

**C:AVA**

Cassava: Adding Value for Africa



# **Cassava Market and Value Chain Analysis**

## **Uganda Case Study**

**Final Version**

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**Ulrich Kleih, David Phillips, John Jagwe and Michael Kirya**

**Bill & Melinda Gates  
Foundation**

**Natural Resources  
Institute, University  
of Greenwich, UK**

**Africa Innovations  
Institute, Uganda**

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## Abbreviations

AFRII	Africa Innovations Institute
ASARECA	Association for Strengthening Agricultural Research in Eastern and Central Africa
AT	Appropriate Technology
BMGF	Bill and Melinda Gates Foundation
C:AVA	Cassava: Adding Value for Africa
CBSD	Cassava Brown Streak Disease
CFC	Common Fund for Commodities
CIF	Cost, insurance and freight
CPC	Corn Products Kenya Limited
CMVD	Cassava Mosaic Virus Disease
DAO	District Agricultural Officer
DFID	Department for International Agriculture
DDF	District Development Fund
DSIP	Development Strategy and Investment Plan
EAAP	East African Agricultural Productivity Programme
FAO	Food and Agriculture Organization of the United Nations
FoB	Free on Board
GoU	Government of Uganda
GLCI	Great Lake Cassava Initiative
Ha	Hectare
HQCF	High Quality Cassava Flour
IITA	International Institute of Tropical Agriculture
MAAIF	Ministry of Agriculture, Animal Industry and Fisheries
MIS	Market information services
NAADS	National Agricultural Advisory Services
NaCRRRI	National Crop Resources Research Institute
NARO	National Agricultural Research Organisation
NGO	Non-Governmental Organisation
NRI	Natural Resources Institute

PEAP	Poverty Eradication Action Plan
PMA	Plan for Modernisation of Agriculture
PRA	Participatory Rapid Appraisal
SAARI	Serere Agricultural and Animal Production Research Institute
SSA	Sub Saharan Africa
SWOT	Strengths – Weaknesses – Opportunities – Threats
UBOS	Uganda Bureau of Statistics
UNHS	Uganda National Household Survey
URA	Uganda Revenue Authority
USAID	United States Agency for International Development
VCA	Value Chain Analysis
VPU	Village Processing Unit

**Exchange Rates**

May 2012

USD1 = Ush 2,450

GBP1 = Ush 3,700

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Last but not least we would like to thank the Bill & Melinda Gates Foundation (BMGF) for providing the funds for this project. The views expressed here are not necessarily those of BMGF.

## Executive Summary

This study was carried out by a Team from the Natural Resources Institute (Ulrich Kleih and David Phillips), Africa Innovations Institute (Michael Kirya), and FarmGain (John Jagwe) from 7<sup>th</sup> to 17<sup>th</sup> May 2012 to reassess the functioning of the cassava value chain in Uganda and analyse the industrial demand for dried cassava products (i.e. primarily dried chips or HQCF) and their equivalent in fresh roots. The value chain analysis highlighted the extent to which prices for both dried and fresh cassava are high in early to mid-2012, reflecting a shortage of supply of roots.

Cassava is identified as one of the emerging market oriented commodities that could contribute to improve the livelihood of small holder farmers in Uganda. Commercialization of higher-value cassava products is occurring at a small scale with HQCF being the main product traded. Since the implementation of projects to produce HQCF at smallholder level as part of the BMGF funded 'Cassava: Adding Value for Africa'(C:AVA) work, sales of HQCF have increased year on year. Between March 2011 and March 2012 a total of 805.3 tonnes of HQCF was sold across the following sectors:

- Biscuits 2 tonnes
- Paperboard 177 tonnes
- Rural bakeries 275.1 tonnes
- Agri foods (composite flours) 388.9 tonnes

Building on such initiatives, there is clear evidence of increased demand for HQCF and the intention of this study was to update the understanding of potential further demand for HQCF and other cassava-based products by actors in different manufacturing sectors. There is scope for further research to understand and seek solutions to supply and demand issues as at present there is insufficient supply of cassava of a sufficient quantity and quality to satisfy both traditional demand for fresh roots from a food security standpoint, and demand from emerging markets such as those discussed in this report.

This study has identified potential significant demand for HQCF and improved makopa chips. Analysis particularly highlights potential for:

- Substitution of wheat flour with HQCF in bakery sectors of up to 10%, subject to trials and support from national policy to look to replace wheat with HQCF from 10-30%. Conservatively demand for 15,000t HQCF in medium-term which is equivalent to 5% of current wheat flour usage;
- Increased use of HQCF in biscuit manufacture from 300t in the short-term towards 4000t of HQCF in the long-term, supported by committed interest shown in the industry for this;
- Immediate interest in HQCF for starch based adhesives in the paperboard industry. Some companies already using cassava, potential demand in short to medium term of up to 1000 tonnes per annum HQCF.

- Demand emerging in the animal feed sector, estimates of requiring 400t in the short-term towards 8,000t of improved chips in the long-term;
- Usage as an adjunct in beer brewing using either HQCF or improved chips starting with an interest in up to 2500t in the short-term subject to trials and availability.

On the basis of such potential demand, if it would be possible to increase supply of HQCF on a reliable basis, possibly with investment in artificial drying technology, and supplying improved chips then markets exist and are emerging for these products. The economic, social and environmental viability of different scales, locations and technologies, and different scaling-up strategies, need to be considered in greater depth. We recommend further, more detailed economic, social and environmental viability research before decisions are made on the most appropriate approaches to increase scale.

### Summary of market opportunities for cassava-based products in Uganda

Sector	Cassava-based product	Current/potential demand of cassava-based product (mt/year)				Long-term potential demand in root equivalents (mt/year)	Conditions	
		Current use	Short-term	Medium-term	Long-term			
a	Large-scale mills	HQCF	0	0	15,000	30,000	120,000	In progress national policy target to replace 10-30% wheat with HQCF for bread and biscuits. Here assumed maximum of 10% replacement.
b	Bakeries (rural)	HQCF	Limited	0	7,000	14,000	56,000	Long-term projection 10% of 140,000 tonnes used in non-bread rural baking products.
c	Bakeries (urban)	HQCF	Very limited	0	0	8,000	32,000	8,000 tonnes based on 10% of wheat for bread, subject to trials and changing industry policy and culture.
d	Composite flour	Chips / HQCF	700	700	1,000	2,000	8,000	Subject to making trial samples available, negotiation on potential increased supply, and growth in sales of wheat/cassava composite flour.
e	Biscuit manufacturers	HQCF	Limited	200-300	1000-2000	3500-4500	16,000	Subject to trials and slowly increasing the percentage of HQCF towards a maximum of 35% replacement in the long-term.
f	Animal feed	Improved chips	300-500	1200-2000	3000-5000	8,000	32,000	Subject to availability of chips at right price and quality, and finding a suitable protein solution.
g	Paperboard	HQCF (starch)	150	500	900	1,400	5,600	Trials need to be conducted, particularly with larger-scale users of starch. Medium to long-term potential to replace current sources 100% with cassava starch for SBAs.
h	Breweries	HQCF / improved chips	0	1500-2500	3,500	5,000	20,000	Initial orders subject to trials of HQCF and pricing of HQCF versus other starch inputs.
i	Distilling	Cassava starch	0	0	0	tbc		A long-term option, currently no cassava used to produce alcohol. Huge potential volumes, 1000s of litres per day but most likely cassava may become one of a few local sources of alcohol.
j	Textiles	Cassava starch	0	0	100	150	600	Unlikely to be an option for technical reasons.
k	Paper (newspaper)	Cassava starch	0	0	60	100	400	Research required to understand technical challenges to produce 'pure' starch from HQCF, i.e. with no ameno pectin
l	Plywood	HQCF	250	250	300	300-400	1,400	Already use traditional cassava flour but may switch to HQCF if trials positive.
m	Sweets	Liquid glucose	0	0	0	3,000	12,000	Currently no plant exists in Uganda so would require large-scale investment from private sector.
n	Other starch uses**	Cassava starch	0	0	0	500-1000	3,000	Subject to production re-commencing at Lira plant.
Total (without mandatory 10% HQCF inclusion in wheat flour for industrial use) [b+c+d+.....n]							187,000	
Total (with mandatory 10% HQCF inclusion in wheat flour for industrial use) [a+f+.....n]							195,000	

\*\* Could include pharmaceutical but very high quality required, may not be possible to produce locally. Also other food processing.

## Background

### Objectives of the study

The purpose of this report was to revisit the understanding of the Uganda market for cassava and cassava products building on the findings of other studies (such as NRI & AfrII, 2009, and IITA, 2003). The Terms of Reference (ToR) included the following:

- A review of published and grey literature on cassava markets and value chains in Uganda.
- Consultations with key informants (including actors in value chains, various service providers, policy makers and funding agencies with an interest in cassava markets and value chains) in Uganda.
- A field survey of potential market options, including regional markets.
- Communication of outcomes of investigations to BMGF staff and other stakeholders in-country. A dialogue will be maintained with staff of the Foundation to ensure synergies between activities.

### Methodology

Field work for the study was completed between 7 and 18 May 2012, focussing on the major demand centres of Kampala and Jinja. In addition, a visit was undertaken to Mbale and production and processing centres in Pallisa District.

The study covered both, aspects of the cassava value chain, as well as an analysis of industrial demand for dried cassava products (i.e. primarily dried chips or HQCF).

Checklists were used for the value chain analysis and the different industries visited in the course of the fieldwork.

A meeting was held at the National Crop Resources Research Institute (NaCRRI), Namulonge, to discuss preliminary findings of the study and industry requirements as far as potential supply of cassava products as a raw material for industrial use is concerned.

### Policy Setting

#### MAAIF

Cassava is one of the 10 strategic crops of the MAAIF / DSIP in that it is expected to be able to greatly contribute to the transformation of the agricultural sector. It is stated that “cassava holds the greatest opportunity and potential as an engine of growth as it is largely grown by smallholder farmers for food, nutrition and income security”.

Value addition and increased industrial use of the crop are encouraged. At the same time Government officials are aware that there are production constraints,

such as diseases (e.g. CMVD, CBSD), and poor agricultural practices (e.g. wrong spacing, poor management of planting material). Most cassava varieties grown in Uganda are sweet, white varieties, which are preferred by consumers compared to orange varieties, which are reputed to have a different taste. It is acknowledged that a cautious approach is needed, including the implementation of feasibility studies for different options as far as industrial use of roots is concerned.

### ASARECA

ASARECA is now organised along the lines of Programmes rather than Networks. In that context, cassava is amongst the priority crops of the Staple Crops Programme. A regional Centre of Excellence for cassava is being established at NaCCRI, Namulonge, with funds from a USD30 million World Bank loan, as part of the East African Agricultural Productivity Programme (start date in Uganda: March 2011). The latter is being coordinated by ASARECA, and will see the establishment of several other Centres within the region (e.g. Dairy Centre in Kenya).

The Centre of Excellence will be implemented by NARO, NAADS (extension), Ministry of Agriculture (seed), NGOs, and the private sector. The following areas are being targeted by the aforementioned East African Productivity Programme: Value addition and marketing, germplasm development, Integrated Pest Management (IPM), diagnosis of diseases, socio-economic aspects of cassava, tissue culture and transformation, cassava conservation. It was indicated that the value addition element of the programme has a high priority and is mostly based at the Kawanda Agricultural Research Institute (KARI).

### NARO

The National Agricultural Research Organisation (NARO) has the mandate to undertake research on crops such as cassava, and several of its member institutes are involved in cassava related research (e.g. NaCCRI, KARI, AEATRI). The speech by the President of the Republic of Uganda, H.E. Y.K. Museveni, at the Official Opening of the Second Scientific Conference on the Global Cassava Partnership of the 21<sup>st</sup> Century on 18 June 2012, confirms the importance which the Government attributes to research as part of agricultural development. For example, it is stated that MAAIF has placed agricultural research as the pillar of the Development Strategy and Investment Plan (DSIP).

## Cassava Production and Value Chain

### Production

Cassava, which can grow well on marginal lands, is one of the most important staple foods in Uganda. It is estimated that 60% of the production is destined for household consumption and 40% for marketing (Kimathi, et al, no date). According to Mugisa (2010), cassava, which is known as a “poor man’s crop”, is predominantly grown by subsistence farmers as a staple crop on plots averaging 1 to 3 acres.

Cassava production statistics are confusing in that there are large discrepancies between different sources of information, as demonstrated in the following figures and tables. Table 1 shows the cassava production figures according to the Uganda Bureau of Statistics (UBOS), quoted in Mugisa (2010). They indicate that there was a decline in production after 2005 from about 5.5 million tonnes to about 5 million tonnes in 2008, also reflecting a decline in yields from about 14.4 t/ha to 12.7 t/ha during this time period.

According to a speech given by H.E. YK Museveni (June 2012) the annual cassava production in Uganda is 6.7 million tonnes, compared to over 30 million tonnes produced annually in East and Central Africa.<sup>1</sup> In addition, it is recognised that the crop is important for animal feed and commercial use in industry sectors such as starch, beverages, and liquid glucose (H.E. YK Museveni, *ibid*).

**Table 1: Cassava Production in Uganda, 2004 - 2008**

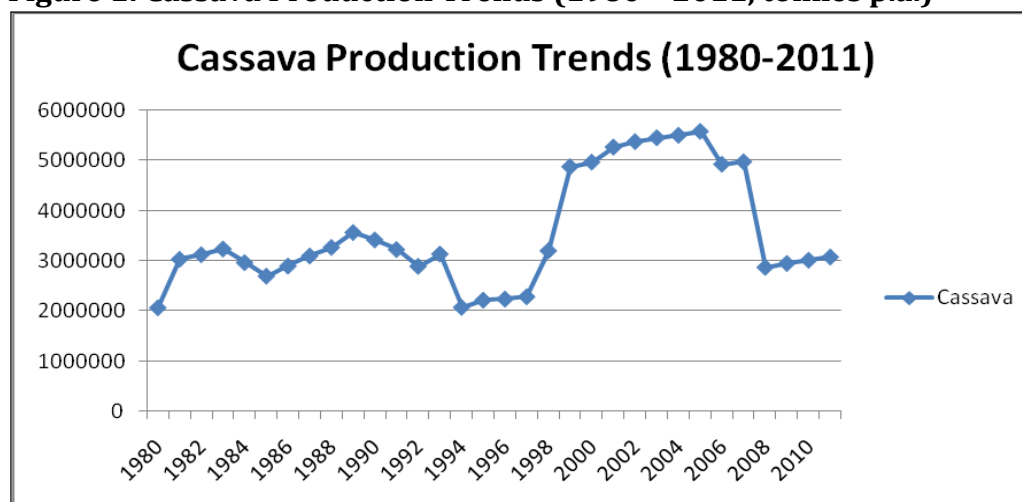
	2004	2005	2006	2007	2008
Area planted (Ha)	407	387	379	386	398
Production (MT)	5,500	5,576	4,924	4,973	5,072

Source: UBOS, 2009, in Mugisa, 2010.

