

C:AVA

Cassava: Adding Value for Africa



Cassava Market and Value Chain Analysis

Ghana Case Study

Final Report (Anonymised version)

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Abbreviations

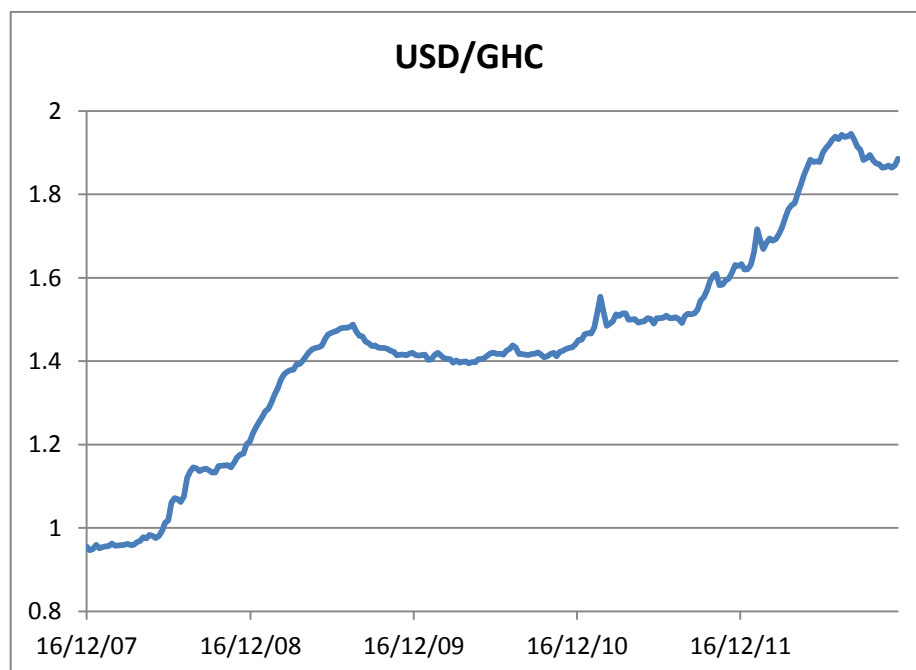
BMGF	Bill and Melinda Gates Foundation
C:AVA	Cassava: Adding Value for Africa
CAADP	Comprehensive Africa Agriculture Development Programme
CIF	Cost, insurance and freight
CRI	Crop Research Institute, CSIR
CSIR	Council for Scientific and Industrial Research
DADTCO	Dutch Agricultural Development and Trading Company
DSF	District Stakeholder Fora
ECOWAS	Economic Community of West African States
FAO	Food and Agriculture Organization of the United Nations
FFF	Farmer Field Fora
FORIG	Forestry Research Institute of Ghana
FRI	Food Research Institute, CSIR
FOB	Free on Board
GAIN	Global Agriculture Information Network
GDP	Gross Domestic Product
GGBL	Guinness Ghana Breweries Ltd
GHC	Ghana Cedi (new)
GNAPF	Ghana National Association of Poultry Farmers
GPC	Good Practices Centres
GTMO	Ghana Timber Millers Organisation
Ha	Hectare
HQCF	High Quality Cassava Flour
IFAD	International Fund for Agricultural Development
MDF	Medium Density Fibreboard
MDG	Millennium Development Goal
MEF	Micro-Enterprise Fund
MEST	Ministry of Environment, Science and Technology
MNC	Multi-National Company
MOFA	Ministry of Food and Agriculture
MT	Metric Tonne
NGO	Non-Governmental Organisation
NRI	Natural Resources Institute

RTIMP	Root and Tuber Improvement and Marketing Programme
SME	Small Medium Enterprise
SRID	Statistics, Research, and Information Directorate
SSA	Sub Saharan Africa
SWOT	Strengths – Weaknesses – Opportunities – Threats
USAID	United States Agency for International Development
USD	United States Dollar
USP	Unique Selling Point
WAAPP	West African Agricultural Productivity Program

Exchange Rates (approx. November 2012):

USD1 = GHC 1.9

GBP1 = GHC 3.0



Source: Oanda at www.oanda.com/currency/historical-rates/ Accessed 05/12/2012

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Executive Summary

This study was carried out by a Team from the Natural Resources Institute (Ulrich Kleih and David Phillips) and Food Research Institute (Marian Wordey and Gregory Komlaga), from 19th to 30th November 2012 to reassess the functioning of the cassava value chain in Ghana and analyse the industrial demand for dried cassava products (e.g. dried chips, industrial flour or HQCF) and their equivalent in fresh roots.

In Ghana as in other parts of Africa, cassava is primarily used for human consumption via sales of fresh roots and processed products in markets. However commercial use of cassava is increasing as a result of increased urban demand for processed cassava products and increased recognition of its industrial potential (Jumah et al., 2006).

Incomes from cassava production and post-harvest processing of cassava represent around one fifth of Ghana's agricultural GDP. With many people engaged in activities related to cassava it contributes significantly to incomes and rural livelihoods for both men and women. Further opportunities for increasing incomes from cassava exist with growing interest in utilising cassava in different industries due to various factors including changes in technology and rising cost of the US dollar relative to local currency.

As part of the BMGF funded 'Cassava: Adding Value for Africa'(C:AVA) work a large number of farmers, small and medium-scale processors are directly involved in producing high-quality cassava flour (HQCF). In 2011 approximately 1000 MT of HQCF was produced in Ghana. Almost one half of this was supplied to the plywood manufacturing sector, and a larger percentage to the food industry, demonstrating that demand exists in both food and non-food sectors for high quality processed cassava products.

From this study it is clear that different processed cassava products have potential utility in different end-user markets. The primary cassava value chains and end-uses can be categorised as follows:

- HQCF – to replace wheat or corn flour/starch in baked goods, biscuits, and paperboard
- Industrial-grade cassava flour – as a glue extender in plywood manufacturing
- Improved chips / grits – as energy provider in animal feed

A brief summary of the potential for each market sector follows. The summary highlights how it is more likely to develop markets in the short to medium term in instances where cassava is a secondary raw material (i.e. plywood and animal feed) compared to markets where it is a more principal component, e.g. bread baking. A brief summary of those with perhaps less potential or non-starters also follows.

HQCF

Short-term demand for increasing sales of HQCF exists. By conducting technical trials and supply chain development work a market of at least 2500 MT should be realised in the next 1 to 2 years. Many companies have tried cassava before and discussed the prospects on many occasions, therefore it is imperative to follow-up on this study by working with industry actor otherwise they will lose interest in HQCF.

Realistically the maximum market for HQCF in the short-term that can be conceived at present is as follows:

- Up to 1000 MT for paperboard to be used as glue extender subject to trials and availability;
- Up to 2000 MT to replace 1-2% of wheat flour used by small bakeries and institutions such as schools;
- Zero for biscuit manufacturing given the current cheap imports of Turkish wheat flour.

For all sectors, trials should be conducted in collaboration with manufacturers and technical results recorded. Companies in each sector (i.e. wheat millers, bakeries, biscuit and paperboard manufacturers) expressed an interest and willingness to participate in such work in the coming months. The data can be used to prepare factsheets based on recent trial experiences. The potential for HQCF in the medium term (2-5 years) should then be re-visited in each sector. In the medium-term theoretical demand could be:

- 2000 MT for paperboard;
- At least 5000 MT if 1-2% of wheat flour are to be replaced;
- 1500-3000 MT / annum for biscuit industry based on 5-10% replacement of current usage of 30,000MT of biscuit wheat flour;

Total demand in the medium-term could be 10,000 MT of HQCF in Ghana.

Plywood

Despite reported declines in employment in the sector, overall the Ghanaian plywood industry is well established with the majority of production destined for the West African market. Other markets include Ghana and overseas markets including US and EU. It is estimated that the industry uses about 4,000 MT of various types of flours as glue extender. The bulk of these flours are cassava flours, including both industrial grade flour and traditional *Kokonte* flour. The industry acknowledges that better quality cassava flour results in improved bonding properties of the glue and a better quality end-product. At the same time, there is shortage of cassava flour during parts of the year. In order to increase the use of good quality (i.e. industrial grade) cassava flour in the plywood industry the following activities are suggested:

- Further awareness-raising on the benefits of using good quality flour (i.e. industrial grade flour or HQCF) to obtain a good quality end-product. For a small amount of extra cost, the quality of plywood would be improved and long-term markets secured.

- C:AVA project needs to be aware of competing flour products and their prices, which can be used in plywood manufacturing (e.g. expired wheat and low quality cassava products (kokonte), which are readily available).
- Dialogue with Standards Board needs to be maintained. Although it may not be possible to prevent the use of cheap *Kokonte* flour for glue extenders, their endorsement of HQCF and industrial grade cassava flour should be beneficial.
- Stronger involvement of the plywood manufacturing companies in the cassava value chain. This may include support of farmers, flour processing intermediaries, or direct involvement in processing activities. In particular, this option exists for plywood manufacturers who are located in close proximity to cassava producing areas.

Animal feed

Cassava can be used as feed ingredient for animals such as cattle, pigs, poultry, sheep, goats, and fish. Whilst the majority of cattle and small ruminants still rely extensively on grazing, the poultry and pig industry have been identified as significant potential markets for dried cassava as a raw material for feeds. In particular, it is estimated that layer hens absorb about 80 – 90% of animal feed rations in Ghana. The broiler sub-sector is relatively small mainly due to overseas imports of poultry meat. The bulk of the poultry feed is mixed on-farm by medium to large-scale farmers, with commercial feed millers often supplying feed concentrates.

In addition, there is a pig industry which is concentrated around Kumasi, and it is understood that pig farmers already use cassava in different forms (e.g. dried chips / flour, peels, and cooked roots). Although the quantities are relatively modest, the pig industry is seen as an easy entry point for dried cassava in feed as a relatively high proportion of the dried roots can be included in feeding rations.

It is estimated that the potential long-term market for dried cassava in animal feed is of the order of 80,000 MT (i.e. 75,000 MT for layers, 2,000 MT for broilers, and 3,000 MT for pigs).

In order to stimulate a cassava based feed industry, the following activities are deemed necessary:

- Awareness-raising amongst industry members regarding technical aspects of including cassava in feed rations. Amongst other things, drawing on international experience (e.g. recruitment of international animal feed consultant/s), this includes information about the nutritional value of dried cassava, and the fact that the content of the protein source (e.g. soybean meal) needs to be increased if cassava is used. Associations (e.g. Ghana National Association of Poultry Farmers) expressed their willingness to organise respective seminars.
- Cost calculations regarding the financial benefits of using cassava in animal feed rations vs. other main sources of carbohydrate (e.g. locally produced white maize, or imported yellow maize in the case of Ghana).

- Feed mixing and feeding trials with the poultry and pig industry. Commercial feed manufacturers will be offered the possibility to participate in the mixing trials. It is important to avoid mistakes of the past, when the wrong equipment has been used or when poultry were trial-fed with cassava meal which was too powdery.
- Depending on the outcome of the trials, industry members will be encouraged to play a strong role in the cassava value chain and to make related investments. Whilst some industry members may primarily buy dried cassava (e.g. grits) to mix it with other feed ingredients, others who own relatively large amounts of land may want to produce and process cassava themselves. Also, feed producers and users will be encouraged to establish a closer link with small-scale farmers and the processing industry, where the latter will be the main source of supply.

Brewery sector

It is understood that both leading brewing companies in Ghana either have plans or already use cassava in the making of beer. For example, Guinness Ghana Breweries have issued a press release in December 2012 stating that they are going to use cassava in their new Ruut Extra Premium beer. Although it has not been stated in what form the cassava will be used, it is assumed that the company requires dried roots.

As for Accra Brewery Limited, which is a subsidiary of SABMiller plc, it is understood that the company is evaluating the experience of cassava based beer brewing in Mozambique. Based on the findings, the company is likely to use a similar approach, which is based on the use of a wet cassava cake, to brewing of cassava beer in Ghana.

If C:AVA 2 is interested in supporting a cassava value chain supplying raw material to the brewing industry, then contact needs to be maintained with the two companies.

Non-starters

- Textiles – in Ghana modified starch has been used in cotton manufacturing for many years now and the potential for switching back to using cassava flour plus additives is unlikely.
- In this context, the negative experience of the Ayensu Starch Company (ASCo) ought to be mentioned. Amongst other things the factory ceased to operate due to lack of raw material supply.
- Liquid glucose - would require significant private sector investment; possible in the longer term but at present beyond the scope of this study.
- Alcohol - it is assumed that the investments required for such an enterprise are beyond the scope of the C:AVA project.

General constraints and recommendations

A range of constraints are being encountered in cassava production and processing, namely:

- Land acquisition issues;
- Lack of investment finance;
- Yields which are well below potential;
- Root price instability;
- Cost of root production;
- Cost of HQCF processing and lack of sunshine during the rainy season where sun-drying is the main mode of drying;
- Transport costs or availability of means of transport in some places.

