UNIDO Report prepared under the Building Capacities for Agroindustry Value Chain Development in Cabinda

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Executive summary

Angola's Ministry of Economy would like UNIDO to implement a value chain-based strategic development approach building on earlier work in Cabinda that, with the support of Chevron, identified five strategic clusters/value chains with potential to strengthen the competitiveness of the agricultural sector in Cabinda, Angola. As part of this process, the cassava value chain was selected, on the basis of a multi-stakeholder participatory approach, for further research.

This report is the result of a desk-based, mainly qualitative assessment of options for an upgrading of local cassava processing systems, based on findings from an on-going cassava chain survey in Cabinda Province undertaken by a separate independent study, and past experiences in other Sub-Saharan African countries (mainly Nigeria, Ghana, Malawi, Uganda and Tanzania).

Specifically, the main aim of the study was to (1) assess options for mechanization of cassava grating at the village level, including that for the development of a small, modern processing enterprise producing quality, well-packed gari for the consumer market and high quality cassava flour (HQCF) for the bakery sector and consumer market, (2) develop technical specifications for a processing unit layout, equipment, and building infrastructure (including fuba de bombó), and where appropriate, (3) produce a business plan for a village-level enterprise providing grating services for a fee, and for a small, modern enterprise producing quality, well-packed gari and flour.

- There are options for the mechanization of grating at village level using fuel driven graters with a capacity of 500-1000Kg/hr being adequate. In addition to graters, hydraulic or screw presses should also be considered as a means of speeding up the dewatering process and reducing fuel costs for subsequent frying of gari or product fumbo drying.
- Technical specifications for processing layout and equipment are provided which can be used for gari, fumbo de bombo, or sun drying HQCF if later found to be viable.
- Grating is a common step in the production of gari and HQCF. With the current key costs and target selling prices provided, the viability of grating services was appraised and found to be viable, providing gari and not HQCF is being produced.
- Basic capital costs for a small to medium sized gari enterprise was provided.

It is suggested that further field work is undertaken to verify the costs involved in producing HQCF in Angola, as some of the equipment invested for gari can be used, and indeed influence the choice initially procured. HQCF has been found to be viable in 5 other African countries, namely Nigeria, Ghana, Tanzania, Malawi and Uganda.

1. Background

The production, processing and marketing of cassava provides a major source of income for 450 million people, often women and the poorest, in Sub-Saharan Africa. Cassava is not only strategically important as a food source and famine reserve, combining high calorific efficiency with versatile low cost/input, reliable and flexible production, but is now seen as a pro-poor vehicle for economic development. However, cassava farmers, particularly from remote areas, have restricted market access for their produce, because the roots are highly perishable, bulky and expensive to transport. Processing by small-scale farmers, to produce dry, shelf-stable products can be cost-effective and provide a means of producing value-addition close to the supply source. If large enterprises start using dried cassava products, and large numbers of small farmers can supply this new demand a substantial number of sustainable, market-led, new livelihood opportunities will be created.

In adding value to cassava, technology has a significant role to play. For small scale commercial operations, it is important that the appropriate technology be adopted. Appropriate for example in terms of fabrication materials to meet required food safety standards, capacity to meet targeted product demand, robustness, design and operation, with minimum fuel consumption, where applicable. Many common cassava processing units are not fit for commercial purpose and were originally donated in pro poor development projects for household utilization. There may be a need to build local capacity in fabrication and maintenance of process technology in the form of technology transfer. In terms of small to medium scale cassava processing, Nigeria have developed appropriate technology that can be transferred to other less advanced cassava processing countries such as Angola. Technology alone however does not yield results. Small-scale producers and processors need to know how to identify profitable market opportunities, differentiate their produce, and work with other stakeholders in the market chain to meet changing consumer demands. To engage effectively, they need to gain new skills.

High Quality Cassava Flour (HQCF)

In an effort to improve the livelihoods of smallholder cassava farmers in selected West Africa countries (Nigeria, Ghana, Tanzania, Uganda and Malawi) through stimulation and expansion of the market for High Quality Cassava Flour (HQCF), the Cassava: Adding Value for Africa (C:AVA) project was initiated. In the cases of Uganda, Tanzania and Malawi, these HQCF value chains have been established for the first time. In this report, reference will be made from experiences in developing the HQCF value chain and also of exploring the potential for upgrading gari operations in Nigeria.
The C: AVA project developed strategies for all five countries depending on the costs of production, market opportunities and appropriate technologies. The market analysis in Malawi for example highlighted two business opportunities-the first was based on small scale sun drying of peeled, grated cassava, dewatered roots and targeted sales in the immediate locality of small-scale processors of mandazis (sweet fritters), muffins

(Figs. 1&2), doughnuts, bread and confectionary products. The second value-chain was medium scale, designed to use artificial drying technology known as flash drying (previously unknown in Malawi, but common in Nigeria, with around two in Ghana and one in Tanzania (under another donor project) and would target larger urban users of HQCF such as the packaging industry, bread and biscuit manufacturers.

In Nigeria, Uganda, Tanzania and Malawi, it has been observed that the cost of wheat flour increases as the distance increases from urban centres and therefore HQCF becomes very attractive to consumers of these local products as it reduces the end the product selling price through the relative lower production costs of cassava flour.

In order to estimate the potential for HQCF substitution in Angola, it is necessary to estimate the volume of wheat imports into Angola, including current breakdown, e.g urban and rural retail market demand.

Figure 1: Mandazi seller (Malawi)

Figure 2: HQCF wheat substitute products

HQCF Specification

HQCF is a fine white powder produced from fresh cassava roots within 24 hours from harvest to packaged product. Desired characteristics of HQCF include white colour (Fig. 3), bland taste, low hydrogen cyanide content (less than 10mg/kg), fine particle size (less than 250µm), odourless, free from foreign matter and microbial contamination, moisture content of 10-12% and pH greater than 5.5. This HQCF specification and characteristics are very important and differentiate the product from traditional fermented cassava flour (fuba de bombó) in Angola.

Figure 3: HQCF

Gari

In Cabinda, the gari value chain is very short. Production is concentrated in the southern part of Cabinda province, in villages located near the provincial capital, the main consumption centre. There are two types of processors identified:

Farmers that sell gari along the road or at markets, but on an opportunistic basis, say once a week or once every two weeks. They use cassava roots from their own farms as raw material. And ladies who also grow cassava but specialize on gari retailing as a business, using some of their own crop as raw material, but purchasing on average around 70% of the volumes processed from other farmers. This group sells several times a week, mainly to consumers, but also to hotels and restaurants.

Gari from Cabinda is said to have a good reputation in Luanda. Cabinda families travelling to the capital often take a few kilograms with them on the plane as a gift to relatives and friends. It is also common for visitors from Luanda to take some gari with them on the plane to eat at home or give to relatives and friends. The Cabinda gari is appreciated for its cleanliness, homogeneous granule size and nice colour.

In Nigeria for example, gari accounts for two thirds of the cassava consumed (the largest producer of cassava globally) and is the most common product made from cassava in Nigeria, commonly fed to children either cold with milk or water and sugar or in the form of a thick puree called eba, eaten with stews. The product is differentiated into white and yellow gari. There is Ijebu gari, which is a variation of white gari and tends to be finer and sourer than others, yellow gari which has been fried with palm oil, and packaged types which are retailed and also exported to Africans in Diaspora. White types are mostly consumed in by the Yoruba's, whilst the yellow is mostly by the Easterners. Packaged gari (Fig. 4) is a variable quality. There are no set standards for gari in Nigeria. In Ghana, the product is also differentiated by the taste and the size of gari grains. The sweeter, smaller grains are of higher value. In Uganda, gari is a minor product. However, there is one processing association who produce small amounts of gari alongside HQCF. The gari is processed to order, to meet the demands of a small but growing Nigerian community. The same pattern is emerging in Tanzania. Typically, up to 50Kg per week is produced by one group, with gari stock reserved for sales during the rainy season where sun drying is not possible.

Figure 4: Packaged Ijebu gari (Nigeria)

Figure 5: Typical form of open selling gari in Nigerian markets

Fuba de bombó

Fermented cassava products are enjoyed in many African countries, including Angola (e.g. chikwange). Fuba de bombó (or Lafun as known in Nigeria, Makopa in Tanzania, or Kondowole in Malawi) is another popular fermented, dried and milled cassava product, with the roots soaked prior to drying, unlike gari or HQCF.