Compared to the aforementioned data, Figure 1 illustrates a sharp drop of production at around 2007 from about 5 million tonnes to 3 million tonnes per annum. In particular the drop in production is due to Cassava Brown Streak Disease (CBSD). This has implications on yield figures. For example, the Agricultural Crop Census 2008/9 projection highlights cassava yields of 3.3 T/ha on high acreage of 933,333ha in 2012.

These major discrepancies in cassava production and yield data make it difficult to establish forecasts about demand and supply situations in the years to come. Amongst other things, this affects the availability of cassava that can be used for industrial processing. The fact that cassava prices have been high since about 2008 confirms data that demonstrates a sharp drop in production.

<sup>1</sup> Speech by H.E. Yoweri Kaguta Museveni, President of the Republic of Uganda at the Official Opening of the Second Scientific Conference on the Global Cassava Partnership of the 21<sup>st</sup> Century, 18<sup>th</sup> June 2012; Speke Resort Munyonyo, Kampala.

**Figure 1: Cassava Production Trends (1980 - 2011, tonnes p.a.)**

Source of data: UBOS/MAAIF 2008/9 Crop Census

Since cassava does not have a mature stage, the crop can be harvested at a farmer's discretion (Mugisa, 2010). A plant can be harvested when its roots are sufficiently developed to meet consumers' needs or delayed until the next growing season. This feature makes cassava an ideal secondary crop for small-scale farmers in Uganda as they can stagger their harvesting activities for food consumption or marketing activities. For example, harvesting can be delayed if the market is oversupplied. At the same time, given the plant's physical attributes (i.e. perishability within a few days), post-harvest activities must follow a strict short timeframe, which constrains a farmer's ability to devote time to post-harvest activities of fresh cassava.

As indicated above, cassava is one of the staple food crops in Uganda, and is a major food security crop used for home consumption. Nevertheless, cassava is also traded either in the form of fresh roots or dried chips/flour. The following sections describe both the markets and value chains for fresh roots and dried cassava.

### Fresh cassava markets and value chain

With its expanding population, Kampala is Uganda's largest market for fresh cassava roots with supplies mainly coming from districts to the West of the capital, such as Masindi, Hoima, Masaka, and Mubende. This is likely to be due to distance and better transport links with that part of the country. Fresh cassava supplies from districts to the East of the capital (e.g. Busoga region) appear to be in the minority.

According to traders, Kalerwe Market is the main wholesale market for fresh cassava. Others include St Balikuddembe Market (formerly Owino) and Kawempe Market. In addition to the capital Kampala, fresh cassava is traded in major district towns such as Jinja, Lira, Mbale, and Mbarara. Although small quantities of roots are also traded in smaller towns, it can be assumed that a significant proportion of the inhabitants of these rural towns are also cassava producers.

Fresh cassava roots are usually traded in bags. However, unlike dried cassava (i.e. 100 kg bags), bags with fresh cassava are not measured and it is estimated that they weigh on average approximately 150 kg, and in some cases up to 200 kg.

Consumers have a preference for sweet, soft varieties, which fetch higher prices. On the other hand, bitter varieties fetch lower prices. Also, it was indicated that a red-skinned variety, which is only produced in the Masindi area, is particularly liked by consumers and fetches a high price (US\$ 70,000 per bag at farm level, and over US\$ 100,000 in Kampala). The latter variety is in relatively short supply and the quantities traded are smaller.

In June 2009 it was reported that 20 – 30 bags of red-skinned type cassava arrived in Kalerwe market, whilst it was 50 – 60 bags of other varieties. Assuming a total arrival of 80 bags of 150 kg per day, would mean a total quantity of 12 tonnes per day in this market. Due to time constraints it was not possible to assess the total annual consumption of fresh roots in Kampala.

#### **Players involved in fresh cassava marketing**

Fresh cassava trading is highly stream-lined by comparison with dried cassava trading. This is due to the perishability of fresh cassava which requires swift movement of the roots from the farm to the consumer, with a minimal number of transactions. As a result, fresh cassava tends to arrive within 24 hours after harvest in Kampala. According to traders, the cassava will be harvested during the day and then transported at night to Kampala, where it arrives in the early morning hours. Retailers will then sell the bulk of the roots during the following day. Unsold cassava roots are stored for a maximum of one night, and roots which are still not sold by then will be used for sun-drying.

Farmers have the following options of selling cassava to traders:

- Travelling trader from Kampala buys entire field (i.e. garden) and arranges for uprooting of the harvest; sometimes the traders use agents.
- Farmers harvest the roots themselves and sell the bags (usually 150 kg and more) to local agents or the travelling traders from Kampala.

As already described, travelling traders who are based in urban areas such as Kampala, play an important role in the marketing chain. They hire vehicles such as pick-ups or trucks of variable sizes (about 4 – 10 tonnes capacity), and have at the same time a wholesaler function. If they are based in a particular market they can also by-pass the commission agents who tend to play an intermediary function between suppliers and urban retailers.

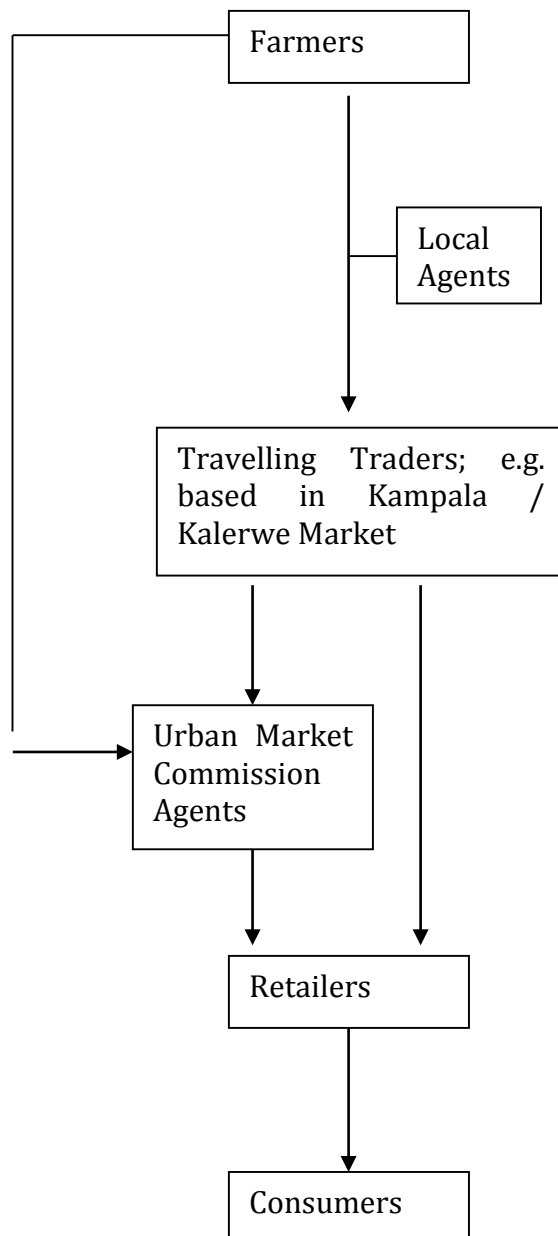
Due to their financial resources, travelling traders / wholesalers deal in larger quantities (e.g. 5 – 10 bags per day, and more), whilst retailers sell one bag or less per day. The latter may sell cassava in small heaps in or near the wholesale markets or take the roots to smaller retail markets in other parts of the town.

Women play an active role in fresh cassava marketing, in particular in retailing. Wholesale trade is more dominated by men – reasons given include financial

requirements as well as the physical side of the job (i.e. lifting of heavy bags, although that is usually done by porters), and women preferring not to travel at night which is part of a cassava wholesaler's job.

Figure 2 provides an overview of the fresh cassava value chain, linking Kampala with supply areas such as Masindi, Hoima, Mubende and Masaka Districts (all districts located in the West of the Capital).

**Figure 2: Fresh Cassava Value Chain**

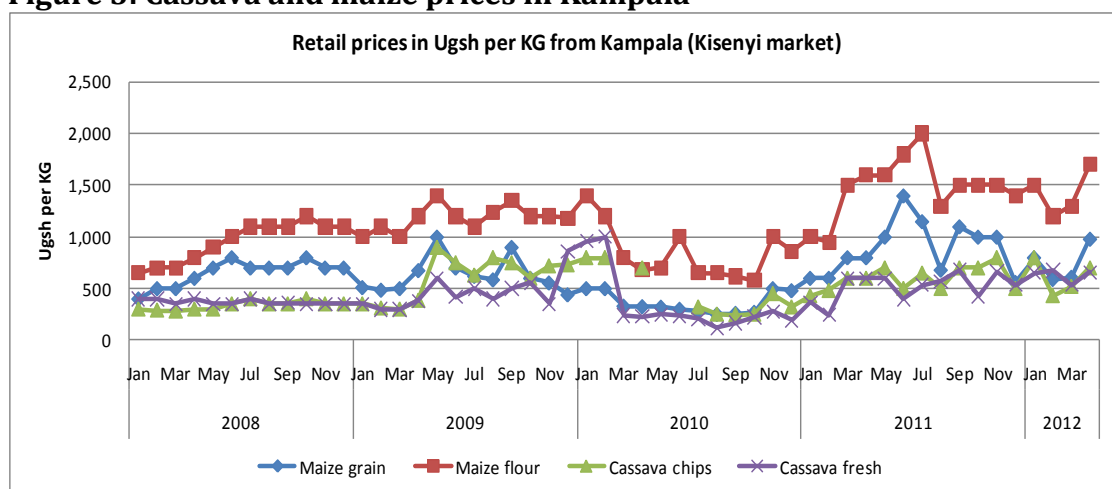


## Prices, costs and margins

In Uganda, fresh cassava is traded in large bags which weigh approximately 150 kg. There was scarcity of fresh cassava on the Kampala market when the survey was undertaken (May 2012), which was reflected in the small quantity and poor quality (e.g. small size) of roots available in Kalerwe Market. For example, it was reported that on the day of the survey 4 trucks each with 30 bags of fresh cassava had arrived in the market (i.e. about 18 tonnes in total), which compares with 10 trucks arriving daily during the main harvest time. At the same time, traders reported that “several” years ago about 60 trucks arrived in the market every day. This latter figure would need to be validated, however with an apparent shortage of cassava in Uganda it is clear that cassava prices are much higher in 2012 compared to ten years ago.<sup>2</sup>

Figure 3 provides prices of cassava (fresh and dried) and maize (grain and flour) in Kampala. Additional tables with food prices for other locations are presented in Appendix 5. Whilst prices have generally fluctuated between 2008 and 2012, it is notable that there has been little difference between the prices of dried and fresh cassava, and in some months the price for fresh roots has exceeded the price of dried chips. Price signals suggest producing and selling more fresh roots, but due to factors such as the short lifespan of fresh roots post-harvest and traditional practices, processing remains widespread.

**Figure 3: Cassava and maize prices in Kampala**



Source: Farmgain Africa, 2012 ([www.farmgainafrica.org](http://www.farmgainafrica.org))

Table 2 provides an overview of costs and margins within the fresh cassava marketing chain. It is interesting to note that farmers in 2012 obtain over 40% of the final selling price, which compares favourably with periods when cassava prices were very low. For example, a study undertaken in 2002 indicated that farmers obtained between 17% to 26% (USh 4,000 – USh 6,000 per bag) of the Kampala retail price, depending on whether they sold their fresh cassava as ‘standing crop’ or already harvested (NRI/Foodnet, 2002).

<sup>2</sup> In 2002 farmers indicated they received prices of Ush 4-6000 per bag (NRI/Foodnet, 2002); in May 2012 they indicated prices of Ush 30,000 per bag and higher.

In May 2012 traders indicated how the Kampala wholesale price of cassava relates to farmgate prices. The wholesalers' gross margin is of the order of Ush20,000 to Ush25,000 per bag of fresh roots (150kg) which remains relatively constant. Therefore, when prices of fresh roots are higher farmers are able to obtain a higher share of the retail price. At the same time, lower quantities of roots available for sale restricts the turnover of traders. In interview traders complained about declining supplies citing poor yields, in part due to cassava brown streak disease. Also, the low quality (i.e. in particular the small size) of roots arriving in the market was highlighted as a concern. Regarding varieties, traders indicated that traditional varieties have a longer shelf-life (three days) compared to new varieties, which reportedly have a shelf-life of one day.

Traders of fresh cassava in Jinja portrayed a similar story to that in Kampala, also complaining about declining supplies, which they attributed to cassava brown streak disease and production constraints (e.g. tractor hire for ploughing is more difficult and farmers rely more on hand hoes). For example, one wholesaler stated that about five years ago five lorries would have supplied the Jinja market every day, whilst now (May 2012) it is one lorry per day. This is also reflected in higher prices; a bag of fresh cassava (150kg) sells at Ush 70,000 in a village in Kamuli and Ush 100,000 in the Jinja wholesale market.

According to traders in Jinja, supply of fresh cassava does not fluctuate very much throughout the year, perhaps with the exception of July when supplies are lower. At the same time, demand for fresh cassava has been declining due to high prices. As a consequence, consumers seek alternative foods such as sweet potatoes, the price of which has increased much less compared to cassava. Traders stated that unsold roots would be chopped up into chips and sun-dried for three days. As for varietal preferences, new varieties also have a poor reputation in Jinja which is relatively close to important cassava production centres. Local varieties such as Kayobyoby allegedly are less affected brown-streak disease.

**Table 2: Costs and margins within the fresh cassava value chain**

Case study: Trader based in Kampala buying from farmers in Masindi District and selling to retailers in Kampala, May 2012

	Ush/bag of 150 kg	% of final selling price
<b>Farmer</b>		
Selling price	30,000	43%
<b>Travelling trader, based in Kampala</b>		
Purchase price	30,000	
Selling price, Kalerwe wholesale market	50,000	71%
Gross margin	20,000	
Costs		
Miscellaneous labour (handling)	2,000	
Packaging material	500	
Transport	10,000	
Transport tax (police)	1,000	
Market dues	1,000	
Capital costs ( @ 3% of all costs)	1,335	
Total costs	15,835	
Net margin	4,165	
<b>Urban retailer, Kampala</b>		
Purchase price	50,000	
Selling price	70,000	100%
Gross margin	20,000	
Costs		
Transport/handling	2,000	
Market dues	1,000	
Capital costs (@3% of all costs)	1,590	
Total costs	4,590	
Net margin	15,410	
<b>NB.</b> Net margins are before income tax and payment of trading license; Figures are average figures based on discussions with traders in Kampala in May 2012		

## Dried cassava markets and value chain

In addition to fresh cassava, substantial quantities of cassava are consumed in dried form. This tends to involve peeling, slicing / chipping, sun-drying, and milling of cassava. It is assumed that most of the flour in Uganda is sold in traditional markets as very small amounts are sold through supermarkets and shops. According to NRI/AfrII (2009), it is estimated that about 200,000 tonnes of cassava flour are consumed per annum in Uganda, which is the equivalent of between 600,000 to 800,000 tonnes of fresh cassava. Using Uganda National Household Survey data from 1996/97, Collinson et al (2003) estimate that the quantities of cassava flour purchased and consumed from own production totalled about 180,000 tonnes in 1997.

