Expanding utilization of RTB crops and reducing their post-harvest losses

Proposed Business Case

Improving Cassava Chips and Flour for Increased Incomes and Post-harvest Loss Reduction

The Team

Name	Institution	Role
Adebayo Abass (PhD)	IITA	Project leader; Postharvest technology, Cassava value chain
Kolawole Peter (PhD); Kelly Wanda; Nicholas Mlingi (PhD) Bussie Maziya-Dixon (PhD)	IITA	Coordination and execution, technical input (Postharvest Engineering and market analysis, Food Science, Consumer tests)
Johanna Bergman Lodin	Swedish University of Agric. Sciences	Sociology/Anthropology/Gender specialist
Fiona Lukwago	Kilimo Trust	Postharvest/market analysis and linkages
Gloria Okello	Africa Innovation Institute (AFRII)	Postharvest processing & market linkages, Value Chain Development
Pamela Nyamutoka	IIRR	Farmer organization; Market linkages
Yusuf Byaruhanga (PhD) Abel Atukwase (PhD) Archileo Kaaya (PhD)	Makerere University, Uganda	Food technology, product and process development and food safety; Training of 2 MSc students
Stella Apolot Hakim Mufumbira	Uganda National Bureau of Standards	Food technology, product and process development and food safety; Standards.
Geoffrey Menya & Cedric Mutyaba	NARO, Uganda	Postharvest technology development & Supervision
Tendu Mirium Wamala	Family Diet	Market assessment
Yield Uganda Ltd	Private Sector	Market assessment/product testing
Family Bakery Uganda Ltd	Private Sector	Market assessment/product testing
Your Choice, Uganda Ltd	Private Sector	Market assessment/product testing
Joshua Sebubo	Technical Services	Equipment information and testing
Joseph Kavuma	Tonnet Enterprises Ltd	Postharvest Equipment Supply
Bernado Ospina	CLAYUCA	Engineering and Technology Transfer
Keith Tomlins	NRI	Sensory analysis

A. Final Business Case

1. <u>DEVELOPMENT PROBLEM/OPPORTUNITY</u> (*specify in 1-2 paragraphs the <u>development</u> problem or opportunity related to postharvest or expanding utilization that this technical innovation will address, e.g. low profitability of RTB, opportunities to increase household incomes, increased farm productivity)*

Cassava is the second most important staple crop in Uganda. The crop is recognized as a major agricultural commodity for poverty eradication, ensuring food and nutrition security, and as an industrial raw material (Collison et al., 2003). Cassava chips processing is an important stage that influences the quality of the final product i.e., cassava flour. It serves as a source of cash income for rural growers and processors, majority of whom are women. Demand for cassava is expected to increase as consumer preference changes with the development of new cassava products (Alacho et al., 2013). Traditionally, cassava is processed into chips by peeling, cutting into chunks and drying on the floor or by the roadside. It is estimated that over 80% of fresh cassava roots produced in Uganda are processed into chips in this way and eventually milled to flour, indicating a market size of about 1,000,000 MT. The drivers of this market expansion include population and income growth, urbanization, and new technologies that enable the substitution of some imported food items and industrial raw materials in food production (e.g., *wheat in bakeries, corn starch in paper mills and barley and other cereals in brewing, etc.*). Cassava chips are used in these industries mostly as a partial substitute to the regular raw materials. Wheat prices have been increasing and they are likely to continue increasing. The current price of wheat is about US$945/ton. If quality is improved and the price is competitive, dried cassava (in form of dry chips, grits or flour) can be a viable partial raw material substitute for wheat in current major food items that are mainly prepared by women small businesses and that include chapattis, mandazis, doughnuts, bhaghia, cakes, in addition to bread and biscuit baking, 10% of maize, 10% maize bran in animal feed rations, 10-30% in wheat flour for snacks, bread and biscuit baking, and completely replace imported starches and flours in plywood, paperboard and textile manufacture (Abass et al., 2001; Graffham et al., 2003).