General recommendations:

- While some of the above constraints ought to be tackled as far as possible as part of a C:AVA phase II project, others are well beyond its remit.
- Value chain fora can be organised to conduct marketing workshops and to improve cassava producers' and processors' access to investment finance.
- More high yielding planting material needs to be introduced in farming communities through links with programmes such as RTIMP.
- Based on achievements in phase 1 of C:AVA, the production of HQCF through different means of drying should be expanded and established and new markets supplied with the flour.
- The cost of HQCF processing needs to be further reduced and a better understanding needs to be developed of production costs for different cassava processing systems.
- Linked to this, competitive prices need to be recalculated for HQCF, industrial-grade flour, and improved chips / grits.
- From interviews it is clear that there is no consistent supply of HQCF and other high quality cassava products to meet existing demand from various industries. In light of this it is important to design supply models whereby larger quantities of HQCF and improved dried cassava products can be supplied, including during the rainy season. This requires a planning exercise involving the entire country C:AVA team (FRI and NRI).
- Review storage options of processed cassava products when larger quantities can be consistently produced.
- End-users (e.g. plywood manufacturers, animal feed industry, and biscuit manufacturers) need to be encouraged to play a stronger role in the value chain. Besides participation in technical trials, this could mean making investments in cassava production and processing or supporting intermediary companies.
- Clarify quality standards for food and non-food grade cassava flour.
- In sum, the following three cassava products are considered to have market potential and should be produced in larger quantities:
 - HQCF for paperboard manufacturing, rural bakeries, and institutions (e.g. schools);
 - Industrial grade flour for plywood industry;
 - Improved cassava chips / grits for animal feed industry and possibly beer brewing.

Summary of market opportunities for cassava-based products in Ghana

Sector	Cassava-based product	Use of cassava-based product (mt/year)				Long-term potential	Conditions	
		Current use	Short-term	Medium-term	Long-term			
a	Wheat total	HQCF	0	0	10,000	34,000	136,000	Currently no legislation for composite flour. Large mills against legislation. Some potential for replacement possible in medium term. Here assumed maximum of 10% replacement long-term based on current volumes.
b	Bakeries	HQCF	Limited	1,000	5,000	17,000	68,000	Medium-term projection based on at least 25% of small (rural) bakeries replacing average of 10% with HQCF for bread and doughnuts, etc.
c	Institutions (e.g. schools)	HQCF	Limited	1,000	5,000	17,000	68,000	Known use of HQCF by some institutions such as schools and demand exists for higher quantities (market demand to be explored).
d	Composite flour	HQCF	0	0	0	0	0	Assume some potential volume from a and b would incorporate composite flours.
e	Biscuit manufacturers	HQCF	Limited	200-300	1000-2000	3,000	12,000	Subject to trials and slowly increasing the percentage of HQCF towards a maximum of 10% replacement in the long-term. Price is significant barrier in current market due to cheap Turkish soft wheat flour imports.
f	Paperboard	HQCF (starch)	0	500	2,000	3,000	12,000	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.
g	Plywood	Industrial grade flour	2,000	2,000	4,000	6,000	24,000	Some already using cassava. Trials and logistic issues to be considered before potential to increase volumes.
h	Animal feed	Improved chips	Limited	2,000	10,000	80,000	240,000	Layers represent the bulk of this potential demand based on 16.6% inclusion in poultry feed rations. Pig rations can also provide an entry point, albeit at a smaller scale.
i	Breweries	HQCF / improved chips	0	?	?	?	?	Guinness Breweries Ghana already use cassava in beer making according to Dec 2012 press release. Quantities to be verified.
j	Distilling	Cassava starch	0	0	0	tbc	0	Currently alcohol mainly imported for mixing into potable alcoholic beverages and other uses.
k	Soft drinks	Liquid glucose	0	0	0	0	0	Currently no plant exists in Ghana so would require large-scale investment from private sector. Likes of Coca Cola not interested.
l	Textiles	Cassava starch	0	0	0	0	0	Unlikely to be an option for technical reasons, and main weaving factor currently uses modified starch.
m	Pharmaceutical	Cassava starch	0	0	0	0	0	Nothing.
n	Other starch uses	Cassava starch	0	0	0	1000-5000	12,500	Subject to production re-commencing at ASCO starch factory which ceased production in 2011. Long-term potential based on assuming average LT requirement of 2500T cassava starch.
Total (without mandatory 10% HQCF inclusion in wheat flour for industrial use) [b+c+d+.....n]							436,500	
Total (with mandatory 10% HQCF inclusion in wheat flour for industrial use) [a+f+.....n]							436,500	

N.B. Here meaning: Short term (1-2 years); Medium term (2-5 years); Long term (5 years +)

Background

Objectives of the study

The purpose of this report was to revisit the understanding of the Ghana market for cassava and cassava products building on the findings of other studies (such as Onumah et al, 2008; Sergeant et al 2011). The Terms of Reference (ToR) included the following:

- A review of published and grey literature on cassava markets and value chains in Ghana.
- 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 Ghana.
- 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

Fieldwork for the study was completed between 19th and 30th November 2012, focussing on the following centres: Accra, Tema, Kumasi, Takoradi, and Volta region (Ho and Hohoe).

The study covered aspects of the cassava value chain and analysis of industrial demand for dried cassava products (HQCF, industrial flour, and dried chips).

Checklists were used for the value chain analysis and the different industries visited in the course of the fieldwork (see Appendices)

Meetings were held at the Food Research Institute (FRI) in Accra to prepare a field research plan and to review findings at the end of the study period, and discuss next steps.

Policy Setting

Ghana economy background

Ghana has attained the status of a middle income country and is likely to have achieved the first Millennium Development Goal (MDG) of reducing poverty by one half (World Bank, 2012). It is estimated that economic growth averaged 6.5 percent per annum (p.a.) over the period 2006 – 2010 compared to an average of 5.1 percent in the previous five year period.

Poverty has declined from 52 percent in 1992 to 29 percent in 2008 (World bank, *ibid*). At the same time it is acknowledged that development gains have not been distributed evenly across the country with the north of Ghana increasingly being characterized as a region lagging behind. According to a poverty assessment jointly carried out by the World Bank and the Ghanaian

government, regional imbalances persist with higher and more extreme poverty rates in the northern sector (World Bank, 2011). This is also reflected in a relatively high percentage of food insecure households in the Northern, Upper East and Upper West Regions (10 percent, 15 percent, and 34% respectively) (WFP, 2009).

In 2009, the share of agriculture of Ghana's GDP was 34.5%, with individual sub-sectors contributing as follows: crop production 61.8%, livestock 5%, cocoa 11.5%, forestry 9.3%, fisheries 12.4%. According to MOFA / SIRD, the real agricultural GDP growth rate was 6.2% in 2009.

Ghana: Cassava policy background

Ministry of Food and Agriculture (MOFA)

The Ministry of Food and Agriculture (MOFA) is the lead agency and focal point of the Government of Ghana, responsible for developing and executing policies and strategies for the agriculture sector within the context of a coordinated national socio-economic growth and development agenda. By means of a sector-wide approach, the Ministry's plans and programmes are developed, coordinated and implemented through policy and strategy frameworks. In this regard, MOFA facilitated the preparation of the Food and Agriculture Sector Development Policy (FASDEP II) and the Medium Term Agriculture Sector Investment Plan (METASIP 2010-15). Based on the role of agriculture in the national development framework, Food and Agriculture Sector Development Policy (FASDEP II) has the following as its objectives:

- Food security and emergency preparedness;
- Improved growth in incomes;
- Increased competitiveness and enhanced integration into domestic and international markets;
- Sustainable management of land and environment;
- Science and Technology Applied in food and agriculture development;
- Improved Institutional Coordination.

The Agricultural sector consists of five main subsectors:

- Crops: Cereals and Starchy Crops;
- Livestock: Cattle, Sheep, Goats, Pigs, Poultry;
- Fisheries: Marine, Inland and Aquaculture;
- Forestry;
- Cocoa.

RTIMP (Root and Tuber Improvement and Marketing Programme)

RTIMP is being funded by the International Fund for Agricultural Development (IFAD) and the Government of Ghana for a period of 8 years (2007-2014). The goal of the programme is to enhance income and food security in order to improve livelihoods of the rural poor. The programme seeks to build a competitive market-based root and tuber commodity chain supported by

relevant, effective and sustainable services that are available to the rural poor. Its programme components include the following:

- Support to increased commodity chain linkages;
- Support to root and tuber production;
- Upgrading of small-scale processing, business and marketing skills;
- Programme coordination, monitoring and evaluation.

Key strategies in the Programme include:

- District Stakeholder Fora (DSF)
- Commodity chain linkage activities through Initiative fund
- Linking up small-scale producers and processors with larger-scale users of R&T products
- Planting material multiplication and distribution
- Farmer Field Fora (FFF)
- Technology transfer for processors
- Establishment of Good Practices Centres (GPC)
- Exposure visits to Good Practices Centres
- Business development training
- Financial services through the micro enterprise fund

During the first years of implementation, the various platforms (FFF, exposure visits to GPC, business development training and planting material distribution) on which clients are equipped to respond to the “demand pull” created by increased access to Micro-enterprise Funds (MEF), have been well developed. The programme has made steady progress in consolidating the establishment and functioning of the various entry points and learning platforms of District Stakeholder Fora (DSF), Good Practices Centres (GPCs) and Farmer Field Fora (FFF). Also, the programme has supported the development of several commodity value chains in the country, namely; *Gari*, High Quality Cassava Flour, bonding cassava flour for plywood industry, and fresh yam. Notable among them is the cassava flour as glue extender for plywood manufacture (cassava plywood chain).

West African Agricultural Productivity Program (WAAPP)

WAAPP is a two-phase, ten-year, horizontal and vertical adaptable program lending to support the implementation of the Comprehensive Africa Agriculture Development Programme’s (CAADP) agricultural research and development pillar, as reflected in the national agricultural investment plans and the regional mobilizing program. The overall goal of the WAAPP is to contribute to agricultural productivity increase in the participating countries. Under the first phase of WAAPP, the Board approved three series of support projects, including WAAPP-1A (for Mali, Senegal and Ghana) in 2007, WAAPP-1B (for Burkina Faso, Cote d’Ivoire and Nigeria) in 2010, and WAAPP-1C (for Benin, Cote d’Ivoire, Liberia, Niger, Sierra Leone, The Gambia and Togo) in 2011. While there is still a need to complete the coverage of the ECOWAS countries, with the inclusion of Guinea, Guinea Bissau, and Cape Verde in the program, the countries under the WAAPP-1A are already at the end of the first phase of the program, and have

thus requested to start their second phase. Ghana's top priority crops focus on root and tuber crops, notably: cassava, yam, sweet potato and cocoyam.

Crops Research Institute

The CSIR-Crops Research Institute (CSIR-CRI) was established in 1964 and is one of the 13 Institutes of the Council for Scientific and Industrial Research (CSIR) of Ghana. Its mission is to develop and disseminate appropriate technologies for high and sustainable food and industrial crop production.¹

The goals of CSIR-CRI are to:

- Develop and disseminate appropriate technologies that are demand driven and acceptable to end users.
- Promote and strengthen strategic partnerships with relevant stakeholders to enhance the generation of solutions to challenges in agricultural research technology development and transfer.
- Improve institutional capability to undertake effective research and service delivery to enhance agricultural productivity.
- Enhance research and technology delivery through efficient mobilization and management and operating procedures and systems as a means of ensuring efficiency in research delivery.

The research mandate of CSIR-CRI covers the following food and industrial crops:

- Cereals (maize and rice);
- Legumes (cowpea, soybean, groundnut and Bambara groundnut);
- Roots and tubers (cassava, yam, sweet potato and cocoyam);
- Horticultural crops;
- Plantain and banana;
- Tropical fruits (citrus, mango, avocado, pineapple, cashew and pawpaw);
- Vegetables (pepper, garden eggs, tomato, onion and leafy vegetables);
- Industrial crops (rubber, sugar cane and tobacco).

¹ Source: <http://www.cropsresearch.org/>

Cassava Production and Value Chain

Production

Cassava, which can grow well on marginal lands, is one of the most important staple foods in Ghana. Cassava production represents approximately 50% of all roots and tubers production in the country. The majority of cassava is grown by small-scale farmers with small landholdings. At that scale production, harvesting, and post-harvest handling are carried out with limited chemical and technical inputs.

It is grown in all regions of Ghana but is particularly abundant in Central, Eastern, Brong Ahafo, Volta, and Ashanti regions as highlighted in Table 1. According to the statistics of MOFA production of cassava roots has increased by almost 40% from 2007 to 2011. In large part this is due to an increase in average yield per hectare of 26% over that period from 12.76 to 16.17 tonnes per hectare.² The amount of land under cultivation has increased 11% in that time.

