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No. 2012-015

The Importance of Sweet Potatoes in Rural Villages in Southern Province, Zambia

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Hidetoshi MIYAZAKI, Yudai ISHIMOTO and Ueru TANAKA

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Vulnerability and Resilience of Social-Ecological Systems

RIHN Research Project E-04

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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, however, a maize monoculture is vulnerable to drought or excessive rainfall. Increasing the diversification of crops and crop varieties is therefore important to achieve food security in the face of a changing climate. The sweet potato is an important secondary food in Zambia and has great potential both as a crop for consumption and as a source of income. The aim of the 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 and farmer interviews were conducted at three sites. Farmers in the study area planted sweet potato in both the rainy and dry seasons, but sweet potato production varied between planting seasons and among the three study sites. As a group, farmers were able to identify a total of 22 sweet potato varieties, but many farmers were not able to identify a single variety, and only 10 of the 22 identified varieties were actually cultivated in the study area. 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 a week, most commonly for breakfast. Consumption was highest during and immediately after the harvest and then gradually decreased. Sweet potato leaves were rarely consumed. Annual sweet potato sales per person generated sufficient income at this site to purchase enough *mealie-meal* (a local staple food) to feed 7.4 adults for a year.

Key words: **Food security, Crop diversification, Food consumption, Cash income, Tuber crop**

要約

ザンビアにおける食料安全保障を改善するためには、安定したメイズ生産と生産性の向上が重要である。しかし、多くの農民は天水農業下でメイズを栽培しており、メイズに偏重した作付けは干ばつや過度の降雨に脆弱である。したがって、気候変動に直面しながら食料安全保障を成し遂げるには、作物の多様性を増すことが重要となる。サツマイモは自家消費用食料、ならびに世帯の現金収入源として大きな可能性があるといわれている。そこで、本研究では、ザンビア南部州農村地帯の 3 サイトにおいて、サツマイモ品種についての農民の知識を理解すること、また、サツマイモの生産と消費を明らかにすることを目的とした。

サツマイモは雨季、乾季ともに栽培されているが、その栽培割合は季節間、サイト間で異なっている。農民へのインタビューの結果、22 種類ものサツマイモ品種があることが判明したが、彼らの多くは 1 種類も回答することができなかった。また、確認された 22 種類のうち栽培されていたのは 10 種類に過ぎなかった。調査した 3 サイトのうち 1 サイトでは、特にサツマイモ生産が盛んにおこなわれていたが、そのサイトでのさらなる調査の結果、サツマイモの塊根は主に朝食として利用されており、1 年間の全食事を通じてみると、1 週間に 2 回程度消費されていた。消費は収穫直後に最も高く、徐々に減少した。サツマイモの葉は、ほとんど消費されていないこともわかった。サツマイモ販売による売り上げ額は高く、1 年間当たりの売り上げで大人 7.4 人分の主食（メイズの粗挽き粉）を購入できることがわかった。

キーワード：食料安全保障, 作物多様化, 食料消費, 現金稼得, 塊根作物

1. Introduction

About 75 percent 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, and 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 and 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) found that the cultivated area of crops excluding maize increased from 1993 to 1998, including that for cotton, groundnuts, cassava, and sweet potato. Production of groundnuts, cassava, sweet potato, and tobacco also increased during this period. Jayne et al. (2007) found that cassava, groundnut, and sweet potato productivity all increased with the introduction of improved varieties in the early- to mid-1990s, so crop varieties also need to be considered when undertaking crop diversification.

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 a source of income for farmers (Rees et al., 2001). Therefore, it is important to understand the production and consumption of sweet potatoes in rural Zambia, but 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 potato in several rural villages in Southern Province, Zambia.

2. Study Area

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 farms in the area are used to cultivate maize under rain-fed conditions. The elevation gradually increases from the Lake Kariba shore to the highlands, and the three sites 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 and social structures were different because of differences in rainfall amount, temperature, and vegetation. All residents of the sites were of Tonga ethnicity, but Site A and B residents belong to the Gwembe Tonga and Site C residents to the Plateau Tonga.

