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ORIGINAL PAPER

Evaluation of cassava processing and utilization at household level in Zambia

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Abstract

Cassava (*Manihot esculenta* Crantz) is the second most consumed staple food crop after maize in Africa and is the main food security crop after maize in Zambia. A study, aimed at analyzing cassava processing and utilization at household level in Zambia, was conducted. Surveys were conducted in five districts (Kasama, Samfya, Mansa, Serenje and Kaoma). A structured questionnaire was administered to a total of 300 randomly selected households. The percentage of households that were involved in processing were 4.3% for income, 34% for consumption and 58% for both income generation and consumption. Levels of awareness and usage of improved cassava processing methods across the districts were low, ranging between 20% and 26%. The only improved processing equipment that farmers used often (69%) was the hammer mill. Product development and utilization were still at a low level (ranging between 9% and 18%) in Zambia. Cassava is mostly consumed in its traditional form for its leaves, as a snack, and for preparing nshima (cassava flour alone or a mixture of cassava and maize meal, called *maize-cassava nshima*). The limited knowledge of cassava products' diversity and the low usage of improved equipment are challenges to the production of confectionery products that could lead to increased cassava consumption. There has been no significant change over the last two decades in cassava processing and product development, which could spur cassava development. This calls for more efforts to support Government policy in diversifying crop use and crop diversification in order to create wealth.

Keywords Cassava processing · Household level · Confectionery products · Product development · Processing equipment

1 Introduction

Cassava (*Manihot esculenta* Crantz) is the second most consumed staple food crop after maize in Africa and is the main food security crop after maize in Zambia (Abass 2008; Nielson 2009; Arega et al. 2013). The production of cassava is confined to the north and northwestern parts of Zambia and is exclusively produced by over 350,000 smallholder farming households for consumption (Haggblade and Nyembe 2007; Sitko et al. 2013;). Simwambana (2005) reported that 30% of the Zambian population depends on cassava as a major staple. Over 800,000 tons of cassava was produced for home consumption (GRZ 2010) but only 8% of it is marketed for income (Sitko et al. 2013). Cassava can supply more calories per unit of land and labor compared to maize (Chitundu et al. 2006) but the consumption of cassava-based products in Zambia is low compared to other staples and their respective derivatives (GRZ 2010). It is often consumed as 'nshima' (cassava flour alone or a mixture of cassava and maize meal, called *maize-cassava nshima*), or dried and roasted as snacks, and to some extent raw as fresh roots (sweet varieties). However, Farnworth et al. (2011) reported that cassava processing into chips or flour is often laborious and time consuming due to lack of the right equipment.

There are reports of several project interventions training women and youth in cassava processing and utilization in the

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cassava growing regions (Simwambana 2005; Abass 2008). Despite the importance of cassava to agricultural-led economic growth, there have been few studies that have investigated the evolution of processing and utilization of cassava at household level in Zambia. Most studies and reports on cassava in the country have focused on increasing cassava production and promoting cassava commercialization for industrial use (Simwambana 2005; Abass 2008; GRZ 2010). Previous studies reported that cassava processing is still simplistic and rudimentary at household level (Abass 2008). The present study therefore aims to establish the present trend of cassava processing and utilization at household level in Zambia. The study's intention is to find bottlenecks that can be addressed to improve cassava commercialization in the country.

2 Methodology and sampling

The household survey was conducted between November and December 2015 by the International Institute of Tropical Agriculture (IITA) in collaboration with the Zambia Agriculture Research Institute (ZARI) Postharvest Unit. Five districts of the project, "Support to Agricultural Research for Development of Strategic Crops in Africa (SARD-SC)" were selected, namely Kasama in Northern Province, Samfya and Mansa in Luapula Province, Serenje in Central Province and Kaoma in Western Province,

2.1 Data collection instrument

Primary data were collected by the use of a structured questionnaire (see Electronic Supplementary Material). The survey instrument was developed and finalised by October 2015 and was field pre-tested on a randomly selected sample of 15 farmers in Chongwe district. Chongwe is a moderately cassava growing district where cassava processing and utilization has been taking place in the community. The objective of the pre-test was to get feedback from the respondents and adjust the instrument to collect quality data. After pre-testing, the instrument was reviewed to address issues of clarity, sequencing and appropriateness of questions as well as gaps that were identified. The final questionnaire had12 main sections with a total of 316 questions.

