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**TEGEMEO INSTITUTE OF AGRICULTURAL
POLICY AND DEVELOPMENT**

**Sorghum Production in Kenya: Farm-level Characteristics,
Constraints and Opportunities**

Technical Report

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Tegemeo Institute

Tegemeo Institute of Agricultural Policy and Development is a Policy Research Institute under Egerton University with a mandate to undertake empirical research and analysis on contemporary economic and agricultural policy issues in Kenya. The institute is widely recognized as a centre of excellence in policy analysis on topical agricultural and food security issues of the day and in its wide dissemination of findings to government and other key stakeholders with a view to influencing policy direction and the decision making processes. Tegemeo's empirically based analytical work and its objective stance in reporting and dissemination of findings have over the past decade won the acceptance of government, the private sector, civil society, academia, and others interested in the performance of Kenya's agricultural sector.

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List of Abbreviations

ASALs	Arid & Semi-Arid Lands
ASDS	Agricultural Sector Development Strategy
CSOs	Community Based Organization
CSR	Corporate Social Responsibility
COMESA	Common Market of Eastern & Southern Africa
EABL	East African Breweries Limited
EAC	East African Community
EAML	East Africa Maltings Limited
KALRO	Kenya Agricultural and Livestock Research Organization
MoALF	Ministry of Agriculture, Livestock & Fisheries
MT	Metric Tonnes
NCPB	National Cereal Produce Board
OPVs	Open Pollinated Varieties
PPP	Public-Private-Partnership
SADC	Southern Africa Development Community
SRA	Strategy for Revitalization of Agriculture
SSA	sub-Saharan Africa
THVC	Traditional High-Value Crop

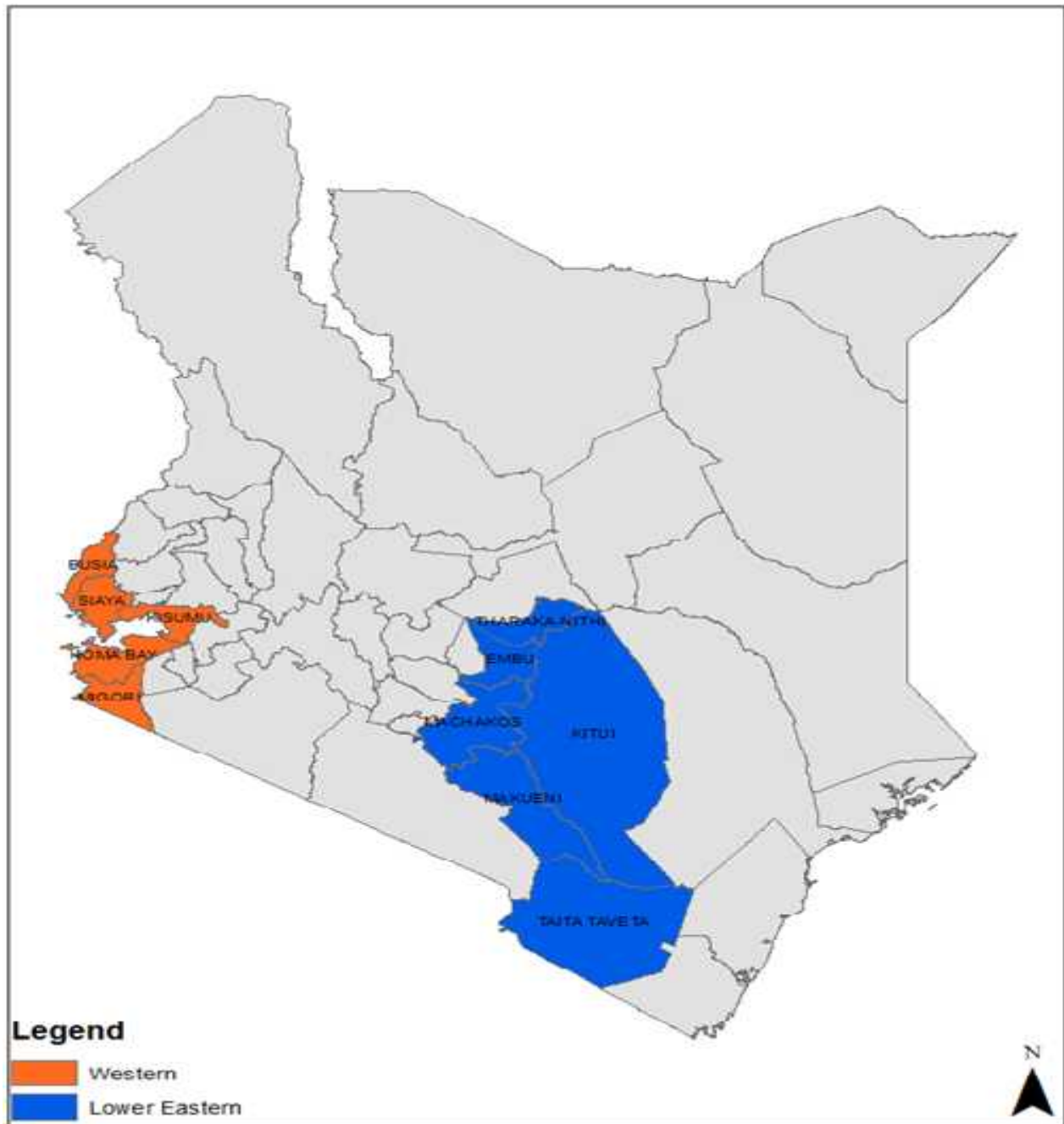
1. Introduction

Sorghum (*Sorghum bicolor* (L) Moench), is a cereal crop quantitatively ranked the world's fifth most important cereal grain after wheat, maize, rice and barley. Sorghum cultivation is mainly practised in developing countries with 90 per cent of the cultivated area found in African and Asian countries. Africa is the largest producer of sorghum accounting for one-third of global production. The suitability and adaptability to tropical conditions prevalent in Africa explain the crops' dominance. In sub-Saharan Africa (SSA), the crop prominently serves as a viable cereal crop for the most food insecure households.

Sorghum is essential to food security in Africa (Taylor, 2003). Its ability to perform relatively well under both favourable and harsh and unpredictable weather conditions predominant in SSA underscores its importance. Sorghum can withstand periods of high temperature and is drought tolerant. It can also endure periods of exposure to waterlogging. Due to the rising trends in global warming and climate change, sorghum is a promising alternative for enhanced food and income security, compared to other staples such as maize that often fail due to drought (Muturi, Rubaihayo, & Mgonja, 2013).

In Kenya, sorghum is typically grown in marginal and semi-arid areas characterised by low and erratic rains and high temperatures (Mwema & Mulinge, 2013). According to MoALF, 2015), from 2012, sorghum production increased progressively in Arid and Semi-Arid Lands (ASALs). For instance, the national production was 1.9 million bags in 2014, with Eastern and Nyanza regions recording the highest production with 761,414 and 757,862 (90 kg) bags respectively. Sorghum is a crop with vast untapped potential which can be harnessed in poverty alleviation, employment creation, and reducing malnutrition in the country. The increase in sorghum production is attributed to strategies implemented to revitalise the crop as a Traditional High-Value Crop (THVC) and the growing sorghum beer market (MoALF, 2015).

Figure 1: Major Sorghum growing regions in Kenya



1.1 Sorghum Production in Kenya

Sorghum lags in importance to staple cereals such as maize, rice and wheat. Whereas these key staples perform well in high potential agricultural areas, sorghum performs well in mid to low potential agricultural areas. Majority of the sorghum produced in the country is grown in the

Semi-Arid areas of Eastern, Western and Coastal regions. (Mwema & Mulinge, 2013). Varied ecological conditions characterise these areas; the altitude range between 500 meters and 1700 meters above sea level with a seasonal rainfall of 300mm and above (Muui et al., 2013). Figure 1 shows the locations of these areas.

