Assessment of African Indigenous Vegetable Grower's Production Practices and the Environment: A Case Study from Zambia

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Manuscript received: April 24, 2020

Keywords: Baseline conditions; production practices; sweet potato leaves; amaranth; orange sweet potato; underutilized vegetables, traditional African vegetables

ABSTRACT

Zambia is gifted with a large land resource base of 42 million hectares, of which, only 1.5 million hectares are under crop cultivation. Moreover, it is constrained with low soil fertility due to degradation, continued mono-cropping, changes in rainfall, and frequent droughts which leads to low crop yields, increasing rural poverty, child malnutrition, and food insecurity. To understand the farmer's background, this study aims to analyze the baseline conditions and production practices of African indigenous vegetables (AIVs) growers in Zambia. Using a structured questionnaire as a tool to collect data on nine AIVs, including amaranth (*Amaranthus* spp.), nightshade (*Solanum* spp.), spider plant (*Cleome gynandra*), cowpea (*Vigna unguiculata*), jute mallow (*Corchorus olitorius*), kale (*Brassica oleracea*), sweet potato leaves (*Ipomoea batatas*), orange sweet potato (*Ipomoea batatas*), and okra (*Abelmoschus esculentus*), the survey was administered to 300 AIV producers from six districts in Lusaka and the Eastern province in 2015. The average size of landholding was two hectares with a land tenure that was predominantly freehold without a title. These producers grow the AIVs for their home consumption, for sale, or both. Amongst the nine AIVs, sweet potato leaves, amaranth, and orange sweet potato were the three most preferred by the farmers to grow. For the seeds, producers mostly used their own farm or recycled seeds.

INTRODUCTION

Zambia, a landlocked country in Southern Africa, is known for its variations in the amount and temporal distribution of annual rainfall (Wood and Haas, 1990). As in much of Southern Africa, the agricultural productivity in Zambia is constrained by several natural factors, such as low soil fertility due to degradation and continued mono-cropping (Vanlauwe and Giller, 2006), changes in rainfall and frequent drought events (Ngwira et al., 2012), and the removal of subsidies on agricultural inputs (Nyirenda et al., 2011), resulting in low crop yields and increasing rural poverty, child malnutrition, and food insecurity (Manda et al., 2016).

Agriculture is the mainstay of the Zambian economy, with maize being the main staple food for the Zambians and is widely grown in central, southern, and eastern Zambia, providing 60% of energy consumption for the local children and adults (Chapoto et al., 2010). Cassava serves as the second staple crop and is widely grown in western Zambia, which provides 15% of calorie consumption for the local (Dorosh et al., 2009). Wheat is the third most important and preferred staple food (Mason and Jayne, 2009). However, as nearly half of local children are malnourished in Zambia (Moramarco et al., 2017), household agricultural production diversity affects the diets and nutrition of young children living in rural farming communities in sub-Saharan Africa and there is an urgent and immediate need to diversify the production including fruits and vegetable that provide nutrients needed for improving the diet and health of local children (Kumar et al., 2015). The introduction and implementation of a series of agricultural practices and interventions to sustainably diversify agricultural production, such as planting vegetables, fruits, and livestock production is needed as it is considered as one of the strategies to promote the diversity in agricultural farm production and increase dietary diversity to provide the minerals and vitamins now lacking in so many.

African indigenous vegetables (AIVs) can be effective in improving nutrition and increase the dietary diversity of underprivileged households due to their high levels of micronutrients, including iron, zinc, vitamin A and phytochemicals (Abukutsa-Onyango et al., 2010; Weller et al. 2015). Meanwhile, compared with typical cash crops or staple crops, there are additional advantages in producing AIVs, such as higher rate of return on labor (Kansiime et al., 2016), higher output value per unit area (Afari-Sefa et al., 2016), better capacity to maximize the use of soil nutrients and scarce water (Weinberger and Lumpkin, 2007), better adaptability to local conditions and environmental stress (Hoffman et al., 2018), the possibility of year-round production systems and cash income received is often twice that of staple crops. Hence, the comprehensive value of AIVs cannot be overemphasized (Laibuni et al., 2018).

The objective of this research was to analyze the baseline conditions and production practices of AIV growers in Zambia. If the production and consumption of African Indigenous Vegetables could increase, it will help address problems related to nutrition, increase food supply, and generate income opportunities for rural households. A baseline production survey was conducted in October/November 2015 to analyze the prevailing status of AIVs in Zambia. The survey was administered in two provinces, Lusaka and Eastern province and the AIV producers from six districts were interviewed.

