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ASSESSING PRODUCTION, PROCESSING AND UTILIZATION OF SORGHUM IN WEST POKOT COUNTY, KENYA

Masinde AA[1]*, Mulindo JC[2], Gitonga J[3], Wanyama JM[1], Lusaga GL[1] and P Tingaa [4]

Anastacia AO Masinde

*Corresponding author email: anastaciamasinde@yahoo.co.uk & Anastacia.ogutu@kalro.org

[1]Kenya Agricultural and Livestock Research Organization (KALRO), FCRI. Headquarters, P. O. Box 450-30200, Kitale, Kenya

[2]Kenya Agricultural & Livestock Research Organization (KALRO), NRI Kakamega, Kenya. P. O. Box 167, Kakamega, Kenya

[3]Kenya Agricultural & Livestock Research Organization (KALRO), HRI Kandara, Kenya. P. O. Box 220-01000, Thika Tel. 020-2055038

[4]Kenya Climate Smart Agricultural Project (KCSA) Coordination Unit, West Pokot Kenya. P. O. Box 14 Kapenguria, Kenya

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ABSTRACT

Sorghum is one of the most important and under-utilized cereal crops in the Arid and Semi-Arid land (ASAL) regions of Kenya. The crop is grown in drought-prone marginal agricultural areas of Western Central and Eastern and coastal regions of Kenya. The diverse biotic and abiotic constraints including climate changes reduce sorghum productivity. Sorghum technology generators continue promoting suitable management practices and innovations to cushion and improve the resilience of smallholder farmers against the adverse effects of climate change. These interventions contribute to the attainment of not only household and national food security but also enhance incomes. Despite the increasing sorghum production and utilization in West Pokot County, there is limited knowledge of the status of production, processing, and utilization technologies. The aim of this study was to assess the current sorghum production, processing, utilization technology, innovations, and management practices among smallholder farmers. A household survey was undertaken using a jointly developed structured questionnaire by a multi- and inter-disciplinary team of researchers. Using a multi-stage sampling technique, 599 households were randomly selected and interviewed. Data collected were on household and farm characteristics including technologies. The study revealed that compared to maize and pasture, land allocated to sorghum enterprise was relatively low ranging from 0.32 acres to 0.80 acres with an average of 0.73 acres. The adoption of various sorghum technological components was also low. Adoption of improved sorghum varieties was less than 7% while fertilizer use was less than 20%. These contribute to low crop yields of about 140kg per acre. In addition, value addition was also low. Sorghum use was limited to ugali (56%) and porridge (39%) against the diverse value-added products including bread baking. and industrial processing of pure and blended products. More farmer and stakeholders training need to be done. In order to fully upgrade the sorghum value chain; there is the need to have targeted sorghum policies focusing on a range of activities along the value chain. These interventions could be integrated into the West Pokot County Integrated Development Plan.

Key words: Sorghum, Production, Marketing, Utilization, Challenges, Opportunities, West Pokot

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INTRODUCTION

Background

Sorghum (*Sorghum bicolar* (L.) Moench) lies fifth globally after rice, wheat, maize, and barley [1, 2] and is one of the underutilized crops in Kenya. The crop is known for its drought tolerant attributes as a cereal crop grown in semi-arid zones of West Pokot county [3]. The crop is classified as a climate smart crop [4] with a climate smart score ranging from 3-6 on a Likert scale ranging from negative 10 to positive 10 [5]. The county is faced with multiple biotic and abiotic factors [6] that are attributed to climate change. The crop contributes to food security to the majority of low resource base households. Additionally, the crop generates incomes to farmers as it is highly tradable. In Kenya, sorghum enterprise is undertaken in ASAL regions of eastern, and western part of the country which are agriculturally marginal and experience food insecurity Republic of Kenya [7].