Table 1: Cassava Production Estimates in Ghana (2007-2011)

Region / Year	Cassava Production Estimates in Metric Tonnes (MT)				
	2007	2008	2009	2010	2011
Western	690,396	707,894	711,950	687,350	556,700
Central	1,861,160	1,992,384	2,036,500	1,914,979	1,976,946
Eastern	2,619,247	2,929,343	3,062,770	3,618,825	3,858,149
Greater Accra	56,576	64,279	67,530	68,170	71,863
Volta	1,048,075	1,357,227	1,558,480	1,529,022	1,660,007
Ashanti	1,160,603	1,205,218	1,255,190	1,842,666	1,900,444
Brong Ahafo	2,426,982	2,489,550	2,606,970	2,728,351	2,883,353
Northern	354,890	605,201	931,240	1,114,723	1,333,406
Upper West	-	-	-	-	-
Upper East	-	-	-	-	-
Total	10,217,929	11,351,095	12,230,630	13,504,086	14,240,867

Source: MOFA/SRID 2012

These figures represent harvested quantities of cassava, it is estimated that an additional 30% remain in the ground unharvested (Onumah et al., 2008) due to insufficient demand, lack of buyers, or more likely weak marketing connections.

² Figures regarding yield per hectare vary, however they are consistently below potentials of at least 25MT/ha that CRI consider achievable with better agricultural practices and improved varieties.

The main planting season for cassava is during the rainy season from May to September. Cassava is harvested approximately 12 months after planting so harvesting can take place any time from March to October (in an average year). The largest percentage of the cassava root harvest comes onto the market in the early part of the wet season (May to July) before planting begins. Harvesting during the dry season (November to March) is not common, only small quantities.

According to Sam & Deppah (2009) harvesting labour accounts for 15-20% of cassava root production costs. Costs vary considerably based on location, in 2008 costs were:

- GHC 525.2/ha in the coastal savannah zone
- GHC 234.6/ha in the forest zone

Table 2 shows to what extent the timing of harvest, yield levels, and selling prices impact on margins (Posthumus, 2011). According to the data, a slightly lower yield but higher prices lead to the highest gross margin (September scenario), whilst the same yield (i.e. 15 tonnes / ha) but lower prices result in the lowest gross margin (June scenario).

Table 2: Cost of production & gross margin of fresh cassava roots in Ghana

	Oct '10	Mar '11	June '11	Sept '11	Dec '11
Typical yields (t/ha)	18	18	15	15	12
Selling price (for processing, farm-gate) (\$/t)	35	33	33	47	47
Returns (\$/ha)	630	600	500	700	560
Labour days (per ha)	122	122	122	122	122
Opportunity cost of labour (\$/day)	3.57	3.33	3.33	3.33	3.33
Cost of labour (\$/ha)	436	407	407	407	407
Planting material (\$/ha)	20	20	20	20	20
Other costs (e.g. annual land prep)	13	13	13	13	13
Total costs of production (\$/ha)	469	440	440	440	440
Gross margin (\$/ha)	161	160	60	260	120
Production costs (\$ per t Fresh Roots Equivalent)	26	24	29	29	37

Source: Posthumus, 2011

Processing

Cassava has traditionally been regarded as 'poor man's food' but increasingly its utilities as a cash crop are being recognised. Opportunities exist for earning incomes from processed cassava products, but significant constraints also continue to place restrictions on some opportunities. For instance traditional processing methods are time-consuming and labour intensive and the technology for processing modern industrial cassava products are often not available to most low income cassava producers and processors.

Cassava is processed to control deterioration of roots and decrease toxicity. Due to its high perishability and potential high cyanide content fresh cassava roots should be processed within 1-2 days of harvesting. These factors, combined with high moisture content of approximately 70%, restrict the marketing and transportation options for cassava.

During a recent study by Vanhuyse (2012) both farmers and processors stated that sufficient roots are available and there have been some yield improvements with new varieties. Of the roots harvested in Ghana approximately 50% of cassava is either consumed or sold as fresh roots to produce (at household level) boiled or pounded cassava (*Fufu*). Of the remaining 50% approximately:

- 25% used to produce *Gari* (roasted fermented cassava)
- 18% used to produce *Agbelima* (fermented cassava mash)
- 6% used to produce *Kokonte* (dried chips)
- 1% used for industrial purposes ³

The majority of cassava is therefore the basis for many traditional food products such as *Gari*. From dried chips and processed flour (e.g. HQCF) cassava is used in a wider variety of products including flour, animal feed, and glue extenders. The technical requirements and specifications for processed cassava increase along the spectrum of cassava processing from traditional food products to industrial grade products to retail food products (e.g. flour).

The most significant processing issue is drying cassava and there are currently three options available for drying: sun drying, bin dryers, and flash dryers. For most small-scale processors the only feasible option is sun-drying and they are naturally restricted in potential volumes they can produce due to inability to dry during many months of the year, and the low volumes of cassava harvested during the dry season. Due to potential mycotoxin development the quality of dried cassava products reduces significantly during the wet season. Some medium scale processors are now using bin and flash dryers in Ghana and they will be referred to in relevant market sections of this report.

In 2011-12 between 800-1000MT of HQCF per year was produced by C:AVA processors. Potential is there for producing larger quantities but constraints exist, particularly financial factors. Of the 800-1000 MT produced, some of that was produced as non-food grade industrial-grade flour produced in bin driers.

³ References: Adjekum, 2006; Onumah et al., 2008; FRI, 2012

According to Dziedzoave & Hillocks (2012) actual production and sales of HQCF and other dried cassava products are those shown in Table 3, produced by both small and medium-scale enterprises.

Table 3: Ghana HQCF Production 2011

Product	HQCF (MT)	Other dried cassava*
SSEs 2011 production (MT)	516	9960
MSEs 2011 production (MT)	659	725
TOTAL	1,175	10,685
2013 Target	4,075	

Source: Dziedzoave & Hillocks (2012)

*Gari, Kokonte

Market supply of HQCF is presented in Table 4, of particular interest is supplies to the plywood sector, details of which are discussed further in that section later in this report.

Table 4: Ghana market supply of HQCF 2011

Type of Market	Type of Product Supplied	No. of Clients	Quantity Supplied (MT)
Alcohol Industry	HQCF	1	10
Beer Industry	HQCF	1	0.3
Biscuit Industry	HQCF	3	99
Food industry	MIXED	58	723
Mosquito Coil Industry	HQCF	1	77
Paper industry	HQCF	2	1
Plywood Industry	HQCF	17	472
Poultry Industry	MIXED	1	2
TOTAL		84	1,384.3*

Source: Dziedzoave & Hillocks (2012)

* Assume includes some carryover stock from 2010.

Discussing HQCF processing with one processor established the following:

- Producing HQCF versus industrial-grade flour adds 30-40% production cost per tonne
- Additional costs come from manual peeling of roots, plus more expensive dewatering, energy, and drying costs (flash dryer costs are more than double those for running a bin dryer)

Table 5 summarises various pros and cons of HQCF and industrial-grade flour. On balance it seems that those processors with the option have been producing industrial-grade flour using a bin dryer. The balance of HQCF production costs and current prices obtained prohibit flash drying of cassava on balance.

Table 5: HQCF / Industrial grade flour - production pros and cons

HQCF - pros	Industrial-grade flour - cons
Higher selling price	Lower selling prices
Regulated heat negates gelatinisation	Gelatinisation can occur
Food and non-food uses	Less utilisation possibilities
HQCF - cons	Industrial-grade flour - pros
Labour unavailable for peeling	Mechanised peeling
Higher production costs	Lower production costs
More stringent quality standards	Fewer quality concerns for non-food
More energy required	Energy costs relatively lower
Machinery investment more expensive	Lower initial investment costs

Source: Pers. comm. Caltech

In 2010 HQCF was sold at GHC 30-40/50kg, and in 2012 GHC 40-50/50kg. In comparison *Kokonte* (dry chips) were available in 2012 for approximately GHC 30/50kg. As discussed in more detail below, bread wheat flour costs (ex-mill) GHC 78/50kg, whereas Turkish biscuit flour was imported at GHC 47-55/50kg. A recent review of C:AVA SME processors by Hillocks (2012) indicate the following as an example of prices received by a processor:

- *Gari*: GHC 45/50kg
- *Agbelima*: GHC 25/50kg
- HQCF: GHC 40-50/50kg
- Roots: GHC 2/50kg

In such market circumstances it is not surprising that *Gari* is by far the preferred product to process and sell. One processor stated that the HQCF prices are not sufficiently encouraging when taking into account the difficulty of preparation. The biggest markets (outside of traditional food products) for them are *Kokonte* and a large potential for industrial starch (Hillocks, 2012).

Preferences for producing *Gari* due to better margins versus HQCF were also highlighted in another recent C:AVA review. Processors can make approximately 50% profit from producing and selling *Gari* at GHC50/50kg (Vanhuysse, 2012). This gets significantly squeezed when processing costs for HQCF increase but selling prices remain around GHC 50/50kg. Looking forward, processors do see potential in HQCF, particularly as wheat prices increase. They also see benefits from HQCF storability compared to *Agbelima*, and potentially a more stable clientele base from which to develop relationships. Consistently however the issue of processing constraints due to lack of drying capacity remains at present.

A more detailed study of actual production costs and selling prices is required to obtain a better understanding of potential profit margins (or otherwise) from processing with bin and flash dryers by SME processors. A review should include analysis of capital investment costs and depreciation in order to present more accurate data to those potentially interested in investing in cassava processing. At present there are many different figures presented for both production costs and selling prices.

There is a need for all value chain participants to record more detailed and accurate product and financial flows as currently there is a lack of quantitative data recording from growers to end users (Hillocks, 2012). In addition there should be more education and work with farmers to ensure they sell by weight and not land area. Some farmers selling by land area are losing out on any yield improvements. Investment in weighing scales would improve the situation.

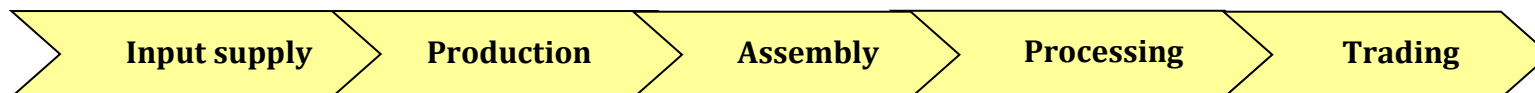
Many market sectors present opportunities for adding value to cassava, the subsequent sections of this report discuss each in turn to highlight markets with most potential for development. Specifically this focusses on the utilisation of dried chips (*Kokonte*), HQCF, and industrial-grade flour. What re-emerges in each instance is the issue of both quality and consistency of supply of cassava processed products.

At present the C:AVA project is being hindered by SMEs as very few are producing significant amounts of HQCF (Hillocks, 2012) and alternative business models need to be explored (e.g. incorporating private sector end users into supply chains). Continuous improvement to meet quality standards is required, focussing repeatedly on factors such as particle size and moisture levels, and generally developing an enhanced 'quality culture' in different sectors.

Fresh and Processed Cassava Value Chain

Figure 1: Ghana Cassava Value Chain Map

Stages in the cassava value chain - overview of functions



Map of sub-channels and actors within the chain

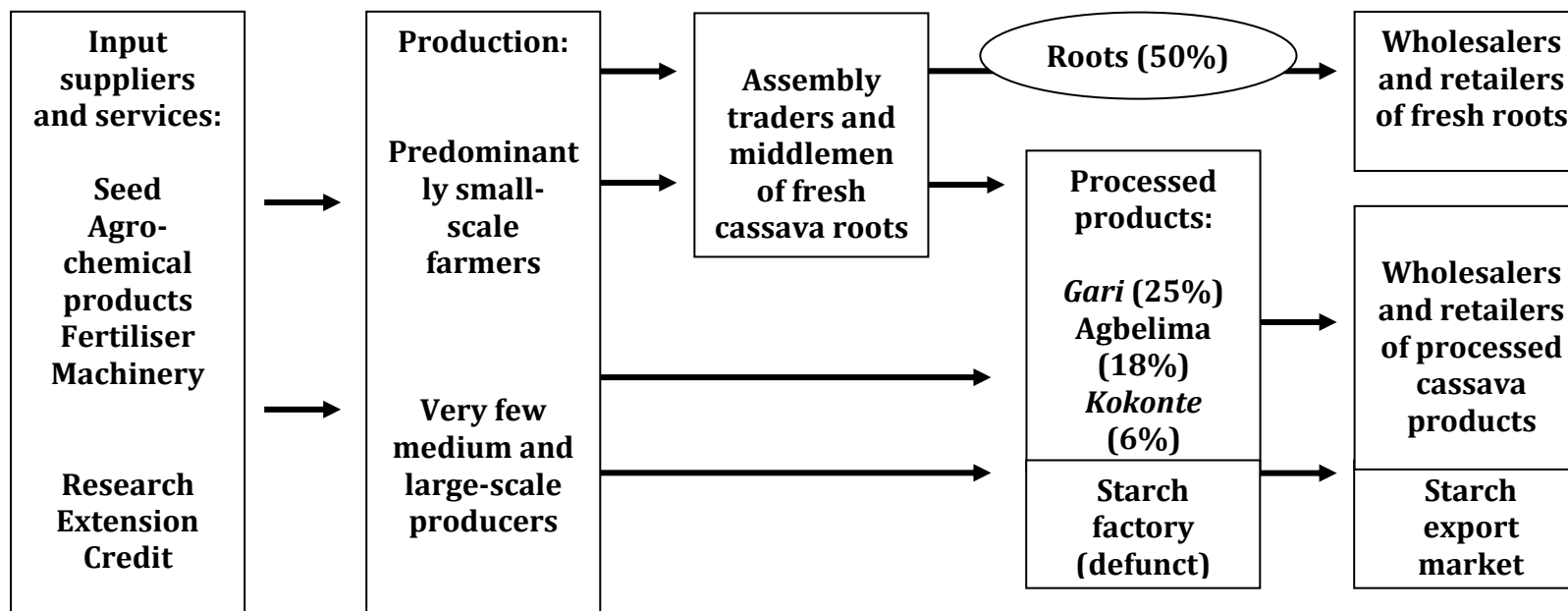


Figure 1 illustrates the main functions, channels, and actors present in the chain. It provides an overview of the main products traded and processed in the chain, demonstrating the importance of processing (i.e. half of the crop is processed into products such as *Gari*, *Agbelima*, *Kokonte*, and HQCF/industrial grade flour). In particular, wholesalers (e.g. cassava queens) play a dominant role in the market. As outlined in the Liquid Glucose section later in the report, the Ayensu starch factory has been defunct since 2011 and never operated to its full capacity due to shortage of raw material.

