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Knowledge and Information Systems on Sorghum Amongst Sorghum Farmers in Nyanza, Eastern and Coastal Regions, Kenya

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Abstract
As climate change continues to impact negatively on crop productivity, hardy crops such as sorghum could end severe food insecurity due to their potential to withstand adverse conditions. Farmers rely on localized indigenous knowledge passed on by word of mouth, informal training systems and growing practices as farmers interact. Though there are many stakeholders in sorghum production and its value chain, access to information and knowledge by farmers is still limited especially in marginalized regions. To understand information and knowledge management systems in sorghum production and how stakeholders interact a study was conducted in Eastern, Nyanza and Coastal regions of Kenya using structured questionnaires. The results showed most farmers were females. Majority had attained primary and secondary education, while 7.5% had no education. Farmer-to-farmer source of information on where to source seed was highest compared to agricultural extension officers and media advertisement. 60% do not consult where to get seed, instead use on farm saved seeds. Majority use traditional knowledge through experience compared to sources such as ministry of Agriculture, trainings and fellow farmers. Farmer-to-farmer information network and market analysis was commonly used on where to sell the grain. On-farm saved seed was selected based on size and color and about 60% conduct germination test on the seed from whichever source before planting. Majority (82.5%) use on-farm saved seeds, manure/compost and cultural methods to control pests. Of the respondents, 15% (eastern) and 7.5% (coastal) reported they have no measures to respond to climate change. Majority use grain for human consumption and about 73.1% are not members of any farmer group. Therefore, sensitization on benefits of sorghum crop, formation of more active farmer groups, involvement of agricultural related stakeholders, provision of more support and capacity building could enable them attain optimum agricultural productivity.
Keywords: drought, food security, information, knowledge, sorghum, stakeholders
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1. Introduction

Sorghum (*Sorghum bicolor* (L) Moench), is ranked as fifth amongst important cereal grains in the world (FAO, 2018). The crop has a potential to withstand high temperature, drought, low fertile soils and therefore could play a key role in food security, income generation, compared to other crops that often fail due to drought (Taylor, 2003; Muturi *et al.,* 2013). Due to its ability to survive and perform under unfavorable and changing weather conditions, sorghum provides a risk reducing alternative compared to other crops hence a more reliable source of income for small holder farmers in arid and semi arid regions (Buerkert *et al.,* 2001; Sultan *et al.,* 2013; Nofou *et al.,* 2017). Climate change is adversely affecting all agricultural activities limiting food and water availability mostly in developing countries (Ringler *et al.,* 2010). This is attributed to the high levels of poverty and capacities in adoption of climate change mitigation strategies; and over reliance on rain fed agriculture (Njagi *et al.,* 2019).

As climate change impact deepens on agricultural systems, landraces of most crops such as cassava, sorghum, millet and peas have exhibited potential to thrive under different adverse environmental conditions hence could end severe food insecurity (ILRI, 2013). Considered as minor crops, there is very little information and knowledge sharing for proper ways of farming, value addition and marketing (ILRI, 2013). However, farmers growing such crops have rich indigenous knowledge of the farming practices for each crop which is localized (Wollni & Qaim, 2014). The indigenous knowledge and information is passed on from one generation to the next either through word of mouth, informal training systems and growing practices as farmers interact (Kilongozi *et al.,* 2005).

Information and knowledge management systems are globally applied in many industries to secure the

know-how, other knowledge and experiences for the future and to accomplish their goals faster and more effectively by delivering the right knowledge to the right people (Lwoga, 2009). However information and knowledge management systems in crop production have not been fully utilized (Amarendra, 2017, Arun Kumar *et al.,* 2014). Therefore, management of such systems can harness capturing, storage and dissemination of information, experiences, skills, and know-how for sustainable agricultural activities amongst farmers and other stakeholders. According to Amarendra (2017), development of efficient management systems requires the participation of stakeholders such as farmers, agriculture extension agents, researchers, and non-government organizations related to agriculture. Enhanced systems could play an important role in storage and transfer of information and knowledge amongst sorghum farmers and the other related stakeholders. Management and sharing of information and knowledge could be useful in improving crop productivity, extended shelf life, income generation and nutrition enhancing food security and livelihoods of small holder farmers.

Though there are many stakeholders in sorghum production and its value chain, access to information and knowledge by sorghum farmers is still limited especially in marginalized regions (Wanyama *et al.,* 2016). In a report by Njagi *et al.,* (2019), findings show extension services are essential in transforming subsistence farming to modern and commercial agriculture improving food security, income and reduction in poverty. In addition, landraces of such crops are under promoted with only farmers growing improved varieties accessing institutional assistance improving their productivity (Muui *et al.,* 2013). Therefore the objective of this study was to understand the information and knowledge management systems in sorghum production and how stakeholders could collaborate to ensure traditional and new advanced information systems are harnessed to improve the sector.

