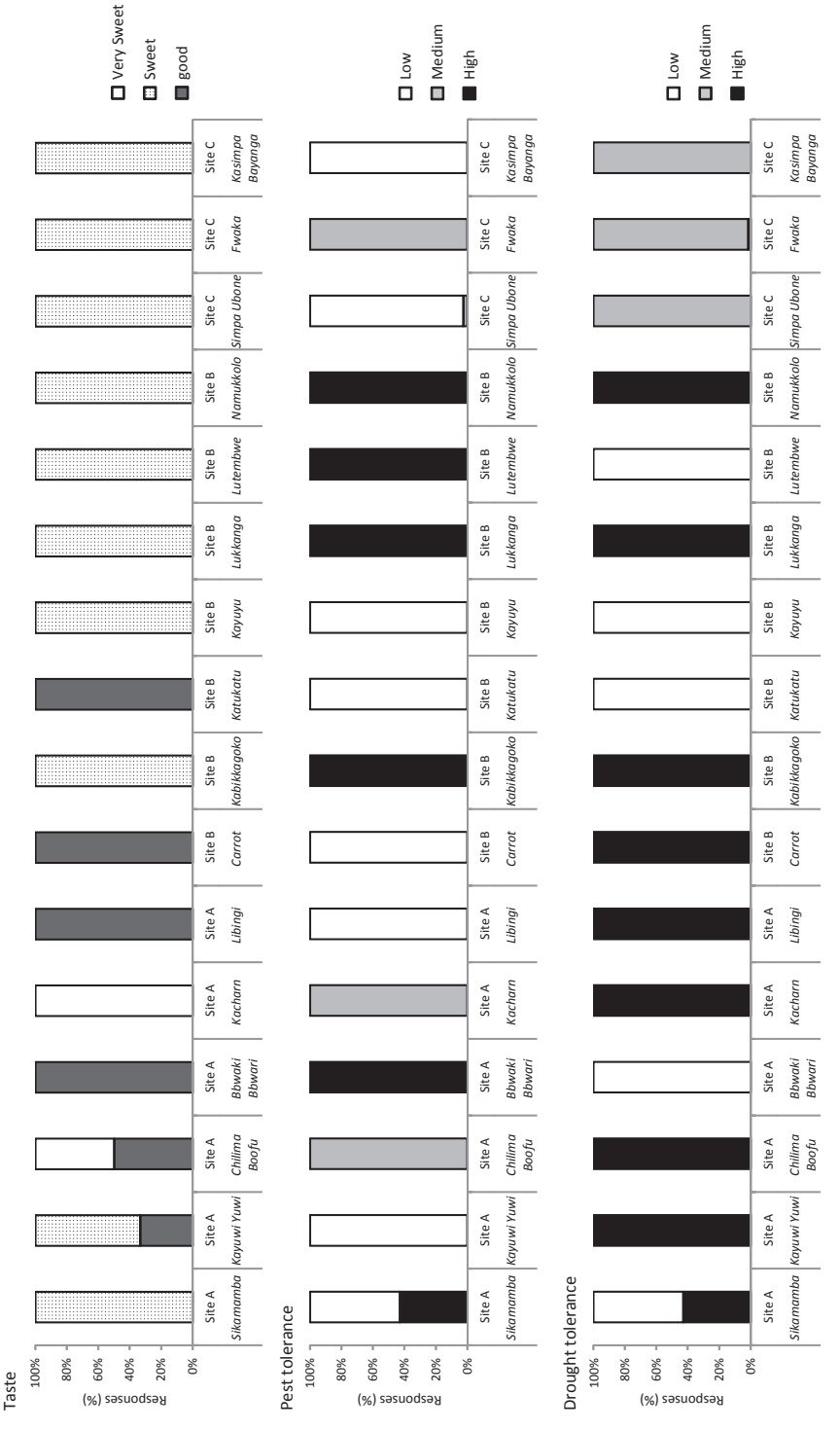
Appendix 1. Sweet potato features identified by farmers at each site: (a) maturation time, (b) tuber size, (c) color of tuber skin, (d) taste, (e) pest tolerance, and (f) drought tolerance.




Taste
Very Sweet
Sweet
good
Responses (%)
100%
80%
60%
40%
20%
0%
Site A Sikamamba
Site A Kayuwi Yuwi
Site A Chilima Boofu
Site A Bbwaki Bbwari
Site A Kacharn
Site A Libingi
Site B Carrot
Site B Kabikkagoko
Site B Katukatu
Site B Kayuyu
Site B Lukkanga
Site B Lutembwe
Site B Namukkolo
Site C Simpa Ubone
Site C Fwaka
Site C Kasimpa Boyanga
Pest tolerance
Low
Medium
High
Responses (%)
Drought tolerance
Low
Medium
High
Responses (%)