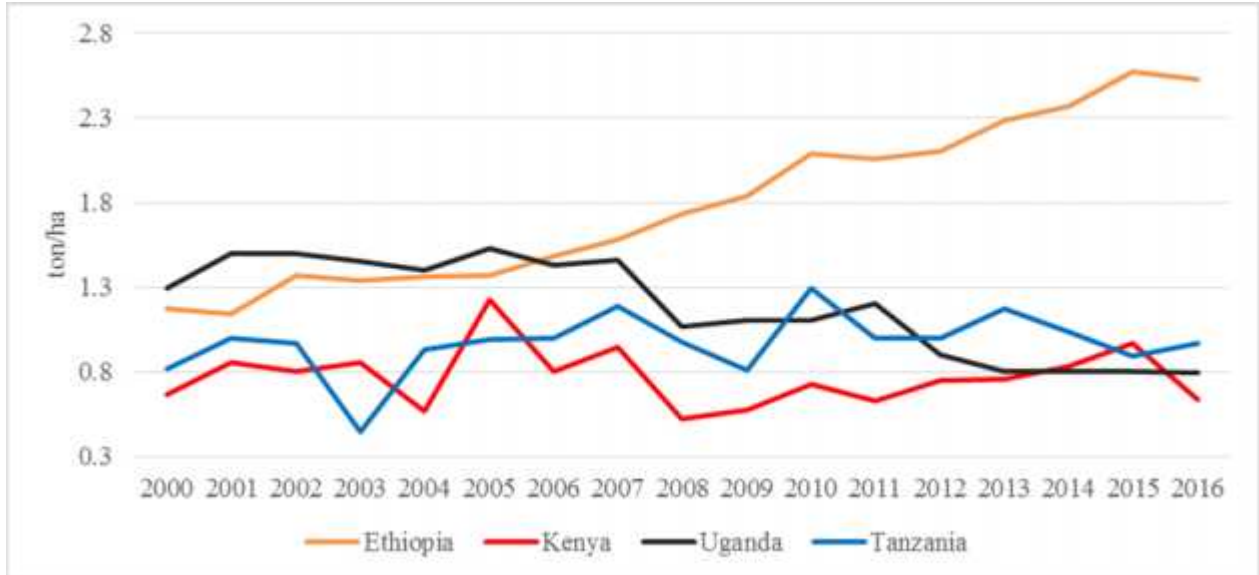
Sorghum is well suited to heavy clay soils (Vertisols) found commonly in these regions, especially the western region because it is tolerant to waterlogging. It also thrives in light sandy soils found in the lower eastern region (Bio vision, 2018). Sorghum tolerates a range of soil pH from 5.0 - 8.5 and is more tolerant to salinity than maize. It is adapted to poor soils and can produce grain on soils where many other crops would fail.

In Kenya, sorghum is mainly grown by small-scale farmers under subsistence production system. It is estimated that there are close to 240,000 small-scale sorghum farmers with farm sizes ranging from 0.4 to 0.6 Ha (1 to 1.5 acres) (KAVES, 2013). Majority of these farmers produce sorghum under the mixed farming system; intercropping sorghum with other crops such as maize, cowpea, beans and pigeon peas (Muui et al., 2013). Though mono-cropping is highly recommended for sorghum, only a small proportion of farmers adhere to this recommendation.

1.2 Production and Productivity

Kenya ranks last in sorghum production compared to the neighbouring countries. Over the past decade, Ethiopia has recorded the most significant growth in sorghum production, and its productivity compares to countries in Southern and South-East Asia (Figure 2). On the other hand, sorghum productivity in Kenya has stagnated over time.

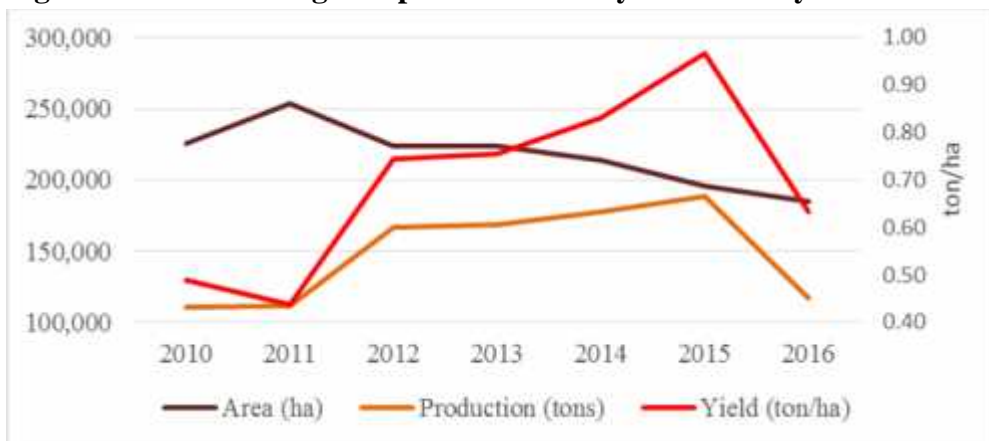
Figure 2: Trends in sorghum productivity in Eastern Africa



Source: FAOSTAT, 2018.

Figure 3 shows the trends in sorghum production in Kenya from 2010 to 2016. The figure depicts an upward trend in sorghum production except in 2016 when the country experienced severe drought. Importantly, domestic yields have also been rising since 2010. Despite recording modest increases in production, Kenya still imports more than one-third of the total consumption (KNBS, 2017). It is estimated that more than half of the production is consumed as food, one per cent as feed, about one fifth is processed and about fifteen per cent lost through the field and post-harvest losses.

Figure 3 Trends in sorghum production and yields in Kenya



Source: KNBS, 2017.

Although utilization of sorghum for industrial processing is low, substantial growth has been recorded in recent years. Over the last five years, in Kenya, the quantity of sorghum utilized for industrial purposes increased by 25 per cent. This growth is mostly attributed to the emergence of sorghum beer. For industrial purposes, sorghum is also used to manufacture wax, starch, syrup, dextrose agar and edible oils (Dicko et al., 2006). However, it is the promotion of sorghum beer production in Upper and Lower Eastern as well as Western regions that has led to increased production and industrial use. Production of sorghum for beer is highly commercial and to out-compete other enterprises such as maize, millet, pigeon peas for productive resources such as land and water, sorghum must perform better and record better returns to the farmers. Productivity and profitability of sorghum farming systems, therefore, remain central to the survival of this enterprise.

2. Farmer characteristics, Farming systems, ecological environment and technologies

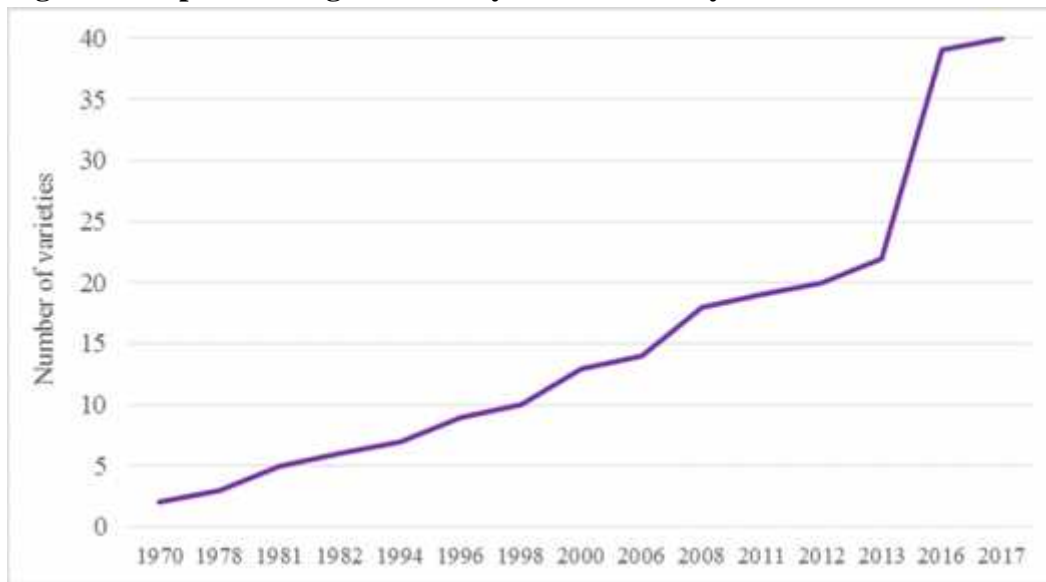
2.1 Inputs – supply and access, quality

Majority of small-scale sorghum producers prepare their land using oxen or human labour. This is not surprising given the land sizes cultivated. Sorghum seeds are mostly Open Pollinated Varieties (OPVs), and its seed industry is still at evolutionary stages. Popular varieties are local variety seeds usually retained from the previous harvest with little formal exchange beyond exchange between neighbours and family. Like most who plant landrace varieties, sorghum farmers use on-farm produced and saved seeds whose quality is not guaranteed (Muui et al., 2013). Farmer saved seed system accounts for 87 per cent of the sorghum seeds sources with the formal seed system accounting for the remaining 13 per cent (Kambi & Mugo, 2016). Farmers who cannot save enough seed borrow from neighbours, relatives or buy from the market.

