

# **END OF PROJECT REPORT**

**Project Title:** INCREASING SORGHUM UTILIZATION AND MARKETABILITY THROUGH  
FOOD PRODUCT DIVERSIFICATION

Period covered: **June 2009 - August 2011**

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**SUB-GRANTEE AGREEMENT NUMBER: PECR 04/ IRC-2**

**SEPTEMBER 2011**

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## 1. INTRODUCTION

Sorghum, *Sorghum bicolor*(L) Moench, is the fifth most important cereal globally after rice, wheat, maize and barley. It constitutes the main food grain for over 750 million people who live in the semi- arid tropics of Africa, Asia, and Latin America (Food Security Department, 2004). In terms of tonnage, sorghum is Africa's second most important cereal. The continent produces about 20 million tonnes of sorghum per annum, about one-third of the world crop (Taylor, 2003). Sorghum production in Kenya has been relatively stagnant over the years (see Fig. 1 below).

Figure 1: Sorghum production in Tanzania, Kenya and Uganda, 1980 - 2010

The largest group of producers in Africa are small-scale subsistence farmers (Food Security Department, 2004; Rohrbach, 2003). Being poor in resources, most of sorghum farmers have only minimum access to production inputs and improved credit facilities for their purchase (Food Security Department, 2004). While total food consumption of all cereals has risen considerably during the past 35 years, world food consumption of sorghum has remained stagnant, mainly because, although nutritionally sorghum compares well with other grains, it is regarded in many countries as an inferior grain (FAO, 1995). Available data from Africa indicate that despite an increase in total food use between the early 1960s and the mid-1980s, the average per-capita consumption declined from 20 to 15 kg per year (FAO, 1988). This decline per capita consumption in many countries was due to shifts in consumer habits brought about by a number of factors: the rapid rate of urbanization, the time and energy required to prepare food based on sorghum, inadequate domestic structure, poor marketing facilities and processing techniques, unstable supplies and relative unavailability of sorghum products, including flour, compared with other foodstuffs (FAO, 1995). The decline in per- capita consumption of sorghum in the sorghum growing countries including the East and Central African (ECA) countries, has contributed to poor income and food insecurity for the population living in the semi-arid areas of the ECA sub-region where by sorghum is the vital crop for economy and food security.

Despite of their relative importance in African food systems, very little sorghum or pearl millet is commercially processed. Rough estimates suggest less than 3% of Sub-Saharan Africa's sorghum production is used in the formal food and feed industries. Most of the processed sorghum is used in the production of lager and opaque beers (Rohrbach, 2003; Food Security Department, 2004). The relative importance of these crops in the rural food systems suggests substantial opportunities should exist for their commercialisation. In the first instance, commercial grain milling can provide urban migrants from sorghum or pearl millet production zones with familiar food product. As incomes rise and food preferences

evolve, a growing share of cereal grains will be consumed in processed form (Rohrbach, 2003). According to Shayo, Laswai and Kundi (1998), no sorghum food products was found in the selected retail outlets in Dodoma urban, which is the leading region in Tanzania in the production and consumption of white sorghum. Consumer acceptance study of dehulled sorghum products conducted in Dodoma region revealed that high demand for high quality processed sorghum products existed in Dodoma urban (Kundi, 1998). In the African rural communities where sorghum is grown, the main food products prepared include thin and thick porridges, fermented and unfermented breads, lactic and alcoholic beers and beverages, malted flours for brewing, malted porridge mixes and weaning foods (Food Security Department, 2004). In general the level of commercial utilization of sorghum and pearl millet appears to depend more on the size of the commercial food and feed economy than the level of crop production (Rohrbach, 2003). Nigeria, Sudan, Ethiopia, Burkina Faso and Tanzania are the largest producers of sorghum in Sub-Saharan Africa, accounting for about 75% of the region's production. However South Africa is the largest commercial processor of this grain and also the country with the largest agro-industrial economies on the continent (Rohrbach, 2003). A partial summary of available estimates for sorghum commercially processed in Africa is shown in Table 1.

**Table 1: Examples of commercial utilization of sorghum in Sub-Saharan Africa**

Country	Processed sorghum	Average annual Production
South Africa (2001/2002)	113,000 t malt 66,000 t meal 11,300 t grits and rice 16,200 t animal feed	250,000 t
Nigeria (1992 estimates)	120,000 t brewing (mostly adjunct) 25,000 t animal	7,500,000 t
Botswana (1999 estimates)	60,000 t meal 4,000 t malt	11,000 t*
Zimbabwe (2000 estimates)	17,500 t brewing (mostly malt) 1,800 t animal feed 150 t meal	100,000 t
Tanzania (2002 estimates)	750 t brewing (mostly adjunct) 125 t meal 400 t school feeding program** 5 t animal feed.	750,000 t

\*Botswana imports virtually all of the sorghum grain being commercially processed.

\*\*This is not a common practice

Sources: SAGIS (2003), Rohrbach et al. (1993), Rohrbach (2000), Rohrbach et al. (2000), Rohrbach et al. (2001) and ICRISAT data files.

This is clear evidence that limited utilization is the major reason for low market of the crop in most of the sorghum growing African countries including Tanzania, Kenya and Uganda. The only way of increasing utilization and hence marketing is by diversifying the sorghum products through value-adding processing.

## **2. GENERAL OBJECTIVE**

Product diversification from value addition technologies promoted for increased utilization and marketing of sorghum in ECA.

## **3. Specific Objectives**

- To conduct baseline survey in the major sorghum growing areas to investigate consumer and market preferences for sorghum.
- To conduct grain quality evaluation for sorghum varieties from improved, farmers' varieties and land races.
- To increase sorghum seed from good quality sorghum varieties for food product processing and for regional adaptability evaluation trials.
- To develop and evaluate product recipes and processing technologies for new marketable products.
- To develop, evaluate and disseminate knowledge sharing and communication products (KSCPs) as a strategy for up-scaling

## **4. GOAL**

Enhanced sustainable productivity, value addition technologies and competitiveness of sorghum crop in ECA

## **5. PURPOSE**

Enhanced value addition technologies and innovations for sustainable productivity, increased utilization and marketing of sorghum in ECA

## **6. JUSTIFICATION**

About one third of the population in Tanzania, Kenya and Uganda depend entirely on sorghum for their livelihoods, this is about 32 million people altogether. Annually, Kenya produce about 133 thousand tonnes of sorghum (Taylor, 2003). Utilization of the crop in Kenya has remained concentrated in the semi-arid of rural areas and has mainly been used for porridges. Shortage of proper processing equipments has led to the tiresome work of food preparation and often times resulting into unpalatable food. Increasing utilization of sorghum and marketing through development of added-value sorghum food products will improve the livelihoods of the people growing sorghum in the semi-arid areas of East Africa and the whole area of ECA sub-region.

This project is going to investigate and identify suitable sorghum varieties for producing a wide variety of acceptable commercial and specific food products for end-uses, put the suitable identified sorghum varieties under regional adaptation trials for selecting the regional adapted varieties, investigate on appropriate methods for producing high quality sorghum grain for processing and try to identify the available conventional and emerging markets for added-value or diversified sorghum products in Tanzania, Kenya and Uganda.

As a consequence of this project’s intervention, incomes of rural households comprising of youth groups, women groups and smallholder farmers growing sorghum in the semi-arid areas of ECA sub-region were expected to increase as the market for sorghum improved as a result to increased utilization of sorghum grain due to increased processing and preparation of various sorghum food products.

## 7. PROJECT OUTPUTS/RESULTS

### 7.1 OUTPUT 1:

Preferred sorghum grain attributes, food types, level of commercial and markets outlets at both rural and urban levels were identified and documented. Attributes hereby means the physical-chemical characteristics that affect sorghum quality, processing and utilization. Four sorghum varieties (KARI MTAMA 1, GADAM, LDSY-M1 and LDSY-2) were received from KARI, a collaborating institution in this project. There were subjected to the following tests as a result of which Gadam variety was selected for use in the development of value-added sorghum products.

- Color
- Testa
- Endosperm texture
- 100 kernel weight
- % floaters
- % water absorption
- Proximate analysis

The table below (Table 1) shows Food types, level of commercial utilization and CURRENT sorghum markets outlets.