Current usage of cassava chips suffers from the poor quality, high post-harvest losses, and poor safety. Processors fail to deliver regular supplies of high quality flour at a competitive price despite the premium prices the industrial users pay for quality (Kleih et al., 2012). It was gathered during the scoping study that while end-users pay US$113.4/ton for the low quality dried chips, the price for improved chips ranges from US$ 302.5 to US$492.5. The total value of poorly processed chips is about USD 40 million; this value can increase to at least USD 120 million if chips of higher quality that meet desired quality standards are traded. Sale of improved cassava flour at US$662/ton (70% wheat flour price) is possible. Previous attempts to improve the quality and safety of cassava chips through pilot activities had mixed results. Most of the efforts were done with food security objectives, with primary producers, where group processors were trained to produce cassava products from own farm outputs. The approach had limited effect as smallholder farmers maintained their interest in primary production and had little financial resources or commercial mindset, less time and lower-than-required technical ability to attain product quality and efficiency as expected from commercial mechanical operations. The processing machines introduced during the pilot phases were not sufficiently robust or efficiently used and the labor input into cassava processing was still high. The processors lacked enough capital to procure raw materials during periods of excess production or invest in proper drying to take advantage of the low processing costs and higher profits. They relied on sun- drying, leading to very low quality. Low quality chips result in low profitability, less savings and difficulty to connect with more profitable market channels that pay higher prices but demand higher quality. The traditional processing practices and the introduced chips and grits processing technologies have two other drawbacks, coming from: a) the peeling operation prior to chipping and drying, and; b) the mechanical pressing operation to remove excessive water in the grating method introduced by IITA (Abass, 2006). These peels and expelled water cause significant environmental disasters in commercialized processing environments such as in Nigeria and Ghana. Therefore, the traditional processing method, the improved chipping method and the use of fossil-fuel heated dryers are not eco-efficient and do not guarantee high quality flour acceptable to industrial users and some consumers. Hence, the uptake of cassava chips technologies on full commercial bases is slow.

If processors have to commercialize, then, the option is to involve commercial-minded processors, apply market-driven approach, improve the quality of the final product, reduce processing cost, and establish and strengthen linkages with more profitable markets. The use of a technology that uses less time and energy, and labour-saving processing steps is required. A dryer that uses agriculture waste as the main source of energy for drying when combined with a technique that circumvents one of the time-taking and labour-intensive traditional practice -manual peeling -could provide the solution to the quality, volume, eco-efficiency and cost issues associated with the supply of cassava chips in Uganda. The testing of this approach with potential end-takers adjusting the processing technology with time, ensuring the supply of cassava roots to allow a more active participation of farmers groups, and enhancing the development and sustainable consolidation of linkages with growth markets (bakers, breweries, paper mills, food sector) - could be a potential innovative approach to developing the cassava sector in Uganda.

2. <u>APPROACH</u> (*indicate in 3-4 paragraphs how the proposed technical and other innovations address this problem/opportunity, and how the research builds on existing knowledge, ongoing/recent initiatives*)

The economic performance and social benefits of cassava chips processing could be improved if labour inputs and the consumption of fossil fuel are reduced, and the impact of the technologies on the environment could be minimized. The Latin American Consortium for Cassava Research and Development (CLAYUCA) has been developing a technology to produce ”refined flour”, using a technology that does not remove the peels at the fresh stage, but rather, in the final step, during the milling/drying process. The process involves washing and chipping of roots without peeling, drying and flour refining. The peels and fibers are separated from the flour and collected in a dry raw flour form, which could be readily used as animal feedstuff and in other uses. However, the technology has the drawback of a drying system with fuel oil or gas as the source of energy, increasing the cost above the competitiveness of cassava. On the other hand, as part of the RTB postharvest complementary funding window, IITA has been testing a simple dryer that is based on principle of gasification (and full combustion). The dryer uses agricultural waste (cassava peels, saw dust, wood shaving, cashew nut shell, palm cannel shell, etc.) for drying of cassava. This technology has been developed to an advance stage with a similar approach already in commercial use in West Africa. It has the potential to reduce environmental pollution from agriculture wastes, eliminate reliance on fossil fuel for drying, reduce drying costs and produce high quality chips.

