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This paper is the report of the research conducted by Mutiat Bolanle Titilola while on internship sponsored by within the IFAD-Universities Win-Win programme Support for the University of Ibadan Centre for Sustainable Development and coordinated by the Global MDP Association Office, Columbia University, New York, USA.

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Abstract

Kenya is a food deficit country even in a bumper harvest year. Though agriculture engages about 75% of the population, 80% of Kenya's land area is classified as arid and semi-arid and is considered unfavourable for rain-fed agricultural production. The intermittent drought has resulted in a significant portion of the population regularly starving and heavily dependent on food aid. The 'Sorghum for Multiple Uses (SMU) value chain' project started in 2011. The project targeted 30,000 farmer households in Kenya. The objective of the SMU project was to support the development and adaptation of agricultural rural innovations in sorghum value chains that would reduce food insecurity and increase the income of the small holder farmer households.

The aim of this research was to assess the impact of the SMU project. It adopted a theory-based approach using mixed method evaluation design and participatory impact evaluation. The study location covered 6 sub-districts in Eastern Kenya and 477 semi-structured questionnaires were administered to both the beneficiaries and non-beneficiaries of the project, using multistage stratified random sampling.

The research analysed the contribution of the project to reduction in food insecurity and increase in income of the small holder beneficiary households. The findings reveal that the beneficiaries now plant more sorghum and receive more income from the crop even during the year 2016 season when there was severe drought in Kenya. The beneficiaries also benefit more in terms of food security as 76% have food that can last for more than 7 months and 41% can feed for the whole year. This implies less dependence on food aid. The survey also shows the strengths and weaknesses in the value chain project.

The research suggests an effective and aggressive advocacy and partnership with government to ensure stable and supporting policies for sorghum production and utilization, intensification of

government diet diversification campaign, showcasing the nutritional and health benefits of sorghum and educational and training workshops on sorghum as substitute for the main raw-material used in feed formulation, granulated sugar, ethanol, confectionaries and so on.

Key words: value chain, climate smart agriculture, food deficit, income, food security

Introduction

In Kenya, sorghum has been identified as one of the climate smart crops with broad adaptation, resilience, and high nutrition value. As a cereal that originated from Africa, sorghum is the 5th world most traded cereal after maize, rice, wheat and barley. Sorghum is tolerant to drought because of its root system, performs better than maize in drought conditions and thus grows in stress-prone semi-arid areas unsuitable for maize (FAO, 2011). Farmers in Kenya have always grown red sorghum varieties, but in small quantities as few people cared to eat it because it is considered the poor man's food, with limited market for it. Due to low production, the market outlets for sorghum have stagnated or declined over the years (Vitale and Sanders 2005). The perception of sorghum as poor people's food has also frustrated the national effort to promote the crop as a viable and commercially marketable food (GOK, 2007). However, the challenge of food and income security has compelled government and development agencies to promote initiatives centred on climate smart agriculture (CSA) since sustainable agriculture and climate change are closely linked (Terdoo and Adekola, 2014). CSA is also one of the approaches that have been championed as the "holy grail" of agricultural development (Naess, 2011). According to FAO (2011), CSA does not only sustainably increase production and resilience but also removes greenhouse gases while enhancing national food security and developmental goals.

In 2011, the "Sorghum for Multiple Uses (SMU) value chain project" started with the development of sorghum cultivars which are adapted to biotic and abiotic stresses. These varieties/cultivars were expected to play a critical role in increasing food security and income of the rural small

holder farmers living inthe Arid and Semi-Arid lands (ASALs).

It was expected that the value chain will link the vulnerable to a market system through which they sell their surplus food commodities, and through which they access basic staples and competitive, efficient and reliable production inputs. SMU project thus aligned with the country's long-term development blueprint: the Kenya Vision 2030, and the Agricultural Sector Development Strategy 2010-2020.

Demand for Sorghum for Food, Feed and Industrial Material

Generally, most of the sorghum grain produced by local farmers in Kenya is consumed after grinding it into flour to make porridge, 'ugi', and hard porridge known as 'ugali'. It was reported that Kenya produced 177,553 tons of sorghum in 2014 (FAOstat, 2017) but 53% of the total sorghum supply in Kenya each year is consumed as food in the form of grain or flour (MAFAP-FAO, 2013). The present demand of sorghum for food is estimated at 94,000 tons per annum. At present, the milling industry mostly mills sorghum as a composite flour with other grains. The present consumption of sorghum mostly through composite food formulation is estimated at 10,000 MT per annum.

Because of shortage of other grains, the milling industries are operating between 30%-40% of their capacity (worldgrain.com/department, 13 June 2017) milling about 600,000 tons of grain per annum for consumption. This indicates a huge potential for sorghum in the milling industries.

The animal feed industry is also growing due to increase in population and a growing middle class, which has resulted in increase in demand for meat and egg. Most of the rural sorghum farmers use sorghum grains as food for their chicken while the folders, leaves and stalks are kept at home or in the field as food for the ruminants. Key informant interview with some of such farmers using sorghum as chicken feed shows a positive opinion regarding its suitability for use as feed and in-home feed formulation. Interview with a small-scale feed manufacturer in Kitui indicated readiness to substitute sorghum for maize, provided it is readily available and the price is much less than the price of maize. He is not bothered by the issue of tannin.

Data by Kenya's State Department of Livestock estimates that demand for feeds and supplements in 2014 is about 650,000 tons out of which 80% is for poultry feed. The feed sector is expected to grow at 10% yearly. Maize is the main ingredient in commercial animal feed in Kenya. However, big processors prefer consistent formulation and do not routinely shift ingredients of the formulation. 80% of the feed formulation is made up of grains with sorghum constituting 4%. Only the sorghum is sourced locally while other grains are always imported because of shortfall in local production.

The use of sorghum by the commercial feed manufacturer started in 2014 when the price of sorghum became disproportionally low due to refusal of East African Breweries to take up sorghum from farmers because of increase in government tax on sorghum beer. During this period, sorghum was available at Ksh2,300 as against

Ksh2,500 per bag for maize. If the price is right and the commercial feed manufacturers are co-opted into the sorghum project with necessary support, the potential in the next five years in poultry feed (given a 50% substitution of maize) can be up to 260,000 MT per annum.

The feed manufacturers, however, have some concerns. There is scepticism regarding the feed value of sorghum. Some argue that sorghum has low levels of protein, that tannins (believed to be in all sorghum) unacceptably reduce the digestibility of sorghum-based feeds. Some argue that sorghum lacks essential amino acids necessary and complain that sorghum does not mill well; this may reduce feed efficiency as well as increase labour cost relating to milling. There is the general belief that sorghum cannot completely replace maize in poultry feed formulation. The feed manufacturers want sorghum price to be 10-20% less to maize to be competitive. Some believe that if sorghum is substituted for more than 40%, palatability of feed will be adversely affected. There is fear of constant availability of sorghum and low fibre content when compared with maize. The feed producers also prefer to deal with credible and reliable source of supply.

Table 1: Sorghum Demand/Supply to EABL

	2013/2014	2014/2015	2015/2016	2016/2017	2017/2018
Demand	18,000	20,000	22,000	15,000	27,000
Supply by Beneficiaries	12,000	2,000	12,000	7,000	?

The East Africa Breweries in Kenya is the only known industry using sorghum in large scale. The brewery is a stakeholder in the SMU value chain project as the main up-

taker of the grain. The quantity demanded by the brewery has increased over the years from 2,000 metric tons in 2009 to 27,000 metric tons for the 2017/2018 planting season.

The 44% of the country's overall alcoholic beverage market is commercial and EABL controls over 95% sales in this market (Excise taxes in Kenya). With the popularity of the "Senator Keg" (low price beer being made from sorghum), it is expected that over time, more people will move from the traditional and illicit beer consumption to the more hygienic and safer one being produced by EABL and this will result in increase in demand for sorghum.

The present demand by EABL is 27,000 MT. It is expected that the demand for sorghum for beer will continue to increase and EABL will increase the sorghum to barley ingredient ration along 60:40.

Description of the SMU Value Chain Project

From 2011 to 2015, the International Fund for Agricultural Development (IFAD) funded Sorghum for Multiple Uses (SMU) value chain project in Eastern Kenya and Tanzania. International Crop Research Institute for the Semi-Arid Tropics (ICRISAT) Kenya developed the Sorghum for Multiple Uses (SMU) cultivars that are higher in yield and adapted to both biotic and abiotic stresses. These varieties were expected to play a critical role in increasing food security and income generation because of their resistance to drought conditions, promising commercial uses and low cost of production relative to other staple foods. Africa Harvest, as the implementing partner, developed the value chain model using the aggregator approach; disseminated the SMU varieties, engaged in capacity building of the

beneficiaries, while actively linking farmers to market outlets for surplus and facilitating linkage with input suppliers.