**Table 1: Food types, level of commercial utilization and CURRENT sorghum markets outlets**

<b>Food types/Grain Attributes</b>	<b>Level of commercial utilization in Kenya</b>	<b>Markets outlets</b>
Preferred grain attributes Red and white Colored grains Floury/ soft endosperm texture Good dehulling properties High kernel weight	-	-
General purpose Porridge flours (whole family ) –straight or composite flours	Large, medium, and small-scale	Supermarkets, local shops & kiosks
Weaning foods (Basically composite flours)	Large, medium, and small-scale	Supermarkets, local shops, kiosks & health shops
Food for invalids, aged & the recuperating (Basically composite flours)	Large, medium, and small-scale	Supermarkets, local shops , kiosks & health shops
Alcoholic beverages (mainly Busaa)	small-scale	Local brewing “dens”
Non-alcoholic beverages (Ukie – fresh porridge popular with the Meru community)		

## 7.2 OUTPUT 2:

Good quality food sorghum varieties both from improved and farmers' varieties and land races identified.

KARI MTAMA 1, KARI MTAMA 2, IS21055, Gadam, LDSY-M1 and LDSY-2 were the varieties that were identified. In particular, the following quality attributes were in favour of Gadam sorghum:

- Early maturity with ability to grow under low rainfall conditions
- Easy to harvest due short plant height
- High yields
- Low tannins content
- Good malting qualities

In addition, national private sector-led promotional activities spearheaded by EABL (assuring ready market) and Equity Bank (availing credit to sorghum farmers) made Gadam a good candidate for diversified product development since raw material availability was not a problem.

## 7.3 OUTPUT 3:

Sorghum varieties with good quality traits multiplied for food product processing, regional evaluation for adaptability and dissemination. From the sorghum varieties identified, KARI MTAMA 1, Gadam, LDSY-M1 and LDSY-M2 were identified as having good quality traits and were thus multiplied for food product processing, regional evaluation for adaptability and dissemination. These were further sent to KIRDI for sorghum product development.

## 7.4 OUTPUT 4:

Products and processing technologies and recipes of newly acquired marketable sorghum products developed and evaluated.

### 7.4.1 Sorghum products developed

Based on the results of the preferred sorghum grain attributes, food types commercially available in Kenyan markets both at rural and urban levels eight sorghum products were developed. These products were:

1. Brown sorghum flour (100%),
2. Soured sorghum composite (*uji*) flour,
3. Unsoured sorghum composite(*uji*) flour,
4. *Supa mtama* (polished white sorghum),
5. Composite brown stiff porridge (*ugali*) flour,
6. Cereal vegetable soup (CeVeg®)
7. Composite sorghum Chapatti and
8. Composite sorghum bread



Figure 2: Pictures of products developed

Formulations and recipes were developed for above sorghum products. These products were subjected to quality assurance tests. Samples of the products were taken to the Kenya Bureau of Standards for laboratory analyses to ensure that they complied with the laid down standard specifications (see laboratory report in Table 1). All the products passed the test and hence were awarded the standardization Mark of Quality thereby allowing them to be sold in the existing market outlets in Kenya. They were also subjected to consumer acceptability test and were found to be highly acceptable. However, to ensure maximum project impact, the products developed in this project require promotion and marketing to attain maximum and wide spread market penetration. This requires further funding

**Table 1. Kenya Bureau of Standards Laboratory Test Report (summary)**

Date	Kenya Bureau of Standards Specification	Report Reference Number	Description of Sample	Parameters	Test Method No.	Limit of Detection (LOD)	Results	Requirements
06/06/2011	KS 1808 Kenya Standard Specification for composite flours	KEBS/TES/22 82/F/11	Composite flours - composite sorghum <i>uji</i> flours	Acid insoluble ash content %m/m	KS 05-171	n/a	0.1	0.4 Max
				Moisture content %m/m	TES/06/TM/08	n/a	12.3	13Max
06/06/2011	KS 1808 Kenya Standard Specification for composite flours	KEBS/TES/22 83/F/11	Composite flours - Brown <i>ugali</i> flour	Acid insoluble ash content %m/m	KS 05-171	n/a	0.1	0.4 Max
				Moisture content %m/m	TES/06/TM/08	n/a	12.5	13Max
06/06/2011	KS 1088-1 Kenya Standard Specification for soups and broths	KEBS/TES/36 84/M/11	Soup mix - Cereal Vegetable soup	E - Coli /g	TES/MIC/TM/17	≥10	Not detected	Shall be absent
				Salmonella /30g	TES/MIC/TM/08	≥1	Not detected	Shall be absent
				Staphylococcus aureus cfu/g	TES/MIC/TM/09	≥10	< 10	Not specified (not mentioned in the standard as a requirement)
<p><b>*NB: ALL THE PRODUCTS TESTED WERE FOUND TO COMPLY WITH THE EXISTING KEBs STANDARDS SPECIFICATIONS AND WERE HENCE AWARDED THE STANDARDIZATION MARK (S-MARK) OF QUALITY - A SIGN THAT THEY CAN BE SOLD IN THE CURRENT MARKET OUTLETS</b></p>								

### 7.4.2 Some of the technologies identified/developed and validated for sorghum processing

The following technologies (Figure 2.) were used during the development and production of value-added sorghum products:



- Grain cleaning (vibro-separator) 
- Mixing (blade mixer) 
- Extrusion cooking (modified oil-seed press) 
- Milling (Hammer mill or pin mill) 

Figure 3: Sorghum value addition technologies



## **7.5 OUTPUT 5:**

Knowledge sharing and communication products (KSCPs) hereby refer to the various methods that will be used by the project to communicate to its stakeholders in order to disseminate its project results. These were to include (but not limited to) the following communication products types: electronic/print media, manuals, books, brochure, newsletters, websites, etc. However, due to limitation of funds and time, following knowledge sharing and communication products (KSCPs) for up-scaling were developed, evaluated and disseminated:

1. Journal papers
2. Posters for 8 products
3. Leaflets for 8 products
4. Recipe books – KIRDI contributed to this by supplying information of 8 products
5. One banner
6. Documentary - a DVD with a running time of 30 minutes was prepared – capturing some of the events from the farmers fields, value-addition/ processing to the consumer/market.

\*NB: Plans are underway to host the results/outputs of this project on KIRDI's website.

### **7.5.1 PRODUCT PROMOTION**

1,000 colored leaflets, 1,000 colored posters, 50 branded head caps, 50 branded T-Shirts and 100 branded banner pens were made and distributed to various stakeholders and market outlets within Nairobi city and its environs as well as in the sorghum growing areas of Machakos and Makueni districts in Kenya. These knowledge sharing and communication products (KSCPs) will be used to facilitate increased levels of adoption of sorghum processing technologies as well as to enhance the utilization of value added sorghum products by large community of the ECA. During the distribution of these KSCPs, practical demonstration of how these product are cooked and served were undertaken with the assistance of home economics officers from the ministry of agriculture (see photo gallery – Annex 5). Samples of the same products were also given to the stakeholders as well as the home economics officers from the Ministry of Agriculture, here in Kenya, for demonstrations further afield.

### **7.5.2 RAPID MARKET APPRAISAL**

Before the development of the final KSCPs and strategies for product promotion, a rapid market appraisal to identify competing non-sorghum products and sorghum and sorghum based products in the market was done (see Annex 6)

## **8.0 CONCLUSIONS AND RECOMMENDATIONS**

The on-going East Africa's most severe drought in 60 years has left 10 million people desperately short of food (<http://www.guardian.co.uk/global-development/2011/jul/12/east-africa-drought-food-crisis?INTCMP=ILCNETTXT3487>). This severe food insecurity could rapidly deteriorate and hence the situation demands immediate, constant attention and a long-term solution. To achieve this, there is urgent need for local, regional and international commitment to address the issues of climate change and other concerns which have brought about this "toxic mix" of drought, failed harvests and rising food prices leading to severe food shortages and deaths of people and livestock amongst the peoples of the Horn of Africa.



Figure 10: Map showing the Horn of Africa (Photograph: Guardian)

From the rapid market appraisal and the range and quality of products developed in this project, it is clear that innovative value-addition to sorghum can produce sorghum products which are acceptable and which can be competitive in today’s market place. In addition, sorghum is a crop that can be used as a source of income and for food security due to its resistance to frequent droughts that affects not only Kenya, but also other countries in Africa. This would go a long way in mitigating against the impacts of drought currently ravaging the Horn of Africa mentioned above. Nutritionally, sorghum compares well with other grains. However, records show declining trends in both production and utilization of the crop, mainly because it is regarded in many countries as an inferior grain (“poor man’s crop”). Thus, there is need to promote its production and utilization through marketing and awareness campaigns. It is truly a wonder crop that can feed the hungry and rid Africa of the pangs of perpetual hunger and cycle of poverty forever!