METHODOLOGY

Study design and setting. The baseline production survey of AIV growers was administered in two provinces in Zambia, namely, Lusaka and Eastern province (Table 1). AIV producers from a total of six districts were interviewed: Lusaka and Chongwe districts from Lusaka province, and Chipata, Lundazi, Katete, and Petauke districts from Eastern province. Lusaka province included neighborhoods and townships such as Ibex Hill, Ngwerere, Chamba Valley, Chisamba, and Lilayi. The townships and neighborhoods included in the Eastern province were: Mteleza, Magwero, Luangeni Mukwekwe Saturday Market, Kapata Market and Eastern Mall in Chipata district. Kabelema, Chimukanono, Jupilo, Ngwali, Chimwale, Kashowo, Chazma, Longwe Tema-Tema, Benson Kulugale, Simon, Botolo, Mohipipi, Chimutengo, Boyeke, and Chimbalasese communities in Lundazi district were surveyed. Kalimeta, Chilingondi, Kafunkha, Msoro, Pulazi, Mphangwe, Chimasuko, Mpoto, Yalela, Mchepa, Chamai, Mbangombe, Undi, and Chakhomphwa communities in Katete district were included. Mumba Mumbi A, Ivuta farms, Mnemano, Kawere, Chimtanda, Mbomboza, Bomakambvum, Mphanda, Kawere, Mbuyamwale, Msato, Mbonga, Nemano, Chimehela, and Kabere stores in Petauke district were surveyed.

These survey participants/producers grow AIVs for home consumption, sale, or both. The survey was conducted between 19 October and 6 November 2015 at various locations and farms where the farmers produced indigenous vegetables across these districts.

Study population and sample selection. The study population included 50 producers from Lusaka, 50 from Katete, 50 from Chipata, 75 from Lundazi, and 75 from Petauke. Given the time constraints and needs of the baseline study, the interviewees were mostly farmers who belonged to existing cooperatives and their household members had ever applied for credit in Commercial Agribusiness for Sustainable Horticulture (CASH) project. The purpose of the survey was explained to them and their consent was obtained before collecting information required for the survey. All was done in compliance with Institutional Review Board (IRB) at Rutgers University and all enumerators were Collaborative Institutional Training Initiative (CITI) approved. No compensation was provided to the survey participants.

Questionnaire and interview of study participants. A structured questionnaire was used to collect data on the production of AIVs, including respondent and household demographics, land ownership, assets, labor allocation, vegetable production, training, access to, and constraints in AIV farming. Local names of these indigenous vegetables were used during the survey to help farmers identify the vegetables. The immediate survey was administered in English and also in the appropriate provincial native language: Soli, Bemba, Tonga, and Nyanja languages were used in Lusaka province; and Tumbuka, Chewa, and Nsenga languages were used in the Eastern province. A total of sixteen interviewers were trained on questionnaire handling and interviewing techniques to ensure that good quality data were collected; some key numerators were also trained and certified in CITI. In Eastern province, data associates, district managers, and technology transfer officers participated as interviewers as well.

RESULTS

Land ownership and use. The average size of the land parcel that each household had access to in 2015 was about 2 hectares (Table 2). The area under vegetables and other crops in the last production cycle was 0.45 hectares and 0.93 hectares. On average, most of the land was under production, only 0.1 hectares remained fallow and only 0.04 hectares were rented out. In terms of land tenure, 59% were freehold without title, 35% were freehold with title tenure, 5.9% were rented-in, and 0.8% were under the communal tenure. A “freehold without title” implies ownership of the property without documentation, while “freehold with the title” implies ownership of the property with the documentation. “common tenure” implies that the land is commonly owned by a community or a group.

Preference and reasons for growing AIVs. Male and female adults, either individually or together, and in some instances, the children, play a role concerning the decision to grow the type of AIV. Sweet potato leaves (246), amaranth (205) and orange flesh sweet potato (204) are the three most preferred among the nine AIVs surveyed that are grown by the households while nightshade (28), kale (37) and jute mallow (45) are grown by fewer participants. (Table 3). The data in brackets represent the number of people who responded to the survey affirmatively for each crop among 300 respondents. Irrespective of whether the AIVs grew were most preferred or least preferred they were primarily grown for home consumption (by at least 40% of participants). The second most influencing factor to grow these vegetables was the good prices prevailing in the market. There was one exception and that related to nightshade where production experience (18%) and the opportunity to earn extra income (14%) were more dominant compared to good prices (7%). The opportunity to earn extra income is the third most influential factor to grow these AIVs.

Production practices awareness and use of AIVs. Extension plays a major role in imparting knowledge about the current production practices to increase yield and income for farmers. Production practices such as using mulch, drip irrigation, hybrid seeds, improved cultivar, etc. are often part of the extension training. Regarding production practices for growing AIVs, more than 50% of the respondents had heard about it and had seen AIVs being produced. Only about 10% of the respondents stated that they had not heard about these production practices.

Furthermore, the application of these practices by the respondents was either negligible (less than 1%) or the other practices were close to non-existent in the past (in 2011) (Table 4). In contrast to the past, more than 75% of the respondents stated that they had begun and still applying these practices in 2015, about 6% to 15% stated that they have never followed up on these practices and about 1% to 8% of the respondents stated that they had used these practices before but stopped applying them for various reasons. Survey data revealed that improved seed and bedding were the only practices that the respondents were aware of and applied in the past.