In the recent period, there has been increased research in the development of new varieties of sorghum. However, the adoption of these varieties is still low due to lack of awareness and access related constraints (Tegemeo, 2014). Based on a nationally representative sample in 2014, Tegemeo Institute estimated that only 15% of farmers were using improved sorghum seeds. In addition, cultivated land area under improved sorghum varieties was only 15%. Figure 4 shows the trends in improved sorghum varieties released to the Kenyan market since 1970. There has been slow growth in the development of improved varieties for sorghum with the exception of 2016 when 17 improved varieties were released to the market. Of these improved varieties, the private sector accounts for only 10 per cent.

Application of fertilizer to sorghum improves yields significantly (Ashiono et al., 2005; Biri et al., 2016; Melaku et al., 2017). However, in Kenya, the application of fertilizers is low, especially among sorghum farmers. Farmers rarely apply agro-chemicals to control sorghum pests and diseases despite the emergence of kernel head smut and other pests which pose a significant threat to its production (KAVES, 2013). However, disease and pest tolerance, and yield-enhancing traits are some of the preferred qualities by sorghum farmers (Timu et al., 2014)

Figure 4: Improved sorghum variety release in Kenya



Source: KEPHIS, 2017

2.2 Knowledge transfer and agronomy

Agricultural information plays a critical role geared towards improved productivity and better nutrition. Extension services are essential in transforming subsistence farming to modern and commercial agriculture thereby improving household food security, incomes and reducing poverty. Traditionally done in the top-down approach where information would originate from public extension officers at the Ministry of Agriculture then trickle down to farmers, agricultural extension has been changing gradually and is currently mostly demand driven. Despite the emergence of different actors in the provision of agricultural extension services beyond the public extension agencies, access to extension services is still limited and is worse for farmers in the marginalized parts of the country where traditional crops such as sorghum are prevalent (Wanyama et al., 2016). Moreover, the effectiveness of government extension provision has significantly declined in the last decade due to structural adjustment programs and liberalization policies (Chimoita et al., 2017).

It is however notable that public sector extension improves the adoption of improved varieties (Chimoita et al., 2017). In addition, Muui et al., (2013) found that farmers with access to institutional assistance such as that offered by non-governmental organizations had better sorghum production in Eastern Kenya. An efficient and well-functioning extension system is

critical for sorghum production to thrive. National and County Governments and other stakeholders must collaborate to ensure traditional and emerging information systems are efficiently harnessed to uplift the sub-sector.

2.3 Farm-level commercialization and profitability

Over the years, sorghum production in Kenya has largely remained non-commercialized with the majority of farmers producing only for home consumption. This is, however, changing gradually with the emergence of the sorghum malting industry. In 2008, the government through the Ministry of Agriculture initiated Gaddam sorghum production on a commercial scale in a Public-Private-Partnership (PPP) with other relevant stakeholders. During this time, farmers were sensitized on how to commercialize sorghum and potential benefits. This, coupled with attractive market prices kick-started the recent drive towards market-oriented sorghum production. East Africa Breweries Limited (EABL) currently leads the drive for sorghum commercialization in Kenya as a malting company that supports farmers to produce efficiently through a contractual arrangement. EABL also provides a ready market for farm output at competitive prices. EABL’s requirement of an estimated 60,000 MT annually, expected to rise with a projected increase in beer consumption, presents a tremendous market opportunity to farmers.

Commercial farming heavily depends on the ability of producers to get decent profits/returns on their investment. The cost of production and marketing must, therefore, be low enough to guarantee profitability at the prevailing market prices. To achieve this, farmers must, either, make decisions on the production systems to undertake or farming options to pursue and investment levels. Table 1 shows the budget per acre for two types of farmers. (i) A typical Kenyan sorghum farm with low yields and no fertilizer and agrochemical use. (ii) A farmer using improved varieties and fertilizer.

Table 1: Typical Sorghum production budget per acre

Activity	Farmer A		Farmer B	
	Cost	Per cent	Cost	Per cent
Land Preparation	5,500	23%	5,500	21%
Seed	140	1%	700	3%
Fertilizer			6,000	22%
Agrochemicals			1,500	6%
Labour	17,600	75%	10,600	40%
Gunny bags	200		1,500	6%

Activity	Farmer A		Farmer B	
	Cost	Per cent	Cost	Per cent
Transport		0%	1,000	4%
Total Direct Costs	23,440		26,800	
Yield (Kgs)	200		1,350	
Production cost/Kg	117		20	
Price Sh/Kg	30		30	
Sales Value	6,000		40,500	
Gross Margin	(17,440)		13,700	

Notes: Own seed values at Ksh.28/kg

Cost of family labour inputted from hired equivalent

Source: KAVES, 2013

Farmer A has most of the cost in labour and land preparation. Typically, this farmer utilizes family labour with little focus on profitability, and thereby negative gross margins are realized. Farmer B uses certified seeds, fertilizers and agrochemicals. As a result, higher yields are realized. At this production level, the farmer has the potential of making Ksh.13,700 per acre. This underscores the importance of improving sorghum productivity in enhancing profitability.

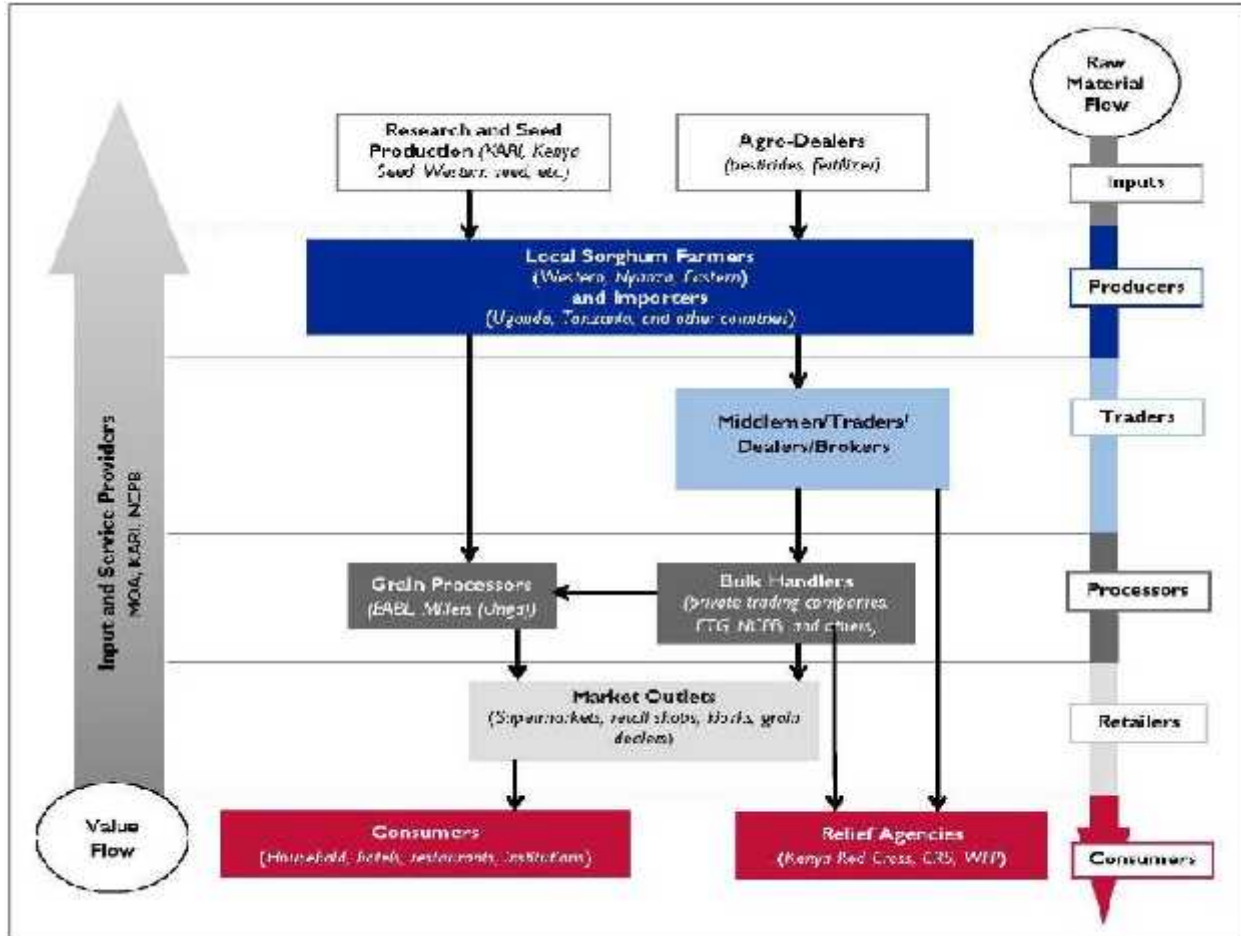
Over the same period, EABL currently offered a farm-gate price of Ksh. 32 per kg and a delivered to mill price of Ksh. 37 per kg to contracted farmers. Based on the figures in Table 1, the EABL market has the potential to raise farmers' profitability by up to 220%. This margin can rise further with the development of rural infrastructure which would reduce the cost of transport to market which is high at 15% of the farm gate price offered to farmers. EABL also offers farmers an interlinked credit market, where it provides inputs to contracted farmers. This also helps farmers become efficient as they overcome constraint associated with input access and a ready market after harvesting.