The SMU project was executed through five output components (Appendix 1) comprising baseline, sorghum value chain upgrading, sorghum cultivars development, partnerships, and capacity building. The objective of the SMU project was to support the development and adaptation of agricultural rural innovations in sorghum value chain that would reduce food insecurity and increase the income of the smallholder farmer households.

The project covered 4 counties in Eastern Kenya, spread over 8 districts. It targeted 30,000 households (150,000), direct beneficiaries in Kenya. At the conclusion of the project, it was expected that the beneficiaries will experience a 20-25% increase in sorghum production, at least 20-30% of the targeted households (30,000) will be selling sorghum collectively to reduce transaction costs and realize a 20% increase in income after their capacity is enhanced and they are linked to commercial-scale sorghum value chain (Marangu et al, 2013).

Major SMU Stakeholders are:

1. International Fund for Agricultural Development (IFAD)
2. European Commission /Consultative Group on International Agricultural Research(CGIAR)
3. International Crop Research Institute for Semi-Arid Tropics (ICRISAT)
4. Africa Harvest Biotech Foundation International (Africa Harvest).

5. Small-holder farmers in the targeted areas

Others are:

- Kenya Agricultural and Livestock Research Organization (KALRO)
- Department of Research and Development (DRD)
- Financial service providers
- Aggregators: agro-dealers and agrochemical companies
- Processors: East Africa Malting Ltd (EAML), Tanzania Breweries Ltd, UNGA Products Ltd
- Seed companies: Namburi Agricultural Company-Seed (NACo Ltd), Kenya Seed Company, KALRO Seed Unit and Western Seed Company.
- Universities: South Eastern Kenya University (SEKU), Nairobi University and Sokoine University of Agriculture (SUA)

This research provides analysis of the contribution of the SMU value chain project on the food security and income of the small holder farmer households in Eastern Kenya. This feedback from beneficiaries of the SMU project is important to measure if the project initiative has made the desired impact on the intended beneficiaries. This assessment is necessary for accountability and learning which is relevant to decision on up-scaling or development of similar future projects.

Statement of the Problem

Eastern Kenya land is semi-arid and characterized with low rainfall. Climate change makes the rainfall pattern also unpredictable. The low or unpredictable rainfall pattern results in intermittent drought as a result of which a

significant portion of the population regularly starves. The most vulnerable group in Kenya in this regard is the small-holder farmers who account for 75% of the total agricultural production and 70% of marketed agricultural output in the country (FAO 2007, and Nwadalu et al 2013). Kenya had serious drought episodes in 2001, 2003, 2006, 2009, 2011 (Fitzgibonn, 2012; Mwadalu et al, 2013) and 2016.

In spite of the successive droughts and socio-economic constraints which led to persistently unstable and declining agricultural productivity in the semi-arid eastern Kenya, government research and policy still show critical inclination for maize (Mwadalu et al, 2013). Farmers then continue to grow and depend on maize, which is high risk (highly vulnerable) as a result of its poor adaptation, especially to low rainfall (Esipisu, 2011), as their main cereal crop while sorghum, considered the poor man's food, is neglected with a very narrow market outlet. With the continued deterioration in food and income security, government and development agencies started to promote initiatives centered on climate smart agriculture. Sorghum was then identified as one of the climate smart crops with broad adaptation and resilience as well as a high nutrition value.

The SMU project was introduced in 2011 to exploit the opportunities of sorghum as food, feed and industrial crop, towards contributing to the achievement of food security and poverty reduction in rural farmer households in Eastern Kenya. But there is need to find out whether the SMU project has contributed to any observable improvement in food security and household incomes of the targeted beneficiaries. This work will, therefore, address the contributions of the SMU initiatives towards improving food

security and income of the beneficiaries in the research area and thus form a basis for informed decision on replications or scale-up.

This research will contribute information to private and public-sector policy and investments aimed at encouraging initiatives for drought tolerant crops as a means of alleviating food security and poverty as well as fighting malnutrition in children.This work will also provide the government with research-based evidence on whether its strategy and efforts in promoting climate resilient crops (sorghum) is having the desired effect of reducing food insecurity during drought condition.

Review of Literature

According to Taylor (2003), the increase in sorghum production recorded between 1976 and 2001 was as a result of increase in land area planted and not as a result of overall improvement in yield. This is because sorghum cultivation in Africa is still mainly characterized by traditional farming practices; with low inputs (no inorganic fertiliser or pesticides) and traditional varieties or landraces. Such low yields meant that there was often no surplus sorghum, without which processing industries cannot be created. Taylor adds that Africa produced a third of the world's sorghum and that though production takes place across the continents, Northern Africa, countries of Nigeria, Sudan, Ethiopia and Burkina Faso accounted for nearly 70% of the production. He also explains that because the structure of maize and sorghum are similar, processing technology for both are similar except that the pericarp of sorghum is small, and this can be a disadvantage in dry milling. Further, he points out that though sorghum pigmentation can colour

food, attention has been recently drawn to the possibility that such polyphenolic compounds have beneficial "functional" antioxidant properties. He compares the nutritional components of sorghum, maize, barley, rice and wheat and also likens the importance of sorghum to the bewildering variety of African traditional sorghum foods and beverages. These include: whole grain rice-type products, breads and pancakes, dumplings and couscous, porridges, gruels, opaque and cloudy beers, and non-alcoholic fermented beverages. He explains further that sorghum is not just a grain of tradition in Africa; it is also increasingly the key ingredient in highly successful novel and non-traditional food and beverage products. Three of these products are instant soft porridge, malt beverages and lager beer.

He concludes that the potential for sorghum to be the driver of economic development in Africa is enormous and that continued focused fundamentals and applied research are essential to unleash sorghum`s capacity to be the cornerstone of food security in Africa.

Mwadalu et al (2013) reviews the potential of sorghum for improving food security in ASALs of Kenya with specific focus on semi-arid eastern Kenya. They trace the declining agricultural productivity over the years and the drought problem, while considering the four most common improved varieties of sorghum (Gadam, Serena, Serado and KARI Mtana) in Kenya. They submit that the government agricultural policies in the past had put more emphasis on maize among other cereals, but the new market initiatives had spurred renewed interest in the commercial production of sorghum due to collaboration with East Africa Breweries

Limited (EABL). They identify the constraints being faced by farmers to include reduced effectiveness of extension services, the menace of the Quelea birds, increased fertilizer prices, inefficiency in input and output marketing, lack of attention on sorghum by government, single market outlet provided by EABL, image problem as sorghum is considered food crop for poor and vulnerable communities. Other issues include pests and diseases, resource constraints, lack of legal and regulatory framework for sorghum as opposed to some other agricultural sub-sectors that have their own policy document. They, however, conclude that sorghum has the ability to end the severe food insecurity in ASALs due to its tolerance to drought and ability to thrive under a wide range of soils.

Klambya (2013) describes the market incentives and disincentives for sorghum in Kenya between the period of 2009 and 2011. His findings reveal a profound fluctuation in both imports and exports of sorghum due to a regional drought and food shortage. According to him, Kenya imports sorghum from United States, European countries and some East Africa countries like Tanzania and Uganda. But the promotion of Sorghum by Kenya Agricultural Research Institute (KARI) in collaboration with East African Breweries Ltd (EABL) for beer making has generated farmers' renewed interest. Yearly averages of farm gate and wholesale prices are compared with reference prices calculated on the basis of the price of the commodity in the international market. The price gaps between the reference prices and the prices along the value chain indicate to which extent incentives (positive gaps) or disincentives (negative gaps) are present at the farm gate and wholesale level. He expresses the gaps of Nominal Rates of Protection (NRPs)

and the key indicators used by MAFAP to highlight the effects of policy and Market Development Gaps (MDGs) on prices.

The results suggest that most of the variability in price incentives and disincentives throughout the period analyzed were due to production shortages, shifts in trade patterns and possibly even food aid subsidies and the removal of import tariffs in certain years. He concludes that market price inefficiencies due to taxes, bribes and other non-tariff barriers reduce price incentives for producers and that volatilities in government intervention is a key disincentive. He therefore recommends the need to strike a difficult balance between providing incentives to producers and protecting consumers. He advises the Government of Kenya (GOK) to focus on reducing costs borne by producers and traders to incentivize production and promote trade.

