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Value Chain Mapping and Cost Structure Analysis for Cassava in Zambia

Paola Cadoni

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Disclaimer

The views expressed in this working paper are those of the author and do not necessarily reflect those of the Food and Agriculture Organization of the United Nations.

List of acronyms

Acceleration of Cassava Utilization (ACU)
Programme Against Malnutrition (PAM)
AAACP All ACP Agricultural Commodities Programme
ACP Africa Caribbean and Pacific
CSO Central Statistics Department
FAO Food and Agriculture Organisation of the United Nations
HQCF High Quality Cassava Flour
ITC International Trade Centre
RTIP Root and Tuber Improvement Programme

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1. Background

This analysis is framed within the work of the All ACP Agricultural Commodities Programme (AAACP), funded by the European Union. Launched in 2007, the overall objective of the AAACP is to improve incomes and livelihoods for ACP producers of traditional and other agricultural commodities, and to reduce vulnerability at both producer and macro levels. The specific objective is to build the capacity of stakeholders along the value chain to conceive and implement sustainable commodity strategies.

As a follow up to the kick-off workshop for Eastern and Southern Africa in Dar es Salaam (June 2008) and consultation with stakeholders in Zambia, the Zambian Ministry of Agriculture requested the International Trade Centre (ITC) and FAO to conduct a sector strategy development and formulation process for the cassava sector in Zambia. In April 2009, FAO and ITC undertook a first consultative mission to Zambia and met with relevant stakeholders and members of the Zambian Cassava Task Force.

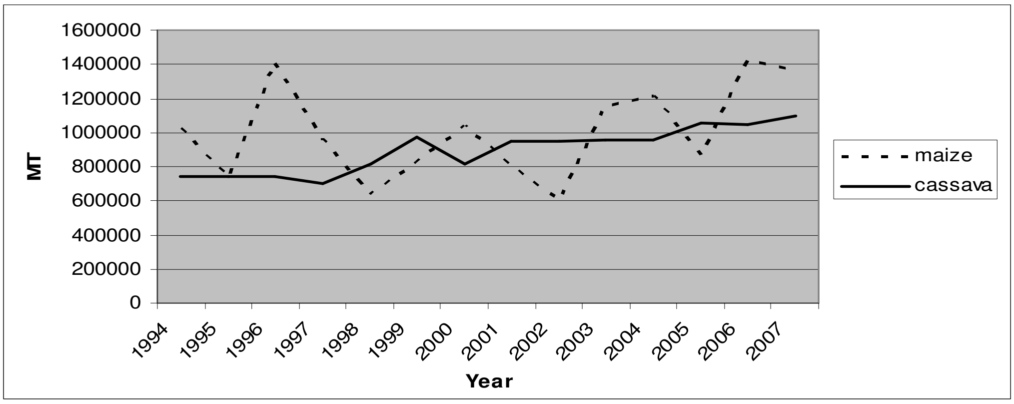
Following a review of available material and extensive consultations, stakeholders identified the need for further analysis related to the mapping and cost structure of the cassava value chain in Zambia, to facilitate the determination of appropriate interventions in support of the sector strategy development.

Following a literature review and some indications on the objectives of the study, this paper is divided into two main sections. The first is dedicated to the analysis of cassava-producing farmers, examining their production patterns, cost structure and market participation. The second main section focuses on formal processors of cassava in Zambia, investigating three different supply channels: industrial production, human consumption and animal feed.

2. Literature review

Until the mid-1990s, maize was the dominant staple food in Zambia, planted on 70 percent of total crop area (Howard and Mungoma 1996). Since then, the combination of two factors has resulted in the rise of cassava from a predominantly food security crop to an increasingly commercial food staple. These factors are: (i) high dependency of maize production on government intervention on maize market and (ii) cassava drought resistance (Barratt et al. 2006). In the past decade, while maize went through erratic production trends, due in part to stop-and-go government subsidies and in part to drought (see Chart 1), cassava production has grown steadily (Howard and Mungoma 1996). Maize is currently still the main food staple in central and southern Zambia, while cassava consumption is prominent in northern and western areas of the country (Haggblade and Zulu 2003). The Zambian Central Statistics Department (CSO) estimates that 3,280,834 tonnes of fresh cassava roots (820,208 tonnes flour equivalent) were produced in Zambia during the 2008/09 agricultural season.

Chart 1: Maize vs. Cassava Production, 1994-2007



Source: FAOSTAT

The release by Zambia's Root and Tuber Improvement Programme (RTIP) of new cassava varieties which are early maturing, high yielding and disease resistant, contributed to the rise of cassava as a commercial crop (Haggblade and Nyembe, 2007). RTIP released three improved local varieties in 1993/94: Bangweulu, Kapumba and Nalumino (Chitundu and Soenarjo 1997) and four new varieties in 2000: (Simwambana et al. 2004) (Table1). Their yielding potential is calculated to be on average four times higher than local varieties, while their maturing time is up to half that of the different local varieties (Chitundu and Soenarjo, 1997).

Table 1. New Cassava Varieties Released in Zambia

Variety	Type	Released	Yield (tonnes/ha)	Taste
Bangweulu	cleaned	1993	31	Bitter
Kapumba	cleaned	1993	22	Sweet
Nalumino	cleaned	1993	29	Bitter
Mweru	bred by RTIP	2000	41	Sweet
Chila	bred by RTIP	2000	35	Bitter
Tanganyka	bred by RTIP	2000	36	Sweet
Kampolombo	bred by RTIP	2000	39	Sweet
Traditional	local variety		7	Bitter

Source: Chitundu and Soenarjo (1997) and Simwambana et al. (2004). All yields refer to research station observations using no purchased inputs but following recommended agronomic practices. Yields were measured 16 months after planting.

However, despite the growth in production levels, commercialization of cassava based products through formalized industrial channels is still in its infancy (Nweke et al. 2004). An increase in demand from different sources (food processing industries, livestock feeds or industrial starch users) could potentially provide a stable market for the increasing cassava supply, which is often unexploited. Generally, cassava remains unharvested until market opportunities arise. Available literature suggests that only 8 to 10 percent of the cassava crop is currently marketed, and that more efficient production methods are required to lower production costs, to make cassava viable as a commercial crop (Haggblade and Nyembe, 2008).

In recent years, the development of value chain analysis applied to markets in developing countries has become particularly relevant for the cassava sector in Zambia (Evans 2004; Ashley, Mitchell 2009). A partnership of public and private stakeholders created the Accelleration of Cassava Utilization (ACU) Task Force in 2006, to develop strategies to tackle the issue of underutilisation of cassava potential using a value chain approach. The value chain task force process (Chitundu, Droppelmann, Haggblade 2006) later developed the basis for the cassava sector strategy developed within the AAACP Programme, which aims at engaging supply chain actors in a participatory analytical process.

There are five main supply channels identified within the cassava value chain in Zambia: (1) subsistence production, (2) marketed fresh cassava for human consumption, (3) processed cassava for human consumption, (4) livestock feed, (5) industrial uses. This study focuses on channels 3, 4 and 5, which, according to available literature, together account for 5 to 10 percent of total cassava production, and hold the main potential prospects to drive the commercial growth of the cassava sector in the country, both in the short and longer term (Chitundu, Droppelmann, Haggblade 2006).

According to ACU estimates, the livestock feed supply channel has the highest chances of commercial development in the short term, with the potential of stimulating an increase of 15 percent in cassava national production - equivalent to an increase of 90,000 to 150,000 tonnes of fresh roots production (22,500 to 37,500 tonnes of cassava flour equivalent).

Similarly, ACU considers cassava-based processed food to have a high chance of commercial development in the longer term, depending on the investment in creating and marketing new products. Based on the example of Nigeria, the ACU calculated a potential of 10 percent substitution rate of blended maize flour with cassava. This could result in cassava-based convenience food accounting for up to 50 percent of total cassava consumption in the long term, the equivalent of 500,000 tonnes fresh cassava per year (125,000 tonnes cassava flour equivalent).

Among the industrial supply channels, the ACU estimates that cassava-based ethanol production should be able to absorb up to 100,000 tonnes of fresh cassava per year (25,000 tonnes cassava flour equivalent), while cassava-based sweeteners could absorb up to 40,000 tonnes of fresh cassava per year (10,000 tonnes cassava flour).

With an estimated 300 tonnes of cassava flour currently used in the paper/glue/wood industrial processing per year, the ACU suggests a role for the paper/glue/wood industry as an additional driver for cassava commercialization in the country (Chitundu, Droppelmann, Haggblade 2006; Haggblade and Nyembe 2008).

According to the ACU, the dominant forces driving change in each of the three supply channels are the innovative players at the top end of the chain. By expanding the use of cassava in their production, these players generate demand, thus creating growth opportunities for producers. However, a lack of trading standards, little market information, long distances, poor processing capacity, small volumes and high marketing margins are still significant constraints for the sector. (Chitundu, Droppelmann, Haggblade 2006).

The available literature provides a framework for understanding the three supply channels. This study aims to further develop this framework to provide a comprehensive mapping of current players in each channel, analyzing their role within the value chain, as well as identifying potential participants in the sector. Similarly, this study aims to provide an overview of market dynamics for farmers participating in the cassava value chain, and to provide an analysis of the costs involved in cassava production, with a focus on farmers' practices and sale patterns.

3. Objectives of the study

This study has two main objectives: First, to obtain a map of processors operating within the formal cassava industry in Zambia, with a focus on understanding market linkages across the value chain. The mapped processors belong to three specific supply channels. These channels are (a) necessary cassava for human consumption, (b) livestock feed, (c) industrial uses. Only formal industrial processors within those channels are included in the study. This selection excludes entities such as small-scale millers or households selling processed cassava for human consumption. The choice reflects the aim to investigate market potential of formalized channels only, and their linkages with different levels of the value chain. Second, to analyse the costs involved in producing cassava at farmers' level.

Consequently, this study has two main target groups. The first target is formal processors of cassava within the three supply channels. The second target is producers of cassava. The mapping focuses on processors, while the cost analysis concentrates on producers.

The mapping of actors within the cassava value chain in Zambia started in July 2009, and was completed in October 2009. Processors' and farmers' interviews took place in October 2009. Data analysis and elaboration was completed in January 2010.

4. Producer survey

4.1 Methodology

The primary objective of the producer survey is to understand the costs and returns associated with cassava production in Zambia, at the farm level. A concurrent goal of the study of producers is to collect information on farming practices, sale patterns and market linkages across the value chain, processing capacity and division of labour. The survey builds on observation of 74 farmers interviewed in Mansa and Samfya Districts (Luapula Province).

