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Characterization of Sorghum Production and Marketing Systems in Eastern Province, Kenya: Sorghum for Multi-Use (SMU) Baseline Survey Report

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Abstract

A baseline survey was conducted to characterize the sorghum production and marketing system in Eastern Province of Kenya and, in combination with other follow up rapid assessment fora with relevant stakeholders, to aid the setting of project performance targets and implementation of interventions including establishment of a commercial pilot sorghum value chain for testing and upgrading. Eight SMU mandate districts/ sub-counties were grouped into 4 technology-adoption clusters out of which 480 farm households were randomly selected from the most important sorghum producing sub-locations.

Women were managers in about 50% of the household farms and about 80% of all farmers reported farming as their main occupation. The mean farm size was 7.8 acres out of which 50% and 30% was under crop and sorghum production, respectively. Farms managed by women were smaller than those managed by men. The farm households exhibited a variable dependency ratio with the women managed farms showing significantly higher dependency ratio (1.3) than male managed farms (0.9) – meaning that labor availability was a more critical constraint in women managed farms. Therefore, labor-saving (mechanization, etc) and land-saving technologies (higher yielding varieties, fertilizer, tied ridges, etc) would enhance sorghum production.

The other constraints were poor production and market infrastructure and information asymmetry in which women farmers, with less access to production information than their male counterparts, reporting more dependence on "other farmers" for agricultural information. Majority of farmers depended on agro-dealers, radio and other farmers for agricultural information. Hence innovative information channels such as use of agro-dealers, radio, training of trainers (TOTs) and farmer innovation platforms should be strengthened.

Although double the number of male than female farmers reported purchase of seed from markets, use of recycled sorghum seed was the norm by the majority of farmers while use of inorganic fertilizer on sorghum was nil. Sorghum grain production per household was 360 kg out of which 65% was sold, 30% consumed while 5% was kept for seed. Sorghum yield was highest in Mwingi (501 kg per acre) and lowest in Kibwezi (216 kg per acre). Farmers who reported use of farmyard manure reported 35% more sorghum grain yield than those who had not used farmyard manure. Furthermore higher household production and productivity was positively correlated with the practice of row planting and use of soil and water conservation technologies, including dry or early planting.

The primary use of sorghum grain at the household level was for making porridge and "ugali" (stiff porridge) while value addition activities were limited to milling of grain or mixtures of sorghum and other grains, wet milling and dehulling. The most important sorghum product marketed was grain, which was bought by brokers, rural assemblers, urban traders and consumers, with the consumers offering the farmers highest prices. Low grain price was the most important marketing constraint and hence, as well as improving market linkage for grain, diversifying value added products of sorghum for household level use and for commercialization would help create demand for sorghum grain and improve prices. Although awareness of collective grain marketing was high, farmers' participation was minimal and their participation was constrained by low grain production (36%), low grain quality (30%), delayed payment for delivered grain (29%) and restriction on free grain marketing (25%).

Key words: *Adoption clusters, constraints, interventions, collective marketing, pilot value chain, production and productivity*

Characterization of Sorghum Production and Marketing Systems in Eastern Province, Kenya: Sorghum for Multi-Use (SMU) Baseline Survey Report

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Executive Summary

Sorghum for Multiple Use (SMU), EC-IFAD funded project, aims to reduce rural poverty, improve food security and nutrition; and will contribute to IFAD's goal and strategic objectives of enabling poor rural women and men to have access to and take advantage of improved agricultural technologies and effective production services. The more immediate objective of SMU is to improve sorghum grain productivity and linkage to grain markets. In Kenya, implemented by ICRISAT in partnership with Africa Harvest (AH) and Kenya Agricultural Research Institute (KARI), SMU activities are in Makueni, Machakos, Kitui, Mwingi, Tharaka South, Meru South and Meru North Districts of Semi-Arid Eastern Province of Kenya, which is home to an estimated 6m people, 50% of whom live below the poverty level. The SMU project is implemented through five output components comprising baseline, sorghum value chain upgrading, sorghum cultivar development, partnerships and capacity building. A baseline survey, purposed to characterize production and marketing systems before implementation of SMU project activities, is the subject of this report.

Production and marketing environment was varied with poor road and market accessibility network reported in most districts. Therefore, interventions that reduce both input and product transaction costs would be important in enhancing farm incomes and food security. Although a large proportion of farmers are within 10 km of extension offices, majority of farmers (70%) report that extension services are poor or non-existent, leading to majority of them depending on radio, other farmers and agro-dealers for general agricultural information. Therefore SMU should promote use of radio, other farmers and agro-dealers for dissemination of production and marketing information. Although awareness about agricultural credit is reportedly high, its use is minimal and SMU needs to assess sorghum production credit needs and match these with availability.

Of the 480 farmers interviewed for the survey, about ½ were women who participated actively in the production of sorghum grain. Higher illiteracy was reported in Meru South and Meru North than in the other SMU mandate districts and there was no variation in illiteracy levels by gender. Farming as the main occupation, however, was reported by a larger proportion of farmers in Meru South and Tharaka South than in other sites.

The mean household size was 6 persons with a higher dependency ratio in Mwingi and Kibwezi than in Meru and Tharaka South districts. Higher dependency ratio was also observed in farms managed by women (1.3) than those managed by men (0.9). The mean farm size was 7.8 acres with greater than 50% of the land put under crop cultivation in each of the two cropping seasons[1]. Sorghum was allocated about 1/3 of the cropping land with the highest allocation of 50% observed in Meru South. Survey data reveal that women operated farms that were 2 acres smaller and cultivated 0.5 acre less sorghum area than their male counterparts. Higher dependency ratio and smaller farm size is an indication that women faced more acute land and labor constraints than their male counterparts. Therefore, SMU should promote labor- and land-saving sorghum technologies in order to enhance the women farmers' chances to adopt the improved technologies.

1. There are two cropping seasons in a year in Semi-arid Eastern Kenya with Short Rains (October-January) season being more reliable than the Long Rains (March-May) season.

Majority of farmers (88%) planted maize and sorghum in the same farm but in separate plots primarily in mixed systems with legumes especially cowpea, green grams and pigeonpea, although a small proportion also intercropped improved sorghum with maize or other sorghum variety. The average use of improved sorghum variety Gadam was 53% but was highest in Tharaka South and lowest in Meru South (23%).

A higher proportion of male farmers (61%) than female farmers (54%) reported use of the preferred improved sorghum variety Gadam. Furthermore, women farmers used 1.5 kg less seed of Gadam than male farmers. This may be due to the fact that women faced more acute land and seed access constraints than their men counterparts. Further analysis showed that technological information asymmetry was a constraint as men farmers had easier access to agricultural information from NGOs and government extension than the women farmers. Women relied more on other farmers for information on improved sorghum varieties than men farmers. Therefore, selecting training and field days sites that are easily accessible to women farmers will be important as well as training of trainer (TOT) farmers and greater use of radio to disseminate agricultural information.

Although the survey revealed that the most important sources of improved sorghum seed was from KARI, NGOs and agro-dealers, farmers' use of recycled seed saved from previous grain harvests and bought from local shops and open air markets was quite common. Farmers used on average 4 kg of sorghum seed per season although those who relied on saved seed preserved up to 16 kg of grain from the previous harvest per season for seed. This ensures that the farmer will still have some seed when there is need to replant or in case of total crop failure in the season.

Purchasing of inputs showed interesting trends. Almost double the number of male farmers purchased seed from markets than women farmers. Use of inorganic fertilizer was nil while use of farmyard manure was highest in Mwingi (44%) and lowest in Kibwezi (10%). Other farm inputs reportedly purchased by farmers were pesticides, hired labor and draft power.

Sorghum production per household was about 4 bags[2] out of which 65 percent was sold, 30% consumed while 5% was preserved as seed. Sorghum productivity was highest in Mwingi (501 kg/acre) and lowest in Kibwezi (216 kg/acre) due to more use of farmyard manure in the former. Farmers who applied farmyard manure in their sorghum grain production reported 35% more grain yield per acre than those who did not. So promotion of microdosing of fertilizer should be intensified by the SMU project. Further, farmers who used row planting as an improved technology realized higher household level grain production than those who broadcasted, perhaps because they were able to do bigger acreages under row planting. Women farmers produced 1.5 bags less sorghum grain than men farmers as they faced more land, labor, seed and information related constraints than their male counterparts. However, there was no variation between gender in sorghum productivity.

The primary use of sorghum grain at the household level was for making porridge and *ugali* (stiff porridge). Further, value addition activities are limited to milling of pure sorghum grain or mixtures of sorghum and other grains, wet-milling and dehulling. Therefore development and

2. 1 bag = 90 kg

promotion of more sorghum value added products and linking these to local and urban markets should be emphasized under SMU project in an effort to diversify the uses of sorghum.