1a. Assessment of options for mechanization of cassava grating at the village level

Grating of cassava is necessary for the production of gari or HQCF, but not for fumbo de bombó which is pounded or moulded after soaking. The process flow for all three is given in figure 5 below. The initial stages are common to both gari and flour processing. For gari, the resulting grated cassava wet mash is dewatered or left for a number of days (depending on degree of fermentation desired), either within the press, or pressed to a degree before roasting. The detwatered wet mash is often referred to as wet cake. For HQCF, no fermentation is allowed to occur and the wet cake is quickly processed further.

A couple of options for improving gari processing in Cabinda were provided. The idea would be to reduce the burden on women processors, thereby providing a context where they could scale-up their gari processing activities and/or save labour that could be used for other productive purposes or household chores. The product would be sold in the local market. There would be no change in target markets. Processors would fetch no premium. It is assumed that farmers in the villages around Cabinda City who sell gari opportunistically process about 20-30 Kg per week. Hundreds of farmer processors are thought to be involved in this activity. Retailers-processors produce about 150 kilograms per week. It is estimated up to 100 such processors in Cabinda. Total estimates are 20-25 tons of gari being sold in the province per week.

The technology employed for producing gari in Cabinda, to process yellow gari, an activity undertaken by women, is extremely basic. During the interviews, processors highlighted the effort and time spent grating the roots and the effort made and discomfort experienced during the frying process as their main concern. According to them, the time-consuming and arduous nature of the work limits their involvement in the activity.

The introduction of mechanized graters and improved roasting facilities/equipment are the most obvious innovations. The availability of mechanised tools for grating significantly reduces the time it takes to do the same work manually. For women, this is a positive development. Previously in Nigeria, the women used to grate their cassava manually. In some Nigerian communities, in addition to the grating and pressing machines, the general processing area includes a frying (roasting) area, where women fry their pressed cassava. One of the most repeated complaints by women using these frying facilities is of overheating and smoke from the firewood. This is slowly being displaced by improved fryers employing chimneys to channel smoke away from operators.

In addition to graters, hydraulic or screw presses should also be considered at this stage also as a means of speeding up the dewatering process and reducing fuel costs for subsequent frying of gari or product drying. The choice of technology capacity however will impact the number of additional or displaced stakeholders. A mechanized fuel driven grater with a capacity of 500-1000Kg/hr is adequate. The number of graters will depend on the planned production model and number of processors to be supported.

One challenge perceived by the field consultant is the lack of mechanical workshops in Cabinda producing simple processing equipment. For example, all the hammer mills used for processing fuba de bombó come from the Democratic Republic of Congo. So any development project would need to have a very strong training component for local workshops to ensure that they would be able to produce the equipment or at least service it (maintenance, repairs). This is not perceived as a huge challenge as has been experienced from technology transfer from the C: AVA project whereby fabricators are now adopting improved equipment on a wide scale in Tanzania, Uganda and Malawi. The technology came from Nigeria.

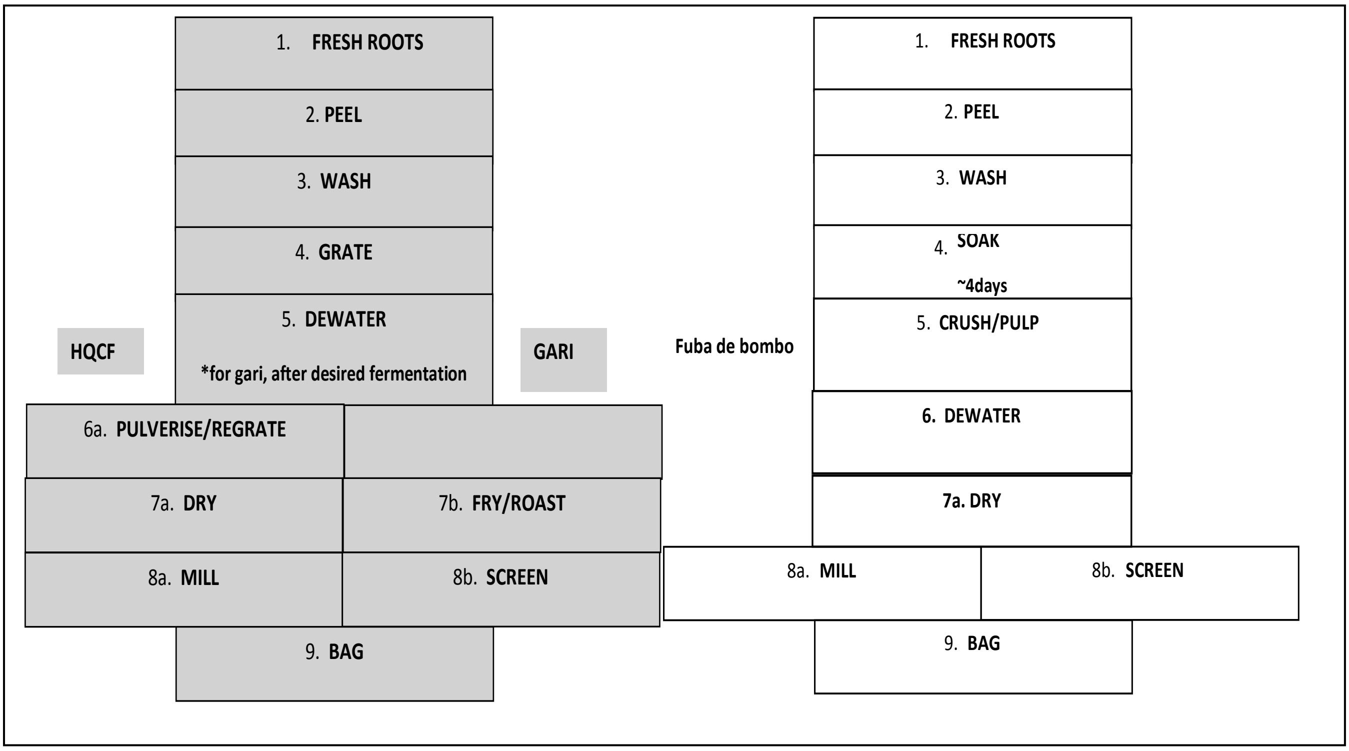


Figure 5: Process flow for HQCF and gari (left), and fumbo de bombó (right)

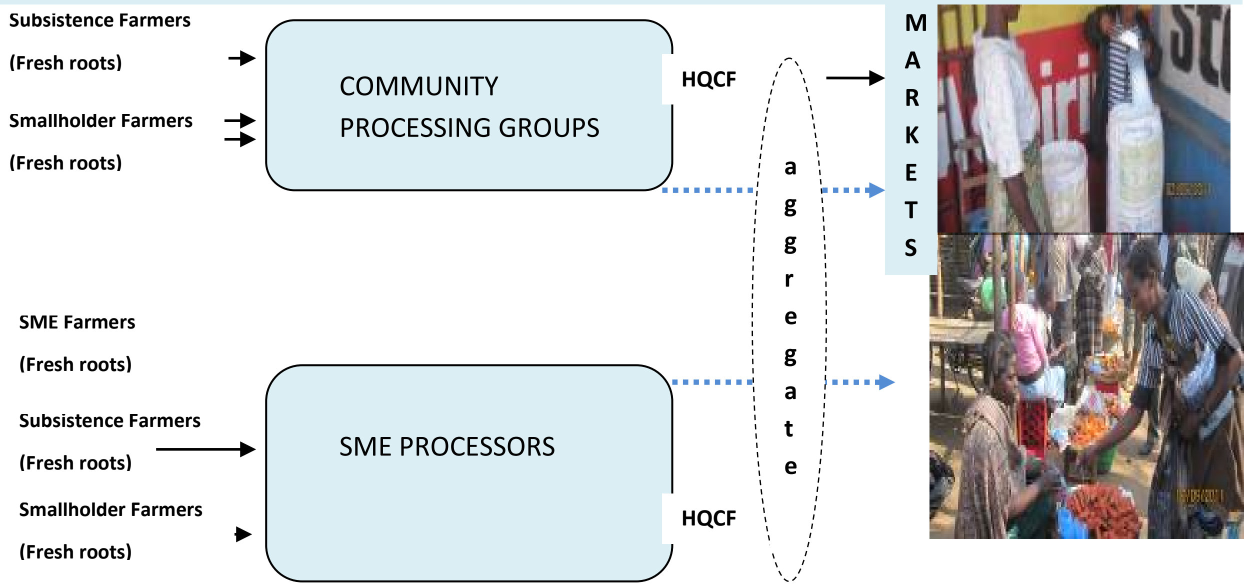
1b. Assessment of options for development of a small, modern processing enterprise producing quality, well-packed gari for the consumer market and quality cassava flour for the bakery sector and consumer market

