Postharvest Handling, Processing, Value, and Marketing of African Indigenous Vegetables: A Case Study from Zambia

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ABSTRACT

Zambia is a country located in the southern portion of Africa and is a producer of African indigenous vegetables (AIVs) which have been a part of their historical culture for generations. Yet, despite their popularity, AIVs were displaced by European introduced vegetables during Colonial days, and even today the limited local production and commercial horticultural industry relative to foods remain focused on European-style vegetables. This paper gives insight into baseline conditions relating to the 'reintroduction' of AIV's with a focus on the supply chain starting with postharvest handling of AIV's, (including transportation, processing), through the marketing of AIVs and other impediments that hinder the efficiency of AIVs production and sale. A survey was conducted in 2015 with 300 producers and intermediaries to gain insight into these elements in Zambian agriculture. Results showed that some postharvest processing occurred with minimal value addition methods and that prices were generally established by farmers who observed the values of produce from surrounding markets. The information yields insight into specific processing, value addition, and marketing information for the indigenous vegetables in Zambia. The most promising interventions for value addition is the processing of AIVs with drying, cleaning/sorting, and packaging AIVs so that they are ready to cook, and ready-mix AIVs with spices to make soup blends.

INTRODUCTION

Zambia is a landlocked country in South-Central Africa with a mild tropical climate and a significant agricultural sector. Fifty-eight percent of the land in Zambia has medium to a high potential for agriculture, yet only fourteen percent of this land is cultivated. Maize and cassava account for

approximately seventy-five percent of Zambia's crop output (*Zambia*, 2009). Sixty percent of the population depends on the production of crops, livestock, and fisheries and seventy percent rely on these fields for employment. The country has abundant land and freshwater resources suitable for aquaculture production. Zambia is estimated to contain 15 million hectares of water in the form of rivers, lakes, and swamps, and another 8 million hectares of wetlands representing huge natural resources that provide the basis for aquaculture industry development. The agriculture sector is comprised of two systems: a subsistence farming system and a commercial farming system. The subsistence farming system includes approximately 430,000 farming households which grow one-two hectares for subsistence and occasional marketable surplus. The number of medium-scale and large-scale farms in Zambia has increased over time. In particular, the number of farms with a landholding of 10-20 ha in 2001 has increased from 36,799 to 65,737 in 2014 (Sitko and Chamberlin, 2015).

African indigenous vegetables (AIVs), also known as traditional African vegetables, are food products of sub-Saharan Africa that have been collected or cultivated and consumed for hundreds of years. They are comprised of approximately 1,000 different edible species of leafy and fruit vegetables. Although these foods have been a part of African culture and traditions, they were largely displaced by Europeans during the Colonial era who brought with them the vegetables they were used to consuming. AIV's were also displaced during this period by the large-scale production of sugarcane, coffee, cotton, maize, cassava, and cocoa as the dominant commercial crops (Muhanji, et al., 2011). In part due to the influence of the Colonial period, urban African society later deemed AIV's to be the "poor people's foods" because of the shift towards non-indigenous foods.

African indigenous vegetables are less common in the Zambian diet today because sub-Saharan countries such as Zambia have attempted to "modernize" their foodways by selling and consuming foods common in Europe (Yang and Keding, 2009). Nonetheless, there is growing support to reverse this trend and reintroduce and expand AIV consumption because AIV's have favorable agricultural and economic qualities such as low production costs, less disease, and pest risk, a fast rate of maturity, and availability of a growing market (Muhanji et. al., 2011). Additional attributes such as their resiliency to drought, flooding, and climate changes make them attractive as commercial crops (Weller et al., 2015). Despite these qualities, there remain many obstacles to overcome in the re-introduction and production of AIVs. These indigenous vegetables have received far less attention and comparatively little farming research by national and international agencies in Africa which indicates a need for refocusing on these agricultural products (Oluoch et. al., 2009).