Within the growing areas, sorghum production and consumption were associated with poverty. Coupled with limited marketing and low demand for sorghum products, its promotion has been constrained. This has led to food insecurity in the region. Despite this sorghum production has been increasing over years from 16,4000 ton in 1961 to 32,8637 ton in 2014(Figure 1) [8]. However, the adoption of the sorghum technology, innovation, and management practices (TIMPs) has not been fully evaluated because of the ever-changing economic and biophysical factors.

Understanding the uptake of TIMPs in sorghum production is critical to not only upgrading the value chain but also improving food security and income generation in West Pokot County. Sorghum is an important subsistence and commercial crop among households that have limited adaptive capacity to mitigate climate change challenges. This study focused on assessing the current management practices (TIMPs) of sorghum production, processing, and utilization in West Pokot County. The goal of this project is to contribute to sustainable production and commercialization of selected sorghum agricultural product value chain for improved food and nutrition security, household incomes, and job creation in the county.

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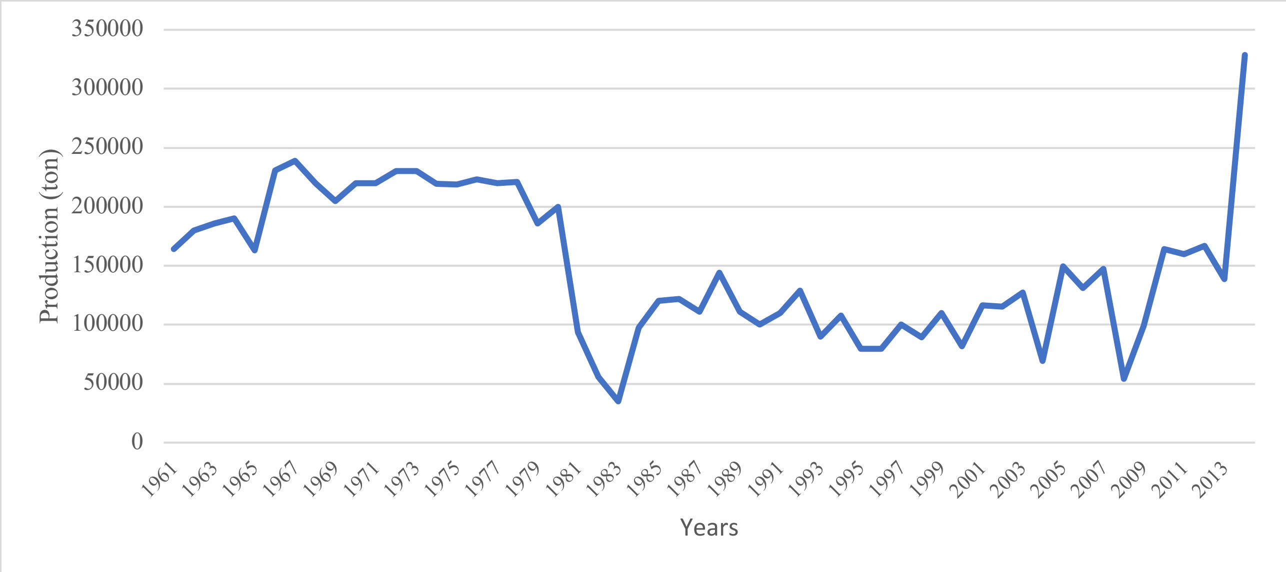

Figure 1: Trends in sorghum production in Kenya, 1961-2014

METHODOLOGY

Description of study sites

The study was undertaken in three sub-counties of West Pokot County. The County lies within Longitudes 34^{0} 47'and 35^{0} 49'East and Latitude 1^{0} and 2^{0} North. The County covers an area of approximately 9,169.4 km^{2} stretching a distance of 132 km from North to South. The county has a bimodal type of rainfall. The long rains fall between April and August while the short rains fall between October and February. There is, however, great variation in the total amount and distribution of the rainfall received in the county. The lowlands receive 600 mm per annum while the highlands receive 1,600 mm per annum [9].