Figure 2 shows the national average wholesale prices for both maize and cassava. In particular, the graph clearly demonstrates the sharp price increases between 2007 and 2011, which have even further increased in 2012. For example, the high maize prices have, amongst other things, been used as a justification by the poultry industry for imports of yellow maize into the country.

Figure 2: Ghana National Average Wholesale Prices for Maize and Cassava



Source: SRID/MOFA

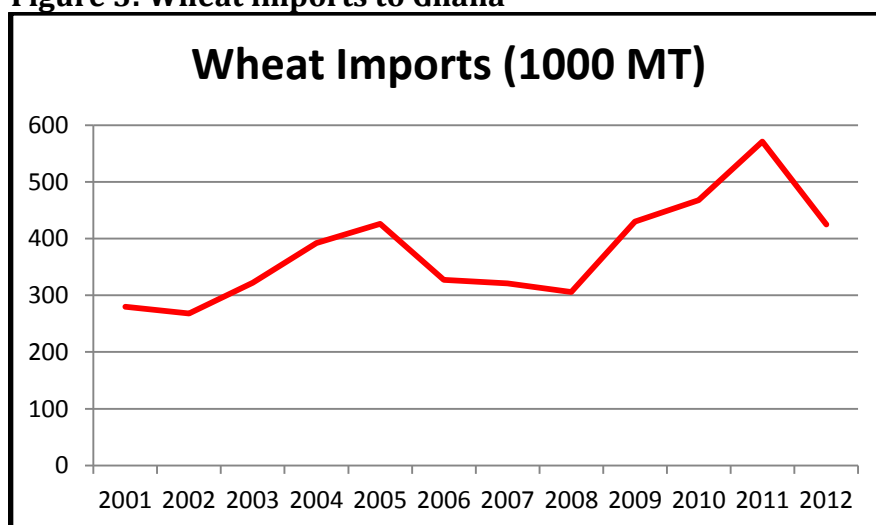
NB: The price for maize is per 100-kg bag. To facilitate comparison, the price of cassava has been converted from 91-kg bag (as in the original data provided) to a 100-kg bag. It is assumed the price data provided for cassava is for fresh roots.

Market Study

Wheat Milling Sector

The Ghanaian wheat milling sector is dominated by a few large milling companies, principally Irani Bros., Flour Mills of Ghana Limited (FMGL),⁴ Takoradi Flour Mill Limited, and Olam (new entrant 2012). Representatives of each mill (with the exception of Olam) were interviewed and all noted significant increases over the past decade in both quantity of wheat imports and prices for wheat as highlighted in Figures 3 and 4.

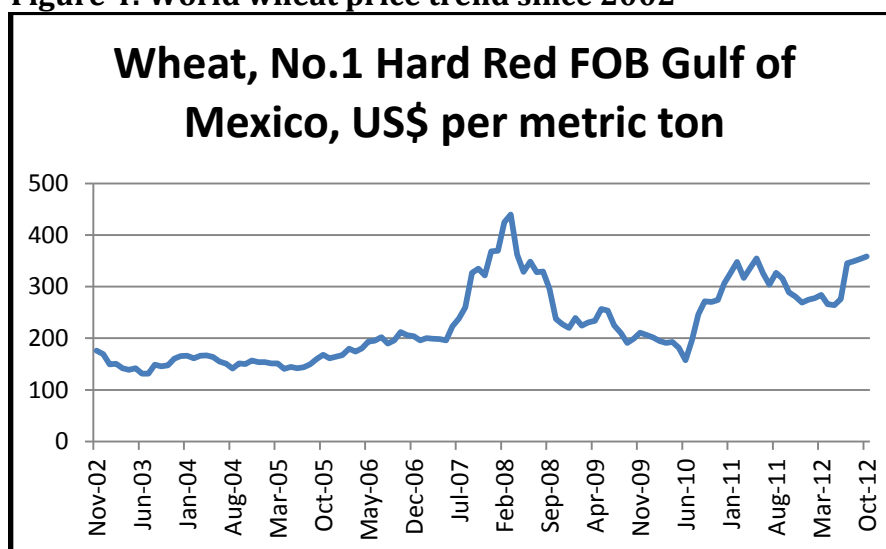
Figure 3: Wheat imports to Ghana



Data Source:

<http://www.indexmundi.com/agriculture/?country=gh&commodity=wheat&graph=imports>

Figure 4: World wheat price trend since 2002



Source: <http://www.indexmundi.com/commodities/?commodity=wheat&months=120>

⁴ Parent company is Seaboard, previously site was GAFCO (Ghana-Agro Food Complex Ltd), see <http://www.blackseagrains.net/photo/seaboard-to-operate-flour-mill-complex-in-ghana>

A steady increase in imports over the past decade has resulted in an increase of approximately 50% in volume. Current volume estimates vary based on official and anecdotal sources. A range of 425,000 MT to 475,000 MT during 2012 with an average of 450,000MT represents a reasonable picture of recent imports. The quantities imported by each mill range from 60,000 MT to approx. 200,000 MT.

Evidence that demand for bread (and therefore wheat) will continue to increase over coming years is reflected by a miller's decision to invest \$55m into a new mill in Ghana. ⁵ By 2015 the miller expects to be producing 115,000 MT of wheat flour (equating to 150,000 MT wheat imports) which is similar to other mills' output. They expect a 7.5% annual increase in demand over the next 5 years, which suggests the following import levels if current imports are 450,000 MT:

- 2013: 485,000 MT
- 2014: 520,000 MT
- 2015: 560,000 MT

The cost of wheat imports increased more than 100% between 2007 and 2008. In 2007 the dollar value of wheat imports was \$73,541,000 and \$149,297,000 in 2008 (Sam & Deppah 2009). As shown in Figure 3 over the same period import quantities actually decreased.

While prices have fallen back since 2008 the general trend remains above pre-2007 levels. In recent periods there was a 24% increase in world wheat prices October 2011 to October 2012 (Figure 4). Current (i.e. end of 2012) prices for hard wheat are in the region of \$350/MT farm-gate, and soft wheat only slightly lower around \$340/MT. ⁶ The preferred wheat to import is Canadian hard wheat due to its strong gluten and protein properties. This is often blended with softer wheat to slightly reduce the gluten properties.

The total cost of wheat to import to factory gate is in the region of US\$490 / MT based on:

- \$400 for wheat (prices quoted by wheat mills in November 2012)
- \$70 freight
- \$20 other costs

Wheat flour (at the time of study) was sold at approximately GHC 78.5/50kg ex-mill, plus taxes to a total of GHC 90.65/50 kg which equates to \$830/MT. This represents the large percentage of wheat flour used in Ghana, principally for baking bread. A significant quantity of cheaper, lower grade, and lower protein wheat flour is imported from Turkey for use in the biscuit industry and the issues and threats related to that in terms of HQCF possibilities is discussed in the Biscuit Industry section below.

⁵ See Appendix 2 and <http://olamonline.com/locations/worldwide/central-west-africa/ghana> ; <http://www.ghana.gov.gh/index.php/news/features/11171-olam-ghana-to-launch-wheat-milling-plant-in-tema>

⁶ See <http://www.indexmundi.com/commodities/?commodity=soft-red-winter-wheat&months=120>

HQCF Potential

With increases in global wheat prices and a strengthening of the US dollar versus the Ghana Cedi, in theory HQCF should represent an interesting alternative to the wheat milling sector in terms of price competitiveness. It remains very difficult, however, to benchmark over a longer period as many external factors need to be considered such as speculation on global markets and impacts of climate change. Also increased milling capacity in Ghana with the entrance of a new miller may reduce prices of wheat flour. For this discussion, Tables 6 and 7 summarise key points as SWOT analysis, highlighting both opportunities and weaknesses regarding HQCF and the milling sector.

Table 6: SWOT Analysis - Wheat milling industry (food grade HQCF)

Strengths	Weaknesses
<ul style="list-style-type: none"> • Large-scale processing capacity • Some millers willing to trial in test bakeries • Mills have blending capability if required • Some mills accept minimum 2% HQCF inclusion is possible & up to 5% • Bakers already use mix of wheat flours 	<ul style="list-style-type: none"> • Millers against legislation for HQCF inclusion based on Nigeria history • Small HQCF volumes not conducive to large mill logistics and storage • Low inclusion rate = low savings and volumes • If HQCF inclusion legislated current HQCF supply insufficient • Inconsistent blending by bakers • Any HQCF inclusion leads to a decrease of gluten and protein • Negative perceptions of cassava still an issue • What is cassava USP? Cassava seen as producing lower quality bread • Distance from cassava producing areas to mills
Opportunities	Threats
<ul style="list-style-type: none"> • HQCF competitive versus wheat imports • Large mills have financial capacity to potentially invest in supply chain • Growing demand for bread and bakery products • Demand from large institutions, e.g. schools • Competitive advantage of local sourcing • Strengthening US\$ versus GHC makes wheat less attractive • Potential to create new products with new bread flavours • Opportunity for marketing 'Made with Ghana flour' 	<ul style="list-style-type: none"> • Cheaper Turkish wheat flour imports • National mill companies targeted by MNCs, e.g. Olam • Increasing HQCF prices a disincentive • Millers unwilling to invest in new storage facilities for HQCF • Difficult to benchmark HQCF against fluctuating international wheat market

Table 7: SWOT Analysis – Bakeries (food grade HQCF)

Strengths	Weaknesses
<ul style="list-style-type: none"> • Popularity of bakers' products • Growing sector • Willingness to try new products • Probably some already using cassava flour 'informally' 	<ul style="list-style-type: none"> • Response of consumers to HQCF unknown • Inclusion rates likely to be low
Opportunities	Threats
<ul style="list-style-type: none"> • HQCF competitive versus Ghana wheat flour 	<ul style="list-style-type: none"> • Cheaper Turkish wheat flour

Regarding strengths and opportunities, there is some willingness to trial and participate in the project among the senior managers of some of the principal milling companies. This includes opportunities to use test bakery facilities in collaboration with FRI and others. In addition small bakeries that were visited also committed to trialling cassava flour as they normally blend 2 different flours anyway so could potentially replace some wheat flour with HQCF. Most bread is manufactured by small (urban and rural) bakeries that commonly use 5-10 tonnes of wheat flour per week.

In terms of potential volumes, in the medium-term 2-5% replacement of all wheat flour with HQCF would mean a potential demand of 9,000 to 20,000 tonnes based on current wheat flour volumes of 340,000 tonnes per annum (450,000 tonnes of wheat). Longer-term, if 10% inclusion emerged as a possibility then a total of 34,000 tonnes could be utilised but this is a long-term vision, not something that can be expected for the time being.