Sections 1 and 2 Identification, Household Composition and Characteristics sought information on the household head, location of the household and an understanding of the availability of farm labor. Specifically, this last was to collect information on labor, which could contribute effectively to agricultural production and processing operations as well as the age range of household members that had a direct effect on the rate of agricultural development. Youthful farmers are open to new innovations because they are not risk averse. If a large proportion of the respondents in both male- and female-headed households fall within the productive age groups, this can contribute to accelerated growth of the cassava subsector by way of introducing improved processing technologies and utilization.

Section 3 Social Capital and Networking sought information on membership of households in cooperatives and other important farmer organizations. Membership of social networks helps members to realize economic benefits (Rogers 1995 and Wossen et al. 2013). Organized farmer groups or other organizations were also targeted for access to agricultural inputs and new innovations and technologies through provision of capacity building activities by both extension service and development partners, which could not be accessed individually.

Section 4 on cassava processing and section 5 Knowledge on Processing Methods sought information on the involvement of households in cassava processing and the time of year cassava was processed: also, to gain knowledge of the methods employed and whether households knew about any other methods of processing cassava.

Sections 6 and section 7 Cassava Utilization and Selling as well as final products of cassava processing sought information on the products the households derived from cassava, what was consumed and what was sold; and the proportion of total household income derived from sales of cassava products.

Section 8 Gender Involvement in the operations, sought information on how family labor, according to gender, participated in harvesting, processing and selling of cassava products.

Section 9 Cassava Fields and Yields sought information on the number of cassava fields a household cultivated, the area planted and the average yield per hectare. Availability of land for cassava farming enhanced agricultural sector development and increased productivity and livelihoods of the land users. Farm size and fragmentation of fields have direct influences on the availability of cassava roots for processing, food security and income generation as well as application of technologies. Cassava yield is also an important attribute among the cassava growers because it entails food security and increased income levels.

Section 10 Harvest Losses, Labor, Input Time and Cost in Relation to Processing sought information on the periods of the year when harvest losses were highest as well as the main source of labor for operations from harvesting to drying and their associated costs.

Sections 11 and 12 Constraints in Processing and Preference Tools. These sections looked at the constraints that affect

cassava processing from harvesting to drying and the most preferred tools used for each operation at the household level.

2.2 Developing the sampling frame and sample selection

A stratified random sampling procedure was used independently in each of the five target districts with a total sample size of 300 households. Three agricultural camps per district were sampled, making a total of fifteen camps that were randomly sampled in the selected five agricultural blocks. An agricultural block is a unit in the agricultural sector encompassing several agricultural camps while an agricultural camp is a small unit in the agricultural sector where farmers are grouped around agricultural extension service provision with an extension officer.

To sample the 300 households, lists of farmers in the camps under study were generated. This was done with the help of the village headmen (traditional leaders) and the Camp Extension Officers (CEO). The lists generated were the sampling frame. Using random numbers, a minimum of 20 households were sampled from the list in each camp.

A structured questionnaire was developed and administered to a minimum of 20 households per selected camp, making the final 300 households. Data generated were statistically analyzed using SPSS (version 16).

2.3 Study framework

This section outlines the conceptual considerations that have informed the study. The study applies the value chain approach as the theoretical model that guided the study and was used for the development of the questionnaire and choice of variables used in generating questions for answering the study objectives. In this study, the value chain analytical framework was used to understand various aspects of cassava processing and utilization at household level. Focus was on the identification of critical processing issues at the processing stage and constraints that undermine the utilization of cassava in different forms. According to Kaplinsky and Morris (2001), a value chain is defined as "the full range of activities which are needed to bring a product or service from conception, through the different phases of production (involving a combination of physical transformation and the input of various producer services), delivery to final consumers, and final disposal after use".

This definition highlights the importance of value addition at each stage of the value chain and treats production as one of several activities within the chain.

Value chains as a conceptual framework is increasingly being appreciated and used by policy makers, researchers and practitioners as a tool for understanding and structuring the way in which markets and relationships are connected (UNIDO 2009). Development of agricultural value chains has the possibility of building sustainable relationships among participants as well as improving food security, such as through increased incomes of smallholders and reduction of post-harvest losses. The framework also enables examination of information flows and dynamics, such as between and within gender relations. This is important in cassava processing when determining the gender that is involved at various stages of processing and product development of cassava-based products. Previous value chain research has been criticized for not considering the gender issues or other economic, political and environmental aspects that affect value chains (Bolwig et al. 2008).