2. Methodology

2.1 Survey

A survey was conducted between January to April 2022 in major sorghum growing regions namely Nyanza, Eastern and Coastal regions of Kenya. Structured questionnaire was used to collect data from sorghum farmers on information and knowledge management systems between the farmers and the related agricultural stakeholders. Purposive sampling technique was used to identify the farmers based on information obtained in an earlier study (Muui *et al.,* 2019). A sample size of one hundred and twenty (120) sorghum farmers was arrived at covering forty (40) sorghum farmers per region based on various factors including availability of participants and variability of sorghum genotypes. The questionnaires were used to gather demographic and socio economic data.

2.2 Data analysis

Survey data obtained was analyzed using Statistical Programme for Social Sciences (SPSS) (IBM SPSS Statistics 20) and parameters expressed as percentages.

3. Results

3.1 Demographic information of sorghum farmers

The results showed that majority of the respondents were female compared to male sorghum farmers in Nyanza, Eastern and Coastal regions of Kenya (Table 1).

Table 1: Gender percentage (%) of sorghum farmers in Nyanza, Eastern and Coastal regions

	Male	Female
Nyanza	45.0	55.0
Eastern	47.5	52.5
Coastal	40.0	60.0

The age of most farmers' respondents was between 26 – 65 years with only 2.5% above 65 years in Nyanza (Table 2). Eastern recorded highest percentage (5.0%) of farmers under the age of between 18 – 25 years while Nyanza and Coastal recorded 2.5% each.

Table 2: Age (Years) percentage (%) of sorghum farmers in Nyanza, Eastern and Coastal regions

	18-25	26-35	36-45	46-55	56-65	>65
Nyanza	2.5	17.5	30.0	22.5	25.0	2.5
Eastern	5.0	47.5	35.0	7.5	5.0	0.0
Coastal	2.5	42.5	30.0	20.0	5.0	0.0

Majority of the farmers' respondents had attained education while only 7.5% had no education across the three regions (Table 3). Eastern and coastal regions had the highest percentage (52.5%) each of farmers who had attained secondary education while Nyanza recorded 32.5%. Nyanza was leading with 50% having attained

primary level followed by coastal region and eastern with 32.5% and 30% respectively. It was observed percentage of farmers who had reached university was lower compared to college level in the three regions.

Table 3: Education level percentage (%) of sorghum farmers in Nyanza, Eastern and Coastal regions

	Primary	Secondary	College	University	None
Nyanza	50.0	32.5	10.0	5.0	2.5
Eastern	30.0	52.5	10.0	2.5	5.0
Coastal	32.5	52.5	12.5	2.5	0.0

3.2 Value addition in sorghum grain

Of the respondents, 50% of the farmers are aware of value addition in sorghum grain in Nyanza while eastern and coastal regions only 37.5% and 40% were aware respectively. Various value addition processes and their importance were reported across the three regions (Fig 1). The value addition processes reported by the farmers include livestock feed, flour (for porridge, ugali, madazi, chapati, cakes), sorghum syrup, sorghum flakes, alcohol, fortification, sorghum rice/pilau. However, the results showed livestock feeds, flour, alcohol and fortification were most popular across the three regions. Farmers reported value addition in sorghum has importance such as enabling diversification of products, integration of sorghum with other processed products enhancing fiber and nutrient contents, enhances taste, for ease of cooking, act as supplement in livestock feed and increases income generation attained by farmers. Diversification of products, increased income and nutrition value were reported by most farmers in the three regions (Fig 1).