Cassava flour is also often mixed in various proportions with millet flour to produce a more nutritious and tasty composite flour, which is preferred by certain populations of the country (e.g. those in the Eastern Uganda). In addition to the cassava flour consumed in Uganda itself, one must add substantial quantities that are exported to neighbouring countries. During the course of the survey (May 2012) it was reported that large quantities of cassava flour were exported to Southern Sudan. Also, some exports were going to the Democratic Republic of Congo (DRC), and occasionally Kenya, Tanzania, and Rwanda.

### Players in the dried cassava value chain

Figure 4 reveals the complexity of dried cassava marketing. The number of links in the chain reflects the many services that are required to deliver cassava flour to consumers. From harvest to purchase at the local store, cassava must be processed into dried chips, bulked (in other words, assembled into tradable quantities), transported, stored, milled and finally retailed at convenient locations for consumers.

Similar to the fresh cassava value chain, high food prices have led to a situation where the farmers' share of the final price is quite favourable (e.g. over 50%). This compares to a situation of higher production and supply of cassava when the farmers' share can be as low as 15% - 20% (NRI/Foodnet, 2002).

The roles of each participant in the value chain, and a description of their relationships and transactions with other participants is given below.

**Farmers.** Farmers harvest, peel, slice / chip, and dry cassava roots. In most cases they sell on a cash basis. Farmers have several marketing options. Using their own or hired transport they can sell to:

- Travelling traders (often via a depot next to a mill in a trading centre),
- Local agents/assemblers who act on behalf of district based wholesalers / millers, or
- Local retailers and consumers.

**Local agents / village assemblers.** These individuals use their local knowledge to bulk cassava chips from the surrounding area. Customers (i.e. usually

wholesalers from local towns or travelling traders) are willing to pay for this service because they would otherwise have to spend time and money assembling sufficient quantities of cassava chips to justify the cost of transport to the next stage in the value chain. To some extent, the assemblers also sort chips into a high quality white, well dried grade chips and a lower quality discoloured grade, sifting for extraneous matter in the process (Collinson et al, 2003).

***District level wholesalers/millers.*** These traders, who at the same time often own one or two hammer mills, operate in district level towns such as Soroti, Pallisa or Jinja. They supply flour to:

- Exporters of flour to neighbouring countries (e.g. Southern Sudan, DRC);
- Wholesalers in Kampala;
- Local retailers.

Their primary roles include the processing of chips into flour, and to store the flour in volumes that are sufficient to enable their customers to transport it to the next destination.

***Travelling traders.*** These traders supply large quantities of cassava flour to export markets and urban consumer markets. They turn over their capital rapidly by minimising the length of time between purchase and sale. Such traders buy from several village assemblers in one trip, and hire vehicles to transport the chips to the urban centres, where they pay for milling and sell flour to wholesalers or to exporters.

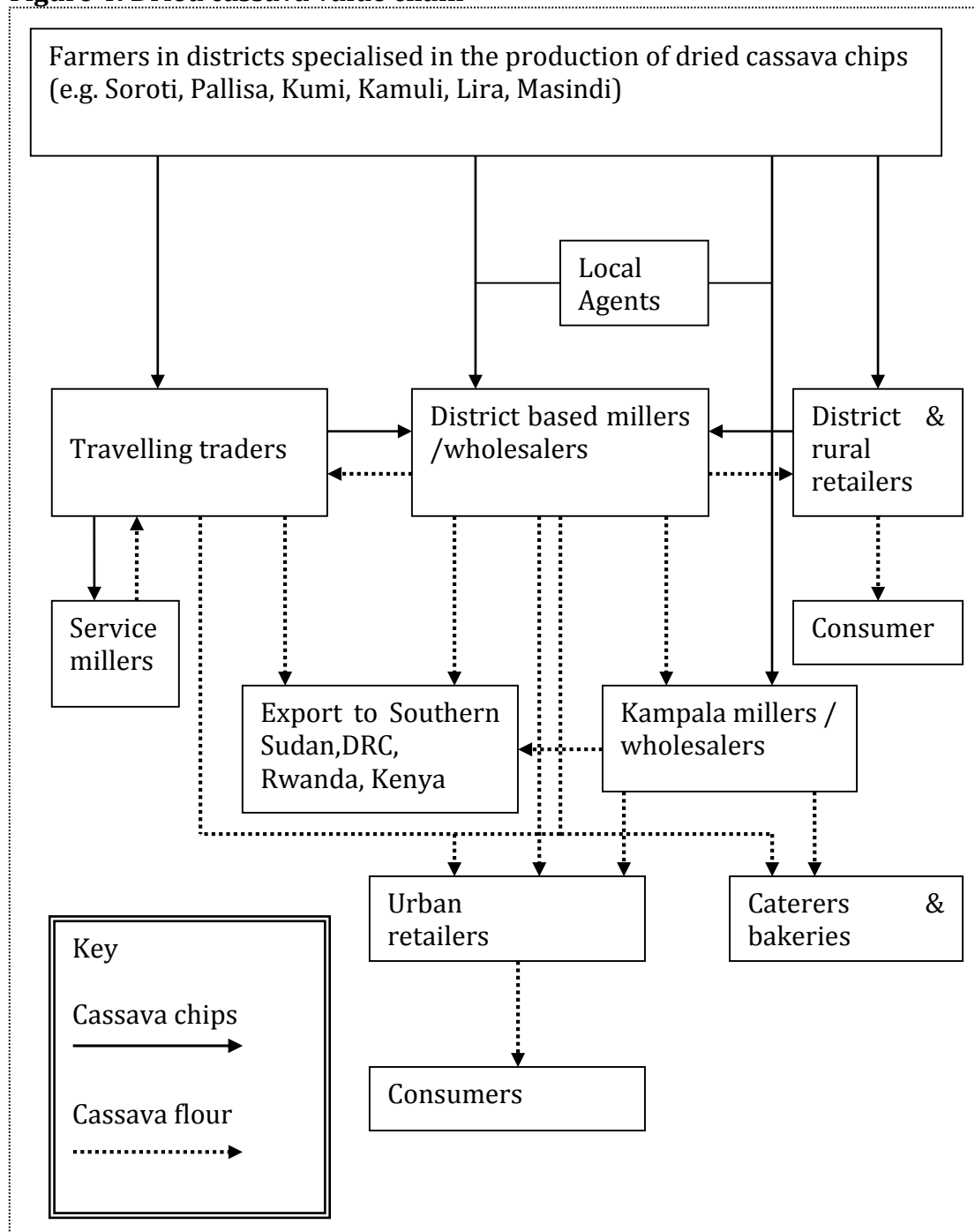
***Kampala based wholesalers / millers.*** In particular, in Kisenyi market of Kampala, a number of traders combine cassava flour milling with wholesaling. These operations purchase cassava chips either directly from village assemblers via agents or from travelling traders.

***Service millers.*** Such businesses do not engage in trade but merely provide milling services. In rural areas and the smaller district towns, millers often use small petrol or diesel powered mills, mainly for milling of maize and cassava. In larger towns, millers are often specialised and run electrically powered mills.

***Urban Retailers.*** The majority of food retailing in urban areas is characterised by a large number of small, non-specialised stores, which sell small quantities of numerous products including different types of flours and household products. Women play an important part in retail trading.

***Exporters.*** This category of trader may be based in Uganda or in neighbouring countries (e.g. Southern Sudan) from where they come to purchase significant amounts of flour. Exports tend to take place via export trading hubs such as Arua, but also via Kampala.

**Figure 4: Dried cassava value chain**



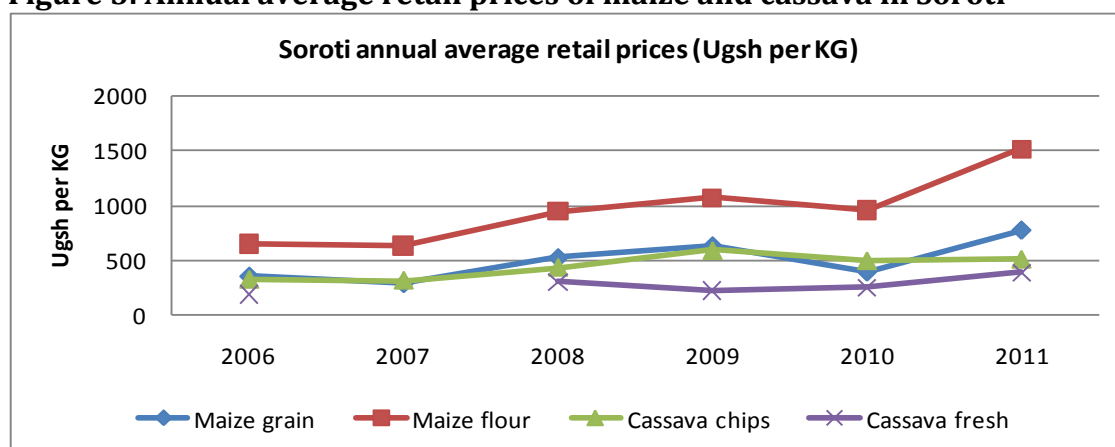
**Table 3: Costs and margins within dried cassava value chain**

Case study: Chips bought in Kamuli and flour sold in Jinja

	Ush/bag of 100 kg	% of final selling price
<b>Farmer, based in Kamuli District</b>		
Selling price, chips	60,000	67%
<b>Trader, based in Jinja Town</b>		
Purchase price, chips bought in Kamuli	60,000	
Selling price, flour	90,000	100%
Gross margin	30,000	
Costs		
Miscellaneous labour	1,500	
Transport	4,000	
Milling, Jinja town (Ush 40/kg)	4,000	
Packaging material	1,100	
Market dues	1,000	
Loss' (3% loss during milling)	1,800	
Store rent	500	
Capital costs ( @ 3% of all costs)	2,217	
Total costs	16,117	
Net margin	13,883	
<b>NB.</b> Net margins are before income tax and payment of trading license; Figures are average figures based on discussions with traders in Jinja, reflecting the situation between October and December when supplies are more abundant		

### Dried cassava prices

Given that about 3 kg of fresh cassava are required to obtain 1 kg of dried chips one would expect a similar price ratio between the two products. However, as Figure 5 shows, this is clearly not the case in Soroti, which is a major centre for cassava production and processing in Eastern Uganda. It is assumed that this reflects market anomalies introduced by low supply of fresh roots and high demand for dried cassava from within Uganda and neighbouring countries, an issue also noted above in the discussion of fresh roots prices.

**Figure 5: Annual average retail prices of maize and cassava in Soroti**Source: Farmgain Africa, 2012 ([www.farmgainafrica.org](http://www.farmgainafrica.org))

## **Market Study**

### **Wheat Milling Sector**

According to latest data from the Ugandan Ministry of Agriculture (MAAIF) and the Uganda Bureau of Statistics (UBOS) Uganda imports approximately 400,000 tonnes of wheat from countries including the USA, Russia, France, and Australia. The milling conversion rate from wheat to flour is 75% and therefore Uganda produces 300,000 tonnes of milled wheat for domestic consumption. The MAAIF national policy is to work towards replacing 10-30% of wheat with HQCF for use in bread and biscuit manufacture.

The milling sector consists of five to six principal millers, most located in Kampala but there is also some milling capacity in Jinja. From discussions with some millers it appears there is capacity to double the quantities of wheat currently milled. There are projections in some sectors of 10% annual growth in demand for wheat flour and therefore in 10 years Uganda could potentially mill twice the amount of wheat it currently mills. There is no formal association of millers but representatives of each company do meet on an ad hoc basis to discuss sector issues.

As with other commodities, wheat prices have sustained increases since 2008. Imported wheat prices since 2008 have ranged between US\$270.00 to US\$320.00 F.O.B. Mombasa, plus US\$130.00 – US\$150.00 to have delivered to Uganda on C.I.F. basis. Therefore the total cost is approximately US\$450.00 / tonne for imported wheat delivered to millers in Uganda. Wheat flour is currently sold at UGX2000 / kg (approximately US\$800 / tonne) to users of wheat flour, principally in the bakery sector.

### **Urban consumption**

Data obtained from interviews indicates a consumption of approximately 100,000 tonnes of wheat flour for use in the urban bakery and composite flour sectors. In the bakery sector there are around 30 urban bakeries, most located in Kampala but also in Jinja, mainly producing bread for the urban household sector. Larger urban bakeries consume up to 60,000 tonnes of wheat flour (across ten companies); medium-scale bakeries use 15,000 tonnes; and a few smaller bakeries consume up to 5,000 tonnes between them. The remaining 20,000 tonnes of wheat flour in urban areas is used in the composite flour sector.

### **Composite flour**

In the short-term the composite flour sector represents an immediate market potential for more sales of either HQCF or improved cassava chips as grits are often used in composite flour blending. Cassava flour is already used in composite flour manufacture, especially for markets in the east of Uganda where a blend of 60% cassava flour and 40% millet is a common staple food. As a result more than 700 tonnes of cassava flour is currently consumed in composite flour manufacture (80% as chips, 20% as flour), and potential demand exists for at least a further 2000 tonnes per annum of HQCF (or high quality chips) with a

willingness to look at replacing 10% of the 20,000 tonnes of wheat flour currently used.

### Urban bakeries

In contrast, there is a strong resistance in the urban bakery sector to consider substituting up to 10% of wheat flour with HQCF in bread manufacture. Anecdotally it appears from previous trials that bread produced using cassava does not produce the same quality loaf, particular issues relate to a lack of brown crust which gives a 'half-baked' appearance to the bread, and also inconsistency in the bread volume. There remains a significant marketing and technical challenge to overcome the perception of cassava flour as an inferior raw material that produces an inferior product that consumers won't buy. Furthermore significant competition in the bread market bakers did complain of thin margins and are therefore more risk averse when it comes to tampering with their current products and trialling something new such as HQCF.

The main concerns expressed by those interviewed are:

- Scepticism regarding consistency of supply
- Concern that cassava flour will not be clean (cassava flour sold in markets often dirty)
- Negative consumer perception of cassava so wouldn't want to put cassava on labels
- Too much starch could be an issue (to be verified)
- Cassava may weaken the volume / size of bread
- 

Due to the level of scepticism and also lack of trials, in discussions there was a suggestion to organise some consumer taste panels after further trials of using 10% HQCF have been completed. The Uganda C:AVA team will follow up on this along with other trials as soon as sufficient quantities of HQCF are available from July/August 2012.