In the short-term a more realistic opportunity is demand from institutions such as schools. Some boarding schools have used HQCF and this is a sector that should be more aggressively pursued. As always quality and consistency of supply are the key traits any customer expects and demands. Anticipating that supply is possible then a demand of up to 1500 tonnes of HQCF per annum exists based on the following assumptions:

- One school in Volta Region uses 15 bags of wheat flour per week.
- Multiplied by 13 weeks and 3 terms this is a total of 30 tonnes per year demand.
- At 10-15% inclusion rate (discussed with the school) equates to 4 tonnes of HQCF demand.
- There are around 75 schools in the Volta region that could do likewise so a total demand for this region of 300 tonnes per year is a potential.
- Four other regions in Ghana (Central, Accra, Ashanti, and Northern) have similar number of education institutions and therefore a total demand for HQCF supplied to schools for baking of up to 1500 tonnes per year could be foreseen.

New trials will take place at schools and if successful should be rolled out further. In addition to schools other medium term prospects include hospitals, prisons, and hotels. Some hotels have been taking small quantities of HQCF to date.

On a broader scale there are a number of factors that suggest interest in HQCF will remain marginal for the time being. First, negative perceptions of cassava still prevail in terms of quality, consistency, and impact on product both from technical and marketing perspectives. Many in the milling industry have negative experiences of cassava and those views are quite embedded. Related to this, the (negative) experiences of Nigeria introducing a 10% HQCF inclusion policy are well known and this contributes to hesitation regarding composite flours.

There is an initiative led by the Ministry of Environment, Science and Technology (MEST) to institutionalise the provision of composite flours by wheat millers that include at least 5% alternative flours (including HQCF) by 2015.⁷ The consultation on this initiative includes representation from FRI and others, in particular Dr Nanam Tay Dziedzoave, C:AVA Country Manager for Ghana. Significant challenges are faced by this initiative, starting with the embedded negativity towards cassava in the milling sector discussed above. In addition there are a number of logistical challenges regarding movement of smaller volumes of HQCF versus wheat flour, and mills currently lack capacity to handle and blend non-wheat flours in smaller volumes.

However, in reality most small bakeries blend their own mix of more than one flour and therefore blending at mills may not be a requirement in all cases. Onumah et al (2008) noted the on-going use of composite wheat and cassava flours by some bakers and caterers to produce bread and confectionary, and such practices continue. Furthermore, whilst it is a more distant prospect, some mills stated in theory they would be willing to get more involved in non-wheat flour supply chains depending on results of trials, experiences of supply and consistency, etc., as noted above. In addition a market study of consumer reaction to potential availability of composite flours would help support a case for true interest.

⁷ See <http://www.ghana.gov.gh/index.php/news/general-news/14161-a-new-face-for-ghanas-flour-industry>

Biscuit Industry

There is a significant demand for biscuits in Ghana. According to one manufacturer demand has increased from 50,000 MT per year (2011) of biscuits consumed to 80,000 MT per year (2012). Ghanaian manufacturers face strong competition from cheaper imports (e.g. from China) and imports capture approximately 70% of the market. The remainder is shared between 7-8 Ghanaian manufacturers who therefore operate in a very competitive market.

In terms of flour consumption, the biscuit sector uses approximately 2500 MT per month (30,000 MT per year) of wheat flour. Some larger manufacturers are optimistic of up to 10% annual business growth, other smaller players sceptical regarding future prospects. As more multi-national companies enter the sector it would appear the number of manufacturers will reduce to a core of 3-4 players. For example one company who recently acquired another smaller company sees growth opportunities, potentially looking to expansion that would add at least 10,000 MT per year to total sector requirements for wheat flour (or equivalents).

Biscuit flour is lower grade flour compared to hard wheat flour and therefore cheaper. Currently all manufacturers seem to be importing cheap wheat flour from Turkey at a cost of approximately \$500-\$580 per tonne delivered CIF basis. At this level price represents a significant barrier for HQCF to enter the market as current HQCF prices do not offer significant savings versus Turkish wheat flour. In a market of low margins HQCF on this basis is not an attractive alternative.

In a scenario where HQCF was 20% cheaper versus biscuit wheat flour there could be savings realised but at current production levels probably still not significant enough to encourage manufacturers to switch raw material supply. Taking an example where a manufacturer currently uses 10,000 MT of biscuit wheat flour per month and HQCF prices 20% cheaper than biscuit wheat flour:

- Replacing 10% wheat flour with HQCF saves ~\$8300 per year (2% raw material cost)
- Replacing 20% wheat flour with HQCF saves ~ \$16,700 per year (4% raw material cost)

In the current market such savings are unlikely given the fact it costs at least \$360⁸ to produce 1 tonne of HQCF, so to compete with a delivered price of around \$550 for Turkish wheat flour is very difficult. Moreover all manufacturers interviewed have previously trialled cassava flour and on the basis of poor results are reluctant to switch even small percentages of flour to HQCF. Principally there are concerns regarding after taste (bitterness) and consistency both in terms of HQCF performance and availability.

Opportunities for relatively small quantities of HQCF do exist for use in soft dough biscuits such as digestives, and potentially for gluten-free biscuits

⁸ Data supplied by C:AVA processor.

although the market for that is untested. Table 8 highlights opportunities as part of a SWOT analysis.

Table 8: SWOT Analysis – Biscuits (food grade HQCF)

Strengths	Weaknesses
<ul style="list-style-type: none"> • Some experience of testing cassava • Many players – 6-7 manufacturers • General willingness to trial cassava 	<ul style="list-style-type: none"> • Low margins and strong competition (1-2 companies going out of business) • Cassava trials to date have seen mixed experiences • Where trials were positive there were supply issues • Concerns re lack of raising properties and bitter taste • If inclusion low, cost savings restricted • High transport costs from source (e.g. Volta) to Tema
Opportunities	Threats
<ul style="list-style-type: none"> • HQCF competitive versus Ghana wheat flour • Possible cassava USP = gluten free for diabetics • Use in digestive biscuits • One producer considering HQCF plant investment • MNC practices supply chain investment projects 	<ul style="list-style-type: none"> • Cheaper biscuit imports • Cheap Turkish flour imports • Inconsistent supply of HQCF

The main points that consistently were raised concerned price, and the fact that HQCF is unlikely to be competitive, and concerns regarding the technical performance of HQCF and after taste.

Investment opportunities

One interesting opportunity to pursue that emerged from the market study is with a company located in Tema. This company now occupies a site intended to be a complex for food and agro-industry. Within this facility they have installed biscuit manufacturing capacity and have operated for almost 2 years. They are interested in expanding their operations and to that end have embarked on a feasibility study to produce cassava flour.

As they already have a facility in Tema they are keen to use that for cassava flour processing. We discussed the following issues related to this:

- Plant location
- Links to farmers
- Transporting raw material (potentially large distances)
- Yield expectations

It was agreed that FRI will continue to liaise with the company to provide input and possibly guidance regarding the issues above and a few ideas offered. To develop the feasibility study further the company requested:

- Information on potential HQCF market and we agreed to discuss that further;
- Advice on processing kit – FRI can provide some ideas from their work and elsewhere in the C:AVA project, e.g. in Nigeria.

One potentially feasible model is the following:

- The company invests in first-stage processing in a cassava production region to produce mechanically dried grits;
- Those grits are then transported at lower cost versus fresh roots to Tema;
- These grits can be kept for some months with no fermentation development;
- Final processing into HQCF in Tema facility.

A lot of work still needs to be done to develop this concept but there is an opportunity to get an industry player directly involved in an HQCF supply chain. To make this feasible the company was expecting yields from processing roots to flour to be in the region of 40%. We explained the most likely yield is normally around 25% and that may be an issue for them regarding feasibility. Discussions with the company will continue regarding this plan.

Summary

The biscuit sector does not represent a huge market potential for HQCF, nevertheless the following should continue in order to try to access some of the market:

- Keep in contact with companies visited and conduct new trials as agreed;
- Re-cost HQCF based on current cost levels and present realistic supply chains;
- Provide information to companies to evaluate supply chain investment opportunities;
- As in the wheat milling sector, consider further opportunities for use of HQCF for production of biscuits for institutions such as the army, government, etc.

Paperboard (boxes)

The paperboard sector in Ghana has and continues to grow, presenting potential opportunities for HQCF to enter an interesting sector. There are 4-5 paperboard companies in Ghana, with the largest company capturing 40% of the market supplying large-scale customers such as Nestle and Unilever. They currently use approximately 1000 MT of maize starch per year, meaning the total sector utilises around 2000 MT per year.

Paperboard manufacturing and HQCF ⁹

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. The 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. The Ghanaian manufacturers interviewed use imported ready-mix powders which are simply added to water and run onto the paperboard line (a common practice).

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 more than 150m per minute.

Some sophisticated factories buy the component parts of the adhesive and mix custom adhesives on the production line (an option the largest paperboard manufacturer is considering as discussed below). 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.

Ghana market

Maize starch-based pre-mixes are imported from India and Israel principally, at a cost of around \$800 / MT delivered to Tema. Pure maize corn starch could be imported for around \$500 / MT delivered into Ghana. With a strengthening dollar, and recognition of the binding properties of cassava, there is interest to localise starch supply and potentially invest in supply chains. As in other sectors companies cite negative experiences of previous trials using cassava and so careful trials should be conducted to convince some that HQCF can work as expected as a glue extender. Table 9 presents SWOT analysis for paperboard.

⁹ Technical details from pers. comm. A.Graffham.

Table 9: SWOT Analysis – Paperboard (HQCF)

Strengths	Weaknesses
<ul style="list-style-type: none"> • Cassava recognised for binding properties • Local sourcing cheaper versus pre-mix imports • Sector willing to trial cassava • Good working relations between paperboard manufacturers (share knowledge, etc.) • Sector growing, especially MNC customers 	<ul style="list-style-type: none"> • Costs of transporting cassava • Concerns re drying of cassava • Trials to date unsuccessful
Opportunities	Threats
<ul style="list-style-type: none"> • Strong interest in sourcing locally • Rising US\$ versus GHC • Largest player looking to invest in adhesive production and looking for local flour source • Also would consider investing in supply chain if ‘win-win’ case 	<ul style="list-style-type: none"> • Inconsistent supply • Cheaper corn starch imports versus HQCF • Questions regarding ability to meet quality and logistics and price demands

Regarding market growth, the largest company currently converts 1000-1100 MT per month of paper and have capacity to convert twice that amount. They are very interested in the project as they are actively looking to invest in high-speed starch-based adhesive units (Fully Automated Starch Kitchens). Such equipment can cost in the region of \$120-140,000 illustrating the level of investment being considered. In order to make savings of \$20,000 per month, the company are benchmarking \$450 for starch purchase, making total cost of pre-mix on site \$650 / MT.

It is a challenge to be able to supply HQCF at \$450/MT but updated calculations of what could be possible as a delivered cost should be considered. The company would place an annual order of 1000 MT (therefore a guaranteed market for that quantity) and request monthly deliveries of 80MT or so.

This opportunity is subject to successful trials in the first place, followed by a review of how a supply chain can be developed to a) meet commercial expectations of the customer, and b) produce required quantities and consistency. Taking one SME processor as an example, if they produce HQCF on a weekly basis the maximum annual output could be 250 MT. HQCF supply is constrained and therefore it may not be possible to supply larger-scale paperboard companies in the coming calendar year. However if such a company is convinced HQCF can work for them commercially and technically, and others enter into cassava flour production then the HQCF sector can start to expand.

There are a total of 4-5 companies manufacturing paperboard and each seems to have their own particular markets and therefore there is an environment where companies are quite open to sharing knowledge and experience. This is an ideal environment for HQCF to be explored within.

HQCF market summary

Realistically the maximum market for HQCF in the short-term (1-2 years) that can be conceived at present is as follows:

- Up to 1000 MT for paperboard to be used as glue extender subject to trials and availability;
- Up to 2000 MT if replace 1-2% of wheat flour used by small bakeries and institutions;
- Zero for biscuit manufacture given the current cheap imports of Turkish wheat flour.

In the short-term demand is much lower but with trials and supply chain development work a market of at least 2500 MT should be realised in the next 1 to 2 years, otherwise industries will lose interest in HQCF. For the biscuit sector trials should be conducted in collaboration with manufacturers and technical results recorded. The data can be used to prepare factsheets based on recent trial experiences. The potential for HQCF in biscuits should then be revisited as a medium term possibility. It is imperative to avoid mistakes and shortcomings which happened in the past regarding HQCF trials.

In the medium-term (2-5 years) theoretical demand could be:

- 2000 MT for paperboard;
- At least 5000 MT if 1-2% of wheat flour are to be replaced;
- 1500-3000 MT / annum for biscuit industry based on 5-10% replacement of current usage of 30,000MT of biscuit wheat flour;
- Medium-term total demand of 10,000 MT of HQCF in Ghana.

Plywood

The plywood industry consists of approximately 13 companies, which are quite variable in size. Based on information provided by trade sources in late 2012 it is estimated that the plywood industry consumes about 4,000 tonnes of flour per annum. Sergeant et al (2011) arrived at a flour consumption of 4,250 tonnes per annum using the annual output of the plywood industry (i.e. 170,000 m³) and the amount of glue required to produce this output. Although there is growing demand for plywood products, employment has reportedly been shrinking during the last five years from 50,000 employees to 20,000 employees in the sector.