Gari

In the supply model currently in operation in Uganda, Tanzania and Malawi for HQCF (Fig. 6), farmers may just be growers or farmer processors. Again, in Nigeria, gari or cassava wet cake is either sold directly by processors to end users, or there is the option of processors aggregating for larger volumes to supply to individual end users demands. The gari market network in Cabinda is given below (Fig. 7). While specialized processors produce gari once or twice a week, farmers undertake this activity on a more opportunistic basis, depending on their cash needs and availability of labour to harvest and process the roots and sell the product.

ACTORS:

Smallholders	CPG's	Traders	Marketers
SME farmers	SMEs		Financiers
Subsistence farmers	NGO's		End users



FUNCTIONS:

Production	Peel, **Grate**, Press, Dry, Package	Transport	Finance
Transport	Transport	Finance	Storage
	Finance		

Figure 6: Current model for supplying fresh roots and processing HQCF in rural area

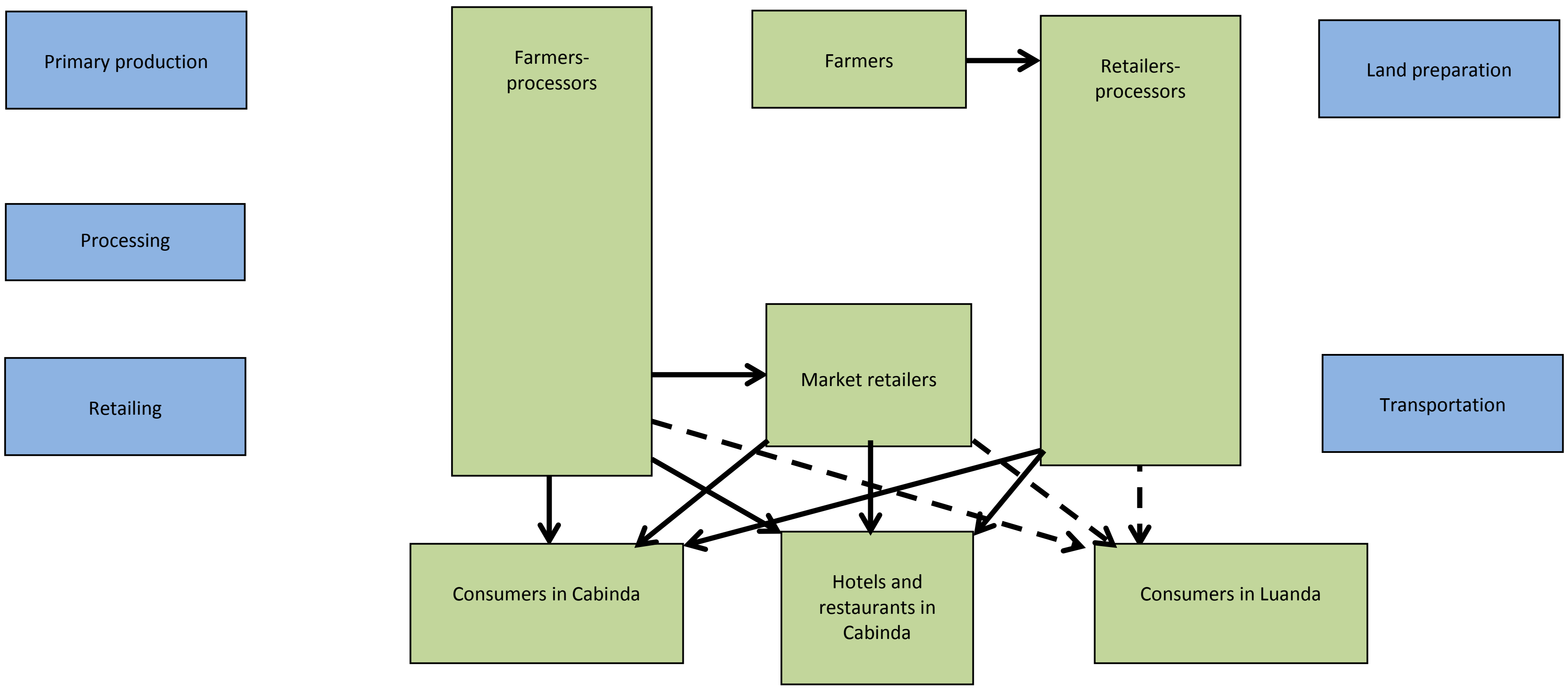


Figure 7: Gari market network in Cabinda, Angola

An option suggested is to promote adoption by two or three women groups, on a pilot basis, who would share the equipment (graters and improved roasting facilities) amongst themselves, or to develop a small gari processing enterprise targeting the Luanda market. In this option support the establishment of a small factory, with washing basin, hydraulic press, mechanized grater, grinder, roasting area, would be made. The initial processing capacity would need to be fairly small within a simple building.

Another model is to support the adoption of graters by two or three local entrepreneurs, who would provide grating services for a fee. These entrepreneurs would have to be located close to the processors so as not to transport at cost wet mash which has very high moisture content. The suggested fee for the entrepreneur would be based on the cost of fuel for grating a known quantity of fresh cassava roots plus a mark up to recoup the cost of the machine, maintenance and service fee etc. In and around the towns in both Ogun and Ondo states, Nigeria, there are many small-scale producers of traditional foods, mostly making gari, lafun (fumbo de bombó) and fufu (fermented cassava). In most villages, machines for grating, pressing and milling are available.

Rural (small) scale HQCF processing

HQCF is mentioned here as it provides another option for gari processors to use the same facilities, to add value to cassava, improve incomes, through substitution in locally produced snacks. In the value chain model above (Fig. 6), individual or groups of farmers can grow cassava, and processes into sun dried HQCF, or simply grow the roots for others to process. Processors can sell HQCF direct to customers/end users, or bulk with other processors in order to meet larger quantities demanded by an end-user. This model may also apply to fumbo de bombó processing. Currently, subsistence, smallholder and SME farmers are key stakeholders feeding into the rural market. Typically, processors involved in sun drying produce 0.5t/week maximum, typically operating 2-3 days per week.

Medium scale HQCF plant

The expected production from a Nigerian type flash dryer (Fig. 8) over a double shift is around 2-10t/day, requiring up to 40t of fresh cassava roots (assuming a 4 to 1 conversion ratio). In this model below, farmers (of different scales) can either sell roots direct to the plant or have the option of producing cassava wet cake, the intermediary product (thus adding value), and supplying to the HQCF plant for onward processing (drying, milling, bagging).