Overall, lack of improving their production practices was self-reported due to the lack of requisite materials, high demand for labor, increased need for investment, ineffectiveness in increasing yield, and fertilizer application led to off-tasting or "bad tasting AIVs"that led to the discontinuation or lack of adoption of these production practices.

Production practice, location, and experience on AIVs in 2014. Good quality seeds and the use of bedding to raise crops were the only two practices that the respondents were aware of and had applied in 2011 while they were aware of and applied (to a certain extent) additional production practices like within and between row spacing, fertilizer types and rate, pesticides, irrigation methods, weeding methods, post-harvest processing, and marketing techniques in 2015. These results are summarized below by category. Overall, the better quality of seeds and improved production practices coupled with increased demand and higher yield would influence farmers to increase the cultivation of the listed vegetables.

Average cultivated area, distance, and harvest. Nightshade (237.9 m^2) occupied the largest hectare of production area (Table 5), followed by kale (122.2 m^2) and amaranth (118 m^2). The average area under cultivation seems to be the lowest for orange sweet potato (46.8 m^2). The average distance between home and grower field plots (Table 4) where the AIVs were grown varies for the AIVs, with kale being grown closer to home (305 m), followed by nightshade (348 m) and orange sweet potato (783 m). The plots where spider plants were raised seemed to record the longest distance from home at 3,984 m, followed by okra at 2,362 m and amaranth at 1,746 m. Meanwhile, the distance from their home presents a hardship so that they have to travel further or take more time to care for and harvest. The choice of planting a crop in a particular field depends on many factors such as soil type, water availability, demand, etc.

The average number of harvests per single production cycle was highest for nightshade (34) followed by kale at 25 harvests per cycle. Jute mallow recorded the lowest number of harvests per cycle at only 5 harvests followed by orange flesh sweet potato which recorded 8 harvests per cycle. However, orange sweet potato recorded the highest average yield per harvest (170 kg) followed by nightshade and okra at 61 kg (each) per harvest. Spider plant recorded the lowest average yield at only 27 kg per harvest followed by cowpea at 42 kg per harvest. Since these AIVs are harvested multiple different times from the same plant, the total harvest from a plant depends on the number of harvests and quantity harvested per harvest.

All AIVs have been harvested three ways: i) cutting just a bunch of the plant from the top, ii) cutting a bunch of leaves from the side shoots, and iii) pulling out the entire plant. Cutting a bunch of leaves from the side shoots or the plant top will result in new shoots leading to subsequent harvests. If the entire plant is pulled from the ground, then there will be only one harvest per cycle. But, such a practice is seldom used. Cutting just a bunch of the plant from the top (50%), stripping and harvesting only the leaves (36%), cutting a bunch of leaves from the side shoots (12%) and pulling out the entire plant and selling the entire plant in bunches (1%) are some forms of harvesting methods adopted by the farmers. Further, more than 80% of the respondents stored the AIVs immediately after harvest. The top three methods of storage growers reported include: in a basket (40%), above the ground in shade (23%), and on the ground under a shade (18%).

Planting method and farm location of AIVs. For the growing season 2014, planting by broadcasting seeds appears to be the preferred method only in the case of spider plant (66%) and jute mallow (79%); whereas single row seed sowing or transplanting was the preferred method (from more than 63% to about 88%) for amaranth, cowpea, kale, sweet potato leaves, orange sweet potato and okra (Table 6). For the nightshade, there does not seem to be a substantial difference in preference between planting by broadcast (46%) or by row (54%). In terms of where these AIVs were grown, 88-99% of these AIVs were grown in the farm and only a small percentage was grown in the kitchen garden.

Seed source. The seeds for growing AIVs were obtained from various sources such as agriculture dealers, farmers, and friends, local shops, farmer's own farm by recycling their own seed (Table 7). Own farm and recycled were the most important seed sources for AIVs including amaranth (44%), spider plant (54%), cowpea (65%), and sweet potato leaves (43%) followed by sourcing seeds from farmers and friends (22%, 23%, 24%, and 31% respectively). For nightshade, sourcing seeds from own farm and recycled seed (29%) and from local shops (29%) were the most common path growers procured seed, followed by sourcing from others (25%). In the case of Jute mallow, farmers and friends (42%) provided the greatest seed source, followed by sourcing from local shops (24%). With kale, seed sourcing was most from farmers and friends (32%) followed by one's own farm and recycled seed (27%) as the second most important seed source. In the case of orange sweet potato transplants, it was farmers and friends (36%) followed by others (43%) and for okra, it was farmers and friends (28%) followed by own farm and recycled (25%). Overall, sourcing from own farm and recycled and from farmers and friends ranked as the top two sources for procuring seeds. Given that seed and transplant costs are high when procured from commercial sources, these results were not surprising. Yet, using self-collected and locally produced seeds, without quality control systems could also lead to some seeds inadvertently crossing with other landraces leading to a mixed population in future generations. Of concern seeds from plants exhibiting diseases and other biotic or abiotic stress may also be collected leading to the use of poorer quality seeds leading to lower yields in future cropping seasons.