The most important sorghum product marketed was grain and the most important buyers (in descending order of importance) were brokers, rural assemblers, urban traders and consumers. Farmers cited low prices as the most important constraint in sorghum grain marketing with the lowest prices being offered by brokers and highest by consumers. Therefore SMU should institute interventions that increase farmers share of the market margin (margin between farm gate and retail outlet) currently being enjoyed by brokers, assemblers and urban traders. The study also revealed women farmers sold smaller quantities of grain (as they produced less) as well as receiving lower prices for their grain. Lower prices received by women need further investigation although it is plausible that women were more likely to accept farm gate prices and/or use market outlets closer to farms than male farmers.

Although farmers reported some level of awareness about collective marketing of sorghum grain, the use was minimal mainly due to low grain production (36%), grain quality restriction (30%), delayed payment for grain delivery (29%) and restriction on free marketing of grain (25%). If collective marketing is one way to increase the share of the farmers' market margin then SMU should encourage collective marketing by undertaking interventions that will increase grain volumes (productivity improvement), improve access of seed of market-preferred sorghum varieties and enable farmers to receive cash payments for delivered grain.

Further focus group discussion study with relevant stakeholders and key informants should be done to establish sorghum grain market margin share by various players in the value chain and to further identify challenges and opportunities along the value chain in order to make recommendations on the best way to upgrade the efficiency of the sorghum value chain for benefit of the stakeholders, especially the farmers. This will lead to selection of producer and market groups that will be a part of a pilot commercial size value chain established with standard procedures and best-bet practices to test, develop and improve the efficiency of sorghum grain marketing in SMU mandate districts. This pilot commercial size value chain will be run by a value chain platform established by the SMU project.

Introduction and Background

Eastern province of Kenya, where the SMU project is being implemented, is largely semi-arid with a bimodal rainfall of 500-800 mm p.a. The province is estimated to have a population of about 6 million people, 50% of which live below the poverty line. Crop productivity in Semi-arid lands (SALs) of Kenya is constrained by frequent drought, highly erodible soils with low organic matter content, inadequate agronomic knowledge, pests and diseases, climate change, endemic poverty and limited access to input and output markets. Consequently, farm production is primarily of subsistence nature that results in crop failure in almost ½ of the cropping seasons and serious food and income insecurity, cyclic famines and suffering for the people of the region.

The SMU project seeks to support initiatives for reduction of both food insecurity and poverty in line with the objectives of the Action Fiche program. The project outputs are anchored on

three System Level Outcomes of the SRF, Reducing Rural Poverty, Improving Food Security and Improving Nutrition; and will contribute to IFAD's goal and strategic objectives of enabling poor rural women and men to have access to and take advantage of improved agricultural technologies and effective production services. The results of the project will ascertain whether, by improving access to sorghum grain markets and improving efficiency at all nodes of the sorghum value chain, food security, nutrition and household incomes can be improved – after all sorghum is better adapted to the SALs.

The project targeted eight districts in Eastern Province of Kenya: Tharaka South in Tharaka Nithi County; Mwingi and Kitui in Kitui County; Yatta in Machakos County; Meru South and Meru North in Meru County; and Kibwezi and Makueni in Makueni County (Annex 1).

ICRISAT and Africa Harvest Biotechnology Foundation International commonly known as Africa Harvest (AH) are the main implementers of this research for development (R4D) project. Another key partner in Kenya was Kenya Agricultural Research Institute (KARI) while other collaborators were Dryland Seed, KARI Seed Unit, SeedCO, CBOs, farmer groups, rural grain assemblers or aggregators, County and Sub-County Agricultural Offices (SCAOs), other seed companies, Equity bank and agro-dealers.

The project was implemented through five components: baseline survey, upgrading of sorghum value chain, sorghum cultivar development, partnerships and capacity building. This report contains the results of the baseline survey in Eastern Kenya that was undertaken to characterize the existing sorghum-based production and marketing systems before implementation of subsequent SMU project activities. The baseline survey results describe physical, household, production and marketing characteristics of the project sites including sorghum production and marketing improvement challenges and potential solutions.

SMU baseline survey objectives

The Objectives of the baseline survey were to characterize the existing sorghum based production systems and to establish the status of the sorghum based production systems before implementing the SMU project. Further, the baseline was to identify the determinants (bio-physical and socio-economic factors) that may explain the differences in productivity and marketing opportunity parameters within and between districts. The results will help in fine-tuning the project implementation process and to identify areas of intervention for improving sorghum based production systems. The findings will assist in monitoring and assessing the progress and expected impact of the SMU outputs. The SMU baseline survey report presented contains physical, household, and production characteristics of the project sites including challenges and potential solutions.

Survey Methods

The survey sampling was a multistage purposive method in which the 8 project districts were grouped in 4 clusters based on farming systems, agro-ecological zones, administrative, and socio-economic and cultural factors. From the 4 clusters, one important sorghum producing district each was selected and from each selected district 2 important sorghum producing sub-

locations were selected as survey sites. From each sub-location 60 farmers (120 per district) were randomly selected for a single visit interview by trained enumerators using a semi-structured questionnaire (Table 1).

Table 1. Sampling methodology for the baseline survey

SMU mandate district	Sorghum producing district selected	No of sorghum sub-locations selected	Random sample of farmers selected
1. Meru North	-	-	-
2. Meru South	Yes	2	120
3. Tharaka South	Yes	2	120
4. Mwingi Central	Yes	2	120
5. Kitui	-	-	-
6. Yatta	-	-	-
7. Makueni	-	-	-
8. Kibwezi	Yes	2	120
Total			480

Source: survey data

Results and Discussions

Production and marketing environment

Roads

Overall, 34 percent of the respondents are connected to the nearest crop market by non-graded dirt roads, 44 percent by graded dirt roads and 21 percent have a murramed (all weather) section of road to the market (Figure 1). Meru South has the poorest roads with 65 percent of the respondents claiming to be served by non-graded roads. Tharaka North, Mwingi Central and Kibwezi 65 percent, 59 percent, 44 percent and 42 percent respondents, respectively, are linked to the nearest crop market by graded dirt roads. In terms of assessment for quality, over 70 percent of respondents from Tharaka South and Kibwezi reported the quality of their roads as good while 52 percent and 42 percent, respectively, reported the roads as good in Meru South and Mwingi Central. Respondents were also asked whether the roads were motorable throughout the year. The highest proportion of respondents reporting in the affirmative in descending order was 68 percent in Tharaka South, 59 percent in Kibwezi, 43 percent in Mwingi Central and 42 percent in Meru South. Generally, Tharaka South and Kibwezi Districts have better accessibility to local markets than those from Mwingi Central and Meru South.

Local Markets

The presence or absence of local markets and the status of the road network and distance travelled by farmers to local markets is a proxy for potential for commercialized agriculture. Table 2 provides indicators for accessibility to local input and product markets. Availability of local produce and input markets varied significantly (chi-square test: p=0.000) between survey districts with unavailability reported in Meru South District where no markets were in existence at the sub-location or location level and 62 percent of farmers reported walking more than