### Rural bakeries

Compared to the urban bakery sector a more likely short to medium term market sector for HQCF can be found in the rural bakery sector. Rural bakeries, which constitute hundreds of small-scale operations, consume approximately two thirds (200,000 tonnes) of wheat flour in Uganda. Around 70% of this (140,000 tonnes) is used to produce non-bread products including chapattis, donuts, pancakes, and baghias. The remainder is mainly used for local bread manufacture. Cassava flour is already used as home-baking flour for production of non-bread products, and at a sector level there is a realistic potential demand for 14,000 tonnes per annum of HQCF (10% of 140,000 tonnes wheat flour currently used).

From a commercial perspective, wheat flour costs on average UGX2000 per kg (US\$ 0.8 per kg) from the handful of large millers in Uganda. In contrast HQCF is currently offered between UGX1400-1700 (US\$ 0.55-0.65 per kg) per kg and

therefore represents a potential 25% reduction in raw material cost applied to the percentage of HQCF that is used to replace wheat flour.

**Table 4: SWOT Analysis – Wheat milling industry**

Strengths	Weaknesses
<ul style="list-style-type: none"> <li>• Large processing capacity.</li> <li>• Investment capacity in new technologies including drying equipment.</li> <li>• A few millers may be prepared to mix flour provided there is legislation on blending HQCF with wheat flour.</li> <li>• Standards have been drafted for composite flour.</li> <li>• Rural bakeries appear more open to mix cassava flour with wheat flour, mainly for non-bread products.</li> </ul>	<ul style="list-style-type: none"> <li>• Absence of supporting legislation for HQCF inclusion in wheat flour.</li> <li>• Millers fear losing their market if they include HQCF on their own.</li> <li>• Bakeries don't accept wheat flour if cassava flour is included, especially in Kampala.</li> <li>• Potential for cost savings is limited if inclusion rates of HQCF are low.</li> <li>• Poor consumer perception – cassava has reputation of poor person's food.</li> </ul>
Opportunities	Threats
<ul style="list-style-type: none"> <li>• Growing demand for bread and bakery products.</li> <li>• High wheat flour price may provide incentive for HQCF inclusion.</li> <li>• Local sourcing of cassava in Uganda has competitive advantage and generates social capital (i.e. support of local communities).</li> </ul>	<ul style="list-style-type: none"> <li>• Limited awareness of HQCF and its uses.</li> <li>• No consistent supply of cassava and HQCF.</li> <li>• Cassava brown streak disease (CBSD).</li> <li>• High cassava prices can be disincentive.</li> <li>• Limited processing capacity.</li> <li>• Inadequate Government support to boost cassava production.</li> </ul>

## Biscuit Industry

There are four main biscuit manufacturers in Uganda (Britannia, Riham, Uganda Biscuits and Fontana). The biggest user of wheat flour is Britannia (about 60% market share), which buys approximately 6,000t – 7,200t per year. In total, it is estimated that approximately 10,000t to 12,000t of flour are used in the Ugandan biscuit industry. It is generally assumed that it is possible to replace up to 35% of wheat flour with HQCF in biscuit production, which would mean a potential opportunity for 3,500t to 4,200t per annum. At the same time, industry sources indicated that they envisage an inclusion rate of 10% to start with (i.e. market potential of 1,200t), given that the type of biscuit which would include cassava flour is expected to be voluminous (i.e. requiring a high gluten content to ensure appropriate raising properties of the dough). Britannia managers stated that they would prefer to start with 20 tonnes of HQCF per month, which could be slowly increased to 60 tonnes per month. They reiterated the importance of continuous supply of HQCF.

There have been some efforts to encourage the Ugandan biscuit industry to use cassava flour in their manufacturing process. Around 2002, Britannia had an unhappy experience when, after some successful trials using cassava flour, they were badly let down when the supplier tried to supply commercial quantities and failed to deliver the correct quality at the correct time. As a result, the company stopped using cassava flour in biscuit manufacturing.

Britannia's interest in using cassava flour restarted again as a result of the C:AVA project. In particular, their General Manager of Operations and the Quality Manager have been involved in activities that should facilitate the use of HQCF in biscuit manufacturing. For example, this includes participation in standard setting meetings at East African Community level. Draft standards were agreed at these meetings which reportedly allow the use of HQCF in biscuits under provisional certification.

Other HQCF related activities by Britannia involved production of biscuits on a trial basis, including testing the product after one year of storage. According to company representatives, there was little difference in the product compared to biscuits that are made from 100% wheat flour. They also did trials based on a 15% HQCF inclusion rate which also showed positive results. In view of these encouraging results, a company representative also visited cassava processing sites in order to obtain a view on HQCF manufacturing and potentially provide processors with advice.

It is to be determined in future negotiations the price a company such as Britannia would be willing to pay for HQCF. As of May 2012, Britannia paid USD 0.7 to USD 0.73 per kg<sup>3</sup> of wheat flour delivered at factory gate. Therefore, working on the assumption that biscuit manufacturers would pay up to 80% of

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<sup>3</sup> This corresponds to Ush1715 to Ush1788 per kg or Ush85,750 to Ush89,425 per bag of 50 kg (based on an exchange rate of Ush2,450 per US Dollar). Figures are based on price information obtained in May 2012.

wheat flour prices, a processor of HQCF would have to supply at around USD 0.56 to USD 0.58 per kg (Ush1,372 to Ush1,431) or Ush68,600 to Ush 71,540 per 50kg bag.

It was stated that the wheat flour price is high because it can only be imported at a high import duty (i.e. 60%), whilst imported wheat is duty exempt (situation in May 2012). Growth expectations of the biscuit industry were indicated to be of the order of 10% per annum. This includes exports to neighbouring countries such as Rwanda, Burundi, Democratic Republic of Congo (DRC), and South Sudan. No exports to Kenya are taking place because a sister company of Britannia is producing biscuits there. At the same time, some producers stated that competition in the biscuit industry is intense, due to competition amongst domestic producers and imports from countries such as South Africa, China, India, and Kenya. The URA data also showed that Uganda imported 1,200t of biscuits in 2008, which was down from 1,800t in 2007. These biscuits come from a range of sources, cheaper imports come from India, Pakistan and the Middle East and more expensive ones are imported from South Africa and Europe.

Riham, the second company visited as part of the survey, reported stiff competition in the sector, but also explained that the company is expanding production facilities. Although the headquarters is in Kampala, the company also has a factory in Tanzania. As of May 2012, Riham is using 1.5 tonnes of wheat flour per day (i.e. 39 tonnes per month). In view of this it has been estimated that the company could use 4 tonnes of HQCF per month (i.e. 48 tonnes per annum). The company predominantly uses soft wheat flour, which is mainly used for cookies, which is the main type of biscuit consumed in Uganda. Crackers require hard flour dough, whilst fermented dough is used for salted cookies.

Regarding specific HQCF quality requirements, the company stipulated that cassava flour shouldn't change the quality and the texture of the product. The company has tested HQCF in the past and overall the result was positive. Nonetheless, the quality manager of the company indicated several issues which should be borne in mind:

- Supply of HQCF was not always consistent, as a consequence of which sometimes more water was required during biscuit manufacturing and sometimes less (i.e. due to varying moisture content of HQCF). In view of this some samples were not satisfactory.
- More raising agents were required due to decreased raising capacity of composite flour.
- Sometimes there is a bitter aftertaste in biscuits as a result of HQCF inclusion in flour, which should be avoided.
- HQCF sometimes has a low starch content which is the result of starch being lost during grating and drying of cassava. As a consequence, the biscuit manufacturer needs to add additional starch to the dough.

Riham has used HQCF in the past but encountered difficulties when the UBOS confiscated a batch of biscuits due to the use of cassava flour in its production which at the time was not permitted.

**Table 5: SWOT Analysis – Biscuit Industry**

Strengths	Weaknesses
<ul style="list-style-type: none"> <li>• Testing of biscuit production with HQCF has been done and product line developed. Test results have been positive.</li> <li>• Satisfactory shelf-life test by largest player.</li> <li>• Biscuit standards for inclusion of HQCF have been developed.</li> <li>• There is potential for reducing input costs without compromising quality.</li> </ul>	<ul style="list-style-type: none"> <li>• Reduced raising properties of dough containing HQCF.</li> <li>• Lack of knowledge about biscuit recipes containing HQCF.</li> <li>• Need to use other materials (e.g. raising agents) when using HQCF.</li> <li>• Processing of HQCF may reduce starch content, as a result of which starch may have to be added to dough.</li> <li>• Limited benefits in terms of cost reduction if HQCF inclusion levels are low.</li> </ul>
Opportunities	Threats
<ul style="list-style-type: none"> <li>• Immediate, medium size market demand exists.</li> <li>• Local sourcing of raw materials (i.e. HQCF) has advantages (social capital).</li> <li>• Biscuit manufacturers' trucks can be used for transport of HQCF at reduced rates (they are often empty when returning from delivery).</li> </ul>	<ul style="list-style-type: none"> <li>• Competition from cheap biscuit imports.</li> <li>• Inconsistent supply of HQCF.</li> <li>• Farmers and biscuit manufacturers fail to agree on a price for HQCF.</li> <li>• High prices of cassava due to undersupply and CBSD.</li> </ul>

## Paperboard (boxes)

Paperboard boxes are manufactured in Uganda for both domestic and regional markets. Principal exports are to neighbouring countries, i.e. Rwanda, South Sudan, Burundi, and DRC. Evidence from this research suggests some optimism of 10% growth per annum in the sector, however this should be cautioned as this is a competitive industry making margins tight, and the general economic slowdown since 2011 has started to affect some order quantities.

In the paperboard industry starch is used to produce starch based adhesives (SBAs) which consist of a blend of water, starch, borax, and caustic soda. There are six paperboard manufacturers in Uganda identified in this research,<sup>4</sup> between them they consume 120 tonnes of starch per month, or 1440 tonnes per annum. Two companies dominate the market accounting for 80% of market share, a third company accounts for 10%, and the remaining 10% of the market is shared between the three smaller companies. The three largest companies all currently use 100% maize flour as the raw material for their starch, however two of the smaller companies are already using High Quality Cassava Flour (HQCF) for their starch. More is discussed on raw material supply and substitution options below.

The maize starch that accounts for over 90% of starch supply for SBAs is imported from Corn Products Kenya Limited from their facility in Eldoret in the west of Kenya, close to the Ugandan border. The price of maize starch from Kenya is approximately US\$800 / tonne delivered, or US\$0.8 / kg, delivered in 50kg sacks. The two largest paperboard companies both confirmed this price based on the following breakdown: US\$740 – US\$750 per tonne F.O.B. Nairobi, plus transport US\$50 – US\$60 per tonne. There are no excise duties as supply is within the East African Community (EAC).

All of those who currently source from Eldoret stated in interview that they are satisfied with their current supply in terms of raw material quality and price, the two most important supply considerations regarding starch stated by all interviewed. There is no need to test each delivery on arrival into their premises, and so long as consistency of viscosity and particle size remain then there are no supply management or performance issues. Since starch is a basic and relatively low-cost raw material there is little incentive to invest a lot of time and effort in switching between different supply sources. Paper purchase represents 90% of the cost of production and naturally companies do not want to take risks with the consistency of SBAs they produce in order to minimise production losses.

As noted above, two of the smaller paperboard companies in Uganda already use cassava starch for their SBAs. One sources HQCF from a C:AVA group (100-200 tonnes per annum), the other from Mombasa. According to both companies cassava starch offers a number of benefits over using maize starch. First, to make a batch of adhesive using 1000 litres of water requires up to 25% less cassava

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<sup>4</sup> All are members of a Carton Manufacturers Association.

starch versus maize starch.<sup>5</sup> Second, it is possible to keep and re-use cassava starch for up to 4 days after mixing; adhesive from maize starch starts to break down after 2 days. Third, and perhaps most importantly, cassava starch appears to provide stronger bonding properties, a trait naturally of importance to box manufacturers and their customers. Finally, sourcing locally is of interest to those using smaller quantities of starch as they can buy in smaller lots instead of minimum 26 tonne lots from Kenya which for some may represent one years' total volume. On the basis of all of these points there was interest and willingness among those already using cassava starch to support and source locally from C:AVA producer groups subject to trials and availability guarantees.

Discussing these issues and positive reasons for advocating use of cassava starch with larger-scale box manufacturers again there was commitment to support local schemes and source locally. All were happy to receive samples and conduct trials to look in detail how adhesives using HQCF compare to their current adhesives. Some have experience of using cassava starch for adhesive in other countries and others were interested to understand such experiences from other countries where cassava is used to make adhesives. The bottom line is that as long as there can be consistent supply in sufficient quantities and at a competitive price,<sup>6</sup> and cassava meets the basic technical specification requirements in adhesive production<sup>7</sup>, there is potential to migrate all of the 1440 tonnes required annually by the industry to HQCF sources.

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<sup>5</sup> This needs to be clarified and verified in trials.

<sup>6</sup> HQCF is potentially \$100/tonne cheaper than imported maize starch at \$0.7/kg versus \$0.8/kg. However, transport and delivery cost would reduce this competitive advantage somewhat.

<sup>7</sup> See Appendix 2 for detailed SBA specification (incl. hot and cold process, need for high starch content)

**Table 6: SWOT Analysis – Paperboard Industry**

Strengths	Weaknesses
<ul style="list-style-type: none"> <li>• HQCF can be used and is already used by industry as adhesive ingredient (glue extender).</li> <li>• Trials conducted by firms as part of C:AVA have been positive.</li> <li>• HQCF has better bonding properties than corn starch (according to two paperboard manufacturers).</li> <li>• Input costs can be reduced without compromising quality.</li> </ul>	<ul style="list-style-type: none"> <li>• Some companies have not been exposed to trials (also due to lack of samples), and lack knowledge.</li> <li>• The two companies who tried out HQCF are only small-scale.</li> </ul>
Opportunities	Threats
<ul style="list-style-type: none"> <li>• Immediate, medium size market demand for HQCF exists.</li> <li>• Companies are open to conducting trials.</li> <li>• Demand for paperboard products is growing.</li> <li>• There is overreliance on imported maize starch from Kenya.</li> <li>• Local sourcing of raw materials (i.e. HQCF) has advantages (social capital).</li> </ul>	<ul style="list-style-type: none"> <li>• Inconsistent supply of HQCF due to limited processing capacity.</li> <li>• Farmers and paperboard manufacturers fail to agree on a price for HQCF.</li> <li>• High prices of cassava due to undersupply of roots and CBSD.</li> </ul>

From a CSR (Corporate Social Responsibility) perspective some companies have the support of large-scale funders and foundations such as the Mahdvani foundation. Such groups are open to possibilities of working with C:AVA on projects relating to logistical and production issues such packaging, transportation, and agronomy extension schemes. In the longer term there could also be willingness to invest in supply chains, for instance in mechanical drying technology, if a business case can be developed that demonstrates a return for doing so.