Odame (2014) did an inventory of innovations which have the potential to be commercialized by using the value chain approach (VCA) and Agricultural Innovation Systems (AIS) Framework. He applied the VCA to the Strengths, Weaknesses, Opportunities and Threats analysis of the value chain, identifying the constraints of the existing or new technologies and innovations with a view to solving them.
He came up with SWOT Analysis for Sorghum as follows:

Strengths: (1) government renewed support for research and development (R&D) of cereal crops suitable for arid and semi-arid conditions including other institutions like ICRISAT. (2) Alliance for a Green Revolution in Africa (AGRA) and KARO with more than 20 released sorghum varieties with varied attributes for various uses. (3) five

genotypes identified for baking by the Kenya Agricultural Productivity and Agribusiness Programme (KAPAP), two for brewing and one for ethanol from stalk juice, capable of producing 600-700 liters per ha. (4) Suitable for marginal areas such as arid and semi-arid regions of East Africa.

Weaknesses: that must be overcome to maximize the potential of the value chain include: (1) Low yield at average of 1.4 tons/ha despite the fact that all released varieties have a yield potential greater than 2 tons/ha., (2) Over reliance on farmer saved seeds, (3) Labor intensive systems, (4) Limited access to appropriate seeds, (5) High relative price-sorghum sold for Ksh 25/kg (US$0.3) compared with maize Ksh 20/kg (US$0.24). This is a challenge facing feed manufacturers in particular.

Opportunities: EABL, the main up-taker, has capacity to utilize 50,000 metric tons per annum in malting and brewing. Other interested private companies in Kenya and Tanzania need sorghum for the production of syrup, bio-ethanol and animal feed.

Threats: **Speculations by grain industries.**

AIS framework was applied in assessing commercialization process of technologies /innovation using AIS elements of technology, aggregation, knowledge and skill, market, financing and enabling environment. Odame's findings reveal that for sorghum, banana and coffee value chain, the capacity built over the years has seen many technologies develop but the rate of deployment is still low largely due to inadequate resource allocation, limited efforts for commercialization and poor linkage to stakeholders. The study also reveals that finance for private sector

engagement in research and development and agribusiness manufacturing is very weak. He then recommends that business incubators must come up with strategies regarding the form of financial support necessary to sustain their ventures beyond the incubation period. He also suggests that apart from the conventional capacities, the process of commercialization requires innovative capacities to document impacts: success stories, pitfall to address and best practice which will provide useful information in shaping policies, research and future related agribusiness development programmes.

According to him, the factors affecting demand and preferences for sorghum depend on whether it is for human consumption, commercial use or a combination of the two. He concludes that sorghum value chain across East Africa is still very weak, considering that the crop is mainly used for consumption.

Kiambi and Mugo (2016) submit that about 80% of all the seeds used in Kenyan farming systems come from the informal sector and despite this, the importance of the informal seed system has been largely underplayed and unappreciated as a distinct and expanding system.

They assert that sorghum seeds are still largely OPVs (open pollinated varieties) and the seed industries for these crops are at evolutionary stages 1 and 2, as are those for most other minor crops. In stage one (pre-industrial stage), there is only local seed and no formalized exchange relationships beyond kinship and other local community networks. In the second emergence stage, specialized knowledge from research organizations is used to generate open pollinated varieties

(OPVs). In the absence of economic incentives, government agencies assume the functions of research, seed multiplication, and provision. Farmers source seeds from both formal and informal seed systems.

Kiambi and Mugo further state that there are currently 8 released varieties that are suitable for low to middle altitude 250-1700 metres above sea level and about 12 varieties suitable for high altitudes of over 1700m above sea level. The western and eastern province of Kenya produced more than 80% of sorghum in Kenya.

The Eastern, Nyanza, Western and Rift Valley provinces accounted for about 42.5, 40.5, 8.5 and 6.6 percent of Kenya's total sorghum production in 2011. Collectively, these provinces produce 99 percent of the country's sorghum (MoA-ERA, 2012).

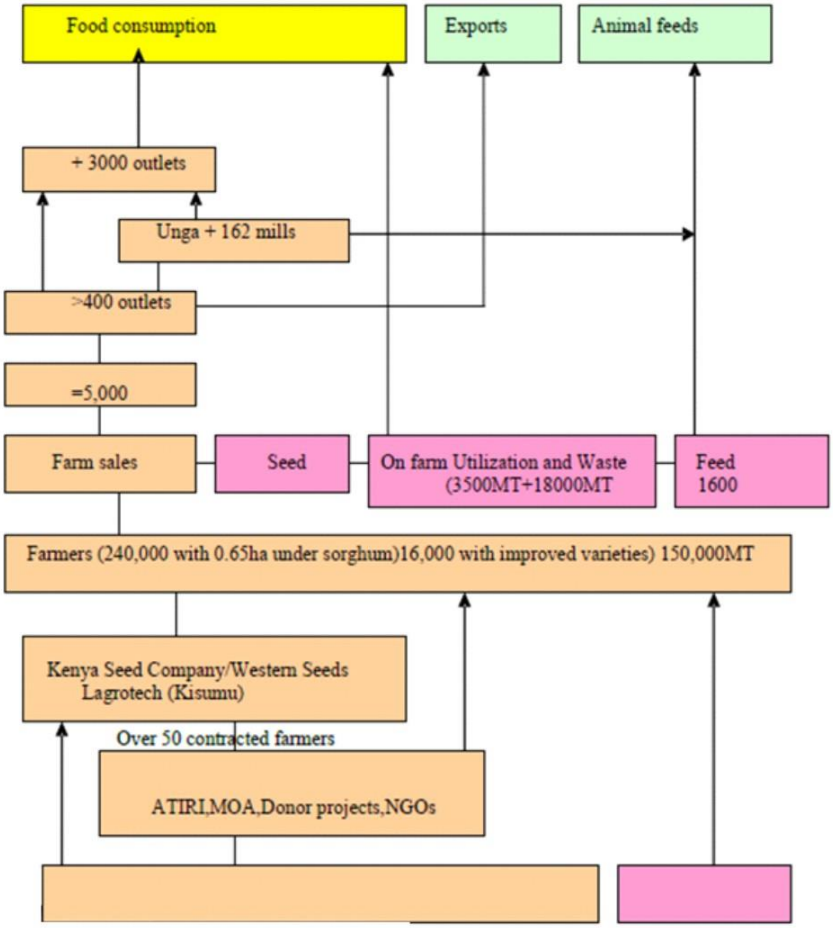

Figure 1: Sorghum Consumption Value Chain
Source: Kiambi and Mugo, 2016

The planting of sorghum for selling to EABL is done either as a group or by individual farmers. Individual farmers can enter into a direct service contract if they have a minimum of 30 acres of land. Smallholder farmers and farmer groups are contracted through service providers. Farmers grow

sorghum on 0.25 acres to 2 acres. Farmer groups grow between 30 acres and a few hundred acres.
The harvesting of sorghum grown for brewing creates a huge demand for labour. This provides an opportunity for mechanization. Threshing machines have been introduced in some areas. Warehouse facilities for aggregating and storage are not readily available to most farmers who largely use their own houses to store harvested sorghum. Only few groups and cooperatives have facilities to store sorghum. To produce for industries, including breweries, also requires a uniform quality of the product.

In the current model, all risks and losses along the value chain are borne by farmers.The formal sorghum seed value chain as depicted below shows a second channel partly with pink background. Although this is part of the formal seed sector in Kenya which provides a big portion of sorghum seed to farmers, it is not market-driven. The value chain depicted above is driven through the Ministry of Agriculture, KALRO and NGOs.

Seed sorghum production is similar to the industrial sorghum value chain and may be considered one of the many industrial sorghum value chains. Additional monitoring of crop development and lower thresholds for pest and diseases are the main difference in the production. These additional tasks are covered by KEPHIS and the extension services of the seed companies and, therefore, do not impact on the work-load of the farmer.