Luapula Province was selected as the centre of the producer survey for three main reasons. According to data from the Zambian Central Statistics Office (CSO), the Province has the highest number of households growing cassava. The Province has the largest diversity in terms of small, medium and large scale farmers within the country, with the highest number of large scale farmers (55), followed by Western (19) and Northern Province (12). The majority of cassava processors identified in the mapping indicated Luapula Province as the main source of raw material for their production. Additionally, the largest cassava-dedicated milling plant in the country, Tute Milling, is located in Luapula Province (Mansa). Its presence creates specific market dynamics and facilitates buyer-supplier linkages that are of interest for this study.

Table 2. Cassava Production by District

	Number of Households growing cassava	Area Under Cassava in Ha	Area under mature cassava	Quantity harvested in 12 months (tonnes)	Cassava root production (tonnes)	Flour Equivalent (tonnes)
Central	16,458	10,457	8,382	59,232	122,347	30,587
Copperbelt	3,366	1,090	1,027	5,531	12,755	3,189
Eastern	2,802	943	885	2,110	11,037	2,759
Luapula	118,040	94,236	48,589	427,161	1,102,557	275,639
Lusaka	624	693	691	1,106	8,112	2,028
Northern	103,354	106,452	59,220	428,096	1,245,487	311,372
North Western	45,067	37,861	19,457	160,844	442,976	110,744
Southern	1,261	426	17,923	5,542	4,988	1,247
Western	31,938	28,254	26,091	127,986	330,575	82,644
Total	**322,910**	**280,413**	**182,264**	**1,217,609**	**3,280,834**	**820,208**

Source: CSO, Household Survey 2008/09

Sampling of farmers selected for this study develops from the Agricultural Household Survey 2008/09, conducted by the Zambian Central Statistics Office (CSO). Through the analysis of the Household Survey, CSO obtained a sample of the cassava growing farmers among total interviewed households in Zambia, differentiating them into small (<5 Ha), medium (5 > 20 Ha) and large-scale farmers (>20 Ha)[1]. According to CSO sample survey (see Table 3), the province with the largest number of Households growing cassava is Luapula (118,040), followed by Northern (103,354) and North Western (45,067). The Total Area under cassava is largest in Northern Province (106,452), followed by Luapula (94,236) and North Western (37,861). According to CSO information, the quantity harvested in the last 12 months is largest in Northern (428,096), followed by Luapula (427,161) and North Western (160,844).

Table 3. Different scale of farmers across Zambian Provinces

	Farmer's Scale	Number of Households growing cassava	Area Under Cassava in Ha	Area under mature cassava	Quantity harvested in 12 months (MT)	Cassava root production (MT)	Flour Equivalent (MT)
Central	S,M	16,443	10,288	8,214	58,493	120,375	30,094
	L	14	169	168	739	1,972	493
Copperbelt	S,M	3,364	1,082	1,027	5,531	12,658	3,164
	L	3	8	0		97	24
Eastern	S,M	2,792	904	847	2,101	10,572	2,643
	L	10	40	38	9	465	116
Luapula	S,M	117,985	93,501	47,860	426,898	1,093,964	273,491
	L	55	734	729	262	8,593	2,148
Lusaka	S,M	621	220	220	1,099	2,578	645
	L	4	473	470	7	5,534	1,383
Northern	S,M	103,342	106,349	59,118	428,066	1,244,288	311,072
	L	12	102	102	30	1,199	300
North Western	S,M	45,066	37,861	19,457	160,844	442,970	110,742
	L	1	1	1	0	6	1
Southern	S,M	1,254	415	415	5,532	4,851	1,213
	L	7	12	17,508	10	137	34
Western	S,M	31,918	28,172	26,022	127,962	329,614	82,404
	L	19	82	69	24	961	240

Source: CSO, Household Survey 2008/09.

[1] Despite the official distinction between small, medium and large scale farmers, the information obtained by the CSO do not match this definition. Some of the farmers indicated as large scale have in fact less than 20 Ha under cassava. This is particularly clear in the CSO tables reported as Table 2, 3 and 4.

Overall, the numbers of households growing cassava in Samfya and Mansa are the highest within Luapula Province (Table 4): 29,035 farmers in Samfya and 24,673 farmers in Mansa. 74 farmers were interviewed in Luapula. Among those, 26 farmers were interviewed in Samfya (3 medium-scale and 23 small scale) and 48 in Mansa (1 medium scale and 47 small scale). Due to the need to access a sample of interviewees with a balance between farm's size, gender and volume of production, the sampling of farmers was not randomized. The DACO offices in both Districts assisted in targeting a diversified set of farmers for the survey. All farmers interviewed grow cassava for commercial purpose as well as household consumption. However, 7 percent of interviewees could not quantify returns associated to cassava sales, either because they had not started selling this year, or because they did not keep accurate records of sales.

Table 4. Cassava growers' characteristics in Luapula Province

		Number of Households growing cassava	Area Under Cassava in Ha	Area under mature cassava	Quantity Cassava harvested in 12 months (MT)	Cassava root production (MT)	Flour Equivalent (MT)
Luapula	*Chienge*	16,579	13,961	9,046	55,897	163,341	40,835
	Kawambwa	13,955	10,140	4,245	62,126	118,644	29,661
	Mansa	24,673	19,483	9,267	78,359	227,956	56,989
	Milenge	4,703	4,046	2,262	15,560	47,343	11,836
	Mwense	13,679	13,142	5,590	45,482	153,760	38,440
	Nchelenge	15,416	15,742	8,665	71,738	184,176	46,044
	Samfya	29,035	17,721	9,515	97,997	207,337	51,834
	Total	**118,040**	**94,236**	**48,589**	**427,161**	**1,102,557**	**275,639**

Source: CSO, Household Survey 2008/09

The questionnaire used in this survey was designed to collect information on two main areas of interest: (i) farmers' practice in cassava production/processing/marketing and (ii) associated costs. The questionnaire was divided into nine sections, each tackling a different farming, processing or marketing stage, from the choice of planting material to sale of final produce. The nine sections focus on (i) varieties and planting material, (ii) land preparation, (iii) planting, (iv) weeding, (v) harvesting, (vi) first processing, (vii) fixed capital investment in tools and machinery, (viii) sale patterns, (ix) storage. Each section of the questionnaire gathers information both on farmers' practices and on costs.

Information gathered from the survey was analysed following conversion of all weight and spatial measures used by farmers into universally recognisable units. For example, one hectare is equivalent to four limas, one bag of dried cassava is equivalent to 50 to 75 Kg of produce, according to its size and *ad hoc* discussion with single farmers and DACO officers.

Only respondents who could quantify the total returns obtained from the sale of their cassava produce are included in the analysis (69 out of the 74 respondents, or 93 percent). Across the data set, the information processed is divided into five main areas: production, first processing, sale, tools and additional costs. Respondents who did not report any costs in any of the areas above are included as zero values, while those ones who reported costs but could not quantify them are included as unknown values. For example, the total cost of milling for a farmer who only sells cassava chips is zero. Based on the literature and on exchange with stakeholders involved in the AAACP Programme, the recovery rate of cassava flour from fresh roots is 25 percent, while the recovery rate of flour from chips is 98 per cent.

4. 2 Production

Area under cultivation
The average area under cultivation across the interviewed farmers varies according to surveyed Districts (see Table 5).

Table 5. Area under Cultivation and Kilos Harvested per farmer per year

	Average Area Under Cultivation (Ha)	Average Harvested Kilos, flour equivalent	Average Area Under Cultivation - extreme values discarded (ha)	Average Harvested Kilos, flour equivalent - extreme values discarded (ha)
Samfya	3.0	7072	2.6	2141
Mansa	1.6	10367	1.5	4364
Weighted Average	2.1	9167		

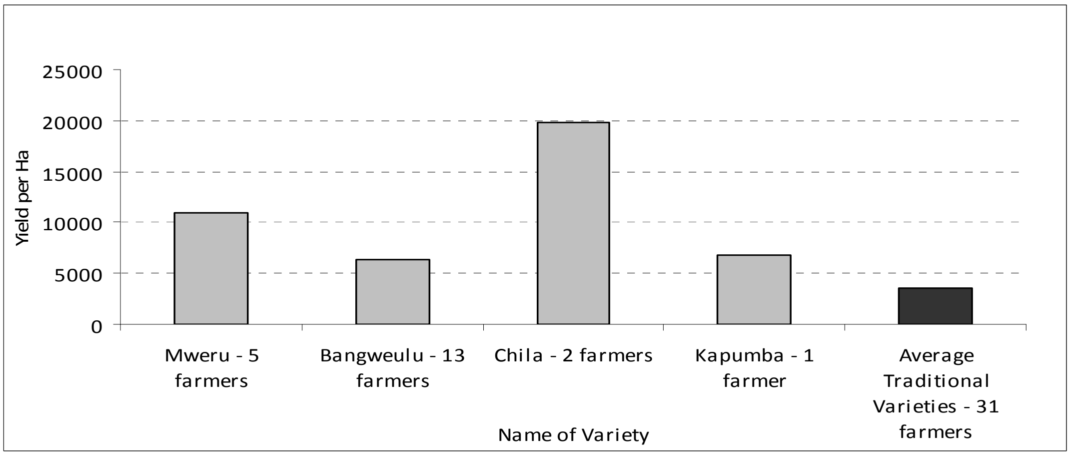
Analysis based on Survey, Mansa and Samfya, November 2009

The highest average area under cultivation is in Samfya, where it accounts for an average of 3 Ha per interviewed farmer, while in Mansa it is 1.6 Ha per farmer (2.1 Ha weighted average surveyed sample). However, although the average area under cultivation is smaller in Mansa, the average harvested quantity (in flour equivalent) is higher than in Samfya, with an average of 10367Kg per farmer, against the 7072Kg in Samfya. The total weighted average cassava harvested among samples farmers are 9167Kg cassava flour per farmer (36,668 kg of fresh cassava roots).

There is a large variation in results between Samfya and Mansa. Calculating backwards, this would indicate a fresh root yield of 9.4 tonnes/Ha for Samfya and 25.9 tonnes for Mansa. The above difference remains even discarding minimum and maximum value, with average yields ranging from 3.2 tonnes/Ha for Samfya and 11.6 tonnes/Ha in Mansa, although average yields are considerably lower. This difference is difficult to explain, and while it is possible that it could be due to the use of either traditional or improved varieties (since yields of improved varieties are on average 2.7 times higher than those of traditional varieties), it is not clear why Samfya farmers should be using traditional varieties at different rate than Mansa farmers.