The county also experiences great variations in temperature. With the lowlands experiencing temperatures of up to 30 °C and the highlands experiencing moderate temperatures of 15 °C. These high temperatures in the lowlands cause high evapo-transpiration, which is un-favourable for crop production. The high-altitude areas with moderate temperatures experience high rainfall and low evapo-transpiration hence suitable for crop production [9]. The total acreage under food crops and cash crops is about 22,000ha. This consists of 17,000 ha under food crops and about 5,000 ha under cash crops. Acreage under food crops continues to increase due to irrigation schemes such as the Weiwei irrigation scheme in Sigor [7].

Fourteen youthful enumerators comprising four females and ten males were used for this study. They were selected based on their educational level (at least BSc) and previous work experience. They were drawn from West Pokot and neighboring

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counties. The survey team was divided into three teams. Each team collected data in each sub-county. The duration of the survey was ten days.

Enumerator training and pretesting the questionnaire

The enumerators were trained at the Our Lady of Mercy Vocational Training Centre at Chapareria market, Kenya for two days on the use of the Open Data Kit (ODK) platform and survey ethics. The team was also trained on interview skills/techniques, the questionnaire content, the flow of questions, and the target sample. The team was sensitized on the objectives of Kenya Climate Smart Agriculture Project survey objectives and the use of Open-Data-Kit (ODK) application in data collection. After developing the questionnaire and training the survey team, the team pre-tested the questionnaire in two sessions. The first pre-testing was done through role-play by interviewing amongst themselves. The second was done in the field in October 2020.

Data collection methods

A multi-stage random sampling design was employed in this survey to identify a representative sample to collect the required sample size. The first stage involved a listing of sub counties where the KCSAP activities were being carried out and randomly selecting two sub-counties. The second stage involved the random selection of two Provincial administrative Units called Wards in each sub-county. The last stage involved selecting one location in each Ward and a random selection of respondents in each location after establishing a sample frame by listing the households in the Location. The survey was at individual household levels where the head of the household or the person actively involved in the target crops (Sorghum, Finger millet, and green grams) was interviewed. The interview took about 45 minutes.

Sample size determination

The total household population was estimated at 61,683 households with an estimated total number of individuals of 437,947 [10]. The average family size was seven members. Based on this population pool, the first stage of sampling involved the selection of three sub-counties with probability proportionate to size (PPS), where size was measured by the number of households estimated in each sub-county.

A sample size of 105 households was determined using the formula by Yamane [11] as follows. The sample size of 599 respondents was computed using the sample determination formula specified in Equation 1 [5].

$$n = Z^2(1-p)p \big/ e^2 \qquad (1)$$

Where ***n*** is the sample size, ***Z*** is the desired confidence level, ***p*** is an estimated proportion of an attribute that is present in the population in this proportion of youth population in study counties, and ***e*** is the absolute size of the error in estimating ***p*** that was adopted. The **p** value was unknown and was assumed about 15% of all the population. Against this background the sample size was computed at a 95% confidence interval with ***Z***=1.96 and ±3.3percentage margin of error [12]. The sample size was approximately 105 respondents as calculated using Equation 2.

$$n = \left({(1.96^2 * (1-0.15) * 0.85)} \big/ {0.033^2} \right) = 599 \quad \text{.......}(2)$$

Types of data collected

In order to answer the set objectives, both qualitative and quantitative data were collected. A pretested semi-structured questionnaire covered all the variables needed to meet the set objectives. These included general characteristics of households, farm characteristics, and institutional factors including climate smart variables. Data was also collected on processing methods and quantities of different ingredients used in value-added products in sorghum. The type of value-added products was listed.

To compute economic analysis, all the costs incurred in sorghum, production practices, agronomic practices, output levels, and utilization practices were enumerated. Direct costs included; seeds, fertilizer, manure, labour (for production), cost of harvest, cost of post-harvest processing, and marketing. Where labour cost was required, the opportunity cost (wage rate) was used to value the family labour.