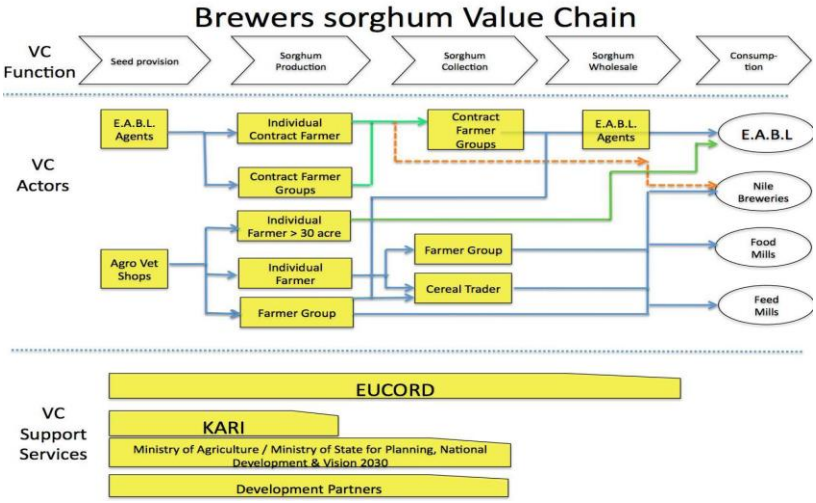

Figure 2: Industrial Value Chain for Sorghum
Source: Kiambi and Mugo, 2016

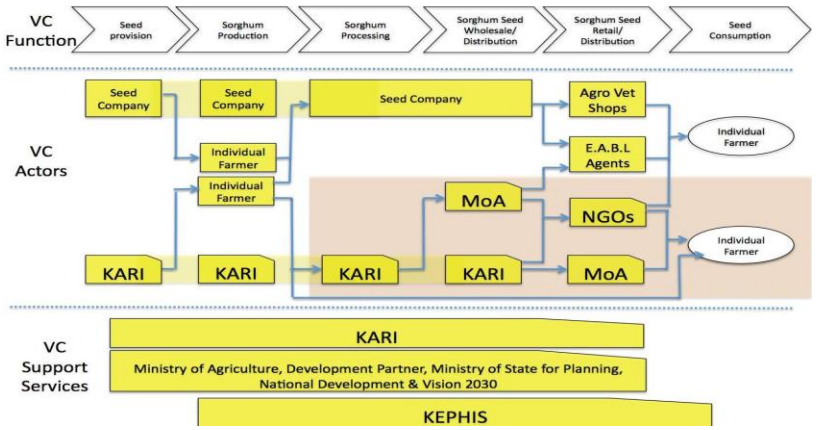

Figure 3: Sorghum Seeds Value Chain
Source: Kiambi and Mugo, 2016

Kiambi and Mugo believe that the formal seed sorghum value chain needs the same operational service as those of the industrial sorghum value chain, and that any investment into the industrial sorghum value chain will also benefit the

niche sorghum seed value chain. Again, since the value chain is driven by the high demand for certified sorghum seeds in Kenya and South Sudan, it can be assumed that the demand will not decrease, but rather increase as more and more farmers are adopting sorghum farming due to changing weather conditions and the promotion efforts of the government. The government, however, needs to ensure that the promotion of sorghum farming is not distorting the market. Kiambi and Mugo, however, caution that farmers' dependence on free seeds alone will make it very difficult to ensure sustainability of the supply chain beyond the government sorghum seed distribution programmes.

The present research will validate some of the issues in the value chain and the recommendations of Kiambi and Mugo as it will also go further to discuss the impact the planting of sorghum has on the life of the rural farmers as it relates to the household income and household food security. One of the strategic objectives of Kenyan government in reducing the food insecure people by 600,000 every year is by identifying and up-scaling successful pilot projects (Wanjama, 2002; GoK, 2008; Lemba, 2009). To this end, this research will provide basis for informed decisions.

Conceptual Framework

Theory-based approaches are concerned with determining logical pathways between aspects of an intervention and its subsequent impacts on different subpopulations, and thus making claims about causation. This research used the result chains in causal model to develop the theory of change (Figure 4). This theory of change will explain how the intervention is expected to bring about the desired results rather than just describing the results. Generally, a theory of

change includes: a logic model/results chain, the assumptions that external factors may influence the expected results; and any empirical evidence supporting the assumptions, risks and external factors (Treasure Board of Canada, 2012).

Attribution takes on a rather constructivist light within the early iterations of the theories of change approach (Mackenzie and Blamey, 2005); in reality, this means that it is the evaluator who must assume the role of skeptical observer (Mackenzie and Blamey, 2007).

Research Methods

Study Area

Kenya has a population of approximately 45 million (2014 estimate) with 73% aged below 30 years and an almost equal number of male and female. The population growth rate is 2.6%. The country covers a land area of 582,646 square km. It is a country of climate and ecological extremes with altitude varying from sea level to over 5000m in the highlands. Kenya has 80% of its land as arid and semi-arid and unfavorable for rain-fed agriculture even though about 75% of the population depends on agriculture for sustenance (FAO, 2007; Nwadalu et al 2013).

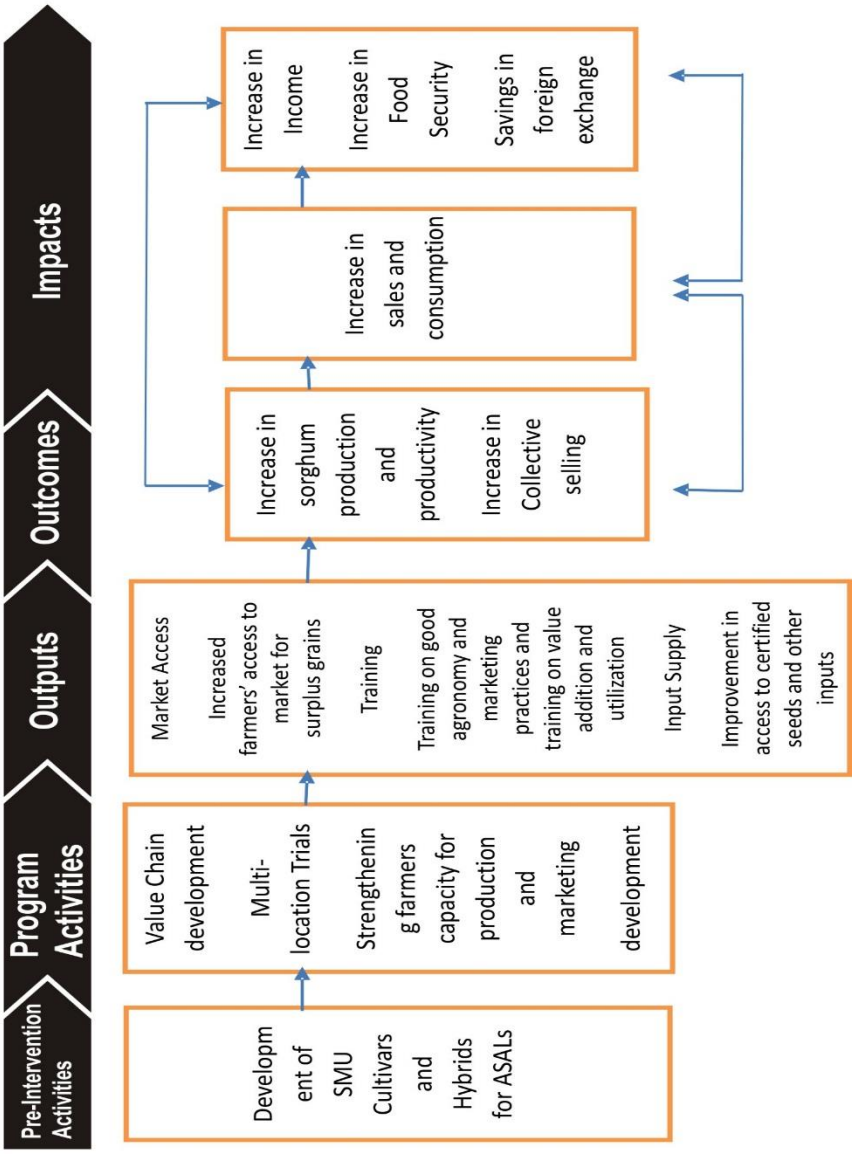

Figure 4: Conceptual Framework for the SMU Impact Study
Source: Adapted from "The Baseline
Research Report MicroReport #33

The Arid and Semi-Arid lands (ASALs) have annual rainfall of between 200 and 1000mm and are vulnerable to drought and climate change with annual rainfall patterns increasingly becoming less predictable (Apollo, 2006). Fifty-three per cent of the rural people live below the poverty line and 30 per cent of the children below 5 years are malnourished. About 93% of the people living in the rural area are located on the ASALs.