Therefore, this research effort will test and adapt the CLAYUCA technology that skips peeling of fresh roots, will combine the technology with mechanical drying with agricultural wastes and compare with the current chipping and sun-drying technique already introduced in Uganda through past projects of SARRNET-CFC-IITA and NARO in the 2000s and other ongoing projects in Uganda. The integrated agro-enterprise project approach, previously applied by CIAT and adopted by IITA and other centers in Uganda, will be used. Suitable local entrepreneurs in cassava development domain (cassava production areas with good market access) have been identified to take part in the research. The local entrepreneurs to be involved will be further screened based on having the minimum technical capability to quickly understand the principles of the technologies, eventually invest in the technology and have capacity to build their own supply chains and adopt the technology faster. Chips and it derivative products (flour, etc) will be tested for safety, economic viability, social compatibility, technical usability of the flour in the production of food products (bread, biscuits, etc) and consumers acceptability of the derived products. The general approach will involve the following:

i. Conduct a thorough analysis and characterization of improved cassava chips markets in terms of demand segments, consumer preferences by gender, quality characteristics, industrial specifications and general demand trends.
ii. Evaluate the technical feasibility and adaptability of dried cassava chips processing technology that eliminates peeling but uses mechanical drying as means of increasing quality, safety and output volume of cassava chips (CLAYUCA technology).
iii. Evaluate the economic viability of (profitability of) making chips by the CLAYUCA technology and for some end-products derived from the chips (biscuits, bread, etc.).
iv. Evaluate the technical usability and consumer acceptability of the chips (and its grits or flour) by brewing plants, bakeries and consumers for making local foods called *Atapa/Kalo/Kwon/Ugali* made by mixing cassava flour with cereal flours (millet and sorghum).

The research will build on existing and past value chain efforts both in Uganda and elsewhere - these include cassava postharvest activities under IITA-CFC, C: AVA, Kilimo Trust, NARO, private sector, etc., and successful postharvest technology of CLAYUCA outside Africa. The processing plant (1MT fresh cassava/day) comprising of a unit of the agriculture waste-heated dryer and the modular flour refining unit of CLAYUCA (dry peeler-mill) will be installed in Soroti and evaluated for technical feasibility and adaptability. In addition, the input and output market research, studies on potential out-scaling locations will focus on Iganga, Bugiri, Kampala, Soroti, Lira, Kabarole and Nakasongola districts.

At the beginning, a baseline data on current costs and processing efficiencies of cassava chips and incomes of the processors will be implemented. Analysis and characterization of improved cassava chips markets will be done using electronic-survey technique. The research team will manage the processing plant together with a local entrepreneur, preferably a woman, as a pilot and training center. Potential entrepreneurs and students will be trained at the center. The derivate product of the chips - refined flour - and the end-user products (composite flour, bread, biscuits, atapa, etc.) will be subjected to quality, safety and consumer tests with backstopping and training from NRI or CIRAD.

The influence of chipping and drying innovations on processing cost and processors' margin will be assessed.

From gender perspectives, the implications that the CLAYUCA technology can have on women's participation in cassava processing will be studied since the technology eliminates the hand peeling that is mostly done by women for income generation. While some gender experts mentioned that it has the potential to disadvantage women, other gender experts argued that hand peeling of cassava roots to make one dollar a day is an activity that could be eliminated while increasing higher outputs from the processing operation and that the time saved by the women will be used to participate in more financially rewarding activities of cassava processing and marketing especially because time-saving and higher product output are expected to lead to higher processing efficiency and labor productivity, and reduced costs. This may translate to higher incomes for the women as currently observed in mechanical gari and flour processing operations in Nigeria. This aspect will form a fundamental part of the gender analysis to be carried out.

Two MSc candidates will be registered and trained. They will conduct their research at the University of Makerere as part of the project. The project team will train processors of cassava chips on mechanical processing and will also train bread bakers, home caterers on the use of the flour for making several food items (bread, biscuits, cake, etc).