Before considering such collaborations and investment potentials, there are a number of areas that require significant attention in order to move forward with cassava as a viable raw material for industrial purposes. Principal areas for focus include:

- An awareness campaign to promote cassava and affect negative perspectives. This could be strongly supported with the preparation of factsheets promoting the positive experiences of using HQCF in adhesives from other countries;
- Drying capacity – a significant challenge with no current mechanical drying capacity and reliance on dry season only for HQCF production;
- Related to the previous point, providing a more regulated year-round supply of HQCF;
- Issue of food security versus industrial demand for cassava – current supply constraints suggest a need for significant increase in production. This situation has been worsened with recent extensive cases of loss from Cassava Brown Streak Disease (CBSD).

## Plywood

During a visit to the country's only plywood manufacturer (Nileply) in Jinja the team was told that they already use locally available cassava flour (4.8 tonnes per week or about 250 tonnes per annum) as an adhesive ingredient (i.e. glue extender). In the past, the company has used wheat flour, which, according to their experience, has a better bonding capacity than cassava flour. However, cassava flour is cheaper and locally available.

Nileply supplies 80% of the domestic market. The remainder is imported. The company expects the sector to grow, however the availability of forests to be used for plywood represent the limiting factor in the near future. The company has its own plantations part of which will mature in 10 years which should ease the supply situation. The cassava flour is sourced locally and the buying agents undertake visual observation of the flour (bought at Ush1,100/kg in May 2012).

They look for a particular quality of flour, which should have the following specifications:

- High starch content;
- Cassava flour should not be mouldy in that this will affect the production (e.g. equipment may be clogged up; or spreading of glue will be affected);
- Cassava flour should be fine, and well dried.

The Operations Manager agreed to test HQCF as an adhesive ingredient to compare its quality with that of traditional cassava flour. Four bags of HQCF would be required to use HQCF on one production line. If the trial results are positive the company may be prepared to change their formula for glue preparation, as a result of which more HQCF may be required.

## Animal Feed Industry

### The Ugandan livestock sector

The livestock sector contributed between 1.5% and 1.7% to Uganda's GDP between 2006 and 2010. In particular, in some parts of the country livestock production (e.g. cattle rearing) plays an important role in the local economy and society. Table 7 provides an overview of number of livestock by type and year, indicating an annual increase of about 3%.

**Table 7: Number of livestock (000') by type and year, 2008 – 2010**

Animal Type	Year		
	2008	2009	2010
Cattle	11,409	11,751	12,104
Sheep	3,413	3,516	3,621
Goat	12,450	12,823	13,208
Pigs	3,184	3,280	3,378
Chicken	37,444	38,557	39,714

Source: MAAIF Statistics Bulletin (2011)

As a result of increasing livestock production, in particular near urban centres, Uganda's animal feed industry has also started to develop. Poultry feed has become the principal form of animal feed. Raw materials typically include maize and milling by-products (e.g. maize bran, wheat bran, wheat pollard). In addition, protein rich raw materials such as soybean cakes or fish meal would be used to enhance the protein level of the rations.

### Field survey results

Three large animal feed manufacturers were visited during the field survey. Two of them started their operations as part of a poultry business whereby they produce feeds in order to avoid reliance on external sources.

Ugachick, which has been in business for over a decade, and is famous in Uganda for its production of day-old chicks, produces about 12,000 tonnes of poultry feed per annum; 30% of this is used for own consumption, while the rest is sold (i.e. for layers and broilers). In addition, in 2006 the company started to produce fish feed (7,200 tonnes p.a.), 70% of which is exported to neighbouring countries (Kenya, Tanzania, Rwanda).

Ugachick has produced cassava (i.e. yellow variety) in 2008/09, however it appears this was on a trial basis for a nearby research station, and there were issues over the harvesting of the crop. At the same time, the company uses dried

cassava chips, the origin of which tends to be Soroti. It was indicated that a trader normally delivers the chips to the factory, although none were available at the time of the survey.

In view of price and supply fluctuations the company tries to store some feed ingredients for about three months. For example, this applies to maize the price of which was around Ush1,000 per kg in May 2012, while it was expected to decline to about Ush300 per kg in August. Company officials expect similar price fluctuations for other ingredients such as dried cassava. It was mentioned that dried cassava can be stored for three months, after which insect attacks may occur.

Apparently, farmers tend to use lower quality chips for animal feed, although this can be a problem in that some of the feed rations are not heated or cooked and may potentially pose a risk to the health of animals. As for quality specifications, the Ugachick quality manager indicated the following:

- No moulds;
- No sand / filth;
- 12% moisture and below;
- No bitter varieties; chips shouldn't contain cyanide;
- Size of chips is not a problem as long as they are properly dried.

The energy level of dried cassava (3200 – 3400 kcal/kg of chips) was favourably compared to that of maize (3100 – 3250 kcal/kg).<sup>8</sup> At the same time, it was pointed out that maize is the more balanced ingredient for animal feed in that it contains about 9% - 10% protein. The protein content of cassava is only between 1% – 2% as a result of which alternative protein sources are required to balance the feed rations. Sources of protein may include soya or fish meal, although there are issues regarding the latter (i.e. availability, price, and sometimes adulteration). It was pointed out that the increased need for protein sources and their potentially high cost may limit the use of cassava in animal feed rations.

As for fish feed, Ugachick appears to include 15% of dried cassava in the fish rations, whilst using soya or fishmeal as protein balancers. At the beginning (i.e. from 2006) the company produced fish feed that sank to the ground, however since 2010 it produces floating fish feed. Dried cassava reportedly enhances the floating properties of fish feed compared to some other ingredients. Tilapia and clarius (catfish) are the main fish species that are being farmed in Uganda.

In sum, Ugachick stated an immediate requirement of about 1,200 tonnes of dried cassava per annum. The price of dried cassava would have to be negotiated but it appears a price of about 70% of that of maize would be acceptable.

Biyinzika, which is located 15 KM east of Kampala near Mukono town, is also a company that is specialised in poultry production, although it is relatively new and has seen most of its expansion during the last few years. In May 2012, the company has a feed milling capacity of 1.5 tonnes per hour, however it was

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<sup>8</sup> This requires further verification.

reported that there are plans to install a new feed mill with a capacity of 20 tonnes per hour. In addition, there are plans to construct new silos. The company uses a computer programme based on least-cost feed formulations. The company has extruding equipment but no pelletiser.

Maize is the principal raw material used by the company (approximately 50%), supplemented by other ingredients such as soya, wheat bran, and an imported premix containing vitamins and minerals. Nonetheless, and in view of the high cost of maize, the company representative interviewed (Farm Manager) stated that a 20% inclusion rate of dried cassava should not be a problem provided that it is of the right price and quality (i.e. in particular no aflatoxins). The different poultry feed formulations which the company produces have crude protein contents of between 15% to 20%, depending on the type of feed (e.g. for chicks, growers, grower parents, or layer parents). It was stated that the company stopped using locally procured fish, because it reportedly is contaminated with sand, is expensive, and has a lower protein content than imported fish meal. As a consequence, the company are planning to import processed fishmeal from Denmark.

In sum, Biyinzika is rapidly expanding, and is clearly open to the use of cassava in its poultry feed rations. They would prefer to receive the dried cassava in the form of chips. A 20% inclusion rate would mean approximately 2,000 tonnes of dried cassava. They would need more of the raw material during the last four months before Christmas when the demand for poultry feed goes up. In addition, they would also need information on the following:

- Processing, storage, and handling of feed and feed ingredients;
- Inclusion of cassava based feed ingredients in animal feed rations;
- Technical information on cassava production if the company became interested in using parts of their newly acquired land for cassava production.

Nuvita, which belongs to Engano Millers Ltd in Jinja, was the third feed milling company visited. It is the largest independent animal feed producer in Uganda, who is not attached to a poultry operation. As of 2012, the company has a monthly feed output of 800 tonnes. 80% of this is poultry feed, 15% dairy rations, and the remaining 5% others (e.g. for pigs, fish, and hounds). According to the general manager of the company, the feed industry represents a growing market. Apparently, when raw material prices are low then farmers mix themselves, however when it is expensive then they come to companies such as Nuvita to buy animal feed.

Nuvita produces poultry feed in the form of mash (not pellets), which may contain 10% maize, 10-15% fishmeal, 40% maize bran, ~20% wheat bran (to compensate for volume), 10-15% cottonseed cake, plus additives (e.g. vitamins and minerals). In sum, given that the company produces about 9,600 tonnes of animal feed, a 10% inclusion rate of dried cassava would mean 960 tonnes.

In view of the above, it is clear that poultry feed is the dominant type of feed produced and marketed in Uganda. In addition to the three major feed

manufacturers, there are numerous small-scale producers of feed rations which are estimated to produce a similar amount of feed. In total it is estimated that about 80,000 tonnes of animal feed are produced (i.e. 40,000 by the large-scale sector and 40,000 by the small-scale sector). Assuming a 10% inclusion rate of dried cassava, which seems feasible, would represent 8,000 tonnes of chips.

### Research into the use of cassava in animal feed rations

Substantial research into cassava utilisation in feed rations has been carried out in Africa during the last three decades (Hahn, *et al.*, 1992; Lekule, 2000, Tewe, 2004). The following tables (Tables 8 and 9) illustrate the results of research undertaken in Ivory Coast into the use of cassava in broiler rations. The findings presented should be taken as an example, since it was not possible to provide a complete overview of the substantial literature dealing with the use of cassava in animal feed rations.

**Table 8: Composition of experimental broiler rations in Ivory Coast**

Raw materials	Percentage of cassava in the ration			
	0%	10%	20%	30%
<b>Ingredients</b>				
Maize	60	50	40	32
Cassava flour	0	10	20	30
Rice flour	12	14	13	10
Cottonseed cake	7	8	7	6
Soybean cake	6	7	7	7
Fish flour	9	9	11	13
Wheat middling	4	0	0	0
Premix (i.e. minerals, etc)	2	2	2	2
<b>Nutrients</b>				
Energy (kcal ME/kg)	2992	2995	2989	2989
Protein (%)	19.08	19.10	18.96	18.90
Lysine (%)	1.02	1.03	1.07	1.12
Methionine (%)	0.40	0.40	0.42	0.42
Methionine + cystine (%)	0.71	0.70	0.70	0.71
Calcium (%)	1.00	1.00	1.12	1.26
Available phosphorus (%)	0.56	0.57	0.61	0.66
Cellulose (%)	3.80	3.70	3.60	3.40

Source: Tiémoko (1992)

Table 9 shows the results of the feeding trials in Ivory Coast based on the experimental rations indicated in Table 8. The experimental phase ranged from the 29<sup>th</sup> to the 49<sup>th</sup> day of broilers of improved stock. The incorporation of cassava flour in poultry diet at rates ranging from 10% to 30% did not affect the final weight or the gain in weight ( $P > 0.05$ ) of the chickens (Tiemoko, 1992). If the rate exceeded 10%, however, the feed consumption index increased, resulting in a lower nutritional efficiency of the diet.

At the same time, it is important to bear in mind that these figures were obtained under experimental conditions. Given uncertainties related to the quality of dried cassava and toxicity issues, a lower level of inclusion in poultry feed rations should be envisaged in Uganda for the time being (i.e. 10%). This is also in light of research undertaken in Ghana during the 1990s, recommending an inclusion level of 10% in poultry rations. Also, palm oil was included in the diets, in order to avoid a reduction in feed uptake by the birds due to the powdery nature of feeds containing cassava flour.

**Table 9: Effect of cassava on the growth performance of broilers**

	Percentage of cassava in ration				Commercial Check
	0%	10%	20%	30%	
Live weight at 49 days old (g)	1657	1617	1610	1623	1656
Weight gain (g) (29 – 49 days)	977	936	930	943	976
Food consumption (g) (29 – 49 days)	2471	2361	2615	2789	2618
Consumption index (29 – 49 days)	2.53	2.52	2.81	2.96	2.68

Source: Tiémoko (1992)

**Table 10: SWOT Analysis - Animal Feed Industry**

Strengths	Weaknesses
<ul style="list-style-type: none"> <li>• High calorific value of dried cassava.</li> <li>• Some companies are familiar with possibility of including cassava in feed rations.</li> <li>• Relatively large quantities required.</li> <li>• Input costs can be reduced without compromising quality.</li> </ul>	<ul style="list-style-type: none"> <li>• Quality observance of cassava based animal feed rations is significant (since some rations are not cooked or heated).</li> <li>• Low protein content of dried cassava requires protein balancers such as soybeans, cottonseed cake or fishmeal, which can be expensive.</li> <li>• Inadequate knowledge and equipment for inclusion of cassava in feed formulations.</li> <li>• Feed standards non-existent.</li> </ul>
Opportunities	Threats
<ul style="list-style-type: none"> <li>• Growing industry.</li> <li>• Possibility of using cassava in the form of improved, dried chips.</li> <li>• Potential exports to neighbouring countries.</li> </ul>	<ul style="list-style-type: none"> <li>• Informal mixers of feed can damage reputation of industry.</li> <li>• Disease outbreak in poultry industry would have serious consequences for animal feed industry.</li> <li>• High demand for fresh cassava roots as food.</li> <li>• Production and processing constraints to supply dried cassava on a consistent basis (CBSD, agricultural practices, reliance on sub-drying)</li> <li>• Competition from grains which may be more suitable (e.g. maize) as raw material for animal feed rations.</li> </ul>

## Brewing Industry

There are two beer brewing companies in Uganda, each having about 50% of the total beer market which is estimated to be about 3 million hectolitres. Annual growth rates of the beer market are of the order of 20%. Both companies have an interest in cassava as a raw material albeit from different angles.

Uganda Breweries Ltd (UBL), which belong to East African Breweries (HQ in Nairobi) / Diageo, express a very open interest in using dry cassava as an adjunct for beer brewing. The company has undertaken trials using traditional cassava flour for beer production. However, although the trials were successful in terms of producing beer, the use of cassava flour has been discontinued following question marks over the quality of the flour (e.g. microbial contamination). Nonetheless Uganda Breweries are interested in the future use of cassava flour as a cheap source of starch. In that respect it would have to compete against other sources of starch, including maize and sorghum (depending on seasonality), although it was stated that cassava has a higher extraction rate.

UBL Managers who are in charge of sourcing locally available raw materials stated the following requirements:

- Quality of the cassava flour needs to be assured. It should not be dried on the ground and should be free of contamination.
- The process involving quality assurance and traceability appears to be important. For example, the company appears to prefer farmers not to get involved in processing, given their poor reputation in terms of respecting quality.
- Supply of dried cassava has to be consistent and on time.
- Cassava should be free of cyanide.
- Low moisture content of cassava is important in that they plan to stock certain quantities of raw materials.

The company expressed an immediate need of a small sample of 5 kg of HQCF. Provided the tests are positive, a weekly demand of 30 – 50 tonnes of cassava flour was expressed (i.e. 1,560 – 2,600 tonnes per annum). Pricing of cassava flour is important and needs to be seen in relation to other locally available raw materials such as sorghum (price was Ush1,150 per kg of sorghum in May 2012). It was indicated that the price needs to be negotiated with the processing associations who would supply the cassava flour. The possibility of UB getting involved in processing was discussed and the option may exist under their Corporate Social Responsibility (CSR) activities. It was agreed that AfrII/C:AVA would link up with the UB manager in charge of local sourcing. If further trials are successful, it was indicated that sister companies of UB in neighbouring countries (e.g. Tanzania) may also use cassava flour as a raw material.