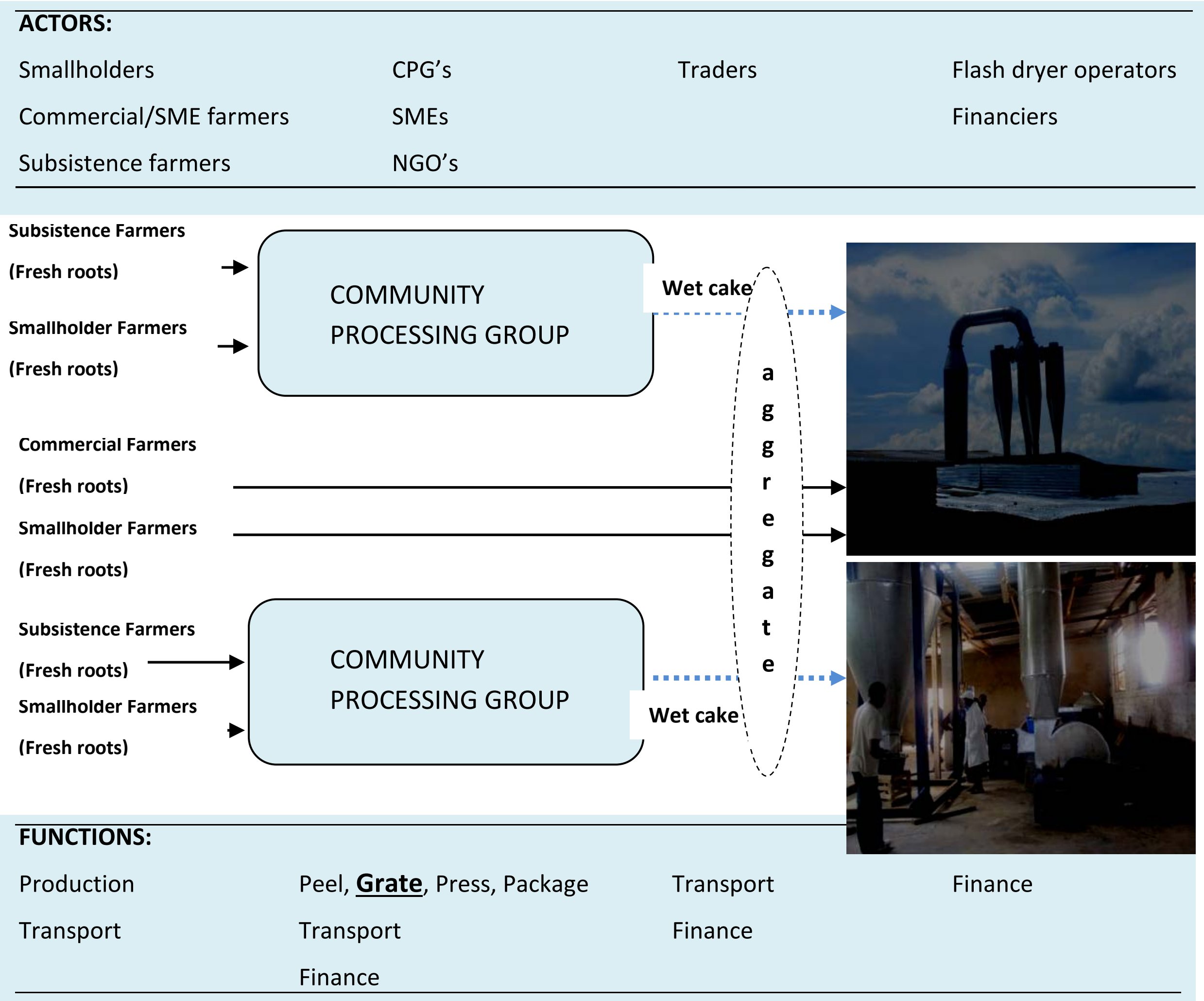


Figure 8: Current model for supplying fresh roots and processing HQCF medium scale

In addition to the grating service options described earlier, one model currently being carried out in Nigeria is that of mobile grating. Here, an SME loads his grater onto the back of a pickup truck and takes it in turn to farms within a catchment area where processors have peeled and washed cassava roots. Farmer processors then dewater the grated cassava mash (wet mash) using 30t jack presses then the resulting wetcake is subsequently collected by the SME for the drying and bagging. Grated wet mash can consist of up to 70% water and is therefore difficult to handle and will add to processing costs if transported. Therefore, processors minimise the transport of this intermediary product. Consequently, dewatering always takes place in proximity to the grating machine. This is the case for all processed cassava products including gari and lafun, or fuba de bombó, irrespective of the scale of operation.

2a. Technical specifications for processing unit layout, equipment, and building infrastructure for gari, HQCF or fuba de bombó

Traditional unit operations result in low product yields and include using home-based, kitchen tools, peeling, cutting roots to chunks (for fumbo de bombó of lafun). Processing may be through soaking of several batches of cassava roots in the same pool of water. Sun drying is still commonly found to be carried out on bare floors (on-farm, road side). Some of these practices lead to low quality human foods and possibly unsafe and attracts low market prices**.** Some of the cited challenges faced in the adoption of equipment include lack of knowledge regarding benefits of improved processing technologies, incorrect targeting by agencies and lack of ownership by beneficiaries, high cost of machines and lack of professionalism of local fabricators. The main buyers of machines have been NGOs, government or support institutions. Very few private sector investors have procured improved cassava processing machines.
The current process for producing yellow gari adopted in Cabinda, including the technology adopted, is given below.

Process	**Technology, inputs**
Peeling and washing of cassava roots	knife
Grating of cassava roots	Perforated metal sheets
De-watering and fermenting of the mash (1-2 days)	Polythene bags, stones and logs
Drying (1 day)	Sun-drying (over a metal sheet)
Roasting	Metal tray, wood, palm oil

Figure 9: Current gari production in Cabinda, Angola

Equipment

Referring to the process flow diagram in figure 5, obtaining good quality roots is the first step to producing a good quality gari, HQCF or fumbo de bombó. Roots should not be too old or diseased (Fig.10), or there will be a high percentage of fibre in the flour, as well as high conversion rates of fresh to flour, thus increasing processing costs. Producing gari requires skill on the part of the processor, with experience determining to a large extent, final quality.

Figure 10: Diseased cassava roots

Peeling

Peeling off the skin is essential. There are various options for peeling. Poor peeling results in poor quality final product. Peeling is commonly done using knives or in some countries, specially made peelers (Fig. 11). Larger scale operations may employ mechanised peeling. However, it should be noted that there are no efficient cassava peelers for cassava in Africa owing to the lack of uniformity of the fresh roots (size, skin type, shape etc). Some enterprises have tried to adopt potato peelers for cassava roots. Where a low quality flour is demanded by the market, this may be acceptable.

Figure 11: Manual peeling options with locally fabricated peeler

Washing

Washing in clean water is the next step after peeling. Washing in clean water is necessary in order for the flour not to result in a high microbial count, thus reducing shelflife and impairing product safety. Peeled roots should not be left exposed for too long, otherwise they are difficult to clean, thus impairing final colour of flour. After washing, the roots are grated. In the case of fumbo, the washed roots will be soaked for a few days in bowls or troughs depending on the degree of fermentation desired. Chippers are not recommended. This is to minimise cyanide levels in the final product. Also, grating facilitates water removal. Below (Fig. 12) shows an example of washing basin within a processing plant. This type is preferred than the tiled basins commonly constructed by processors, and often supported by donor projects. The tiles often break within a short time as they are not designed for heavy industrial use. Moreover, they are unsafe as product contamination is likely.

Figure 12: Acceptable (left) washing/soaking facilities vs unacceptable (right) washing facilities

Grating

In Nigeria, motorised graters have long been used instead of metal sheets to breakdown the cassava roots in processing gari and HQCF. Chippers are not recommended for HQCF. There are a number of designs for graters, some of which are more robust than others. Generally 1t per hour for a motorised grater for gari or HQCF processing is adequate, as the process constraint is not grating or pressing, but drying. Such graters are either diesel or petrol powered (Fig. 13). Maximum capacity of manual grating is around 20Kg per hour. Hand driven mechanical graters of similar designs are possible but not common as once a decision to upgrade from hand grating has been made, the advance is generally towards much quicker and less manually demanding options. This removes the drudgery associated with this stage of processing. The machinery contact surface must be fabricated using stainless steel to avoid cross contamination of product with rust.

Figure 13: Variation of motorised graters

Dewatering

After grating, the resultant cassava wet mash (as it is commonly referred) is loaded (quantity depends whether gari or HQCF is being produced) into PP bags. Screw presses are used in Nigeria, Ghana and Tanzania to dewater fermented cassava wet mash for gari. This method speeds up the dewatering process, is, easier, and more efficient in reducing the water content than the use of stones and wooden logs. The dewatering equipment below (Fig. 14) is typically used in gari production. These press models are not ideal for the production of HQCF, though appropriate for gari processing where fermentation and a degree of water retention is required.