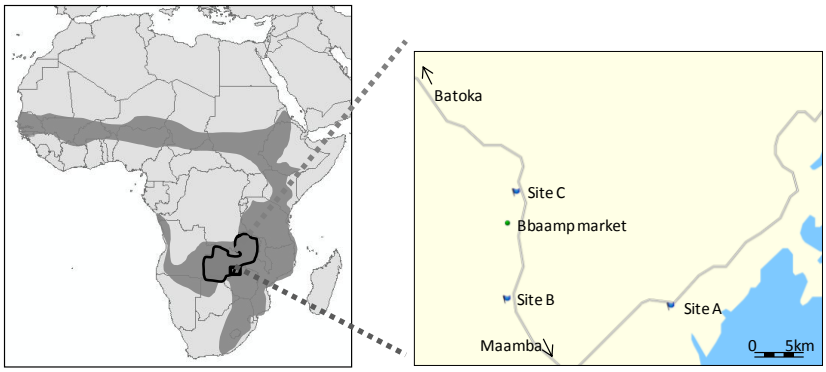


Figure 1 Study sites in Southern Province, Zambia

3. Crop Distribution

3.1 Crop calendar

Planting and harvesting dates were determined though group discussions at each site. Figure 2 shows the crop calendar for all three sites. Farmers plant maize at the beginning of the rainy season in November either by dry planting, where they start planting by hoe after the first rain, or by using an animal-drawn plow after the first several rains. They usually plant other crops (e.g., pumpkin, sorghum, pearl millet, and beans) mixed in with the maize at the same time. When they finish planting maize, they begin to plant other crops in other fields. Some "green" maize is harvested in March, and the remaining maize is harvested after it dries in the fields. The dried maize is used to make ground maize meal, usually beginning in the end of April. The sowing time for dry season maize differs between Site A and Sites B and C. At Site A, planting takes place from the end of February to the beginning of March, but at Sites B and C, it goes from the end of August to October. Other crops are also grown during the dry season. The dominant dry-season crop is okra at Site A and sweet potato at Site C. Vegetables such as cabbage, tomato, and rape are planted in gardens at all of the sites. They are planted in March or April by farmers with suitable fields, such those near riverbanks or *dambo* (shallow wetlands). Some of the farmers continuously grow and harvest vegetables to sell, particularly at Site C.

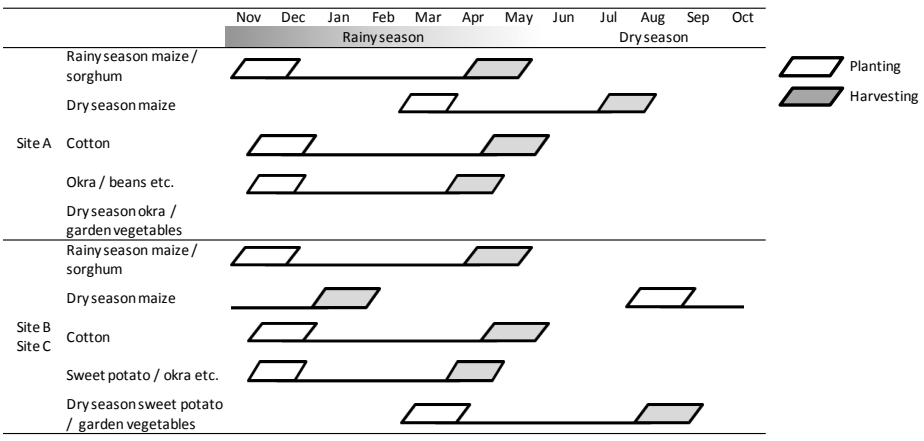


Figure 2. Crop calendars for the study sites.

3.2 Spatial distribution

We measured the size of all cultivated fields at the three sites in the 2008_09 rainy and 2008_09 dry seasons with the aid of hand-held GPS units (Garmin etrex, Garmin Ltd., USA) . Rainy season fields were measured from March to April/2009. Dry season fields were measured from August to October/2009. There were 80 households at Site A, 39 at Site B, and 95 at Site C. Table 1 and 2 show the crop distribution for each crop as a percentage of the total cultivated area for each of the sites in the rainy and dry seasons, respectively. As noted previously, some other crops are usually planted with maize in the same field. In these cases, the entire planted area was considered as the primary crop, which was determined by the field's owner.

Maize is the dominant crop grown during the rainy season, but there were many other types of crops planted, ranging from 9 at Site C to 11 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 (44%). Site C had the largest percentage of land devoted to sweet potato cultivation (20%). Other crops included sorghum, cowpea, sugar cane, sunflower, and groundnuts, but none was larger 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 potato and vegetables each had a 25% share. At Site C, maize was planted on 90% of the total area and garden vegetables on the remaining 10%.