Survey data processing and analysis

Descriptive statistics which included; means, proportions, ranges, minimum and maximum values, frequencies, percentages, standard deviations, and cross-tabulations were mainly used to make summary tables, charts, and narratives for various variables using Statistical Package for the Social Sciences (SPSS) version 20 ([13]) and Excel software. Where applicable, the association of farmer data and income variables with those in the technical section in sorghum, production system were investigated and tested. Farmers rated disease and pest incidence as low, medium or high.

RESULTS AND DISCUSSION

Sorghum acreage

The size of the land allocated for the cultivation of sorghum is an indication of the importance the household attaches to sorghum production. The annual acreage under sorghum in West Pokot County (WPC) ranged from 0.32 acres in West

Pokot subcounty to 0.8 acres in Pokot North subcounty with an overall acreage of about 0.80 acres in the whole county (Table 1). The proportion of cropped land per household ranged from about 10% (West Pokot subcounty) to about 0.8 acres in Pokot North subcounty with an average of 0.73 acres in the whole county. This was an increase from about 1% some decades ago when the households were not growing the crop. This acreage has increased over years Brent *et al*. [14] and Orr *et al*. [15] and the crop replaces pasture.

Land preparation in sorghum production

Farmers cleared the bush using slashers and *pangas*. Some farmers also burned bush as an option in bush clearing. Further analysis revealed that land preparation for sorghum production in the County was predominantly done manually (71 %) by hand using hoe/*jembe* (Figure 2). This was followed by the use of tractors (28%) and the least method used for land preparation was oxen ploughing (<1%). Variations across the sub Counties were noticeable. The usage of the oxen-plough (one person) was recorded only in Pokot North while tractor use was reported in West Pokot and North Pokot sub Counties only. Households in Pokot Central Sub-County, on the other hand, relied exclusively on the hand hoe for land preparation. This could be attributed to the topography of the land. Pokot Central is relatively hilly and tractor use could be unsuitable particularly in Sekerr Ward where the survey was carried out. However, there is a need to mechanize some of the activities to enhance efficiency in production. Similar studies undertaken in Kenya have shown significant changes in agronomic practices among farmers Enserink [16]. Some of the new agronomic practices farmers had embraced include dry planting, row-planting, one new sorghum variety, and pest control