In other countries, high transaction and transportation costs impede agricultural transit and revenue from a significantly higher growth rate. A study in Ghana found that there are several impediments to marketing including lack of access to finance, markets, and external market information. This study also addressed the lack of processing capacity and technical training necessary for handling (Govindasamy et al., 2006). Another study in Tanzania found that 62% of AIV sellers had access to cell phones which had the potential to influence the speed of communication with regards to product pricing and marketing. Despite this, an organized system for small-farm AIV producers has yet to be created in Tanzania and much of sub-Saharan Africa (Lotter, et al., 2014). The existence of an organized system for small-farm AIV producers could help in the process of aggregation and transportation, thus reducing the cost of transportation. Information gathered by members of agricultural villages is potentially redundant and homogenous. One study reveals that network connections outside of these villages could offer more opportunities for increased commercialization of African products. This enables the producers to make more informed decisions about their pricing strategies relative to other farmers (Mwema and Crewett, 2019). These studies reveal the transportation, processing, and marketing issues of produce in Africa.

The objective of this research is to examine the postharvest handling, value addition, and marketing and sale of African indigenous vegetables in Zambia. This report will describe the post-harvest and value addition techniques, as well as the differences in value addition between subsistence crop production and commercial crop production. It will also analyze the marketing of African indigenous vegetables concerning buyers, market meetings, and price awareness.

MATERIALS AND METHODS

A survey for information about the production, postharvest handling, and marketing of African indigenous vegetables was conducted in the Lusaka and Eastern Provinces in Zambia between October 19, 2015, and November 6, 2015. The Lusaka Province included interviewees from the Lusaka and the Eastern Province includes interviewees from Chipata, Lundazi, Katete, and Petauke. The study sample totaled 300 participants, with 50 producers from Lusaka, 50 from Katete, 50 from Chipata, 75 from Lundazi, and 75 from Petauke. 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 CITI approved. No compensation was provided to the survey participants.

The African indigenous vegetables included in the survey were amaranth, nightshade, spider plant, cowpea, jute mallow, kale, sweet potato leaves, orange sweet potato, and okra. These African indigenous vegetables were selected based upon their popularity and Zambian consumer preference during the pilot study and each is grown for subsistence, commercial selling, or both.

Sixteen trained interviewers administered the questionnaires to the participants in both English and their native provincial languages. Some of the data sets were returned incomplete because of the limitations of respondents' lack of record-keeping or in some cases their reluctance to answer certain questions. The questionnaire was categorized into eleven sections including respondent information, land ownership, and use, asset and livestock ownership, vegetable production and preference, processing, and value addition, packing during transportation, marketing, labor allocation to the AIV value chain, farmer training, and extension needs, constraints to AIV farming, and household demographics. The production survey information serves as a baseline for the status of African indigenous vegetables in Zambia while addressing other aspects of their agricultural lifestyle such as income, nutrition, and food supply. This paper focuses on the data collected from the postharvest information, specifically the processing, value addition, and marketing sections. The processing and value addition section of the questionnaire was further divided into postharvest processing for home consumption versus commercial sale.

RESULTS

Postharvest processing of the African indigenous vegetables is being conducted in Zambia using a variety of approaches (Tables 1 and 2). Since different approaches for household consumption may be used in comparison to preparing fresh produce for processing and commercial sale, the survey questions and responses are presented separately. Table 1 displays the number of survey respondents who participated in postharvest processing for home consumption and illustrates that the majority of each AIV that is processed. Table 2 illustrates the data for the postharvest processing of African indigenous vegetables for commercial sale.

Respondents indicated that among all the AIVs, nightshade was the most processed African indigenous vegetable by drying leaves with 95.5% of participants acknowledging that they added some value to this crop after its harvest. The “other” category was the next most processed (86.2%) followed by okra (85.8%), cowpea (81.8%), sweet potato leaves (72.6%), orange sweet potato (70.6%), jute mallow (69.7%), kale (66.7%), and spider plant (59.5%). Some of the examples for the “Other” categories could include the most common vegetables such as peppers, tomatoes, etc. Amaranth had the least amount of processing with

slightly greater than half (51.6%) of the crop being processed for home consumption. The "other" category in Table 2 was the most processed group with 92.3% of the produce having value-added after harvest. The next group with the most value-added was kale (88.2%), cowpea (87.5%), okra (85.2%), jute mallow (83.9%), orange sweet potato (83.7%), nightshade (82.6%), sweet potato leaves (79.8%), and spider plant (77.4%). The least processed crop, again, was amaranth with 64.1% of it being processed for sale. Overall, based on Table 3, the group that had the largest value-added was the "other" category at 89% processed. This was followed by nightshade (88.9%), okra (85.5%), cowpea (84.5%), sweet potato leaves (78.2%), orange sweet potato (77.2%), kale (77.1%), jute mallow (76.9%), and spider plant (67.1%). Totaled, amaranth was still the least processed AIV at 56.7%.