Like other cereal grains, farmers sell sorghum without undertaking any value addition. Before the growth of the sorghum beer market, industrial use for sorghum was mainly as animal feed, blending of food products, and bio-industrial products like syrup, bio-ethanol, and glucose (Odame et al., 2014). Sorghum beer industry development and growth in Kenya has opened commercial opportunities for farmers and other agri-entrepreneurs in the sorghum value chain.

3. Sorghum value chain actors

The sorghum value chain is presented in Figure 5. The value chain actors can be grouped into six broad categories namely; inputs sellers, sorghum producers, traders, processors, retailers, and consumers. The earlier sections have already characterized sorghum producers. The next section characterizes the other road categories along the value chain.

Figure 5: Sorghum value chain



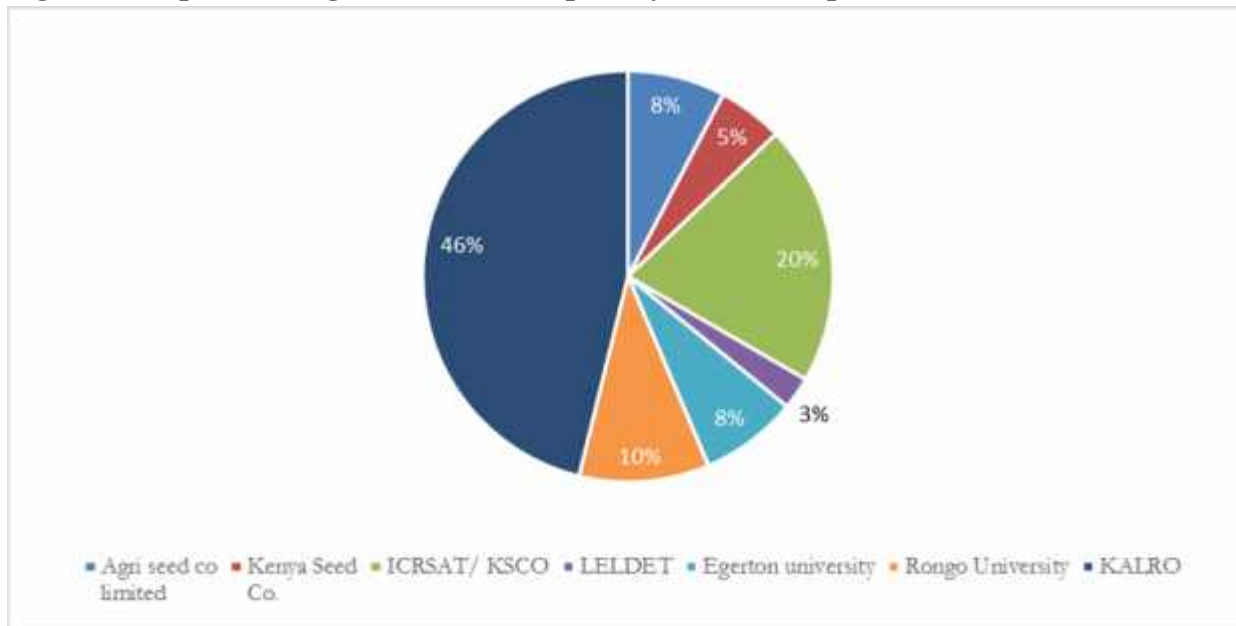
Source: USAID-KAVES, 2013

3.1 Input sellers

Majority of the improved sorghum varieties have been developed locally by research institutions and universities. According to Figure 6, the Kenya Agricultural and Livestock Research Organization (KALRO) accounts for 46% of improved sorghum varieties released into the Kenyan market. Farmers access seed mainly from agro-dealers. However, a number of civil

society organizations work with seed producers to provide seed through the Community Based Organizations (CSOs).

Figure 6: Improved sorghum seed developers by share of improved seed released



Source: KEPHIS data, 2017

Farmers still face challenges in access to seed and fertilizer. The constraints stem from liquidity constraints, awareness and distribution. To overcome these challenges, contract farming – which is an interlinked system is gaining traction for commercial sorghum production. The output buyers provide inputs to farmers and get into contract to purchase the harvested crop. EABL, for instance, plays a critical role in the supply of high-quality seed for industrial sorghum production in partnership with local academic and research institutions to contracted farmers. Apart from their primary role as producers and sorghum supply engines, farmers perform simple value addition through sorting, cleaning and packaging. The contracted farmers are likely to be efficient facing similar cost structures as that of farmer B in Table 1. A key benefit of contract farming is bypassing small traders who act as aggregators (see Figure 5) as the processors can contract farmers to supply the required capacity for processing.

3.2 Middlemen and small traders

Traders and dealers are usually located at the county level in the main sorghum production areas. Middlemen and small traders play a significant role through aggregating sorghum mainly from

smallholder farmers. They purchase sorghum from farmers during the harvesting season and sell to wholesalers.

3.3 Wholesalers

Wholesalers perform a similar function to small traders and dealers, but a larger scale. Wholesalers are usually located in major towns and buy sorghum from middlemen and small traders. They handle relatively large quantities of grain and most have storage facilities. They then bulk and sell to retailers and grain millers and processors. Some wholesalers also export sorghum to other countries.

3.4 Processors/millers

Sorghum processing is twofold; milling and malting. For milling, processors will mill sorghum for food products with the byproducts being used as animal feed. For milling, the large millers such as Unga limited dominate the market. The recent entry of sorghum malting has expanded the opportunity for sorghum processing in Kenya. East Africa Breweries Limited (EABL), for instance, has an estimated capacity of 60,000MT per annum. With the growth of the sorghum beer market, EABL is developing a second processing plant in the western region of the country. This will also increase the volumes demanded from farmers.

3.5 Retailers and consumers

Retailers are mainly located in both rural and urban areas and include shops, supermarkets, and kiosks which sell to consumers and institutions. Consumers are the final users of sorghum, sorghum products and by-products. They are located across the country and are responsible for the pull effect in the sorghum supply chain.

3.6 Service providers

The government extension service is largely the avenue through which extension messages are passed to sorghum producers. Private companies such as seed companies and EABL also offer extension and technical support to sorghum producers at various levels. Other services available within the value chain include transport/hauling, drying and marketing services.

3.7 Sorghum output markets and linkages

The opportunity for sorghum farmers and other value chain actors to raise their income from this enterprise largely depends on their ability to participate in the market successfully. Sorghum was

largely grown for home consumption; surpluses are sold mainly to consumers, traders/aggregators, schools and hotels within the locality. The opening of commercial sorghum production has created an opportunity to produce for the market.

Collective marketing through farmer groups is an avenue gaining prominence mainly due to the relatively low sorghum volumes from individual farmers and the ability to secure reliable markets with better prices in a group. Currently, collective marketing to a large extent involves farmers in market-oriented sorghum production. The emergence of sorghum beer and the projected increase in beer consumption has expanded the sorghum market. Models such as contract farming guarantee the sale price is providing farmers with the incentive to reduce their cost. In addition, private companies within Kenya and in the region, have a market for sorghum for production of syrup, bio-ethanol and animal feeds.