3. MAIN RESEARCH QUESTIONS (*indicating the knowledge gaps to be addressed*):

a) What are the characteristics of the different market segments for cassava chips in terms of consumer preferences (gender disaggregated), prices, demand seasonality, quality characteristics, industrial specifications and growth trends and opportunities?
b) What is the technical feasibility of adapting the CLAYUCA technology to Uganda?
c) Will dry cassava chips (and its refined flour) made without peeling of cassava roots at fresh state (by using CLAYUCA technology) be microbiologically hygienic enough for the brewing industry and chemically safe for human consumption (cyanogen levels, fibre & tannin from peel)?
d) Will the technology eliminate the negative environmental impact of the traditional peeling of fresh cassava roots in Africa?
e) Does the expected high output volume of the CLAYUCA technique create economy of scale large enough to make the process low-cost and the dry chips (and its products) competitive for use in brewing, baking, paper and for household consumption?
f) Will the local foods (*Atapa, Kalo, Kwon or Ugali)* from the chips/flour made with the technology be acceptable to the consumers?
g) Is the CLAYUCA technology socially, culturally and economically viable in Uganda? Will women and rural youth not be deprived of job opportunity they currently have for peeling of fresh cassava?
h) Does the technology offer scope for reducing the current high labor inputs into processing and how can women processors benefit from the mechanical processing of the improved cassava chips compared to the traditional chips?
i) What are the cost/benefit ratio and return on investment and what are the constraints to and opportunities for reducing inefficiencies and postharvest losses of cassava by using this processing technology?

4. OUTPUTS/DELIVERABLES (*specify the outputs/deliverables to be produced and indicate when they will be available* *within a 2 year time frame*)

Research output/deliverable	Delivered output	Expected time (year/quarter)	Next users
1. Characteristics of improved cassava chips markets in terms of demand segments, consumer preferences by gender, quality, industrial specifications and general demand trends determined.	Survey reports	Quarters 2 of Year 1	Beneficiary farmers and marketers
2. Technical feasibility and adaptability of CLAYUCA technology that eliminates peeling and uses mechanical drying as means of increasing quality, safety and output volume of cassava chips evaluated.	Research report & protocol	Quarters 4 of Year 1	Beneficiary farmers/ processors
3. Improved dried chips evaluated for quality, safety and consumer acceptability based on end-user requirements and East Africa harmonized standards.	Research reports	Quarter 2 of Year 2	Beneficiary processors/ end-users of chips and refined flour
4. Capacity of students, cassava processors and users of chips (the derived product – refined flour) enhanced in the processing technology, business planning and safety/quality management and through learning alliance and in-house training.	Reports	Quarter 3 of Year 2	Beneficiary processors/ end-users of chips and refined flour; Uganda NARS
5. Gender sensitivity, social and cultural evaluation of the technology implemented.	Reports	Quarters 4 of Year 2	Beneficiary processors/ end-users of chips and refined flour
6. Effective communication strategy that promotes and facilitates up- and out-scaling of the technology and approaches designed and implemented	Communi cation materials,	Quarter 4 of Year 2	Potential processors & investors
7. Project experience written and published/ communicated.	Research articles	Quarter 4 of Year 2	Science community

5. DEVELOPMENT GOAL (*indicate in one paragraph the overarching goal to be achieved* *after 10 years**, for example: [number] producers and [number] small-scale processors of [crop] in the [name] region have improved their food security by [number] percent and their agricultural*

income by [number] percent. Explain the gender equity and environmental aspects of your goal as well)

It is expected that the research outputs will be adopted by local entrepreneurs who will make investments in SMEs in the rural areas to use the new technology for processing of chips and refined cassava flour. When they emerge, at least 80 SMEs will provide gainful employments to over 20,000 households, especially women and youth through supply of fresh cassava, transportation, marketing of the chips/flour, and use of the flour in making pastries. Women play a leading role in cassava production, processing and marketing activities. The new processing method will reduce the high labor inputs into cassava processing by women, and increase their incomes and food security. 1500 smallholder cassava-producing households (50% women or youth) in the project areas will have achieved improvement in their food security and 20% increase in their income levels. 3000 traders (wholesalers and retailers), including at least 2000 women, will increase their incomes derived from cassava processing by 20%. It is expected that the rural development outcomes observed in Nigeria as a result of small processing enterprises (Small & medium enterprise – SME) that mushroomed over the last decade will occur in Uganda also. The project will reduce the ongoing exploitation of the forest by poor farmers for livelihoods in the wet season when processing through sun-drying is not easy and glut of cassava occurs (due to reduced processing activities, reduced price of roots), and thereby slow down deforestation. The project will contribute directly to reducing the negative environmental impact of cassava wastes and effluent and the negative environmental impact of agricultural/ industrial wastes such as sawdust, wood shaving, rice straw, and dried maize cobs.