Plywood manufacturing and HQCF ¹⁰

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 previous work in Ghana 100% replacement of wheat flour with HQCF was achieved and this was adopted commercially by one mill. Several other mills wished to purchase but the processors lacked capacity to supply at that time. HQCF does not interfere with bond strength or reduce the durability of the boards.

Ghana market

The majority of companies use several hundred bags (50 kg each) of cassava flour per month, although the smallest one only consumes 30 bags. The plywood manufacturers use cassava flour as glue extender together with urea-formaldehyde. According to industry sources the quality of cassava flour compares to other flours used as glue extenders as follows:

1. Wheat flour. It is the preferred glue extender, given that it has high bonding properties. Less glue is consumed. Disadvantage: too expensive.
2. Industrial grade cassava flour (dried with bin dryer). Also considered good, and is used if available. Disadvantage: not always available, in particular during rainy season. Also, this type of flour may not meet HQCF specifications, although this is not seen as a problem by the industry.
3. Traditional cassava flour made from *Kokonte* (sun-drying). Disadvantage: shortage of supply during rainy season (e.g. September to November).

¹⁰ Technical details from pers. comm. A.Graffham.

4. Corn flour. Only recently introduced by an unnamed supplier. Still being tested. If successful it may be used as part of a mix containing corn and cassava flour. Disadvantage: high moisture content, and quality unknown. Advantage: very cheap.

In particular, the use of cassava flour has accelerated since 2008 as wheat flour has become very expensive. The Forestry Research Institute of Ghana (FORIG) has assisted plywood companies in using cassava flour as a glue extender, which may have been influenced by earlier, joint research between NRI and FORIG. As of November 2012, wheat flour prices were of the order of GHC 78/bag of 50kg (ex-mill), compared to GHC 35 for industrial grade cassava flour, approximately GHC 30 for traditional cassava flour, and GHC13 per bag of corn flour (this may be an introductory price).

Cassava flour producing companies which have been supported by the C:AVA project have also supplied improved quality cassava flour to some plywood companies. It is recognised that this type of flour does not meet the specifications of HQCF although it may sometimes be called as such. Not all companies use this type of flour, in particular since the quantities produced are too low.

It was reported that cassava flour is short in supply during parts of the year, i.e. in particular between September and November. Plywood manufacturers are accustomed to the use of cassava flour and have asked for increased supply. In particular, this could be an opportunity for the production of better quality, industrial grade cassava flour in larger quantities. Regarding quality, this flour would occupy a middle ground between HQCF and traditional cassava flour.

Cassava flour specifications required by plywood manufacturers were given as follows:

- Flour has to be free from fibres and other particles;
- Texture of flour needs to be fine (i.e. fluffy / smooth);
- Moisture content has to be low (<12%);
- Colour or fermentation is not a problem.

Usually, testing of flour does not involve any equipment, only the hands and experience of the buyer (e.g. testing for moisture content or smoothness).

Markets for plywood products were stated as follows:

- Ghana (approximately 20% - 30% of production is destined for this market);
- Other West African countries (in particular Nigeria, but also Togo, Burkina Faso, etc.). This is the main market for Ghanaian plywood (i.e. over 50% of production);
- Overseas markets, such as US, EU, Australia, Middle East. These are relatively small markets, but nonetheless demonstrate that Ghanaian plywood suppliers can compete in international markets, also with different types of cassava flour being used as glue extender.

Manufacturers state that there is growing demand in the sector, however there are also several constraints:

- It is becoming more difficult to obtain logs for raw material;
- There is growing competition from Chinese MDF;
- Sometimes, the outputs of Ghanaian plywood factories are of questionable quality, as GTMO marketing trip to Nigeria revealed large stocks of poor quality plywood (Sergeant et al, 2011).
- Utility prices have gone up during recent years (e.g. for electricity).

Various opportunities and constraints regarding the plywood sector are summarised in Table 10.

Table 10: SWOT Analysis – Plywood (industrial grade flour)

Strengths	Weaknesses
<ul style="list-style-type: none"> • Well-established sector in Ghana • Many companies already successfully use cassava flour as glue extender (industrial grade or <i>Kokonte</i> flour) • Established export markets • National production standards in place (less stringent vs. EU) • Volta Forest already using cassava 	<ul style="list-style-type: none"> • Some companies had mixed experiences of cassava to date; where positive, supply issues • For some manufacturers, cassava source distant, wheat local • Sector shrinking in terms of employment versus 5 years ago
Opportunities	Threats
<ul style="list-style-type: none"> • Recognition of binding properties of cassava • Potential savings from less glue per batch • Industrial grade specification more tolerant versus food grade • Volta Forest can dry and mill their own flour and willing to source from C:AVA producers 	<ul style="list-style-type: none"> • Inability to ensure dryness • Prohibitive transport costs • Increasing electricity costs squeezing business • Competition from Chinese MDF • Discounted and lower grade wheat flour cheaper vs. cassava

There is no association for plywood manufacturers as such, however there is one for the entire timber sector, which is called GTMO (Ghana Timber Millers Organisation).

As far as raw material supply is concerned, plywood companies have both, logging concessions from Government, and they buy timber from contractors. Also, there are afforestation projects to increase future supply of logs and compensate for the forests cut.

Given the importance of cassava flour for the plywood sector, some companies expressed interest in assisting producers of dried cassava. For example, once company in the Volta Region stated that it would be willing to dry and mill grits supplied by farmers and intermediary organisations. They have had very negative experiences with supplies and relations with C:AVA SME processors.

In sum, a relatively large quantity of industrial grade and traditional cassava flour is being used as glue extender in the plywood manufacturing sector. Wheat flour is only used in small quantities due to its high cost and where plywood factories are located relatively far from cassava processing facilities. Based on the consumption figures obtained during the course of the survey and previous research, about 4,000 tonnes of flour are used per annum by the industry. It can be assumed that all of this flour can be industrial grade cassava flour or HQCF. In order to achieve this, the following suggestions are made (also based on Sergeant et al, 2011):

- Plywood industry needs to be made aware of the benefits of using industrial grade cassava flour or HQCF, as compared to *Kokonte* flour. For a small amount of extra cost, the quality of plywood would be improved and long-term markets secured. Related calculations need to be carried out with industry members (e.g. GTMO).
- C:AVA project needs to be aware of competing flour products and their prices, which can be used in plywood manufacturing; i.e. hard wheat flour (very expensive), soft wheat flour (less expensive), *Kokonte* flour (relatively cheap but leads to questionable quality of output), and recently introduced corn flour (very cheap but quality not yet ascertained).
- Dialogue with Standards Board needs to be maintained. Although it may not be possible to prevent the use of cheap *Kokonte* flour for glue extenders, their endorsement of HQCF and industrial grade cassava flour should be beneficial.

Animal Feed Industry

Cassava is widely used in many tropical countries for feeding pigs, cattle, poultry, sheep, goats, and fish (cassavabiz.org; Lam, 2012). For example, cassava based animal rations are quite common in Latin America, and large quantities of dried cassava have been used in livestock feed in the EU, in particular when locally produced feed grains were relatively expensive.

Cassava is similar to feed grains as it consists almost entirely of starch and is easy to digest. However, due to its deficiency in protein and vitamins, cassava cannot be used as the sole feedstuff but has to be supplemented by other feeds that are rich in these elements (Lam, 2012). The maximum content of cassava products in compound feedstuffs is officially set in many countries (Buitrago et al. 2002). In Germany, it varies according to the type, but is generally as follows: 10-40% for pigs, 20-25% for cattle, and 10-20% for poultry. In the Netherlands and Belgium, the figures are much lower (cassavabiz.org).

The use of cassava for animal feed exists in Africa, however only on a small scale, which also reflects the use of cassava as a food security crop. Ghana's livestock production has seen a gradual increase during recent decades, including an intensification of livestock keeping. Nonetheless, the smallholder agropastoralism remains the main cattle production system in Ghana (Oppong-Anane, 2013).¹¹ Although it is geared towards beef production it is also linked with milk production whereby milk is shared between the herdsman and the calf, with the surplus going to the market (Okanta, 1992, in: Oppong-Anane, 2013). Feeding of cattle, and to a lesser extent small ruminants, is almost entirely dependent on grazing on natural pastures, with its seasonal variation in quantity and quality. Most farmers practice supplementary feeding, using crop residues, in the dry season. Those who fatten cattle and back-yard sheep and goat farmers in the cities and towns tend to practise stall-feeding. The animals are fed on both crop residues in the form of groundnut tops, maize cobs, by-products from grain winnowing, cowpea pods, and peels of plantain and cassava (Oppong-Anane, *ibid*). These are often supplemented with cut grass and browse as well as leaves from fodder plants.

Table 11 below provides some information on livestock numbers in Ghana for the period 1996 – 2005. In particular, the poultry and pig feeding sectors have been identified as areas where there is potential demand for cassava as a feed ingredient. Statistics for the poultry sector will be provided separately.

¹¹ Source: <http://www.fao.org/ag/AGP/AGPC/doc/Counprof/ghana/Ghana.htm>;
Accessed: 07/01/2013

Table 11: Numbers of selected livestock in Ghana (1996 – 2005)

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Cattle (millions)	1.25	1.26	1.27	1.29	1.30	1.32	1.33	1.34	1.37	1.39
Sheep (millions)	2.42	2.47	2.52	2.66	2.74	2.77	2.92	3.02	3.11	3.21
Goats (millions)	2.34	2.63	2.74	2.93	3.08	3.20	3.23	3.56	3.60	3.63
Pigs (thousands)	317.9	353.3	351.8	332.0	324.0	312.0	310.0	303.0	300.0	305.0

Source: Oppong-Anane (2005)

Ghana's poultry sector

According to GAIN (2011), Ghana's poultry industry developed rapidly into a vibrant sector that supplied about 80% of the available chicken meat and eggs in the country. The development of the commercial poultry sector was initially slow due to constraints such as irregular supply of imported day-old chicks, lack of veterinary drugs, and frequent outbreaks of poultry diseases. However, following the increase of production, broiler production has experienced a steep decline from 80% of the market supply in 2000 to 10% in 2010 (GAIN, *ibid*). Poultry imports have more than quadrupled since 2002 and reached about 100,000 tonnes in 2010. Table 12 shows the increase of Ghanaian poultry imports, with Brazil, the US and the EU being the main suppliers.

Here it is important to distinguish between broiler and egg production. Whilst the broiler production can hardly compete against imported poultry meat (except for certain periods of the year such as Christmas or Easter when consumers prefer live birds), the egg sub-sector appears to be doing well and is growing (at 5% or above). In that respect, the argument that Ghana's poultry sector is in decline needs to be viewed with caution. According to GAIN (2011), the commercial poultry production of Ghana can be categorised into large-scale (over 10,000 birds), medium-scale (5,000 – 10,000 birds) and small-scale (50 – 5,000) enterprises. It is estimated that the large-scale category represents about 20% of the total poultry sector, producing mainly eggs. Locally produced eggs face only minor competition on the Ghanaian market.

According to the 2009 national poultry census, Ghana's poultry layer count stands at 21 million birds while broilers are at 5 million (GAIN, 2011). Layer birds reach 16 weeks before the pullets (young hens) start laying eggs. Average egg production is estimated at 230 – 250 eggs per layer per year. At the same time, according to industry sources there are about 50 egg producers in Ghana, who own more than 100,000 layer birds (i.e. one with 500,000 birds, 20 with about 200,000, and 30 with 100,000 to 200,000 birds). In addition, there are over 100 companies owning more than 2,000 layer hens.

Table 12: Poultry imports into Ghana

Year	Total poultry imports by Ghana (tonnes)
2002	20,752
2003	34,107
2004	40,357
2005	42,288
2006	47,794
2007	66,899
2008	93,258
2009	89,000
2010	98,000

Source: GAIN (2011) based on MOFA, Poultry Industry, and USAPEEC

Poultry feed

The main feed ingredients are locally produced corn or imported yellow corn, cotton-seed cake, kernel cake, soybean cake, copra cake, fish meal, soybean meal, plus imported vitamin-mineral premixes (GAIN, 2011). It is estimated that about 90% of feed produced by commercial feed millers is layer feed. The composition and cost of poultry feed is best illustrated by an example of pre-layer feed formulation (Table 13). It is estimated that 50% - 60% of poultry feed is maize, followed by milling by-products (e.g. wheat bran), and protein sources (e.g. soya beans).

It is assumed that 10 million layer birds and their feed requirements represent the potential market for layer feed in which dried cassava can be included. Given that a layer bird consumes 125 grams of feed per day (www.cassavabiz.org), this would equate to an annual feed demand of 456,250 tonnes. If half of this is maize, and a third of the maize can be replaced by dry cassava, then the potential demand for dry cassava chips would be of the order of 75,281 tonnes per annum. It is further assumed that half the broiler production of 5 million birds (see above) can be based on a diet, one sixth of which can be dried cassava. According to cassavabiz.org (accessed January 2013), a broiler requires 5 kg of feed for 2 kg of live weight (12,500 tonnes of feed for 2.5 million broilers). Again, if half of this is maize and a third of the maize is replaced by cassava, then the demand for dried cassava would be 2,062 tonnes p.a. in the broiler producing sector.