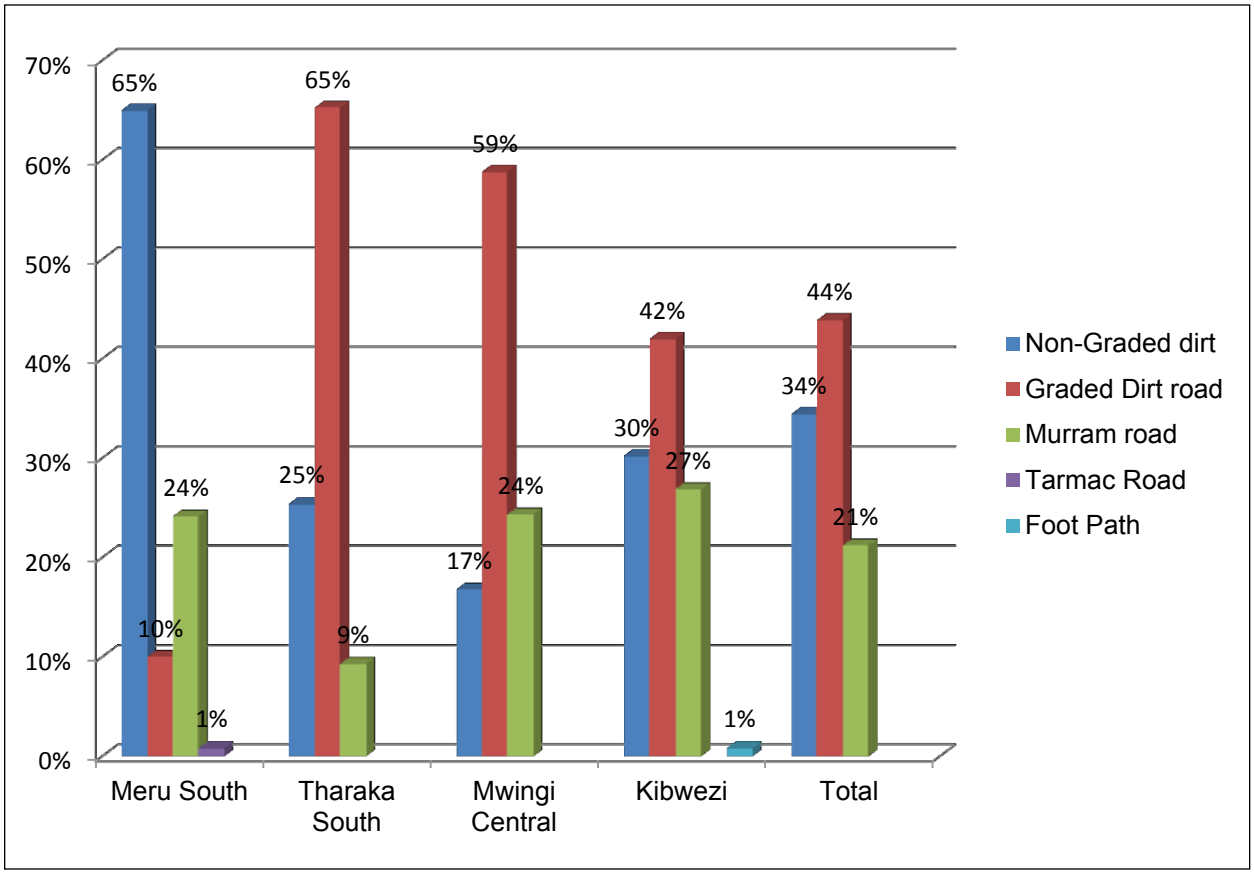


Figure 1. State road infrastructure in survey areas.

2 hours to the markets. Availability of local markets was highest in Tharaka South District where about ¾ of the respondents reported the existence of a market in their sub-location and less than 10 percent of them reported walking more than 2 hours to the market. In Mwingi Central and Kibwezi, although the majority of respondents reported existence of markets at the sub-location or location level, more than one half of the respondents reported walking more than 2 hours to those markets.

Table 2. Availability of local markets and the distance (in walking time) to local markets in the 4 SMU survey districts of Eastern Province of Kenya.

District	Percentage reporting existence of a market in the sub-location	Percentage reporting existence of market in location	Percentage reporting walking for more than 2 hours
Meru South	0	0	62
Tharaka South	74	93	9
Mwingi Central	13	67	63
Kibwezi	42	98	56
Total	31	56	47

Chi-square test: p=0.000; Source: survey data

Extension services

The farmers' proximity to extension services is a proxy for access to production and market information. Although 47 percent of respondents in all survey districts were located within about 10 km to the nearest extension office, this proximity varied significantly (chi square test: p=0.000) between districts. The descending order of proportion of respondents reporting that they are located within 10 km of extension office: Meru South (86%), Mwingi Central (42%), Tharaka South (33%) and Kibwezi (25%). Quality of extension services was rated as good (25%), poor (37%) and non-existent (34%). The most important sources of general agricultural information were radio (35%), agro-dealers (23%), Extension (17%) and other farmers (15%).

Access to credit

Awareness of existing credit institutions is significantly higher in Mwingi South and Kibwezi and a higher proportion of farmers from Kibwezi than in other sites had applied for credit (Table 3).

Table 3. Access to credit for agricultural production.

	% of respondents reporting in the positive		
District	Credit institution exists	A member of the institution	Applied for credit
Meru South	9	16	27
Tharaka South	19	19	34
Mwingi South	57	13	14
Kibwezi	86	36	34
All	42	21	28
P value	0.000	0.000	ns

Source: survey data

Household characteristics

Gender, age, education of farmer

The gender, age and education level (Table 4) of the farmers are proxies for the managerial skills that the farmers employ to make farming decisions such as what to plant, when to plant, how much to plant, how to plant and how much to sell. About ½ of the surveyed farmers were women and there was no significant difference between survey districts. The mean age of farmers was 45 years and farmers were younger in Kibwezi than in the other survey districts. Farmers' formal years of education varied significantly across the districts with Kibwezi and Mwingi Central showing the highest literacy levels, and Meru South and Tharaka South districts depicting lowest literacy levels.

Table 4. Gender, age and education of farmers across the survey districts.

		Age in years	% reporting formal education in years (p=0.000)			
District	% Female	(mean)	0-3	4-8	9-12	College
Meru South	48	47	39	48	12	1
Tharaka South	48	46	38	44	7	11
Mwingi Central	47	46	25	61	10	3
Kibwezi	55	42	17	54	21	9
All	49	45	30	52	12	6
F test p-value	ns	0.02				

Source: survey data

Main employment or occupation of farmer or respondent

Farming is a source of employment, income and food for the majority of rural households. Farmers can be employed fulltime in farming or be employed off-farm to supplement the farming as a household enterprise. Farming is the major occupation for farmers in all districts, although a higher proportion (p=0.02) of respondents report it as a major occupation in Meru and Tharaka South districts than in Mwingi and Kibwezi (Table 5). Other important sources of income for respondents were salaried employment and local business.

Table 5. Main occupation (% reporting) of the respondent.

District	Farming	Salaried	Casual labor on farms	Casual labor off-farm	Local business
Meru South	82	2	2	5	6
Tharaka South	85	7	2	3	3
Mwingi Central	73	8	2	7	10
Kibwezi	67	11	1	3	13
All	77	7	2	4	8

Chi-square test: p=0.02; Source: survey data

Household size and family labor

The farm family is the main source of farm labor in subsistence or semi-commercial agriculture and Table 6 shows the family and farm labor size in the 4 survey districts. The farm household consists of about 6 persons out of which 3 are of working age and 3 are either children or aged above 65 years. The dependency ratio[3] for all districts was 1.1 and significantly higher in Mwingi and Kibwezi than in Meru and Tharaka.

Table 6. Household size and farm dependency ratio.

District	Household size	Adults	Aged & children	Dependency ratio
Meru South	5.4	3.2	2.2	0.81
Tharaka South	5.8	3.2	2.6	0.97
Mwingi Central	6.4	3.2	3.1	1.3
Kibwezi	5.9	3.0	2.9	1.2
All	5.9	3.2	2.7	1.1
F test p value	0.02	0.63	0.001	0.00

Dependency ratio = (No. aged <15 + no. aged >64)/no. aged between 15 and 64

Household size and dependency ratio by gender

While the household size did not vary by gender of farmer, dependency ratio was significantly higher in farms where women were the farmers/respondents (Table 7). This means that there were more persons of non-working age in farms run by females than males.

3. Dependency ratio is defined as proportion of non-contributors to family labor to be cared for: a dependency ratio of 1.5 means than one unit of working family labor works in order to sustain him/herself and 1.5 other persons. It's calculation = no of persons aged less than 15 years of age plus the elderly of more than 64 years divided by family members between 15 and 64 years.

Table 7. Household size and dependency ratio by gender.

Gender of farmer	Household size	Dependency ratio
Female	5.8	1.3
Male	5.9	0.9
All	5.9	1.1
F test p value	ns	0.001

ns=no significant difference

Land resources and ownership

In all districts, leasing out or hiring of land is rare as 99 percent of respondents reported owning the land that they cultivated during the long rains (March-May) and short rains (October-December). Table 8 shows farm size and cultivated area. The mean farm size was 7.8 acres and the farms were significantly larger in Kibwezi than in other districts. During LRs in all districts, 54% of the land was cultivated and as expected larger areas were cultivated in Kibwezi than in other districts. While in SRs 58% of the land was cultivated, with the area cultivated being significantly higher in Kibwezi than in other districts. Farmers cultivated slightly larger areas in SRs than in LRs and this was expected as the SRs are more reliable than LRs in the SALs of Eastern Kenya.

Table 8. Farm size and area of land cultivated.

		Area (acres) cultivated		Area (acres) left fallow	
District	Farm size	LRs	SRs	LRs	SRs
Meru South	8.2	3.4	3.5	5.2	5.2
Tharaka South	5.6	4.0	4.0	3.7	4.0
Mwingi central	7.1	4.3	4.5	3.4	3.3
Kibwezi	10.3	5.2	6.0	6.0	5.4
All	7.8	4.2	4.5	4.7	4.6
F p value	0.000	0.000	0.000	0.096	0.076

Farm and cropland size by gender

Female farmers had significantly smaller farms, smaller cultivated and pasture areas than their male counter parts (Table 9). Farm sizes and cultivated land, respectively, for male farmers were 2 acres and ½ acre larger than for their female counterparts. Therefore, land resource constraint was more important to female operated farms than male operated ones.

Table 9. Farm and cropland size (acres) by gender.

		Area (acres) cultivated		Area (acres) left fallow	
Gender of farmer	Farm size	LRs	SRs	LRs	SRs
Female	6.9	3.9	4.2	3.8	3.7
Male	8.8	4.5	4.8	5.5	5.3
All	7.8	4.2	4.5	4.7	4.6
P level	0.016	0.045	0.075	0.067	0.073

Sorghum cropping systems

Number of crops

There was a wide diversity of crops grown in the 4 survey districts during the October-December 2011 season (Table 10) with some cultivating more than 10 crops in a single season.