Postharvest processing and value addition practices for each of the African indigenous vegetables can differ as shown in Tables 3, 4, and 5. These tables simplify the information by dividing the responses into subcategories for cutting/slicing methods, storage methods, and miscellaneous methods, respectively. Table 3 includes the categories cutting/slicing only, cutting and sun-drying, cutting/ slicing/ drying, and cutting/ drying/ storing. Table 4 includes sun-drying and storing, storing only, and cutting/drying/storing. There were no specific details about the nature of the storage for the storage only category. It should be noted that there was an overlapping category between the cutting/slicing methods and storage methods: cutting, drying, and storage. This group of data is included in both Tables 3 and 4. Table 5 introduces sorting and grading, bulking with other farmers, and boiling. It should be noted that the survey did not specify the length of time for the boiling process nor did it specify the specific practice for bulking with other farmers. The sorting and grading were likely done using appearance, marketability, and leaf size characteristics as these are the most valued characteristics for the producers and appearance is the most sought-after characteristic by the buyers.

The most common cutting/slicing methods shown in Table 3 are cutting and sun-drying at 52.7% followed by cutting/slicing only (34.8%), and cutting/slicing and drying (7.6%). Cutting, drying, and storing was the least common cutting/ slicing method with it account for 4.9% of the activity in this dataset. Cutting/slicing only was the most common cutting/slicing method for amaranth (52.6%), jute mallow (50%), and sweet potato leaves (54.2%). Cutting and sun-drying was the most common cutting/slicing for all of the other AIVs: nightshade (100%), spider plant (50%), cowpea (75%), kale (66.7%), orange sweet potato (60%), okra (68.1%), and the "other" group (50%).

The most common storage method is sun-dried and stored, making up 85.4% of the storage category (Table 4). Storing only and cutting, drying, and storing were less common as storage techniques making up 6.4% and 8.2% of the group, respectively. All of the AIVs were most commonly stored after sun-drying: amaranth (75%), nightshade (100%), spider plant (100%), cowpea (97.1%), jute mallow (75%), kale (100%), sweet potato leaves (63.6%), okra (93.3%), and "other" (83.4%). The orange sweet potato was the only AIV that was not dominated by this technique; it was equally split at 50% between the sun-drying and storing and only storing. The most frequently used miscellaneous processing and value addition method was sorting and grading at 95.5% (Table 5). This was followed by boiling (3.2%) and bulking with other farmers (1.3%). All of the AIVs most commonly used the sorting and grading process: amaranth (100%), nightshade (88.9%), spider plant (100%), cowpea (84.4%), jute mallow (100%), kale (100%), sweet potato leaves (97%), orange sweet potato (98.4%), okra (100%), and the "other" group (54.5%).

Overall, the most commonly used value addition process was sorting and grading with it accounting for approximately half (49.7%) of the methods. This was followed by cutting and sun-drying (16.4%), sun-dried and stored (15.6%), cutting/slicing only (10.8%), cutting/slicing and drying (2.4%), boiling (1.7%), cutting, drying, and storing (1.5%), and storage (1.2%). The least common method was bulking with other farmers

(.7%). AIVs that were most frequently sorted and graded were amaranth (54.8%), nightshade (42.1%), spider plant (46.4%), kale (66.7%), sweet potato leaves (65.3%), orange sweet potato (80.8%), and okra (43%). The AIVs that were most commonly sun-dried and stored were cowpea (33.7%), jute mallow (32.1%), and others (38.5%).