Table 1. Crop distribution in the rainy season for Sites A, B, and C. The values are the amount of cultivated area for a given crop as a percentage of the entire cultivated area for that site.

	Maize	Cotton	Sorghum	Sunflower	Groundnut	Cowpea	Sweet potato	Cassava	Sugar cane	Banana	Okra	Green beans	Garden vegetables	Orchard	Others	Total
Site A	45.7	44.2	4.2	0.0	0.0	0.4	0.5	0.0	1.4	0.0	3.2	0.1	0.1	0.0	0.1	100
Site B	87.5	1.3	2.2	2.0	0.4	0.5	1.4	0.0	0.02	0.4	3.8	0.0	0.3	0.0	0.0	100
Site C	69.6	5.9	0.8	0.0	1.5	1.3	20.5	0.2	0.0	0.0	0.0	0.0	0.1	0.1	0.0	100

Table 2. Crop distribution in the dry season for Sites A, B, and C. The values are the amount of cultivated area for a given crop as a percentage of the entire cultivated area for that site.

	Maize	Sweet potato	Banana	Okra	Green beans	Garden vegetables	Others	Total
Site A	35.7	0.0	0.0	56.0	0.0	8.3	0.0	100
Site B	41.2	25.7	2.7	0.3	0.6	24.9	4.6	100
Site C	89.4	0.7	0.0	0.0	0.0	9.9	0.0	100

3.3 Sweet potato production

Sweet potato was planted in both the rainy and dry seasons in this area. In the rainy season, 20% of the cropped area at Site C was planted with sweet potato, but the amounts were much smaller (<2%) at Sites A and B (Table 3). Similarly, a much larger percentage of households planted sweet potato 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 potato (25.7%) as well as the highest percentage of households (17.9%). There was almost no production of sweet potato at the other sites during the dry season. Clearly, sweet potato production varied by both site and growing season. On average, 30% of households planted sweet potato on 8.3% of total cultivated land during the rainy season.

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

	Rainy season				Dry season			
	Area (ha)		Households (No.)		Area (ha)		Households (No.)	
Site A	0.5	(0.5)	1	(1.3)	0.0	(0.0)	0	(0.0)
Site B	0.9	(1.4)	5	(12.8)	0.5	(25.7)	7	(17.9)
Site C	22.0	(20.5)	59	(62.1)	0.1	(0.7)	1	(1.1)
Total	23.5	(8.3)	65	(30.4)	0.7	(2.6)	8	(3.7)

The numbers in parentheses represent the percentage of the entire cultivated area for that site.

4. Farmer Familiarity with Sweet Potato Varieties

We were not only interested in the types of crops grown, but also in the varieties of sweet potato grown. To clarify the farmers' familiarity with sweet potato varieties, we interviewed the household head or spouse at all households at the three sites from August to September in 2009. Interviewees were asked about the number of varieties they were familiar with as well as their features, including 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. Demographic data for the interviewees are presented in Figure 3. The male to female ratios for respondents who reported their age were 35 to 30, 17 to 16, and 43 to 22 at Sites A, B, and C, respectively. 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.

4.1 Number of varieties identified

Distributions of the number of identified sweet potato varieties for each site are shown in Figure 4. In the figure, a "0" means one of two things: the farmer knew there were different varieties but could not name them or the farmer was totally unfamiliar with any variety of sweet potato. Farmers at Site C consistently could identify 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. 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 ($p<0.01$).

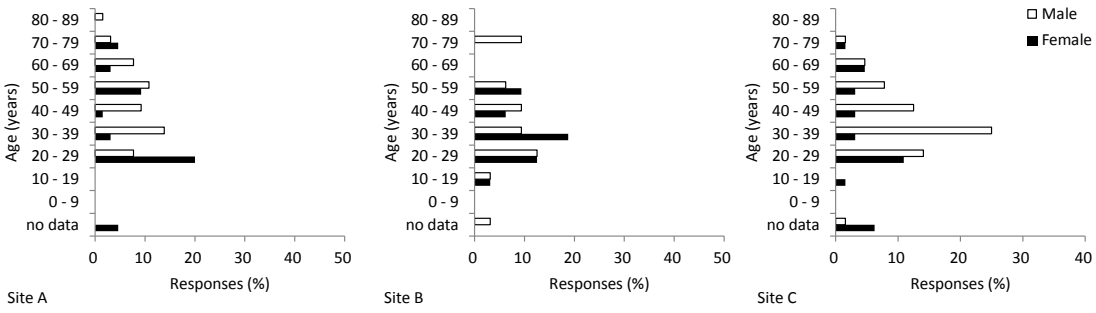


Figure 3. Demographic characteristics (age and sex) of interviewees at Sites A, B, and C.