#### **9.0 LINKAGE OF PROJECT OUTPUTS TO ASARECA RESULTS/OUTPUTS**

The results of this project led to the generation of demand driven value-addition agricultural technologies and innovations and availability of information (KSCPs) to enhance scaling up and out. The project results therefore linked very well with the following ASARECA results/ outputs:

1. Generation and uptake of demand driven agricultural technologies and innovations facilitated
2. Availability of information on agricultural innovation enhanced

#### **10.0 PROJECT MANAGEMENT AND RESOURCES UTILIZED**

- i) **Directorate of Research & Development,  
Ministry of Agricultural Food Security & Cooperatives,  
P.O Box 2066,  
Dar-es-salaam, Tanzania**

**Amount allocated**

US \$ 72,412.00 (United States Dollars Seventy Two Thousand Four Hundred Twelve only) for Department of Research & Development, Ministry of Agriculture Food Security and Cooperatives)

- ii) **Kenya Industrial Research & Development Institute,  
P.O Box 30650 – 00100,  
Nairobi, Kenya.**

**Amount allocated**

US \$ 25, 858.14 (United States Dollars Twenty Five Thousand Eight Hundred Fifty Eight and Fourteen Cents only) for Kenya Industrial Research & Development Institute (KIRDI).

iii) **National Semi-Arid Resources Research Institute (NaSARRI)**

P.O Box Soroti,  
Serere – Soroti, Uganda

**Amount allocated**

US \$ 31,215.00 (United States Dollars Thirty One Thousand Two Hundred Fifteen only) for National Semi-Arid Resources Research Institute (NaSARRI)

**Table 4; Actual Expenditure vs. Total Budget Allocation according to Sub-Grant Agreement**

	Name of Lead Institution + Amount Allocated (USD)	KIRDI {+ USD}	Name of Partner Institute 2 {+ USD}	Name of Partner Institute 3 {+ USD}	Name of Partner Institute 4 {+ USD}	Total Project {USD}
<b>Allocated Budget</b>		25, 858.14				
<b>Actual Expenditure</b>		25, 858.14				
<b>Balance</b>		Nil				

**11.0 KEY ACHIEVEMENTS AND CONTRIBUTIONS TO RESEARCH & DEVELOPMENT**

The project engaged the private sector (Public Private Partnerships) and developed a range of value added products and innovative sorghum processing technologies. Specifically, the following eight new sorghum products were developed:

1. Brown sorghum flour (100%),
2. Soured sorghum composite (*uji*) flour,
3. Unsoured sorghum composite(*uji*) flour,
4. *Supa mtama* (polished white sorghum),
5. Composite brown stiff porridge (*ugali*) flour,
6. Cereal vegetable soup (CeVeg®)
7. Composite sorghum Chapatti and
8. Composite sorghum bread

In addition, the following eight sorghum processing technologies were developed and/or tested and validated:

1. Low-cost extruder\*,
2. blade mixer\*,
3. pin mill,
4. bread dough mixer,
5. proofer,
6. electric oven,
7. dough kneader,
8. polysealer

\*NB: These two equipments were true innovations developed under this project and which will require intellectual property (IP) protection.

In addition, the following documents were written:

- a. Research Reports
  1. Quarterly report
  2. Bi-annual report
  3. Annual report

4. Final report
  - b. Journal Articles
    1. Low Cost Extrusion Technologies For Enhancing Sorghum Value Addition
    2. Sensory Evaluation of Selected Sorghum Based Products in Kenya
    3. Status of Sorghum Production, Processing, Utilization and Marketing in Uganda, Kenya & Tanzania

Another key achievement was that we were able to conduct a Rapid Market Appraisal

The final achievement was that a number of KSCPs were developed and distributed to stakeholders.

## 12.0 Lessons learnt

- Processors are willing and enthusiastic to adopt value addition technologies. They however need to be involved from the beginning for ownership.
- Involving all stakeholders is very important for successful technology transfer
- One year project period was not adequate for complete up-scaling of the technologies as well as market penetration
- Inter-country study tours/visits by project implementing scientists is very useful. This was evident when a team of scientist from this project visited the Food Research Center in Khartoum, Sudan and witnessed commercial sorghum processing IN ACTION through Public-Private-Partnership (PPP). This successful model should be emulated by the other ECA member countries.
- Product promotion /marketing is a very expensive exercise and needs substantial funding if a product is ever to see the light of success in a competitive market place.

## 13.0 Challenges

- Project stoppage for 2 years (June 2006 – June 2009) had very negative effects on stakeholders' confidence.
- Late disbursement of funds
- Budgetary constraints for up-scaling technologies
- Inadequate funds for effective product promotion and marketing
- Inability of current technologies to handle big volumes for commercial processing
- Institutional delays in funds release

## 14.0 WAY FORWARD AND SUSTAINABILITY PLAN

There is urgent need for further funding of this project to ensure up-scaling of the value added products and technologies so far developed. A case that needs to be supported in terms of postharvest handling, value-addition, technology transfer and marketing is that of Turkana district (see annex 6). There is also need to engage both the mass (electronic and print) media and the policy makers in order to overcome the current hiccups that have prevented sorghum from taking its rightful place in the socio-economical development of Africa and the ECA region in particular.

## ANNEXES

### Annex 1: List of all publications/knowledge products produced

Please list the titles of scientific publications and conference presentations arising from the project under the following types:

Category	Year	Author(s) & Organization	Title of Publications or Knowledge Product
a) Research Reports		Wambugu, et al. - KIRDI	Quarterly report
		Wambugu, et al. - KIRDI	Bi-annual report
		Wambugu, et al. - KIRDI	Annual report

			Final report
b) Journal Articles		Wanyeki, et al - Allgrain/ KIRDI, ASARECA	Low Cost Extrusion Technologies For Enhancing Sorghum Value Addition
		Wambugu, et al. - KIRDI, ASARECA	Sensory Evaluation of Selected Sorghum Based Products in Kenya
		Mugure, et al. - KIRDI, NaSSARI, SOSSPA, IARI, ASARECA	Status of Sorghum Production, Processing, Utilization and Marketing in Uganda, Kenya & Tanzania
c) Occasional Papers		-	
d) Books and Book Chapters		-	
e) Conference Papers		-	
f) Others (please specify)			Information Hand book on sorghum value addition (Products & Technologies)

### Annex 2: Trainings:

No training was undertaken. However, sensitization sessions were conducted on new product development, machine operation and maintenance as well as sensory evaluation.

### Annex 3: General Project Information.

Summary of the Key Performance Indicators.

	Indicator	Unit of measure	Target (for Life of Project)	Achieved (for Life of Project)	Comments
<b>OUTPUT</b>					
<b>1</b>	Information on preferred sorghum grain attributes, food types, level of commercial utilization and markets documented.	Number	<p>5 Grain attributes</p> <ol style="list-style-type: none"> <li>1. Red Colored grains</li> <li>2. white Colored grains</li> <li>3. Floury/ soft endosperm texture</li> <li>4. Good dehulling properties/corneous grains</li> <li>5. High kernel weight grains</li> </ol> <p>5 Food types</p> <ol style="list-style-type: none"> <li>1. composite flours</li> <li>2. Weaning foods</li> <li>3. Non-alcoholic beverages</li> <li>4. Alcoholic beverages</li> <li>5. General purpose Porridge flours</li> </ol> <p>3 Levels of commercial utilization</p> <ol style="list-style-type: none"> <li>1. Large,</li> <li>2. medium,</li> <li>3. small-scale</li> </ol> <p>5 Market outlets</p> <ol style="list-style-type: none"> <li>1. Supermarkets,</li> <li>2. local shops/ convenience stores,</li> <li>3. kiosks</li> <li>4. health shops</li> <li>5. Local brewing "dens"</li> </ol>	<p>5 Grain attributes</p> <ol style="list-style-type: none"> <li>6. Red Colored grains</li> <li>7. white Colored grains</li> <li>8. Floury/ soft endosperm texture</li> <li>9. Good dehulling properties/corneous grains</li> <li>10. High kernel weight grains</li> </ol> <p>5 Food types</p> <ol style="list-style-type: none"> <li>6. composite flours</li> <li>7. Weaning foods</li> <li>8. Non-alcoholic beverages</li> <li>9. Alcoholic beverages</li> <li>10. General purpose Porridge flours</li> </ol> <p>3 Levels of commercial utilization</p> <ol style="list-style-type: none"> <li>4. Large,</li> <li>5. medium,</li> <li>6. small-scale</li> </ol> <p>5 Market outlets</p> <ol style="list-style-type: none"> <li>6. Supermarkets,</li> <li>7. local shops/ convenience stores,</li> <li>8. kiosks</li> <li>9. health shops</li> <li>Local brewing "dens"</li> </ol>	-