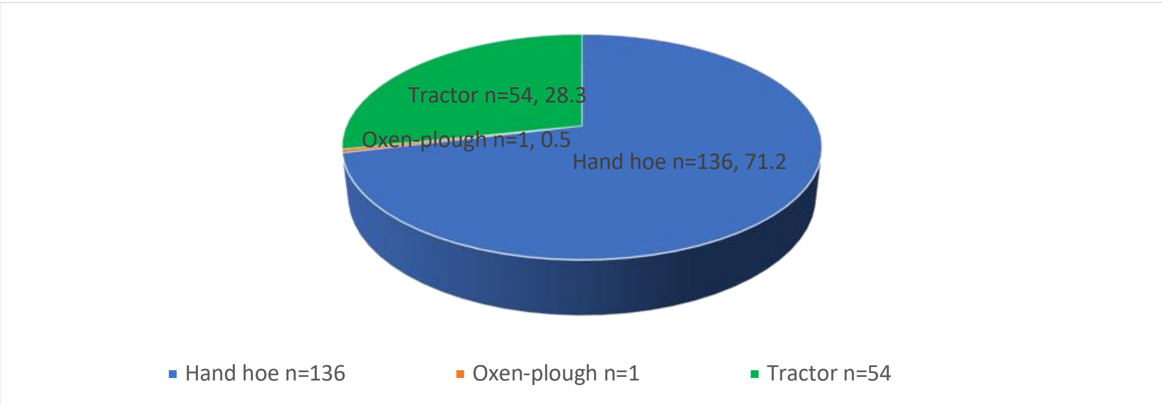


Figure 2: Percentage of households practicing different land preparation methods

Sorghum Varieties

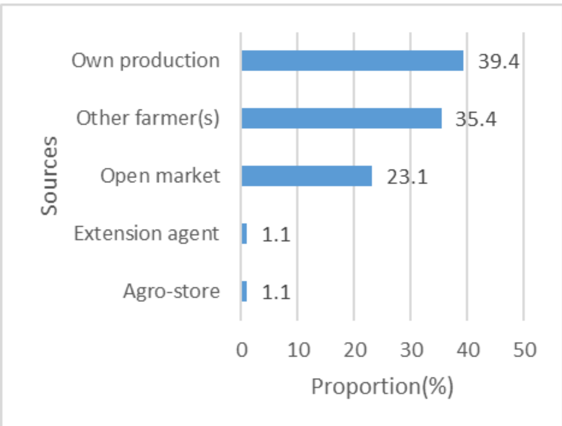
The findings revealed that in all the sub-counties, the majority of sampled households planted local sorghum varieties as shown in Figure 3a. In North

Pokot, none of the household planted an improved sorghum variety and over 92% of the households in other sub-counties planted the local sorghum varieties (Figure 3a). Similar studies have shown low uptake of sorghum-improved varieties in Kenya [21].

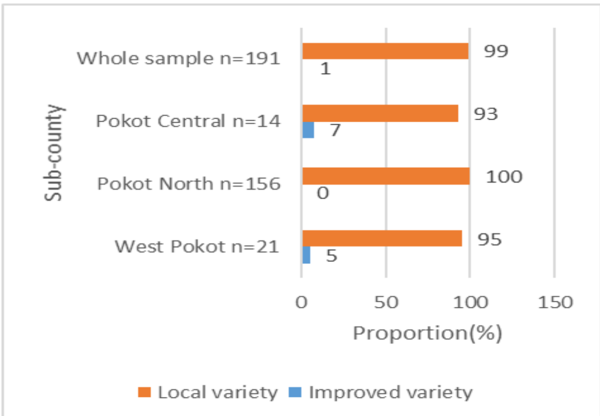
This implies that the sorghum production potential of the improved varieties has not been fully achieved yet. Adoption of the improved sorghum varieties may increase production and yield levels. Studies undertaken by other authors indicate that adoption of the new improved sorghum varieties is determined by the phenotypic and genetic characteristics of the grains, such as the size, colour, and shape of panicles. Other characteristics for the adoption of the new improved varieties include taste, brewing, and cooking properties Dugje *et al*. [17] and Oyier *et al.* [18]. This calls for stakeholders in the sorghum value chain to promote the many improved varieties.

Sources of sorghum varieties

The seed market liberation in the country led to multiple sources of sorghum seed for farmers. Out of the 277 households who responded, about two percent sourced the sorghum seed from agro-stores/dealers and extension agents (Figure 3a) which are the improved seeds. The majority of the farmers used retained/local seeds from the previous harvests, open markets, and other farmers (≈98%) (Figure 3b). These results corroborate with the low adoption of improved sorghum varieties in the county. These demands for enhanced promotion of improved varieties including bio-fortified types. Similar studies by Ochieng *et al.* [19], have observed that the key challenges to sorghum seed production were; poor seed source; suboptimal crop husbandry; suboptimal post-harvest handling of seed; weeds effect, pests and diseases effects, and lack of marketing outlets.



3a. Source of sorghum seed to plant



3b. Households who grew local and improved sorghum

Figure 3: Percentage of households who grew different Category of sorghum and their sources

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Sorghum Planting

Planting time of sorghum

Responses to the planting time of sorghum are as shown in Figure 4a. The results showed that out of 191 households, the majority of the households planted at before onset and the onset of the rains (83%). About 15 % of the respondents planted within one week of the onset of the rain, whilst 3% planted beyond one week. This trend was reflected across all the three sub-counties with only less than 10% of farmers planting two weeks after the rains. The results reflect that farmers do timely planting of sorghum given that the county lies in a semi-arid zone.