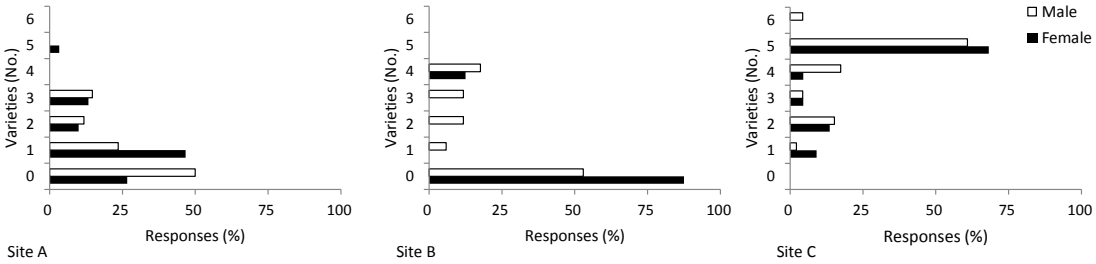


Figure 4. Distribution of the number of sweet potato varieties identified by farmers at each site.

4.2 Varieties and features

4.2.1 Identified varieties

The varieties of sweet potato identified and the distribution of the responses are presented in Table 4. A total of 22 varieties were identified. Apart from the major varieties, there was a large number of minor sweet potato varieties at each sites; *Kalyabalumi*, *Kalembula*, and *Mandala* at Site A, *Kalyabalumi* and *Mandala* at Site B and *Kalyabalumi*, *Kalembula*, *Muvuba Chacha*, *Simpa Ubone* and *Fwaka*. There were 12 varieties identified by farmers at Site A, 13 at Site B, and 6 varieties at Site C. The varieties identified by farmers were very different 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 only at one site. Two of the varieties commonly noted at Site C were not mentioned at Sites A or B. Ministry of agriculture, Zambia recommended the following improved sweet potato varieties: *Lukulu*, *Lukusashi*, *Lunga*, *Mulungushi*, and *Kalungwashi* FoDiS (2009). None of these varieties was mentioned by a single farmer at any site, which means that these improved sweet potato varieties have not yet been introduced in this area.

Table 4. Sweet potato varieties identified by farmers at the study sites

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

The rate is the percentage of households that identified a particular variety relative to the total number of households interviewed at that site. The rates do not add up to 100% because some households identified more than one variety. The number of households is given in parentheses. They do not add up to the total number of households because some households identified more than one variety.

4.2.2 Features of the varieties

Figure 5 summarizes responses for the following features of the six main varieties of sweet potato: maturation time, tuber size, color of tuber skin, taste, pest tolerance, and drought tolerance.

Maturation time

There were great differences between Sites A and C for *Kalyabalumi*, *Kalembula*, and *Muvuba Chacha*, and Site B was intermediate between the two 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, for example, temperature or rainfall amount.

Tuber size

Sites A and C again showed notable differences and Site B was intermediate between the two 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 Site A to B to C.

Color of tuber skin

Except for *Muvuba Chacha* and *Ndindinkuni*, the identified tuber skin colors were very similar for each variety. *Kalyabalumi*, *Kalembula*, and *Kapiri* ranged from white to yellow and *Mandala* from white to orange. See Figure 5 for the color variations for *Muvuba Chacha* and *Ndindinkuni*.