<b>2</b>	Number of sorghum varieties selected for acceptable grain and flour qualities in project areas	<b>Number</b>	<b>6 VARIETIES</b>  1. KARI MTAMA 1, 2. KARI MTAMA 1, 3. IS21055 4. GADAM, 5. LDSY-M1, 6. LDSY-2	<b>6 VARIETIES</b>  1. KARI MTAMA 1, 2. KARI MTAMA 1, 3. IS21055 4. GADAM, 5. LDSY-M1, 6. LDSY-2	
<b>3</b>		<b>Number</b>	<b>4 VARIETIES</b>  1. KARI MTAMA 1, 2. GADAM, 3. LDSY-M1, 4. LDSY-2	<b>4 VARIETIES</b>  1. KARI MTAMA 1, 2. GADAM, 3. LDSY-M1, 4. LDSY-2	
<b>4</b>	Product development and processing technologies for producing preferred and marketable value-added sorghum food products identified and developed	<b>Number</b>	8 products: 100% sorghum flour, soured composite ( <i>uji</i> ) flour, unsoured composite ( <i>uji</i> ) flour, supa mtama, brown stiff porridge ( <i>ugali</i> ) flour, Cereal vegetable soup (CeVeg®), Chapatti and bread  8 technologies: Low-cost extruder, blade mixer, pin mill, bread dough mixer, proofer, electric oven, dough kneader, polysealer	8 products: 100% sorghum flour, soured composite ( <i>uji</i> ) flour, unsoured composite ( <i>uji</i> ) flour, supa mtama, brown stiff porridge ( <i>ugali</i> ) flour, Cereal vegetable soup (CeVeg®)  8 technologies: Low-cost extruder, blade mixer, pin mill, bread dough mixer, proofer, electric oven, dough kneader, polysealer	
<b>5</b>	Knowledge sharing and communication products (KSCPs) developed	<b>Types</b>	14 KSCPs: Electronic media, print media, manuals, handbooks, posters, leaflets, Journal papers, occasional papers, brochures, magazines, newsletters, websites, billboards, Feature film/documentary	7 KSCPs: handbooks, posters, leaflets, Journal papers, brochures, websites, Feature film/documentary	

#### Annex 4 Inventory of equipment.

Equipment name	Serial number	Date of purchase	Original value (including VAT)	Location and User
N/A	N/A	N/A	N/A	N/A

**Annex 5: PHOTO GALERRY OF ASARECA SORGHUM PROJECT PRODUCT PROMOTION PICTURES AND KSCPS**



Photo 1: Project Co-PI of Kenya ASARECA Sorghum Project, Samuel M. Wambugu, explaining the contents and purpose of the KSCPs to some stakeholders in Machakos district in Kenya



Photo 2: Joseph Wanyeki of All grain Co. Ltd, a sorghum processor incubated at KIRDI South "B" Campus in Kenya, explaining the benefits of the sorghum products and how to cook them to some stakeholders in Makueni district in Kenya



Photo 3: A stakeholder prepares Ugali in Machakos district in Kenya



Photo 4: A Home Economics Officer demonstrates how to prepares uji in Makueni district in Kenya Machakos district in Kenya



Photo 5: Preparation of the sorghum based Ceveg soup



Photo 6: A stakeholder enjoying a meal of brown sorghum Ugali and Ceveg soup in Machakos district in Kenya



Photo 7: A stakeholder enjoying a cup of sorghum Uji in Machakos district in Kenya



Photo 8: Project Co-PI of Kenya ASARECA Sorghum Project, Samuel M. Wambugu, with the Home Economics Officers outside their offices in Machakos district in Kenya

The following are some of the KSCPs developed under this project:



Photo 7: Banner pens – Uniquely branded pens containing a summary of the sorghum project including its achievements



Photo 7: Branded head cap



Photo 7: Branded T-shirt



Photo 7: Branded head cap, T-shirt and pens



Annex 6: RAPID MARKET APPRAISAL

**RAPID MARKET APPRAISAL (RMA) ON SORGHUM GRAIN, COMPETING VALUE-ADDED SORGHUM AND NON-SORGHUM PRODUCTS IN NAIROBI AND ITS ENVIRONS**

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  - 7.9 Marketing constraints faced by sorghum SMEs**
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Figure 1: Crop production areas in Kenya

Figure 2: Tedious threshing practices discourage increased production of sorghum

Figure 3: Some non-sorghum competing products in the market

Figure 4: Products' Price ranges

Figure 5: Sorghum Value Chain

Figure 6: ASARECA Sorghum project products on display at KIRDI Business incubatees' Shop in Nairobi

Figure 7: Oasis of Hope in Arid Turkana, The Standard (Peter Ochieng and Edwin Chesereck, 2011)

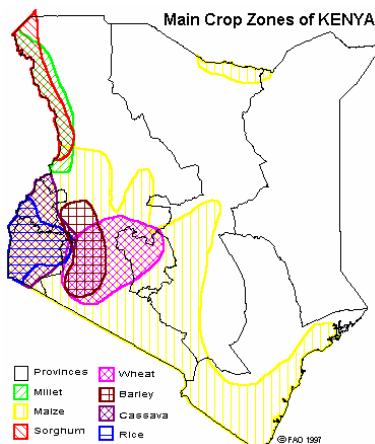


**Table 1: Case summary of non-sorghum competing products**

**Table 2: Case summary of competing sorghum and sorghum-based products**

## 1. INTRODUCTION

Sorghum is a globally cultivated cereal, and is a major crop grown in the semi-arid and arid regions of Africa and Asia where it is used as a staple food. The map below illustrates the main growing areas for the Kenya's key grains, which include maize, wheat, rice, sorghum and millet. Sorghum is predominantly and traditionally grown in Eastern, Western, and Nyanza provinces. Generally sorghum productivity is influenced by rainfall. As an indigenous Kenyan crop, sorghum provides food security and is becoming a suitable alternative in many places where maize crop fails.



**Figure 1: Crop production areas in Kenya**

Despite the growing population in Kenya which mainly depend on cereal grains as their main staple diet, the sorghum sub-sector's economic contribution at the micro or macro level is well below its potential due to various reasons; notably grain shortage, low processing capacity, low processing efficiency levels, inability to consistently maintain product quality, repair and maintenance problems (spares parts availability and quality problems), inappropriate technologies, labour intensive and time consuming production postharvest (Figure 2.) and value-addition technologies as well as changing food habits of the people. These problems are compounded by inefficiencies in the input (fertilizer and extension services) and output (grain sorghum and value-added sorghum products) marketing, including poor market infrastructure, lack of marketing support services and limited market information.



**Figure 2. Tedious threshing practices discourage increased production of sorghum**

The types of sorghum supplied in the country differ from place to place depending on origin as conditioned by the agro-climatic conditions and postharvest handling technologies. Buyers and sellers have various perceptions about the quality of the sorghum supplied to the market. There are competing uses of sorghum grain. All the sorghum crop residues are retained in the farms and are rarely sold in the open market. In Kenya, sorghum, like many grains, has a diversity of uses, including human consumption and animal feed. It is a major crop for many poor farmers. Grain sorghum is used for flours, porridges and side dishes, malted and distilled beverages, and specialty foods such as popped grain. Most farmers grow sorghum for own consumption while but sell surpluses. Available price data indicated that there are significant price differences between farm gate and wholesale prices and that grain prices are rising sharply particularly in the recent times when Kenya has been hit by a severe drought.

Sorghum marketing studies are scarce in Kenya. This Rapid Market Appraisal (RMA) – as opposed to a formal sub-sector analysis – aimed to provide a quick, flexible, and effective way of collecting, processing, and analysing information and data about markets and marketing systems. RMAs are an efficient way to acquire knowledge about marketing systems, with a view to inform production and marketing strategies, policy processes, and the design and implementation of relevant interventions. RMA is an iterative and interactive research methodology, which is used to better understand complex market systems in a short time (adapted from Young 1994). It is a process for discovering market opportunities and how to capture them through a focus on an entire value chain.

## **2. OBJECTIVES**

This study was aimed at assessing the sorghum marketing system in Nairobi and by extension in Kenya in order to generate a general understanding of the sorghum supply and demand characteristics, sorghum marketing, sorghum prices, market places, value-addition technologies and market actors.

The objectives of this RMA were to:

- obtain information about how the sorghum sub-sector is organized, operates and performs;
- identify market constraints and opportunities;
- identify and diagnose policy and regulatory problems that require government (and donor) and private sector analysis, attention and action; and,
- recommend interventions in the sorghum marketing system, organization and value-addition technologies.

## **3. PURPOSE OF STUDY:**

The purpose of this survey was to carry out a rapid market appraisal of the value-added sorghums and sorghum-based products as well as the competing products in various market outlets in Nairobi city and its environs.