The Zambian AIV growers used many trading partners and buyers for their AIVs (Figure 1). The most frequent trading partner was the ultimate consumer, 73%, where the crop was sold directly to them without an intermediary and usually at a local market. The next most common trading partner was the wholesaler (22%), retailer (4%), roadside stand (3%), broker (1%), and direct to a supermarket (1%). The difference between "Direct to Consumers" and the "Roadside stand" is the location of the sale. "Direct to consumer" often occurs at the common market place, whereas, "Roadside stand" occurs at the farm. Just like "Direct to Consumer", producers with "Roadside stand" sell their own produce to consumers. The "Wholesalers" take charge of the produce, whereas, "Brokers" only connect the buyer and the seller and get a commission for their service. Figure 2 illustrates the frequency of market meetings for AIV sale to trading partners, most commonly the individual consumer. Markets most often met once weekly (67%), followed by daily (19%), twice weekly (12%), and thrice-weekly (2%). Other meeting frequencies accounted for less than 1% of the market meetings. Figure 3 details the different types of packaging during transport for sale. Reed/woven and bamboo baskets were the most common packaging accounting for approximately half (49.5%) of the total packaging. Following this method were plastic bags/sacks (22.9%), crates (15.7%), polyethylene bags (3.1%), cartons (3.1%), and other methods (3.1%). Plastic containers accounted for less than 3% (2.7%) of the total packaging.

Of interest to note was that almost 84% (83.9%) of farmers were aware of the prevailing price before the sale of their AIVs (Table 6). Other farmers were the most frequent and trusted source of market information. Using this awareness, the majority of farmers make their final price decision by themselves (55%) as shown in Figure 4. Negotiation was the next most common pricing method, accounting for 22% of the total, followed by not applicable (18%), the buyer (4%), and other (1%). Figure 5 details what methods the farmers use to determine their pricing decisions. The majority (56.9%) determine prices using neighboring markets, followed by not applicable (19.6%), cost of production (10.9%), other (10.9%), newspaper publications, (1.1%), and radio broadcasted prices (0.7%).

DISCUSSION

Overall, the Zambian AIV producers in 2015 used minimal value addition after harvest. Many of the value addition practices require additional materials, increased labor, and downgrade in taste. This is relevant to processing categories such as cutting, drying, and storing which was the least used cutting or slicing technique. Additionally, the downgrade in taste or quality impacts which AIVs are processed in certain ways. Specifically, it is the reason that amaranth is the least processed AIV. Harvests were immediately stored, most commonly in a woven basket or above ground in a shaded area. The survey did not include an option for the time length of storage. Sorting and grading were the most common postharvest and value addition processes, followed by sun-drying and storing and cutting and/or slicing. Reed/woven or bamboo baskets were the most common form of packaging for the transport of crops for sale. It should be noted that the packaging categories had some categories that could be considered overlapping, such as confusion between plastic containers and plastic bags/sacks. The further specification would serve to clarify the details of this data concerning plastic consumption, specifically. The AIVs were most commonly sold to individual consumers (neighbors/community members) at daily or weekly local markets where the produce was generally sorted and sold loose and fresh.

About the sale price decision, other farmers were the most common and trusted source of market information. The price is fixed by the grower who

knows the prevailing prices from surrounding markets which are monitored for several days before the harvest. Ultimately, with this information, the prices were generally set by individual farmers. Yet, 18% of farmers responded that price decision was not applicable, meaning that they were unaware of how the prices were fixed. Of the farmers that set their own prices, most used prices that were set by neighboring markets. Few (less than 2%) used widespread, public resources such as newspapers and radio broadcasts, and there was no inclusion of more modern resources such as cell phone communication. An increase in technology availability and public communication has the potential to affect this process and the fairness of AIV market pricing.

Table 1: Postharvest processing of African indigenous vegetables for home consumption

AIV	Those who do not process AIV's	Those who process AIVs	Total
Amaranth	91	97	188
% Amaranth	48.4	51.6	100
Nightshade	1	21	22
% Nightshade	4.55	95.45	100
Spiderplant	17	25	42
% Spiderplant	40.5	59.5	100
Cowpea	22	99	121
% Cowpea	18.2	81.8	100
Jute Mallow	10	23	33
% Jute Mallow	30.3	69.7	100
Kale	6	12	18
% Kale	33.3	66.7	100
Sweet Potato Leaves	34	90	124
% Sweet Potato Leaves	27.4	72.6	100
Orange Sweet Potato	25	60	85
% Orange Sweet Potato	29.4	70.6	100
Okra	17	103	120
% Okra	14.2	85.8	100
Other	4	25	29
% Other	13.8	86.2	100

Table 2: Postharvest processing of African indigenous vegetables later made available for sale