3 Results and discussion

3.1 Household characteristics

The socioeconomic characteristics of the survey households are presented in Table 1. The average age of the household head (HH) was 48 years with 33% of the households being male headed and an estimated 20.0% being female headed. The remainder were dual-headed. Educational levels of HHs were low as a total of 63% had either only primary or no education. Just over half (55%) of the HHs had had only 7 years of formal education. Around 28% had had lower secondary education while a mere 7% had higher secondary education. However, only 9% of the respondents indicated that they had not received any form of formal education and could neither read nor write. Most of the respondents were literate to at least primary education level. However, level of education of the HH is important in explaining access to processing advice. Those without formal education are less likely to access processing advice and this could explain the level of knowledge on processing methods and equipment. Though adoption of new technologies is a complex process, influenced by both extrinsic and intrinsic variables, education is one of the household–specific factors affecting adoption. Higher levels of education of famers increases their ability to obtain, process and use relevant information in adopting new technology (Mwang and Kariuki 2015). Other studies have reported that higher education influences respondents' attitudes and thoughts and this has made them rational and able to critically analyze the benefits of the new technology (Waller et al. 1998; Uematsu and Mishra 2010).

3.2 Membership of farmer groups and motivation

The average length of time the HHs had lived in the village was 25 years, showing high social capital and networking in the village (Table 2). Arega et al. (2013) reported that social

Table 1 Mean values of household demographics in survey districts

Characteristics	District					All
	Serenje (n = 60)	Samfya (*n* = 60)	Mansa (n = 60)	Kasama (n = 60)	Kaoma (n = 60)	(*n* = 300)
Household demography						
Male-headed households (%)	48.3	30.5	31.1	35.0	21.7	33.3
Female-headed households (%)	20.0	23.7	16.4	13.3	26.7	20
Dual-headed household (%)	31.7	45.8	52.5	51.7	51.6	46.7
Average Age of Male Headed	40.6 (2.16)	44.6 (2.72)	42.8 (2.89)	47.2 (3.22)	52.4 (4.69)	44.7 (1.35)
Average Age of Female Headed	52.6 (3.33)	54.6 (4.54)	47.9 (5.07)	46.5 (4.89)	39 (3.27)	47.8 (1.96)
Average Age of Dual Headed	43.7 (2.67)	44.4 (2.31)	42.8 (2.51)	46.7 (2.00)	52.7 (2.63)	46.3 (1.12)
Age of the household head (years)	43.9 (1.58)	46.9(1.78)	43.7 (1.78)	46.8 (1.63)	48.9 (2.03)	47.6 (0.79)
Household size (#)	7.5 (0.51)	6.9 (0.32)	6.2 (0.33)	7.1 (0.34)	6.8 (0.38)	6.9 (0.17)
Male household members (#)	3.5 (0.33)	2.4 (0.25)	3.36 (0.23)	3.5 (0.22)	3.4 (0.27)	3.2 (0.12)
Female household members (#)	3.9 (0.29)	2.6 (0.26)	2.6 (0.24)	3.6 (023)	3.2 (0.24)	3.2 (0.12)
Children <15 (#)	3.8 (0.41)	3.8 (0.24)	3 (0.21)	3.4 (0.27)	3.2 (0.25)	3.4 (0.28)
Active Age Group >15 ≤ 64 (#)	3.5 (0.23)	2.7 (0.21)	2.7 (0.27)	3.3 (0.19)	3.5 (0.33)	3.1 (0.25)
Elderly >64 (#)	0.2 (0.06)	0.15 (0.05)	0.3 (0.16)	0.6 (.23)	0.3 (0.17)	0.31 (.13)
Single household head (%)	1.7	0.0	5.0	3.3	15.0	5.0
Married household head (%)	78.3	79.7	81.9	85.0	70.0	78.98
Divorced household head (%)	6.7	3.4	3.3	1.7	6.7	5.7
Widowed household head (%)	13.3	16.9	9.8	3.3	8.3	10.32
Education of household head						
Tertiary education (%)	0	0	8.2	0	0	1.6
Higher secondary (%)	3.3	6.8	11.5	10	1.7	6.6
Lower secondary (%)	26.7	25.4	34.4	30	25	28.3
Primary (%)	60	59.3	42.6	53.3	58.3	54.7
None (%)	10	8.5	3.3	6.7	15	8.7