Figure 14: Various models of screw press

For HQCF, pressing to reduce water content of the wet mash to ideally 35% using a 30t or 50t jack press for HQCF is desired. This facilitates rapid drying, including the use of less fuel use if drying artificially. The press structure has been reinforced at the top using railway bar. The following press models below are adopted for micro or household level processing and are not suitable for commercial scale use (Fig. 15). During a previous cassava project scoping study, these models were found, and still are to an extent, widespread in Tanzania, Malawi and Uganda. As a result, it was necessary to undertake a technology transfer workshop whereby the modern presses (Fig. 16) and graters in use in Nigeria were fabricated in Malawi from scratch, with participation of Tanzanian and Ugandan fabricators. Since then, over 300 units have been fabricated as a result from demand from additional development projects.

Figure 15: Household (low capacity screw) dewatering press

Figure 16: Preferred 30t and 50t hydraulic jack press used for dewatering wet mash in HQCF production

After pressing, regrating the pressed cassava (known as wet cake, Fig 17) for gari or HQCF production is undertaken with the same model grater as for grating step in order to break up clumps arising from pressing.

Figure 17: Resultant cassava screened wet cake in containers awaiting frying (gari) or drying (HQCF)

Screening

Options for screening are given below (Fig. 18). Screening is carried out to eliminate any foreign matter, fibre, and result in a uniform product ready for drying.


Figure 18: Small scale screening

Drying

Following pressing and breaking down (pulverising) of wet cake or semi-processed fumbo de bombó, the product is dried. Drying should not take place on the floor (Fig. 19). Elevate product on drying racks and black tarpaulin as it absorbs heat and facilitates faster drying. Spread wet cake at a rate of 5kg /m^2 or less. This is to facilitate rapid drying and minimise the development of damp spots. Drying racks (Figs. 20) are constructed out of bamboo, other wood or metal rods, each generally with an area of around 20m^2. Typical volumes for processing units are ~50Kg dried cassava grits. Drying is the first constraint in rural scaling up. The second is management. Drying rates are further influenced by weather conditions (humidity, rain, irradiation, temperature). When scaling up operations by increasing drying areas for example, careful attention needs to be paid to quality management. Product incorrectly dried will start to ferment and develop off colour, flavours and aromas. The dried wet cake for HQCF is referred to as dried grits.

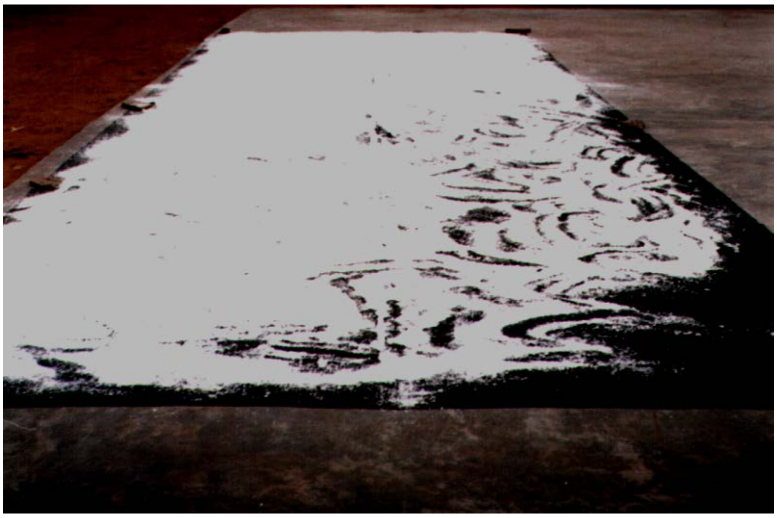


Figure 19: Traditional drying of processed cassava on the ground

Smale scale sun drying of HQCF on raised racks with black tarpaulin

Simple sun drying racks constructed with wood

Simple sun drying racks constructed with wood and mesh

Figure 20: Parallel screening and spreading of wet cake for drying

Gari frying

For onward processing for of wet cake for gari, there are a number of gari fryers, traditionally made out of cast iron (Fig. 21), or upgraded versions out of stainless steel. Most use fire wood or coal as the heat source, with processing taking place out in the compound. More modern operations process within a simple housing or shed which have a chimney for the smoke to dissipate. Pans are lined with a small quantity of oil, then wet cake is placed in the steel pans and stirred periodically. There are semi-automated models for producing larger batches (Fig. 22). Control of temperature and stirring times is required to ensure a uniform quality product.

Figure 21: Traditional gari processing in cast iron and clay pans

Upgraded gari frying layout showing multiple frying units

Figure 22: Semi-automated gari fryer for processing larger batches

Milling (for flour)

Once the cassava grits (HQCF) or fumbo de bombó are dried to 10-12% moisture content, the grits are milled and screened (Fig. 23). With milling, the correct aperture screens should be considered for HQCF. This is smaller than that used for milling maize, and ideally, fabricated from stainless steel.

Figure 23: Small scale milling and screening of dried cassava grits

Hygienic packaging is required in order to maintain quality. HQCF readily absorbs water. The use of polypropylene sacks with thin polythene liner (Fig. 24) is commonly used.

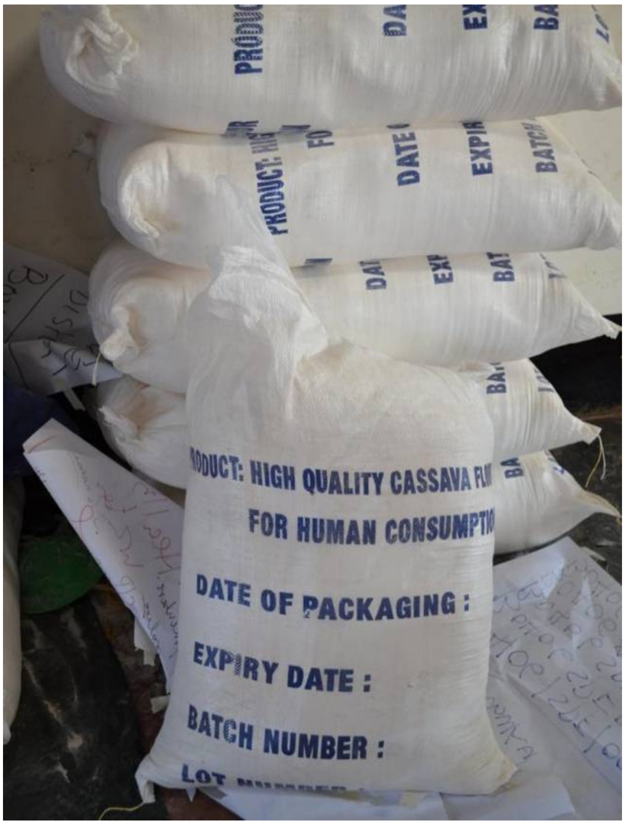


Figure 24: Correct bagging of flour with PE lined PP bags

Storage of finished product for both gari and flour should be off the ground (Fig. 25) in order to maintain quality.

Figure 25: Storage of product off the ground

Processing plant layout

For both good quality gari and HQCF production, the most important thing is to keep the wet (washing, grating and pressing) processing and dry processing areas separate (Fig. 26). The size of the plant depends on the size of the demanded output from end users. Below, shows a very basic gari processing setup typical in rural settings. Peeling is sometimes carried out beneath a tree. Water for washing is normally fetched from nearby boreholes, with peeling and washing being carried out in parallel once sufficient roots have been peeled. The figure shows a basic structure for wet processing measuring around 10x8m.