The price of poultry feed ingredients has seen a steady increase during the last few years. For example, in November 2012, the cost of maize was GHC 0.79 per kg compared to GHC 0.65/kg in Dec 2011. Likewise, the cost of wheat bran had risen from GHC 0.34 to 0.40 per kg and that of soyabeans from GHC 1.00 to GHC 1.10 per kg during this period (pers. comm. Industry sources). According to GAIN (2011) the price of a 50kg bag of white maize in June 2011 was GHC 45, compared to GHC 25 in the same period in 2010. The same source states that the poultry industry absorbs close to 30% of all maize produced in Ghana.

Table 13: Example of poultry feed cost (pre-layer feed cost sheet)

Raw materials	Inclusion rate (kgs)	Unit cost (GHC/kg)	Total cost (GHC)
Maize	510	0.65	331.50
Fish meal (local)			
Wheat bran	235	0.34	79.90
Cotton cake			
Groundnut cake			
Soyabeans (local)	155	1.00	155.00
Copra cake			
Oyster shell	43	0.20	8.60
Premix	2.6	2.50	6.50
Salt	4.4	0.50	2.20
Lysine			
Methionine			
Florac			
Super Concentrate	50	2.00	100.00
Other	2	4.00	8.00
Total	1002		691.70

Source: Poultry industry (December 2011 figures)

Industry sources point out the importance of keeping poultry feed costs low. According to a large-scale poultry producer (mostly layer hens), feed represents 70% of total production costs. According to GAIN (2011), controlling poultry feed costs is critical since it represents approximately 82% of the variable production costs.

The issue of importations of yellow maize for the poultry industry is contentious. According to industry sources, the maize harvest in 2011 was low as a result of which the poultry industry lobbied for imports of yellow maize, which have arrived in early 2012, and were distributed from mid-2012 onwards (source: poultry industry). The quantity imported was reportedly 15,000 tonnes, although the real figure may be higher. Sergeant et al (2011) state that Ghana imports 150,000 to 200,000 tonnes of maize per annum, some of which could be replaced by dried cassava. The total amount of yellow maize imported in 2012 by or for the poultry industry is likely to lie somewhere between 15,000 tonnes and 150,000 tonnes. Given their contentious nature, it proved difficult to obtain reliable data on maize imports from official sources.

Those members of the poultry industry visited expressed interest in participating in trials, however some also explained that they would need “convincing” of the benefits of using cassava in their feed rations. In particular, large poultry producers are risk averse in that they hesitate to introduce new feed rations without fully understanding their composition and consequences. It was stated that dried cassava would have to have the following specifications to make it acceptable in the poultry feed industry:

- It should not be too powdery, and should not stand out from other feed ingredients, in order to avoid selective feeding by birds;

- The dried cassava shouldn't be flour but small grits, similar to soyameal;
- No cyanide;
- No aflatoxins.

According to industry sources, feeding trials with dried cassava, which have been conducted about a decade ago, were not successful given that farmers did not like cassava flour. For example, it was reported that after a while of being fed with powdery cassava, the flour got stuck in the birds' mouths. It was mentioned that the link between research institutes and industry requires strengthening.

Large-scale poultry farmers increasingly own land to produce feed ingredients (e.g. maize or soyabeans). For example, one farmer owns 300 hectares of land which he plans to use for the production of white and yellow maize, however it could also be used for cassava if maize production proves too challenging due to lack of water where the land is located. In any case, the farmer appears to be open to use at least a proportion of the land for cassava production. Another, large-scale poultry producer owns 2,600 acres of land, which are also earmarked for the production of feed ingredients (e.g. yellow maize and soybeans).

Seminars for awareness-raising and the provision of information can be organised by the Ghana National Association of Poultry Farmers (GNAPF). Given that the majority of poultry producers are concentrated in Ashanti Region it appears preferable to organise these seminars in Kumasi. In addition, some SME processors are now supplying HQCF grits to the poultry feed sector (Hillocks, 2012) and could be invited to participate in such fora.

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 14 and 15) 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 14: Composition of experimental broiler rations in Ivory Coast

Raw materials	Percentage of cassava in the ration			
	0%	10%	20%	30%
Ingredients				
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
Nutrients				
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 15 shows the results of the feeding trials in Ivory Coast based on the experimental rations indicated in Table 15. The experimental phase ranged from the 29th to the 49th 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 (Tiémoko, 1992). If the rate exceeded 10%, however, the feed consumption index increased, resulting in a lower nutritional efficiency of the diet.

Table 15: 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)

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, a relatively low level of inclusion in poultry feed rations should be envisaged in Ghana for the time being (i.e. 10% to 20%).

Pig industry

According to Oppong-Anane (2005), there have been approximately 300,000 pigs produced in Ghana in 2005, although this number is somewhat lower than figures for the late 1990s, which were about 350,000. Ashanti Region is a hub for pig and pork production. As such the bulk of the following information is based on information provided by representatives of the Pig Farmers and Processors Association of Ashanti Region. Local associations at municipality level form regional associations.

According to these associations, the pig industry can be classified as follows:

- (a) Large-scale producers: 300 to 800 pigs and above;
- (b) Medium-scale producers: 100 to 300 pigs;
- (c) Small-scale producers: 50 – 100 pigs, and below.

A large-scale producer's farm (e.g. about 700 pigs in total) would consist of the following stock: 3 boars, 52 sows, 160 finishers, 250 weaners, and 200 piglets. According to the association representatives, female pig producers have entered the business in recent years, also as processors. It was reported that the pig industry is growing (i.e. at about 5% per annum), however less due to an expansion of existing farms, but due to newcomers who have recently entered the industry.

Feed consumption by the pig industry has changed during the last two years (i.e. between 2010 and 2012), in that formerly maize was easy to obtain. However, this has changed as the maize crop is now considered scarce and expensive. As of November 2012, prices quoted were of the order of GHC 50 – 60/bag (in Ejura) up to GHC 100 per bag in Kumasi. Maize bran was GHC 20 per bag of 50 kg, wheat bran about GHC 10/ 25kg bag. Pig producers don't have access to yellow maize which has been imported for the poultry industry.

A typical pig feed would include the following ingredients: maize, fishmeal, rice bran, soyabean cake, maize bran, mineral traces, and some pre-mix. However, less maize is used as a consequence of the scarcity of the crop, and also less fishmeal is used. As a consequence, more local feed ingredients are used such as rice bran, bico (a waste product from maize meal processing), palm kernel cake, and spent grains from breweries.

Although the association does not have data on actual consumption of dried cassava by the pig industry, it is understood that some industry members consume significant quantities of dried cassava per annum (e.g. one producer apparently uses 100 bags per week corresponding to 260 tonnes per annum). In addition to dried cassava, some producers use peels from cassava and other crops (e.g. plantain, yam, chop-bar left-overs) which can be procured locally or near processing sites. Also, it was reported that some small-scale producers

would feed boiled cassava roots to pigs together with some salt, a feed-mix which is apparently liked by the pigs.

In light of the above, there is no doubt that cassava can and is used by the pig industry as a feed ingredient. At the same time, due to the scarcity of data it is difficult to provide estimates of quantities required. For the time being it is estimated that 3,000 tonnes of dried cassava can potentially be used by the pig industry, for mixing with other feed ingredients such as soyabean cake and different types of bran.

As for prices for dried cassava, which pig farmers are willing to pay, these are likely to be on the low side. For example, industry representatives stated that they prefer dried cassava at a price of GHC10 – 20 per bag of 50kg, although this may be unrealistically low. A more realistic price would be GHC 20 – 30 / bag, which would have to be negotiated, depending on prevailing market conditions. When asked what they needed from a cassava project (if it were to be implemented), industry members stated the following:

- Assistance with feed ingredients;
- Farming inputs;
- Feed formulation plant;
- Training;
- Scholarship for further training overseas;
- Study visits to other countries.

Some of these requests may be unrealistic within the scope of the C:AVA project (e.g. installation of feed plant), however it is clear that the industry would benefit from technical advice on using different forms of cassava as pig feed.

Feed millers

According to GAIN (2011), there are about ten commercial feed mills in Ghana, with a total installed operating capacity of 1000 tonnes per day. At the same time, it is clear that the feed mills operate well below their installed capacity due to, amongst other things, the low demand from poultry producers who often have their own feed mixing facilities. According to industry sources, in November 2012 the number of feed millers who are operating in the market is closer to four.

The information in this section is primarily based on a leading feed miller based in Kumasi and a wheat flour mill in Accra, which produces wheat bran as a by-product which is used in animal feed.

The poultry industry is by far the main market for animal feed in Ghana. For example, the company in Kumasi stated that they produce about 6,000 tonnes of animal feed per annum, 80% of which is for layer hens, 15% for broilers, and the remaining 5% for sheep, goats, and pigs. According to industry representatives, cattle feed is not in demand. Also, the company does not produce aquaculture feed, although trials have been conducted which were not positive.

It is understood that only half of the Kumasi-based company's capacity is used in 2012, and production of feed used to be 900 tonnes per month several years ago (i.e. 10,800 tonnes p.a.). This appears to reflect the overall prospects of the industry. Factors which have negatively influenced the growth of independent feed mills include feed mixing facilities owned by poultry producers, the importation of feedstuffs (e.g. yellow maize, soyabeans), which bypass the mills, and the importation of broilers.

The company has undertaken research into the use of dried cassava for animal feed rations, however the results were negative in that processing led to clogging of the equipment. According to the company this was due to dried cassava gelatinising when heated, resulting in clogged dyes of the pelletizer. This shows the importance of having appropriate equipment when processing cassava, in particular where pelletizers and extruders are concerned. Given the importance of poultry feed (mainly for layers) this needs to reflect the equipment needed and end-products to be manufactured.

In view of their negative experience with cassava in the past, the company may need some convincing to use dried cassava for trials again. In order to do so, the following would have to be in place:

- Dried cassava needs to be readily available. At the moment it is not (neither in quantity nor quality) which restricts its use, for example for pig feed although there is demand for it.
- Concerning quality, the cassava needs to meet certain standards, in terms of nutritional aspects, processing, moisture content (12% max), and absence of mycotoxins / fungal growth.
- The feed milling company appears to be interested in cassava grits.

Cassava would be especially needed when maize is short in supply, i.e. during the lean season (February to June), when maize prices are highest. Maize prices paid by the company on delivery at factory-gate were GHC35/bag (50kg) in November 2012, when supplies were readily available, but they expected them to increase to GHC 55 – 60 per bag when supplies will be scarce (e.g. May). Similarly, soybean meal cost GHC 55/bag towards the end of 2012, but was expected to increase to GHC80/bag during the lean season.

Although soybeans are produced locally (e.g. Tamale, Techiman), at times they are also imported when local supply is scarce. Imported soybean meal can cost as high as GHC95 – 110 per bag (shop price). Importations of yellow maize have been dealt with above. It is preferred by egg producers since its pigmentation gives a yolk which is more yellow in colour. Nonetheless, the bulk of maize used by feed millers is locally produced white maize.

A second feed milling company which was visited is attached to a wheat mill. It produces 320 tonnes of feed per week or 16,640 tonnes per annum. It considers itself the largest feed miller in the country, estimating its market share at approximately 30%. Based on this information, Ghana's total commercial feed sector can be estimated to produce approximately 55,000 tonnes of feed.

The same company used to produce 1,300 tonnes of feed per week (i.e. 67,600 tonnes p.a.), however demand declined for the aforementioned reasons (i.e. poultry sector produces large amount of feed themselves, imports of some feedstuffs, and imports of broilers).

Whole grain maize imported from the US represents 55 – 60% of feed produced by the company; other feed ingredients being soya, wheat bran, oyster shells, etc. Farmers mainly buy concentrates and mashes from feed millers. Interestingly, some poultry producers (e.g. SMEs) may mix their own feed but would prefer to buy complete feeds from millers. This is likely to be due to the multitude of ingredients used and smaller companies struggling with the technical aspects of feed mixing at the right proportions.

Pricing of dried cassava for animal feed

Dried cassava chips are often valued at about 80% of the price of the main cereals used in animal feed manufacturing (i.e. maize in the case of Ghana). Feed millers use least-cost ration models which calculate the value of cassava in relation to the price of the protein balancer (e.g. soya beans) required to obtain a feed approximating the nutritional value of maize grain. In this context, it is suggested that dried cassava chips should be priced below the 80% benchmark in order to provide a strong incentive for the feed millers (including poultry producers) to start utilising cassava. In addition, prices of other cereals (e.g. sorghum or millets which may also be used as feed ingredients), milling by-products (e.g. wheat bran), protein balancers (e.g. soyabean meal or fishmeal) also play an important role in determining the price of dried cassava.