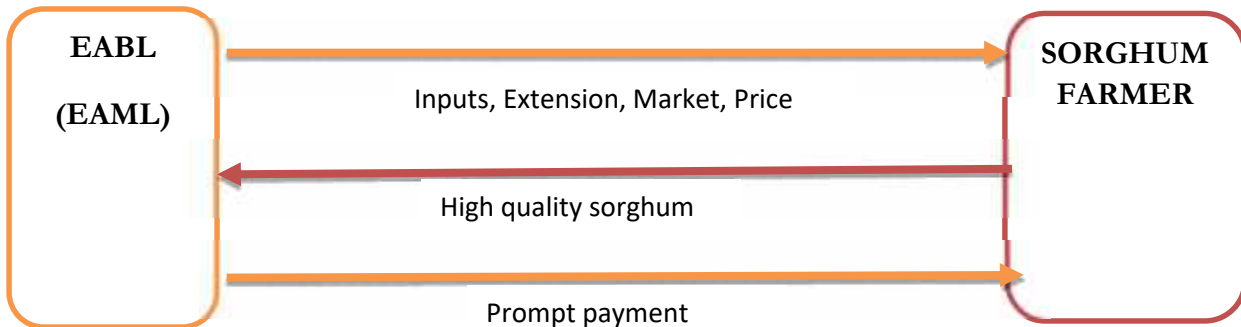
Although sorghum has a considerable market potential in Kenya and the region with increasing demand for processed sorghum products, the market remains mostly unorganised and characterised by the inconsistent quality of products, inadequate marketing resources and strategies, lack of competitiveness and inability of market participants to exploit economies of scale. For instance, despite the increase in consumption of sorghum foodstuffs, and health campaign on healthy diets, the sorghum value chain did not utilise this opportunity to catalyse production and productivity. The market also lacks backward linkages that would incentivise production. Majority of sorghum producers are facing primary constraints of awareness and access. The only exception is producers under contract, as is the case of sorghum for malting, who enjoy farm inputs and agricultural information provision and in return supply, high quality produce at a pre-agreed price.

4. Market models and value addition

Sorghum is viewed as a traditional food security crop and has largely been marketed through the local traditional marketing system. This system entails production, promotion and sale of produce, usually in low volumes, through traditional channels which include the exchange between neighbours and family and other informal avenues. The traditional channels are more supply driven and promotion is by word of mouth.

Contract farming, defined as agricultural production carried out according to an agreement between a farmer and a buyer, with predetermined conditions for production and marketing (Shepherd, 2013), is another marketing model applied in the sorghum value chain. There are many ways in which companies work with farmers. The simplest approach is where the company supplies extension and all other inputs to farmers including land preparation sometimes, and then deducts the cost of those inputs and services from the final price paid to the farmer after harvest and delivery. EABL through EAML contracts farmers willing to grow sorghum varieties suitable for malting, and sell the produce with a pre-set quality to the malting company. In return, EABL provides a ready market at a guaranteed price and extension services. EABL also ensure availability of improved sorghum seeds at an affordable price. The model used by EABL is depicted in figure 7.

Figure 7 Sorghum contract model (EABL and Farmers



Source: Authors

4.1 Opportunities along the value chain

The expanding demand for sorghum beer targeting low-income consumers as a cheap and safe alternative to illicit liquors has been a pull factor in the sorghum beer value chain. This has created vast opportunities among value chain actors. It is estimated that sorghum beer now accounts for about 40 per cent of Kenya's regulated beer market with a supply chain that employs over 100,000 people (KEPSA, 2014). This investment has been proved to open employment opportunities for locals, men, women and youth, who supply labour and services.

Increased sorghum supply also creates opportunities for other value chain actors. Breeders and seed companies in response to the renewed interest in sorghum production now have an opportunity to produce better yielding varieties for uptake. Inputs and extension services will also be required as demand grows. Besides direct opportunities to value chain actors, the Corporate Social Responsibility (CSR) programme executed by EABL together with other partners and local communities contribute to community sustainability through job creation for the locals, building local talent and leadership, sourcing from local businesses where possible, and addressing local concerns through community investment programs. Some of the primary focus areas include water access initiatives that aims to provide safe, reliable and sustainable water supply to communities in water-stressed areas; skills for life program that provides education and training to prepare participants for employment in a variety of industries in the local communities in Kenya; Disaster response programs to help alleviate the effects of disaster in the local communities, among others.

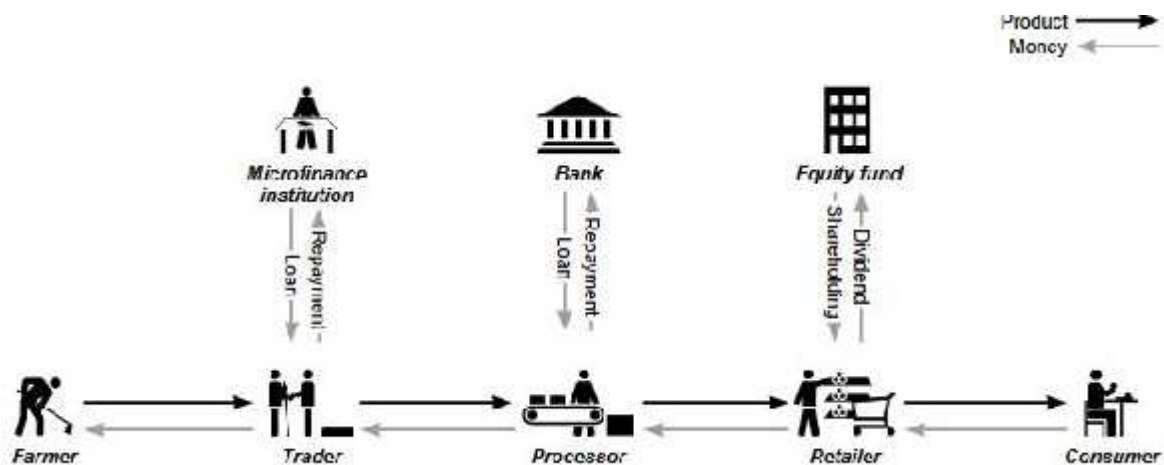
4.3 Finance and business environment

Systematic and prudent financing of smallholder agriculture has been and continues to be a difficult goal in Kenya in spite of remarkable progress in microfinance over the last 20 years (Pelrine, 2009). According to Hong & Hanson (2016), in a number of developing countries, much of the demand for personal and business loans stem from the agriculture sector and given the nature of agricultural risk to exogenous factors—weather, pests, diseases, and commodity price fluctuations—and its long-term seasonal nature, many banks perceive lending to farmers as too risky. The authors further assert that though local bank lending should be the main point of access, the financial sector meets less than three per cent of the total smallholder demand for financing. Despite this, access to adequate and timely financial services for all actors in

agricultural value chains has proven an essential element for success. This implies that not only large producers and traders but also small producers need access to appropriate financial services to make optimal use of value addition and income generation (Peppelenbos, 2010).

Sorghum value chain, regarded as traditional and non-commercial, grapples with inadequate financing. This has hampered the development of the value chain for decades further dwarfing its transition to a commercial and profitable enterprise. In the advent of sorghum malting and the gradual shift to commercial production, sorghum value chain financing in Kenya has registered some improvement. Though still low and inadequate, three types of finances suffice in the sorghum value chain. These include: (a) Chain liquidity finance; short term loans from suppliers or buyers within the value chain and are most common between farmers, farmer groups and traders. (b) Agricultural finance; this is where an outside agency such as a microfinance institution, offers specialised financial services to sorghum value chain actors. This is schematically illustrated in figure 8. Value chain finance; this is where financial institutions link into the value chain offering financial services which build on the relationships in the chain. This implies that the seller, the buyer and the financial agent work together to bring financial services.

Figure 8: Agricultural finance model



Source: Peppelenbos, 2010

A major concern for agricultural entrepreneurs is the cost of doing business that largely determines their profitability levels and competitiveness. In the sorghum value chain, apart from the farmers, other chain actors face buying price, labour, transport, storage, cess, taxes, levies

and fees as their costs in Kenya. For processors and millers, the cost for value addition adds to the overall cost of production. The taxes, levies, cesses and fees distort the market price and make farm produce uncompetitive on the domestic and international markets.

The pricing and marketing of sorghum and all other cereal crops are liberalised, except for maize where the government exercises price regulation through the National Cereals and Produce Board (NCPB). Despite this, the non-tariff barriers hamper progressive value chain development and trade thereby impacting negatively on the livelihoods of chain actors. Regionally, there are no tariffs levied on food crops traded among East African Community (EAC) and Common Market of Eastern and Southern Africa (COMESA) countries. This serves to ease trade flow in food commodities such as sorghum from areas of surplus to deficit areas among the member states. However, food commodities traded with the rest of the world including Southern Africa Development Community (SADC) are subject to a 25 per cent tariff though Kenya is not a significant player in the international sorghum trade.