Cropping system. The cropping system adopted for growing AIVs was reported to fall within three groups: i) a sole cropping or monoculture, ii) intercropping, and iii) mixed cropping (Figure 1). Mixed cropping and intercropping are two methods of diversified farming techniques where more than types of crops are grown in the same area. In mixed cropping, two independent crops are mixed together and grown in an area, whereas, intercropping is a multiple cropping technique where two or more crops are grown in proximity.

Respondents indicated that sole cropping system was the most preferred system for growing amaranth (41%), nightshade (53%), cowpea (45%), kale (43%), sweet potato leaves (54%), orange sweet potato (59%) and okra (76%). Mixed cropping seems to be the preferred cropping system for growing spider plants (56%) and jute mallow (62%). Intercropping was also adopted for growing these AIVs but not as often as other cropping systems.

Production costs of AIVs. The majority of the respondents (62%) stated that there has been an increase in the cost of production in the past five years (2011-2015). However, 25% of the respondents felt that there has been no change in the cost of production while about 5% felt that the cost of production had decreased in the past five years. Concerning the indications to cause of the increase, high prices of improved seeds, high prices of fertilizers, and lack of credit are the main constraints for AIV growers.

Fertilizer. Several fertilizers were used for growing these AIVs and the quantity used varied from crop to crop (Table 7). Applying fertilizer diammonium phosphate (DAP) (26.7 kg/ m^2), green manure (24.9 kg / m^2) and farmyard manure (21.3/ m^2) were the three most commonly used fertilizers for growing amaranth. Farmyard manure (18.8 kg /m^2), DAP (7.3 kg / m^2) and green manure (3kg / m^2) were the only three fertilizers used for growing nightshade. The DAP (50 kg/ m^2), green manure (20.9 kg/ m^2) and farmyard manure (20.4 kg/ m^2) are the top three fertilizers used for growing spider plants. For growing cowpea, the top three fertilizers used were green manure (54.5 kg/ m^2), farmyard manure (25.8 kg/ m^2) and DAP (18 kg/ m^2), for jute mallow and kale it was farmyard manure (16.2 kg/ m^2 and 18.9 kg/ m) and DAP (7.9 kg/ m^2 and 3 kg/ m). The top three fertilizers used to grow sweet potato leaves, orange sweet potato and okra were DAP (13.9, 19.8 and 15.5 kg/ m^2), Calcium ammonium nitrate (CAN) (6, 40.9 and 33.2kg/ m^2), Monoammonium Phosphate (MAP) (12.4, 12.5 and 25kg/ m^2), farmyard manure (24.4, 24.2 and 23.4 kg/ m^2) and green manure (29.3, 26.8 and 34.2 kg/ m^2).

In general, farmyard manure and green manure were the most used fertilizers while ammonium sulfate nitrate (ASN) and urea seemed to be the least used fertilizers. Farmyard manure and green manure were the least expensive fertilizers costing 6 and 9 kwacha/kg while ASN was the most expensive fertilizer at 38 kwacha/kg (local currency of Zambia and at time of the survey, the conversion was approximately 10 kwacha/$US1).

Labor Cost. Family labor and hired labor were used to cultivate AIVs (Table 8). For hired labor, the number of full-time days (FTD) per week of work for the top two AIVs were: Nightshade (2.3 FTD) and spider plant (2.2 FTD). Family labor was highest for sweet potato leaves (4.5 FTD) and amaranth (3.1 FTD). Sweet potato leaves (1) and orange sweet potato (1) use the lowest number of FTD per week in case of family labor while it was orange sweet potato (1.8) and okra (1.7) in the case of hired labor.

In terms of cost of labor per FTD for family labor, cowpea at 27 kwacha/FTD and jute mallow at 24.1 kwacha/FTD were the most expensive. Okra at 8.9 kwacha/FTD and amaranth at 10.7 kwacha/FTD were the least expensive. In the case of hired labor, orange sweet potato (39.6 kwacha/FTD) and sweet potato leaves (28.8 kwacha/FTD) were the most expensive while kale (15.8 kwacha/FTD) and nightshade (17.7 kwacha/FTD) were the least expensive.

In terms of the total cost of family labor, spider plants (46.86 kwacha) and cowpea (40.5 kwacha) were the most expensive while sweet potato leaves at 15.1 kwacha and amaranth at 17.12 kwacha were the least expensive to grow. For hired labor, sweet potato leaves at 129.6 kwacha and spider plant at 46.28 kwacha were the most labor expensive AIVs while okra at 31.11 kwacha and cowpea at 41.14 was the least expensive.