Table 10. The number of crops grown during October-December (SRs) 2011 season.

District	Mean number of crops grown	Min	Max
Meru South	6.3	1	12
Tharaka South	6.8	3	13
Mwingi Central	6.3	0	12
Kibwezi	6.5	1	11
All	6.5	0	13
P value	0.18	-	-

Cultivation of sorghum and maize

Virtually all households cultivated sorghum in the survey districts (Table 11). Over 82% of households cultivated maize, although the proportion of maize cultivators was higher in Mwingi and Kibwezi than in Meru South and Tharaka South districts. With the knowledge that maize is more susceptible to drought, one expects more households to suffer the effects of food insecurity in Mwingi and Kibwezi than in Meru South and Tharaka South districts. Nevertheless, the majority of households (> 81%) cultivated both sorghum and maize with only a tiny proportion cultivating only one without the other. This was a strategy by local farmers to avert the risk of drought on cereals production and reduce household food insecurity.

Table 11. Percentage of farmers cultivating sorghum and maize during SRs 2011-2012 season.

	Percentage of farmers reporting cultivating the crop 2011-2012 season				
District	Sorghum	Maize	Maize & sorghum	Sorghum only	Maize only
Meru South	97.5	87.5	85.0	12.5	2.5
Tharaka South	99.2	82.5	81.7	17.5	0.8
Mwingi Central	96.5	94.2	90.8	5.0	1.7
Kibwezi	100	95.8	95.8	4.2	0
All	98.5	90.0	88.3	9.8	1.2
P value	0.326	0.002	0.003	0.001	0.337

Intercropping

A greater proportion of farmers in Meru South and Mwingi Central than in Tharaka and Kibwezi intercrop sorghum (Table 12). The main intercrops of sorghum as reported by respondents were:

1. Cowpea – 26%
2. Another sorghum variety – 23%
3. Maize – 21%
4. Green grams – 16%
5. Pigeonpea – 9%

Awareness creation through training of farmers on intercropping techniques and to discourage them from intercropping sorghum with other cereals is proposed in SMU.

Table 12. Level of intercropping in sorghum cropping systems.

District	Percentage intercropping sorghum
Meru South	90
Tharaka South	57
Mwingi Central	75
Kibwezi	37

P = significant

Row planting

Row planting, as opposed to broadcasting, was widely practiced with 100 percent of farmers in Kibwezi and Tharaka South reporting the practice while in Meru South and Mwingi Central, respectively, 77 percent and 89 percent of respondents practiced row planting.

History of sorghum and maize cultivation

Generally, sorghum had been cultivated for a longer period in Meru South and Mwingi Central than in Tharaka South and Kibwezi (Table 13). Maize, however, had been cultivated for a slightly longer period than sorghum in all the districts, except Meru South, where the period was the same for both the crops.

Table 13. Average period maize and sorghum has been farmed.

District	Mean years for sorghum cultivation	Mean years for maize cultivation
Meru South	20.8	19.7
Tharaka South	10.0	12.0
Mwingi Central	15.7	17.8
Kibwezi	11.8	18.2
All	14.7	17.3
P value	0.00	0.00

Acreages for sorghum and maize

About 1/3 of cropland in the 4 survey districts was allocated to sorghum production (Table 14). The highest allocation of land for sorghum production was in Meru South where about 50% of cropland was used. About 50% of the cropland in all districts was allocated for maize production, with the highest allocation reported in Kibwezi at 55%. At the end of the project, it is expected that land allocation to sorghum would have increased.

Table 14. Land allocation to sorghum and maize during the SRs 2011-2012 season.

	No of plots		Mean area in acres (% of farm size)	
District	Sorghum	Maize	Sorghum	Maize
Meru South	1.2	1.0	1.7 (49)	1.3 (37)
Tharaka South	1.0	1.0	1.2 (30)	1.6 (40)
Mwingi Central	1.0	1.1	1.2 (27)	1.9 (42)
Kibwezi	1.1	1.0	1.9 (32)	3.3 (55)
All	1.1	1.0	1.5 (33)	2.1 (47)
P value	0.000	0.046	0.000	0.000

Use of improved sorghum varieties

About 2/3 of the respondents in Tharaka South, Mwingi Central and Kibwezi used improved sorghum variety Gadam, while in Meru South the use level was about ¼ of the respondents (15). The most popular local sorghum landrace, because of its good fermenting qualities, was Mugeeta.

Table 15. Use of improved sorghum varieties during SRs 2011-2012 cropping season.

	Use of sorghum varieties (% of responses)				
District	Gadam	Mugeeta	Kaguuru	Serena/Seredo	Others
Meru South	23	29	33	3	12
Tharaka South	64	11	21	2	2
Mwingi	66	2	0	7	25
Kibwezi	64	0	0	20	16
All	53	11	14	8	14

Gender and use of improved sorghum varieties

Higher proportion of male than female farmers reported use of improved Gadam sorghum variety (Table 16). Mugeeta, a local variety, was used by female and male farmers in equal proportions. The reasons for this was not obvious, but could be due to limited access to extension information by women and/or women farmers are not owners of land and many are not allowed to use new technologies on family land without prior consent of the spouse.

Table 16. Use of improved sorghum seed: male and female farmers compared.

Gender of farmer	Use of sorghum varieties (% of cases)				
	Gadam	Mugeeta	Kaguuru	Serena/Seredo	Others
Female	54	13	20	9	10
Male	61	12	12	8	16
All	58	12	16	8	13

Sources of information in survey sites

Varietal information

The most important sources of information on improved varieties in general were (in descending order of importance) other farmers (35%), government extension (30%) and NGOs (17%). When you analyze for improved variety Gadam this order changes slightly to government extension (41%), other farmers (24%), NGOs (21%), seed grain stockists (6%), research trials and demos (5%), farmer groups (2%) and radio (1%). A radio is owned by every household and has much greater potential for information dissemination for improved sorghum varieties.

Table 17. Major sources for information on improved sorghum varieties.

	Information sources for improved varieties (% of responses)				
District	Other farmers	Government extension	NGOs	Farmer groups	Research trials and demos
Meru South	57	27	7	4	3
Tharaka South	22	34	5	13	4
Mwingi	23	52	20	0	0
Kibwezi	29	9	39	2	11
All	35	30	17	5	4

Sources of information on improved sorghum variety by gender

The most important sources of information on improved varieties were (in descending order of importance) other farmers, government extension and NGOs with government extension and NGOs reaching more male than female farmers (Table 18). However, other farmers, as a source of information on improved varieties, reached a greater proportion of female than male farmers, while government extension reached a greater proportion of male respondents than their female counterparts – explaining why a greater proportion of male farmers than female have adopted Gadam. This calls for interventions such as use of other farmers to pass variety information to the rest, especially women farmers.

Table 18. Information sources on improved varieties: Male and female respondents compared.

	Information sources for improved varieties (% of responses)					
Gender	Other farmers	Government extension	NGOs	Seed/grain stockist	Farmer group	Research trials/demos
Female	38	25	15	9	6	6
Male	32	34	19	7	4	3
All	35	30	17	8	5	4

Farmer awareness for Gadam sorghum

Figure 2 shows that awareness creation for Gadam started about 2006 but was most intense from 2009-2011 when the majority of farmers learnt about the improved variety. This could be directly attributed to the work of Africa Harvest in this area.