Varieties and yields
There are two main types of cassava varieties in Zambia: traditional and new varieties. The latter are enhanced varieties with better yielding characteristics. There are seven main enhanced cassava varieties grown in Zambia: Bangweulu, Kapumba, Nalumino, Mweru, Chila, Tanganyka, Kampolombo. Among them, four are grown by the farmers involved in the survey (Mweru, Bangweulu, Chila and Kapumba). Aside from the enhanced varieties, interviewed farmers indicated a large number of traditional varieties grown in the sampled area. The total of identified local varieties grown by interviewed farmers is 27.

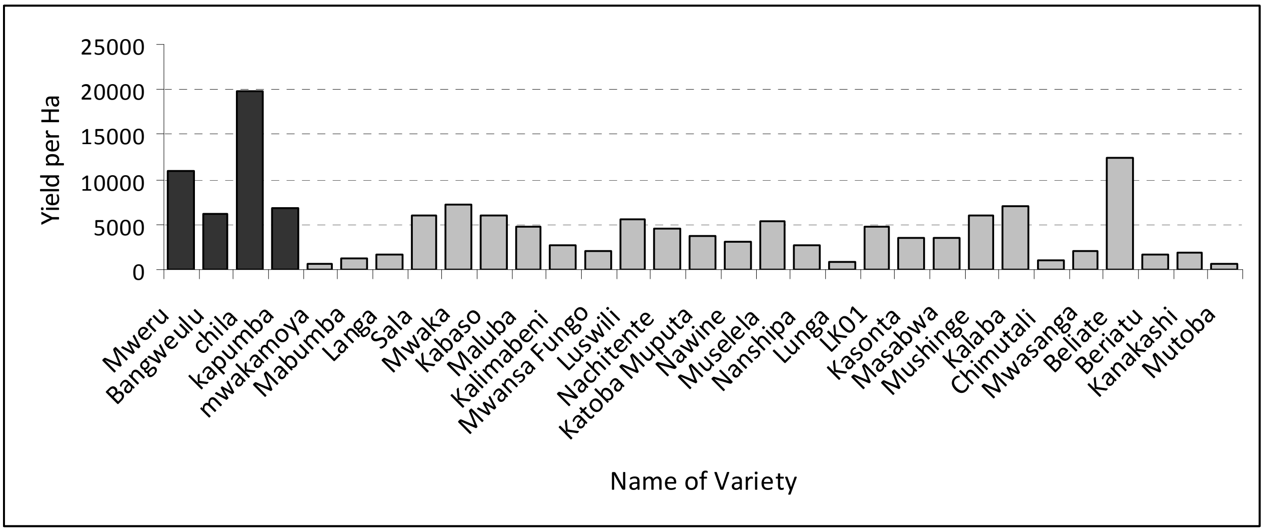
Chart 2: Average Yield New vs. Traditional Varieties



Analysis based on Survey, Mansa and Samfya, November 2009

Among the new varieties, the most commonly used is Bangweulu (18 percent of interviewees planted it), followed by Mweru (7 percent of interviewees planted it). Only one interviewee grows Kapumba, while two farmers cultivate Chila. Interestingly, the choice of varieties is not based on specific buyers' requirements, although 7 percent of interviewed farmers indicated that they have a preference for sweet varieties, particularly when they sell fresh cassava. Three local varieties were mentioned as sweet: Mushinge, Katobamputa and Mutoba. Essentially, farmers appear to choose the planted variety based on considerations mainly made on (i) high yielding potential and (ii) early maturing properties. In terms of farmers' size, among the four medium scale farmers interviewed, two cultivate new varieties only, while the other two could not indicate the name of varieties planted.

Chart 3: Average Yield per Variety

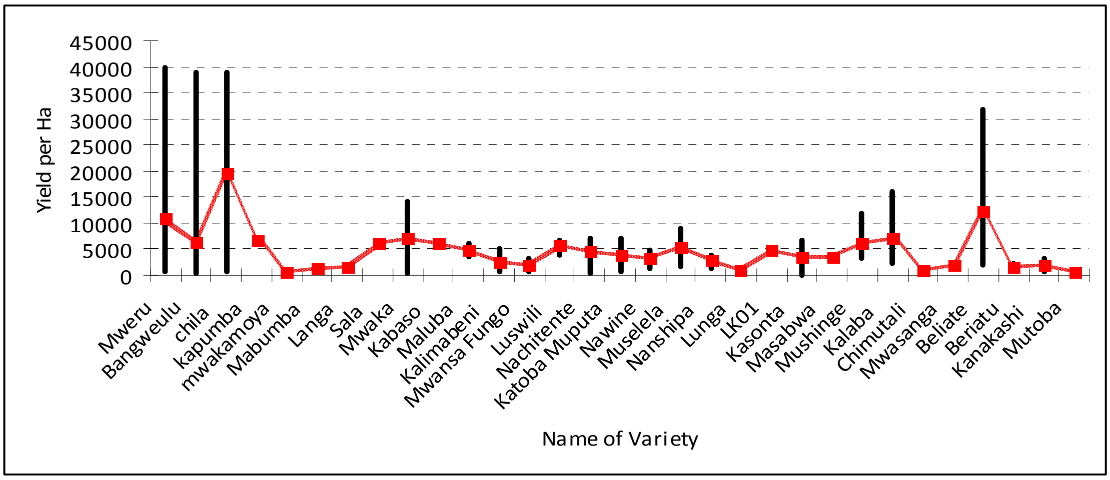


Analysis based on Survey, Mansa and Samfya, November 2009 - darker columns represent new varieties

The enhanced varieties tend to mature significantly earlier as compared to the traditional ones, and have higher yields. Mweru, for example, can be harvested within thirteen months, while some traditional varieties take longer than twenty months. In terms of yields, enhanced varieties can produce yields that are significantly higher than those of traditional varieties. Although it changes according to different variety, on average, yields of traditional varieties combined are 36% of those of the new varieties combined. On average, the yields of new varieties combined are 2.7 times higher of those of traditional varieties. Chila, for example can produce up to five times the average yields of local varieties combined (chart

2). The number can go up to seven times the yielding potential of certain local varieties (Chart 3).

Chart 4: Higher, Lower and Average Yield per Ha per Variety



Analysis based on Survey, Mansa and Samfya, November 2009

When extreme values are considered, although the minimum yield per hectare indicated by farmers for new varieties is 3.4 times higher than the minimum yield per hectare for traditional varieties, the maximum yield reported is actually similar. As reported in Table 6, the highest yield recorded within the interviewed sample is, 31.8 tonnes/Ha for traditional varieties (Belieate), and 40 tonnes/Ha for new varieties (Mweru). The maximum yields recorded are considerably higher than the second highest yields recorded of 8 tonnes/Ha for new varieties and 16 tonnes/Ha for traditional varieties. Similarly, average yields are considerably lower than the maximum, with 19.7 tonnes/Ha for new varieties and 4 tonnes/ Ha for traditional varieties. Therefore, when the highest yielding varieties among the traditional cuttings (Beliate) and the highest values reported for each of the new varieties are discarded, the maximum yield reported goes down to 8 tonnes/Ha for new varieties and 3.2 for traditional.

The reported minimum, maximum and average yields per hectare are therefore extremely variable across both traditional and new varieties (Chart 4). This finding shows that the enhanced yielding potential that the literature normally attributes to new varieties is not entirely reflected in practice. This might be due to a diverse set of reasons, which would be important to take into further consideration when developing the strategy for the cassava sector in Zambia. For instance, poor farmers' training on handling new varieties might play a role in performance below expectations for new varieties. This could include different factors, such as storage of cuttings and/or use of chemicals such as fertilizer and products used in weeding. Similarly, different soil composition across Zambia might play a role in yielding performance for new varieties, due to the broad diversity in flora within the country, which consulted literature does not take into consideration.

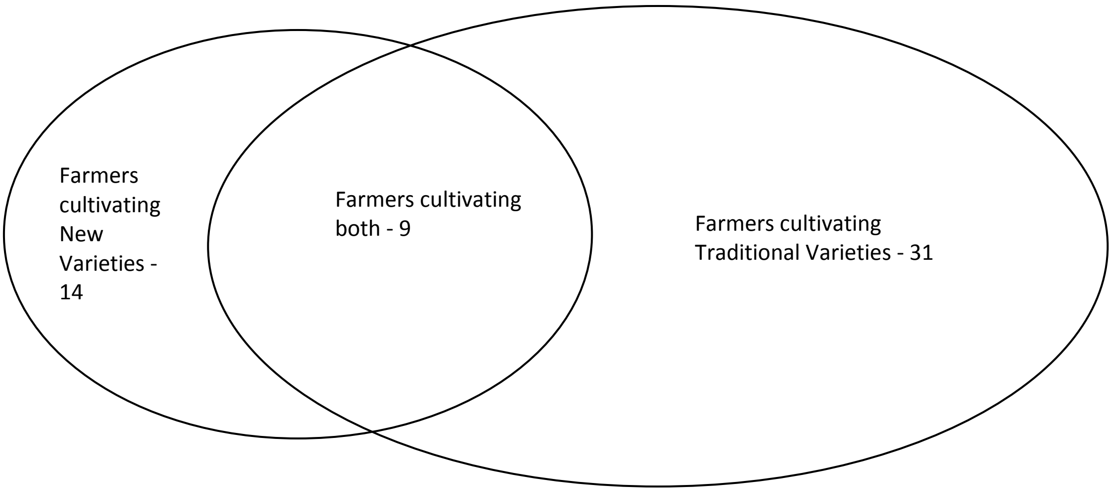
Table 6. Average Yield of enhanced and Traditional Varieties in Zambia - with and without extreme values

	Average Yield/Ha (tonnes)	Minimum Yield/Ha (tonnes)	Maximum Yield/Ha (tonnes)	Average Yield/Ha - extreme values discarded (tonnes)	Minimum Yield/Ha - extreme values discarded (tonnes)	Maximum Yield/Ha - extreme values discarded (tonnes)
Mweru	11	0.7	40	4.7	1.5	8
Bangweulu	6.3	0.48	39	3.8	0.7	8
Chila	19.7	0.5	39	n.a.	n.a.	n.a.
Kapumba	6.8	-	6.8	n.a,	n.a,	n.a.
Enhanced Varieties	**10.96**	**0.48**	**40**	**4.3**	**0.7**	**8**
Combination of Traditional Varieties	**4**	**0.14**	**31.8**	**3.6**	**0.1**	**3.2**

Analysis based on Survey, Mansa and Samfya, November 2009

Aside from their properties, the use of new varieties has increased in recent years due to donor and government commitment to the free distribution of planting material for multiplication and diversification purposes. Generally, farmers buy or receive the cuttings from different sources: inheritance, government-funded research agencies, family, friends, NGOs, UN agencies and traders. Both UN Agencies (FAO) and NGOs have been involved in free distribution since 2000, as well as government-lead research projects, particularly in Luapula province, where the number of cassava growers is highest. Distribution covered all provinces in Zambia, with a focus on diversification for the provinces where maize production is predominant, and on multiplication and product enhancement where cassava cultivation is predominant (Simwambana 2005). The availability of free enhanced varieties led to a distribution of new varieties across both surveyed districts. However, due to the relatively new distribution, and to maturation time, new varieties are still not developed on a large scale, and the full potential from the use of enhanced varieties in commercial farming is still unexplored (Chart 5).