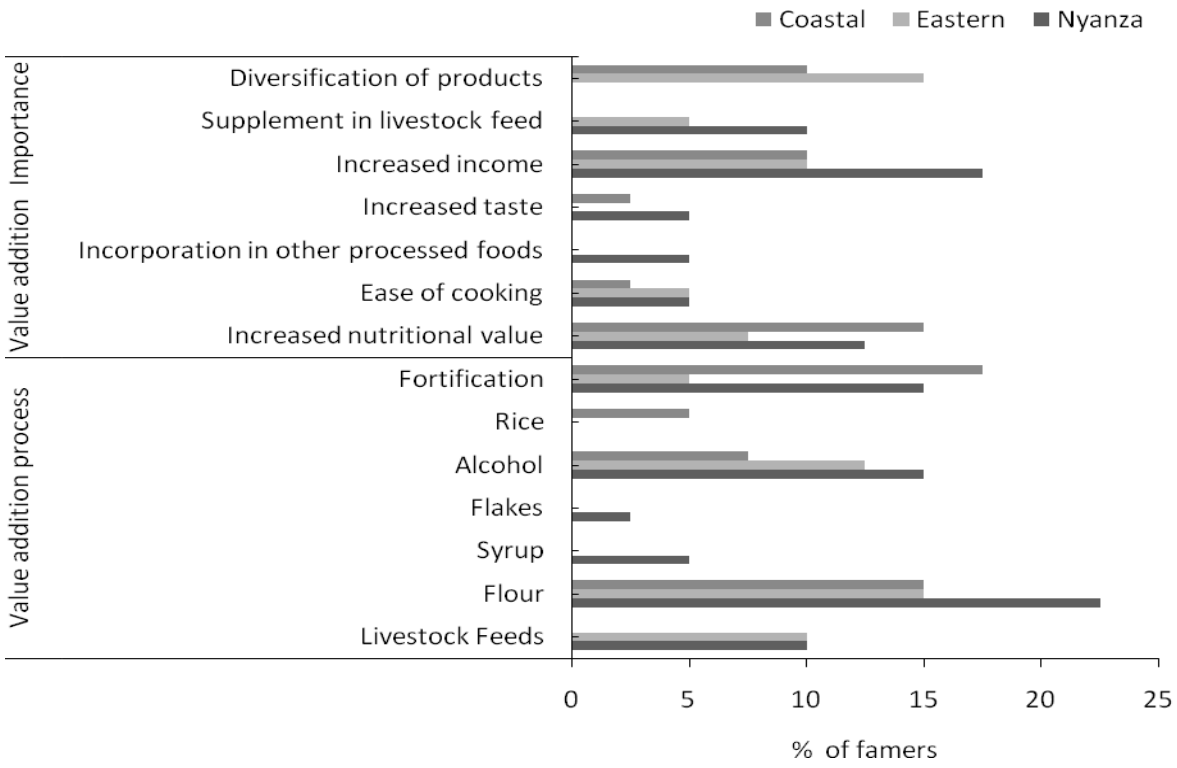

Figure 1: Value addition processes and their importance reported by sorghum farmers

3.3 Source of information by sorghum farmers

Information on where to source seeds for planting is diverse amongst the farmers in the three regions (Fig 2). Farmer to farmer source of information was highest in Nyanza (32.5%), Eastern (32.5%) and Coastal (27.5%) followed by agricultural extension officers with Nyanza (35%), Eastern (22.5%) and Coastal (30%). Farmers who reported obtaining information from media advertisement were 5% (Nyanza), 20% (eastern) and 7.5% (Coastal). A high percentage of the farmers reported they do not consult and instead use self-saved seeds from their own farms with 22.5% from Coastal, 20% Nyanza and 17.5% Eastern.

Farmers get information on management practices of sorghum from different sources (Fig 2). Majority of farmers use traditional knowledge through experience with Coastal region leading with 47.5% followed by Nyanza (30%) and Eastern (25%). The results showed other major sources of information by farmers were

ministry of Agriculture (Nyanza 27.5%, Eastern 25%, Coastal 22.5%), training (Nyanza 22.5%, Coastal 22.5%, Eastern 20%), and from fellow farmers (Eastern 15%, Coastal, Nyanza 10%). For farmers selling the grain, they get information on where to sell from various sources with farmer-to-farmer information recording 100% and market analysis 75% across the three regions (Fig 2). Other sources include media, cereal and produce board, cereal merchants, Ministry of Agriculture. A total of about 52.5% of the farmer respondents reported self-consumption of the grain besides sourcing of information on where to sell across the three regions (Fig 2).