Water management practices. For water management practices, natural rainfall was most widely used for amaranth (47%), nightshade (40%), cowpea (56%), jute mallow (66%), sweet potato leaves (55%) and orange sweet potato (72%) followed by bucket irrigation at 37%, 30%, 28%, 24%, 33%, and

22% respectively (Figure 2). However, in the case of spider plant and kale, bucket irrigation was the most widely used (56% and 38% respectively) followed by natural rainfall (22% and 29% respectively). For okra, drip irrigation (36%) closely followed by bucket irrigation (35%) was most widely used. In general, AIV cultivation was mainly dependent on natural rainfall and bucket-irrigation. Drip and sprinkler irrigations were not widely practiced.

DISCUSSION AND CONCLUSION

A structured questionnaire was used to collect information about the respondent and household demographics (including relationship to household head, marital status, the highest level of education, most important occupation, and so on), land ownership, assets, labor allocation, and vegetable production. A total of 300 respondents participated in the survey. The survey was designed to specifically collect data about nine AIVs, namely, amaranth, nightshade, spider plant, cowpea, jute mallow, kale, sweet potato leaves, orange sweet potato, and okra.

The average size of landholding was two hectares with a land tenure that was predominantly freehold without a title. These producers grow the AIVs either for their home consumption or sale or both. Amongst the nine AIVs, sweet potato leaves, amaranth, and orange sweet potato were the three most preferred.

Good quality seeds and the use of bedding to raise crops were the only two practices that the respondents were aware of and had applied in 2011, while they were aware of and applied (to a certain extent) additional production practices like within and between row spacing, fertilizer types and rate, pesticides, irrigation methods, weeding methods, post-harvest processing, and marketing techniques in 2015. Some of the production practices of AIVs were discontinued due to lack of availability of requisite materials, high demand for labor, increased need for money, susceptibility to diseases and pests, ineffective increased yield, or downgrade in taste.

The average cultivated area for each of the nine AIVs was less than a hectare per category. Meanwhile, these AIVs were mainly grown in farmlands and not in kitchen gardens. The average distance between home and plot where the AIVs were cultivated varies with kale being cultivated closest to home and spider plant being cultivated farthest from home. Nightshade recorded the highest number of harvests per cycle, averaging about 34 and jute mallow recorded the lowest number of harvests per cycle at 5. Orange sweet potato recorded the highest average yield in kg per harvest (170 kg) and spider plant recorded the lowest average at 27 kg per harvest. The harvests were immediately stored, predominantly in a basket or above the ground in shade. About half of the harvest was just a cut off a bunch of the plant from the top. The AIVs are harvested using several techniques. Cutting just a bunch of the plant from the top (50%), stripping and harvesting only the leaves (36%), cutting a bunch of leaves from the side shoots (12%) and pulling out the entire plant and selling the entire plant in bunches (1%) are some the forms of harvesting methods adopted by the farmers.

Sowing seeds by broadcast was the preferred method for spider plant and jute mallow while single row sowing or transplanting was the preferred method for the rest of the AIVs. Seeds were primarily sourced from the growers/respondents' own farm and other farmers and friends. Sole cropping is the preferred cropping system except for spider plant and jute mallow where mixed cropping was adopted.

Farmyard manure and green manure are the most used types of fertilizers and were least expensive in terms of kwacha per kg compared to other types of fertilizers. AIV cultivation is mainly dependent on natural rainfall and bucket irrigation. Drip and sprinkler irrigations were not commonly practiced. About 62% of the respondents felt that the cost of production had increased in the past five years and about 5% felt that the cost of production had decreased.

The farmers face several socio-economic and biophysical constraints while farming AIV. Despite the existing challenges they can use alternative strategies to counter these challenges. Survey respondents extensively use the extension services provided by NGOs, government agencies, and other organizations. These organizations can play a bigger role in increasing production, providing the farmers with better and improved quality seeds, availability of inputs like fertilizers and pesticides, better production processes, and providing for better and efficient harvesting, and storage techniques.

Table 1. Selection of Research Area

Provinces	Districts	Townships and neighborhoods
Lusaka	Lusaka	Ibex hill, Ngwerere, Chamba valley, Chisamba and Lilayi
	Chongwe	
Eastern province	Chipata	Mteleza, Magwero, Luangeni Mukwekwe Saturday Market, Kapata Market and Eastern Mall
	Lundazi	Kabelema, Chimukanono, Jupilo, Ngwali, Chimwale, Kashowo, Chazma, Longwe Tema-Tema, Benson Kulugale, Simon, Botolo, Mohipipi, Chimutengo, Boyeke, and Chimbalasese
	Katete	Kalimeta, Chilingondi, Kafunkha, Msoro, Pulazi, Mphangwe, Chimasuko, Mpoto, Yalela, Mchepa, Chamai, Mbangombe, Undi, and Chakhomphwa
	Petauke	Mumba Mumbi A, Ivuta farms, Mnemano, Kawere, Chimtanda, Mbomboza, Bomakambvum, Mphanda, Kawere, Mbuyamwale, Msato, Mbonga, Nemano, Chimehela, and Kabere