Taste

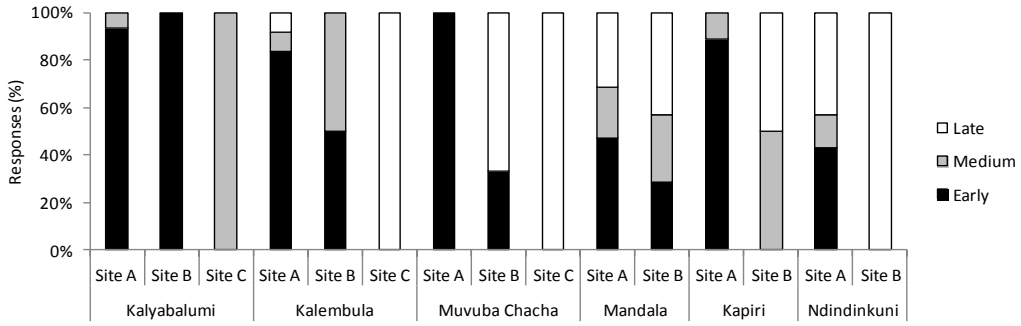
Mandala, *Kapiri*, and *Ndindinkuni* each generated consistently negative taste comments (normal taste). *Kapiri* generated contradictory comments, ranging from tasteless to sweet. The other varieties had only positive comments such as good, sweet, and sweet and soft.

Pest tolerance

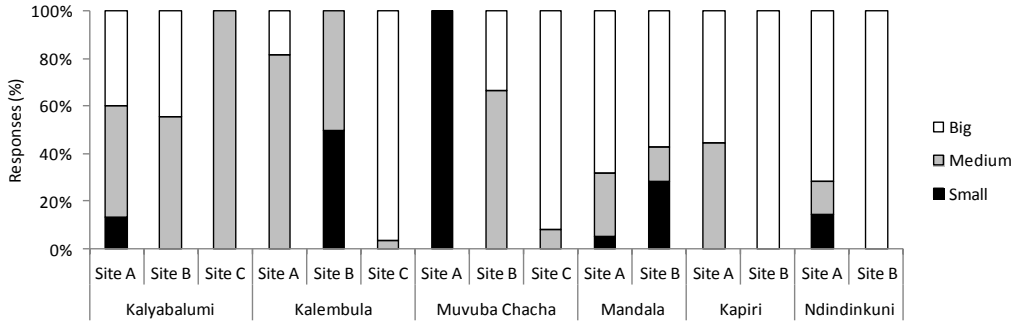
Pest tolerance comments were inconsistent between varieties and among sites. Overall, 40% of responses indicated the varieties were low tolerance and 36% that they were tolerant.

Drought tolerance

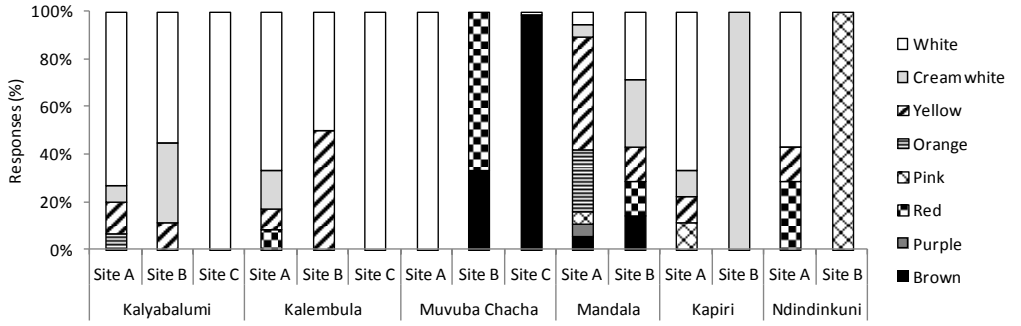
At Sites A and B, *Kalyabalumi*, *Kalembula*, and *Muvuba Chacha* were thought to be tolerant to drought, but they were not considered to be tolerant at Site C.