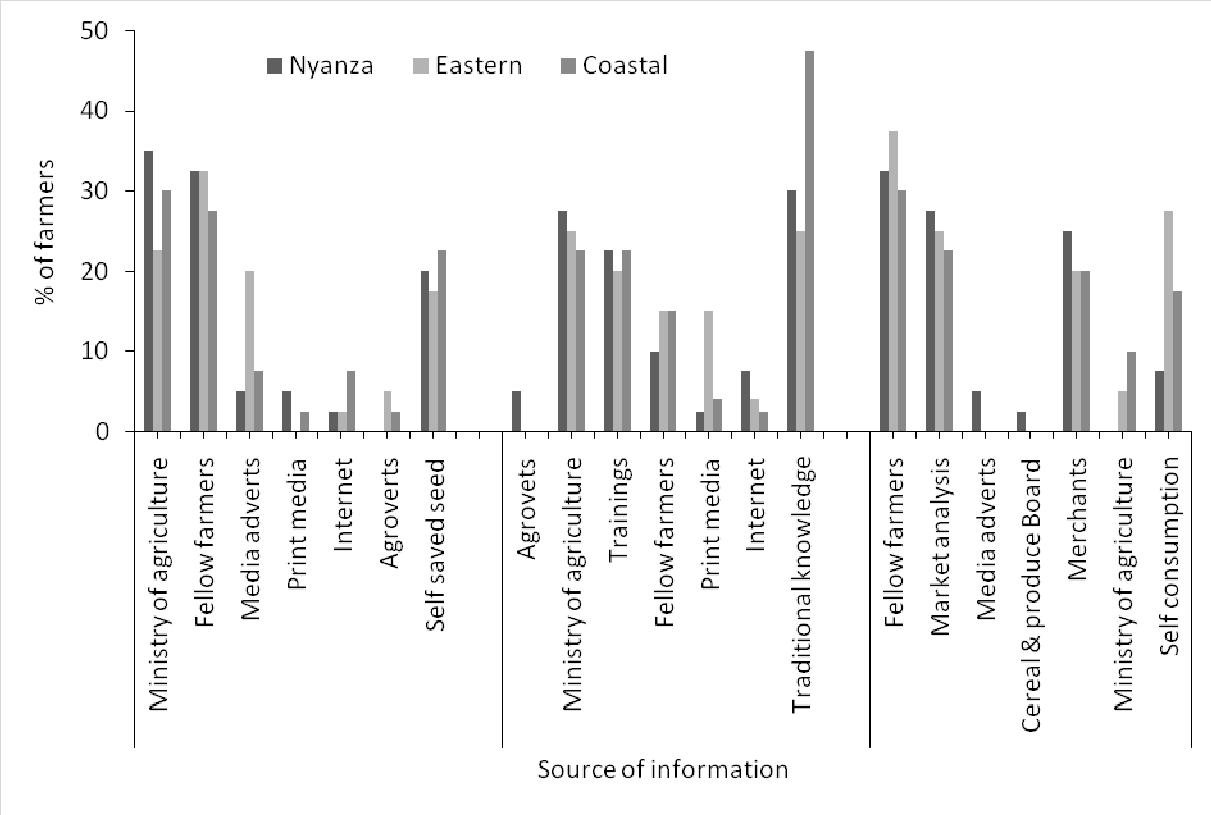

Figure 2: Source of information on source of seed, management practices and marketing of sorghum grains

3.4 Farmers farm management practices for sorghum production

Farmers use different methods to ascertain the quality of seeds before planting (Fig 3). 52.5% ensure they plant only certified seed while 30% use seed provided by Ministry of Agriculture across the three regions. In addition, 65% (Eastern), 47.5% (Coastal) and 45% (Nyanza) of farmers select seeds from previous harvest based on size and color for planting. Only 60% of respondents in the three regions conduct germination test on the seed from whichever source before planting. Source of farm inputs (fertilizers, seeds, pesticides) include agrovet shops, non Government Organizations (NGO), Ministry of Agriculture, Cooperatives and farmer saved seed. Farmers obtaining inputs from agrovet shops were 85% in Eastern followed by Nyanza (60%) and Coastal (57.5%) region. Those who used farm saved seeds, manure and or compost from their farms and controlled pests using cultural methods were 30% in Eastern followed by Coastal (27.5%) and Nyanza (25%).

Most farmers rely on onset of rainfall to know its proper time for planting with Eastern recording 92.5% followed by Nyanza (75%) and Coastal (70%) (Fig 3). Other farmers rely on information from Ministry of Agriculture (25%), fellow farmers (22.5%) while 20% plant only when there is adequate moisture in the soil and 17.5% when weather conditions indicate onset of rains. Farmers respond to changes in climate conditions in various ways though 15% (Eastern) and 7.5% (Coastal) reported they have no measures. In order to mitigate climate change, majority of the farmers plant alternative crops with 65% reported in Eastern, 42.5% Coastal and 17.5% Nyanza. Other common mitigation measures reported were waiting for onset of rains with coastal (37.5%), Nyanza (22.5%) and Eastern (20%); and irrigation with 20% in Nyanza, 7.5% in Eastern and Coastal each.