A summary of the key points regarding the animal feed sector is presented in Table 16.

Table 16: SWOT Analysis - Animal feed (improved chips / grits)

Strengths	Weaknesses
<ul style="list-style-type: none"> • Growing poultry sector, esp. layers • Strong poultry association • Feed now more pelletised • A lot of informal feed production by large-scale farmers • Poultry producers have own mixing capacity 	<ul style="list-style-type: none"> • A lot of informal feed production by large-scale farmers • Issue of protein replacement cost • Questions regarding ability to meet supply and quality demands year-round • Trials carried out about 10 years ago not successful
Opportunities	Threats
<ul style="list-style-type: none"> • Cassava competitive versus maize • Largest producer (Seeboard) willing to trial and work with FRI • Feed costs = 70% to 80% of poultry production costs so any savings = big impact • Producers looking for alternative sources of feed ingredients • Domestic / household market still prefer fresh birds vs. frozen imports • Some producers have their own land for feed ingredient production 	<ul style="list-style-type: none"> • Cheaper imports of frozen chicken (popular esp. with restaurants) • Informal Kokonte purchases cheaper vs. C:AVA chips or grits • More suitable maize is competitive vs. C:AVA chips or grits • Powdery cassava chokes birds, therefore important to use good-quality pelletisers • Limited investment climate • Imported yellow maize can destabilise local market, including for dried cassava if produced for animal feed

Brewing Industry

Ghana's beer industry is dominated by two companies, which have both been visited. Ghana's beer market is estimated at 169 million litres of beer, reflecting a per capita consumption of about 7 litres per annum.¹²

One company currently evaluates the experience of a sister company in Mozambique which is using cassava for the production of cassava based beer, which is considered a cheap beer based on locally produced raw material.¹³ The production process uses an autonomous mobile processing unit which is based on processing cassava roots as soon as possible after harvest and then transporting the resulting wet cake (40% moisture) to the brewery where it is used for making beer. The cake is reported to have a shelf-life of 5-7 months, compared to two days for fresh cassava. During discussions with company staff it became apparent that the brewery are planning the use of locally sourced cassava for beer brewing in Ghana (e.g. identification of supply areas), but during the interview they were not in a position to provide details regarding quantities of cassava required and in what form.

During the course of the study in November 2012 it proved difficult to arrange an interview with the production management of the second large brewery. They indicated their interest in cassava as a raw material in beer brewing but were also unable to provide details. The reason for this became apparent when in early December 2012, Guinness Ghana Breweries Ltd made a press release stating that they have launched a new home-grown beer called Ruut Extra Premium Beer. According to GhanaWeb (December 2012),¹⁴ Ruut Extra Premium is Ghana's first cassava beer, which is brewed from the "very best local raw materials" sourced from around the country and is an authentic beer with a pleasant aroma and a distinctive refreshing taste.

The plan was to roll out supply of the beer in December 2012 in Western, Central and Volta regions. The statement further added that:

"Guinness Ghana Breweries Limited, over the years has been working tirelessly behind the scenes to find the perfect recipe to produce a beer worthy of its Ghanaian roots".

The company believes that by producing this beer, it is demonstrating its commitment to local agriculture and providing a positive impact on the local economy and farmers, particularly in the more deprived areas of the country. For example, the press release also states that the company has been investing in local raw material sourcing for more than a decade and as a result impacted about 7,000 farmers in the three Northern Regions in Ghana. The press release did not provide details about the crops which were supplied by the farmers but it is assumed that this was sorghum. As to the form of cassava required for beer making by GGBL, it was not stated whether dried cassava, fresh roots, or wet cakes are required.

¹² Source: www.sabmiller.com; January 2013

¹³ Source: <http://www2.macleans.ca/2012/12/17/sorghum-suds/>

¹⁴ Source: <http://www.ghanaweb.com/GhanaHomePage/NewsArchive/artikel.php?ID=258453>

In sum, both leading brewery companies in Ghana are either planning the production of a cassava based beer or have already started producing it. If the C:AVA project is interested in cooperating with them then this would require follow-up visits by project staff and further discussions regarding the companies' requirements in terms of cassava supply.

Starch and Liquid Glucose

A starch factory to be operated by the Ayensu Starch Company (ASCo) at Bawjiase in the Central Region of Ghana was opened in 2003. The \$7million project was financed by the Agricultural Development Bank (ADB), the National Investment Bank (NIB), the Ghana Commercial Bank (GCB), the Export Development and Investment Fund (EDIF) and a Dutch credit financial institution (Oiko). There was a plan for this to be replicated in all the 10 regions of the country. The aim was to add value to cassava by exporting starch to the international market.

ASCo initially ceased operations in 2006 due to a lack of raw material. Despite interventions by the Ministry of Trade and Industry and other bodies the factory continued to start and stop production over recent years. From the supply side there was a lack of raw material, farmers contracted to supply cassava roots could only produce 13,000 MT meaning the factory could only produce less than 4,000 MT. ASCo had projected to operate at 70% capacity but in reality less than 20% was achieved.

The management of ASCo invested in 2000 acres of land to cultivate cassava to make up for the shortfalls from farmers. In the end production at the factory finally ceased in 2011 having only managed to export 2000 MT of starch to the EU, and earlier exports to Nigeria ceased as Nigeria embarked on its own starch production.

Textile Industry

Cotton is a crucial source of income for millions of small-scale farmers in Africa, and can be an engine for economic development with competitive advantages of hand-picked quality fibre. However, production is generally declining and the majority is exported as unprocessed raw material. In 2006 Ghana produced a total of 19,600 MT of yarn, and Pakistan exported 666,000 MT to give an indication of the relative scale of the sector (USAID, 2006).

In terms of international scale the largest spinning and weaving factory in Ghana lags behind others. To give an indication, the company has 35,000 spindles compared to a Turkish factory with 500,000 and there are clear economies of scale. Historically they used native starch and would add additives such as softeners and emulsifiers on site. Since the 1990s they have been sourcing modified starch.

All of their production is cotton for which starch is required. The site is only running at 30% capacity and therefore there is certainly capacity to expand.

However due to a lack of investment since the machinery was installed in the 1960s as a government-run entity, their ability to compete is restricted. According to company sources they are not competitive versus neighbouring countries but the quality of what they produce is still highly regarded, hence garment finishers still purchase from it.

It seems unlikely that there would be a switch away from modified starch but a desk-based exercise should be conducted to demonstrate the relative costs involved of using cassava starch plus additives compared to modified starch.

Liquid Glucose Industry

Glucose syrup is a concentrated aqueous solution of glucose maltose and other nutritive saccharides from edible starch, which is used in large quantities in drinks/liquors, crystallised fruits, bakery products, pharmaceuticals, and brewery products (Lam, 2012).

We spoke to two fruit juice and soft drinks manufacturers in Accra. The Ghana branch of a large international soft drinks company was visited in order to gauge the views of the drinks industry and their use of raw materials. According to company representatives, the company does not use glucose syrup but refined, modified, sugars which are imported from countries such as South Africa and Egypt.

A second, local company visited also stated that they use sucrose as a drink-manufacturing ingredient rather than glucose syrup. According to them glucose syrup is not imported because it mainly means 'transporting water'. A company representative also stated their preference for importing drinks ingredients given their negative experience with locally produced ingredients in the past. They do not see cassava being cost effective for glucose syrup versus cane sugar. Ghana imports a lot of cane sugar so if processing of cassava was on a larger scale it should be competitive against dollar-based imports. At present there is no such facility in Ghana.

In view of this, a functioning liquid glucose supply chain may only be an option for the long-term future, provided there are sufficient quantities of cassava roots available. Also, such an industry is beyond the scope of this project. Statements by cassava processing companies that there is a potential demand of 40,000 tonnes from brewery companies ought to be seen in this light. The negative experience by the starch industry (see above) should be seen as a reminder.

Other Food Processing

A potential opportunity could emerge from a national school feeding programme. The Ministry of Local Government tried to promote locally produced food to improve nutrition for school children. According to an Accra-based drinks company this scheme is unlikely to succeed as it is difficult to control the quality of food produced in 50,000 kitchens. An alternative could be to produce single-serve packs, perhaps a custard-based drink that includes cassava and vitamins. If

1 million school children consume 200ml per day that represents a demand of 200,000 litres per day. This would require 3-4% modified starch, potentially using cassava flour for starch. The demand would equate to 8 MT per day of cassava flour, 2400 MT per year.

Alcohol Industry

For the alcohol industry, only a fragmented picture could be established. According to a manufacturer of alcohol products for human consumption, the company imports all their drink spirit requirements (i.e. 160,000 litres of extra neutral alcohol imported per month) and blend it on their premises in Accra. While the imported alcohol includes grain spirit from suppliers such as France, the end-products may be liquors and other alcoholic beverages. In addition to potable alcohol, industrial alcohol is used in numerous applications (Ayernor and Ocloo, 2003).

According to UN trade statistics, in 2011 Ghana imported undenatured ethyl alcohol of an alcoholic strength by volume of 80% volume worth USD 24.2 million. For the same year, imports of ethyl alcohol and other spirits (denatured, of any strength) were of the order of USD 26.2 million, leading to a total import value of USD 50.4 million. It should be noted that this import value is more than double the value of imports in 2009 and 2010, when it was about USD 24 million each. Correspondingly, the total quantities of alcohol imported jumped from about 29 million litres in 2010 to 59 million litres in 2011.

In sum, the trade statistics for alcohol imports may be incoherent to some extent and need to be viewed with caution. Assuming a conversion ratio of 400 litres of ethanol per tonne of dried cassava (Ayernor and Ocloo, 2003), the amount of raw material required to replace imports with locally manufactured alcohol would be of the order of 72,500 to 145,000 tonnes of dried cassava. It is assumed that the investments required for such an enterprise are beyond the scope of the C:AVA project.

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Appendices

Appendix 1: Terms of reference

- A review of published and grey literature on cassava markets and value chains in Ghana.
- 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 Ghana.
- A field survey of potential market options.
- Communication of outcomes of investigations to the FRI Director and other stakeholders in-country. A dialogue will be maintained with staff of the Foundation to ensure synergies between activities.

Appendix 2: Olam News Release



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NEWS RELEASE

OLAM INTERNATIONAL TO INVEST IN NEW WHEAT MILL IN GHANA

Singapore, February 11, 2010 – Olam International Limited (“Olam” or “the Company”), a leading global, integrated supply chain manager of agricultural products and food ingredients, announced today that it will invest US\$31.5 million to set up a greenfield 500 metric tonne-per day wheat mill near Port Tema, close to the largest flour market in Ghana.

Ghana is a large market for wheat flour in West Africa, consuming approximately 270,000 metric tonnes annually. Wheat milling is a fundamentally attractive opportunity in Ghana due to i) growing wheat flour consumption of expected 7.5% per annum over next five years; ii) the country imposing tariffs on flour imports; iii) the country having to import all its wheat requirements; and iv) the oligopolistic nature of the industry.

Olam's President for the Grains business K C Suresh said: “In January 2010, we acquired Nigeria's third largest wheat milling company, Crown Flour Mills. This greenfield investment in Ghana is in line with our strategic thrust of building a configuration of port-based wheat milling facilities in Africa. It also carries a high strategic value for our distribution business in Ghana as it will significantly strengthen our competitive position by adding wheat flour to our current distribution portfolio of Rice, Sugar, Dairy Products, Tomato Paste and Edible Oil.”

Olam plans to commence construction of the wheat mill in March 2010 and commission the plant by September 2011. The Company aims to achieve 115,000 metric tonnes in annual flour production in three years (FY2014) and become the third largest wheat milling company in Ghana. The mill is expected to turn in US\$64 million in revenues and US\$14.9 million in EBITDA by that time, and generate a project IRR of 25%.

Appendix 3: Map of Ghana



Source: World Bank (2012)

Appendix 4: Checklists used for fieldwork

Brief checklist

- What is the size of company – production, outlets, output
- What is the market share within the sector?
- Markets – national, regional, international?
- What raw materials currently used? Quantities and prices and origins
- Any issues with supply currently – prices, availability, quality?
- Any experience of trialling / sourcing cassava flour?
- Potential scope for substitution with cassava based products?
 - What percentage
 - What quality / specification required
 - What price level
- How is the growth in the industry? Recent industry performance?
- Overview of the sector re trends and opportunities
- Any associations / membership

Full 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.

Company name:

Name of respondent(s):

Position:

Full postal address (with details of physical location) and contact details

Type of business (e.g. 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? (e.g. 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; e.g. 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 e.g. local 60% export 40%):

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

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 (*e.g. 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 (*e.g. industrial trials of cassava based products*)?

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

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 (*e.g. 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 (*e.g. 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 (*e.g. 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 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.