AIV	No	Yes	Total
Amaranth	47	84	131
% Amaranth	35.9	64.1	100
Nightshade	4	19	22
% Nightshade	17.4	82.6	100
Spiderplant	7	24	31
% Spiderplant	22.6	77.4	100
Cowpea	14	98	112
% Cowpea	12.5	87.5	100
Jute Mallow	5	26	31
% Jute Mallow	16.1	83.9	100
Kale	2	15	17
% Kale	11.8	88.2	100
Sweet Potato Leaves	24	95	119
% Sweet Potato Leaves	20.2	79.8	100
Orange Sweet Potato	14	72	86
% Orange Sweet Potato	16.3	83.7	100
Okra	17	98	115
% Okra	14.8	85.2	100
Other	2	24	26
% Other	7.7	92.3	100

Table 3: Methods of postharvest processing of African indigenous vegetables and value addition of cutting/slicing methods

AIV	Cutting/slicing only	Cutting/sun-drying	Cutting, slicing, & drying	Cutting, drying, & storage	Total
Amaranth	19	7	4	3	33
% Amaranth	57.6	21.2	12.1	9.1	100
Nightshade	0	7	0	0	7
% Nightshade	0	100	0	0	100
Spiderplant	4	5	1	0	10
% Spiderplant	40	50	10	0	100
Cowpea	7	24	1	0	32
% Cowpea	21.9	75	3.1	0	100
Jute Mallow	7	5	0	2	14
% Jute Mallow	50	35.7	0	14.3	100
Kale	1	2	0	0	3
% Kale	33.3	66.7	0	0	100
Sweet Potato Leaves	13	7	2	2	24
% Sweet Potato Leaves	54.2	29.2	8.3	8.3	100
Orange Sweet Potato	3	6	1	0	10
% Orange Sweet Potato	30	60	10	0	100
Okra	9	32	5	1	47
% Okra	19.2	68.1	10.6	2.1	100
Other	1	2	0	1	4
% Other	25	50	0	25	100
Total	64	97	14	9	184
% Total	34.8	52.7	7.6	4.9	100

Table 4: Postharvest processing of African indigenous vegetables and value addition with storing methods

AIV	Sun-dried & stored	Storage	Cutting, drying, & storage	Total
Amaranth	9	0	3	12
% Amaranth	75	0	25	100
Nightshade	3	0	0	3
% Nightshade	100	0	0	100
Spiderplant	5	0	0	5
% Spiderplant	100	0	0	100
Cowpea	33	1	0	34
% Cowpea	97.1	2.9	0	100
Jute Mallow	9	1	2	12
% Jute Mallow	75	8.3	16.7	100
Kale	2	0	0	2
% Kale	100	0	0	100
Sweet Potato Leaves	7	2	2	11
% Sweet Potato Leaves	63.6	18.2	18.2	100
Orange Sweet Potato	2	2	0	4
% Orange Sweet Potato	50	50	0	100
Okra	14	0	1	15
% Okra	93.3	0	6.7	100
Other	10	1	1	12
% Other	83.4	8.3	8.3	100
Total	94	7	9	110
% Total	85.4	6.4	8.2	100

Table 5: Postharvest processing of African indigenous vegetables and value addition using additional reported methods

AIV	Sorting & grading	Bulking with other farmers	Boiling	Total
Amaranth	51	0	0	51
% Amaranth	100	0	0	100
Nightshade	8	0	1	9
% Nightshade	88.9	0	11.1	100
Spiderplant	13	0	0	13
% Spiderplant	100	0	0	100
Cowpea	27	3	2	32
% Cowpea	84.4	9.4	6.2	100
Jute Mallow	4	0	0	4
% Jute Mallow	100	0	0	100
Kale	10	0	0	10
% Kale	100	0	0	100
Sweet Potato Leaves	66	1	1	68
% Sweet Potato Leaves	97	1.5	1.5	100
Orange Sweet Potato	63	0	1	64
% Orange Sweet Potato	98.4	0	1.6	100
Okra	46	0	0	46
% Okra	100	0	0	100
Other	6	0	5	11
% Other	54.5	0	45.5	100
Total	294	4	10	308
% Total	95.5	1.3	3.2	100

Table 6: Those who are aware of AIV market prices before the sale

Awareness	Frequency	Percent (%)
Not Aware of the Prices	47	16.1
Aware of the Prices	246	83.9
Total	293	100