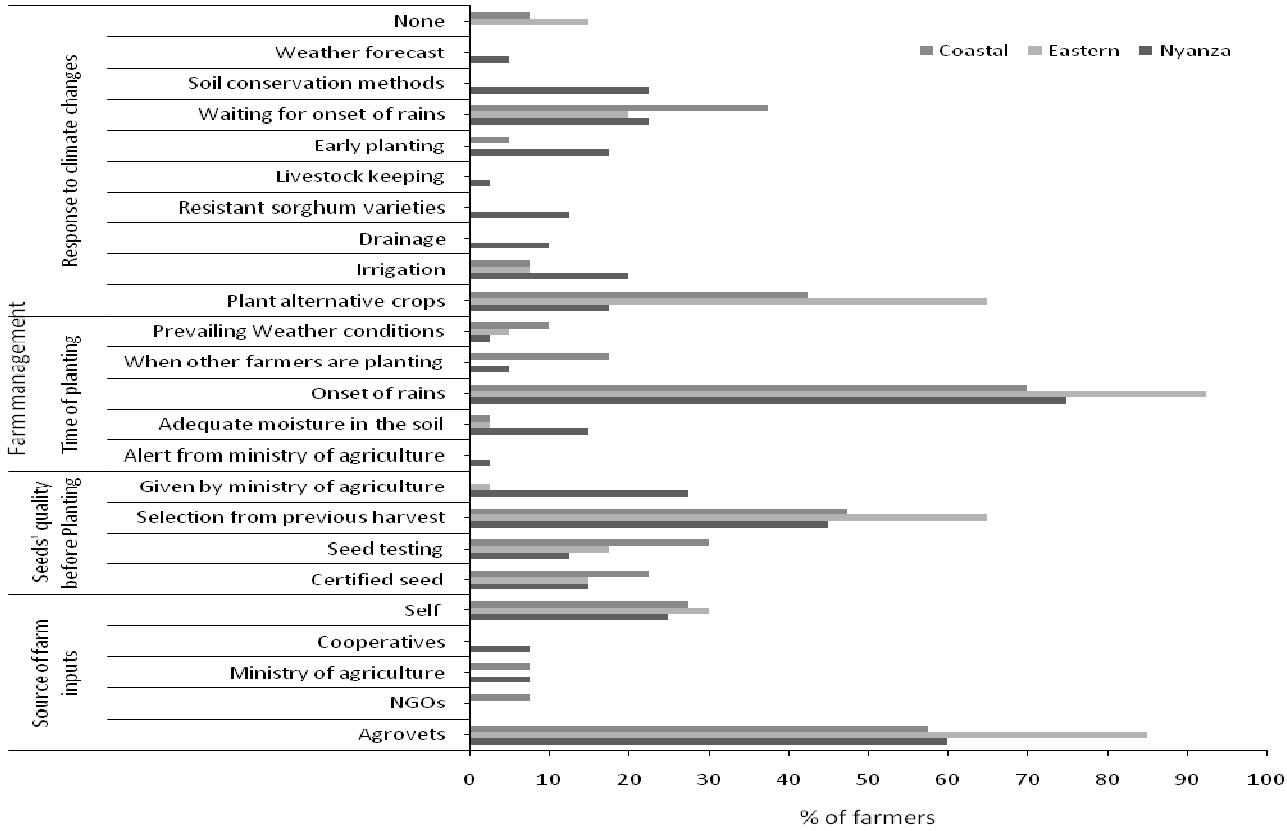

Figure 3: Source of information on farm management practices

3.5 Storage of sorghum grain

Grains are stored by farmers in various ways which are determined by factors such as prevailing weather conditions, prevalence of pests and diseases in the region, the duration the grain will be stored, amount of harvest and availability of storage materials and facilities (Fig 4). Quantity of the grains (55% (Eastern), 47.5% (Coastal), 7.5% (Nyanza) and availability of storage materials and facilities with 32.5% (Coastal), 30% (Eastern), 7.5% (Nyanza) were reported as most common determinant of storage methods used by farmers. Most farmers who considered storage period before use, prevailing weather conditions, pests and diseases prevalence was highest in Nyanza with 32.5%, 27.5% and 25% respectively.

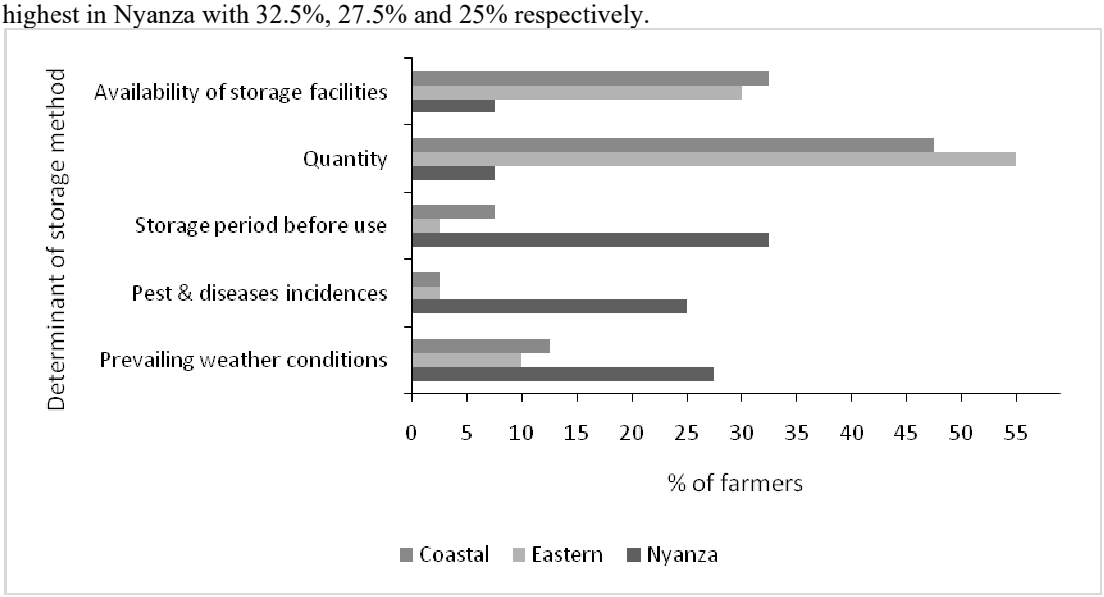

Figure 4: Factors determining choice of storage method used by sorghum farmers

3.6 Use of sorghum crop

Sorghum grain harvested is used for human consumption, brewing, income generation and livestock feed across the three regions (Fig 5). Human consumption was reported by farmers as highest with 88% in Eastern, 85% Nyanza and 60% at Coastal region.