6. EXPECTED OUTCOMES (for each research output mentioned above, *indicate the principal outcomes to be achieved* *__after 10 years__* *through scaling out and up the proposed innovations, and their likely effects on food security, gender, and the environment; outcomes are understood as change of behaviour of actors inside and outside of the value chain*)

Research output/deliverable	**Users/beneficiaries** (*e.g., producers, small-scale processors, retailers*)	**# of Users/ Beneficiaries after 10 years**	**Outcomes** (*expected use of technical and other innovations; e.g. farmers using on-farm storage technology, processors applying new procedures*)	**Food security** (*direct effects through products, or indirect effects through increased income and other effects*)	**Gender equity** (*inclusiveness and benefit sharing among women, men and youth*)	**Environmental performance** *(increase of positive or reduction of negative impacts on the environment)*
Characteristics of improved cassava chips markets determined.	- Processors - Wholesalers - Financiers	- 80 processors - 80 wholesalers - 220 retailers	- Processors, wholesalers and retailers design better plans for market access - Financiers design better products that benefit cassava producers, processors and traders.	- Increased marketed cassava with positive effect on financial stability to buy foods - Increased access of consumers to cassava foods	- Strategies to increase youth & women participation - Strategies that ensure gender equitable share of benefits	- Increased knowledge on how negative impacts can be reduced and benefits increased.
Technical feasibility and adaptability of CLAYUCA technology that eliminates peeling but uses mechanical drying as means of increasing quality, safety and output volume of cassava chips	- Small-scale processors - Consumers - Local entrepreneurs (potential investors in	- 80 processors - 50,000 consumers - 10 equipment manufacturers	- Processors using efficient processing technology -Higher volume of cassava chips produced - Safer, improved cassava chips	- Increasing availability of low cost cassava chips - Expanded consumption and utilization by consumers and	- More time available to women processors - Women using less energy to process	- Less peels that constitute major environmental hazard - Less water for processing cassava and reduced effluent generation

evaluated.	cassava processing) - Equipment manufacturers	- 20 inventors	processed - Less drudgery for women involved in cassava processing	industry - Increased incomes for traders from cassava sales - Less processing costs		- Less negative impact on aquatic life & pollution of underground drinking water around processing plants
Improved dried chips evaluated for quality, safety and consumer acceptability based on end-user requirements and East Africa harmonized standards.	- Small-scale processors - Traders - Consumers (urban and rural)	- 80 processors - 300 traders - 100,000 consumers - 20,000 traders	- Processors sell better quality and safe cassava products - Traders sell high quality and safe cassava products - Industries gain confidence to use cassava as ingredient/input - Consumers eat high quality & safe products.	- Availability of high quality cassava products - Increased demand for cassava chips (and its derivative products) - Increased incomes for value chain actors	- Improved access to cassava products - Increased regional trade - Increased incomes and better purchasing power for men and women	- Less pressure on environment as women and men have better alternative sources of incomes than felling trees
Capacity of both processors and users of chips (the derived products-grits and flour) enhanced in the processing technology, business planning and safety/quality management and	- Processors of improved chips - End-users of improved chips	- 80 processors of chips - 2 brewing plants - 5 bakeries - 10 composite	- Increased competitiveness of cassava chips value chains - Processors sell quality product - More consumers & end-users linked to	- Availability of high quality cassava products - Increased incomes - Increased sales	- Improved safe food for children, men and women	- Less pressure on environment as women and men have better skills to process cassava without generating heaps of peels or fell trees