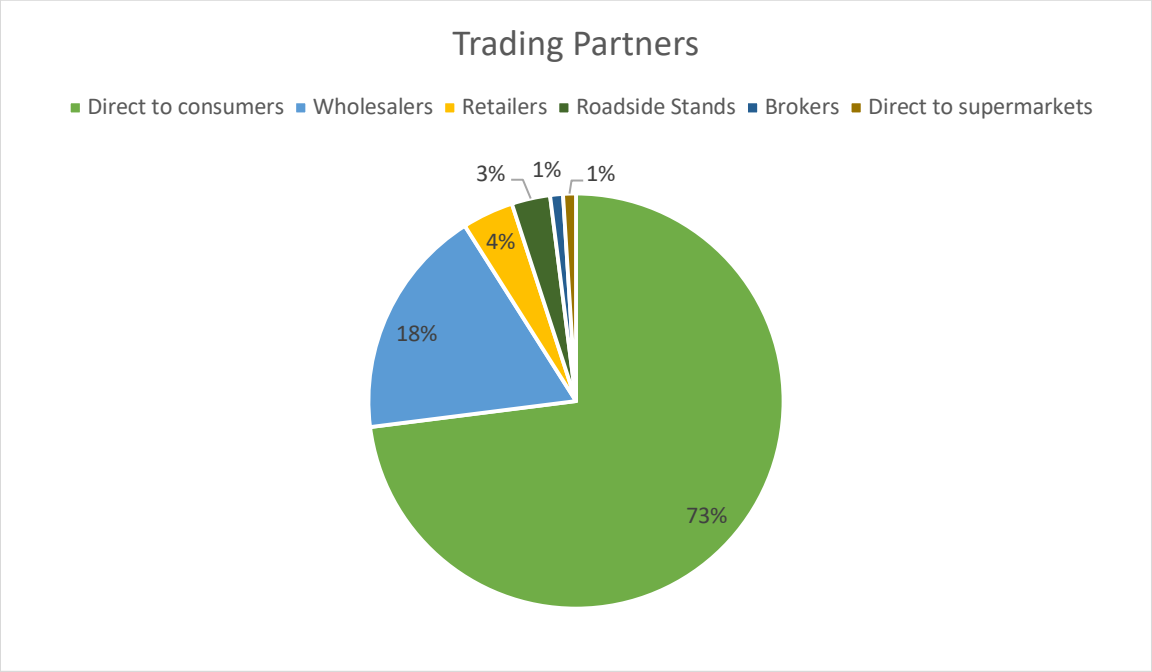

Figure 1: African indigenous vegetable trading partners

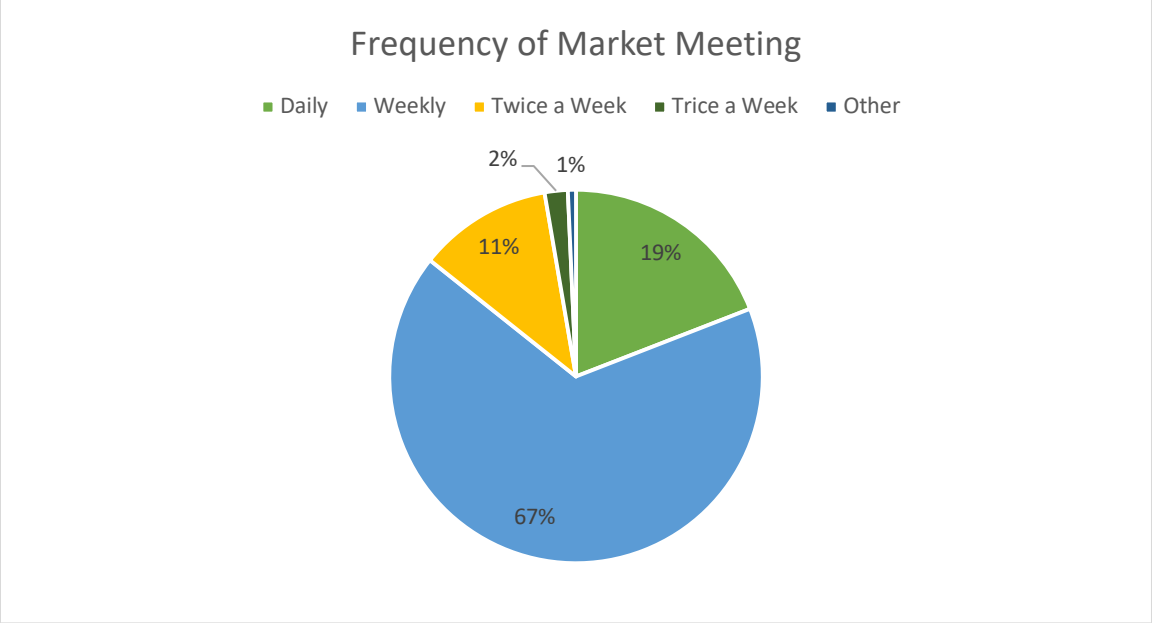

Figure 2: Frequency of bringing the African indigenous vegetables to market