Chart 5. Number of Farmers Planting Traditional and New varieties



Analysis based on Survey, Mansa and Samfya, November 2009

A total of 44 percent interviewed farmers paid to get their planting material (Chart 6 and 7). More specifically, 41 percent of interviewees paid to purchase planting materials of traditional varieties, while only 8 percent paid to get cuttings of new varieties. [2]

Paradoxically, in terms of the cost for planting material, since the new and better performing varieties are often obtained for free, farmers tend to pay the highest price for the local varieties, therefore generally paying more for lower performing planting material. The reasons behind the choice of variety among farmers are not specified in the survey. Since producers do not market cassava final products differently according to their variety, it might be suggested that reasons such as lack of access to free and better yielding varieties and taste, together with traditional farming practices and uses might play a role in the choice of variety.

Chart6 : Percentage of Farmers Purchasing Planting Material

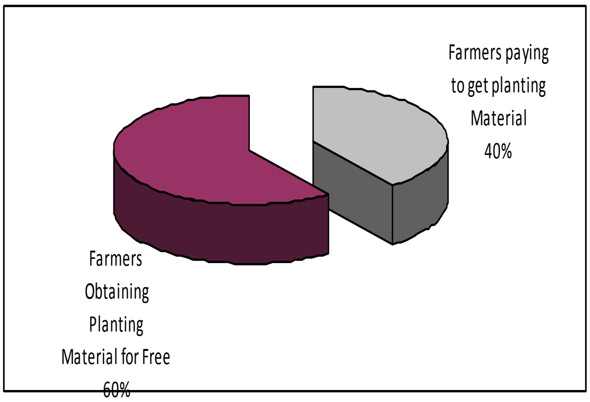
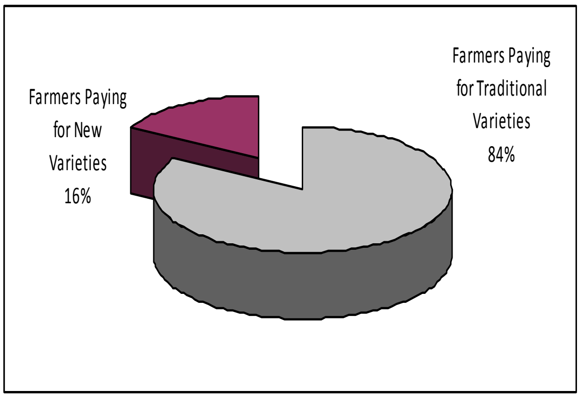


Chart7 : Percentage of farmers Purchasing New and Traditional Varieties



Source: Analysis based on Survey, Mansa and Samfya, November 2009

4.3 Farmers' Cost Structure

According to data from surveyed farmers, the total average cash cost[3] of producing cassava products in Zambia (flour, grates, chips and full peeled cassava) is 1,270,422 Kwacha per Ha (see Table 7 below). In terms of average variable and fixed costs, the sum of variable costs is 1,044,034 Kwacha per Ha, representing 82 percent of total cash costs of producing cassava.

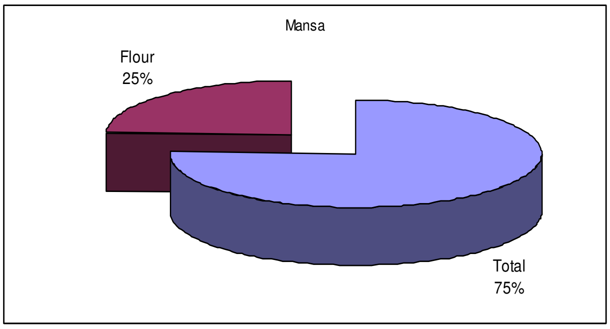
Gross returns represent 57 per cent of average cash costs per Ha, with a maximum of 81 percent in Samfya surveyed farmers and a minimum of 47 percent in Mansa. The difference between the two districts might be explained as a more prominent incidence of fixed costs (mainly farming tools) in Samfya as compared to Mansa District (28 per cent versus 9 per

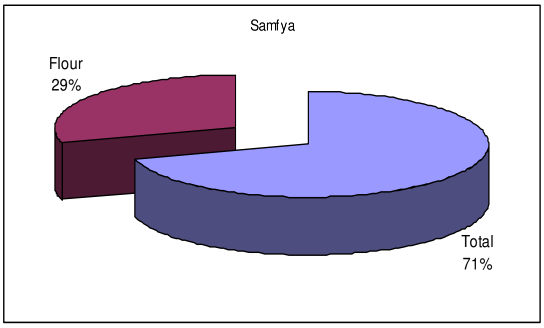
[2] According to Antonio Lopez, cassava expert working on the cassava strategy on the behalf of ITC, the different varieties can actually be described as multiclonal varieties , due to a mixture of cross-pollination and poor storage practices. Each farmer has an average of 3 multiclonal varieties both in Samfya and Mansa district. This would be the reason behind the difficulty for farmers in differentiating characteristics of one specific variety from the others, since characteristics have intercropped during the years. For example, the same variety is described as more or less sweet, according to different geographical areas of origin. For instance, Mutoba, Katobamputa and Mushinga (local varieties) are chosen because of their sweetness (ideal for consumption as fresh roots), but their sweetness vary according to geographical area of origin. Farmers explain the difference in terms of different soil characteristics in areas of cultivation, although this can also be explained as a result of multiclonal varieties diluting the original characteristics of each product.

[3] Cash costs include (1) variable costs: input, labour, transport, storage, packaging, levies; and (2) fixed costs: investment in farming and first processing. Non-cash costs such as family labour are not included.

cent). This factor might be the result of a better capability for sampled farmers in Samfya to quantify their fixed costs, more than the concrete higher incidence of fixed costs in that District. Also, there seems to be a tendency for farmers in Mansa to outsource their milling to other farmers or local mechanical milling facilities - although sampled farmers were not able to quantify the cost for the service (which is often obtained for free or paid in kind as a barter). Two different ways of milling flour and grates were observed across the interviewed sample. The first is through mechanically powered equipment, generally outsourced; while the second is through crushing by home mortars. 31 percent of farmers outsource the milling of flour in Mansa, either for selling or household consumption, while none among the interviewees in Samfya does. In Samfya, instead, it appears more common to own a mortar for both grating and milling. This also increases fixed costs. 23 percent of interviewed farmers in Samfya own a mortar, against 17 percent in Mansa.

Chart 8 : Sale of Flour vs. total Sale in Mansa and Samfya





Analysis based on Survey, Mansa and Samfya, November 2009

In terms of final marketed produce, it is slightly more common for farmers in Samfya to sell cassava flour as the final produce, rather than chips or dried cassava as in Mansa (Chart 8). This might be connected to buyer requirements, as the buyers in Samfya are located at small distance from fishing camps, whose households have a preference for flour-based cassava meals over other processed cassava-based products.

Table 7. Gross Returns and Costs

		TOTAL SAMPLE	SAMFYA	MANSA
CASH COSTS Kwacha/Ha	Average	**1,270,422**	1,431,041	1,176,198
	Lowest Value	**1,266**	25,396	1,266
	Highest Value	**6,847,634**	6,171,927	6,847,634
NET RETURNS Kwacha/Ha	Average	**2,235,347**	1,769,966	2,495,095
	Lowest Value	**128,000**	128,000	333,333
	Highest Value	**16,000,000**	16,000,000	105,000,000
COSTS per Ha as a percentage of NET RETURN	Average	**57%**	81%	47%
	Lowest Value	**1%**	20%	0%
	Highest Value	**43%**	39%	7%

Analysis based on Survey, Mansa and Samfya, November 2009. Cash Costs include (1) Variable average costs: input, labour, transport, storage, packaging, levies; and (2) Fixed average costs: investment in farming and first processing. Non-cash costs such as family labour are not included.

In terms of cost structure, hired labour is the largest component of cash costs, accounting for 55 percent of total costs, with an average of 46 percent in Samfya and 61 per cent in Mansa (Table 8). Among the different components of hired labour, harvesting is the most prominent, accounting for an average of 20 percent overall, 9 percent in Samfya and 28 percent in Mansa.

Generally, the prominence of harvesting among labour costs might also be determined by the fact that peeling, soaking, transport to soaking area and chipping are often included in harvesting costs (when so, it was not possible to break down the numbers according to processing stage). The second largest component among labour costs is weeding, with an average of 20 percent overall, of which 26 percent in Samfya and 16 percent in Mansa.

Although it would be useful to get an indication of the difference in labour costs between 1 Ha planted to traditional cassava and 1 Ha to improved cassava, it was not possible to obtain this information within the farmers sampled. This limitation is due to the fact that farmers do not keep records of costs or revenues according to different varieties used. Farmers sometimes separate different varieties when planting, but subsequently mix them during the following stages of production, first processing and sale.

Only two farmers among the interviewees (one for each district) had a cost of zero for labour. The rest of the interviewed farmers used hired labour in at least one of the production and processing stages.