The beer industry is increasingly cementing its position as a major player in the sorghum value chain in Kenya and continues to play a critical role in the chain. The increasing demand for Senator beer has created a high demand for high-quality white sorghum for malting. At an estimated sorghum malting capacity of 60,000MT annually and the national sorghum production standing at 117,000MT in 2016, EABL alone can utilise more than half of the national production. However, EABL faces competition for sorghum from Unga limited and other feed processing companies though according to KNBS (2017), only 19,000MT of sorghum was used to manufacture feed in 2016. Sorghum can also be processed to produce ethanol and syrup and companies dealing in these products also compete for the same sorghum. To meet the growing demand, the existing sorghum potential must be fully exploited in the country through commercial production and trade in the commodity.

4.4 Inclusivity and empowerment

It is worth noting that there are changes in the agricultural landscape in Kenya in terms of population, household characteristics and the emergence of the medium scale farmers. Hence, inclusivity in all nodes in agriculture is a prerequisite and a necessary condition for achieving food security. The inclusion of youth and women in agriculture is paramount to agricultural transformation. These calls for innovative and attractive ways to make youth and women participate in agriculture. Youth will participate in an agricultural activity if they deem it more lucrative than participating in non-farm activities.

In Kenya, sorghum has traditionally been identified as women's crop in many smallholder-farming communities. However, according to a survey of households in the major agro-ecological zones excluding the arid areas, the majority of the male-headed households planted sorghum with only 12% of the youth headed household participating in sorghum production (Table 2). Table 2 also shows that more male-headed households in Kenya are engaged in sorghum cultivation than female-headed households.

Table 2: Sorghum productivity by household type

Household type	Cultivated sorghum (%)	Productivity (Kgs/acre)	Commercialization	Land size owned (Acres)
Adult Male	57.0	188.5	0.06	3.9
Adult female	30.8	215.6	0.07	2.6
Youth	12.2	219.4	0.12	2.5

Source: Tegemeo Institute, 2014

While the majority of male-headed households cultivated sorghum, their yields were lower than that of female and youth-headed households. This is an indication that female and youth-headed households manage their farms better than the male-headed counterparts. Youth-headed households had higher yields per acre (219.4 Kgs/acre) compared to adult male and female-headed households. This is because sorghum cultivation is extremely labour intensive, especially during harvesting and de-hulling when most of the post-harvest losses occur. Female and youth-headed households are less likely to own agricultural land compared to male-headed households. Results show that male-headed household own about 1.5 times more land than youth and female-

headed households. From the preceding paragraphs, it is evident that sorghum production is not inclusive and this may be the reason why its production has lagged than other cereals in Kenya. The average commercialisation index is 0.06, 0.07 and 0.12% among the male, female and youth-headed households respectively.

Farmers in Table 2 typify farmer A in Table 1. On average these farmers are likely to get a negative return from sorghum farming. However, if these farmers were engaged in commercial sorghum production, they would have a return of up to Ksh.52,650 per harvest based on their cultivated land. Positive returns allow for investment both on the farm to improve productivity and off-farm to improve household welfare.

4.5 Opportunities for women & youth in the sorghum value chain

A gender-sensitive value chain approach to agricultural interventions increases the visibility of men's and women's roles in various nodes and eliminates gender-specific barriers to entry and opportunities for growth in the society. Some of the documented gender barriers include low access to markets owing to cultural seclusion of women, reduced income control by women with increased commercialisation and women's lower access to technology (Odongo, 2014). These barriers influence the level of entry in the value chains and an actor's capacity to compete with other actors. Generally, while there is the variation of opportunities and constraints for women, men and the youth between regions and value chains, women tend to play significant roles in production and elementary post-harvest processing that are often key determinants of size and quality of the final product/produce. These roles are however often informal, unacknowledged and under-resourced. These challenges also face the youth hindering their participation in agricultural value chains.

While most early works on agricultural value chains centred on improving the competitiveness of different supply channels, many recent efforts have instead focused on increasing opportunities for the poor and the marginalised in the society in the spirit of inclusive growth and development. Inclusivity of value chains can be broadly interpreted to mean equal availability and accessibility of various opportunities and benefits thereof along the value chain to all actors. Women and the youth are in most cases the most constrained groups to participate effectively in various nodes of the value chains. Inequality is still high in Kenya although some social

indicators have improved (GoK, 2016); there are significant differences in opportunities and outcomes between men and women living in remote and most under-developed regions.

Women and the youth are an integral part of the agricultural transformation and must be accorded equal opportunities to contribute to the desired sustainable agricultural growth meaningfully. Agricultural Sector Development Strategy (ASDS) notes for instance that to attract the youth to agriculture; there is need for attitude change among the rural communities to perceive agriculture as a business and make it commercially viable. In 2017, the Ministry of Agriculture, Livestock and Fisheries (MoALF) developed the Kenya Youth Agri-business Strategy 2017 - 2021 aimed at addressing the challenges that hinder youth from efficiently participating in the sector and provide new opportunities for the youth in agriculture and its value chains.

In the sorghum beer value chain, women tend to concentrate more on production at the farm level where they mostly provide agricultural labour. Muui et al. (2013) found that females were more involved in sorghum production than men. This finding can be attributed to the subsistence nature of sorghum production, where it is produced for home consumption primarily by children. A separate study in Nakuru also showed more significant proportions of females as opposed to males being involved in sorghum production (Ogeto et al., 2013). Women were likely to be involved in planting, weeding, harvesting and post-harvest processing. Up the value chain, the roles of men become more prominent.

The youth, on the other hand, offer labour at the farm level and are mostly involved in support services to the value chain. The youth, for instance, offer loading, offloading, transportation and advisory services in the sorghum beer value chain. Oduol et al. (2013) looking at avocado value chain, however, asserted that men tend to be more concentrated in high status, more physical, and more remunerative activities in the value chain. This could also be the case for sorghum value chains.

The growth of the sorghum beer industry offers a huge opportunity for the value chain actors especially women and the youth. The continuing expansion of EABL's capacity implies that there is demand for more sorghum and presents an excellent opportunity for farmers to continue in commercial sorghum production given ready market and the price assurance. Sorghum,

therefore, plays a critical role in economic security for all actors especially women (Oar et al., 2018). The roles of both youth and women in the value chain move in tandem with available and accessible opportunities along the value chain. Sorghum value chain agribusiness could be the key to unlocking the potential of an inclusive sorghum industry in Kenya with opportunities for women and the youth.

5. Food security and poverty reduction

Food security and poverty reduction is one of the key objectives of Kenya's agricultural sector and a major development agenda by the Kenyan government. It is also one of the Four Big agenda of the current government administration. The unending food insecurity incidents have led to many of Kenya's development initiatives with an emphasis on rural poverty reduction. Some of these policies include; the Kenya National Food Policy of 1981 and revised into Sessional Paper2 of 1994, the Poverty Reduction Strategy Paper in 2001 to 2004, the Economic Recovery Strategy for Wealth and Employment Creation in 2003 to 2007, the Kenya vision 2030, the Strategy for Revitalization of Agriculture (SRA) 2004 to 2014 and ASDS in 2010 to 2020 (Smith et al., 2004). Despite these strategies, food problems have persisted in most parts of the country.

Population data estimates indicate that, in Kenya, 10 million persons and their households are highly food insecure, with 3.2 million food insecure persons living in arid and semi-arid (ASALs) regions of the country that comprise of 88% of Kenya's land area (Gitu, 2004). These regions experience prolonged and frequent drought that have greatly reduced the country's ability to meet its food requirement (FAO, 2008a). Droughts in ASAL areas of Kenya have led to a decline in agricultural productivity, especially among the small-scale farmers. This has prompted households to come up with varying coping strategies which include the adoption of drought-tolerant crops that are more suited to such regions. One such crop that has the potential to eradicate poverty and end severe food insecurity is sorghum. This is because sorghum is drought tolerant and can survive under a wide range of soils (Fetene et al., 2011).

However, in Kenya, this crop has been grown majorly for subsistence with few households growing for commercial purposes (Ogeto et al., 2013). This is because traditionally, sorghum is perceived to be a low-value crop with minimal returns making farmers shy away from its production. In addition, the marketing system of sorghum is unstructured, and the prices to farmers are relatively low. Notably, sorghum, a crop that was initially neglected has become increasingly important as a source of cheap raw material for the brewers, food and feed to livestock. In the recent past, Kenya Breweries Limited (KBL) in collaboration with Kenya Agricultural & Livestock Research Institute (KALRO) has been promoting the use of sorghum in the brewing process in place of barley. This has led to renewed interest in the production of

sorghum and what was once a subsistence crop grown in ASALs has turned to be a business-oriented crop (Kilambya and Witwer, 2013).