The ASAL areas are all remote rural areas, lacking in good infrastructure, having limited options for livelihood and generally neglected in development initiatives. The Eastern Kenya in particular is generally characterized by drought, sometimes going without rain for two to three years at a stretch. In the rural area, the high cost of transaction due to the dispersed pattern of habitation and dilapidated road network does not make a compelling business case for the traditional business person.

Climate change and low rainfall limit the options of crop technologies that can be used in these areas to address food security. As a result, the challenges of poverty, food insecurity and income inequality persist. The people in this area tend to respond to drought-related crop and livestock loss by adopting harmful coping practices, such as selling their only money-earning assets, withdrawing children from school, and undertaking income-generating activities that damage the environment (WFR, 2017). Kenya has not had less than one million people on food assistance in the last 12 years, with the number raised from 1.3 million in September 2016 to 2.6 million in January 2017. Though the Government of Kenya has come up with different initiatives, Kenya still remains on the Global Hunger Index (Global Food Security

Index, (2017). Since the agricultural sector is increasingly showing a high level of vulnerability and impact to climate, farmers need to be able to adapt or remain impoverished (Olayide et al. 2017).

This survey was conducted in Eastern Kenya where the SMU project was implemented. The project study area is in the Eastern Province of Kenya and can be divided into Upper and Lower Eastern with two counties each. Lower Eastern has Kitui and Makueni counties while Upper Eastern has ThatakaNithi and Meru counties. The impact survey samples were taken from Kitui and TharakaNithi counties.

TharakaNithi County

The county lies between latitude 000 07′ and 000 26′ South and between longitudes 370 19′ and 370 46′ East (google map). It is divided into four administrative sub-counties namely: Tharaka North, Tharaka South, Meru South and Maara. The lower altitude is classified as semi-arid.

The county has a bimodal rain pattern with the long rains between April and June and the short rains between October and December. The rainfall is poorly distributed with average annual volume of about 2,200 mm in M.T Kenya and about 500mm in Tharaka region and annual precipitation rate of 1.8% (Government of Tharaka Nithi, 2017)

According to the Kenya Bureau of Statistics, the Tharaka Nithi county covers an area of 2,639km^2 with a total population of 365, 330 people (2009 census) of which 178,451 are male and 186, 879 are female. There are 88,803

households in the county and a population density of 138 people perkm^2. About 13.6% of the county's population is under five years old while 5.2% of the population is aged 64 years and above. The labour force (15-64 years) is 50% of the county's population. The key economic activities revolve around crop farming. According to the 2009 national census, 98.2% percent of households in the county engage in crop farming. Like any semi-arid land, water for domestic consumption and farming is a problem.

Kitui County

Located in the lowlands of southeastern Kenya, Kitui County is home to 1,012,709 people (2009 census) with 481,283 males and 531,426 females covering an area of 30,497 km^2. The population density is 33.21/km^2. The population has been growing rapidly at 2.1% (Kenya Bureau of Statistics).

Kitui is between altitude 400m and 1800m above sea level. The central part of the county is characterized by hilly ridges separated by wide low-lying areas and has slightly lower elevation of between 600m and 900m above sea level. The rainfall pattern is bi-modal with long rains falling in the months of March to May. These are usually very erratic and unreliable rainfall. The short rains which form the second rainy season fall between October and December and are a bit reliable. Temperature range is between 12^{0}C and 34^{0}C (Government of Kitui, 2017).

Poverty is prevalent in the county and manifests itself in other socio-economic outcomes such as poor nutrition, health, and education, as well as lack of access to basic services. Unemployment is a major challenge in the county,

especially among the youths. The livelihood of most county residents depends on rain-fed small-scale farming, a practice that is highly vulnerable to the effects of climate change and environmental degradation. The county is faced with serious water scarcity challenges. Recurring droughts have diminished water supply, rendering many rivers seasonal or drying them completely.

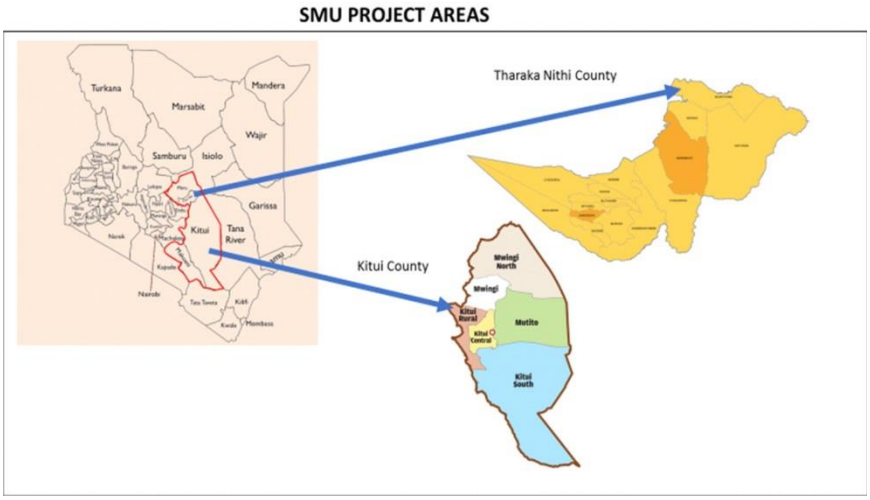

Figure 5: Map of Kenya and the Study Areas
Source: Africa Harvest Biotech Foundation

Research Methods

Sources of Data

Both primary and secondary sources were used. The secondary data were collected from journals, newsletters, base-line survey, published research works and books. The primary data were collected through key informant interviews, focus group discussions, individual farmers' interviews, questionnaire, observations and participatory impact assessment (PIA). In the interest of comparability, some baseline questions relevant to the impact assessment

survey were kept, and other ones were added. To assess the demand for sorghum for feed, this research draws heavily on an assessment of the current use and opportunities for sorghum in the feed industry in Kenya done by ICRISAT and Africa Harvest.

Instrument of Data Collection

Both structured and semi structured questionnaire were used to collect data from beneficiary and non-beneficiary farmers. Visual cards/diagrams and counters were used during the participatory impact assessment data collection. Voice recorder and photo camera were also used following proper ethical standards.

Sampling Methods

Eastern Kenya was divided into Upper Eastern and Lower Eastern. Using random sampling, one location each was selected from each stratum. From each location, three sub-locations (districts) were purposefully selected and sample size calculated using sample size calculator (Kadam and Bhalerao, 2010).

Due to constraint of time and fund, the questionnaire was administered to 10% of the calculated sample size of the beneficiaries. For the control farmers, half (50%) of the beneficiary sample size was used. So, the questionnaire was administered to a total of 318 of beneficiary farmers and 159 control farmers. The total sample size was 477.

Table 2: Sample Locations and Sample Sizes

Province Project Area	Division	County	Location (Sub county)	Sub-locations	Sample Size (Beneficiary)	Sample Size (Control)	Total
Eastern Province of Kenya	Upper Eastern	TharakaNithi	Tharaka North	Gikingo	128	64	192
				Thiiti	77	38	115
				Ntooroni	51	26	77
	Lower Eastern	Kitui	Kitui Central	Kavuta	26	14	40
				Mbusyani	23	10	33
				Utooni	13	7	20
Total Sample Size					318	159	477

Method of Data Collection

Meeting with farmer groups and other stakeholders in the study area was facilitated by personnel of Africa Harvest and ICRISAT. The focus group discussions and interviews with beneficiaries were facilitated and conducted through an experienced interpreter.

Both qualitative and quantitative data were collected (Andre et al, 2016). Structured questionnaires were administered through enumerators after the objectives of the survey have been properly explained and they were properly trained on the questions. Pre-testing of the questionnaires was done in the survey areas after which the answers were reviewed, and necessary corrections done to the questions while more explanations were given to the enumerators where necessary. In the interest of comparability, some baseline questions relevant to the present study were kept, while some others were added.

For strengthening and better understanding of the data collected through questionnaires, some complementary data were also collected through Participatory Impact Assessment (PIA), (Catley et al, 2014).

Analytical Methods/Techniques
Data collected were coded and keyed into excel. SPSS (Statistical Package for Social Sciences) computer-based analytical tool was used to run the analyses. Descriptive statistics like percentages, averages, frequencies were employed using tables, graphs and bar charts to present the data. Perceptions, opinions and feelings were expressed numerically using Participatory Ranking and Scoring methods (Catley, 2014).