Figures in parenthesis are estimates of standard error of means

Table 2 Membership of farmer group and social capital

	District					All
	Serenje	Samfya	Mansa	Kasama	Kaoma	
Membership of group						
Yes (%)	91.7	59.3	59.0	71.7	63.3	69
Association (group) type						
Cooperative (%)	86.7	44.2	41.7	70	55	59.9
Farmer Association (%)	1.7	9.6	10	0	1.7	4.5
CBO (%)	0	7.7	6.67	0	0	2.7
Womens' Club	0	1.9	0	0	3.3	1
Does Not Belong (%)	6.7	21.2	35	30	35	25.7
Other (%)	5	15.4	6.67	0	5	6.2
Motivation						
Easy access to credit	5	23.1	18.3	0	1.7	9.3
Easy access to inputs	83.3	28.9	26.7	33.3	60	46.9
Group selling of cassava	0	1.9	1.7	0	0	0.68
Training and learning	3.3	13.5	10	35	0	12.3
Other	0	5.8	3.3	3.3	1.7	2.8
Not Applicable	8.3	26.9	40	2	36.7	28.1
Socio capital						
Years respondent living in village	3.0(0.99)	17.8(3.02)	12.9(1.70)	7.0(1.91)	1.3(0.59)	7.9(0.84)
Years household head living in village	19.6(2.12)	26.5(2.89)	22.4(2.21)	27.2(1.92)	28.6(2.36)	24.8(1.04)

Table 3 Cassava processing and reasons for processing

	District					All
	Serenje	Samfya	Mansa	Kasama	Kaoma	
Cassava processing & reasons for processing						
Cassava processing (%)	91.7	100	100	91.7	100	96.7
Income (%)	2.0	13.6	4.9	1.7	0	4.3
Consumption (%)	53.3	33.9	21.3	30.0	30.0	33.7
Both consumption & income (%)	36.7	52.5	73.7	61.7	66.7	58.3
Other (%)	8.3	0	0	6.7	3.3	3.7

capital, mostly in the form of groups, especially in rural areas, is used for mutual aid around the globe.

At least 69% of the respondents showed that some members of the active age group (15–65 years of age) in the household belonged to either a formal or informal farmer organization. Sixty percent of households belonged to a cooperative, which was the most common type of farmers' organization. Serenje District had the highest percentage of respondents (92%) that belonged to an association.

From the respondents that belonged to some association, 47% were motivated to join on account of access to inputs — fertilizer and seed. Approximately 12% reported receiving training and learning from other group members was their motive for joining groups. Fewer than 1% of the households joined an association to promote selling of their cassava through the group, indicating that there was little cassava commercialization. Most farmer groups were formed with the purpose of accessing subsidized inputs (fertilizer and seed) through the Farmer input support programme (FISP). Adong et al. (2012) reported that the purpose of farmer groups is to allow farmers to access market and credit information as well as other important agricultural information. According to Kariuki and Place (2005), farmers can also try out new agriculture technologies using pooled resources in groups and, in the process, create opportunities to learn from research and from one another. Furthermore, groups enable farmers to receive help from economies of scale through bulk selling of their produce.

3.3 Cassava processing and reasons for processing

The results presented in Table 3 show that about 97% of the respondents were engaged in cassava processing. Primarily, cassava needs to be processed into various forms to increase the shelf life of the products and improve palatability (Hahn and Keyser 1985). Processing reduces food losses and stabilizes seasonal fluctuations in the supply of the crop. A total of 4% of households were involved in processing for income, 34% for consumption and 58% for both income generation and consumption. The present results show clearly that very few households process cassava for income only. Samfya District had the highest percentage (13%) of respondents who processed cassava solely for income. This could partly be explained by the overwhelming number of fishing camps around the District. Fishermen from across the islands tend to provide a market for the processed cassava in Samfya.

Cassava is not processed solely for income in any district, implying that it is cultivated as a food security crop with only the surplus sold to generate income. Serenje District had the highest number of households (53%) processing cassava only for consumption, which was above the average (34%) across all districts. This corroborated the literature findings of GRZ (2010) that reported over 800,000 tons of cassava produced were for home consumption and only 8% was marketed for income (Sitko et al. 2013). This is contrary to findings in Nigeria and Cameroon where cassava is becoming an income generating crop (Hahn and Keyser 1985). In Nigeria and Cameroon about 60% and 50% of households' cassava output was sold for processing, respectively (Okezie et al. 1988).