Table 8. Cost Structure, Percentage

	TOTAL SAMPLE				SAMFYA				MANSA			
VARIABLE AVERAGE COSTS	Av	Med	Min	Max	Av	Med	Min	Max	Av	Med	Min	Max
INPUT	**3%**				**4%**				**2%**			
PLANTING MATERIAL per Ha	3%	0%	0%	60%	4%	6%	0%	60%	2%	0%	0%	38%
CHEMICALS	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
LABOUR	**55%**				**46%**				**61%**			
LAND PREPARATION per Ha	0%	0%	0%	13%	1%	0%	0%	12%	0%	0%	0%	13%
PLANTING per Ha	6%	4%	0%	44%	4%	7%	0%	44%	7%	4%	0%	32%
WEEDING per Ha	20%	18%	0%	94%	26%	21%	0%	94%	16%	15%	0%	82%
HARVESTING per Ha	20%	15%	0%	89%	9%	10%	0%	60%	28%	18%	0%	89%
PEELING per Ha	6%	0%	0%	60%	6%	0%	0%	43%	6%	0%	0%	60%
SOAKING per Ha	2%	0%	0%	45%	0%	0%	0%	7%	4%	0%	0%	45%
CHIPPING per Ha	0%	0%	0%	13%	0%	0%	0%	13%	0%	0%	0%	5%
MILLING per Ha	1%	0%	0%	21%	1%	0%	0%	21%	1%	0%	0%	8%
GRINDING per Ha	0%	0%	0%	5%	0%	0%	0%	3%	0%	0%	0%	2%
TRANSPORT	**17%**				**14%**				**20%**			
TO MARKET per Ha	16%	0%	0%	100%	12%	0%	0%	70%	19%	10%	0%	100%
TO SOAKING AREA per Ha	2%	0%	0%	56%	2%	0%	0%	56%	1%	0%	0%	52%
STORAGE AND PACKAGING	**5%**				**4%**				**6%**			
RENT WHILE SELLING per Ha	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
BAGS per Ha	5%	3%	0%	61%	4%	3%	0%	61%	6%	5%	0%	19%
LEVIES	**3%**				**4%**				**2%**			
MARKET LEVIES per Ha	3%	0%	0%	8%	4%	0%	0%	8%	2%	0%	0%	8%
FIXED AVERAGE COSTS												
FARMING AND PROCESSING INVESTMENTS	**18%**				**28%**				**9%**			
MORTARS per Ha	0%	0%	0%	25%	2%	0%	0%	25%	0%	0%	0%	0%
FARMING TOOLS per Ha	18%	14%	0%	100%	26%	16%	1%	99%	9%	11%	0%	100%
*Av: Average; Med: Median; Min: Minimum Value; Max: Maximum Value.												

Analysis based on Survey, Mansa and Samfya, November 2009. Percentage calculations include only farmers who could quantify their sale of cassava products. Across the different entries, zero values are associated to the lack of a specific production/processing stage. No value is associated to production/processing stages when farmers could not quantify the entry.

After labour, the second highest cost component among interviewed farmers is transport, particularly transport to market, which accounts for 16 percent of total average production costs, and it is higher in Mansa (19 percent) than in Samfya (14 percent). Generally, it was observed that farmers in Samfya tend to sell their produce more locally than in Mansa. This might be explained by the specific geographical features of Samfya, which is slightly more isolated than Mansa, and has a comparative advantage catering for the neighbouring swamps and islands as compared to Mansa. Interviewed farmers in Mansa, instead, seem to be more involved in trading with neighbouring districts, such as the Copperbelt, where the industries processing cassava into adhesive are located, as well as traders dealing with such firms. Also, both in Mansa and in Samfya, transport costs are affected by Tute Milling's operations, which carries the costs of transport when buying from farmers in the Province, therefore lowering transport costs for farmers, as well as providing an incentive to sell locally (to Tute Milling directly).

Although this study does not account for non-cash costs, it is observed that the highest component of the overall costs of producing cassava is family labour. In addition, it is observed that costs for farming machinery and fertilizers among interviewed farmers is equal to zero in both sampled Districts. None of the interviewed farmers use chemicals in their production, neither in weeding nor as fertilizer. Similarly, none of the interviewed farmers owns machines (such as tractors) to facilitate land preparation and production in general.

Generally, interviews show that there are no clear determinants for final price of different cassava products among farmers. For example, the average price of whole dried cassava roots among the interviewed sample is actually higher than that of chips, regardless of the fact that chips require more labour. Season and contingency appear to be the most important factors in price setting. One farmer interviewed in Samfya explained that he sells the same product at the same price both at the market or at farmer's gate (therefore without accounting for the price of transport to market) as a result of the changing seasons within the cassava production cycle. He argued that when there is scarcity of produce, buyers are inclined to pay a higher price for the product, and are ready to travel at their expense to farm gate, paying the same price as they would at the market. Similarly, he argued that at times of high need, farmers are ready to sell their produce at a price below margin.

4.4 Market Participation

In terms of market dynamics, interviews showed a complete absence of contractual agreement between suppliers and buyers (both industrial and private). This market pattern is at the same time the result and a cause of price uncertainty. According to both producers and processors interviewed, the lack of contractual agreements is the result of uncertainty of supply because traders and processing industries are not prone to bind themselves in contracts, given that they are unsure about effective time of delivery and quality of supply. However, it can be equally argued that such contractual agreements could become a drive in promoting certainty in supply.

Chart 9. Cassava Uses in Mansa

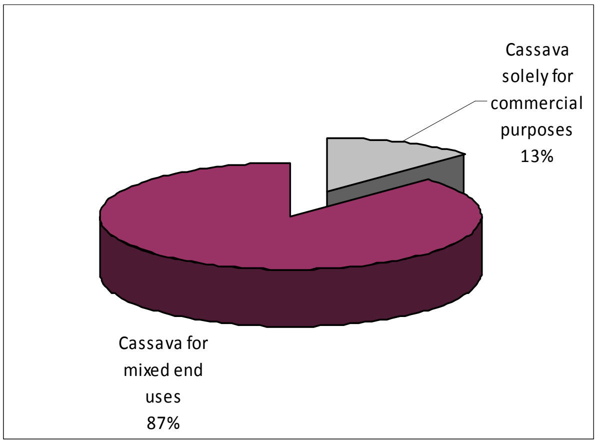
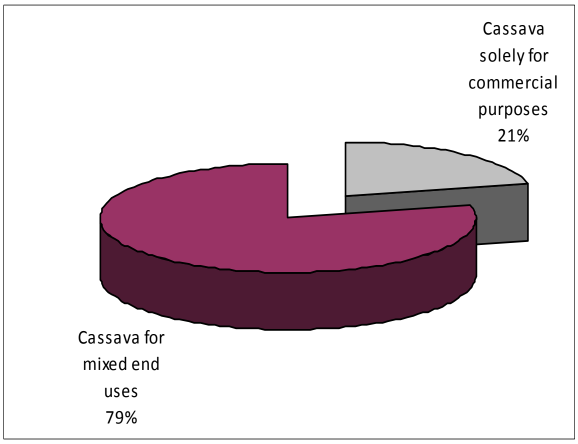


Chart 10. Cassava uses in Samfya

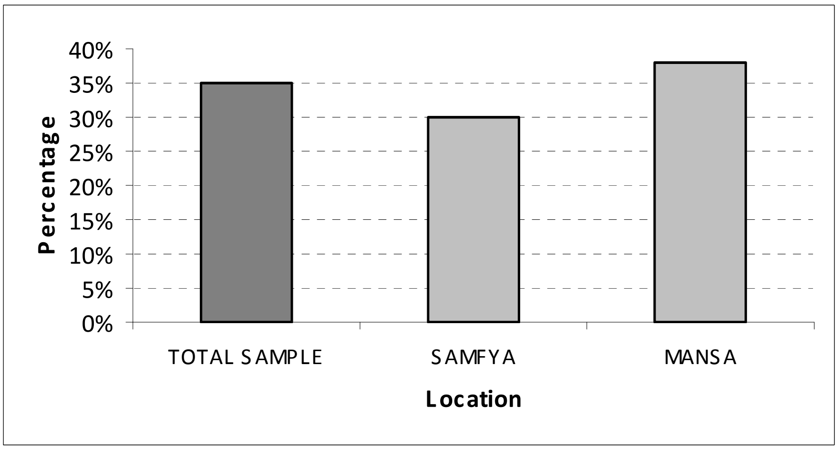


Analysis based on Survey, Mansa and Samfya, November 2009

Among interviewed farmers, a total of 14 cultivate cassava for solely commercial purposes (19 percent), of which 13 percent of sample farmers in Mansa and 21 percent of sample farmers in Samfya (see Chart 9 and 10). A total of 69 farmers among the interviewed sample sell cassava at a quantifiable price. This trend reflects cassava properties as a food security crop, as well as nutritional habits of Zambians in Luapula province, where cassava consumption is highest (as it is in northern Zambian in general).

Home consumption represents a consistent part of total production within the interviewed farmers' population. Among the interviewed sample, an average of 35 percent consumes their cultivated cassava within the household. On average, 42 percent of total production among interviewed farmers in Mansa is used in home consumption, against 31 percent in Samfya.

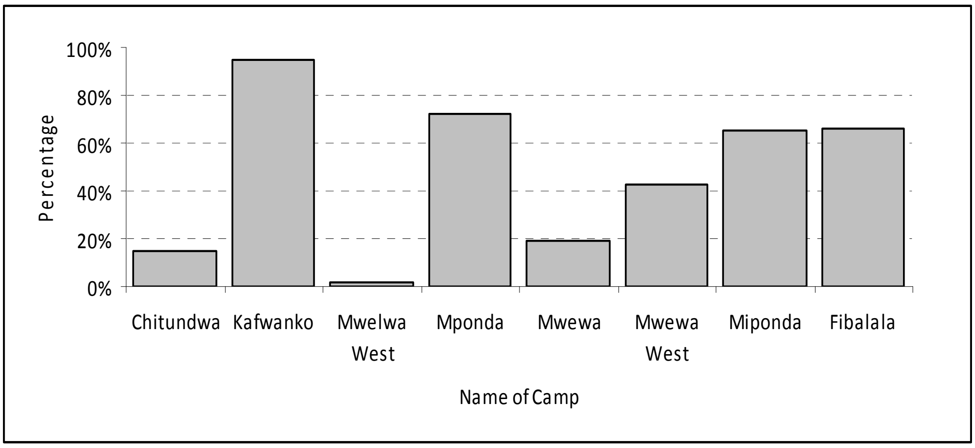
Chart 11. Average Cassava Home Consumption as a Percentage of Total Production



Analysis based on Survey, Mansa and Samfya, November 2009

In Samfya, consumption patterns are different across surveyed districts, with home consumption varying from zero percent of total production in Mulungushi camp to 95 percent in Kafwango Camp in Samfya (Chart 12).