through learning alliance and in-house training.		flour millers	processors - More traders sell quality cassava products - Consumers eat safe foods			
Gender sensitivity, social and cultural evaluation of the technology implemented.	- Small-scale producers - Small-scale processors - Traders	- 80 processors (40 men & 40 women) - 80 wholesalers (50% women) - 220 retailers (150 women)	- Cassava products fit in all social settings - More farmers use improved varieties and quality inputs including fertilizers - More producers use better management practices - Better marketing techniques used	- Increased incomes to producers and other actors increase food access	- More benefits to women - More equitable income distribution between men and women	- More land conservation - More output per unit area - Less environmental degradation due to improved value chain
Effective communication strategy that promotes and facilitates up- and out-scaling of the technology and approaches designed and implemented	- Producers - Processors - Wholesalers - Retailers	- 15,000 small producers - 80 processors - 10 fabricators	- More farmers use improved varieties - More processors use better processing method - More equipment available	- More availability of cassava - Increased incomes to all more women in the value chain	- More benefits to women - More equitable income distribution between men and women	- More output per unit area - Less environmental degradation due to better methods of agriculture

7. <u>FEASIBILITY:</u>

a) Technical feasibility (*provide evidence that the proposed innovation is likely to be effective at an experimental level; e.g. that it has worked elsewhere*)

It is technically possible to process cassava chips by peeling, washing, chipping or cutting into smaller particles and drying (Abass, 2006). Traditional processing has relied on manual cutting and sun-drying, which does not usually produce a quality product. Chips need to be dried quickly to retain quality and energy content. Research has improved this process and motorized chipping technology is already in use, although its operation has not been effective, with output being low. Information from fabricators indicates that, if used efficiently, motorized chipping can process about 0.8ton/hour, but it needs to be combined with rapid drying, reduced exposure to contamination, discoloration and spoilage. The CLAYUCA technique has been demonstrated at a research station in Colombia while the gasification technique (based on agriculture waste) has been practiced commercially in cashew nut roasting, tobacco drying, and is currently being improved for cassava drying by IITA. The combination of these technologies (chipping, bio-drying, dry peel-mill) is technically possible and can be easily tested in Uganda.

Based on the results achieved in Colombia on the use of this technology, it is expected that the flour will be suitable for use by Uganda end-users (caterers, bakers, breweries, etc). The project team will link the local end-users and supermarkets to the processing plant for delivery of the cassava chips and its derivative product - flour. The successful use of the flour for making various food products by the end-users (who will be trained or have been trained during past projects) constitutes the strategic market linkage approach that **AfrII** (in partnership with IITA and NRI) had used successfully in the past in Uganda. SOSPPA, P'KWI and PATA processing groups were trained by IITA (in collaboration with NRI and AfrII) for using raised platforms for drying. There are many companies producing composite flour for porridge and cassava flour for instant food preparation (Maganjo Grain Millers, Family Diet Ltd, NUMA feeds, East African Basics Foods and MACO Ltd). In the bakery industry, cassava is used to produce non-bread products including cakes, mandazi, chapattis, doughnuts, pancakes, and baghias (Abass et al, 2014).

b) Economic feasibility (*provide a rough estimate of costs-benefits; a more precise analysis of costs-benefits will be carried out during scoping*)

The test will be conducted in major cassava producing locations with good market access and potential end-takers of the technology. The cost of cassava fresh roots is a major determinant of economic viability. Uganda has some high dry matter varieties that have a cassava root/chips ratio of 3.8:1. Available data (Table 1; Annex 1) indicates that with traders paying US$143.6/ton of fresh roots, it is also possible to make profits from cassava chips processing using mechanical drying technique. At the current price of US$471.5/ton of improved quality chips, mechanical processing is profitable. Our estimates indicate a net margin of US$78.9/ton of mechanically dried chips, which suggests a real potential for viable SME enterprises to be established in Uganda.

c) Social feasibility (*indicate if socio-cultural norms or practices facilitate or hamper adoption of technical and other innovations, considering gender and intergenerational differences*)

Cassava processing is mainly an activity undertaken by women who also play a big role in its production and marketing. Given the labor shortage, the time-wasting and high labour inputs associated with manual processing (peeling and drying), women spend a lot of time processing cassava and, hence, are unable to attend to other important tasks in the homesteads. The proposed technology innovation is expected to be inexpensive and shorten the time and physical energy required for processing of cassava. The innovation is easy to adapt as women are already operating chippers and milling machines in the rural areas. Many cassava-based processing groups are women-led and managed and there is growing interest from the youth to take an active role in agriculture. This research option will greatly facilitate and strengthen youth participation in cassava processing and marketing, and will increase agro-processing's contribution to rural development in Uganda.