The survey measured outcome/output indicators as well as impact indicators. Outcome /output indicators are activities relating to the implementation of the project while impact indicators relate to changes that occur as a result of the project activities. The methods used include simple ranking, proportional piling and scoring techniques, 'before and after' scoring and impact calendar.

Measurement of variables
Measuring output indicators**:** Output indicators, also called process indicators, usually measure a physical aspect of project implementation. Process indicators show that project activities are actually taking place according to the project work plan.

Measuring Impact indicators: Impact indicators measure changes that occur as a result of project activities. They usually relate to the end result of a project on the lives of the project participants. This represents the benefits or changes realized through the utilization of these assets transfer.
The variables that were measured here include average yield, gross margin/income, contribution to crop income,

hunger period, contribution to household food crop intake and household expenditure pattern.

Limitation of the Research: This research is limited by time and resources at the disposal of the researcher. The sample size and the scope of stakeholders selected were also limited by time and resources.

Results, Discussion and Implication

Demography of Respondents

About 40% of the respondents are male while 60% are female (Table 3). This is in consonance with the project beneficiary female gender bias of ratio 40:60 and with the fact that women's participation in agriculture is higher in developing countries (Adesope et al, 2014). More than 90% of the beneficiaries are within the economically active age of 18-64years (Okongo, 2009). Age is an important factor in the decision to adopt innovation and to continue using it (Atibioke et al, 2012). This shows that the probability of the sustainability of the SMU initiative is very high.

Table 3: Age Distribution of Respondents

Age Range (in years)	Beneficiaries	Control
18-35	30.5%	40.3%
36-45	32.8%	28.3%
46-60	27.4%	25.2%
More than 60	9.3%	6.3%

More than 65% of the respondents fall between the age of 18 and 45. This agrees with the young population of Kenya with less than 3% of the Kenya total population falling above 65years of age (Index Mundi, 2017; KNBS, 2017).

Table 4: Age Distribution of Respondents by Gender

Age Range (in years)	Female	Male
18-35	66%	34%
36-45	64%	36%
46-60	62%	38%
More than 60	11%	11%

About 74% of the respondents are married while about 10% are single (Table 5). High number of married farmers means more family labour on the farm. About 81% said they are involved in other initiatives apart from the SMU project. This means that the observed change/impact may not be attributable only to the SMU project. This makes the calculation of the project attribution very important. Beneficiary respondents who took part in decision making are 77.5% as against the non-beneficiary figure of 61%. This means that the women can put the skills and knowledge acquired during the capacity building training into action.

Table 5: Marital Status/Participation in decision and other initiatives

Variables	Beneficiary	Non-beneficiary
Marital status	74%	73%
Involvement in other initiatives	81%	n/a
Participation in decision making	77.5%	61%

Kenya has two planting seasons, March-June and October-January. More than 90% of the respondents said their main

planting season is October-January (Table 6). The respondents' preference was based on their belief that rainfall is more stable during this period.

Table 6: Preferred Planting Season

Preferred Planting Seasons	Beneficiary	Non-beneficiary
March -June	8%	3%
October-January	92%	97%

About 81% of the data on yield used in this survey came from the 2016 October-January planting season when there was very low rainfall resulting in one of the most severe droughts in Kenya's recent history (WFP, 2017; Peter et al, 2017).

Contribution of the SMU project to Beneficiary Income

a. The average cultivated area for beneficiary farmer is 1.7 hectares out of which 0.9 hectares (56%) are for sorghum. The non-beneficiary farmers cultivated an average of 1.3 hectares out of which 0.6 hectares (42%) are for sorghum. This is against the baseline sorghum land of 33% (Table 7).

Table 7: Average Cultivated Area, Yield and Gross Margin

	Beneficiary Farmers	Control Farmers	Baseline Studies
Average Total Cultivated land/household	1.7 ha (±2.96)	1.3 ha (±2.45)	N/A
Average Sorghum cultivated land/household	0.9 ha (±2.70)	0.6 ha (±2.08)	33%
Average sorghum harvested/hectare	1204kg (±3282)	381kg (±2991)	N/A
Average sorghum price/kg	33.3Ksh (±9.2)	31.8Ksh (±7.8)	28Ksh
Average Sorghum Gross Margin/hectare	38,877Ksh (±3208)	19,390Ksh (±2991)	N/A

Ksh=Kenyan Shillings; 1 Ksh= USD 0.01

The average yield per hectare for sorghum for beneficiary is 1,204kg while control is 381kg per acre. The average price of sorghum for beneficiary is 33.3Ksh per kilogram while for non-beneficiary and baseline studies are 31.8Ksh and 28Ksh respectively. The gross income for both beneficiary and non-beneficiary are 38,877Ksh and 19,390Ksh per hectare respectively.

There is wide variability between the prices of sorghum. EABL, the main up-taker, presently buys at 33Ksh/kg, brokers buy as low as 20Ksh/kg depending on the desperation of the seller, while at the market, after including transport and other costs, a kilogram can sell as high as 70Ksh. It is important to note that this data being analysed is related to the 2016 October-January planting season when

there was severe drought that necessitated increase in food aid to millions of Kenyans. Though the drought effect reduced the yield, those farmers who planted at first rain or before first rain, had a yield that was up to 16.5bags /hectare for sorghum where maize completely failed.

Table 8: Average land and price by Gender

	Female	Male
Average Total Cultivated land/household/hectare	1.6 ha (±2.32)	1.9 ha (±3.55)
Sorghum cultivated land/household	0.8 ha (±1.49)	1.2 ha (±2.09)
Average sorghum price	34.36 Ksh/Kg (±10.2)	31.50 Ksh/Kg (±4.9)

The average total cultivated land as well as land used for sorghum is higher for male than female respondents (Table 8). This still aligns with the trend during the baseline study. The data are a reflection of the land tenure system which tends to favour the male gender. On the average, the male beneficiary price is less than the female. This is because many of the males sell to brokers due to financial pressure while only few females did. Also, females were patient enough to take some of the grains to nearby markets where they sell in bits at a higher price.

b. During the PIA, the percentage of crop income contributed by sorghum before and after beneficiaries joined the project is shown in Figure 6:

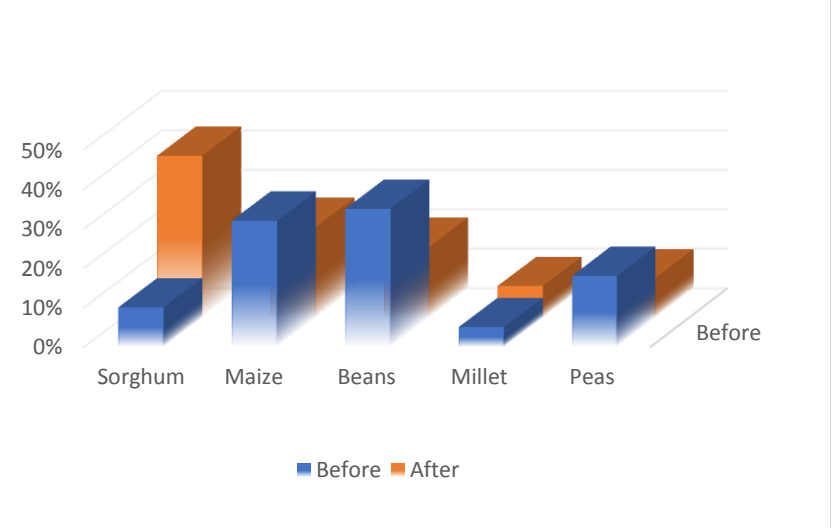

Figure 6: Contribution of Main Food Crops to Income

Income from sorghum increased in relative terms from 10% contribution to over 40% contribution because the farmers' switched more cultivated lands to sorghum as a result of which they have more sorghum to sell for cash compared to other staple food crops.

The quantitative data from the survey indicated that income contribution of sorghum ranges between 40-50% while it is less than 30% in non-beneficiary farmers.

c. When respondents were asked to rate their income situations as either 'better off', 'the same" or "worse off.", 80% of beneficiaries rated it 'better off' while 11% rated it 'the same'(Table 9). The non-beneficiary has 53% and 41.5% respectively. The questionnaire also asked whether farmers have been able to make some savings. 82% of beneficiaries said 'yes' while 57% of control said 'yes'. This result, therefore,

indicates that beneficiary farmer households made more money and were able to save some of the money.