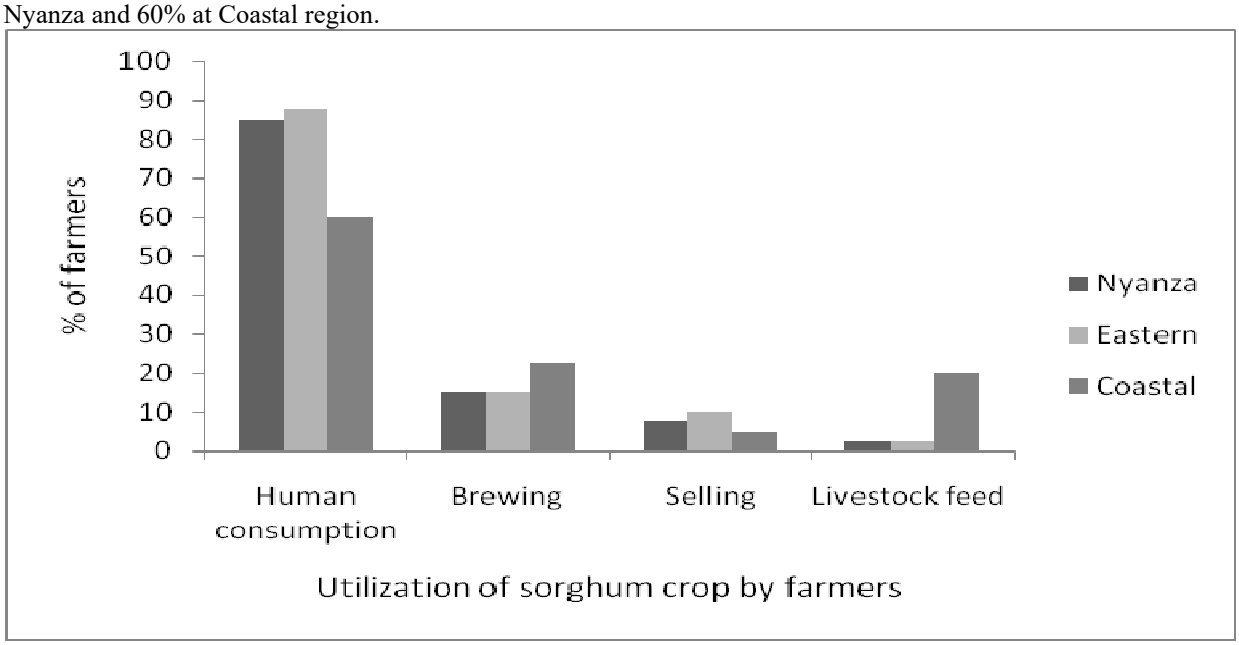

Figure 5: Utilization of sorghum crop by farmers

3.7 Membership in farmers groups

Majority (73.1%) of the farmers are not members of any farmer group across the three regions. About 26.9% belonged to localized farmer groups such as *ukulima bora* farmers group, AGRA, *bidii* farmers group, farmers united, *jitoe*, new vision *kanaani*, NAKEP, NARIGP, *Ndethye ngutethye*, one acre fund, *lotima* conservation agric service providers, *mrabani* farmers groups, *mur-malanga* self help group, *nyajuok* self help group. The farmers meet either weekly, biweekly, once in a month and after every six months based on the need and matters to be discussed. Information discussed by farmers include agribusiness, farming practices, marketing, strategies to improve farming skills, adoption of high yielding varieties and climate change.

4. Discussion

The results of this study revealed sorghum farming is dominated by female farmers across the three regions. Sorghum farming among other farm activities is usually carried out by women as men source for income elsewhere. The results agree with previous findings indicating females were more engaged in land preparation, sowing, weeding, scaring birds, harvesting and processing of sorghum after harvest as opposed to males (Patrick, 2013; Robert *et al*., 2013; Muui *et al.,* 2019). The results showed majority of the interviewed sorghum farmers were within the age of 26 to 55 years with only a few aged below 26 years and above 55 years. This shows high involvement of young and middle aged groups in sorghum farming as their livelihood. In a related study in Uganda, majority of the respondents were in the age group of 25–50 years (Andiku *et al.,* 2021). Suvi *et al.,* (2020) reported similar findings in rice production in Tanzania. Bushara & Abuagla (2016) reported old farmers have the lowest sorghum production efficiency compared to young farmers in the age group of 25–35 years in Sudan.