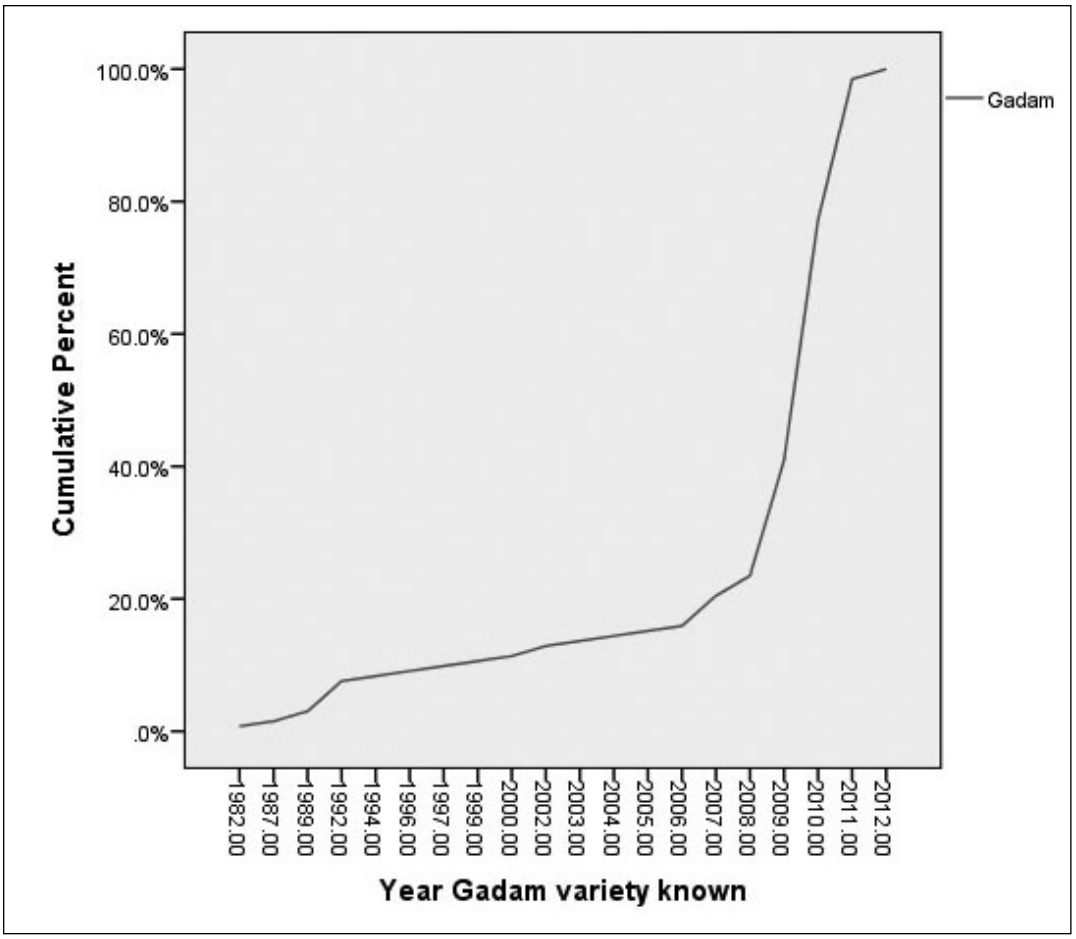


Figure 2. Knowledge of Gadam sorghum.

Seed systems for sorghum

Seed sources

The main sources of improved sorghum seed (in descending order of importance) were Government or KARI, agro-dealers and NGOs (Table 19). For local sorghum the predominant seed sources were recycled (51%) and local shops (39%). The majority of the farmers recycle seed of sorghum and hence training on on-farm seed production is required to improve the quality of seed through this channel. Further analysis showed that there was no significant variation between male and female respondents with regard to their preferred sources of sorghum seed.

Table 19. Main sources of seed.

Sorghum types	Agro-dealers	Local shops	NGOs	Govt/KARI	Ext & Res demos	Farmer groups	Recycled/ Own seed
Improved	17	23	16	23	7	7	7
Local	4	39	1	0	0	3	51
All	12	28	11	15	5	6	34

Chi-square test: p=0.000

Quantities of local and improved seed used

Farmers in Meru South and Kibwezi used significantly larger quantities of sorghum seed than in Tharaka South and Mwingi Central (Table 20). This could be due to earlier results in this report that showed the mean area under sorghum was larger in those 2 districts.

Table 20. Quantities of sorghum seed used.

District	Quantity used (kg) per farmer
Meru South	4.5
Tharaka South	2.8
Mwingi Central	3.6
Kibwezi	6.1
All	4.1
P value	0.001

Quantity of sorghum seed and Gender

Female farmers used 1.5 kg less of sorghum seed than their male counterparts (Table 21). This may be a reflection of the smaller sorghum acreages they cultivate than their counterparts. However, there was no significant variation between amount of improved and local seed used.

Table 21. Quantity of seed used and gender.

Gender	Quantity of seed used (kg)
Female	3.4
Male	4.8
All	4.0
P value	0.015

Seed prices

Seed prices were lower in Tharaka South than in the other 3 sites (Table 22). However, there was no significant variation, statistically, in prices by gender and by seed types (local or improved), although improved sorghum seed prices were higher than for local sorghum seed by KES 20.

Table 22. Sorghum seed prices in the survey sites.

District	Mean prices (KES per kg)
Meru South	76
Tharaka South	40
Mwingi Central	94
Kibwezi	76
All	74
P	0.02

Sorghum grain production

Household production and use

Household production is significantly higher in Mwingi than in the other 3 districts (Table 23), while sorghum grain consumption was significantly less in Tharaka South.

Table 23. Quantity of grain harvested and used (kg).

	Quantity of grain harvested and used (kg) per household (% total harvest)			
District	Total harvest	Sales	Consumed	Seed
Meru South	280	171 (61)	91 (33)	17 (6)
Tharaka South	231	200 (87)	38 (16)	12 (5)
Mwingi South	553	238 (43)	74 (13)	15 (3)
Kibwezi	366	278 (76)	81 (22)	16 (4)
All	340	226 (66)	73 (21)	16 (5)
P level	0.08	ns	0.000	ns

Household sorghum grain production and use, and gender

Male farmers realized a household production of 135 kg (1.5 bags) more than the female farmers (Table 24) as well as exhibiting significantly higher sorghum grain consumption amounts. The reason for this variation is that the male respondents cultivated 0.5 acre of sorghum more than their female counterparts (Table 9).

Table 24. Household sorghum grain production and use by gender.

	Quantity of grain harvested and used (kg) per household			
District	Total harvest	Consumed	Sales	Seed
Female	239	61	190	16
Male	373	85	254	15
All	307	73	224	16
P value	0.08	0.01	ns	ns

Sorghum productivity

In both seasons, sorghum grain productivity was significantly higher in Mwingi than in the other 3 sites (Table 25). However, further analysis showed no significant productivity difference between male and female farmers nor was there any significant difference between use of local and improved sorghum varieties. Nevertheless, use of farmyard manure on sorghum grain production significantly ($p<0.02$) improved productivity by about 35%. Furthermore although there was no significant positive correlation between row planting and sorghum grain productivity, the households that practiced row planting reported significant ($p<0.05$) higher sorghum grain production by over 40% than those who practiced random planting or broadcasting. Row planting enables farmers to manage bigger plots of sorghum than in random planting. Therefore, to improve grain volumes for consumption and marketing, row planting and soil fertility enhancing technologies should be promoted by SMU.

Table 25. Sorghum productivity in SRs and LRs.

	Sorghum productivity in kg per acre	
District	Short rains	Long rains
Meru South	336	266
Tharaka South	272	201
Mwingi	501	305
Kibwezi	216	190
All	327	239
P value	0.000	0.04

Purchased inputs

Generally, in all the 4 survey districts use of purchased farm inputs was minimal, except for hired labor and seed.

Farmyard Manure

Farmers used mainly their own preserved manure and its use was highest in Mwingi and Meru South (Table 26).

Table 26. Manure use and purchase.

District	Percent using farmyard manure	Percent purchasing manure
Meru South	36	0
Tharaka South	23	2
Mwingi	44	5
Kibwezi	10	1
All	28	2
P value	0.000	0.02

Other inputs

The most important purchased inputs were, in descending order, hired labor, oxen, sorghum seed and pesticides with the use varying significantly between the survey sites (Table 27). The use of inorganic fertilizers was nil. The use of purchased inputs did not vary significantly by gender of farmer except in the use of purchased seed where almost twice as many male famers (22%) purchased sorghum seed compared to the female farmers (12%).

Table 27. Purchase of other inputs.

	Percent of farmers reporting purchase of the farm input			
District	Sorghum seed	Pesticides	Oxen	Labor
Meru South	15	8	50	68
Tharaka South	14	10	56	63
Mwingi	29	2	23	43
Kibwezi	8	29	26	44
All	17	12	39	54
P value	0.000	0.000	0.000	0.000

Sorghum utilization

Household level use

The majority of farmers interviewed used sorghum grain as food (43%), feed (38%) for chicken and for sale (19%) in local markets (Table 28). Further analysis showed that higher proportion of women farmers (47%) than male farmers (38%) cited using sorghum grain as a food. Sorghum grain was important both for human food and feed, especially for chicken.

Table 28. Uses for sorghum grain.

	Uses for sorghum grain (% of responses)		
District	Food	Feed	Sale
Meru South	51	29	19
Tharaka South	31	33	36
Mwingi Central	56	39	5
Kibwezi	34	54	12
All	43	38	19

The most important uses for sorghum flour were for preparing porridge and ugali (Table 29). In Kibwezi, sorghum flour uses at household level were more diversified than in the other sites to include use in chapatti and in chicken feed.

Table 29. Household level uses for sorghum flour.

	Major use of sorghum flour (% of responses)					
District	Porridge	Ugali	Alcohol	Cake	Chapatti	Chicken feed
Meru South	46	39	10	5	0	0
Tharaka South	73	19	7	0	0	0
Mwingi Central	43	40	0	18	0	0
Kibwezi	47	41	0	2	4	6
All	50	37	4	7	1	2

Marketing

Sorghum varieties and their products sold

Table 30 shows that the most important sorghum products sold were grain (90% of responses) and non-alcoholic drink (8% of responses). Furthermore, there was no variation between female and male farmers in the sale of sorghum products.