The second brewery with a potential interest in cassava is the SABMiller owned Nile Brewery in Jinja. It is understood that the company is operating at its maximum capacity and is building a new brewery in Mbarara. They are interested in a range of raw materials to be used including barley, maize, sorghum, and sugar. The experience of a sister company in Mozambique is

currently being evaluated in that the latter are using cassava for the production of Impala beer. The production process is based on an AMPU (autonomous mobile processing unit), which has been developed by DADTCO (Dutch agricultural development and trading company). The process is based on processing cassava roots as soon as possible after harvest by the AMPU and then transport the resulting wet cake (40% moisture) to the brewery where it is used for making beer. Apparently, the cake has a shelf-life of 5 – 7 months, compared to two days for fresh cassava. If the evaluation turns out to be positive then it is likely that Nile Breweries will make an attempt to also use cassava as a raw material in beer production in Uganda.

## Starch and Liquid Glucose

Commonwealth Secretariat / COMESA (2001) estimated the demand for starch and starch products for industrial use in 2001 and 2005 as shown in Table 11.

**Table 11: The Ugandan market for starch and starch products for industrial use.**

	Starch grade used in 2001	Market in 2001 (tonnes/year)	Projected Market for 2005 (tonnes/year)
Pharmaceutical	Pharmaceutical	200	250
Paperboard	Technical	120	140
Textiles	Technical	220	300
Brewing	Food		500
Processed Foods	Food	50	60
Glucose	Food	400	800
Various	Adhesives	50	40

Source: Commonwealth / COMESA (2001)

No doubt, the small domestic market and potential competition from major producers in countries such as Kenya and South Africa was one of the reasons why the Lira starch factory has not been reactivated since a pre-feasibility study was undertaken by Commonwealth / COMESA (2001).

## Newspaper Industry

One pulp and paper company based in Jinja is looking for starch for surface sizing newsprint. This process provides surface strength to newspaper and reduces powdery paper coating that can otherwise appear. The process requires pure starch with no ameno pectin present as ameno pectin reduces bonding properties of starch. Research is required to understand in more detail the technical challenges involved and to what extent HQCF could be considered an option. Potential monthly demand would be in the order of 6 tonnes per month. If trials were to prove the use of HQCF as a feasible option then potential further demand exists where other newsprint companies are using starch imported from South Africa. Essentially this is a medium to long-term sector for HQCF.

## Textile Industry

From market research conducted the principal garment manufacturer in Uganda is Southern Range Nyanza Limited (Nytil) based in Jinja. In garment manufacture starch is used in two different process stages, yarn sizing and finishing. This company has almost 100% of school uniform market and 10-15% of t-shirt market. The bulk of the t-shirt market is absorbed by overseas competition with many imports from China and second-hand clothes sectors.

In terms of starch requirements, starch is a very minor raw material component and therefore does not receive attention in terms of tracking different source options. Nytil currently import approximately 7-8 tonnes per month of maize starch from CPC in Kenya which could increase to 12-13 tonnes by 2014. Starch gives strength to yarn but after applying starch to yarn it is important that it should remove when washed and leave no sticking properties. In 2009 Nytil trialled cassava and found it too sticky versus maize starch but stated a willingness to trial with HQCF to see how it performs. It was also noted that cassava starch tends to leave a shiny surface, and therefore maybe more suited for garments such as ladies scarves.

More broadly in the textiles sector, according to Nytil in 2011 cotton became too expensive which prompted a shift to increase production of synthetics (polyester, nylons, viscose). There has been growth in recent years in order of 20% per annum in the synthetic sector. In contrast the cotton sector has remained stagnant and this it is only the cotton sector where starch is used. In addition there doesn't appear to be any potential in the laundry and dry cleaning sectors in Uganda, these remain very small markets. In the region Kenya and Tanzania have more factories and larger markets for starch demand.

## Liquid Glucose Industry

The potential sector for liquid glucose was discussed with Kakira Sugar, a member of the Madhvani group of companies. Kakira currently sources approximately 80 tonnes per month of liquid glucose for sweet manufacture from CPC in Kenya.<sup>9</sup> This quantity produces approximately 200 tonnes of confectionary at Kakira. According to Kakira this production quantity represents 40% of the 500 tonnes per month sector total.<sup>10</sup> There is, therefore, potential national demand of 200-250 tonnes per month (or 2500-3000 tonnes per annum) for liquid glucose for use in sweet manufacture.

The current price of liquid glucose from CPC is US\$800/ tonne F.O.B., plus transport to give a total of US\$850 delivered. Liquid glucose requires large-scale capital to manufacture and therefore restricts the number of potential players in the sector. Kakira expressed potential interest in investing in a glucose factory as they feel increasingly frustrated by being reliant and exploited by the sole supplier, CPC Kenya. Going forward, they are therefore open and willing to discuss such long-term investment options which could include looking at

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<sup>9</sup> Sweets are made from 60% sugar and 40% liquid glucose.

<sup>10</sup> Compared to 4000 tonnes per month produced in Kenya.

difference starch sources to produce liquid glucose (including cassava). Naturally this is a long-term option for cassava but it would be prudent to keep on the agenda and further research required into potential business cases and models that could incorporate small-scale producers in the value chain.

Britannia, which is by far the largest food processing company in Uganda, uses liquid maize glucose in the manufacturing of confectionary, drinks, etc. (i.e. 200 tonnes per month).

### **Other Food Processing**

There are about 20 food processing companies in Uganda, most of which are SME-type businesses. Britannia, as already indicated, is the largest company in the sector with a market share of 65% - 70% according to competitors. Producers of processed foods such as ketchup tomato sauce and fruit juices expect annual growth of the industry to be of the order of 10%.

Some of the processors have conducted trials using traditional cassava flour, however the results obtained by the company visited (Jtwine Investments Ltd., 3<sup>rd</sup> largest producer in country) were not positive in that the following constraints were encountered:

- Ketchup using traditional cassava flour as an ingredient is of brownish colour;
- Ketchup contains particles (i.e. fibre in cassava flour);
- Cassava flavour was apparent when traditional flour was used.

Britannia uses liquid maize glucose in the manufacturing of confectionary, drinks, etc. (i.e. 200 tonnes per month).

### **Paint**

The team spoke to the MD of Sadolin, which is one of the two leading producers of paints in Uganda. They use specialist processed starch derivatives from Japan – 10 tonnes per month of hydro ethile cellulose (HEC) – used to thicken water-based paints. They have never heard of cassava starch being used in paints.

## Alcohol Industry

The principal source of alcohol for use in the distilling industry is from molasses, a by-product of sugar cane processing. One of the largest distillers in Uganda, Premier Distilleries, consumes 15,600,000 litres of alcohol per year in manufacturing a range of alcohol based consumer products. The majority of the alcohol is imported from India and South Africa with 10% sourced locally in Uganda from Masindi. The volume from Masindi is 5000 litres per day or 1.8m litres per year with a view to look to source up to 20,000 litres per day from Ugandan sources. Current prices of molasses range from UGX 100 – 150,000 per tonne (US\$40-60 per tonne).

According to Premier it is possible to extract 220 litres of alcohol per tonne of molasses. In comparison it could be possible to extract 360 litres per tonne of maize corn and 430 litres per tonne of rice, versus 180 litres per tonne of cassava. [1] Further research is required to verify yields, conversion rates and conduct cost benefit analyses of the different raw material sources of alcohol.

Premier stated a willingness to learn more about the different production and processing possibilities from cassava in addition to other crops. There is a need to gather research from other parts of the world, for instance Brazil, and prepare an overview of the technical and commercial potential of using cassava for alcohol production. Larger private sector operators such as this are investing and considering further investment in sourcing raw material. Initially there appears to be a preference for supplying their own grown raw material but perhaps other sourcing options could be considered. The distilling sector is very much a long-term option regarding cassava.

In addition, the Sugar Corporation of Uganda Ltd (SCOUL) was visited, which currently only produces industrial alcohol from the molasses, which are a by-product from its sugar production. It was indicated that Uganda currently imports 90% (i.e. about 20 million litres) of its ethanol requirements. In view of this SCOUL is planning to invest in a new ethanol factory with a capacity of 8 – 10 million litres of alcohol per annum.

The issue of high human alcohol consumption in Uganda was raised by the General Manager (Marketing and PR) who participated in the interview. In addition to his role as General Secretary of the Uganda Alcohol Industry Association, he is also Vice President and Director of the Uganda National Chambers of Commerce and Industry.

Apparently, the alcohol manufacturing sector is also lobbying the Government to look into the possibility of using ethanol in fuel for vehicles. If this option would materialise then large quantities of raw material would be required, in that current supply of molasses is unlikely to be sufficient.

The following types of information were requested:

- Technical issues related to processing (e.g. can cassava be fermented together with molasses) and the use of cassava based products (in particular from an ethanol production point of view);

- Cassava production issues, including technical aspects, profitability of the crop, and the possibility of an outgrower scheme to supply cassava.

Given the role of the General Manager (Marketing and PR) of Lugazi Sugar in the Uganda National Chambers of Commerce and Industry it was discussed to what extent this industry association could be used as an avenue for information dissemination as part of a project.

## Summary of potential demand of cassava-based products

The evidence gathered in this study suggests there is substantial potential demand for cassava-based products in Uganda. At the same time there are also barriers to entry in some markets. This section summarises market opportunities for cassava-based products in Uganda.

- Wheat milling sector
  - There is currently little enthusiasm for blending HQCF with wheat flour, all of which is processed locally predominantly using imported wheat;
  - Government legislation and setting of standards would be required to motivate the industry to consider the production of blended flour on a large scale and at HQCF levels of 5% - 10%.
  
- Biscuit manufacturers
  - Largest manufacturer (60% market share) shows very strong interest in HQCF
  - Biscuits with HQCF have been tested
  - Standards have been drafted
  - Issues:
    - Low acceptable cyanide levels
    - Low fibre content
    - High starch content.
  
- Bakeries
  - Bakeries in cities (in particular Kampala) not keen on HQCF
  - Total wheat flour available in Uganda: about 300,000t p.a.
  - 200,000t for rural bakeries, 70% of which (140,000t) goes into non-bread products (e.g. chapattis, doughnuts, pancakes, baghias, etc); assumption that 10% of this can be substituted by HQCF.
  - Potential HQCF demand: 14,000 tonnes p.a.
  - Issues:
    - Shelf-life of bread and other products is important
    - Aroma of end-product
    - High dry-matter content but low fibre content required (fast maturing varieties)
    - Volume / size of bread is important (related to gluten content).
  
- Composite flour
  - SME companies already produce composite flours (e.g. cassava/millet flour)
  - Potential demand: 1000t of chips, grits or flour p.a.
  - Issues:
    - High dry-matter content, but low fibre content required
    - High starch content (low starch content affects quality of bread).

- Plywood
  - There is one plywood manufacturing company in Uganda
  - Traditional cassava flour, which is bought from local cassava millers, is already used as glue extender by the company
  - Potential HQCF demand: about 250 tonnes p.a.
  - Issues:
    - The advantage of using HQCF in plywood manufacturing needs to be demonstrated to the end-user (sample required)
    - Price of HQCF needs to be competitive.
  
- Animal feed industry (improved chips)
  - Total output of large feed millers is about 40,000t
  - Similar amount produced by SMEs
  - Poultry feeds are main product, but also other rations
  - Potential demand: 8,000t (based on 10% inclusion rate)
  - Issues:
    - High energy in cassava required (at least 3,200 – 3,400kcal/kg, tbc)
    - Protein balancers such as fish meal, soya-bean cake, etc required
    - Dried cassava has good floating properties, which is favourable for the production of fish feed.
  
- Breweries (improved chips or wet cake)
  - Beer market is growing and industry is expanding capacity.
  - One brewery (out of 2) indicated that 30 – 50 tonnes of HQCF could be used per week (i.e. 1500 – 2500 tonnes p.a.; sample (5kg) is required asap; price has to be negotiated and will depend on price of other raw materials (e.g. sorghum); consistent supply important.
  - Second company is building new brewery in Mbarara; appears to consider the use of fresh cassava roots but is assessing their experience with cassava beer in Mozambique (use of mobile processing unit producing wet cassava cake for brewery).
  
- Possible markets - long term options
  - Starch for textiles (about 100t p.a.) and paper industry (70t – 80t p.a.)
  - Liquid glucose for the production of sweets, drinks etc (about 3,000t – 4,000t p.a.)
  - Starch for beverage and food industry: several hundred tonnes of starch required per annum (e.g. ketchup production); some companies have carried out tests with cassava flour (mixed results)
  - Distilling (i.e. ethanol production), issues:
    - Alcohol for human consumption and industrial use; issue of high levels of human consumption
    - Market is rapidly expanding (10 – 15% p.a.) ; industry is increasing capacity; bulk of alcohol is currently imported
    - Molasses from sugar industry is currently main raw material used by distilleries in Uganda
    - Other raw materials such as maize and rice are considered for future production on land acquired by distilling companies

- Industry seems to be lobbying with GoU for the inclusion of ethanol in fuel for cars; if this is successful then large quantities of raw material would be required.
- Non-starter:
  - Paint industry (require high quality ingredients such as HEC starch derivative which is imported from Japan).