Majority of the interviewed sorghum farmers had acquired primary and secondary education. However, the results indicated Nyanza and Eastern regions had a significant high percentage of farmers with no education at all. Similar trend was reported by Andiku *et al.,* (2021) in Uganda. Literacy level is still low among most sorghum farmers in Nyanza, eastern and coastal regions in relation to production of sorghum crop (Muui *et al.,* 2013; 2019). This implies majority get information on production, marketing and value addition through their involvement in growing the crop. Level of education plays a key role in enhanced awareness of importance of the crop, farming and value addition techniques therefore farmers with low or no education have a low understanding on agronomic practices, handling and utilization which could help increase sorghum yield. The educated farmers could be useful in training of other farmers, and be involved in information and knowledge management systems. Chepng'etich *et al.,* (2015) reported that farmers with formal education were more efficient in sorghum production than their counterparts with non-formal education.

According to the results, majority of the farmers are aware of value addition in sorghum and their

importance in socio economic development. Though a wide diverse use of sorghum was reported, only livestock feed, flour, alcohol and fortification were most popular. In Uganda, farmers grow sorghum as staple food, for sale, brewing and animal feed (Andiku *et al.,* 2021). The results showed farmers recognize the importance of sorghum crop which enables diversification of products, integration with other processed products enhancing fiber and nutrient contents, enhancement of taste, for ease of cooking, supplementation in livestock feed and increased income generation. Diversification of products could result to more opportunities increasing income generation and food security. Sorghum is emerging as an industrial crop especially in substituting barley in industrial breweries providing an opportunity to farmers to earn income (Angelucci, 2013). Due to the increasing awareness of importance of sorghum especially in addressing health concerns, the use of sorghum products such as flour have been reported to be on the rise (Chemonics 2010; Kilambya & Witwer, 2013).

The results indicated that, sorghum farmers get information on source of seed for planting either from fellow farmers, Agricultural extension officers and media advertisements. A high percentage of the farmers do not rely on external information on source of seed instead they use farm saved seeds. The low use of internet and agro-shops as source of information could be attributed to limited access and high cost. A related study in Ghana indicated electronic media channels were not important to farmers as source of information due to limited or no access to electricity (Azu *et al.,* 2021). Also, Azu *et al.,* (2021) reported that most sorghum farmers got information from agricultural extension officers, relatives and friends. Other findings in west Africa indicated majority of sorghum farmers save seeds for subsequent seasons (Kudadjie-Freeman & Dankyi-Boateng, 2012; Dossou-Aminon *et al.,* 2015).

From this study, majority of sorghum farmers use traditional knowledge through experience in managing the crop while others rely on Agricultural extension officers, trainings and from fellow farmers. In an earlier study carried out in Makueni county Kenya, most sorghum farmers relied on ministry of agriculture and small farmer groups as source of information on production management practices (Kagwiria *et al.,* 2019). Rees *et al.,* (2000) reported that government extension is a major source of information on crop production practices. However, not all farmers have access to the important information on how to improve crop productivity hence poor crop performance persistence (Mwadalu and Mwangi, 2013). The results of this study indicated farmers get information on where to sell the grain mainly from fellow farmers and through market analysis. The findings revealed majority of the farmers reserve the grain for self consumption despite selling the surplus. In other related studies, it was reported most farmers produce enough sorghum to meet domestic requirements selling only the surplus (Ochieng, 2011; Muui *et al.,* 2019). The low trend in trading of sorghum could be attributed to low production volumes, prices and poor marketing channels (Muui *et al.,* 2019).

The results showed farmers use seed obtained from various sources such as on-farm saved, from local markets, agrovet shops and from ministry of agriculture. The results are in line with findings of earlier studies on source of seeds (Simiyu *et al.,* 2003; Catherine *et al.,* 2013; Kange *et al.,* 2014; Muui *et al*., 2019; Azu *et al.,* 2021). The results indicated some of the farmers who use farm saved seed select what to plant based on size and color. Other farmers ascertain the quality of the seed from various sources by conducting germination test before planting. The results also revealed farmers rely on information provided by agrovet shop dealers and agricultural extension officers. Earlier studies conducted in the three regions have reported poor quality of seed used by sorghum farmers (Muui *et al.,* 2017; 2020). Majority of farmers plant landraces using on farm saved seed which accounts for 87 percent of sorghum seed sources (Kambi & Mugo, 2016). The quality of such seed is not guaranteed (Muui *et al.,* 2013) and could result to poor crop establishment. The results showed farmers obtain farm inputs from agrovet shops, non governmental organizations, ministry of agriculture, cooperatives and self (farmers own farm). A high percentage of farmers use farm saved seeds, manure and or compost from their farms and control biotic stresses using cultural methods. Farmers still face challenges in accessing certified seed and fertilizer which is attributed to low purchasing power, awareness and poor distribution channels (Njagi *et al.,* 2019).