## **4. EXPECTED OUTPUTS**

The expected output of this survey was report containing the following:

1. Sorghum value chain
2. Overview of the sources/suppliers/manufacturers of raw sorghum grains and value-added sorghums and sorghum-based products as well as the competing products.
3. Identity and documentation of the market outlets and target clients of raw sorghums and value-added sorghums and sorghum based products as well as the competing products
4. Identity and documentation of the volumes/quantities and prices of raw sorghums and value-added sorghums and sorghum based products traded as well as the competing products traded
5. Documentation of the seasonal availability of sorghum grains

6. Documentation of sorghum products' range, branding, types, packaging and labeling, compliance to statutory requirements; quality (KEBS), VAT, PIN, bar codes, etc
7. Identify some of the constraints affecting sorghum value-addition technologies.
8. Come up with sorghum and sorghum-based products and value addition technologies **prioritization list.**

## 5. METHODOLOGY

This RMA was conducted in seven steps: (1) problem identification and setting objectives; (2) selecting a team; (3) collecting secondary data and information including personal observations of sorghum market places (open markets, supermarkets, shops, kiosks, etc) ; (4) developing questionnaires, pretesting them and scheduling interviews; (5) training the team and questionnaires' administration/ conducting interviews; (6) data entry, "cleaning" and analysis (7) interpretation of results, report writing and meeting to identify opportunities, formulate strategies and plans to capture value.

Following the framework of value chains and associated business development services, the rapid market appraisal study attempted to collect and analyze information on sorghum production and supply; sorghum transportation and storage; sorghum processing and marketing, demand and use; prices; sorghum quality; market places, the main actors as well as the institutions dealing with cereal grains in Kenya.

## 6. DATA ANALYSIS

The data was analyzed using SPSS version 14.0.

## 7. RESULTS AND DISCUSSION

The study was carried out in six main market areas in Nairobi City and its environs where sorghum, sorghum-based and sorghum competing products were considered popular. These areas were: Eastlands , Kahawa West, Kiserian, Ngong, Nyamakima and Ongata Rongai. The majority of the market outlets sampled were in Eastlands (see Tables 1 and 2).

Non-sorghum-based branded products that competed with sorghum products developed under this project were found in cereal shops, retail shops and supermarkets and included those based on finger millet, soya, cassava, humanized milk powder, amaranth and maize composites (**Figure 1**). These products were also either fermented or unfermented. Those meant for weaning were unfermented whilst those targeting family consumption were mainly fermented. The composite flours were meant for "*uji*"- (a thin porridge/ gruel) preparation. An example of a few main brands was:

- Eve's pride special sour flour
- Fafa pure wimbi/ sour *uji* mix
- Toto afya
- Jogoo maize flour
- Pendana maize flour
- Hostess maize flour
- Soko *uji*
- Pembe pure wimbi



Figure 3; Some non-sorghum competing products in the market

The composite flour pack sizes ranged from 500g to 2Kg. Other flours were sold unbranded in polythene bags from cereal and retail shops and were blended according to the consumer's preference. Prices also ranged from as little as KES 35 to as much as KES 150 also depending on the pack size and the contents.

**Table 1. Case summary of non-sorghum competing products**

NO.	LOCATION	PRODUCT NAME	COMPANY NAME	PACK SIZE	PRICE	LOCATION FOUND	COMMENTS	INTEREST IN TRADING IN VALUE-ADDED SORGHUM PRODUCTS
1.	Kiserian	Famila millet & Maize	Unga Ltd.	500g	40.00	Supermarket	Local, packet	Yes
2.	Ngong	Maspets soya Wimbi flour	Maspets packers	1kg	55.00	Supermarket	Local unprecooked, packet, uji	Yes
3.	Estalands	Pembe pure wimbi	Pembe flour millers	1kg	60.00	Supermarket	Finger millet	Yes
4.	Eastlands	Soko uji	Capwell Ltd.	1kg	96.00	Supermarket	Finger millet	Yes
5.	Kahawa West	Mony uji mix	Mbuku sales & services	500g	37.00	Supermarket	Local unprecooked, packet, uji, millet & maize	Yes
6.	Estalands	Fafa wimbi mix sour uji	Soy afric	1kg	75.00	Retail shops	Maize, finger millet, soya flours & souring agent, packet	Yes
7.	Eastlands	Fafa wimbi mix sour uji	Soy afric	1kg	75.00	Retail shops	Maize, finger millet, soya flours & souring agent, packet	Yes
8.	Estalands	Fafa pure wimbi	Soy afric	1kg	75.00	Supermarket	Pure wimbi	Yes
9.	Estalands	Our porridge baby porridge	Our porridge Ltd.	500g	35.00	Cereal shops	Maize, millet, packet	Yes
10.	Eastlands	Soko uji	Capwell Ltd	2kg	96.00	Supermarket	Finger millet	Yes
11.	Estalands	Totoafya	Winnies pure health	1kg	96.00	Retail shops	Organic pure finger millet, humanized milk powder, packet	Yes
12.	Eastlands	Eves pride special sour flour		500g	37.00	Supermarket	Finger millet and souring agent	Yes
13.	Estalands	Soya porridge flour	Rimmwabi enterprises	500g	55.00	Retail shop	Soya, finger millet	Yes
14.	Eastlands	Kisii wimbi	Nature ways	1kg	150.00	Supermarket	Pure wimbi	Yes
15.	Ongata Rongai	Fafa pure wimbi	Soy afric	1kg	75.00	Supermarket	Pure wimbi	Yes
16.	Ongata Rongai	Fafa pure wimbi	Soy afric	1kg	75.00	Supermarket	Pure wimbi	Yes
17.	Nyamakima	Millet, cassava & maize,	Sacks			Cereal shops	Cereals packed as per customer's requirements	Yes
18.	Estalands	Mom's pure wimbi	Mbuku sales &	500g	37.00	Retail shops	Finger millet	Yes

			services					
19.	Eastlands	Mom's uji mix	Mbuku sales & services	500g	35.00	Retail shops	Finger millet	Yes
20.	Estalands	Inga maize flour	Neutral manufacturing	2kg	11.700	Supermarket	Whole maize flour, pure amaranth mixed with gums and bran	Yes
21.	Estalands	Jag family pure wimbi	Mbuku sales and services	1kg	55.00	Cereal shops	Whole finger millet	Yes
22.	Estalands	Kisii wimbi	Nature ways	1 kg	150.00	Supermarket	Pure wimbi	Yes
23.	Estalands	Joy time pure wimbi mix	Euny investment	500g	35.00	Supermarket	Millet cassava	Yes
24.	Estalands	Joy time pure wimbi mix	Wuny investment	1kg	68.00	supermarket	Millet, cassava, soya flours, souring agent	Yes

Sorghum and sorghum-based competing products were also found in cereal shops, retail shops and supermarkets. Those that were sorghum based were mixed with flours from finger millet, cassava, soya, amaranth, humanized milk powder, maize, groundnuts, beans, green grams, peas, carrots, omena, kales, parsley and potatoes. Some also had added vitamins and minerals.

These products were also either fermented or unfermented. Those meant for weaning were unfermented whilst those targeting family consumption were mainly fermented. The composite flours were meant for “uji”- (a thick gruel porridge) preparation and also for *ugali* preparation. Examples of a few main brands were:

- Jabali omena porridge flour
- Our pride baby porridge
- *Ugali* brown
- Soko *uji* Porridge
- Proctor and Allan baby Porridge
- Maspert sorghum and millet
- Natures baby porridge

The composite flour pack sizes were from 500g, 1Kg to 2Kg. Other flours were sold unbranded in polythene bags from cereal and retail shops and were blended according to the consumer’s preference. Prices also ranged from as little as KES 35 to as much as KES 199 with most products costing between KES 60 and KES 99(Fig. 2). Prices also depended on the pack size and the flour constituents.