Sorghum Seed rate

The seed rate of germination is important in realizing optimum yields. The highest seed rate was reported in North Pokot (8kg per acre) and the lowest was in Pokot Central at 3kg per acre (Figure 4b). The huge standard deviation implies the great variability of seed-rate among the farmers and sub-counties. The overall seed rate was 4 kg per acre. No thinning was reported by any of the households. The recommended rate is about 4 to 5 kg per acre with a spacing of 10-15cm intra-row and 75cm inter-row [20]. This reveals that the plant population was below the optimal and this could be a contributory factor to the yield gap, despite the compensatory aspect of sorghum tillering.

Sorghum cropping patterns

Sorghum inter-cropping system

The highest proportion of households that intercropped sorghum with other crops was reported in Pokot Central (86%) followed by West Pokot (37%) (Figure 4c). The lowest proportion of households that intercropped was in Pokot North (18%). However, out of the total sample size of 174 households who responded about 25% intercropped sorghum with other crops. As indicated by Karanja *et al.* [20], sorghum can be grown as a sole crop or as an intercrop at different spacing. Intercropping can be done with leguminous crops for enhanced profitability. Besides the benefit of yield and income, intercropping leads to increased resource use efficiency in intercropping, modification of microclimate, light interception and radiation use efficiency, increased canopy and relative humidity, reduced pest and disease incidences [21, 22].

Crops intercropped with sorghum

For those households that intercropped sorghum with other crops, more of them intercropped sorghum with finger millet (50%) and maize (26%) (Figure 4d). However, inter-cropping with legumes is recommended Karanja *et al.*, [23] Kisilu *et al.* [24] because of the benefits accruing from them. This is against good agricultural practices as they intercropped crops in the same family of *graminae,* (for example, maize and finger millet) whose rooting systems, diseases and pests are almost the same. These challenges make it critical for the promotion of sorghum agronomic practices with the active participation of all value chain actors with farmers playing a lead role.

Fertilizer application in sorghum

Fertilizer uses in sorghum

Soils in WPC may be deficient in nutrients due to erosion, leaching, and continuous cropping. Sorghum yields can be increased through the use of manures and fertilizers in the county. The majority of the farmers in Pokot Central (79%) and Pokot North (96%) used limited basal/planting fertilizers. However, given that sorghum is a gross nutrient feeder, the low or non-use of fertilizers means (Figure 4e) that the sorghum plots are mined with nutrients. This will lead to soil fertility decline and decreasing land productivity. This practice should be reversed to save deterioration of land and decline in sorghum yields. Type of basal fertilizers used in sorghum production were those used in maize production like Diammonium phosphate (DAP).

The overall analysis of the results showed that about half the sampled farmers used both organic and inorganic fertilizers. In West Pokot, sub-county more farmers (74%) used inorganic fertilizers than organic ones (Figure 4e). In North and Central Pokot, all farmers used organic fertilizers mainly from animal droppings. Organic manures slowly release nutrients to plants and therefore the crop does not quickly respond immediately they are applied

Type of manure used in sorghum production

Households used manure from the following animals; poultry (31%), goats (30%), cattle (22%), and sheep (18%) (Figure 4f). More farmers used poultry manure in North and West Pokot while goat manure was common in Central and North Pokot. The use of cattle manure was popular in West and Central Pokot probably attributed to more farmers practicing non-pastoral farming practices. This could be attributed to large herds and flocks of livestock in WPC. The results are in tandem with a study undertaken by Ndakidemi [22], where most of the farmers (68.9%) used farmyard manure in sorghum production while 30.9% of the farmers did not use any fertilizer in Machakos County.

Weed management in sorghum production

Weeds significantly reduce sorghum yields as they compete for moisture, soil nutrients, and light. The frequency of weeding corroborates to sorghum yields. The more the number of weeding the higher the yields. The pooled analysis across all the sub-counties gave a mean of 1.6 (Figure 4g). Across the sub-counties weeding ranged from one to five. The highest number of weeding was reported in the West

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Pokot sub-county followed by Pokot Central. West Pokot sub-county receives the highest amount of rainfall and relatively high productive soils. Weed infestation in sorghum fields can reduce the yields significantly. Therefore, sorghum fields should be free of weeds and this can be achieved through effective land preparation methods and using effective weed control methods [1]. These methods may include both chemicals and manuals that should be effectively promoted.