Table 2. Size and Use of Household Land Parcel in 2015

S. No	**Category**	**Average / Percent (%)**
1	Total Land holding (Hectares)	2.02
2	Area under vegetables in the last production cycle (Hectares)	0.45
3	Area under other crops (Hectares)	0.93
4	Area under fallow(Hectares)	0.08
5	Area rented out (Hectares)	0.04
6	Freehold without title (%)	59.00
7	Freehold with title tenure (%)	35.00
8	Rented-in (%)	5.90
9	**Communal tenure (%)**	**0.80**

Table 3. Preference and Reasons for Growing AIVs

S. No	Vegetable	Preference and Reason to grow AIV								
		Good prices	Contract with partner	Production experience	Avail able market	Opportunity to earn extra income	Cultural reasons for IVs	Home consump tion	Others	Total
1	Amaranth	50	1	13	14	17	2	107	1	205
	Percent (%)	24.4	0.5	6.3	6.8	8.3	1	52.2	0.5	100
2	Nightshade	2	0	5	2	4	1	14	0	28
	Percent (%)	7.1	0	17.9	7.1	14.3	3.6	50	0	100
3	Spider plant	8	0	2	3	4	1	47	0	65
	Percent (%)	12.3	0	3.1	4.6	6.2	1.5	72.3	0	100
4	Cowpea	34	5	4	13	20	1	74	0	151
	Percent (%)	22.6	3.3	2.6	8.6	13.2	0.7	49	0	100
5	Jute mallow	11	1	2	1	8	0	22	0	45
	Percent (%)	24.4	2.2	4.4	2.2	17.8	0	48.9	0	100
6	Kale	9	0	1	4	7	0	16	0	37
	Percent (%)	24.3	0	2.7	10.8	18.9	0	43.2	0	100
7	Sweet Potato Leaves	44	1	13	31	32	1	123	1	246
	Percent (%)	17.9	0.4	5.3	12.6	13	0.4	50	0.4	100
8	Orange Sweet Potato	52	1	19	24	17	3	87	1	204
	Percent (%)	25.5	0.5	9.3	11.8	8.3	1.5	42.6	0.5	100
9	Okra	59	0	7	18	20	0	63	2	169
	Percent (%)	34.9	0	4.1	10.7	11.8	0	37.3	1.2	100
10	Other	5	1	0	0	0	9	1	0	16
	Percent (%)	31.3	6.3	0	0	0	56.3	6.3	0	100