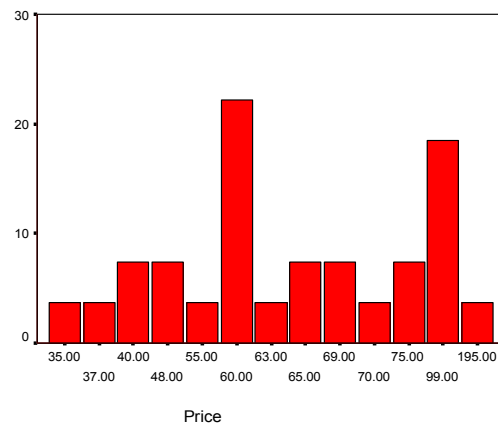


Figure 4: Products' Price ranges

Table 2: Case summary of competing sorghum and sorghum-based products

NO.	LOCATION	PRODUCT NAME	COMPANY NAME	PACK SIZE	PRICE	LOCATION FOUND	COMMENTS	INTEREST
25.	Ngong	Maspet sorghum and millet	Maspet packers	1kg	65.00	Supermarket	Local packet uji flour	Yes
26.	Ngong	Soko uji porridge	Capwell industries	1kg	63.00	Supermarket	Local packet uji flour	Yes
27.	Kiserian	Famila sorghum and millet	Unga Ltd.	1kg	60.00	Supermarket	Local , branded flour	Yes
28.	Kiserian	Soya uji	Soya investment	1kg	60.00	Supermarket	Local ,packed uji flour	Yes
29.	Eastlands	Rimbwabi uji mix	Rimbwabi enterprises	500gm	40.00	Retail shops	Ingredients: Finger millet, sorghum and souring agent	Yes
30.	Eastlands	Mum lizas baby porridge	Soy afric Ltd.	1kg	99.00	Supermarket	Maize, finger millet, soya, amaranth, sorghum, SMP	Yes
31.	Eastlands	Proctor &Allan baby porridge	Proctor & Allan	1kg	99.00	supermarket	Sorghum, maize, soya, millet, minerals & vitamins	Yes
32.	Eastlands	Shamba jui	Mark miller	1kg	60.00	Supermarket	Sorghum and millet	Yes
33.	Eastlands	Natures baby porridge	Natures ways	1kg	195.00	supermarket	Sorghum, millet, carrot, alfafa corn, soya, kales, parsley, potatoes	Yes
34.	Eastlands	Ugali brown		1kg	55.00	Cereal shop	Sorghum cassava	Yes
35.	Eastlands	Our pride baby porridge	Our pride Limited	500gm	37.00	Retail shops	Millet, sorghum, maize germ	Yes
36.	Kahawa West	Omena mix	Rimwabi enterprises	500gm	48.00	Supermarket	Local, plastic bags	Yes
37.	Kahawa West	Kep unga	Pripal milliers	1kg	70.00	Supermarket	Local, plastic bags	Yes
38.	Kahawa West	Ever Pride	Pripal millers		60.00	Supermarket	Local, plastic bags	Yes
39.	Kahawa West	Uji mix	Pripal millers		35.00	Supermarket	Local, plastic bags	Yes
40.	Eastlands	Proctor & Allan baby porridge	Proctor & Allan	1kg	99.00	Supermarket	Sorghum, maize, soya, millet, minerals & vitamins	Yes
41.	Eastlands	Proctor & Allan baby porridge	Proctor & Allan	1kg	99.00	Supermarket	Sorghum, maize, soya, millet, minerals & vitamins	Yes
42.	Eastlands	Omena mix	Rimwaki enterprise	500gm	48.00	Supermarket	Packet: fish, soya, groundnuts, beans, green grams, finger millet sorghum	Yes
43.	Eastlands	Mum lizas baby porridge	Sit afric Ltd.	1kg	99.00	Supermarket	Maize, finger millet, soya, amaranth, sorghum, SMP	Yes
44.	Eastlands	Jabli omen porridge flour	Rafiki general service	1kg	69.00	Supermarket	Sorghum, fish, cassava, fine maize flour	Yes
45.	Eastlands	Shamba uji	Mark miller	1kg	60.00	Supermarket	Sorghum and millet	Yes
46.	Eastlands	Jabali special porridge	Rafiki general service	1kg	69.00	Supermarket	Sorghum, fine, maize flour, beans, peanuts, green grams, peas, black beans, cassava, soya	Yes
47.	Eastlands	Rimwabi uji mix	Rimwabi enterprises	500gm	40.00	Supermarket	Ingredients: Finger millet, sorghum and souring agen__	Yes

48.	Nyamakima	Millet, sorghum, cassava mix	Imende stores	Sacks		Cereal shops	Everything packed in sacks	Yes
49.	Ongata rongai	Fafa sorghum & millet	Soy afric Ltd.	1kg	60.00	Supermarket	Local packet uji	Yes
50.	Ongata rongai	Organic uji	Babelysa	1kg	75.00	Supermarket	Local packet uji	Yes
51.	Ongata rongai	Babisa	Kirinyaga flour mills	1kg	65.00	Supermarket	Local packet uji	Yes
52.	Eastlands	Omena mix wimbi	Gateway cereals	1kg	75.00	Cereal shops	Omena, sorghum, cassava, millet, soya, amarantha, fine maize flour	Yes

### 7.1 Sorghum value chain

In Kenya, sorghum is grown principally in the often drought-prone marginal agricultural areas of Eastern, Nyanza and Co w ast Provinces. Consumption of sorghum is, however, not localized to these growing areas. The crop performs well in areas between 500 metres and 1700 metres above sea level, with seasonal rainfall of 300mm and above.

Below is shown the sorghum value chain that was identified (Figure 2). It shows the flow of raw sorghum from source up to the point the processed products reaches the consumer. Raw sorghum is either obtained locally from Eastern, Western and Nyanza provinces or imported from Uganda and Tanzania. The sorghum is sent directly to the processors or gets into the hands of middlemen and finally to the processors.

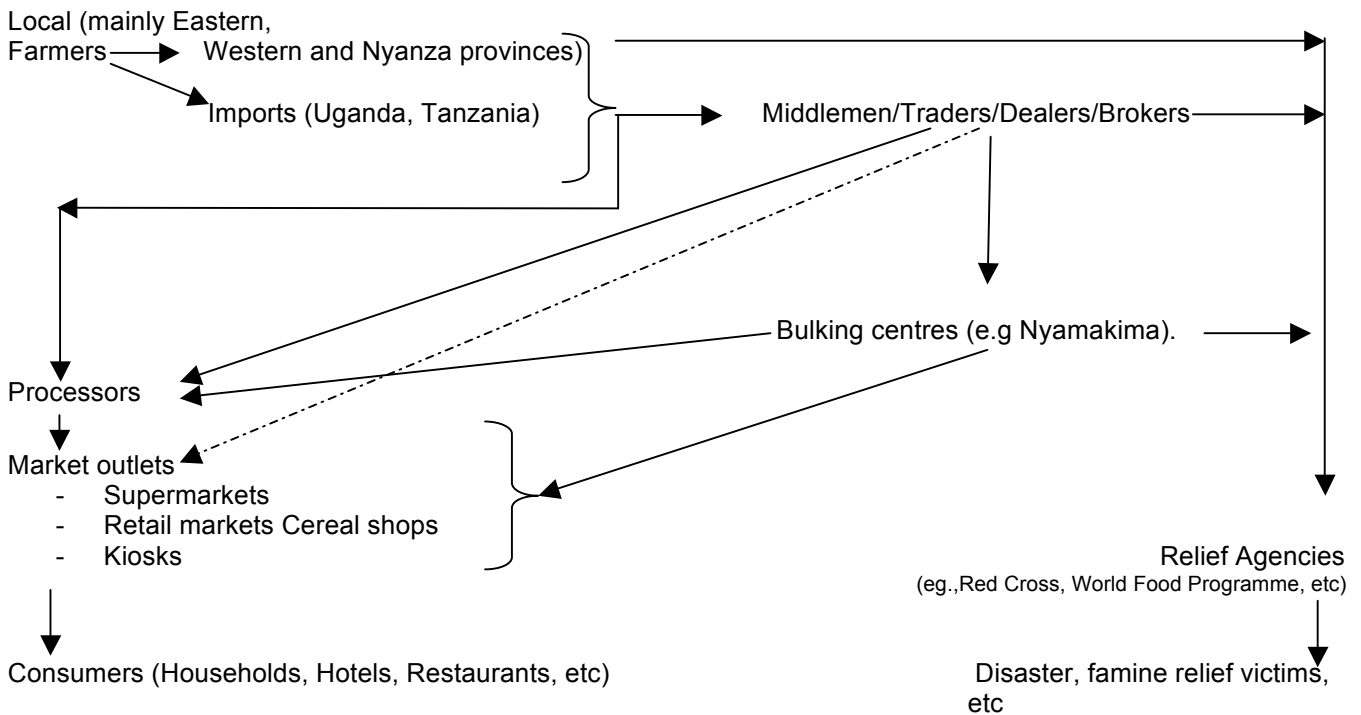


Figure 5: Sorghum Value Chain

### 7.2 Packaging and transportation

The following methods were found to be used in the transportation of sorghum grain: human back, ox and donkey carts for short distances and bicycles and motor bikes for longer distances. The main mode of transportation was by trucks. The main packaging materials were sisal or synthetic bags. Sale of sorghum grain were generally higher in Nairobi than in its environs. Here sales volumes were not very dependent on the time of the month, but fluctuated according to seasons and the type of sorghum (whether white, red or mixed). On the outskirts of Nairobi, sales were higher during market days. Packaging materials for processed sorghum products ranged from polythene bags, craft paper to cartons and paper boards.