Table 30. Sorghum varieties and their products sold.

Sorghum varieties	Percent of responses reporting sale of the product				
	Grain	Flour	Alcoholic drink	Non-alcoholic drink	Fodder
Gadam	93	1	2	4	0
Mugeeta	81	2	0	17	0
Kaguru	86	2	1	10	0
Serena	79	0	0	21	0
Seredo	80	0	1	20	0
All	90	1	1	8	0

Sorghum products sold and buyers

Table 31 shows major sorghum products sold to key buyers, which included broker/or middleman (67%), consumer (16%), rural assembler (13%) and urban trader (4%).

Table 31. Types of sorghum products sold and their buyers.

Sorghum product	Percent of farmers reporting buyers				
	Broker or middlemen	Consumer of other farmer	Rural assembler	Urban grain trader	Exporter
Grain	67	16	13	4	0
Flour	0	60	40	0	0
Alcoholic drink	57	29	0	14	0
Non-alcoholic	17	33	33	17	0
All	65	17	13	4	0

Location of buyers

The majority of buyers were located in equal proportions in village and town markets except the urban trader who transacted business mainly in towns. Ten percent of respondents reported some purchases from the farm gate (Table 32).

Table 32. Location of buyers.

Buyer	Percent reporting location of buyer		
	Farm gate	Village market	Town market
Broker/middleman	8	49	43
Consumer	15	32	52
Rural assembler	11	58	31
Urban trader	10	10	81
All	10	46	45

Buyers, quantity sold and prices

While the mean quantities sold by farmers to different buyers did not vary statistically, the grain prices differed significantly with the consumers and urban traders offering higher prices than other buyers (Table 33).

Table 33. Buyers: quantity sold and prices.

Buyer	Mean quantity (kg) sold	Price (Kes/kg)
Broker/middlemen	321	20
Consumer	190	38
Rural assembler	326	22
Urban trader	375	27
All	304	28
P value	ns	0.000

Location of buyers and grain prices

The buyers bought grain from farm gate, village and town markets. Mean quantities sold to town markets were significantly higher than to other markets, while prices were significantly higher in town than in other markets (Table 34).

Table 34. Grain prices and location of buyers.

Location of buyer	Mean quantity (kg) sold	Price (Kes/kg)
Farm gate	304	25
Village market	220	26
Town Market	403	32
All	303	28
P value	0.05	0.02

Quantities sold and prices received by gender

Although female and male farmers did not differ significantly on who they sold the sorghum grain to nor the location of their point of sale, the female farmers, however, transacted significantly smaller quantities and received significantly lower prices (Table 35). Female respondents traded in smaller quantities because they produced less grain (Table 24) and received lower prices perhaps because the majority are forced to sell when the supply is high and prices are low. This has a further implication in that it will depress farm incomes in households whose farms are managed by women.

Table 35. Amount of grain sold and prices received by gender.

Gender	Quantity sold (kg)	Price per kg received
Female	227	26
Male	333	31
All	280	28
F Value	0.06	0.01

Sorghum grain marketing challenges

Table 36 shows that the most important sorghum marketing challenge cited by farmers is low pricing (41%). Furthermore, the challenges affected both female and male farmers equally, despite the earlier finding that showed that female farmers received significantly lower prices for their sorghum grain.

Table 36. Sorghum grain marketing challenges.

	Percentage of responses on marketing challenges						
District	Quality info	Buyer info	Low prices	Market distance	Price info	Brokers fix price	Others
Meru	5	11	39	17	13	13	2
Tharaka	2	7	49	5	13	23	1
Mwingi	6	11	38	16	8	21	0
Kibwezi	10	21	39	6	11	11	2
All	6	12	41	11	11	17	2

Value addition

The major value addition activities reported by respondents were milling sorghum grain alone (38%), blending or mixing with maize, pearl millet, cassava, cowpea, green gram or wheat for milling (36%), wet milling (15%) and dehulling (6%).

Collective action in sorghum marketing

Access and participation

Table 37 shows that collective action activities were significantly higher in Tharaka South (15%) and Kibwezi (12%), although farmer participation in these activities were minimal in Tharaka South (2%). Some collective action activities mentioned were food for work, women groups for money lending and/or farm work and limited product marketing.

Table 37. Access to and participation in collective sorghum marketing.

	Percentage of farmers reporting	
District	Availability of collective action in village	Participation in collective action
Meru South	2	2
Tharaka South	15	2
Mwingi	6	0
Kibwezi	12	12
All	8	4
P value	0.002	0.000

Gender and collective action

Significantly higher number of female than male farmers was aware of collective action activities in their village, but their level of participation was minimal and not significantly different from men's participation (Table 38).

Table 38. Gender perspectives in access to and participation in collective action.

	Percentage of farmers reporting	
Gender	Availability of collective action in village	Participation in collective action
Female	12	3
Male	4	5
All	8	4
P value	0.002	ns

Constraints to collective action

The most important constraints to collective marketing, in descending order of importance, were low grain production, inability to adhere to grain quality requirements, delayed payment for deliveries and restrictive nature of collective marketing (Table 39). Female and male farmers were affected in equal proportion by the collective marketing constraints. Amalgamation of producer marketing groups from existing farmer groups for the purpose of group marketing can only succeed in improving income from grain marketing if SMU intervenes in promoting productivity improvement technologies, better access to seed of market-preferred varieties, better postharvest handling techniques, cash payment to farmers on delivered grain and linkage to urban traders and industry.

Table 39. Constraints to collective marketing.

	Percentage of farmers reporting constraint				
District	Inadequate supply of grain	Grain quality restriction	Delayed payment for deliveries	Prices lower than in local market	Limited market options
Meru South	35	41	39	10	24
Tharaka South	36	48	15	1	0
Mwingi	27	11	36	8	63
Kibwezi	50	22	26	0	2
All	36	30	29	5	25

Food insecurity

Adequacy of food produced

In all sites only 30% of the households produced food to last 7 months or more in a year (Table 40). With the data disaggregated by gender, 32% of female farmers compared to 28% male farmers produced food to last 7 months or more.

Table 40. How long self-produced food lasts in the household.

	Percent reporting no of months food from own production is available			
District	1-3 months	4-6 months	7-9 months	>9 months
Meru South	22	38	38	1
Tharaka South	31	43	20	7
Mwingi	23	46	25	6
Kibwezi	31	44	21	5
All	27	43	25	5

P value = ns

Period of food shortage

The hunger period for the survey sites was from April to November for all sites except for Kibwezi, which showed a longer period, to December (Figure 3). A smaller proportion of households where women were the respondents exhibited hunger episodes for a shorter period of time than the male respondents (Figure 4).