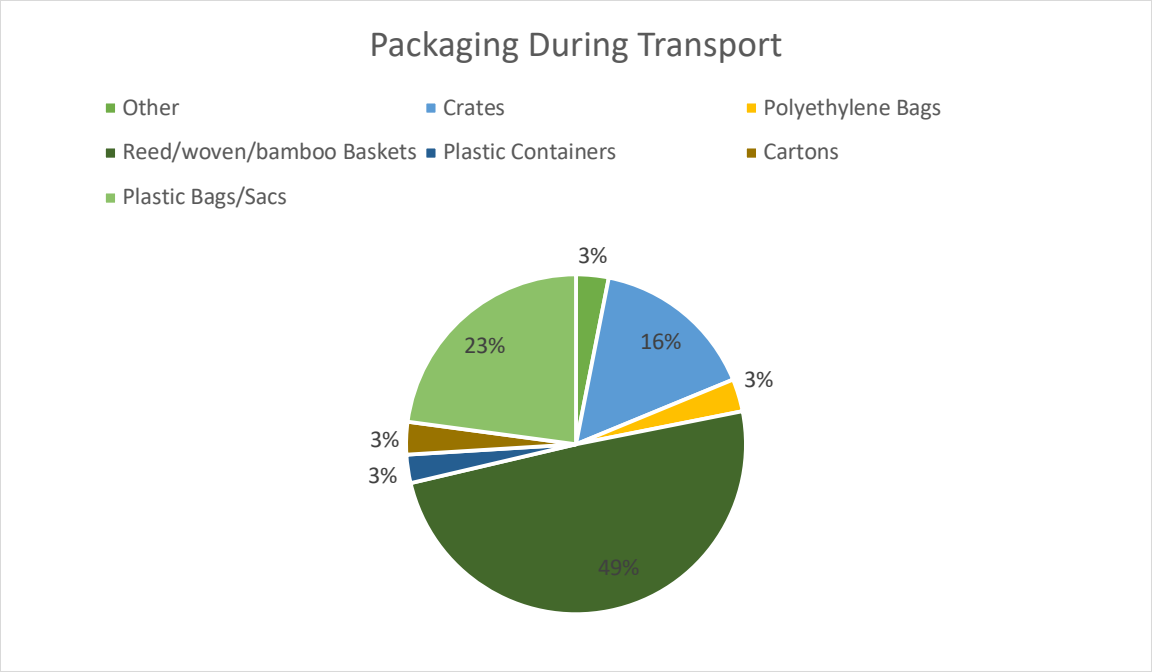

Figure 3: Packaging of African indigenous vegetables during transport

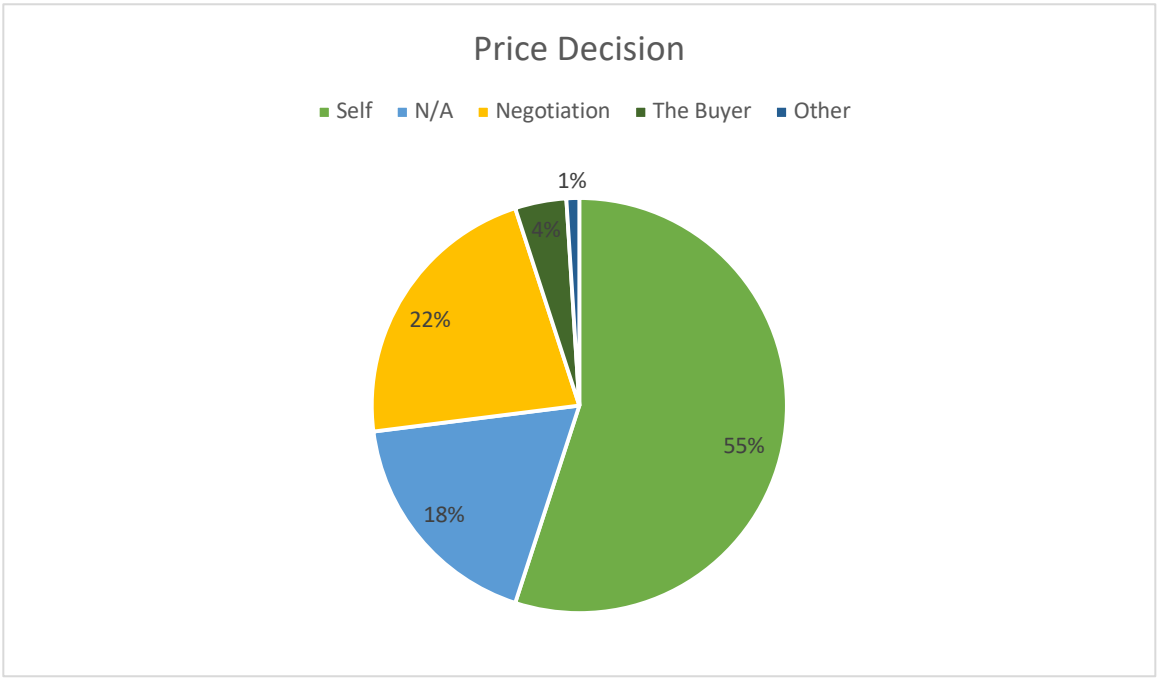

Figure 4: Who is making the final price decision for