**Table 12 - Summary of market opportunities for cassava-based products in Uganda**

Sector	Cassava-based product	Current/potential demand of cassava-based product (mt/year)				Long-term potential demand in root equivalents (mt/year)	Conditions	
		Current use	Short-term	Medium-term	Long-term			
a	Large-scale mills	HQCF	0	0	15,000	30,000	120,000	In progress national policy target to replace 10-30% wheat with HQCF for bread and biscuits. Here assumed maximum of 10% replacement.
b	Bakeries (rural)	HQCF	Limited	0	7,000	14,000	56,000	Long-term projection 10% of 140,000 tonnes used in non-bread rural baking products.
c	Bakeries (urban)	HQCF	Very limited	0	0	8,000	32,000	8,000 tonnes based on 10% of wheat for bread, subject to trials and changing industry policy and culture.
d	Composite flour	Chips / HQCF	700	700	1,000	2,000	8,000	Subject to making trial samples available, negotiation on potential increased supply, and growth in sales of wheat/cassava composite flour.
e	Biscuit manufacturers	HQCF	Limited	200-300	1000-2000	3500-4500	16,000	Subject to trials and slowly increasing the percentage of HQCF towards a maximum of 35% replacement in the long-term.
f	Animal feed	Improved chips	300-500	1200-2000	3000-5000	8,000	32,000	Subject to availability of chips at right price and quality, and finding a suitable protein solution.
g	Paperboard	HQCF (starch)	150	500	900	1,400	5,600	Trials need to be conducted, particularly with larger-scale users of starch. Medium to long-term potential to replace current sources 100% with cassava starch for SBAs.
h	Breweries	HQCF / improved chips	0	1500-2500	3,500	5,000	20,000	Initial orders subject to trials of HQCF and pricing of HQCF versus other starch inputs.
i	Distilling	Cassava starch	0	0	0	tbc		A long-term option, currently no cassava used to produce alcohol. Huge potential volumes, 1000s of litres per day but most likely cassava may become one of a few local sources of alcohol.
j	Textiles	Cassava starch	0	0	100	150	600	Unlikely to be an option for technical reasons.
k	Paper (newspaper)	Cassava starch	0	0	60	100	400	Research required to understand technical challenges to produce 'pure' starch from HQCF, i.e. with no ameno pectin
l	Plywood	HQCF	250	250	300	300-400	1,400	Already use traditional cassava flour but may switch to HQCF if trials positive.
m	Sweets	Liquid glucose	0	0	0	3,000	12,000	Currently no plant exists in Uganda so would require large-scale investment from private sector.
n	Other starch uses**	Cassava starch	0	0	0	500-1000	3,000	Subject to production re-commencing at Lira plant.
Total (without mandatory 10% HQCF inclusion in wheat flour for industrial use) [b+c+d+.....n]							187,000	
Total (with mandatory 10% HQCF inclusion in wheat flour for industrial use) [a+f+.....n]							195,000	

\*\* Could include pharmaceutical but very high quality required, may not be possible to produce locally. Also other food processing.

## Summary of the Cassava Breeders and Value Chain Workshop

A meeting was held by the Team on 17<sup>th</sup> May 2012 with Dr Robert Kawuki of NaCCRI in Namulonge. According to NaCCRI in the 541,000 hectares of land in Uganda used for cassava production there are a number of different varieties of cassava, approximately 60% are landraces and 40% new 'improved' varieties. Many of these new varieties have been developed to increase yield and combat disease.

### Combating Cassava Disease

As highlighted in this report there are supply issues regarding fresh cassava root volumes and this issue is compounded by spread of disease in Uganda. Dr Kawuki explained that in recent years new varieties have been introduced to combat both cassava mosaic disease and cassava brown streak disease (CBSD). It appears there has been a lot of success in reducing the impact and occurrence of mosaic disease, however CBSD remains a significant problem after seven years of work developing varieties to combat this. In fact it appears that anti-mosaic varieties have become susceptible to CBSD.

A new variety, 4271, has recently been introduced with the hope that it will be more resilient to CBSD. To support this variety a strategy of pairing different varieties on the same farm is promoted as good practice. On a visit to Palissa Agribusiness Trading Association (PATA) the Team observed farms that had planted one half of their land with 4271 and the other half with existing varieties such as Majera and Muyindu. The Team discussed concerns raised by traders in markets concerning the quality of cassava roots and CBSD. Breeders would prefer to review more rigorous research versus anecdotal data to check traders' understandings and knowledge of different varieties as there is some scepticism that all traders are fully aware of the different varieties currently in production. There remains an on-going challenge to enhance the links between breeders and value chain participants regarding the performance of different cassava varieties.

### Industry Sectors

Normally breeding for industrial purposes is not common but the Team sought agreement to discuss traits required in certain industry sectors with a view to increasing the focus on such traits. The Team presented findings from meetings with different industry sectors to NaCCRI, particularly highlighting technical properties of cassava that different industries require and discussed these with Dr Kawuki. A summary of main points from this discussion follows:

- Paperboard
  - NaCCRI offered to obtain a sample of maize corn currently used to make SBAs to analyse functional properties and compare to existing cassava varieties. Improved knowledge of the relative starch chemistries will help to understand how cassava starch should perform in terms of product stability and processing efficiency.

- Composite flour
  - Confidence in most varieties of cassava in production that they have both low acceptable levels of cyanide and high starch content, two traits required in this sector.
- Bakeries
  - Important to look at product stability on shelf-life when mix cassava flour with wheat. Potential for NaCRRRI to mobilise funds and work with the private sector on experiments to obtain empirical material.
- Animal feed
  - Challenge that protein content has increased in corn in recent decades through breeding. In Latin America an initiative has started to enhance protein levels in cassava. This is a long-term project so the issue of protein remains a challenge when looking at substituting maize with cassava flour in animal feed.
- Liquid glucose
  - Acceptance that this is a longer term option. There is an opportunity to discuss this with the department of food science and technology at Makerere University who have conducted research on liquid glucose. Also possibly look to exchange visits to other countries with more experience in this sector, e.g. Thailand or Brazil.

NaCRRRI agree that it is a good idea to produce factsheets regarding technical properties and specifications of cassava for those in the private sector looking to trial HQCF. Scientists at NaCRRRI are willing to assist in generating such material with C:AVA practitioners.

#### Cassava Centre of Excellence

In 2009 the World Bank approved a \$30 million fund to strengthen agricultural productivity and growth in Uganda, with a special focus in researching and improving the cassava crop.<sup>11</sup> Uganda is one of a few countries receiving support as part of the Eastern Africa Agricultural Productivity Program (EAAPP). Under the EAAPP, a Regional Centre of Excellence for cassava will be established at Uganda's Namulonge Research Institute, with similar efforts in the other countries on priority commodities identified by the Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA). The project started in March 2011 and will run for five years.

Dr Kawuki advised that among the projects identified to utilise these funds include:

- Value addition – plans to have an incubation centre in Kawanda
- Germplasm development
- Integrated pest management
- Diagnostics of diseases (main focus so far)
- Social and economic aspects of cassava
- Tissue culture transformation

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<http://web.worldbank.org/WBSITE/EXTERNAL/NEWS/0,contentMDK:22394306~pagePK:64257043~piPK:437376~theSitePK:4607,00.html>

- Conservation

A review meeting was scheduled for the end of May 2012 and it was agreed that AFRII could attend and should keep in contact as the projects develop. Through the different initiatives more institutions are in contact with farmers and their organisations.

## Emerging recommendations from value chain analysis

Following the summary of opportunities for cassava-based products in Uganda, this final section summarises the principal opportunities, challenges, and short and long-term recommendations of next steps.

It is evident that there is immediate demand for HQCF and improved dried chips from a range of industries. It is important to focus on those industry sectors and companies that have expressed interest in exploring options for sourcing cassava as a replacement for existing raw materials. As soon as fresh supplies of HQCF are available sample quantities should be made available to those willing to trial HQCF, in particular paperboard and biscuit manufacturers, and the brewing industry. It would be useful to draw up a schedule of pilot trials and where possible, subject to company approval, representatives of AFRII or NaCRRRI could attend to observe and review the results of trials.

As noted in the Executive Summary, markets for HQCF have already been established and it is important to ensure sufficient quantities of HQCF are available to meet existing orders. It is essential to continue assessments of potential output from each C:AVA group to provide a production estimate for the season. After satisfying current order demands then appropriate quantities can be set aside for trials. It is also necessary to review storage options as part of on-going research of how to supply sun-dried HQCF in the rainy season.

There is clearly an issue with the perception of cassava as a low-quality crop that has little purpose beyond providing food security to those on lowest incomes. To start to address this perception an awareness raising campaign is needed to improve the profile of cassava and ultimately its marketability. This could be of particular use in the immediate term in rural areas to encourage those producing goods in rural bakeries to look to adopt HQCF as a wheat replacement and start to realise some of the potential demand identified in that sector. Confidence in marketing cassava for various uses could also be enhanced by exploring possibilities for expansion of demonstration labs or incubation technologies to test and trial cassava in various industrial uses.

In addition to raising awareness, end-users require technical factsheets on the use of cassava products (e.g. HQCF or improved chips) in their industries. There is evidence from experience both in Uganda and from other countries of the use and performance of cassava in different industrial uses. In a meeting at Namulonge, NaCRRRI expressed a willingness to assist in this exercise and it would be very useful to be able to provide such factsheets alongside supplying trial quantities of HQCF. The Team also discussed the idea of setting up taste panels in collaboration with some urban bakeries to collect and observe consumer reactions to viewing and tasting bread containing HQCF.

A significant issue and constraint regarding cassava is the current low levels of fresh roots supply which is reflected in high market prices. As always there is

competition between national food security, industrial use demands, and demand from neighbouring countries (e.g. South Sudan, DRC). It is impossible to consider significant increases in availability of cassava for industrial purposes until cassava supply increases.

There are two areas for continued work to help redress the supply issue. First, it has been identified that improvements in good agricultural practices could lead to relatively short-term increases in yields on smallholder farms. Therefore support needs to continue to assist farmers in improving their yields. Second, the spread of Cassava Brown Streak Disease (CBSD) continues apace and the impacts are evident when visiting local fresh root markets and talking to farmers and traders. There are new varieties being released to combat CBSD and it will take time to understand the effectiveness of new varieties in increasing supply of disease-free cassava. There is an on-going national strategy to tackle cassava supply issues and that requires continued support from the GoU and relevant partners.

Linked to the issue of fresh roots supply is the supply of HQCF. Currently supply is constrained as small-scale processors are only able to produce HQCF in the dry season, and as noted above, also do not have adequate storage facilities to be able to store HQCF for sales in the rainy season (May to August). In order to not lose the momentum gathering behind cassava-based products, research is required into opportunities for introducing medium-scale operations to compliment small-scale production. This could include further investigation into public private partnership (PPP) opportunities as a number of commercial actors expressed a willingness to participate in such research and potential investment in artificial drying (e.g. flash-driers) by end-users.

Longer-term opportunities for cassava-based products have been identified in sectors such as animal feed, starch manufacturing, and distilling. There are a range of technical and supply issues to understand in more detail before re-visiting companies in these sectors. For instance in animal feed there is the challenge of finding solutions to the lack of protein in cassava versus maize. Some short-term solutions could be found in sourcing protein substitutes on a small-scale but such substitution would not be commercially viable on a larger scale. Starch manufacturing and distilling are large-scale projects for the future that would require significant investment and expansion of cassava production and therefore remain research projects at this stage.

## Appendices

### Appendix 1: Terms of reference

- A review of published and grey literature on cassava markets and value chains in Uganda.
- Consultations with key informants (including actors in value chains, various service providers, policy makers and funding agencies with an interest in cassava markets and value chains) in Uganda.
- A field survey of potential market options, including regional markets
- Communication of outcomes of investigations to Foundation staff and other stakeholders in-country. A dialogue will be maintained with staff of the Foundation to ensure synergies between activities.

## Appendix 2: Specification for starch to be used in manufacture of starch based adhesives

Specification for starch to be used in manufacture of starch based adhesives. The paperboard industry would accept a lower moisture content of 9% that is normally present in HQCF.

PRODUCT : CORAGUM 03431

PROPERTIES	
Form	Powder
Moisture	MIN 12.0      MAX 14.0 (2)
SCTT, Viscosity seconds(120g/100ml)	(65) (1)
PH	4.0      5.5
Applications	Corrugation Adhesive
Packing	50Kg Bag
Ash % DB	0.3 ±0.5 (3)
Total Protein	0.6 ±0.1
NSR	A

### Appendix 3: Technical aspects of HQCF use in plywood and paperboard manufacturing

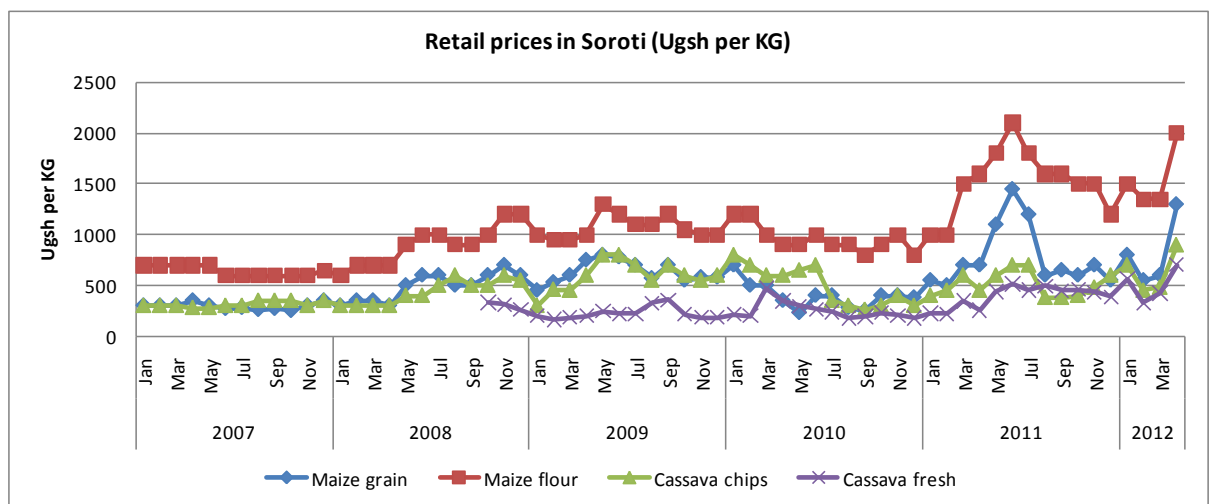
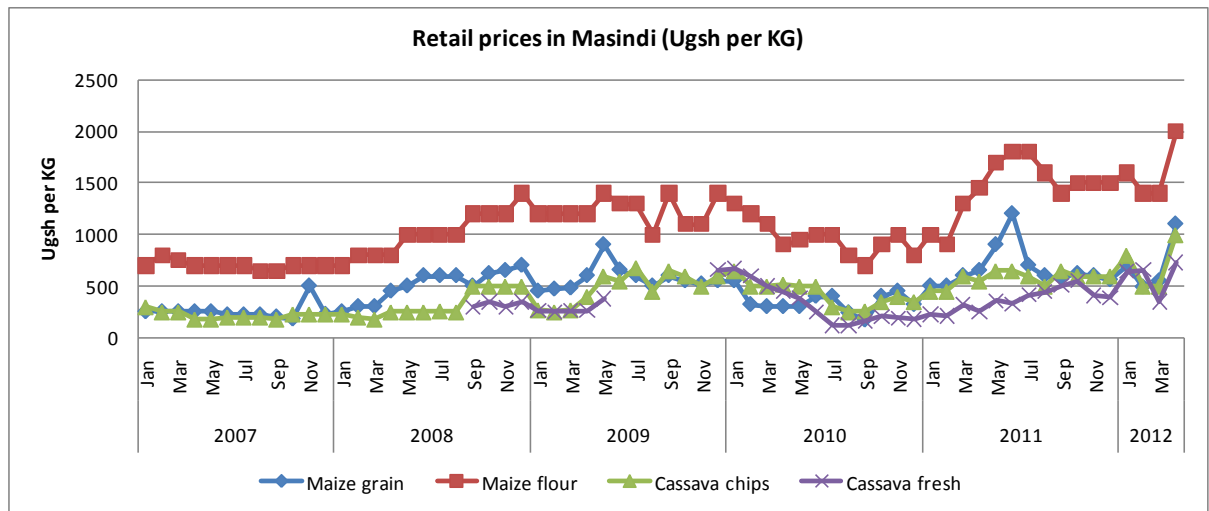
**Plywood** is made by gluing together 3 or more thin sheets of wood known as veneers. The favoured glue formulation in African mills consists of expensive imported urea formaldehyde resin with a catalyst dissolved in water. Phenol formaldehyde can be used to produce waterproof boards but this is rarely seen in Africa as phenol formaldehyde is too expensive. The adhesive quality is of importance for the finished product and is measured using either a crude knife test or an Instron testing rig. Glue viscosity is measured crudely using a fixed aperture Steinhall viscometer and a watch. Glue viscosities are quoted in Steinhall seconds. Wheat flour has been used widely as a glue extender since 1968. The wheat flour replaces a portion of the resin and is much cheaper than urea formaldehyde, there is no loss of bond strength. In Ghana we achieved a 100% replacement of wheat flour with HQCF and this was adopted commercially by one mill. Several other mills wished to purchase but the processors lacked capacity to supply. HQCF does not interfere with bond strength or reduce the durability of the boards. Mills will typically require about 20-50MT per month to make it worthwhile switching to HQCF.