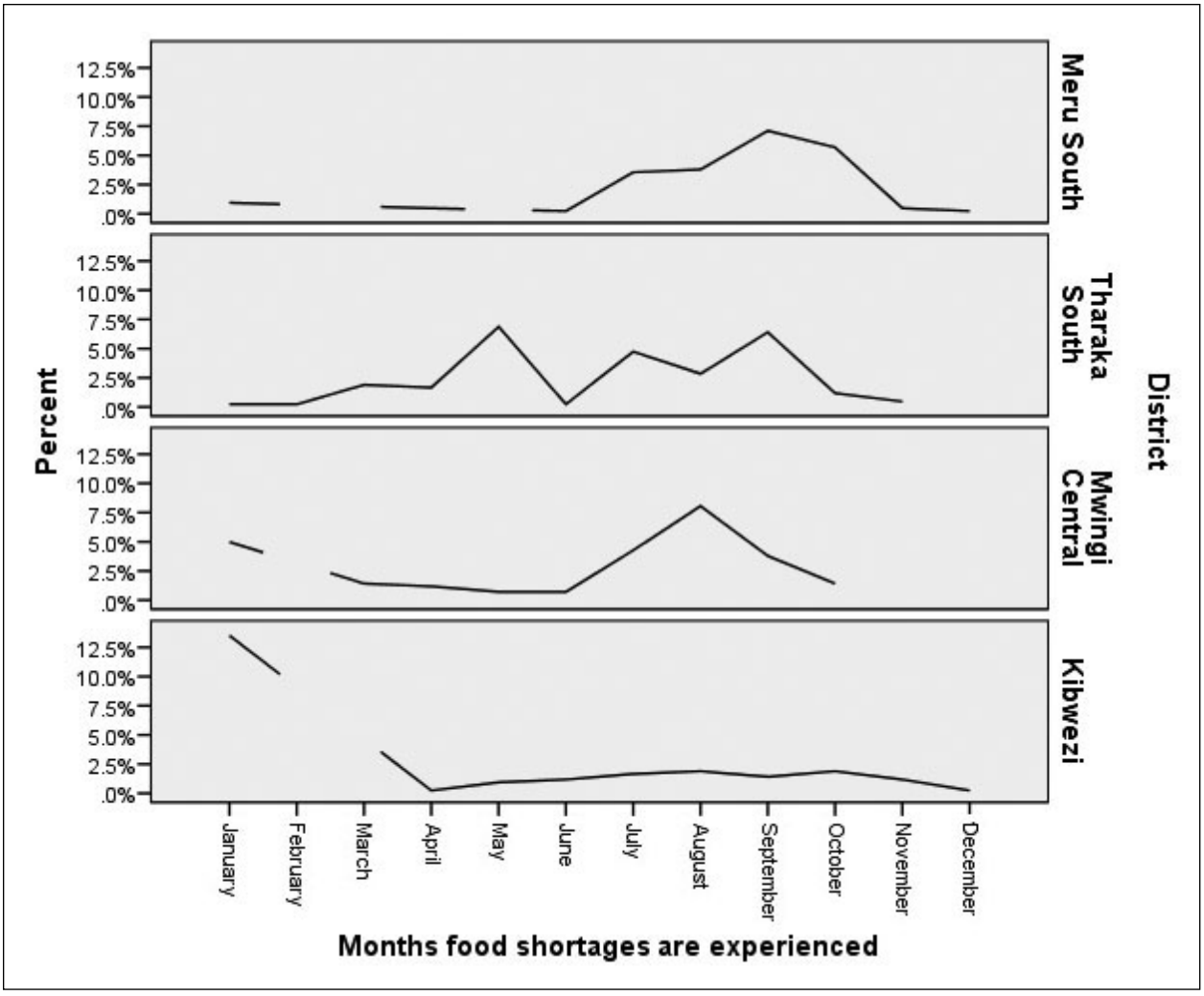


Figure 3. Hunger period in the survey sites.

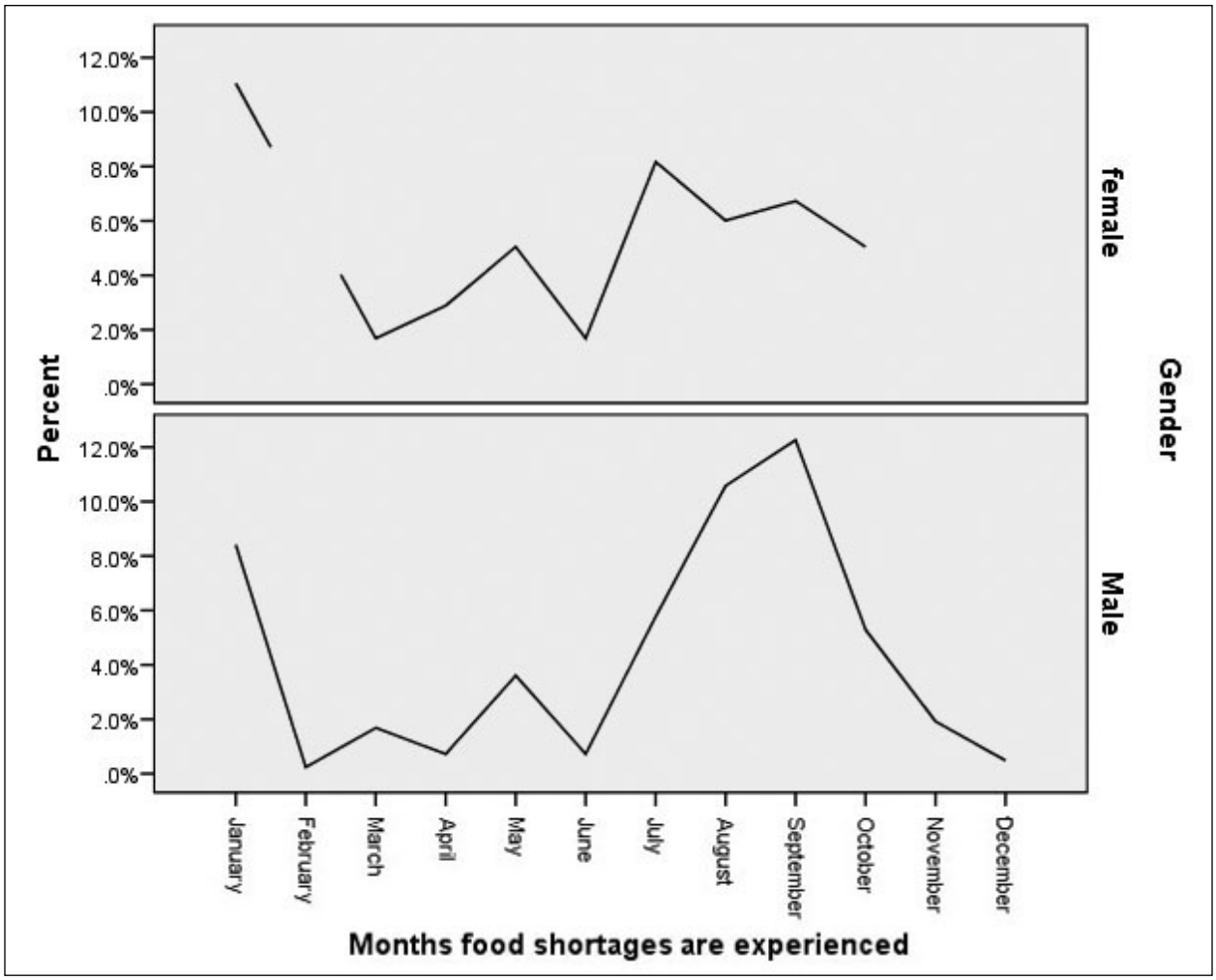


Figure 4. Hunger periods in the survey sites as perceived by male and female respondents.

Food production constraints

The causes of food insecurity in the survey districts as reported by respondents, in descending order of importance, were drought (85%), pests and diseases (56%), poor soils (38%), land shortage (22%), sale of produce (21%), inadequate seed (17%), lack of fertilizer (14%), labor shortage (12%) and draft power shortage (5%).

Summary, conclusions and recommendations

The Eight SMU mandate districts in Eastern Province of Kenya were grouped into four technology recommendation clusters according to agro-ecologies from which 4 survey sites (Meru South, Tharaka South, Mwingi Central and Kibwezi) were selected purposively through a multistage sampling process, and subsequently a random sample of 120 respondents was selected from each of the 4 chosen sites for the baseline survey. A total random sample of 480 was interviewed.

The production environment was varied with better road infrastructure and accessibility to local markets reported in Tharaka South and Kibwezi than was reported in Meru South and Mwingi Central Districts. Marketing transaction costs, especially transport cost, is expected to be higher in Meru South and Mwingi and collective marketing action to reduce these costs is critical. Although about ½ of the respondents reported that they were within 10 km of extension offices, the majority of respondents (71%) rated extension as poor or non-existent. Most farmers were dependent on radio, other farmers and agro-dealers for general agricultural information. Therefore, strengthening use and effectiveness of these innovative information channels in SMU is important. Although credit awareness was higher in Mwingi and Kibwezi clusters than Meru South and Tharaka South clusters, their use was minimal. This calls for strengthening the credit-farmer linkages in the SMU project.

Of the 480 farmers interviewed, about ½ were women who actively participated in decision making in the farming process. Higher illiteracy level was reported in Meru South and Tharaka South than in the other 2 clusters. Higher proportion of respondents in Meru South and Tharaka South than in Mwingi and Kibwezi reported farming as the only occupation and source of livelihood.

The average household size was 6 persons with a higher dependency ratio (more dependents or non-working age group to care for) in Mwingi and Kibwezi clusters than Meru South and Tharaka South. There was also a significantly higher dependency ratio in farms run by women (1.3) than those managed by men (0.9). Therefore, the implication is that farms managed by women are more constrained by labor shortage. Labor-saving technologies are, therefore, recommended to reduce the bottleneck.

The average farm size was 7.8 acres out of which 54% was cultivated in long rains (LRs) in March-May and 58% cultivated in short rains (SRs) in October-December. About one-third of cultivated land was under sorghum production in the 4 survey sites with highest allocation of about 50% reported in Meru South.

Furthermore, female farmers or respondents reported a smaller farm size and cultivated area of 2 acres and 0.5 acre, respectively, than their male counterparts. Land constraint was more acute in farms owned by women and therefore require interventions for intensification and productivity enhancement technologies.

All farmers (100%) in the 4 survey sites cultivated sorghum, with a majority cultivating it in combination with maize (88%) although a minority (10%) were cultivating only sorghum. Cultivation of sorghum and maize together was a strategy to reduce risk of crop failure due to uncertain weather and in order to reduce food insecurity.

Intercropping sorghum with cowpea, another sorghum, maize, green grams or pigeonpea was a common practice. Training in agronomic management practices is important so that farmers are discouraged from intercropping sorghum with other cereals.

Although the use of improved sorghum (Gadam variety) in all sites combined was at 53%, this use rate was lowest in Meru South (23%) and highest in Tharaka South; in Mwingi and Kibwezi about two-thirds of the farmers used Gadam. A higher proportion of male farmers (61%) than female farmers (54%) reported use of the improved variety Gadam. This could be due to limited

access to extension information and/or seed of Gadam by women or because women farmers are not owners of land and many are not allowed to use new technologies on family land without prior consent of the spouse.