### 7.3 Units of sale

The most common and preferred unit of sale was the kilogram. A bag of sorghum was generally weighing 90Kg. In some instances, particularly in the rural areas as well as in some market places (eg. Nyamakima), a tin called a “*gorogoro*”, which is assumed or believed to contain 2Kg of sorghum, is used.

### 7.4 Uses and preferences

There are competing uses of sorghum in Nairobi and its environs. The most common uses were found to be in thin porridges (*uji*) and baby (weaning) foods. *Uji* is a very popular drink for many households and also among the workers in the house construction industry not only because of its health benefits but because of its ability to keep hunger at bay particularly in the current hard economic times! Both sored and unsoured flour were found in the market. The souring agent in used was found to be citric acid. However, the product made in this project using lactic acid was found to be more favoured by the consumers. Some isolated cases of sale of *Ukie* (a very popular traditional fermented porridge amongst the Meru people of Kenya made by wet milling of bulrush and/or finger millet) was mentioned by some people as being on sale, but none was found in the supermarkets. A sizeable quantity is also used in the preparation of stiff porridge (*ugali*). An important use of sorghum which may go unnoticed is its use in the making of traditional brews (e.g. *busaa*) which are commonly consumed in the low-income areas – in illegal dens which are informal and so conducted without licenses. It was however not possible to document the quantities of sorghum grain used in these areas due to time limitations and unwillingness of the players to co-operate. No sorghum-based animal rations/feeds were found in the areas visited.

### 7.5 Storage

Most farmers usually store their sorghum grain in sacks or any other container easily found in the homesteads. Few have good storage facilities and loss of the grain due to pest infestation was reported, particularly due to the large grain borer (commonly referred to as *osama* in some parts of Ukambani areas of Machakos district). Cases of use of metal bins were mentioned, but could not be validated. The storage period of most of the processed products (be they sorghum, sorghum-based or non-sorghum was generally 4 months).

### 7.6 Demand for processed sorghum foods

The demand for processed sorghum products is increasing due to the increasing number of Kenyans who wish to keep at bay various ailments (e.g., diabetes, high blood pressure, coeliac disease or gluten allergy) currently being attributed to adoption of western foods and health styles.

### 7.7 Institutions affecting sorghum Marketing

In Kenya, there exists a Legal and regulatory framework that affects the marketing of sorghum and sorghum processed products.

#### 7.7.1 The Ministry of Agriculture:

Has the overall responsibility of the grains sector. Within this ministry, various Boards are mandated to regulate and license the operators in each sub-sector. The **National Cereals and Produce Board of Kenya (NCPB)** established in 1985 under the National Cereals and Produce Board Act (Cap 338) of the laws of Kenya is mandated by the Government to regulate



and control the marketing and processing of grains in Kenya. It does this through licensing and regulating the key players in the sector, who include traders, farmers and millers among others. The Board may import or authorize importation of maize, wheat, or scheduled agricultural produce in quantities that are directed by the Minister for Agriculture.

Various agencies play a pivotal role in adding value to the sector. The **Crop Development Division** of the Ministry of Agriculture promotes food crop production in order to enhance food security in Kenya. It provides advisory and educational services to farmers through field days, demonstrations, trials and agricultural shows. The division also collects, collates and issues sectoral reports for Early Warning and Information Systems.

### 7.7.2 Regulatory institutions:

#### 6.7.2.1 Kenya Bureau of Standards

All the standards of packaging of any grains and processed product derived there from have to meet the quality standards set by the Kenya Bureau of Standards (KEBS). The regulations include:

- Company name and details
- Nutritional contents
- Weight
- Manufacture and expiry date
- Instructions on how to use

#### 7.7.2.2 The Kenya Plant Health Inspectorate Service (KEPHIS)

KEPHIS is a State Corporation established in October 1996. The Corporation's activities and services involve offering inspectorate services on all matters related to plant health and quality control of agricultural inputs and produce. The activities include:

- Certification of the quality of seeds.
- Testing and monitoring the presence of harmful residual agro- chemicalson agricultural produce, soils and water systems.
- Co-ordination of the release of superior and well-adapted varieties / cultivars to the farming community.
- Protecting the rights of the breeders / discoverers of new plant varieties through grant of rights to the owners of such varieties and registering them.
- Preventing introduction into the country of harmful foreign weeds, pests and diseases through adherence to strict quarantine regulations and procedures.
- Inspecting and grading agricultural produce for import and export to ensure that they are of high and acceptable quality.
- Implementing the national policy on the introduction and use of genetically modified plant species, insects and microorganisms in Kenya.

### 7.7.3 Research institutions

Continuous research and development has been carried out in all the crop sub-sectors with the sole purpose of enhancing productivity, value-addition and reduction in postharvest losses.

Key institutions include:

7.7.3.1 Kenya Agricultural Research Institute (**KARI**), which is mandated to carry out agro-based research services by the Government.

7.7.3.2 Kenya Industrial Research and Development Institute (**KIRDI**). KIRDI's mission is to undertake industrial research and development and disseminate findings that will have a

positive impact on national development. KIRDI's mandate is to carry out research and development in Industrial and Allied Technology including: -Civil Engineering, Mechanical Engineering, Electrical Engineering, Power Resources, Textile Technology, Mining, Chemical Engineering, Industrial Technologies, **Food Technology**, Ceramics and Clay Technology.

\*NB: KIRDI has been instrumental in the development and promotion of various sorghum processing technologies in Kenya. One of these technologies is dehulling/ decortications or pearling of sorghum for use by Small- and Medium-Scale Enterprises (SMEs). Another innovative technology is wet-milling technology pin-mills which was developed in KIRDI has proved very popular for wet-processing/milling of sorghum and millets in the Eastern province of Kenya for the manufacture of a product known as *ukie*. *Ukie* is a very popular traditional fermented porridge amongst the Meru people of Kenya made by wet milling of bulrush and/or finger millet. The porridge is a delicacy consumed by thousands of households in the community. It is sold in some residential areas of the city of Nairobi. The process however, still needs further research so as to standardize and optimize it and commercially present the final product in modern packaging materials to more consumers in supermarkets. The porridge has a strong cultural appeal and every woman worth her social status must have skills to prepare it to her husband and family members. The beverage is also served in cultural events like wedding ceremonies and during women's merry-go-round meetings. It contributes positively to the nutritional well-being of the people particularly children, lactating mothers, the elderly, the sick and recuperating persons. It is also a source of employment and income for the households which make the porridge as well as those who sell the product. This technology needs to be promoted more areas in the ECA region.

7.7.3.3 Academic institutions have equally taken up continuous agro-based research. These include the University of Nairobi, Egerton University, Moi University and the Jomo Kenyatta University of Agriculture and Technology.

## **7.8 Sorghum Value addition Technologies currently in use**

### **7.8.1 Traditional processing methods of sorghum**

Cleaning of sorghum is done manually in every homestead to remove chuff, dust, stones and infested or moldy grain. In most households found in remote sorghum-growing villages, sorghum (as well as other cereal grains) is invariably processed using traditional methods. Dry, moistened or wet grain is normally pounded with a wooden pestle in a wooden or stone mortar. Moistening the grain by adding about 10 percent water facilitates not only the removal of the fibrous bran, but also separation of the germ and the endosperm, if desired. Although this practice produces slightly moist flour, many people temper the grain in this way before they pound it. Pounding moist or dry grain by hand is very laborious, time consuming and inefficient. A woman working hard with a pestle and mortar can at best only decorticate 1.5 kg per hour. This unpleasantly hard work is almost always done by women. Pounding gives a non-uniform product that has poor keeping qualities.

Traditional grinding stones used to grind whole or decorticated/dehulled grain to flour usually consist of a small stone which is held in the hand and a larger flat stone which is placed on the ground. Grain, which should be fairly dry, is crushed and pulverized by the backward and forward movement of the hand-held stone on the lower stone. The work is very laborious, and it is hard work for anyone to grind more than 2 kg of flour in an hour. Whole or decorticated grain may also be crushed to a coarse flour either with a pestle and mortar or between stones. Grain is also ground to coarse or fine flour in hand grinders/ mills or mechanized mills where these may be located in some villages.

When hard white sorghum grains, contaminated with seeds with a red testa, are decorticated in an abrasive decorticator, any pericarp left on the grain is hard to see, and when the pearled grain is milled, the presence of pericarp goes largely unnoticed. However, the ability of abrasive decorticators to produce an adequately white product falls sharply with increasing levels of contamination from seeds with a coloured seed-coat. When the contaminating seeds have a red testa (which is deeply coloured and is practically the last player to be abraded away) a decorticator's ability to produce an acceptably white product falls even more sharply.