The findings revealed majority of farmers rely on onset of rainfall to know its proper time for planting. Other farmers rely on information from Ministry of Agriculture, fellow farmers while others plant only when there is adequate moisture in the soil and when weather conditions indicate onset of rains. Though the results showed farmers employ measures to mitigate climate change, about 22.5% from eastern and coastal regions do not hence poor crop performance or failure. The recurring drought episodes among other constraints could be associated with the low grain yields below estimated yield potential attained by farmers in these regions (Muui et al., 2019). Drought has been reported as major constraint in sorghum production in most countries including Kenya, Ghana, Uganda and Ethiopia (Gebretsadik *et al.,* 2014; Muui *et al.,* 2019; Andiku *et al.,* 2021; Azu *et al.,* 2021). In Benin, sorghum farmers use strategies such as planting drought tolerant genotypes to mitigate climate change (Dossou-Aminon *et al.,* 2014).

The results showed common determinant of storage methods for sorghum grain by farmers were the quantities of harvested grain, and availability of storage materials and facilities. An earlier study in the three regions (Muui *et al.,* 2019) showed almost all farmers planted sorghum for consumption purposes with a few

selling the surplus. Therefore the quantities of harvested grain and availability of storage facilities as the key determinants of the storage method could be associated with the vast utilization of the grain. Though the results showed the grain is used for human consumption, brewing, selling and livestock feed, human consumption was reported by farmers as highest across the regions. Other studies indicated sorghum is among the highly consumed cereal crop in most parts of Africa and India (Muui *et al*., 2013; Infonet-biovision, 2018). In Namibia, sorghum grain is mainly produced for household consumption though in small quantities per household by majority of the farmers while others sell surplus as source of income (Wanga *et al.,* 2022). Therefore the need to promote the crop for more uses such as making of value added food products such as bread, biscuit, grain flakes, popped sorghum, livestock feed and brewing (Waniska *et al.,* 2016; Alavi *et al.,* 2019).

The findings showed majority (73.1%) of the farmers are not members of any farmer group across the three regions. Mwanajuma *et al.,* (2020) reported that farmers belonging to women farming groups have more access to agricultural resources and improved farming practices enhancing the crop productivity, income generation and their livelihoods. Therefore, provision of more support and capacity building to such groups by involving related stakeholders could enable them attain optimum agricultural productivity. Labeyrie *et al.,* (2014) and Kagwiria *et al.,* (2019) reported sorghum farmers use their social organization, that is, farmer groups in accessing inputs such as seeds. Since some farmer groups are already in existence, strengthening and increasing their capacity through training on better sorghum production practices, seed multiplication, post harvest handling, storage, diversification of products to increase productivity and support crop livestock integration for better livelihoods. Due to the low quantities of sorghum produced by small holder farmers, farmer group could be an avenue in marketing of the produce securing better prices (Njagi *et al.,* 2019).

5. Conclusion

The ability of the crop to perform well in drought areas make sorghum an important cereal crop which can be used to substitute maize in these areas in order to achieve food security and increase income generation. Young and middle aged groups of farmers are highly involved in growing of sorghum due to its importance for consumption, livestock feed, brewing and as source of income. Low level of literacy could still be a hindrance to enhanced awareness of importance of the crop, improved agronomic practices, value addition processes, and marketing strategies which could increase its production. The educated farmers could be involved in training the other farmers, and in management of information and knowledge systems. Though most farmers are aware of value addition in sorghum and their importance in socio economic development, use of the crop is still limited. Diversification of products and increased awareness of its benefits could result to increased production and utilization alleviating food insecurity and poverty levels. Majority of the farmers do not rely on external information for inputs and management practices but instead use on farm inputs and traditional knowledge through experience in managing the crop. Though the information could be available not all farmers have access to the important information on how to improve crop productivity hence poor crop performance persistence. Enhancing the farmer to farmer exchange network could enable broader coverage and dissemination of information amongst the small holder farmers even on where to sell the grain. Since most farmers use on farm saved seeds, strengthening of the informal seed production systems for sorghum landraces could improve the quality, accessibility and cost of seed used by farmers. Farmers still wait for onset of the rains to plant the crop without any measures to mitigate the prevailing weather changes. Most farmers are not members of farmer groups leaving them out of more access to agricultural resources and improved farming practices which could enhance the crop productivity, income and their livelihoods. Therefore, sensitization on benefits of sorghum crop, formation of more active farmer groups, involvement of agricultural related stakeholders, provision of more support and capacity building could enable them attain optimum agricultural productivity. Increasing production of sorghum in these regions will contribute significantly towards realizing food security and improved livelihoods.

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