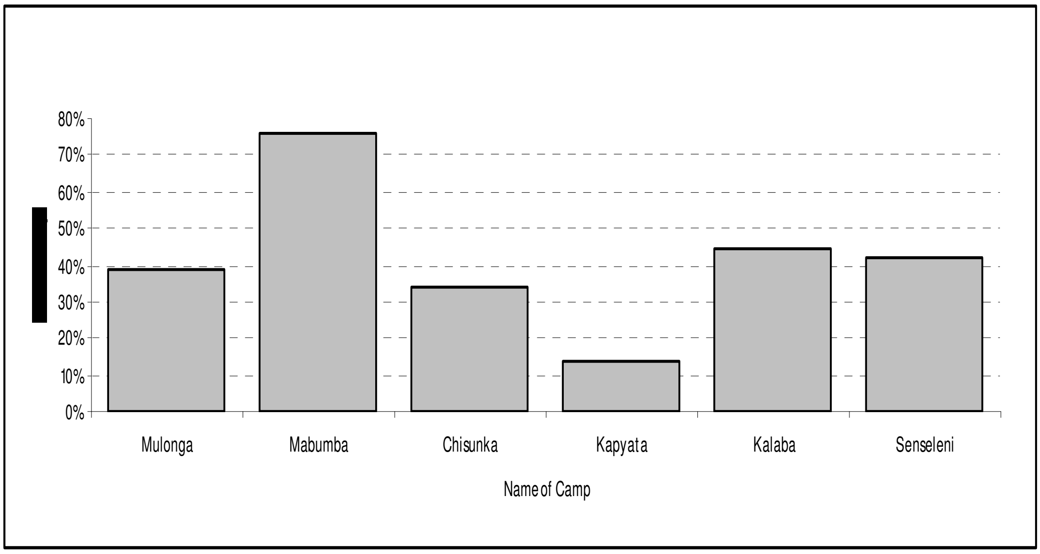
Chart 12. Cassava Home Consumption as a Percentage of Total Production - SAMFYA District



Analysis based on Survey, Mansa and Samfya, November 2009

In Mansa, household consumption varies from zero percent in Chipende Camp to 76 percent in Mabumba camp (Chart 13). Overall, the highest average percentage of home consumption of produced cassava is registered in Kafwango camp, Samfya, among the interviewed population.

Chart 13. Cassava Home Consumption as a Percentage of Total Production - MANSA District



Analysis based on Survey, Mansa and Samfya, November 2009

5 Processor Survey

5.1 Methodology

The primary objective of the study of processors is to obtain a mapping of the formal operators involved in processing cassava within three main supply channels: (i) human consumption, (ii) industrial uses and (iii) livestock feed. A concurrent goal is to gather and analyse information on processors' practices, sale and supply patterns and market linkages across the value chain. The survey builds on interviews with 26 processors in three Provinces: Lusaka, Copperbelt and Luapula. The study purposely focuses on formal processors only. Therefore small millers and households selling snacks and convenience food were not included in the survey. This choice stems from the interest in understanding market linkages across the value chain, and the need to connect buyer's requirement to the analysis of producing farmers, to understand the prospects for development of a formalised processing industry for the cassava sector in Zambia.

Based on consultation with stakeholders within the Zambian cassava value chain, as well as background research, it emerged that the main formal processors of cassava for the three cassava supply channels (human consumption, industrial uses and animal feed) are located in three Provinces: Lusaka, Copperbelt and Luapula. Specifically, the sampled interviewed processors are twenty-six, of which thirteen were engaged (currently, prospectively or previously) in processing of cassava for human consumption, five for livestock feed and eight for industrial uses. Most processors interviewed are located in Lusaka Province (fourteen). There are eleven interviewed processors in Copperbelt (mainly involved in processing of cassava for industrial uses) and one in Luapula (Tute Milling, the main cassava-specialized miller in the country).

Less than 50 percent of the interviewed processors are currently purchasing cassava as a raw material for their final products. Among those who are currently not buying, some were involved in trials of cassava processing in the past, some might be potentially interested in utilizing cassava in the future, and some would normally employ cassava, but are currently not doing so, due to business priorities (Chart 14 and 15).

As summarized in Table 8 and Table 9 below, among the interviewed processors:

- 12 are currently buying cassava
    - 1 in Luapula (miller)
    - 6 in Copperbelt
        - 5 for industrial uses
        - 1 for human consumption
    - 5 in Lusaka
        - 2 millers
        - 2 processors for human consumption
        - 1 for industrial uses (glue manufacture)
- 2 normally use cassava but are currently not doing so
- 2 had one trial in cassava processing and then stopped
- 10 never used cassava in the past and have not yet elaborated a specific business plan for doing so in the near future

Chart 14. Mapping of Interviewed Processors, Luapula and Copperbelt Province

		PROCESSING CASSAVA FOR		INDUSTRIAL USES				LIVESTOCK FEED
		FLOUR	BISCUITS /SNACKS	Adhesive GLUE	Adhesive PAPER	Adhesive WOOD	INDUSTRIAL SWEETENERS	
PROVINCE	**DISTRICT**							
Luapula	Mansa	Tute Milling, blended nshima.						
	Samfya							
Copperbelt	Ndola		Sunrise Biscuits Company	Monterey Printing/Zambezi		Wood Pocessing Industry		Olympic Milling Stock Feeds Ltd.
		Olympic Milling		Unity Packaging Co.		PG Bisonite Zambbia Plc.		
				Ashwas Industries Ltd.				
	Kitwe	Jamas Milling Co. Ltd						
		Mpongwe Milling						

processors currently employing cassava
processors normally using cassava but currently not employing it
processors who did one trial in cassava use and stopped
processors who never used cassava in the past and are currently not employing it

Considering that none of the interviewed processors producing animal feed are currently purchasing cassava as a raw material, human consumption and industrial processing are the only two formal processing industries currently purchasing cassava as a raw material in Zambia. According to the interviewees, the glue, paper and wood industry bought a total of 558 tonnes of cassava flour equivalent in the past 12 months. This is almost double the amount estimated in available literature (Hagglade and Nyembe 2008) and might thus indicate this industry is a growing market for cassava. At the same time, the interviewed processors for human consumption combined bought only 20 tonnes.

The questionnaire used in this survey is designed to collect information on two main types of processors: (i) those who are currently purchasing cassava and using it for their activities and (ii) those who are not.

For the latter, the survey aims at collecting information on the reasons for such choices, and on whether they might purchase cassava in the future or did in the past. For the first type of processors, the questionnaires collect information on five main areas: (i) supply, (ii) capacity, (iii) sale patterns, (iv) comparative information on purchase, (v) costs and typology of necessary equipment. On the costs and typology of equipment, information actually collected is scarce, mainly due to difficulties in the interviewees quantifying their fixed costs.

Chart 15. Mapping of Cassava Processors, Lusaka

		PROCESSING CASSAVA FOR		INDUSTRIAL USES				LIVESTOCK FEED
		FLOUR	BISCUITS /SNACKS	Adhesive GLUE	Adhesive PAPER	Adhesive WOOD	INDUSTRIAL SWEETENERS	
PROVINCE	DISTRICT							
Lusaka	Chongwe	Kanamantapa Women Processors.						
	Lusaka City	Lusaka West: Millcare Milling			Trishul Adhesive and Chemicals Ltd		Zambian Breweries Plc - Freshpikt	Tiger Animal Feeds
		PECO Ltd.	Lamise/Batul Inv. Bibi Biscuits					Novateck Animal Feed (member of Zambeef group of Companies)
		Simba Milling	PECO Ltd.					Yielding Tree Co.
		National Milling Co.	Lusaka: Carnival Resort					
			Lusaka: Sylva Catering					Perfect Milling

processors currently employing cassava

processors normally using cassava but currently not employing it

processors who did one trial in cassava use and stopped

processors who never used cassava in the past and are currently not employing it

Information gathered from the survey resulted in a combination of numerical and qualitative entries. A key focus of the survey was to compare information given by processors currently using and not using cassava in their firms. Information such as the procurement savings were indicated by processors directly, and not calculated in the analysis, for both processors who currently are, and those who are not purchasing cassava.

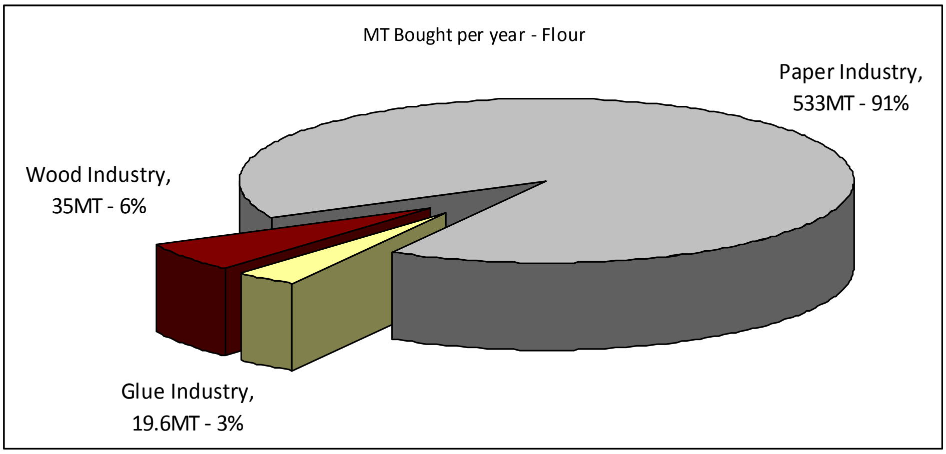
The analytical approach focused mainly on the mapping and on comparison of purchasing and selling patterns across different processors. Qualitative analysis played a greater role in the analysis of processors as opposed to the analysis of producers. Buyer’s linkages and information about the use or lack of cassava in production played a more significant role. The analysis of the use of cassava in animal feeding is a leading example. Available literature and ongoing discussions among stakeholders indicate the use of cassava in animal feed as the industry that is the greatest potential driver in the development of cassava utilization. However, none of the interviewees was actually employing cassava. In this case, the focus of the analysis was to understand the reasons behind the choice of not using cassava, more than analysis of the current pattern. Comparison and contrast with available literature and stakeholders’ discussion played a leading role in the analysis of data on processors.

5.2 Cassava for Industrial production

Glue, Paper and Wood Industry

Adhesive producing firms, together with processors of glues for the paper, board and wood industry are the main cassava buyers among total interviewed processors (Chart 16). High starch content makes cassava particularly suitable for this manufacture. Specifically, cassava flour is used in the coating operation. When a pigment coating is required for paper, starch acts as a coating agent and as an adhesive. As an adhesive, cassava is generally used to bond paper in some form to itself or to other materials such as glass, mineral wool, and clay. In Zambia, it is used specifically to bond paper, cardboard and wood (for the latter, particularly in the production of plywood, veneering and shutterply). Starch can also be used as a binder or adhesive for non paper substances such as charcoal in charcoal briquettes, mineral wool in ceiling tiles and ceramics before firing, although no examples of these specific manufactures have been found in the Zambian market.