5.1 Effects of climate change on food security

Under climate change, agricultural productivity and human welfare is /will be adversely affected. In the next coming decades, climate change is likely to affect food and water security in a more significant and in uncertain ways, and this will be adverse in developing countries like Kenya (Ringler et al., 2010). This is majorly so because these countries have a high level of poverty and low capacities to adopt climate mitigation measures. In addition, the majority of the rural population draw their livelihoods directly and indirectly from the agricultural sector which relies heavily on rain-fed agriculture. Therefore, climate change is likely to aggravate an already worse situation. Irrigation is one of the mitigation measures against climate. However, only 1.8% of the cultivated land in Kenya is irrigated which is lower than Africa's average of 5%, 37% in Asia and 14% in Latin America. All these challenges coupled with low agricultural funding pose a critical challenge to food security.

Global warming in SSA and specifically in East Africa is expected to be higher than the rest of the world; the rainfall levels will generally decrease while temperatures will increase across the region (IPCC, 2007; Funk et al., 2008). This will, in turn, affect food production and productivity. Cereal production in SSA is projected to decline by 3.2% by 2050 as a result of climate change (Ringler et al., 2010). Consequently, per capita, calorie availability across SSA is projected to be lower than of 2000 and levels of child malnutrition will also increase (Nelson et al., 2009).

Wheat and barley yields are projected to be most negatively affected while millet and sorghum will be positively affected by climate change. This perhaps is because the two are tolerant to high temperatures and drought stress. While cereal yield will be declining, its demand is likely to increase by 30% from today's 2.1 billion tonnes to 3 by 2050 (FAO, 2009). Further, at the same time, the world's population is expected to grow by over a third. According to Van Ittersum et al. (2016), cereal demand in SSA is likely to triple by 2050.

Climate change will affect the four dimensions of food security namely: availability, accessibility, utilisation and stability. It will negatively affect human well-being, agricultural

productivity, marketing channels and systems and affordability of agricultural products. In addition, as a result of climate change, food prices for both crops and livestock products is expected to rise which will in turn lower households purchasing power (Herrero et al., 2010). There will be short, medium and long term effects of climate change. The most vulnerable population are those whose livelihood is agriculture-based which is characterised by increased incidents of food insecurity (FAO, 2008a). People living in arid and semi-arid regions will be adversely affected and at high risk of food insecurity given the property loss due to climate change.

Agricultural landscapes will also be affected through possible migration (internal and international) which will lead to resource-based conflicts as a result of impacts of climate change. Therefore it is vital to build resilience among the poor rural households and to help them cope with this additional threat to food security. This can be through encouraging households to grow especially the drought-tolerant crops.

5.2 Constraints and opportunities for commercial sorghum farming and sorghum beer

Sorghum production in developing regions, especially in Africa, is dominated by subsistence farmers who seldom produce excess to sell. Thus limitations in production vary from conventional to commercial scales of production (Omoro, 2013). Sorghum farmers in Kenya face several constraints which vary in combination and degree from one area to another. Studies on sorghum have found that production constraints can be broadly classified into two; Biotic and Abiotic factors (Kudadjie et al., 2004; Omoro, 2013). Drought severely hinders sorghum production in the semi-arid regions of the world (National Research Council (NRC), 1996); a problem compounded by management, variable climate, soil characteristics, pests, and in some cases socio-economic and political aspects. Low sorghum grain yields could be attributed to production constraints such as lack of market incentives, low income to buy inputs, use of low-quality seed, poor agronomic practices, and crop infestation by pests and diseases (Muui et al., 2013). These factors explain the general lag in sorghum productivity in Kenya which should be urgently addressed for the enterprise to thrive.

The commercialisation of sorghum in Kenya also seems to be lagging behind that of other important cereals such as maize, wheat and rice. Low and variable levels of production, high

assembly costs, high processing costs, and uncompetitive grain prices are some of the reasons that explain the lag in sorghum commercialisation (Rohrbach, 2003). Businesses dealing in sorghum and its products also face a myriad of constraints including inconsistent quality of raw materials (sorghum grain), inadequate marketing resources and strategies, inability to exploit economies of scale and low competitiveness of products in the markets owing to high production/processing costs.

Opportunities exist in the sorghum value chain which includes the expanding markets through regional integration, a vibrant jua-kali sector dealing in agro-based machinery, existence and willingness of the donor community to help Africa eradicate hunger and malnutrition, and expanding sorghum beer market in Kenya (Wambugu, 2011). EABL has an industrial capacity of 60,000 MT per annum in malting and brewing (Odame et al., 2014) and this presents a dazzling opportunity to farmers and other actors in the sorghum value chain. Appropriate sorghum varieties are also being sought by other private companies in Kenya and Tanzania for production of syrup, bio-ethanol and animal feeds (Odame et al., 2014). Biofortification is a potential game-changer in the sorghum enterprise in Kenya and should be explored and exploited.

5.3 Policy incentives/support for the business environment

In the policy arena, the government through MoALF has focused their attention on improving food security for the country in the face of a growing population, climate change and declining land sizes. Most sector policies are under review to align them with the devolved system of governance. Sector policies aimed at improving food security by targeting improved cereal production also affect sorghum as a crop. The Strategy to Revitalize Agriculture for instance identified promotion of orphan crops (sorghum being among them), as one of the solutions to chronic food insecurity in ASALs. Currently, there is a proposal to develop a cereals policy which is expected to lay the framework for improving production of all cereals in Kenya including sorghum.

Within the devolved system, some counties are focusing more on high-value crops, a situation which may hinder value chain development of crops regarded as low value. On the other hand, some counties have taken the lead in the promotion and commercialisation of sorghum. Kitui County, for instance, developed the Kitui County Sorghum Act 2014, which seeks to accelerate

the growth and development of the sorghum industry. The principal objectives of this Act are to: enhance productivity and incomes of farmers and improve the investment climate and efficiency of agribusiness through the promotion of production, processing, marketing and distribution of sorghum in suitable areas in the county.

At the national level, the government in response to research evidence on adverse effects of 50 per cent excise duty on sorghum beer, signed the Alcoholic Drink Control (Amendment) Act in May 2015 which changed the excise remission from 50 to 90 per cent. This was in line with the Excise Duty Act 2015 which granted the possibility of remission of excise duty on beer or wine derived from sorghum, millet, cassava or other Kenya grown agricultural commodities – excluding barley (Mailu & Mulinge, 2016). This has served as a supportive policy decision for the sorghum value chain growth. This together with other policies must, however, be monitored from time to time in a bid to avert any adverse effects that might arise during implementation.

Agricultural development policy in Kenya has emphasised the use of incentives to achieve enhanced production (Onono et al., 2013). Some of the incentives to farmers implemented over the years include setting producer prices as seen in maize, subsidy on farm inputs and intermittent provision of agricultural credit. Kenya implemented an input subsidy programme for improved seed and inorganic fertiliser in 2007/2008. The fertiliser subsidy was in pursuit of the Vision 2030 fertiliser cost reduction strategy and was implemented through the fertiliser price stabilization plan aimed at supplying affordable fertilisers to the market. Sorghum producers, like producers of other crops, have access to this resource supplied through local NCPB depots. Farmers under contract with EABL also enjoy this facility at no extra cost and the input is supplied much closer to the farms. Additionally, county governments together with other stakeholders collaborate with the Kenya Wildlife Services (KWS) to control birds; one of the biggest threats to sorghum productivity and a major contributor to its cost of production.

Up the sorghum beer value chain, the government in response to research evidence of adverse effects of 50 per cent excise duty on sorghum beer, signed the Alcoholic Drink Control (Amendment) Act in May 2015 which changed the excise remission from 50 to 90 per cent (Mailu & Mulinge, 2016). This has served as an incentive for beer production from sorghum thereby stimulating trade and value chain development.

Output storage has been a significant challenge for Kenyan producers and distributors especially those dealing in cereals. Apart from field losses, many sorghum actors suffer high post-harvest losses largely due to lack of adequate storage facilities. This together with other factors such as the need for cash to pay for other needs such as land preparation and farm inputs, force farmers to sell their produce immediately after harvest when prices are rock-bottom. Warehouse receipt system Act 2018 was passed to provide the legal framework for the development and regulation of a warehouse receipt system for agricultural commodities such as sorghum. After harvesting, sorghum farmers/traders can now deposit their produce in certified warehouses and are issued with warehouse receipts which they can use to purchase seeds and fertilisers in time for the planting season. Receipt holders can also apply for short-term credit from participating financial institutions using the receipt as security. Kavoi et al. (2013), noted that after harvesting, gaddam sorghum farmers in Eastern Kenya collected the grain in one central place for the buyer to collect and issue a warehouse receipt for later payment through commercial banks.