8. DEMAND FOR THE INNOVATION (*provide evidence that there is immediate demand for the proposed technical innovations by targeted users/beneficiaries*)

Currently, a number of processors cannot satisfy the demand for good quality chips from bakers, the breweries and composite flour millers. This is due to difficulty in drying, especially during the wet season. The quality of the chips supplied to the main market in Kampala usually deteriorates further in storage or on the shelf during the wet season. Also, the volume of supplies reduces, leading to increased prices and frustration by industrial end users and expenditure on food at the level of consumers. Many processors and end-users had requested for information and technical expertise. From 2009, the AfriII, NRI and IITA had collaborated to train these actors (Appendix; Table 2. The technologies introduced to these actors needed to be upgraded to enable the actors supply and obtain improved cassava flour (from chips) at the required quality, safety, regularity of supply and at competitive price. For example, improved cassava chips are often used in composite flour blending (e.g. 60% cassava flour with 40% millet) for traditional meals – atapa, etc. As a result several industries are producing composite flour for porridge and cassava flour for instant food preparation. These include Maganjo Grain Millers, Family Diet Ltd, NUMA feeds, East African Basics Foods, MACO Ltd and EDRAC Ltd. All these flour millers are requesting for a technology that will ensure consistent supply of flour.

Rural bakeries consume approximately two thirds (200,000 MT) of wheat flour in Uganda. Rural bakeries offer a realistic potential demand for 14,000 MT per annum of HQCF. Wheat flour costs on average US$1000/ton from the handful of large millers in Uganda. In contrast HQCF is currently offered between US$ 550-650/ton and represents a potential 25% reduction in raw material cost with HQCF replacing wheat flour in bakeries. Improved cassava flour is now commercially used at 30-50% in mandazis and doughnuts. But, supply is insufficient, mostly because of the inefficient processing methods and lack of commercial orientation of the predominantly food-security minded farmers to whom the cassava chips processing methods, with the inefficient manual peeling and sun-drying, we introduced to.

Biscuit manufacturers: About 12,000 tons of wheat flour is used by the Ugandan biscuit industry. Improved cassava flour can replace 35% of wheat flour in biscuit production, which translate to a demand of 4,200 tons of improved cassava flour per annum. According to industry sources imported biscuits have become a serious threat to local manufacturers. Hence cost reduction is now a priority. The harmonized standards for improved cassava flour that was approved for East Africa makes it legally allowed to use cassava flour for biscuit baking but the industry explained that a major constraint is the insufficient supply of the right quality at the correct time. A cost analysis done for one of the four biscuit factories in Uganda suggests that biscuit makers are willing to pay US$570/ton of flour. With a monthly requirement of 200MT of biscuit flour, the biscuit factory projects that up to USD130, 560 per annum can be saved through substitution of wheat flour (US$710/ton) with cassava flour. The total annual demand for cassava flour would be of the order of 480t if a 20% inclusion rate were to be assumed. Making chips with the proposed technology innovation for milling into flour could be a viable opportunity to meet the demand of the biscuit industry for locally sourced raw materials like cassava flour.

HQCF use in paperboard sector:

HQCF could replace imported corn starch to produce starch based adhesives (SBAs) for the paperboard box manufacturers. There are six paperboard manufacturers importing about 1,440MT per annum. The main suppliers - Corn Products Kenya Limited, has stopped operation, creating a raw material crisis for the Uganda paperboard sector. Corn starch is imported at about US$ 620/ ton. Two paperboard companies in Uganda are currently demanding for improved cassava flour.