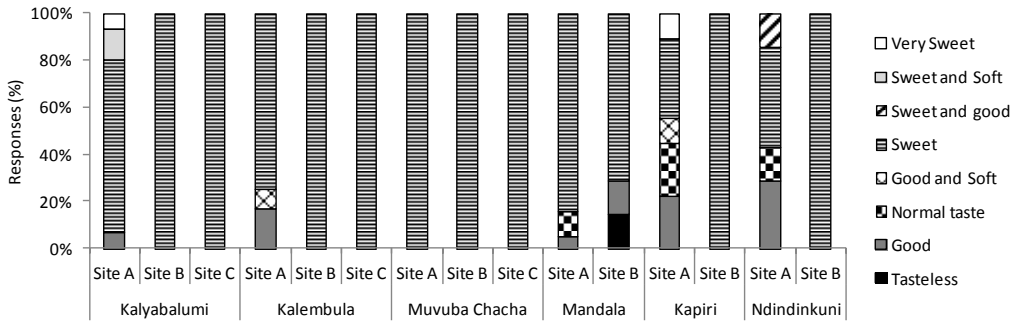
Maturation time



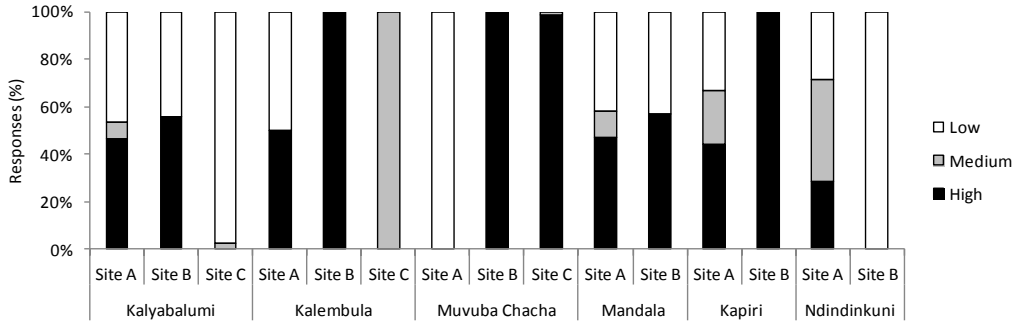
Tuber size



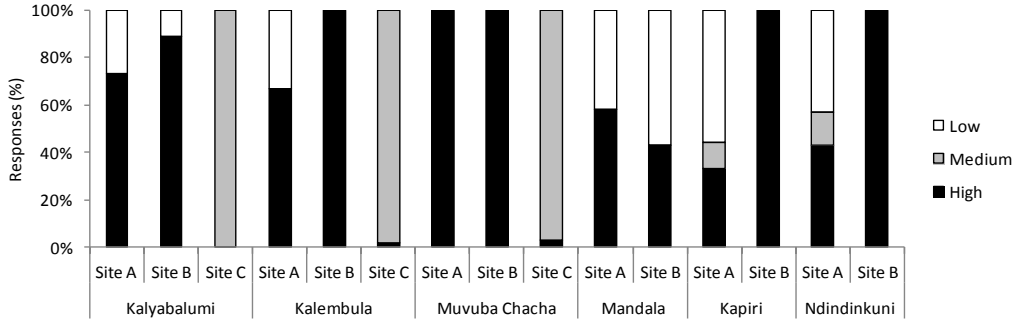
Color of tuber skin



Taste



Pest tolerance



Drought tolerance

Figure 5. 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.

4.3 Planted varieties of sweet potato

Eleven households (14% of all households interviewed) planted sweet potato at Site A, 11 (29%) at Site B, and 54 (66%) at Site C. These numbers include farmers who intercrop and use mixed cropped fields. The planted varieties 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 number of varieties planted differed between 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.

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

Name	Site A Rate (%)	Site B Rate (%)	Site C Rate (%)
Kalyabalumi	27 (3)	73 (8)	100 (54)
Kalembula		9 (1)	20 (11)
Muvuba Chacha			31 (17)
Mandala	36 (4)	27 (3)	
Kapiri	27 (3)	9 (1)	
Ndindinkuni	18 (2)	9 (1)	
Chilima Boofu	9 (1)		
Kabikkagoko		9 (1)	
Simpa Ubone			89 (48)
Fwaka			31 (17)
Not known	9 (1)	18 (2)	

The rate represents the percentage of households that cultivated a given variety relative to the total number of households that planted sweet potatoes at each site. The rates do not add up to 100% because some households planted more than one variety. The number of households growing the variety is given in parentheses. They also do not add up to the total number of households for the same reason.

4.4 Simpson's diversity index

Simpson's diversity index was calculated from the results for sweet potato varieties identified by farmers and for those actually planted (Table 6). Site C's values were much higher for both sets of results. Although farmers have knowledge of many varieties of sweet potato at Sites A

and B, their knowledge of the varieties varied widely at both sites.