5.4 Quality & standards

EABL, the leading consumer of sorghum for malting is a company that is passionate about consumers of its products and as such endeavours to supply high-quality brands to its customers. The company, therefore, emphasises on production and supply of high-quality produce. In a bid to achieve this, the company outlines the expected quality requirements that must be met before sorghum can be received for processing. These are specified in the binding contracts and are signed against by both farmers/supplies and the company representative. This ensures that the storage, handling, and movement along the value chain is done in a manner that maintains and guarantees the set quality standards.

Some of the quality standards outlined in the contracts include nine to 11 per cent moisture content, less than two per cent broken kernels, less than five per cent weevil damage, no insect and mould infestation, no foreign matter contamination, no foreign odour and minimal aflatoxins. To ensure strict adherence to the quality standards, EABL monitors field crop development through field inspectors such as EAML staff and other partners which may include aggregators, third-party monitoring and evaluation teams, Ministry of Agriculture amongst others. The company also has to produce traceability mechanisms for ease of quality monitoring

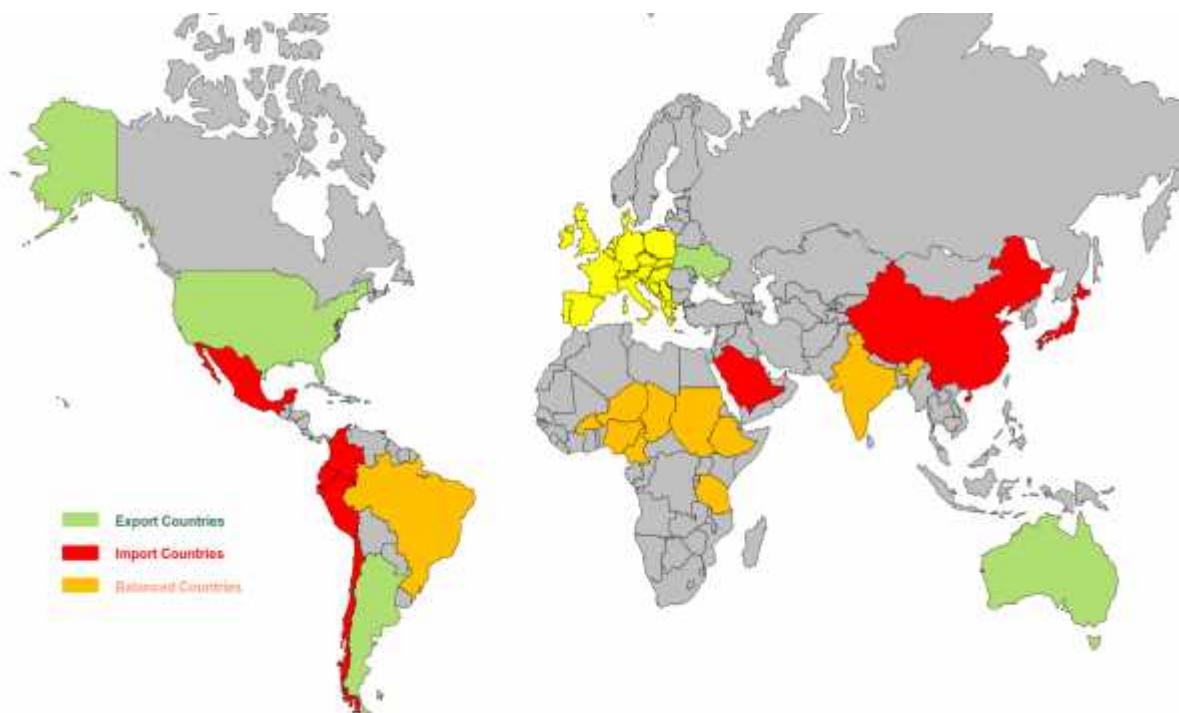
and assurance. The company also sensitises its sorghum suppliers on the quality requirements and ways to ensure the standards are strictly adhered to and met.

5.5 Opportunities for Sorghum growers in the global market

Kenya's sorghum productivity potential currently ranges between 2-5ton/ha against the current realised productivity levels of 0.7 tons/ha. At this productivity level, it is unlikely that the country can satisfy the growing domestic market that is growing with the increasing utilisation of sorghum for industrial purposes. The industrial utilisation in the domestic markets is way below that in the global market. Sorghum can be used in the production of ethanol and bio-fuels (Stevens, 2014). This is the case with countries in North and Latin America. In addition, there is little utilization of sorghum in the production of gluten-free flour. Availing gluten-free products in the local market as a healthier alternative for people with gluten-related disorders is expected to have a significant impact in demand for sorghum. Sweet sorghum, such as the variety grown in the Middle East is used to produce sorghum syrup is also an alternative to molasses and sugar in the production of pastries and confectionaries.

Globally, the market for sorghum is untapped by SSA countries despite the growing market. The global market for sorghum is estimated to grow at 2% annually with increased utilisation of sorghum for biofuels and livestock feed (World-Grain, 2018). Since 2012, China has emerged as the largest importer for sorghum due to its increasing consumption for livestock feed. Sorghum has been preferred as an alternative to maize for livestock feed production because it is cheaper to produce/purchase (Altuna, 2013). This is similar to major importers such as Japan. This demonstrates that local livestock feed manufacturers can benefit by reducing production costs and costs of livestock feed by making the same change. Reduction in costs of livestock feeds could have a more significant impact on the livestock industry as the cost of feed is one of the most significant costs of production for livestock value chains.

Figure 9: Balance sheet for top 22 sorghum producers



Source: Altuna 2013

The largest sorghum exporter in the world is the United States. Currently, due to the differences in trade policies, the trade between China and the United States is opening markets for other producers. However, of the top ten sorghum producers in the world, only the United States and Argentina have significant volumes for export. Other countries such as Mexico, Japan and India still import sorghum to meet domestic consumption. Therefore, Kenya needs to learn from big sorghum producers in SSA such as Ethiopia, Nigeria, Sudan and Burkina Faso to boost production and take advantage of bilateral agreements with countries such as China, Japan and India, whose current account balance is already heavily skewed in their favour and negotiate for market opportunities.

The driver for these opportunities should be the private sector. However, the private sector will find it prohibitive to tap into global markets without assistance from the public sector. The country, therefore, needs to facilitate the private sector to take advantage of these opportunities. For example, KBL already has contract farming with sorghum producers to meet its demand. Offering incentives to allow the company to tap into export markets for semi-processed or fully

processed sorghum will greatly boost the agriculture and manufacturing sectors in the country. This incentive could include negotiated quotas to supply bilateral partners, incentives to develop new products for the local market, and providing the necessary public goods before these investments are made.

6. Summary and Conclusions

Sorghum production has been declining majorly due to declining productivity and area under cultivation. The decline in productivity was mainly as a result of low development and adoption of improved varieties, and low market integration and development. As a result, sorghum production has for a long time been mainly under subsistence production. Despite this scenario, sorghum production has a high potential in Kenya. With the entry and expansion of sorghum beer, and substantial investment in the development of market opportunities by private sector actors such as EABL, opportunities to transform the industry and increase production, productivity and profitability are now available to Kenyan farmers. However, to achieve this potential, the industry needs to be transformed to be market-oriented and competitive at the farm level.

The role played by different actors in production must be enhanced to achieve transformation. EABL as a private company has invested in sorghum beer production and marketing. In addition, the company has also invested in increasing production through direct involvement with farmers. Efforts by the company include the provision of inputs and a ready market when farmers harvest. However, the country is still a net importer of sorghum despite this growing market, underlying the importance of raising production. To realise the expected production increase, farmers must realise the competitive returns from sorghum production in light of competing commodities such as other cereal crops such as maize. This study shows that a farmer can improve profitability by up to 220% by becoming commercially oriented. This also shows the importance of private sector companies such as EABL that have invested in developing agro-based processing and manufacturing industries.

The public sector should supply essential public goods to match private sector investments. In sorghum production, for instance, public extension systems should be vibrant and provide farmers with the necessary information and knowledge for sorghum production. Further, they should facilitate easier access to input and output markets, pursue policies that make credit services available to resource-constrained farmers and enhance market participation by smallholder farmers. Example of critical initiatives could include the development of rural infrastructure to lower the cost of transport, which is currently high at 15% of the farm gate price. Further, the public and private sector should support research to enable the development of

appropriate technologies to lower the costs of production including the development of higher yielding varieties and appropriate mechanisation of sorghum production.

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