3.4 Gender involvement in processing

Three groups (females, males and females + males) were involved in various stages of cassava processing at the household level (Table 4). Gender participation is a term that describes the roles and activities of men and women according to the traditions and beliefs of a culture (Buckland 1993). Male and female processors took part in the various stages of processing. Peeling was performed by females (52%) alone, 4% by males, while 44% of the HHs sampled showed

Table 4 Gender involved in various stages of processing

Processing steps	Male	Female	Both
Peeling (%)	3.7	52.3	44
Soaking (%)	4	63.6	32.4
Chipping (%)	3	73.7	23.3
Grating (%)	1	45	54
Pressing (%)	1.3	45.2	53.5
Drying (%)	4	67.2	28.8
Pounding (%)	6	76.9	17.1

Table 5 Most common methods of processing cassava

Processing methods	District					All
	Serenje	Samfya	Mansa	Kasama	Kaoma	
Bwabi/Kuombeka (%)	95.0	69.5	96.7	93.3	51.7	81.3
Kapesula/Kandalya (%)	25.0	5.1	81.9	28.3	66.7	41.7
Kasabe (%)	16.7	81.4	22.9	33.3	26.7	36
Chisole (%)	0	0	1.6	0	18.3	4
Mang'ende (%)	0	0	0	0	33.3	6.7

that both females and males performed peeling together. Similarly, females were more involved in soaking (63.3%), chipping (74%) and drying and pounding (70%). On average, males were involved in less than 10% of cassava processing activities across all districts. This division of labor among the sexes is in agreement with Fapojuwo (2007), who reported that most cassava processing activities were carried out by females and where their activities showed low participation this might be because their children were involved. Women involvement in processing is estimated to be as high as 85% in Zambia and this agrees with Farnworth et al. (2011), who did not, however, disaggregate gender involvement in the various processing procedures. There is therefore a need to motivate male participation in cassava processing and in processing agricultural products in general, which should not be seen exclusively as a female job.

3.5 Processing methods

Processing techniques and procedures differ with countries and localities within a country according to food cultures, environmental factors, the cassava varieties used, and the types of processing equipment and technologies available (Hahn and Keyser 1985). The most common method of processing in Zambia is "bwabi" (81%) followed by "kapesula" (42%) and "kasabe" (36%) (Table 5). "Bwabi" involves peeling fresh cassava and soaking it in water for a period of between 2 and 6 days and sun drying it. However, "kapesula" processing involves peeling, sun drying for at least two days and soaking in water for 1–2 days before sun drying for the second time. Drying in the sun is common because it is simple and does not need fuelwood. The key attribute of "kapesula" is its long shelf life and good storability. The practice of drying cassava either naturally under the sun or artificially in ovens is meant to improve the shelf life of tubers and reduce postharvest losses (Oghenechavwuko et al. 2013). Drying is one of the simplest and most common methods in the different processing stages of cassava.

On the other hand, "kasabe" involves chipping fresh peeled cassava roots which are then mixed with a starter culture (fermented cassava) to begin the fermentation process. The product is usually dark in color and has a strong fermented odor. The "kapesula" process was less commonly used in Samfya (5%) where households would rather use the "kasabe" process (81%), the product being mostly used for their own consumption.

3.6 Processing tools used by households

Traditionally, cassava processing does not need sophisticated equipment. The most common tool for peeling cassava in Zambia is the kitchen knife, used by 90% of the respondents. This agreed with the observation of Abass

Table 6 Processing tools most commonly used by households

	District					All
	Serenje	Samfya	Mansa	Kasama	Kaoma	
Processing Tools used by HH						
Knife (%)	95	98.3	98.4	73.3	83.3	89.7
Mortar (%)	95	96.6	77.1	95	100	92.7
Ichinkolobondo (%)	15	94	18	32	2	32.2
Reed Baskets (%)	41.7	71.2	72.1	86.7	78.3	70
Reed Mat (%)	83.3	89.3	60.7	63.3	96.7	78.7
Winnower (%)	70	38.9	54.1	75	78.3	63.3
Drums (%)	81.7	39	52.5	20	70	45
Buckets (%)	85	77.9	68.9	58.3	18.3	61.8

Table 7 Knowledge and usage of improved processing equipment in the survey area

	District					All
	Serenje	Samfya	Mansa	Kasama	Kaoma	
Aware of processing equipment by HH						
Mechanical peeler (%)	28.3	35.6	24.6	15	26.7	26
Hydraulic presser (%)	20.0	30.5	18.0	8.3	48.3	25
Cassava chipper (%)	20	27.1	16.4	13.3	36.7	22.7
Cassava grater (%)	13.3	25.4	22.9	10	28.3	20
Cassava dryer (%)	21.7	25.4	22.9	10	40	24
Hammer mill (%)	98.3	96.6	83.6	93.3	51.7	84.7
Processing equipment used by HH						
Mechanical peeler (%)	6.7	0	6.6	0	2	3.1
Hydraulic presser (%)	3.3	3.4	0	0	0	1.3
Cassava chipper (%)	5	0	3.3	0	1.7	2
Cassava grater (%)	5	0	3.3	0	0	1.7
Cassava dryer (%)	5	5.1	8.3	3.3	0	4.3
Hammer mill (%)	88.3	81.4	80.3	71.7	21.7	68.7