Table 6. Simpson's diversity index for sweet potato varieties identified and planted by farmers at the study sites

	Site A	Site B	Site C
Sweet potato varieties known by farmer	0.086	0.069	0.324
Planted sweet potato varieties	0.015	0.034	0.148

5. Home Consumption and Sales

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

5.1 Household consumption

Boiling the tubers of sweet potatoes in a small amount 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 sometimes fried and used as a side dish accompanying *nshima*, which is a staple food in Zambia made from a ground maize flour called *mealie-meal*. Only two varieties are used for this purpose, most commonly *Kalembula* and occasionally *Kalyabalumi*. *Kalyabalumi* leaves were said to have a slightly more bitter taste than *Kalembula* leaves.

We collected self-reported data from six Site C households on household consumption of sweet potato tubers from May 2009 to April 2010. The respondents noted the number of times they ate the tubers for breakfast, lunch, or supper inconsecutive two weeks a month during this period. From these data, we calculated the average monthly frequency of consumption (Fig. 6). On average,

sweet potato tubers were consumed about once every 3 days, but as can be seen in the figure, the frequency peaked in May 2009 and decreased to almost nothing 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 rarely consumed throughout the study period, possibly because of the attributes of the varieties grown in the area, primarily *Kalyabalumi* and *Simpaubone*, the leaves of which are not considered to be suitable for consumption.

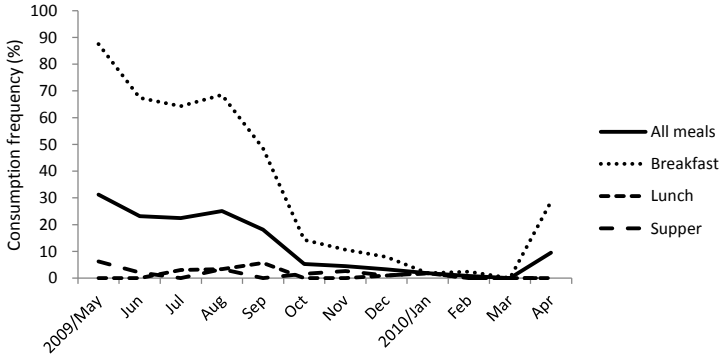


Figure 6. Monthly household consumption frequency of sweet potatoes for selected households at Site C. The values are the monthly average percentage of meals at sweet potatoes are consumed.

5.2 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 (Fig. 1). Many farmers sell products, including sweet potatoes, to passengers on buses and other vehicles. We collected self-reported data from a sample of 13 women from 12 households, including the six households discussed in Section 5.1, from May 2009 to April 2010. The respondents reported the frequency and monetary value of sweet potato

sales inconsecutive two weeks a month . From these data, we estimated the average monthly sales frequencies and average monthly income per household (Fig. 7). 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 *mealie-meal* per 25-kg bag 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 a year.

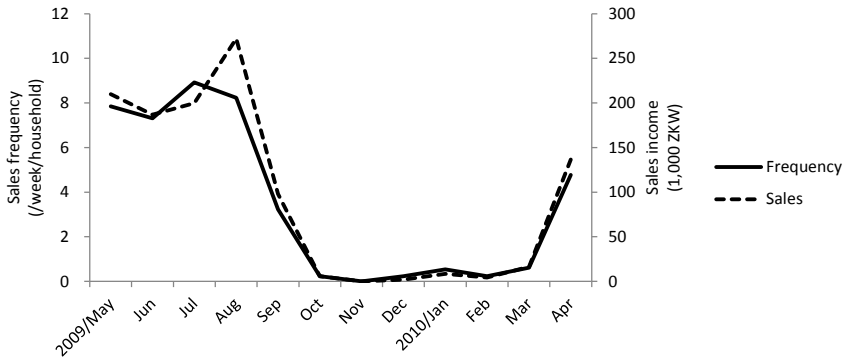


Figure 7. Average monthly sales frequency and income from sales of sweet potatoes for selected households at Site C.

6. Conclusion

This study clarified that farmers planted sweet potatoes in both the rainy and dry seasons in the study area, but production varied between the seasons and among the sites. Many Site C farmers planted sweet potato in the rainy season, and the area of cultivation was the largest at this site. Dry-season planting was 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. Although Sites A and B had more crop diversity in number of varieties planted, Site C had a larger Simpson's crop diversity index value than either Site A or B.

Sweet potato was not a primary crop at Sites A and B, but it was important at Site C. Further study at this site indicated that boiled sweet potato tubers were consumed about twice a week on average and were most commonly eaten for breakfast. The leaves were rarely eaten. Sweet potato sales generated sufficient income at this site to purchase enough *mealie-meal* to feed 7.4 adults for a year. 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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