Table 9: Self-Assessment of Income situation "before" and "now"

Income Situation	Better-off	The Same	Worse-off
Beneficiary	80%	11%	9%
Non-Beneficiary	53%	41.5%	5.5%

SMU Project Contribution to Food Security

Impact Calendar

Using Participatory Impact Assessment, the beneficiary participants were given 25 counters representing house hold post-harvest food balance and asked to distribute the counters along the twelve-month calendar (Catley, 2014).

The result (Figure 7) showed that 44% of the non-beneficiaries' farmers have food that can last for at least 7 months while more than 76% of the SMU beneficiaries have food that can last for more than 7months. The baseline result shows that only 30% of the respondents have food that can last 7months and beyond. When the farmers were asked in the questionnaire whether they have been able to produce and/or purchase enough food that can last the whole year, 41% said "yes". This implies that the beneficiary farmers can feed their households for longer period within the year, thereby reducing the hunger periods and food insecurity.

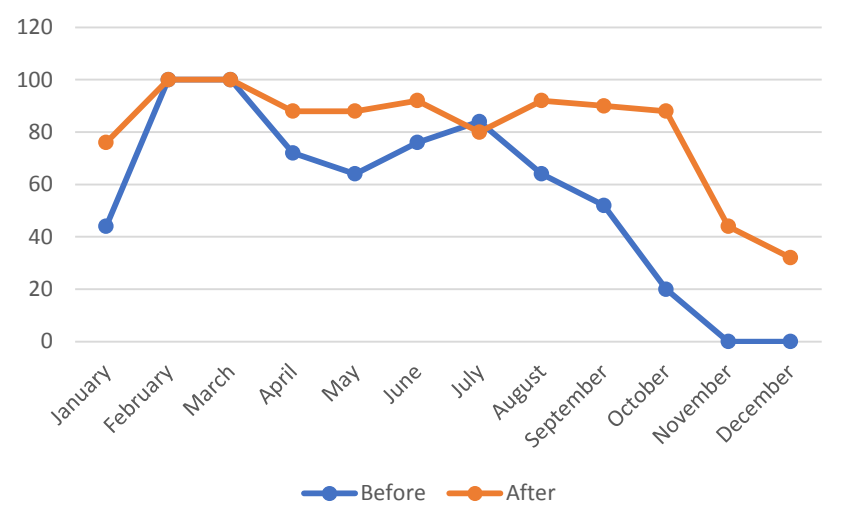

Figure 7: SMU Impact Graph

Number of Meals per Day

When the respondents were asked how many meals they eat per day on the average, their response shows that 69% of them eat 3 times while 31% eat twice a day. In contrast, 62% and 37% of non-beneficiary eat thrice and twice daily respectively. This result indicates that beneficiary farmer households have more meals per day and are, therefore, less exposed to hunger.

Contribution to Household Food Source

The contribution of sorghum as a source of household food has increased. The change in relative proportion of sorghum consumption against the other main cereals grown in the study area is depicted in Table 10.

Table 10: Contribution of the Main Food Sources to Household Consumption

Crops	Before	After	Absolute change
Sorghum	12%	28%	+125%
Maize	31%	20%	-25%
Beans	22%	14%	-10%
Millet	11%	10%	-15%
Peas	21%	19%	-15%

Beneficiaries are now moving from dependency on maize to sorghum. Beneficiary farmers are now less vulnerable to unpredictable local weather pattern and frequent drought as they change their eating habit to sorghum which is more resilient to weather variability. This will improve their food security.

SMU Project Effect on Coping Strategy

The SMU beneficiaries (27%) are also less dependent on aid from governments and NGOs than the non-beneficiaries (33%). At the same time, the deployment of undesirable coping strategies like selling household assets and selling firewood to buy food is less frequent with the beneficiaries. The project has therefore been able to reduce the food insecurity of the participants, their dependency on food aid as well as the deployment of undesirable coping strategies.

Assessment of the SMU Project Activities

The beneficiaries were asked in the questionnaire to rate some SMU project activities according to whether it is "Highly Helpful", "Helpful" or "Not Helpful" (Table 13). "Highly Helpful" was given 3 points, "Helpful" was given 2 points and "Not Helpful" was given 1 point. Input availability and training came tops with cumulative total of

767 and 751 points respectively, while all the market linkage activities were far behind (Table 11). This result reinforces the importance of input availability and ease of access to the successful adoption of any initiative. The result also corroborates the fact that training and capacity building are central to the wellbeing of the farmers.

Breaking the training and input activities further during the Participatory Impact Assessment and asking farmers about their perceptions of the relative effectiveness of the various SMU project activities/outputs by ranking according to which of the activities has the most impact. The following scores (Table 12) were recorded.

The agronomy training was most impactful followed by availability of improved seed and marketing training. The project participants believed the agronomy training has helped not only in increasing the yield of sorghum but also other crops. The least impactful is access to other inputs such as fertilizer and chemicals. This is because these other inputs are only available in towns, whereas transportation cost, distance and road access are big issues to these rural dwellers (Appendix).

Table 11: Beneficiaries Rating of SMU Project Activities

	Activities	Highly helpful	Helpful	Not Helpful	Point
	Input availability	56.6%	42.1%	1.3%	767
Market Linkage	Aggregator System	16.8%	49.4%	33.9%	578
	Collective action	22.5%	52.5%	23.7%	617

Group Marketing system	26.9%	48.1%	23.7%	634
Training activities	46.5%	46.8%	4.4%	751

Note: To calculate the points of the responses, Highly-Helpful ', 'Helpful' and 'Not-Helpful' are given 3, 2, and 1 point respectively.

Table 12: Beneficiaries Ranking of SMU Activities during PIA

SMU Activity	Total Score
Agronomy Training	124
Improved Seed Availability	110
Marketing Training	92
Utilization Training	86
Marketing Linkage	80
Others Input Supply	52

Impact of the SMU Project on the Beneficiaries Life-Style

The beneficiary participants prioritized the following as indicators of the impact of the SMU Project which represent changes in their life as a result of their participation in the programme. The indicators are: availability of more food, availability of more varieties of food, ability to easily pay school fees, better house, better clothing and self-confidence. The first four also represent the most frequent items of household expenditures as confirmed in the quantitative data. The participants were then asked to relate the changes to their expectations at the point of joining the SMU project. Their responses are summarized in the Table 13 below:

Table 13: Benefits Ranking and Scoring by Beneficiaries

	Rank score	Met	By How Much
More Food	3rd	92%	56.8
Varieties of Food	1st	88%	58.2
Payment of School Fees	2nd	88%	59.2
Prestige/confidence	6th	60%	34.8
Better House	5th	76%	42.6
Clothing	4th	68%	37.5
		AV	48.18%

The ranking indicated that after the ability to eat varieties of food, payment of school fees is the most important thing to the respondents.

92%, 88% and 88% of the respondents believed their expectations as it concerns food, food varieties and payment of school fees have been met partially (56, 58% and 59% respectively). This indicates that the project had positively impacted on respondents' ability in respect of the six criteria. Finding the average of the total should mean that the SMU project has been able to meet the farmer beneficiaries' expectation by 48.18%

Beneficiary Assessment of Project Benefit Attribution

The benefit attribution is important in this survey because the Eastern part of Kenya has many ongoing and past development initiatives from different organizations aimed at improving the lots of the people in the study area. This was confirmed by the project beneficiaries where 81% of them are involved in other initiatives apart from the SMU project.

Beneficiary farmers were asked to ascribe (Table 14) present wellbeing to the activities and initiatives going on around them including the weather condition (Catley, 2014). Each respondent was asked to allocate 100 marks among the five identified activities according to its contribution to their achievements over the past 5 years.

The farmers attributed 47% of their present wellbeing to the SMU activities. The result implies that the beneficiaries believe that the SMU project is responsible for 47% improvement of their present wellbeing

Table 14: Benefit Attribution Scoring

Attribution	Points	%
Africa Harvest SMU project	980	47
Good weather condition	450	21
Infrastructure and Extension Activities	330	16
Activities of Other NGOs	340	16
	2100	100

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Summary of Major Findings

This impact assessment survey was carried out on the beneficiaries of the Sorghum for Multiple Uses (SMU) Value Chain Projects in Tharaka North and Kitui Central districts of Eastern Kenya. A total of 477 questionnaires were administered. Adopting a theory-based approach and mixed methods evaluation technique, results were analysed using output, outcome and impact indicators. About 60% of the respondents are female and about 63% of the respondents' beneficiary fall between the age of 18 and 45with 27% in the 45 to 60 age bracket.