the African indigenous vegetables

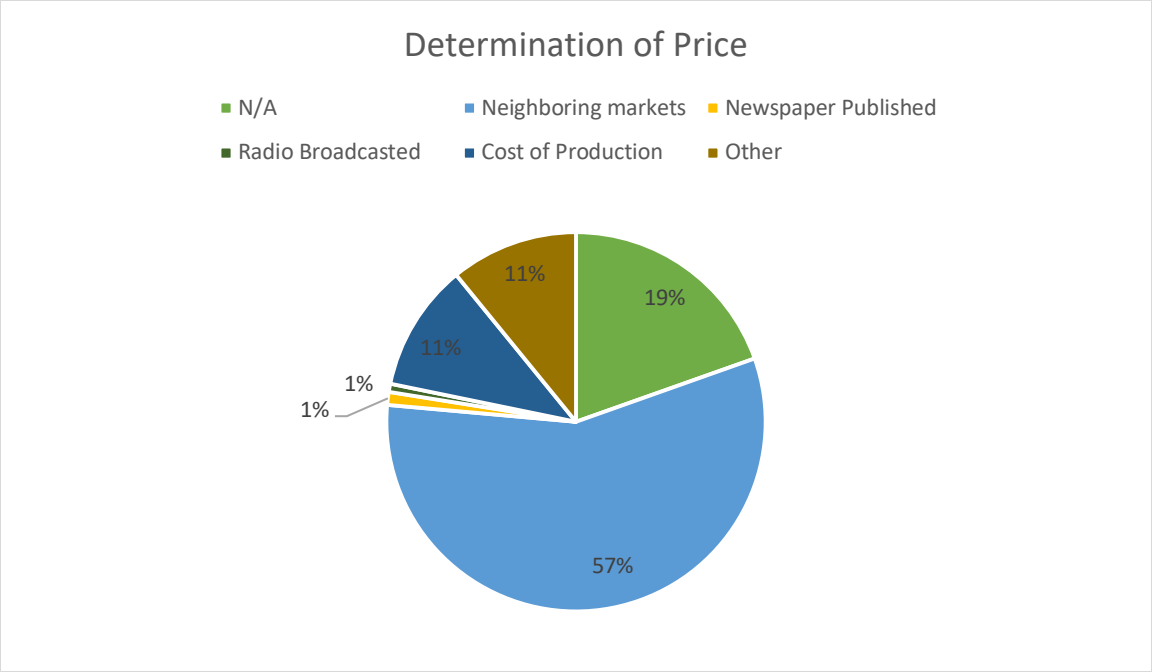

Figure 5: How do farmers learn of the current African indigenous vegetable prices

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