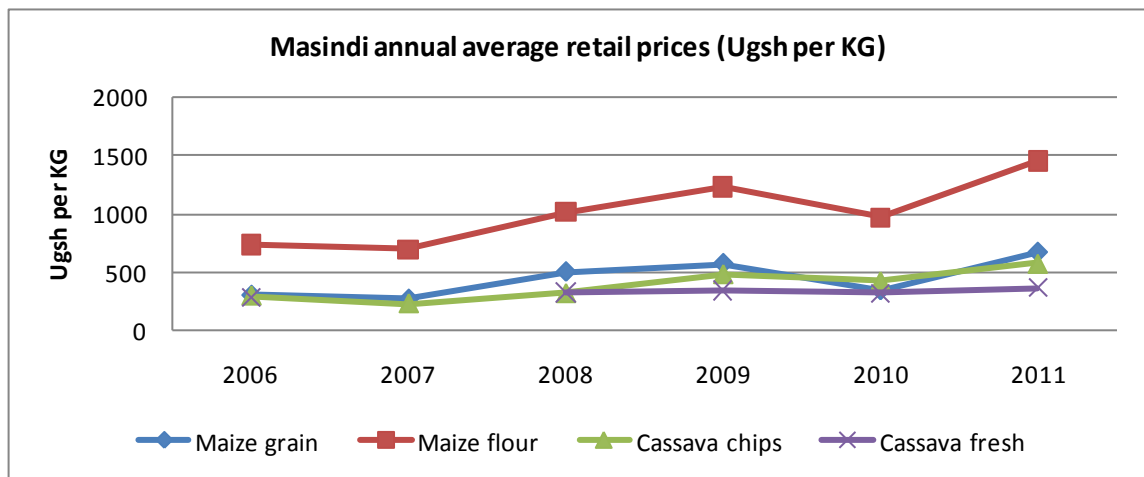
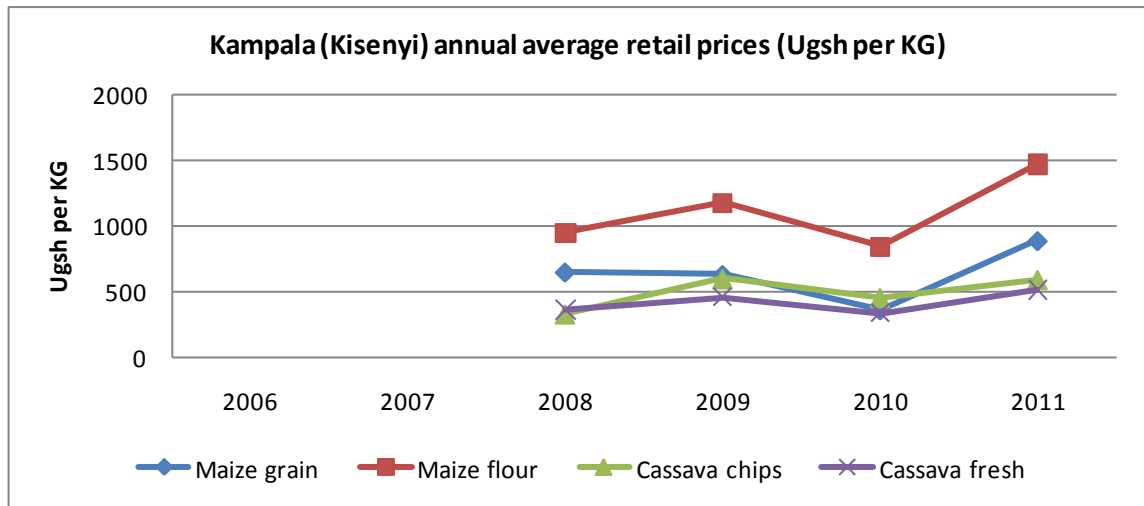
**Paperboard** is made by gluing together sheets of kraft paper and adding a corrugated sheet between the outer layers to form paperboard sheet used for making packaging materials. The layers of paper are glued together using a bauer type paperboard adhesive. Factory staff normally refer to the adhesive as "starch". However this is not correct, paperboard adhesive is normally made from starch, caustic soda and soluble borax made up in water. The starch used will be either maize(corn) or cassava starch depending on origin of the adhesive. Most African factories use ready mix powders which are simply added to water and run onto the paperboard line. Bonding is achieved by a combination of heat and pressure as the paper passes through heated rollers at high speed. Formulations must be adjusted to suit the speed of the production line. Most lines are mechanised with older equipment running at 30-40m per minute whereas modern lines can run at >150m per minute. You may encounter small manual factories with very low operating speeds. Some sophisticated factories buy the component parts of the adhesive and mix custom adhesives on the production line. HQCF can be blended with caustic soda and soluble borax to make a complete adhesive to achieve a 100% replacement of the existing glue powder. It is necessary to adjust the formulation to match the operating speed of the factory otherwise expensive mistakes will be made. When properly done the HQCF adhesive will match the performance of the commercial starch based adhesive.

Source: Pers. comm. A. Graffham

## Appendix 4: Cassava and Maize Prices in Selected Locations

Source: Farmgain Africa, 2012 ([www.farmgainafrica.org](http://www.farmgainafrica.org))





## Appendix 5: Checklists used for Fieldwork

### Checklist for interviews with end-user industries - General information

Before asking questions make clear the purpose of the visit and give brief details of the project and its expected outcomes. You should provide brief details on the potential of cassava for the specific user, quoting examples from other countries or regions.

An important general point: When asking about costs and prices (particularly for imported raw materials), make sure you get a clear statement of what the price means, for example \$400 /tonne means nothing, is it FOB, CIF or receipt at factory gate, if you are quoted FOB or CIF then ask where (eg \$400/tonne FOB Kampala). In every case you should try to get an estimate of the total price for delivery to the end user (all costs inclusive).

Company name:

Name of respondent(s):

Position:

**Full postal address** (with details of physical location):

**Phone** (with area code):

Fax:

Mobile:

Email:

**Type of business** (eg plywood factory, bakery industry, food processing):

History of business - how long has it been operating?

Technology used?

Staff – skilled, unskilled, gender and age structure

**Product range?** (eg non water resistant paperboard, water resistant board etc):

Which of your products is most important to you? (in term of sales)

Do you experience fluctuations in demand for your products during the year?

**Are there seasonal high or lows?** (obtain information on months)

**What is the cause of the seasonality?** (try to get a reason; eg many bakeries experience peak demand related to religious festivals):

Do you experience unpredictable changes in demand for your products? *(If yes)*  
What are the causes?

**What has been your annual output over recent years?** (tonnage or value, whichever is most appropriate, for a large factory tonnage is best, for a bakery an estimate of value would be more appropriate):

For the industry as whole, is demand for your main products static/increasing or decreasing: *(this question should help us to estimate market potential)*

**What are your markets** (local / export / both, if both then what are the proportions for each market eg local 60% export 40%):

**How does government economic policy affect your business?** (for instance interest rates, inflation, tax, import duties, privatisation, infrastructural investment)

## **Checklist for interviews with end-user industries**

### **SPECIFIC QUESTIONS FOR Bakery industry**

Type(s) of flour used, source *(imported/local get details of supplier in each case)*, amount used per kg of product, cost and date of purchase.

What has been your annual utilisation of each type of flour over recent years, is supply constant or do you have seasonal highs and lows in supplies *(get details of these)?*

Do you use composite flours (if yes get details of proportions, and whether there are any seasonal changes {with reasons} for each flour)? Also, details on contents of composite flours.

If you are using more than one type of flour / composite blend of flours what influences your choice *(eg price, quality, availability, consumer preferences try to get details)?*

In choosing flours, what are your specifications?

Do you face any problems in getting supplies of flour *(if yes get details, and ask how they can be overcome)?*

How do you cope with unhygienic or discoloured flour?

Do you produce to a national standard, if yes do you send samples for analysis by the national standards board or other body *(is this voluntary or mandatory)?*

Have you used cassava flour (if yes who supplied, and if not using now what was the reason for stopping use)?

Do you store cassava flour? If yes, for how long? If composites are used, do they store as well as wheat flour?

Does the end-product (e.g. bread containing cassava flour), have the same storability than wheat based bread?

#### Potential purchase of cassava based raw materials

(It may not always be possible to get answers to the following questions. Try to engage the person interviewed in a discussion and probe if necessary. If you see it is impossible to get an answer don't insist).

If you don't use cassava flour as a raw material now, would you be prepared to do so in the future?

- If yes, why? (reasons, and conditions that have to be in place)
- If no, why not? (reasons, constraints)

If the answer was NO, go to questions related to potential sales of cassava based bakery products (below)

Quantities of cassava flour potentially required in the future. Rates of substitution (e.g. cassava for wheat flour)

If you were to use cassava flour, in what form would you want to buy it. What would be the minimum specifications required (moisture, starch content, ash, etc).

What prices would you be prepared to pay for cassava flour (range of price depending on quality). Is price "Delivered at Factory".

(If the person interviewed cannot give a clear price, try to obtain a price ratio, for example, cassava grits compared to maize, or cassava flour compared to wheat flour).

What potential suppliers of cassava flour (location and operators) can you envisage?

If you were to use cassava flour as a raw material, how would this influence your processing costs? (In many cases we are unlikely to get a clear answer to this, but it is important to obtain users' views).

#### Potential sales of cassava based bakery products

Which customers are more likely to purchase cassava based products?

In what form do you think you could sell cassava based products ?

What quantities of cassava based products do you think you could sell per annum?

How many tonnes of cassava based products do you think the different industries as a whole would be prepared to purchase per annum?

At what price do you think cassava based products could be sold?

#### Follow-up

Would you be interested in receiving a copy of the findings and recommendations of this study?

Would you be interested in being involved in future activities (*eg industrial trials of cassava based products*)?

If necessary, would you mind if we came back to ask you more questions?

## **Checklist for interviews with end-user industries**

### **SPECIFIC QUESTIONS FOR Plywood Industry**

(e.g. plywood manufacturers, potentially using high quality cassava flour as adhesive or adhesive extender)

What types of adhesive do you use in production of plywood at your factory (*eg urea formaldehyde, phenol formaldehyde*)

Do you use starch or flour as an extender for your adhesive?

If yes, then what type(s) of starch/flour do you use, source (*imported/local get details of supplier in each case*), amount of extender required per kg (per bag) of glue, cost per kg and date of purchase

Amount of flour / starch that is bought per batch. Is there a seasonality of demand (e.g. peak demand during certain months in the year)? What are the minimum quantities?

What has been your annual utilisation of flour and/or starch over recent years, and is your demand constant or do you experience highs and lows (get details of these).

If you are using more than one type of extender, what influences your choice (*eg price, quality, availability, product specification try to get details*)

In choosing a glue extender, what are your specifications?

Do you face any problems in getting supplies of starch/flour (*if yes get details, and ask how they overcome*)

Do you produce to a national standard, if yes do you send samples for analysis by the National Board of Standards (*is this voluntary or mandatory*)

Have you used cassava flour (if yes who supplied, and if not using now what was the reason for stopping use)

If HQCF or CF was used, what was the experience with the product or what are the production characteristics?

#### Potential purchase of cassava based raw materials

(It may not always be possible to get answers to the following questions. Try to engage the person interviewed in a discussion and probe if necessary. If you see it is impossible to get an answer don't insist).

If you don't use cassava based raw materials now, would you be prepared to do so in the future?

- If yes, why? (reasons, and conditions that have to be in place)
- If no, why not? (reasons, constraints)

If the answer was NO, go to questions related to potential sales of cassava based end products (below)

Quantities of cassava based products potentially required in the future? Rates of substitution (e.g. cassava starch for maize starch) ?

If you were to use cassava based products, in what form would you want to buy them? What would be the minimum specifications required?

What prices would you be prepared to pay for cassava based products (range of price depending on quality). Is price for product "delivered at factory gate".

(If the person interviewed cannot give a clear price, try to obtain a price ratio, for example, dried cassava chips compared to maize, or cassava flour compared to wheat flour).

What potential suppliers of cassava based products (location and operators) can you envisage?

If you were to use cassava based products as raw materials, how would this influence your processing costs? (In many cases we are unlikely to get a clear answer to this, but it is important to obtain users' views).

### Potential sales of cassava based end products

Which customers are more likely to purchase cassava based end products?

In what form do you think you could sell cassava based end products ?

What quantities of cassava based end products do you think you could sell per annum?

How many tonnes of cassava based end products do you think the different industries as a whole would be prepared to purchase per annum?

At what price do you think cassava based end products could be sold?

### Follow-up

Would you be interested in receiving a copy of the findings and recommendations of this study?

Would you be interested in being involved in future activities (*eg industrial trials of cassava based products*)?

If necessary, would you mind if we came back to ask you more questions?

## **CHECK-LIST FOR DISCUSSIONS WITH TRADERS**

[Explain background to the project, but ensure that this does not lead to biased answers]

General Information

What type of trader (i.e. intermediary, wholesaler, or retailer)?

Gender of trader?

Where is s/he located in the market?

### Interview

Which products do you trade?

From whom do you buy and where?

At what price do you buy? How is price influenced by varieties, seasonality, size and quality of produce / product?

How much do you buy and sell per week? Has your business declined or expanded in the last three years?

How do you transport your products?

What are your marketing costs (per unit)? What are transaction costs that are less “visible”

How do you store and for how long? How much is lost after storage? Reasons?

Who are your customers, and where are they based?

How is price determined?

At what price do you sell? How is price influenced by varieties, seasonality, size and quality of produce / product?

Do you do any sorting and grading?

Do you listen to the radio price broadcast? And how do you use it?

Do you get credit?

How does the market association function?

What are your problems? Please rank (verbally) ?

What are your suggestions?

Mapping of the chain can be done if the trader has time and is knowledgeable.

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