(2008), who reported that cassava processing was still done in the traditional way in Zambia. About 45% of the respondents showed they used open drums for soaking cassava and 62% said that they use buckets to fetch water used for soaking. Samfya District reported the highest percentage (94%) in using "Ichinkolobondo", a mortar with an extended surface area mostly used for processing "kasabe". Approximately 79% of the respondents indicated they used reed mats for drying cassava (Table 6) and this showed that most of the farmers observed basic food safety rules by not drying on the bare floor. If there were to be an improvement in the economic value of cassava in Zambia at household level, the adaptability of each processing stage to mechanization would be very important. Slight changes in the equipment used in processing could help to reduce or remove the discomfort, health hazard, and drudgery for the operating women However, it has been suggested by Hahn and Keyser (1985) that the first step to take for improvement of cassava technology should be to improve or change the simple processing equipment or systems presently used to accommodate the rural set up, rather than to change to entirely new, sophisticated, and expensive equipment.

3.7 Knowledge and usage of improved processing equipment

In comparison to commonly used processing tools and equipment, households are using more traditional cassava processing tools rather than improved cassava processing equipment. The level of knowledge and usage of such equipment was low among respondents across all districts (Table 7). The hammer

Table 8 Forms of cassava consumption by household

	District					All
	Serenje	Samfya	Mansa	Kasama	Kaoma	
Forms of cassava consumption						
Raw cassava (%)	98.3	100	95.1	100	35	85.7
Boiled cassava (%)	96.7	96.6	100	98.3	23.3	83
Roasted cassava (%)	98.3	94.9	100	98.3	35	85.3
Fried cassava chips (%)	90	40.7	93.4	38.3	21.7	57
Cassava nshima (%)	93.3	94.9	100	96.7	46.7	86.3
Cassava & maize nshima (%)	98.3	89.8	98.4	96.7	28.3	82.3
Cassava leaves (%)	98.3	91.5	98.4	98.3	85.7	86
Cassava leaves with groundnut (%)	98.3	98.3	91.8	98.3	38.3	85
Cassava leaves with soy (%)	20	5.1	8.2	5	45	16.7

Table 9 Cassava secondary products consumed/produced by household

	District					All
	Serenje	Samfya	Mansa	Kasama	Kaoma	
Cassava secondary products Consumed/produced by HH						
Cassava bread (%)	5	0	6.6	0	48.3	12
Cassava buns (%)	3.3	1.7	1.6	1.7	61.7	14
Cassava fritters (%)	6.7	10.2	9.8	3.3	61.7	18.3
Cassava cake (%)	0	1.7	4.9	0	61.7	13.7
Cassava biscuits (%)	0	1.7	3.3	0	41.7	9.3
Cassava beer (local brew) (%)	0	11.8	18	10	60	20

mill was the most common equipment that respondents were aware of (85%) and used often (69%), while the cassava grater was the least known (20%). Kaoma district had the least usage of hammer mill services (22%) whereas Serenje had the highest (88.3%). The higher level of awareness and usage of a hammer mill among the respondents could be due to the common usage of the equipment for milling of maize to make mealie meal. Most often, cassava flour is blended with maize meal before cooking into 'cassava-nshima'.

3.8 Forms of cassava consumption

The different forms of cassava consumption (utilization) are presented in Table 8. Eighty-six percent of respondents consumed cassava as a raw snack and 85% consumed it boiled and as a roasted snack. Only 57% of the respondents consumed cassava as a fried snack. Two types of nshima were reported — Type 1 was prepared solely from cassava meal and Type 2 was prepared as a blend of cassava and maize meal. Nshima Type 1 was the most common form consumed (86%). Approximately 86% of the respondents consumed cassava leaves prepared with cooking oil, while around 85% of the respondents consumed cassava leaves prepared with groundnut powder and only 17% consumed cassava leaves prepared with soybean. Kaoma District had the lowest level of cassava consumption in all forms apart from cassava leaves prepared with soybean (45%). To promote cassava and its commercialization, there is a need to promote a wide range of cassava-based products to improve consumption and utilization in its various forms.