Figure 26: Rural cassava peeler

Figure 27: Simple small scale village processing plant

Figure 28: Simple processing plant showing wet processing (grating) carried out

Figure 29: Simple processing plant showing wet processing (pressing) carried out

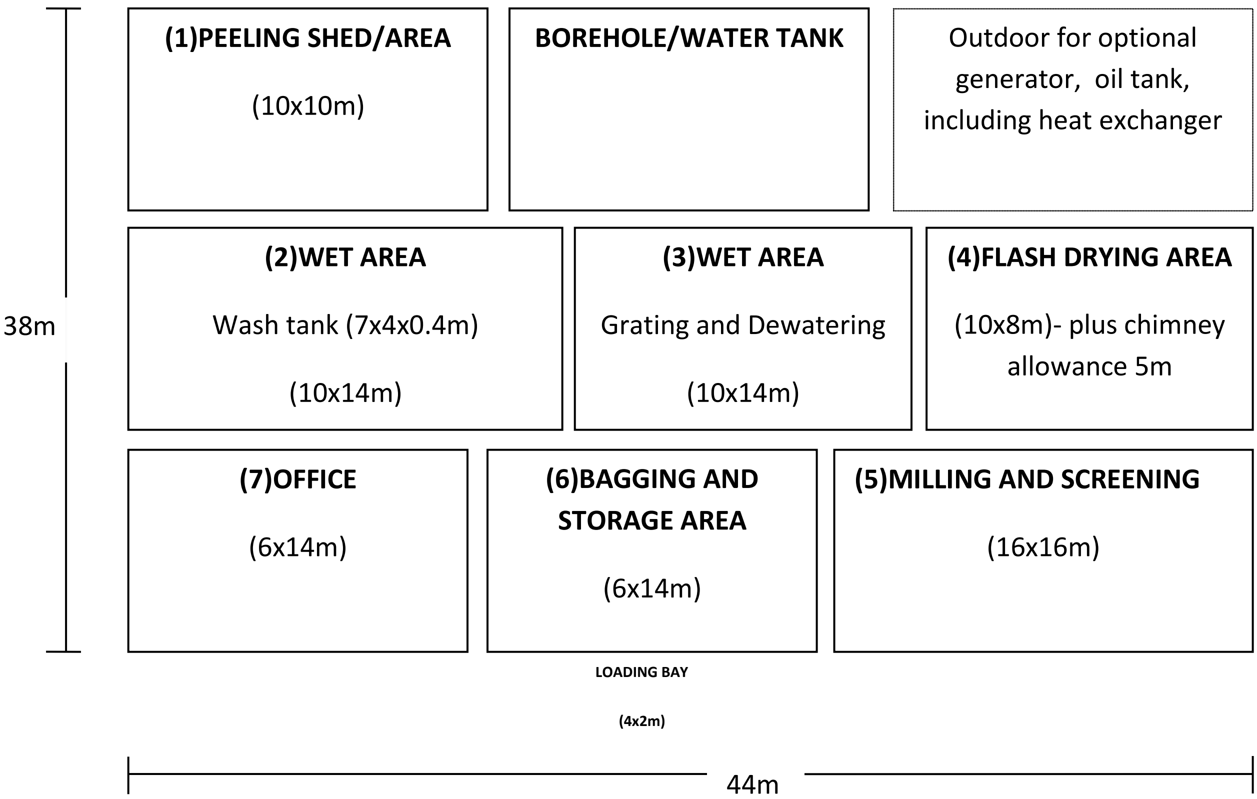
Figure 30: Small scale sun drying racks in series, and behind, typical village scale cassava processing structure

Figure 31: Sun drying using multiple drying racks (alternative design)

The type of building below is generally for the housing of processing equipment and storage of finished or semi-dried product.

Figure 32: Upgraded village product storage ~35m^2

Improved SME processing plant configuration below (Fig. 33)



1. Open sided peeling area,

2&3. Wet area with wash tank with outdoor opening, 3. Root grating, pressing and regrating in wet area,

4&5. Dry area consisting of flash drying, milling and screening

6.Bagging and storage area with outloading structure

7. Optional office space

Additional notes: Wet and dry areas must be kept separate. Allowance for exhaust from chimney required. Heat exchanger, burner and fuel storage must be in a separate area to avoid contamination of product

Figure 33: Sketch for 2-10tonne/day High Quality Cassava Flour (HQCF) flash drying plant in Malawi indicating minimum dimensions (not to scale), (Adapted from Graffham, 2013)

Figure 34: Peeling area in SME processing HQCF

Figure 35: Peeling area on right, washing area on left

Figure 36: Two upgraded processing plants (left and right) showing wet processing layout with dewatering for HQCF and gari respectively

Figure 37: Drying of HQCF using a flash dryer (2-10t/shift)

3a. Business plan for a village-level enterprise providing grating services for a fee, and for a small, modern enterprise producing quality, well-packed gari and flour

Grating is a common step in the production of HQCF and gari. The appraisal below is intended to be generic for all the above mentioned products, given the same key activities are involved to a large extent. It is necessary to cover all key costs involved in the operation. It is estimated that 2.5litres of diesel or gasoline would grate 1t fresh peeled cassava. The smaller the batch volume of cassava roots to be grated, the less efficient, and therefore the higher the unit cost will be. Therefore, at ~$0.55/liter fuel, it would cost $1.38 in fuel alone to grate a tonne of roots. A grater of the suggested capacity may cost $1,000-1,500. For a potential investor, gari sales in the province of 20-25t per week, implies a grating requirement (4:1 conversion ratio) of 80-100t per week of fresh cassava roots. Clearly, it would not take too long to get a return on the investment. That is, providing of course, that processors are willing to pay the grating charge ultimately set by the entrepreneur. 80-100t per week of fresh cassava equates to 100-200 hours per week of grating time depending on grater capacity, implying several graters (assuming a 5 day week and 10hour day) could be adopted, or up to 4 entrepreneurs supported.

Viability of sun drying and flash drying HQCF

The market size for HQCF is unknown. However, the cost of simple labour and fresh cassava roots have been provided at $10/day and $0.2/Kg ($200/t) respectively. At these prices, developing a HQCF value chain is not viable as the cost of processing is too high (over $1000-see tables 5&6) versus an assumed selling price of $656. See table breakdown below. However, it is suggested that all key costs provided are further verified (raw material, labour, energy), including the landing price for wheat. Average root prices across Ghana, Nigeria, Uganda, Malawi and Tanzania are in comparison much lower ($50/t, with unskilled labour at $2/day). Also, the wholesale price of wheat flour was given as $41/50Kg bag ($820/t). Field work on market sizes and prices are also to be explored as this exercise has not been undertaken, and thus buying prices have been set as the wholesale cost of wheat. Revenues can therefore not be estimated. However, normally, HQCF would sell at 60-80% (i.e. $492-$656) of wheat prices to be attractive as a wheat substitute.

MARKET PRICES & SIZES

Biscuit	
Buying price for HQCF ($/t)	656
Transport cost to buyer	?
Ex-processor price for biscuits	>656
Bread	
Buying price for HQCF	656

Transport cost to buyer	?
Ex-processor price for bread	>656
Rural market	656
Buying price for HQCF	656
Transport cost to buyer	
Ex-processor price for rural markets	>656

Table 1: COSTS OF PRODUCTION AND GROSS MARGINS OF FRESH CASSAVA ROOTS (FCR)

Typical yields (t/ha)	10
Selling price (for processing, farm-gate) ($/t)	200
Returns ($/ha)	2,000
Labour days (per ha)	90
Opportunity cost of labour ($/day)	10.00
Cost of labour ($/ha)	900
Planting material ($/ha)	30?
Other costs (eg annual land prep)	
Total costs of production ($/ha)	930
Gross margin ($/ha)	**1,070**
Production costs (per t FCR)	**93**

Table 2: PROCESSING COSTS (wet mash stage)

Cost RM (USD/t)	200 (figure supplied)
Peeling rate (kg/person/day)	300
Labour days for peeling (per t of FCR)	3.33
Other labour days	2.50
Labour cost	58.33
Other costs	1.70
Total cost of wet mash processing ($/t FCR)	260
Percentage wet mash from FCR	53%
Costs of producing wet mash ($/t of wet mash)	**491**
Margin on wet mash	9
Selling price of wet mash USD/t	**500?**

Table 3: SUN DRYING PROCESSING COSTS (wet mash to HQCF)

Cost RM ($/t)	491
Labour costs ($/t)	20
Other costs	3
Percentage HQCF from wet mash	47%
Direct Costs of HQCF ($/t)	**1,093**
Capital costs ($/t)	103
Direct + capital costs ($/t)	1,196

Table 4: PROCESSING COSTS (Flash dryer)

Cost of RM (Actual or 125% of cost)	500
Transport cost to Flash Dryer	16
Labour	60
Other costs	17
Sub-total	593
Percentage HQCF from wet mash	47%
Litres of diesel for 1t HQCF	86
Bulk cost of diesel ($/l)	0.5
Total cost of diesel ($/t HQCF)	43
Direct costs of HQCF from Flash Dryer	**1,305**
Capital costs ($/t)	**51**
Direct + capital costs ($/t)	1356