### **7.8.2 SME's processing of sorghum**

Cleaning is done manually as in the case of traditional processing. Dry milling is done using locally made and imported hammer, disc, pin or roller mills. Mixing for composite flours is done manually using drum mixers or and shovels. These processing methods are faced with the following problems:

1. Low processing capacities
2. Low efficiency levels
3. Inability to consistently maintain product quality due to use of inappropriate technologies (e.g. shovels) and packing (which is normally done using polythene paper), being manual is prone to contamination.
4. Repair and maintenance problems (spares parts availability and quality problems)
5. Labour intensive and time-consuming
6. Inadequate access to affordable technologies and technology transfer services

### **7.8.3 Large Scale processing of sorghum**

Cleaning, milling, mixing (for composite flours) and packaging for large scale sorghum processors such as Unga Limited and Capwell Industries is done using automated state of the art machines.

### **7.9 Marketing constraints faced by sorghum SMEs**

The following are some of the constraints faced by SME sorghum processors in Kenya:

1. Seasonal availability of raw materials
2. Inconsistent quality of raw materials - buyers and sellers had various perceptions about the quality of the sorghum grain supplied to the market. Buyers used different methods to assess grain quality, including visual observation, smelling, and touch feeling. Visual observation was used to assess the colour, adulteration or physical spoilage of the grains.
3. Poor packaging and labeling due to inadequate information on the importance of the same for product success in the market place.
4. Inadequate marketing resources and strategies (e.g. marketing personnel, brand visibility, poor distribution channels, poor pricing)
5. Lack of a marketing plan
6. Inconsistent quality of raw materials
7. Inability to exploit economies of scales (purchase of raw and packaging materials in bulk)
8. High production costs leading to high product costs and hence lack of competitiveness in the market

### **7.10 Opportunities for sorghum SMES in Kenya**

The following are some of the opportunities which can be exploited by sorghum processors in Kenya:

1. Favorable GOK policies e.g. on Public Procurement and Disposal (Preference and Reservations) Regulations, 2011) – intended to assist SMEs.
2. Expanding markets through regional integration (ECA)
3. New and existing international markets e.g., AGOA
4. Increasingly favorable financial assistance from MFIs
5. A very vibrant '*Jua Kali*' sector in Kenya dealing fabrication of with agro-industrial machinery

6. Existence and willingness of donor a community to assist Africa eradicate hunger, malnutrition, disease, ignorance and other socio-economic problems affecting its people.
7. Existence of business incubation facilities from government institutions (KIRDI and KIE) – these offer production floor space, back-office services, shop shelf-space, etc. (see Figure 7.)



Figure 6. ASARECA Sorghum project products on display at KIRDI Business incubatees' Shop in Nairobi

### 7.11 Volumes of raw sorghum handled

Volumes of raw sorghum handled by farmers – varies according to seasons, Transporters/ deal with approx 7 tonnes and above while traders handle from 90 kg (one bag) and above while SME sorghum processors handle 90 kg (one bag) per batch. Retailer and shops handle a minimum of one bale of 1KG of value-added sorghum products per order while the supermarket orders are not fixed.

### 7.12 Seasonal availability of sorghum

Sorghum available closely patterned against Kenya's bimodal rainfall pattern – long rains (April-August) are more reliable while lately due to changing global weather patterns, the short rains season crop is unreliable.

### 7.13 Sorghum products' prioritization

Due to the current enforcement by the Government (KEBs) on product quality and adherence of businesses to laid down statutory requirements in Kenya, there has been a decline in the number and range of unbranded and low quality sorghum products in the market outlets. There has also been considerable improvement in the quality of packaging and labeling of sorghum products in the market. All sorghum and sorghum-based product currently on sale in the market now meet all the statutory requirements (S-Mark, bar-coding). One of the most important finding of this RMA was that most of them had a shelf life of about three months. Cases of product recall by the manufacturers from the market have been reported due to insect infestation. Apart from some sorghum products from South Africa which entered the Kenyan market about a year ago, there were no other products in the market which had been precooked/ extruded. Extrusion is defined as “the act by which one shapes a product by forcing it through an aperture”. The term “extrusion cooking” is used since, often, heat is applied or generated during extrusion resulting in a plasticized/cooked product. High-temperature short-time extrusion cooking is a valuable way of producing low-cost, nutritious and instantised foods which only require mixing with boiled water or milk before use. The product is rendered instant by the process of extrusion cooking gelatinizing the starch, thus cooking it. Extruded sorghum products developed under this project have been shown to have an extended/long shelf life (8 months). This finding presented us with an opportunity to supply the consumers with products with the following desirable qualities:

1. Quick to cook (thereby saving on energy (read environmental conservation) and time)
2. Enhanced organoleptic attributes
3. Improved shelf life
4. Brand name (“All Grain”)

It is against this background that we **prioritized** the development of branded extruded/ pre-cooked sorghum-based products. With the available budget, four products were chosen for further promotion. These were: brown sorghum *ugali* flour, composite *uji* flour (unsoured) composite *uji* flour (soured) and

CeVeg sorghum soup. CeVeg sorghum soup was chosen based on the findings that there were many and popular vegetable, cereals and mixed cereal/vegetable powder soups in the market, but none of them was utilizing sorghum and Moringa tree leaves as the main ingredients despite their suitability and potential nutritional and food security contribution they can make to the people of the region.

### 7.14 Conclusions and recommendations

From the results of this study, it is evident that sorghum plays a very significant role in ensuring food security in Nairobi and its environs. It is worth noting that the majority of the sorghum and sorghum-based products in the market were intended for porridge making for the whole family, but with a special target to children (as weaning foods) where high nutrient densities are required to ensure that a sizeable portion of porridge delivers to the child the desired amounts of nutrients for healthy growth and development. No study has so far been done on the nutrient densities of such foods in Kenya. This pointed to an urgent need to do a study to determine the nutrient densities of these products, particularly those targeted at the children as weaning foods. A study done by Wambugu S.M., 1999 showed that infant weaning foods of high nutrient densities can be formulated and manufactured by extrusion cooking using combinations of plain, malted and fermented sorghum flours. It was very tempting, and justifiably so, to try and develop such products under this project, but funds could not allow. Nevertheless, the range of value-added sorghum and sorghum-based products in the market was quite significant when compared to those from maize and other cereals. It is however very sad that the on-going East Africa's most severe drought in 60 years has left 10 million people desperately short of food (Mark T., 2011). This severe food insecurity could rapidly deteriorate and hence the situation demands immediate, constant attention and a long-term solution. To achieve this, there is urgent need for local, regional and international commitment to address the issues of climate change and other concerns which have brought about this "toxic mix" of drought, failed harvests and rising food prices leading to severe food shortages and deaths of people and livestock amongst the peoples of the Horn of Africa.

It is also hereby recommended that, given the large number of people sorghum and millets are serving as food, feed, beer, etc., researchers, policy makers and other stakeholders need to be aggressive in ensuring increased production and value-addition/ preservation of sorghum to ensure food security in the region. In this context, minimizing bird and storage pests' damage need immediate attention. In addition, assistance in improving dehulling, decreasing sand contamination and ensuring organized markets is needed. Good quality and appealing foods need to be in place as a result of product development work. In achieving all these goals networking is central and has to facilitate exchange of information from production, processing, marketing and utilization of the sorghum and the millets. Sorghum foods need to target the biggest forms of consumption which are mostly porridges (*uji* and *ugali*), weaning foods, famine relief foods and dehulled sorghum products as well as any other novel food products that will ensure hunger and malnutrition are eliminated from Africa once and for all!

We need to hear and see more of such projects as the "Turkana success story: Irrigation project" Kenya Television Networks, 2011

([http://www.ktnkenya.tv/new/?page\\_id=1&id=%202000043358&cid=626&story=Turkana%20success%20story:%20Irrigation%20Projects](http://www.ktnkenya.tv/new/?page_id=1&id=%202000043358&cid=626&story=Turkana%20success%20story:%20Irrigation%20Projects), Ochieng P. and Chesereck E., 2011) where Naoros' villagers in Turkana Central have long discovered and used irrigation to avert hunger – and have produced enough for their consumption since 1985 whereas their neighbors are dying of hunger (Fig. 5).



In this project, more than 800 families grow sorghum on 450 acres three times a year and the harvest is huge. This shows that with continued and focused basic and applied research it is possible to unleash sorghum's potential to be the cornerstone of Africa food security. Finally, it is recommended that there is need to up-scale and out-scale the results of this project and that ASARECA should commit more funds to develop more value-addition technologies and more innovative sorghum products suitable to the different consumer needs and to ensure that the results of this project benefit as many people as possible within the ECA region and beyond.

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