3.9 Cassava secondary products at household level

The assessment results of cassava secondary products either produced or consumed by the households showed that there were extremely low levels of production of secondary products. Cassava fritters (18%) were notable amongst the secondary products. Around 20% of the respondents indicated that they consume a local cassava brew. The local brew is mostly produced in Kaoma and Mansa, 60% and 18% respectively (Table 9). Kaoma District had the highest level of consumption of cassava secondary products. This could be part of the reason for the observed low level of cassava use in its primary form in the district. There is minimal diversity in the way cassava is consumed or its derivatives in all districts. This is despite the level of effort that has been put in through past projects to train women and youth to process and utilize cassava in diverse ways (Simwambana 2005) in cassava growing regions. The cassava strategy document, developed in 2010, had, as one of its aims, promotion of cassava diversification and utilization at both household and industry levels, but the present study shows clearly that this objective has not been achieved. This calls therefore for further efforts to be made.

4 Conclusion

This study has shown that there are still low levels of awareness of cassava processing equipment and their use. Hence cassava processing in Zambia is still rudimentary and laborious, and is mostly done by women still using traditional tools, i.e., knives, mortar, drums etc. There is a considerable need to promote a wide range of cassava-based products to increase their consumption and utilization. Gender friendly tools and equipment aimed at improving processing at the household level will improve livelihoods of rural communities. This action will not only bring about efficiency but also raise the interest of men and get them involved in cassava processing activities. Greater effort is needed to support the introduction of efficient equipment to improve the processing methods as cassava demand is ever increasing in the country at both household and industrial levels. The little knowledge of cassava product diversity and the low usage of improved cassava equipment are challenges to cassava processing and utilization. Households need to be encouraged to join farmers' groups, not only to benefit from agro-inputs, but more importantly to gain access to new processing technologies. The

present results call for greater efforts to improve processing methods and to develop products in line with the Government's demand for promotion of the cassava subsector in order to diversify and improve the agricultural economy.

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Compliance with ethical standards

Conflict of interest The authors declare that there is no conflict of interest about the publication of this paper.

References

Abass, A. (2008). Recent developments in cassava processing, utilization and marketing in East and Southern Africa and lessons learned. Paper presented at the FAO Expert Consultation Meeting held at the Natural Resources Institute, University of Greenwich, United Kingdom. http://projects.nri.org/gcpmd/files/1_Abass_paper.pdf.

Adong, A., Mwaura, F., Okoboi, G. (2012). What factors determine membership to farmer groups in Uganda. Evidence from the Uganda census of Agriculture 2008/09. Economic Policy *Research Centre (EPRC)*, Research Series No. 98.

Arega, D. A., Khataza, R., Chibwana, C., Ntawuruhunga, P., & Moyo, C. (2013). Economic impact of cassava research and extension in Malawi and Zambia. *Journal of Development and Agricultural Economics, 5*, 457–469.

Bolwig, S., Ponte, S., du Toit, A., Riisgard, L. & Halberg, N. (2008). 'Integrating poverty, gender and environmental concerns into value chain analysis: A conceptual framework and lessons for action research', DIIS working paper 2008/16. Copenhagen: Danish Institute for International Studies. Printed in Denmark by Vesterkopias ISBN: 978–87–7605-275-1. https://www.econstor.eu/bitstream/10419/44670/1/573597499.pdf.

Buckland, L. (1993): Gender Analysis in Agricultural Production: IITA Research Guide Vol. 58. pp 6–14.

Chitundu, M., Droppelmann, K., Haggblde, S. A. (2006). Value chain task force approach for managing Private-Public Partnerships: Zambia's task force on acceleration of cassava utilization. International development collaborative working paper No. 21, Food Security Research Project, Lusaka, Zambia. http://www.aec.msu.edu/agecon/fs2/zambia/index.htm.

Fapojuwo, O.E. (2007). Gender Participation in Cassava Processing Activities in Ayetoro Area of Ogun State. Paper prepared for presentation at the Farm Management Association of Nigeria Conference (FAMAN Conference 2007), Ayetoro, Nigeria, September 4–6, 2007. https://ageconsearch.umn.edu/record/54387?ln=en. pp 9.

Farnworth, R. C, Akamandisa, M.V., Hichaambwa, M. (2011). Zambia feed the future gender assessment. United States for International Development (USAID) Report, pp 63. https://static1.squarespace.com/static/551bb3ade4b04041100c31678/t/5628f381e4b0b08f4a3ea876/1445524353383/Farnworth+Akamandisa+Hichaambwa+Feed+the+Future+Gender+Assessment.pdf.