Table 5: Summary data: FLASH DRYING

Cost of FCR	372
Farmer's net margin	428
Wet mash processing	240
WMP's net margin	20
Diesel	43
Other factory costs	198
capital costs	51
Total	**1,352**

Table 6: Summary data: SUN DRYING

Cost of FCR	372
Farmer's margin	428
Wet mash processing	240
Other sun drying costs	49
Capital costs	103
Total	**1,192**

3b. Business plan for a small, modern enterprise producing quality, well-packed gari for the consumer market and quality cassava flour for the bakery sector

It is believed a well branded product packed in 0.5 kg bags could be sold in Luanda for US$ 2 (US$ 4 per kilogram). Assuming a 40% margin charged by wholesalers, then the gari would need to be sold for US$ 2.4 per kilogram after transportation. Current transportation costs by ship, the most reliable option, plus port charges in Cabinda and Luanda, are US$ 0.6 per kilogram (US$ 600 per ton). This means that the processing unit would need to produce the gari at a cost of no more than US$ 1.5 per kilogram, similar to the local retail price for the traditionally produced gari, if it is to earn some profit. In fact, the appraisal shows that gari is produced just over $1500/t at $1530/t. This does not include fixed costs. The business plan targets 70% of sales at retail (Luanda) and 30% to wholesale/local markets. In the current model, the cash position is positive in the fifth year. There can be different scenarios with the percentage target markets (70/30 retail-local) to give better and earlier returns as the cost of transport reduces the potential margins. For this reason, a vehicle was included with the fixed costs (Table 7).

Most labour is assumed to be hired on a casual basis. The monthly wage in Cabinda for unskilled labour is assumed as US$ 10/d. This is high for Africa. The model assumes a gari output of 50Kg/hr working on a 10 hr shift, and cassava roots at $200/t.

The main retail outlets in Luanda would be Cantinas and supermarkets. There are 9 chains with a total of 37 stores, plus a couple of small supermarkets with one or two stores. It is believed it would be possible to sell in Luanda 1 ton per month during months 1-3 of operation; 2 tons per months during months 4-6; and 5 tons per month during months 6-12. If the product gains acceptance amongst consumers in Luanda, then 10 tons per month during the second year, 20 tons per month during the third year, 25 tons per month during the fourth year, and 30 tons per month during the fifth year. The following analysis is based on this production schedule. The capital investment costs for a small-medium scale gari processing plant with simple building structure are given below (Table 7). If producing fumbo de bombó only, the wet mill/grater can be omitted, including the vehicle and gari fryer. Alternatively, for small scale gari production using traditional fryers, these can be purchased for around $50 each with a capacity of around 25Kg/d.

Table 7: CapEx gari SME

Unit	Cost ($US)
Factory Buildings	3,000
Gari fryer 500Kg/d	6,000
Pneumatic jacks and frames	3,000
Grating equipment /wet hammer mill	2,000
Hammer mill	1,000
Weighting scale	500
Tables, benches, bowls, knives etc	147
Sieving machine	2,000
Vehicle	30,000
Furniture & fittings	196
Computer	196
TOTAL	**48,039**

The cash position based on the production plan above is positive in the fifth year (Table 8)

Table 8: Cash position based on gari production plan

	2014/5	2015/6	2016/7	2017/8	2018/9	2019/20
Direct costs of Production	6,087	6,087	18,730	37,460	46,825	56,190
Overheads	17,959	16,745	16,745	16,745	16,745	16,745
Fixed costs	5,199	-	16	-	3,271	696
Total costs	29,245	22,832	35,490	54,204	66,840	73,631
Revenues	11,258	11,258	34,639	69,278	86,598	103,918
CASH POSITION	- 17,987	- 11,574	- 851	15,074	19,758	30,287
CUMULATIVE CASH POSITION (Thousands AOA)	**- 17,987**	**- 29,561**	**- 30,412**	**- 15,338**	**4,419**	**34,706**

<u>**ASSUMPTIONS**</u>

Financial				
	Exchange rate - (AOA to USD)		102	
	Basic labour plus 25% to cover other costs (AOA/day)	$10/d	1,275	
Processing				
	fryer capacity (kg/hour)		50	
	Length of shift (hours)		10	
	Gari produced per shift (tonne)		0.5	
Revenue				
	Selling price of Gari		**AOA**	**$US**
	a) LUANDA RETAIL			
	$4,000/t			4000
	assumed selling price, urban (minus$600/t transport costs)		346,800	**3,400**
	Selling price of Gari			
	b) CABINDA			
	$1,500/t			
	assumed selling price at source		153,000	**1,500**

Processing Margins - AOA per tonne gari

Fresh cassava roots (FCR)	kgFCR/day	
Farm gate price (AOA/t)		20,400
Transport to factory (AOA/t)		5,000
Conversion rate; FCR to gari		4.00
Total price FCR per tonne gari		101,600
Labour		
Off loading FCR (kg/person day)	2,000	2,550
Peeling (kg/person day)	200	25,500
Washing	3,000	1,700
Crushing/milling/bagging (kg/person day)	2,000	2,550
Loading Gari, other jobs (kg/person day)	2,000	2,550
Total Labour		34,850
Energy for drying		
Units of wood		500
Unit cost		2
Total cost of drying		1,000
Water		1,000
Packaging		
Printed laminated bags (kg bags)	10.2	10,200
Transport		
Internal	Internal	
External		
Waste disposal		
Contingencies	5%	7,433
TOTAL DIRECT COSTS OF GARI		**156,083**
		$US1,530
Revenue		
70% to RETAIL	70%	242,760
30% LOCAL	30%	45,900
Total revenue		288,660
PROCESSING MARGIN		**132,578**

Production Schedule (tonnes)

		July	August	Sept	Oct	Nov	Dec	Jan	Feb	March	April	May	June	2014/5	2015/6	2016/7	2017/8	2018/9
FCR roots (delivered to factory)		4	4	4	8	8	8	20	20	20	20	20	20	156	480	960	1,200	1,440
Conversion rate		4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Output of GARI		1.0	1.0	1.0	2.0	2.0	2.0	5.0	5.0	5.0	5.0	5.0	5.0	39.0	120.0	240.0	300.0	360.0

Total Direct Costs of Production (thousands of AOA)

		July	August	Sept	Oct	Nov	Dec	Jan	Feb	March	April	May	June	2014/5	2015/6	2016/7	2017/8	2018/9
Cost FCR		102	102	102	203	203	203	508	508	508	508	508	508	3,962	12,192	24,384	30,480	36,576
Labour		35	35	35	70	70	70	174	174	174	174	174	174	1,359	4,182	8,364	10,455	12,546
Energy for drying		1	1	1	2	2	2	5	5	5	5	5	5	39	120	240	300	360
Water		1	1	1	2	2	2	5	5	5	5	5	5	39	120	240	300	360
Packaging		10	10	10	20	20	20	51	51	51	51	51	51	398	1,224	2,448	3,060	3,672
Transport		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Contingency		7	7	7	15	15	15	37	37	37	37	37	37	290	892	1,784	2,230	2,676
Total Direct costs		**156**	**156**	**156**	**312**	**312**	**312**	**780**	**780**	**780**	**780**	**780**	**780**	**6,087**	**18,730**	**37,460**	**46,825**	**56,190**

Revenue (thousands of AOA)

		July	August	Sept	Oct	Nov	Dec	Jan	Feb	March	April	May	June	2014/5	2015/6	2016/7	2017/8	2018/9
Tonnage HQCF																		
LUANDA	70%	0.70	0.70	0.70	1.40	1.40	1.40	3.50	3.50	3.50	3.50	3.50	3.50	27.30	84.00	168.00	210.00	252.00
CABINDA	30%	0.30	0.30	0.30	0.60	0.60	0.60	1.50	1.50	1.50	1.50	1.50	1.50	11.70	36.00	72.00	90.00	108.00
Selling price																		
Sold to LUANDA		347	347	347	347	347	347	347	347	347	347	347	347	347	347	347	347	347
Sold in CABINDA		153	153	153	153	153	153	153	153	153	153	153	153	153	153	153	153	153
Total revenue		**289**	**289**	**289**	**577**	**577**	**577**	**1,443**	**1,443**	**1,443**	**1,443**	**1,443**	**1,443**	**11,258**	**34,639**	**69,278**	**86,598**	**103,918**
Margin		**133**	**133**	**133**	**265**	**265**	**265**	**663**	**663**	**663**	**663**	**663**	**663**	**5,171**	**15,909**	**31,819**	**39,773**	**47,728**