Dried chips for beer production

Some brewing companies have done trials and expressed interest in using dry cassava as an adjunct for beer brewing. Cassava was found to have higher extraction rate than corn, the main challenge is the level of microbial contamination in traditional cassava chips. The anticipated demand for dried cassava is of the order of 4,000MT per annum at a price of US$420/ton.

References

1. Abass, A.B. 2006. How to make High Quality Cassava Flour (HQCF). International Institute of Tropical Agriculture, Ibadan, Nigeria.
2. Abass, A. B., A. Onabolu and M. Bokanga. 2001. Impact of the High Quality Cassava Flour Technology in Nigeria. In Root Crops in the 21st Century. Proceedings of the 7th International Conference of the International Society for Root and Tuber Crops - African Branch (ISTRC- AB*)* pp. 735-741
3. Abass A., N. Mlingi, R. Ranaivoson, M. Zulu, I. Mukuka, S. Abele, B. Bachwenkizi and N. Cromme. (2013) Potential for commercial production and marketing of cassava: Experiences from the small scale cassava processing project in Eastern and Southern Africa. International Institute of Tropical Agriculture (IITA): Ibadan, Nigeria.
4. Alacho, F.O., Otim-Nape, G.W., Okello, G.A., Okwadi, J., Masembe, T. and Osiru, D. 2013. Promoting rural sustainable development and transformation in Africa: Uganda Cassava Study, First Draft, Africa Innovations Institute (AfrII), Kampala Uganda
5. Graffham, A., Kleih, U., Jagwe, J., Nabawanuka, J., Wanda, K., Kalunda, P., Ntibarikure, G., and Ferris, S. 2003. A market opportunities survey for value-added utilization of cassava-based products in Uganda. Part I: Demand analysis for industrial utilization, NRI/IITA Foodnet.
6. Kleih, U., Phillips, D., Jagwe, J and Kirya, M. 2012. Cassava market and value chain analysis. Uganda Case Study. C:AVA Final Report. Natural Resources Institute, UK and Africa Innovations Institute, Uganda.
7. Collison, C., Wanda, K. and Muganga, A. 2003. Cassava marketing in Uganda: Constraints and opportunities for growth and development. Joint report for Natural Resources Institute, FOODNET-IITA, and Kawanda Agricultural Research Institute.

Annexes

Annex 1

Table 1: Cost-analysis for improved cassava chips

Item/Activity	Cost (US$/ton) of improved chips
Cassava (dry equivalent)	140.01
Transport to processing site	26.41
Peeling	17.50
Water	4.30
Washing	4.58
Fuel for chipping	4.24
Labor for chipping	18.35
Mechanical drying (to CHIPS)	19.16
Dry peeling-milling (to flour for food or grits for brewing)	19.16
Bagging/packaging material	25.00
Packaging (labour)	26.20
Weighing, sewing, stacking	19.65
Marketing costs	23.34
Sub-total	*347.90*
Overhead (15%)	52.19
Total costs	400.09
Selling price (current price of improved chips)	479.00
Margin	78.91

Table 2: Demand for innovation

<table>
<tr><th>Actors</th><th>Actors’ knowledge demand and achieved with support of IITA/NRI/AfrII; year</th><th>Current demand for innovation</th></tr>
<tr><td>70 representatives (Total membership number = 2585) of Farmers' Associations, NGOs, and processors</td><td>Commercial Production and Utilization of HQCF in Uganda, 2009</td><td rowspan="2">Low cost and mechanical drying of cassava</td></tr>
<tr><td>PATA, SOSPA, Vision TERUDO and P’KWI</td><td>Processing and value chain service provision, 2009</td></tr>
<tr><td>14 Bakery firms in Soroti</td><td rowspan="2">Utilization of hqcf in the bakery items, 2009</td><td rowspan="4">HQCF as either total or partial replacement of wheat flour in baked items</td></tr>
<tr><td>7 Bakery firms in Kumi</td></tr>
<tr><td>7 Bakery firms in Mbale</td><td rowspan="2">Utilization of hqcf in the bakery items, 2010</td></tr>
<tr><td>8 Bakery firms in Jinja</td></tr>
</table>

Source: IITA reports of training conducted in Uganda as part of C:AVA activities