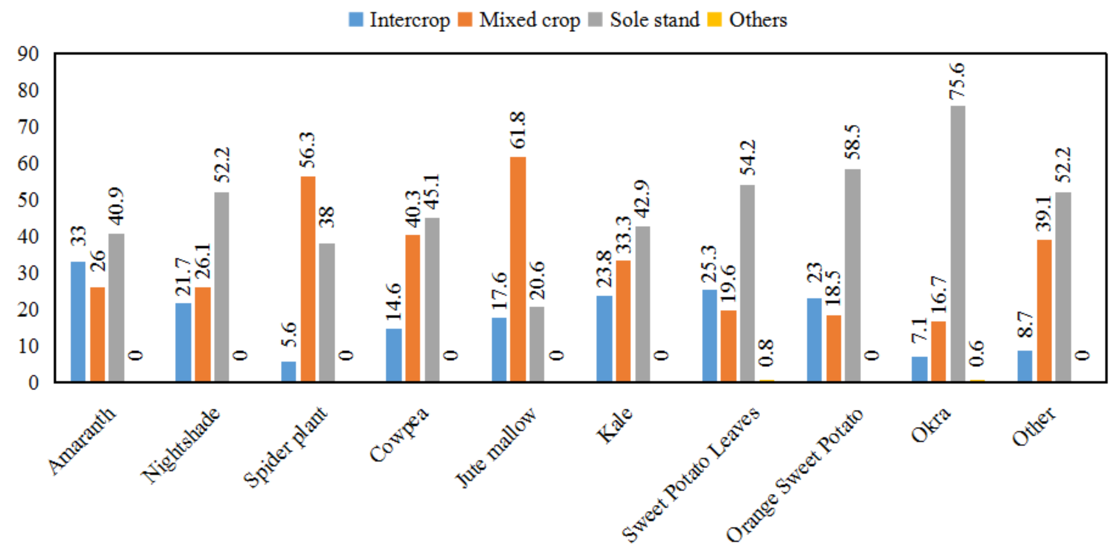

Figure 1. Cropping system reported for each of the AIVs surveyed in 2015

Table 4. Production Practices Awareness and Use

S.No	Practices	Particulars	Never	Used before but stopped	Applied in 2011	Still applying in 2015	Total
1	Improved Seed	Frequency	34	19	2	180	235
		Percent (%)	14.5	8.1	0.9	76.6	100
2	Bedding	Frequency	14	1	1	200	216
		Percent (%)	6.5	0.5	0.5	92.6	100
3	Spacing (Within & Between Rows)	Frequency	13	4	0	200	217
		Percent (%)	6	1.8	0	92.2	100
4	Fertilizer Type	Frequency	28	12	0	170	210
		Percent (%)	13.3	5.7	0	81	100
5	Fertilizer Rate	Frequency	29	8	0	150	187
		Percent (%)	15.5	4.3	0	80.2	100
6	Pesticides	Frequency	27	9	0	159	195
		Percent (%)	13.8	4.6	0	81.5	100
7	Irrigation	Frequency	10	3	0	198	211
		Percent (%)	4.7	1.4	0	93.8	100
8	Weeding	Frequency	10	4	0	142	156
		Percent (%)	6.4	2.6	0	91	100
9	Post-Harvest	Frequency	12	7	0	204	223
		Percent (%)	5.4	3.1	0	91.5	100
10	Marketing	Frequency	21	6	0	164	191
		Percent (%)	11	3.1	0	85.9	100

Table 5. Average Cultivated Area, Distance, and *Harvest*

S.No	Crop Name	Average Area planted (m^2)	Average distance of plot from home (m)	Average number of harvests per cropping season	Average yield (kg)/ harvest
1	Amaranth	118	1746	13	46
2	Nightshade	237.9	348	34	61
3	Spider plant	72.2	3984	16	27
4	Cowpea	91.1	1394	9	42
5	Jute mallow	53.4	1310	5	52
6	Kale	122.2	305	25	46
7	Sweet potato leaves	54.5	1003	13	54
8	Orange Sweet Potato	46.8	783	8	170
9	Okra	80.8	2362	11	61
10	Other	1.9	2080	7	37

Table 6. Planting Method and Farm Location (2014)

S. No	Vegetable Name	Planting method	Frequency	Percent	Location	Frequency	Percent
1	Amaranth	Row	135	62.8	Farm	199	92.6
		Broadcast	80	37.2	Kitchen garden	16	7.4
		Total	215	100	Total	215	100
2	Nightshade	Row	13	54.2	Farm	22	95.7
		Broadcast	11	45.9	Kitchen garden	1	4.3
		Total	24	100	Total	23	100
3	Spider plant	Row	24	33.8	Farm	69	97.2
		Broadcast	47	66.2	Kitchen garden	2	2.8
		Total	71	100	Total	71	100
4	Cowpea	Row	109	75.2	Farm	143	99.3
		Broadcast	36	24.8	Kitchen garden	1	0.7
		Total	145	100	Total	144	100
5	Jute mallow	Row	7	20.6	Farm	31	91.2
		Broadcast	27	79.4	Kitchen garden	3	8.8
		Total	34	100	Total	34	100
6	Kale	Row	16	72.7	Farm	20	90.9
		Broadcast	6	27.3	Kitchen garden	2	9.1
		Total	22	100	Total	22	100
7	Sweet Potato Leaves	Row	144	63.7	Farm	203	90.2
		Broadcast	82	36.3	Kitchen garden	22	9.7
		Total	226	100	Total	225	100
8	Orange Sweet Potato	Row	143	71.5	Farm	176	88.4
		Broadcast	57	28.5	Kitchen garden	23	11.6
		Total	200	100	Total	199	100
9	Okra	Row	136	87.2	Farm	139	89.7
		Broadcast	20	12.8	Kitchen garden	16	10.3
		Total	156	100	Total	155	100
10	Other	Row	21	91.3	Farm	22	91.7
		Broadcast	2	8.7	Kitchen garden	2	8.3
		Total	23	100	Total	24	100

Table 7. Seed Source

No	Vegetable name	Seed Source					
		Ag. Dealers	Farmers &Friends	Local Shop s	Own farm & Recycled	Others	Total
1	Amaranth	5	47	28	94	39	213
	Percent (%)	2.3	22.1	13.1	44.2	18.3	100
2	Nightshade	1	3	7	7	6	24
	Percent (%)	4.2	12.5	29.2	29.2	25	100
3	Spider plant	1	16	6	38	9	70
	Percent (%)	1.4	22.9	8.6	54.3	12.9	100
4	Cowpea	0	35	11	93	5	144
	Percent (%)	0	24.3	7.7	64.6	3.5	100
5	Jute mallow	0	14	8	7	4	33
	Percent (%)	0	42.4	24.3	21.2	12.1	100
6	Kale	1	7	4	6	4	22
	Percent (%)	4.5	31.8	18.1	27.3	18.1	100
7	Sweet Potato Leaves	3	68	22	95	32	220
	Percent (%)	1.4	30.9	10	43.2	14.5	100
8	Orange Sweet Potato	1	70	11	31	84	197
	Percent (%)	0.5	35.6	5.6	15.7	42.6	100
9	Okra	7	43	37	39	29	155
	Percent (%)	4.5	27.8	23.9	25.2	18.7	100
10	Other AIV	0	3	1	0	20	24
	Percent (%)	0	12.5	4.2	0	83.3	100