Chart 16: Share of Cassava Flour bought per year by different industrial Processors



Analysis based on Processors' Survey, November 2009

The type of glue that can be produced with the existing in-country supply is defined as an emulsion adhesive, a milky-white dispersion used extensively in the woodworking and packaging industries. This type of mild glue can also be used with fabrics and fabric-based components, and in engineered products such as loudspeaker cones. Cassava-based adhesives are particularly viscous and smooth. The final glue produced is fluid and stable, with a neutral pH that can be easily prepared and combined with synthetic resin emulsions. In comparison, corn and rice starches are more time consuming to prepare and require a higher temperature to reach the same level of conversion[4].

The essential ingredients in starch-based adhesives are starch/flour, viscosity enhancer/stabilizer (borax), gelatinization modifier Sodium hydroxide(NaoH), and preservative (sodium formaldehyde). The amount of stabilizer and NaOH must be determined on a case by case basis, so as to provide the adhesive with the correct viscosity and pasting temperature to meet the necessary requirements.[5] Generally, the most frequent sources of starch for adhesive pastes, aside from cassava, are maize and potato.

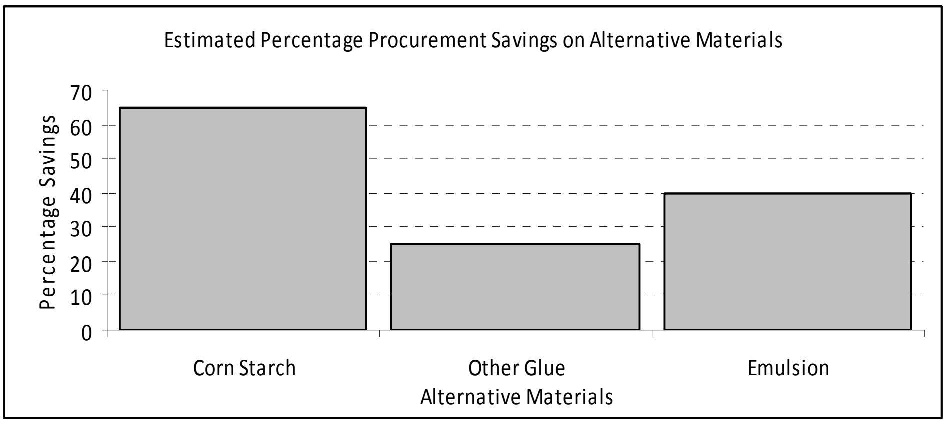
Producers of cassava-based adhesive for the different industries are not concerned with cyanide content, microbiology, colour, taste or odour. Although, they do have a preference for fine, white flour, which does not show signs of mould. Four of the five interviewed processors purchase flour only, while one buys whole dried cassava roots, which then processes into flour with an in-house hammer mill. None of the industrial processors interviewed expressed any preference for specific varieties.

Generally, all five surveyed industrial processors produce cassava-based glue, one of them as final product, three of them as a raw material to use for their production of carton boxes and one to use in the production of wood derivates, mainly plywood, shutterply and veneering. One processor is located in Lusaka, while four are located in the Copperbelt. The Copperbelt appears to be the most receptive area in the country for this kind of industry.

[4] **Cassava starch in paper, textile and adhesives industries, http://www.cassavabiz.org/postharvest/starch01.htm**
[5] cassavabiz http://www.cassavabiz.org/postharvest/starch01.htm

According to data collected during the survey, cassava is a substitute for the following raw materials in the industrial processing of adhesive for different types of processing: enzyme emulsion, corn starch and other types of glue. The main reason for substitution to cassava is price. According to interviewees, cassava is consistently cheaper when compared to alternative raw materials. Specifically, processors estimate a procurement saving of an average of 40 percent when compared to emulsion, 60 percent when compared to corn starch and 25 percent savings when compared to other types of glue. (See Chart 17).

Chart 17. Estimated Percentage Procurement Savings on Alternative Raw Materials in adhesive Production



Analysis based on Survey, Copperbelt, November 2009

In terms of supply, none of the industrial buyers relies on a contractual agreement with suppliers, with either farmers or traders. According to the interviewees, contractual agreements are avoided due to the scarcity and unpredictability of supply, which creates the need to diversify suppliers, to minimize risks of suppliers' default. Based on the survey, adhesive and related industries have a preference towards buying in bulk, dealing with organized farmers' groups or traders. There are, however, some exceptions, such as a medium scale farmer in Mansa, who, although without a specific contractual agreement, produces cassava flour to supply solely for the glue/paper/wood industry, and bears the cost of transport to the Copperbelt.

Three out of the four industries surveyed in Copperbelt rely on Tute Milling as a supplier of cassava flour – although neither of them relies on Tute as their exclusive supplier. Aside from Tute, suppliers are traders and farmers. Although Tute does not guarantee a consistent price and supply, the quality of its flour appears to be guaranteed. Given uncertainty over supply patterns and price, most of the interviewed processors tend, given the chance, to stock cassava supply in flour form when available.

Industrial Sweeteners

The high starch content of cassava makes it particularly suitable for the extraction of industrial sweeteners. The development of isoglucose has opened up significant markets, such as carbonated beverages in the United States. Cassava can be converted into sugar syrups with a range of dextrose equivalents to meet different end-user requirements, by using enzymes from plant seedlings.[6]

[6] http://www.researchintouse.com/nrk/RIUinfo/PF/CPH21.htm

Based on the mapping of processors, there is currently no firm processing cassava into industrial sweeteners in Zambia. However, there was a trial on 2006/7 when, within a project supported by UNDP, Zambian Breweries outsourced the production of cassava-based glucose to a private firm, Freshpikt. Although the results of the trial were encouraging, there was no interest among the parties involved to actually undertake large scale production.

In glucose production, cassava flour is used as a substitute for maize. Procurement savings estimated by interviewees indicate that cassava should be 10 to 20 percent cheaper than maize to profit from the substitution. However, since there was never large-scale production of industrial sweeteners in the country, specific procurement savings are uncertain. According to interviewees, aside from the need of further investment in equipment, the trial did not develop into a viable business enterprise because of uncertainty of supply.

5.3 Cassava for Human consumption

According to FAO statistics cassava is the third most important source of calories in Africa, Asia and Latin America, after rice and maize.[7] This root is particularly rich in carobhydrates (64 to 72 percent of which in form of starch), being the highest producer of carbohydrates among crop plants, aside from sugarcane. A typical cassava root is composed of moisture for 70 percent, starch for 24 percent, fibre for 2 percent, protein for 1 percent and other elements for 3 percent (FAO and IFAD 2000). Although rich in calories, cassava roots are deficient in proteins, fat, minerals and vitamins. Consequently, cassava has a lower nutritional value, when compared to cereals, legumes, and different root and tuber crops, such as yams. The flesh of cassava root contains slightly less protein than the peel,although fermentation of the roots contributes to protein enrichment by a factor of 6 to 8. Cassava leaves are richer in proteins than roots are. [8] The cyanogenic potential of cassava leaves is 5 to 20 times greater than that of roots. However, the risk of intoxication associated with the consumption of cassava leaves is greatly reduced because of the ability of the leaves to rapidly loose cyanogens during processing.[9]

Some cassava varieties contain larger amounts of cyanogenic glucosides that produce cyanide, a chemical compound toxic for human health, which also gives the root a bitter taste. Cultivars can broadly be classified as sweet or bitter depending on their cyanide content, although bitterness is not necessarily an indication of cyanide levels. Generally, bitter varieties are richer in starch, and are especially fitted for feed and industrial uses, while sweet varieties are preferred to be consumed as food (although interviewed farmers and processors did not indicate any preference on specific varieties, unless to be consumed fresh, in which case sweet varieties are preferred). Unlike sweet cassava, bitter cassava is not suitable for human consumption unless properly treated. Cyanide can be removed by peeling, grating and dewatering the root. Dried cassava can be stored for several months.

Its high water content makes cassava root bulky and highly perishable, necessitating processing within 48 hours of harvest. Rapid processing and drying of the fresh roots reduce weight, extend shelf-life and facilitate their transport to market (FAO and IFAD 2000).

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[7] http://www.fao.org/ag/AGP/AGPC/gcds/index_en.html
[8] http://www.unu.edu/unupress/food/8F024e/8F024E01.htm
[9] http://www.actahort.org/books/375/375_18.htm

The interviewed manufactures of cassava for human consumption within the formal sector purchased a total of 20 MT of cassava flour equivalent in the past 12 months. The main final products are Nshima, Gari, Biscuits, Leaves, Muffins, Soup. Three manufacturers are currently buying cassava among those surveyed. Two of them are located in the Lusaka Province, and get their supply mainly from the Mansa and Lusaka area. The third processor is located in the Copperbelt, and purchases its supply from Mansa. The latter is a particularly interesting case, since it has an exclusive supplier, Tute Milling , although without any specific contractual agreement.

Tute Milling, according to information collected during the interview, sold 146 tonnes of flour to various buyers. Specifically, Tute only sells to selected clients, all of them located in the Copperbelt Province. The transport from farmers' gate to the mill and from the mill to buyers is provided by Tute. Three of Tute's clients are within the glue/paper/wood industry, and only one is a processor for human consumption, mainly specialized in biscuits.

In human consumption, cassava is mainly a substitute for wheat and maize. Interviewees estimate procurement saving in the range from 6 to 30 percent savings in raw material. However, despite saving potential, in some cases cassava-based products are specifically marketed as cassava-based, and the focus shifts from price to marketing.

All of the interviewees indicated the need for improved supply, availability and safety of purchased cassava, to expand their use of cassava as a raw material for their produce.

5.4 Animal Feed Processing

The Zambian livestock feed industry is currently highly dependent on maize as a basic ingredient for mixed feeds formulas used in the sector. This reliance exposes the sector to two major drawbacks: (i) high and fluctuating costs of maize; and (ii) competition with the demand of cereal grains for human consumption. Stakeholders, in view of (a) the elevated costs of holding foreign exchange for importation of cereal grains from abroad and (b) the fluctuating price of supplying conventional feed resources in country, are investigating alternative raw materials produced locally.[10]

The literature on the use of cassava for livestock feeding dates back to early Twentieth Century (Tewe 1994)[11]. While the use of cassava for animal feed is becoming an established practice in large markets such as the European Union, Brazil and Southeast Asia (IFAD 2004), there are two main constraints to its establishment in Sub-Saharan feeding industry, the lack of information on the specific nutritional characteristics of cassava in animal feed and concerns over its potential toxicity.