The most important source of information on improved sorghum varieties reported by 35% of respondents was other farmers. The other interesting result on information dissemination was that government extension and local NGOs reached a greater proportion of male farmers than female farmers while other farmers as a channel of information dissemination reached a higher proportion of female than male farmers.

SMU should take full advantage of this, and train farmers as trainers (TOT) and facilitate them to train others. Although currently, the use of radio to access sorghum varietal information is minimal, radios are virtually available in all households and should be targeted by SMU to communicate varietal and other information on improved technologies to target farmers. The greatest awareness creation realized on Gadam variety was between 2009 and 2011. SMU need to learn from these awareness creation activities and upscale them.

Although the study revealed that the most important sources of improved seed were NGOs and KARI, agro-dealers and local grain shops, recycling of seed from the previous harvest was very common. SMU should, therefore, train farmers on on-farm seed production and preservation to improve the quality of recycled seed. On average, farmers used about 4 kg of sorghum seed for planting in a single planting although they preserve about 16 kg of seed from the previous harvest to cater to repeated planting and crop failures due to drought episodes. The study also revealed that female farmers used 1.5 kg less of sorghum seed than their male counterparts. This was due to the fact that they cultivated smaller areas or experienced other limitations in accessing seed.

The major household level use for sorghum was to make porridge and ugali, while the other uses such as making of cake, chapati, chicken feed and alcohol were minimal. SMU should, therefore, have value addition activities to promote and diversify the household level use of sorghum products for food and marketing.

On average, farmers produce about 4 bags of sorghum grain per household out of which about 65% is sold, 30% is consumed and 5% is preserved as seed. Women produce about 1.5 bags per household less than their male counterparts due to land, labor, information and seed access constraints. Sorghum productivity was highest in Mwingi (501 kg/acre) and lowest in Kibwezi (216 kg/acre) and there was no productivity difference between male and female farmers. There was a positive and significant correlation between sorghum grain productivity and farmyard manure use while household level grain production had a positive and significant correlation with use of row planting technology.

While use of inorganic fertilizer was nil, use of farmyard manure was highest in Mwingi (44%) and lowest in Kibwezi (10%). Sorghum seed, pesticides, draft power and hired labor were other purchased inputs used by farmers. Almost double the number of male respondents compared to their female counterparts purchased seed from the market.

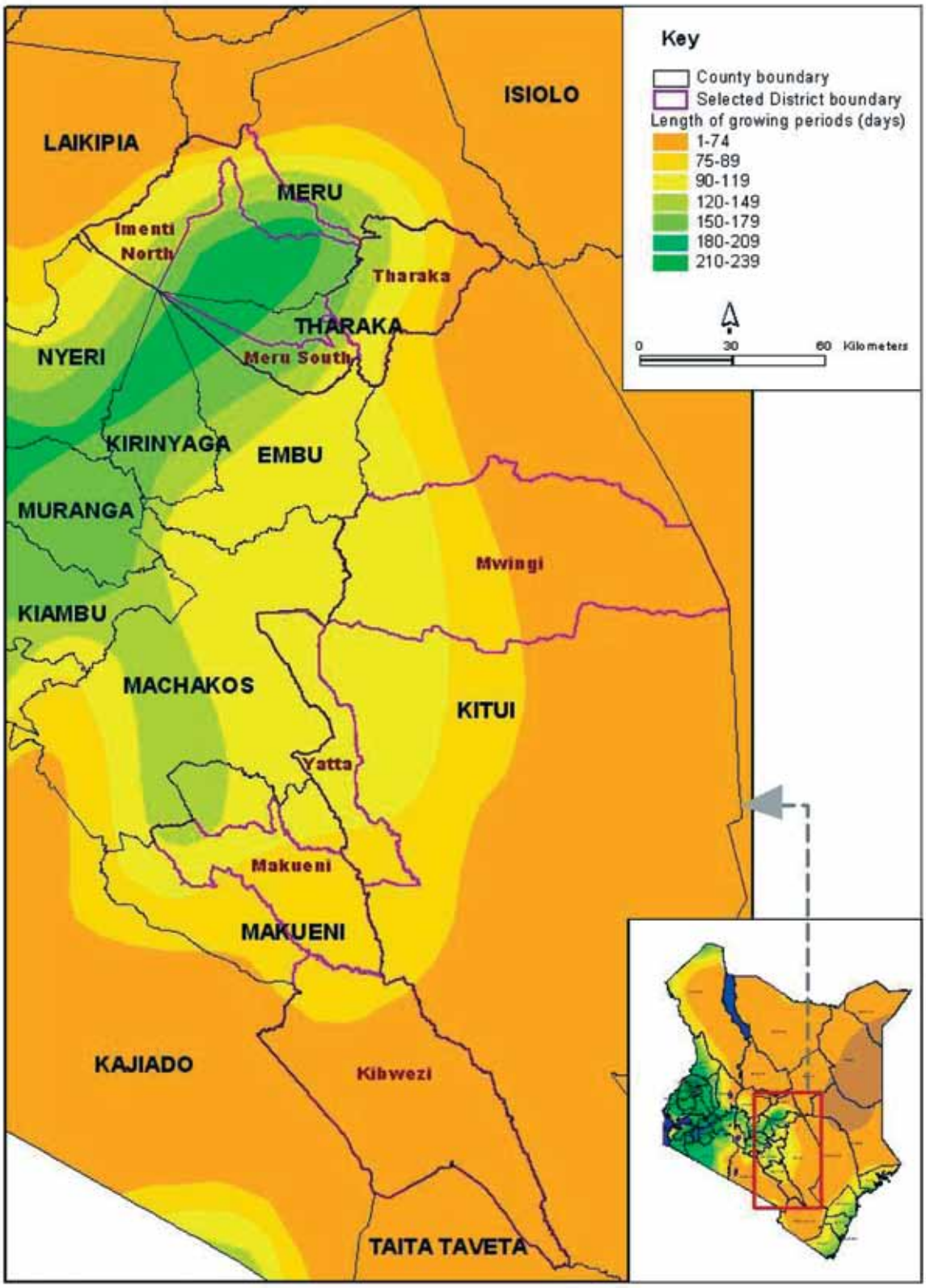
The most important sorghum product marketed is grain. The most important buyers were (in descending order of importance) brokers or middlemen, consumer, rural assembler and

urban trader who transacted business mostly in village and town markets. The most important sorghum grain marketing constraint was low prices. Lowest prices were offered by brokers and rural assemblers, while the highest prices were offered by consumers and urban traders. Therefore, farmers can increase their sorghum grain market margin by engaging in collective market action to compete with brokers and rural assemblers. The study reveals that the female farmers transacted significantly smaller quantities of grain and received significantly lower prices. Female respondents traded in smaller quantities because they produced less grain and received lower prices, perhaps, because the majority were forced to sell when the supply was high and prices were low during the peak harvest time in order to meet their urgent financial needs. Therefore, the SMU project should undertake interventions that enhance farm productivity, reduce input and product transaction costs, expedite cash payments on grain delivery and stabilize prices and farm incomes.

Although collective marketing awareness was significantly more in Tharaka South and Kibwezi, the participation of farmers in these activities were minimal due to low grain production (36%), grain quality restriction (30%), delayed payment for grain deliveries (29%) and restriction on free marketing (25%). With these study results and further discussion with grain buyers to establish their market margins, SMU will be well placed to identify producer and marketing groups to establish a pilot small-size version of commercial scale value chain and work out standard procedures and best practices to test and improve the efficiency of sorghum grain marketing in SMU mandate districts. As SMU and stakeholders initiate this activity, there should a deliberate effort to overcome identified collective marketing constraints with consultation/ participation with all major stakeholders.

Furthermore, current value addition activities were limited only to milling of sorghum grain, blending with other crops and milling, wet-milling and dehulling. Development and promotion of more sorghum value added products and linking these products to local and urban markets is essential.

Annex 1



Length of growing periods in selected study districts of Kenya. SMU project mandate districts labeled in red.

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International Crops Research Institute for the Semi-Arid Tropics

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The **International Crops Research Institute for the Semi-Arid Tropics** (ICRISAT) is a non-profit, non-political organization that conducts agricultural research for development in Asia and sub-Saharan Africa with a wide array of partners throughout the world. Covering 6.5 million square kilometers of land in 55 countries, the semi-arid tropics have over 2 billion people, of whom 644 million are the poorest of the poor. ICRISAT innovations help the dryland poor move from poverty to prosperity by harnessing markets while managing risks – a strategy called Inclusive Market-Oriented Development (IMOD).

ICRISAT is headquartered in Patancheru, Telangana, India, with two regional hubs and six country offices in sub-Saharan Africa. It is a member of the CGIAR Consortium. CGIAR is a global research partnership for a food secure future.

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