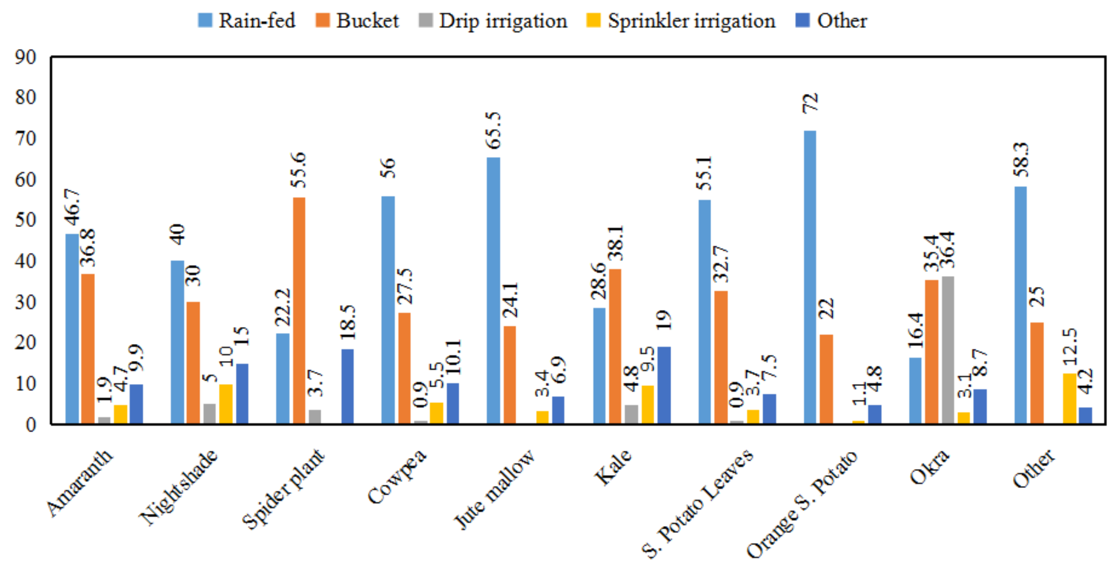

Figure 2. Water management practices

Table 8. Inputs and Costs of Producing AIVs

Particular		1	2	3	4	5	6	7	8	9	10
		Amaranth	Night shade	Spider plant	Cowpea	Jute mallow	Kale	Sweet Potato Leaves	Orange Sweet Potato	Okra	Other
Fertilizer Usage (kg/ m^2)	DAP*	26.7	7.3	50	18	7.9	3	13.9	19.8	15.5	26.2
	CAN*	2.9	0	2	0	0	0	6	40.9	33.2	0
	MAP*	0	0	29	0	0	0	12.4	12.5	25	0
	Farmyard manure	21.3	18.8	20.4	25.8	16.2	18.9	24.4	24.2	23.4	21.4
	Green manure	24.9	3	20.9	54.5	0	0	29.3	26.8	34.2	0
	ASN	5.7	0	0	0	0	0	0	0	0	0
	Urea	1	0	0	0	0	0	0	3	3	0
	Other	10	0	0	0	0	0	0	0	42.5	0
Family Labor	Man-days per week	1.6	2.3	2.2	1.5	1.4	1.6	1	1	1.1	0.3
	Kwacha/FTD**	10.7	15	21.3	27	24.1	13.4	15.1	17.3	8.9	15.9
	Total Cost	17.12	34.5	46.86	40.5	33.74	21.44	15.1	17.3	9.79	4.77
Hired Labor	Man-days per week	3.1	2.6	2.6	2.2	2.3	2.7	4.5	1.8	1.7	0
	Kwacha/FTD	20	17.7	17.8	18.7	18.9	15.8	28.8	39.6	18.3	30
	Total Cost	62	46.02	46.28	41.14	43.47	42.66	129.6	71.28	31.11	0

*DAP= Diammonium phosphate; CAN= Calcium ammonium nitrate; MAP= Monoammonium Phosphate; **FTD=full time days.

ACKNOWLEDGEMENTS

This research was supported by the Horticulture Innovation Lab with funding from the U.S. Agency for International Development (USAID EPA-A-00-09-00004), as part of the U.S. Government's global hunger and food security initiative, Feed the Future, for project titled ''Improving nutrition with African indigenous vegetables'' in eastern Africa. We thank the participating smallholder growers who gave their consent and time to be interviewed and for inviting us to work with them. We also thank the New Jersey Agriculture Experiment Station (HATCH project 12131); Himoonga Moonga and John Shindano, University of Zambia; Kenneth Chali and Lupiya Sakala, AgriSmart, Zambia; David Byrnes and Emily Merchant, Rutgers; John Bowman, USAID- Washington; and Beth Mitcham, UC-Davis. We especially appreciate the encouragement and fruitful discussions from USAID-Zambia, notably Anna Toness, Ayana Angulo, Brian Martalus, Harry Ngoma and Mlotha Damaseke.

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