Government of the Republic of Zambia (GRZ) (2010). Zambia cassava sector development strategy 2010–2015. pp 90. Lusaka, Zambia. www.intracen.org/Workarea/DownloadAsset.aspx?id=69309.

Haggblade, S. and Nyembe, M. (2007). Commercial Dynamics in Zambia's Cassava Value Chain. Cassava Transformation in Southern Africa (CATISA). Startup Task 3. Report on Zambia's Cassava Value Chain. https://www.researchgate.net/publication/23535493.

Hahn, S. K., & Keyser, J. (1985). Cassava: A basic food of Africa. *Outlook on Agriculture, 4*, 95–100.

Kaplinsky, R., Morris, M. (2001): A Handbook for Value Chain Research, paper prepared for the IDRC, http://www.ids.ac.uk/ids/global/pdfs/VchNov01.pdf.

Kariuki, G., Place, F. (2005). Initiatives for rural development through collective action: The case of household participation in group activities in the high lands of Central Kenya, CAPRi working paper # 43. International food policy research institute 2033 K street, N.W. Washington, D.C. 20006 U.S.A. pp 45. https://core.ac.uk/download/pdf/6242728.pdf.

Mwang, M. and Kariuki, S. (2015). Factors determining adoption of new agricultural technology by smallholder farmers in developing countries. Journal of Economics and Sustainable Development. Vol.6, No.5. ISSN 2222–1700 (Paper).

Nielson, H. H. (2009). The role of cassava in smallholder maize marketing in Zambia and Mozambique. MSc thesis. In *Michigan State University*. MI: East Lansing.

Oghenechavwuko, U. E., Saka, G. O., Adekunbi, T. K., & Taiwo, A. C. (2013). Effect of processing on the physico-chemical properties and yield of gari from dried chips. *Journal of Food Processing and Technology., 4*, 255. https://doi.org/10.4172/2157-7110.1000255.

Okezie, B. O., Proctor, C. M., & Numfor, F. (1988). Tropical root and tuber crops storage, processing and utilization in Cameroon-a diagnostic survey report. *Tropical Roots and Tubers Research Project, USAID Contract No.*, 631–005 117 pp.

Rogers, E. (1995). Diffusion of innovations (4th ed.). The Free Press, A Division of Macmillan Publishing Co., Inc. 866 Third Avenue, New York, N. Y. 10022. Collier Macmillan Canada, Inc. pp 375.

Simwambana, M. (2005). A study on cassava promotion in Zambia. Report. URL: http://fsg.afre.msu.edu/cassava/simwambana_Cassava_StudyFinal_Report_October_2005.pdf

Sitko, N.J., Chapoto, A., Kabwe, S., Tembo, S., Hichambwa, M., Lubinda. R. (2013). Technical compendium: Descriptive agricultural statistics and analysis for Zambia in support of the USAID Mission's Feed the Future Strategic Review. URL: http://fsg.afre.msu.edu/zambia/wp52.pdf. Accessed December 2016.

Uematsu, H., Mishra, A., (2010). Can Education Be a Barrier to Technology Adoption? Selected Paper prepared for presentation at the Agricultural & Applied Economics Association 2010 AAEA, CAES, & WAEA Joint Annual Meeting, Denver, Colorado, 25–27. https://www.researchgate.net/publication/254383748.

UNIDO (2009) 'Agro-value chain analysis and development – The UNIDO approach', staff working paper, Vienna: United Nations Industrial Development Organization, pp 73. https://www.unido.org/sites/.../Agro_value_chain_analysis_and_development_0.pdf.

Waller, B., Hoy, W., Henderson, L., Stinner, B., & Welty, C. (1998). Matching innovation with potential users: A case study of potato IPM practices. *Agriculture, Ecosystems and Environment., 70*, 203–215.

Wossen, T., Berger, T., Mequaninte, T., & Alamirew, B. (2013). Social network effects on the adoption of sustainable natural resource management practices in Ethiopia. *International Journal of Sustainable Development & World Ecology, 20*(6), 477–483.

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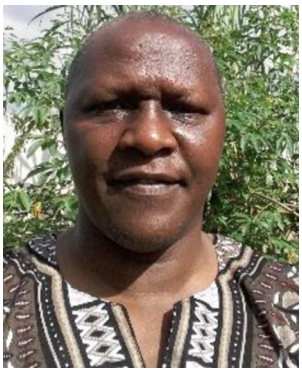

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