The cassava root is effectively a carbohydrate source, since its protein content is very low and of poor quality. Aside from its limited protein content, cassava contains low quantity of vitamins, minerals, lack of sulphur, and methionine content (IFAD 2004). Therefore cassava-based animal feeding always require additional ingredients (nutrient supplementation) to counterbalance the deficiency in proteins, minerals and vitamins, and to ensure cost-

[10] Discourse within the taskforce for Acceleration of Cassava Utilization is posing increasing emphasis on the study of viability of cassava as an alternative to maize in Zambian Livestock feed industry.
[11]

effectiveness and satisfactory performance of livestock (IFAD 2004). Additionally, cassava also contains cyanogenic glucosides, which are toxic to animals. Essentially, the use of cassava and its by-products is viable in the feeding of monogastric animals only when its nutrient composition is improved through supplements in the formula of ration. Such supplements include oils, pelletizing, fat, molasses, sulphur amino acids, and urea nitrogen. Similarly, a combination of efficiently performed boiling, drying, grating, soaking and fermentation removes cyanide while microbial activity and aflatoxin contamination can be reduced through efficient sun drying to a suitably low moisture content (FAO 1994).

Energy sources account for between 15 and 60 percent of compound livestock concentrates and feed, and maize provides the bulk of that energy. Other cereal grains used in the animal feed industry include oats, barley, millet and sorghum, although at a lesser extent than maize. Studies conducted with cassava flour on poultry indicate satisfactory results can be obtained in poultry feed when the inclusion rate of cassava flour in chick ration is between 5 and 10 percent (FAO 1994). In the swine industry, the inclusion rate might vary between 10 and 40 percent, while the rate can go up to 50 percent substitution of basal grass ration with 50 percent cassava leaves in cattle. Cassava-based animal feed for poultry is the most developed worldwide, and also the production with the main prospects in the Zambian market. However, cassava processing and handling are of major consideration to obtain satisfactory results, since poultry is particularly susceptible to microbial proliferations and aflatoxin contamination (IFAD 1994).

Cassava peels, which are a by-product of cassava processing operations, can also be successfully fed to animals. The peels should be dried and milled to a coarse particle size. They can also be mixed with dried cassava leaves to enhance their nutritional value.

In spite of available literature and experience in cassava-based animal feeds worldwide, none of the five livestock feed industries interviewed in Zambia is currently using cassava for their products. Generally, interviewees seem interested in exploring the use of cassava for their produce, although remain uncertain, mainly due to five factors: (i) uncertainty of supply and costs, (ii) lack of nutritional information, (iii) lack of established formula, (iv) concerns about toxicity of cassava due to poor management at processing level, (v) need of investment for machinery to process cassava flour[12].

Among the five interviewed firms, two have purchased cassava in the past for their operations. One has currently stopped due to constraints internal to the firm, while the other engaged in a trial in 2007. However, the trial was never translated into large scale production, mainly due to a combination of the factors mentioned above, and the fluctuating price in cassava supply, whose price increased following the trial. Four of the interviewed firms expressed an interest in receiving information over the processing of cassava for animal feed, both in terms of inclusion rate and toxicity. Four of the five firms interviewed recognized the potential in the use of cassava feed for their operation, although seem reluctant to invest in cassava-dedicated hammer mills in their firms, due to lack of information and uncertainty of supply/price.

The taskforce on Acceleration in Cassava Utilization suggests that on the basis of results in previous trials the cassava-based products would be commercially viable as long as cassava

[12] It is uncertain whether a cassava-dedicated hammer mill is actually necessary in order to process cassava for animal feed. However, four of the five firms interviewed indicated it as a necessity.

chips could be purchased at 60% of the price of maize (Simbaya 2006; Chitundu, Droppelmann, Haggblade 2006). However, this figure cannot be confirmed by the current study. Two main areas require further investigation to establish which substitution rate is viable in the Zambian market, the fact that cassava cannot completely substitute maize in the industry, since its low nutritional characteristics need to be supplemented with additional ingredients (substitution rate might vary also according to availability and cost of additional ingredients), and the lack of large scale production of mixed animal feed in the Zambia. Since the feed will keep a mixed nature, this might change the price of buying maize for firms (since the quantities would decrease). Similarly, the instability of supply for cassava might make the price fluctuate, given that price of maize also fluctuates due to Government intervention in grains market. Essentially, interviewed processors could not quantify the actual profitability of substituting cassava with maize in livestock feed, since price of both raw materials are variable and advocated for further clarification on the matter.

6 Conclusions

Cassava commercialization has great potential in Zambia, although neither farmers nor processors are currently fully exploiting this potential, with negative repercussions on farmers' income and on the development of the cassava sector.

The main limitations of the study relate to three areas that require development in further work. Specifically, due to the size of the sample set and on farmers' responses, it was not possible to identify significant differences in cost structure based on the scale of farms, the different cassava products processed by farmers, or by cassava varieties. Similarly, this study did not provide an estimate of non-cash costs of farmers, such us family labour. Further work might be useful to establish the impact of family labour and farm size on productivity and costs, as well as the profitability of employing new and traditional varieties, also in relation to different marketed products.

The main findings of this study in relation to producers revolve around five specific areas of development: (i) choice of varieties, (ii) organisation of labour, (iii) farming practices (iv) production methods (v) supplier-buyer linkages.

According to the literature, different varieties hold different marketing potentials, which both producers and buyers in the Zambian market overlook. The focus of farmers is on high yielding and fast maturing varieties. The new enhanced varieties introduced within the past decade could meet yielding and maturing requirements. However, based on observations from the sample, such varieties are not performing according to the potential as cited in the literature. This might be due to lack of training and farmers' awareness on better farming practices, as well as on poor storage and handling of cuttings, which might have exposed bundles to crosspollination and therefore diluted their yielding and maturing potential.

Labour is the largest cost involved in producing cassava in Zambia. Although the survey only focused on the quantification of the costs in hired labour, the diffuse use of family labour indicates that non-cash costs of labour are also high. This cost might be increased by the lack of mechanisation in the sector, as well as in the low rate of formalized cooperation among farmers.

According to data gathered, there is a difficulty among farmers in quantifying both costs and revenues from different cassava products. Similarly, post-harvest handling, processing and storage are not given adequate attention, resulting in poor quality products which do not meet safety or quality specifications of buyers. For instance, only one farmer among those interviewed could quantify loss of produce and value due to poor storing practices and pests infestation. Similarly, none of the farmers interviewed uses pesticides or fertilizer. There is a chance that improved farming practice might have a positive impact on developing the full potential of enhanced varieties.

The same is also observed in connection to production and processing methods and equipment. Organisations such as the Programme Against Malnutrition (PAM) provided some pilot projects where machinery is bought by the NGO and then utilized by different farmers' groups for processing. The same model might be taken into consideration at village or camp level, to maximize processing. Similarly, the model might be taken into consideration for production equipment. Moreover, practices such as leasing or renting of different machineries and equipment (for both production and processing purposes) might also be taken into consideration, perhaps in connection with farmers' associations or cooperatives at village and/or camp level.

Among interviewed farmers, only one produces cassava with a specific buyer as target (the paper and cardboard industry in the Copperbelt). This farmer is of medium scale, and also caters for the milling and transport cost of his product from Mansa to the Copperbelt, where buyers are located. There is little and contrasting information on buyers' requirements across farmers. For example, although stakeholders' discourse and literature put a relevant emphasis on the production and utilization of High Quality Cassava Flour (HQCF), none of the sampled farmers is actually producing HQCF on a regular basis, although there would be a market for it, particularly among processors for human consumption. Similarly, the adhesive/paper/wood industry utilising cassava could potentially be interested in starch production rather than flour, although there is no supplier supplying starch as such (since starch can be substitute for very fine cassava flour).

The main findings of this study in relation to processors revolve around two specific areas of development: (i) the current size of different processors operating within different supply channels and (ii) the actual potential of development for the different industries.

Cassava for industrial uses emerged as the most developed supply channel. The quantity of cassava purchased through this channel appears to be double that estimated in the literature, solely on demand from the adhesive, paper and wood industry. It would be useful to further the study for market potential of this specific industry. Similarly, it could be important to expand the mapping of the industry to the firms which are not currently using cassava in their processing, and might create further demand in the near future. The biggest advantage of this specific supply channel, differently from animal feed, is that the use of cassava in this sector is already in place, and does not depend on the development of farming or processing practice, since there are no concerns over cassava toxicity. Animal feed could potentially be an important driver for the cassava strategy, although the actual substitution rate remains unknown, since the price of both cassava and maize are uncertain and there is no firm currently employing cassava for animal feed on a large scale. Cassava for human consumption seems not to be particularly well developed at the moment. The market could expand considerably if more processors grow interested in mixing a certain percentage of cassava with wheat in manufactures such as snacks and biscuits and incorporating cassava flour into maize meal for nshima. However, food safety, overall quality and uncertainty in price and supply can play a significant role in the development of the sector.

Based on the findings, the strategy to develop the cassava sector in Zambia might usefully focus on the following six areas:

(1) Quantify the relative potential growth of the three analysed supply channels, and ensure that the cassava strategy reflects this. As discussed, currently industrial processors of glue, paper and wood industry are the largest buyers in the country. It might be useful to expand the mapping of processors to include those within the sector who are currently not employing cassava and to assess their growth potential, to determine the prospective growth of the sector in the shorter and medium term. As for human consumption and animal feed, results suggest that toxicity is among the largest obstacles to development of large-scale production, along with certainty of supply. A combination of research and training might prove useful in promoting the use of cassava in animal feed, both in assistance in providing the required formula and dealing with food safety.

(2) While the issue of food safety suggests caution would be required in trying to enforce 10% compulsory cassava inclusion across millers in the country, the strategy might prove successful in promoting uses of cassava in industrial sweeteners. Such products might be associated to production already developed in the country, such as beer and beverages, requiring refined sugars.

(3) Improved access to improved processing equipment (graters, presses and driers) would alleviate a major obstacle to improving the quality and increasing volume of processed products.

(4) Promote training and build capacity in the use and handling of new and traditional varieties. This specific target might touch upon both food and safety standards and farming practices. The survey highlighted the lack of use of chemicals and machineries in the growth of cassava products. Similarly, storage of cassava in dedicated spaces is limited, contributing to increased post-harvest loss due to pests and diseases.

(5) Given the potential for improving both production and processing, the strategy might assist in the development of financial tools appropriate for a more efficient production, processing and marketing (for example, improved access to finance might have beneficial results on farming practice as well as on productivity, with the investment in machinery for farmers and processors). This is also associated with the development of training programmes on finance along the value chain, for Financial Institutions and sector stakeholders.

(6) Promote the creation and strengthening of sector associations. This might have a positive impact on production and marketing. Sector associations have the potential to decrease the cost of hired labour through collaboration. Similarly, they have the potential to strengthen farmer-buyer linkages through vertical integration. Sector associations might also promote the use of contractual arrangements between processors and producers to assure certainty on prices and volumes received/delivered.

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