The findings show that the average cultivated land for the beneficiaries is 1.7 hectare out of which 56% was for planting sorghum as against 44% and 33% for non-beneficiaries and baseline respondents. The yield per hectare was 1,204kg/ha for beneficiary and 381kg/ha for non-beneficiary. Gross income (sales minus the variable cost) is 38,877Ksh/ha and 19,390Ksh/ha for beneficiary and control farmers respectively. Compared to the main crops grown by farmers in the study area, sorghum contributed an average of 41% of the income as against 10% before the SMU project. As a food source, sorghum contributes 28% of the household food as against 12% before the project. In terms of availability, more than 76% of beneficiary farmers have food that can last for more than 7 months as against 44% of non-beneficiaries and 30% of baseline farmers. In addition, 41% of the beneficiaries can feed for the whole year. The findings also reveal that beneficiaries are less dependent on food aid from government and NGOs while undesirable coping strategies like selling productive assets and picking of firewood have greatly reduced.

An assessment of the SMU project activities indicates that the beneficiaries believed training (especially the agronomy training) and the availability of improved seeds are the most impactful. All the respondents said their expectations at the point of participation in the project have been met but at varied levels. Beneficiary farmers further attributed 47% of their achievements to the SMU.

The project has also been able to support the diversification strategy of the main commercial brewery in the country. This suggests that saving cost, keeping employment and

providing substitute have helped to save the country's meagre foreign exchange. Although the use of sorghum in feed and industry is very low, the potential is enormous.

The efficiency of aggregators and sub-aggregators is very crucial to the sustainability of the project. The inadequacy of the numbers of aggregators and sub-aggregators therefore needs urgent attention. Also important is the linkage to other commercial end users especially the feed and the milling industries (Appendix).

Discussions

The SMU project was able to capture a large percentage of the active labour force and household decision makers. This is very good for the continued adoption and sustainability of the sorghum production and trade. This means that these farmers will be able to make informed decisions on when to plant, how much acreage to devote to sorghum production, what agronomy practice to employ, when and how to harvest, when and who to sell to, at what price to sell and so on. These will have positive and sustained impact on their livelihood. The average sorghum cultivated land has increased along with the prices at which a kilogramme of sorghum is sold. But this increase in price is not market-driven because the price sold to the main up-taker is still being determined by the buyer. Opening more trade outlets/avenues by bringing in more food and feed industries will help in pushing sorghum prices to near equilibrium market determined price. The research also confirms the ability and tolerance of sorghum to drought condition. In spite of the fact that Kenya had one of its worst droughts in 2016, sorghum farmers still had bounty harvest, especially those who planted early. This confirms the

resilience and suitability of sorghum as a crop capable of fighting food insecurity and poverty in drought-prone areas. The fact that 41% of the beneficiary farmers can feed for the whole year in an area where extreme poverty is prevalent also confirms that sorghum production and trade can be used in Eastern Kenya to fight extreme poverty.

This research also confirms that household self-respect, self-worth and confidence have been enhanced because beneficiaries are now less dependent on food aid.

Conclusion

The SMU project has been effective in improving the food security and income of the small holder farmers in the project areas. Diversification of the end user markets is urgently required to stimulate competition and further open up additional avenues for trade. The Sorghum for Multiple Uses Value Chain Project has effectively contributed to increase in income and food security of the beneficiary farmers as well as the economy of Kenya. There is need to establish more value chain platforms, plan a monitoring and evaluation system to draw lessons for future improvement of the value chain and for up-scaling.

The volatility of government intervention may create uncertainty in the sorghum market, which not only hinders domestic trade, but also increases the risk borne by farmers (Chemonics, 2010). Effective advocacy and partnership with government to ensure stable and supporting policies for sorghum production and utilization are very important.

Recommendations

i. The government of Kenya should ensure stable and supporting policies for sorghum production and

utilization. The policies should be designed in such a way to ensure increased productivity which must not result in market glut due to limited market outlets.

ii. Government and development agencies should support ICRISAT to develop more varieties that are better adapted to the environment and at the same time having traits preferred by end-users (food, feed, sugar, bioenergy and brewery industries).

iii. There is need for diversification of end user market through aggressive campaign, advocacy and partnership with food, animal feed processors as well as the sugar, ethanol and brewery industries. This must involve addressing the concerns of the industries, training and demonstration of sorghum as a low cost, nutritious (healthy) and sustainable local alternative raw-material. Assistance to industries on flexible conversion facilities will also enhance diversification strategy.

iv. Government and development agencies should support investment in drying and storage facilities or stock holding in sorghum producing areas to ensure availability throughout the year. Investment in cleaning and threshing equipment at the community and group levels will increase and standardize quality.

v. More effective and efficient aggregator and sub-aggregator systems need to be developed in order to assist farmers to maintain quality standard and stable supply.

vi. There is need to plan a robust monitoring and evaluation (M&E) system to draw lessons and adjust policies as necessary.

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Appendix

Summary of Things Working Well and Things Not Working Well

	Things Working Well	**Things Not Working Well**	**Things Needed to be Done**
Agronomy Training	Agronomy training is very effective as farmers imbibed the skill of good agronomy and practice it	Farmers still use the traditional way of bird chasing thus discouraging planting bigger area.	Partnership and more aggressive advocacy with national government on policy support for sorghum farming and marketing
	Involvement of farmers in the selection of their preferred varieties through multi-location participatory variety/hybrid selection trial encourage farmers to take ownership of the project		County government of Kitui and Ukambari talking about policy support (agriculture is devolved), need to speed up the process through aggressive lobbying and expand such to other county governments.
Input Supply	Assistance in identifying equipment need of farmers and assisting the aggregators to procure loans for its purchase and subsequent rentage to	The partnerships with private seed companies and the agro-dealers has not be effective in providing needed improved seeds	Breweries and milling industries are two out of the four prominent industries in Kenya. High energy and time must be devoted to getting the major players in

	farmers.	and other input to the SMU beneficiaries	milling/feed industries into the loop.
Marketing Training and Market Linkage	The use of aggregators who are farmers in the locality has built trust and is highly effective	The collective action by farmers is very low as seen in very few farmers collectively selling to EABL and very many selling to brokers instead of pulling together and transporting to the aggregators	More encouragement, emphasis and support for collective action and group selling.
	Getting World Food Program interest in buying sorghum grains from the farmers in Eastern Kenya for its relief program	EABL is still the only main up-taker from beneficiary farmers. Efforts at getting other users like food and feed industries not working yet	Aggressive targeting of millers and feed processors for inclusion in the chain.
	Encouraging and helping farmers to maintain quality grains as reflected in less	Few numbers of aggregators and semi aggregators give chance to	Policy support for sorghum marketing and storage as seen in maize.

	than 1% rejection rate by EABL	sharp practices and exploitation of desperate farmers by the stockbrokers. Farmers losing up to 10KSH per kilograms.	
Utilization Training and Utilization	Consumption and value addition strategy well embraced especially in Kitui (Lower Eastern area)	The negative stigma attached to the consumption of sorghum is still strong in Tharaka.	

Centre for Sustainable Development

ABOUT CENTRE FOR SUSTAINABLE DEVELOPMENT (CESDEV)

The Centre for Sustainable Development (CESDEV) was established by the University of Ibadan through Senate paper 5386 in May 2010 as a demonstration of the University's commitment to Sustainable Development. It was based on the need to provide intellectual platform for identification of issues germane to sustainable development, critically analyse them, and provide leadership in finding enduring solutions that will enhance sustainable development.

The establishment of CESDEV was sequel to series of events, paramount among which was the winning of a USD 900,000 grant from the MacArthur Foundation to establish the Master's in Development Practice (MDP) Programme. The University of Ibadan was one of the ten original Universities that won the grant in a global competition involving over 70 Universities. Further brainstorming led to defining the composition of the emerging Centre beyond the MDP Programme. It was resolved that a number of development programmes that were "hanging in the balance" be moved to the Centre. The **Centre for Sustainable Development** (CESDEV) thus became a Teaching and Research Centre with a mandate in multi- and inter-disciplinary approach to Sustainability issues affecting not just our continent but the whole universe. The Centre is designed to be a Teaching, Research and Development unit in the University. Presently, CESDEV has the following academic and outreach programmes:

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- Indigenous Knowledge and Development Programme (IKAD)
- Sustainable Integrated Rural Development in Africa Programme (SIRDA)
- Climate and Society Programme (CSP)
- Environmental Protection and Natural Resources Programme (EPNARP)
- Leadership and Governance Programme (LGP)
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