Overheads (AOA thousands)		Annual cost		2014/5	2015/6	2016/7	2017/8	2018/9
Management								
Factory Manager	1	10,000						
Secretary	1	4,500						
Supervisors (2)	1,020	4,500		4,500	4,500	4500	4500	4500
junior staff	1,020	3,000		3,000	3,000	3000	3000	3000
other junior staff(4)	1,020	2,000		2,000	2,000	2000	2000	2000
Other permanent staff (various/part time)		500		500	500	500	500	500
Vehicle running costs								
POL		1,200		1,200	1,200	1200	1200	1200
REPAIR AND MAINTENANCE- R&M	10%	306		306	306	306	306	306
Other R&M								
R&M Buildings/site	2%	6		1,200	1,200	1200	1200	1200
R&M Processing equipment	10%	117		117	117	117.3	117.3	117.3
R&M Other	10%	4		4	4	4	4	4
Quality		500		500	500	500	500	500
Electricity		1,000		1,000	1,000	1000	1000	1000
Communications		120		120	120	120	120	120
Office supplies		120		120	120	120	120	120
Insurance		0		0	0	0	0	0
Marketing		720		720	720	720	720	720
Site rental								
Certification/Permissions etc								
Training		120		120	120	120	120	120
Local travel/accommdation		120		120	120	120	120	120
Audit		300		300	300	300	300	300
Other		120		120	120	120	120	120
Sub-total				15,947	15,947	15,947	15,947	15,947
contingency (5%)				797	797	797	797	797
TOTAL OVERHEADS				16,745	16,745	16,745	16,745	16,745

Fixed costs								
	Unit cost (AOA thousands)	Economic life (years)	2014/5	2015/6	2016/7	2017/8	2018/9	2019/20
Company set-up	51	25	51					
Factory Buildings	306	25	306					
Gari fryer 500Kg/d	612	10	612					
Pneumatic jacks and frames	306	5	306					306
Grating equipment /wet hammer r	204	5	204					204
Hammer mill	102	5	102					102
Weighting scale	51	5	51					51
Tables, benches, bowls, knives etc	15	2	15		15		15	
Sieving machine	204	5	204					
Vehicle	3,060	4	3,060				3,060	
Furniture & fittings	20	4	20				20	
Computer	20	4	20				20	
contingency (5%)			248	0	1	0	156	33
TOTAL			**5,199**		**16**	**0**	**3,271**	**696**

Depreciation								
Company set-up			2	2	2	2	2	2
Factory Buildings			12	12	12	12	12	12
Gari fryer			61	61	61	61	61	61
Pneumatic jacks and frames			61	61	61	61	61	61
Grating equipment			41	41	41	41	41	41
Hammer mill			20	20	20	20	20	20
Weighting scale			10	10	10	10	10	10
Tables, benches, bowls, knives etc			8	8	8	8	8	8
Sieving machine			41	41	41	41	41	41
Vehicle			765	765	765	765	765	765
Furniture & fittings			5	5	5	5	5	5
Computer			5	5	5	5	5	5
contingency (10%)			52	52	52	52	52	52
TOTAL			**1,083**	**1,083**	**1,083**	**1,083**	**1,083**	**1,083**

Table 9: Comparison of scales of rural (sun) and flash drying HQCF technology

Technology	Size reduction equipment	Dewatering equipment	Drying equipment	Building	Milling	Average level of investment ($)	Operations management/level of technical skill required
HQCF Sun drying	1t/hr stainless steel grater (x1 unit required)	50t hydraulic press (x1 unit required)	Dried on black tarpaulin raised on drying racks ($100m^2$) 250Kg HQCF/d	Simple shed	Hammer mill (x1 unit required)	**$5,000-7,000**	Low
HQCF Flash (artificial) drying	1t/hr stainless steel grater (2-4 units required)	50t hydraulic press (x4 units required)	HQCF flash dryer 2t/hr	Concrete building with reinforce flooring to house dryer	Hammer mill (x1 unit required)	**$300,000**	High

Appendix

Challenges and lessons from the Cassava Adding Value for Africa Project (C: AVA)

Some challenges encountered in developing the cassava value chain are described below

Access to markets

While steady progress was being made to attract potential inventors in the artificial (flash) drying technologies for the medium-large scale value chain, the rural sun-dried small-scale value chain in Malawi for example was quick to take up as there were already some existing rural processing groups (RPGs) and small-scale entrepreneurs that had some knowledge and equipment in processing cassava. These small to medium sized enterprises (SMEs) and entrepreneurs were mobilised, and where no equipment was available, the project facilitated the provision thereof alongside capacity building in processing HQCF. The main problem being cited by the processors was in accessing markets for HQCF. Despite some previous end-user trials with large and small scale bakeries, the HQCF was not being bought by these users. The inability of processing groups to market their own HQCF led to reliance on the project staff. Nigeria has been more successful promoting HQCF using both sun drying and artificial (flash) drying. This is partly attributable to boosting of the cassava sector by the former Nigerian presidential (Obasanjo) initiative of 2002 on cassava composite flour, i.e. the government encouraged commercialisation on larger scale than had previously been the case, facilitating loans, facilitating access to soft loans, including the adoption of improved technologies in production and processing to increase output. Still, penetrating the rural market with HQCF has always been a problem because the main target markets have traditionally been the large end-users, such as wheat flour millers, biscuit manufacturers, and large bakeries, thereby posing challenges of capacity, reliability, quality and competitiveness for small-scale operators. Little attention has been given to the market opportunity within rural communities surrounding processing units. To address the issue of market access, the C: AVA project organized business management and marketing training. Since then sales have steadily increased.

Climatic constraints

Unfortunately, given the number of unpredictably rainy days in Uganda and Tanzania it is difficult for the HQCF producers to consistently meet production volumes demanded by large established market players such as flour mills, biscuit manufactures and paperboard factories.

Supply, demand and aligning incentives

A key point is to align incentives and interests locally in such a way as to sustainably increase productivity in line with the demand for cassava, aiming to minimize gluts and shortages and as a result bring about improved smallholder livelihoods. This matching of supply and demand is a critical balancing act which may be addressed through, for example, involving cassava producers of various scales of operation, and regular feedback of market intelligence on price movements and production costs. Another aspect of the imbalance between supply and demand is seasonality of production. Increased demand for cassava for alternative uses reduces the supply for the HQCF value chain and in the short term, results in higher prices.

Skills

Skills in business management, group dynamics, leadership and accountability at farmer organizations are key to successful participation in value chains. The lack of these skills in farmer processor groups was a constraining factor in each project country. Stronger farmer organizations possessing such skills have benefitted most from the new HQCF value chains as shown in Malawi, Tanzania and Uganda.

Financing

The issue of how best to finance these investments will be a common feature that will require ongoing dialogue with potential stakeholders in order to build a sustainable value chain, whether it be SME's, community processing groups, donors, aggregators or flash dryer investors. Typical CapEx requirements (~$5000) for a sun drying SME producing HQCF for the rural markets needs to cover a number of items, such as sun drying racks, spare parts, grater, press and jack, hammer mill, sifter/screen, building, and working capital. The CapEx requirement for a flash (artificial) drying plant is estimated at $300K. For a gari producing enterprise at micro level, this can be as little as $500. Scaling up generally involves procuring additional frying pans, followed by dewatering equipment, then graters. Upgrading normally involves investing in stainless steel frying pans and housing operations within a building. Where processing groups can contribute their own labour for building the housing structures, this helps to reduce the cost of the overall investment.

Scale options are tabulated below (Table 1). Additional equipment such as basins for washing cassava roots, sacks for holding the pressed wet cake, packaging or knives have not been included. In order to achieve higher standards of quality and safety for food products, it is desired that processor move towards housing their operations in what can be in the form of a simple structures, and also start to adopt simple quality management systems, such as hand washing, use of clean water, planned machine maintenance etc.