Pests, diseases and control

Rating pest and disease incidence in sorghum production
Household rating on sorghum diseases and pests revealed that the highest proportion (95%) of them said the disease effect is medium and high (Figure 4h). This implies that there is an urgent need for intervention to reduce the damage on sorghum crops. Stakeholders in this value chain need to design integrated approaches to intervene in this situation.

Pest and disease control in sorghum
Household ratings on sorghum diseases and pests revealed that out of 156 households interviewed the highest proportion (95%) rated disease effect was medium to high. This implies that there is an urgent need for intervention to reduce the damage to the sorghum crop. Further analysis revealed that pest and disease control was mainly by traditional methods (71%). The chemical control method was practiced by about 12% while mechanical was done by about 12% of the farmers (Figure 4i). The same trend was observed in sub-counties where the highest use of traditional methods was registered in Central and North Pokot and the least was in West Pokot.

Sorghum crop rotation and agro-forestry
Crop rotation is important in maintaining soil fertility and sorghum yields in addition to disease and pest management [24]. Results in Figure 4j, revealed that more than 70% of the households who responded practiced crop rotation. Given that sorghum is one of the gross feeders of soil nutrients, more farmers could be encouraged to practice crop rotation with sorghum but using it in different families other than *graminae*. Farmers in West Pokot county have relatively large though fragile farm land that can easily accommodate crop rotation.

However, agroforestry practice seems to be low given that the county lies in a semi-arid zone where deforestation and bush clearing for charcoal and firewood are relatively high. Out of 174 households sampled in the whole county, only 17% practiced agro-forestry technology. Across the sub-counties Pokot Central (43%) had more farmers practicing agro-forestry than other sub-counties (West

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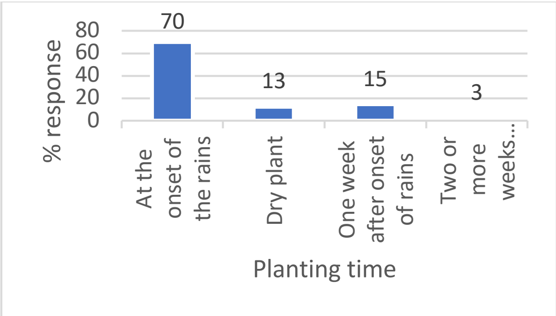
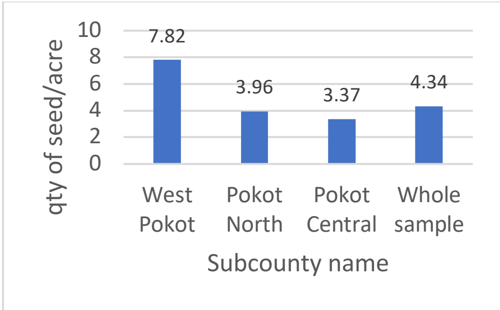
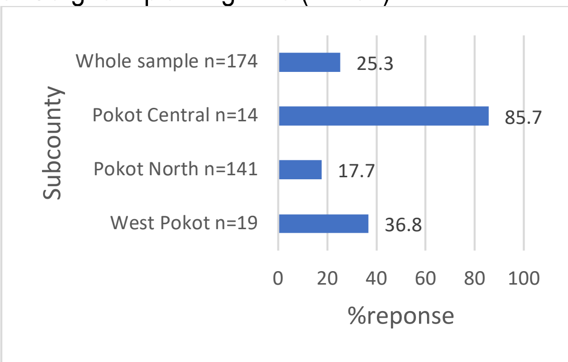
Pokot=21% and Pokot North=14%) (Figure 4j). Enhanced agro-forestry will contribute to climate change management in the county.



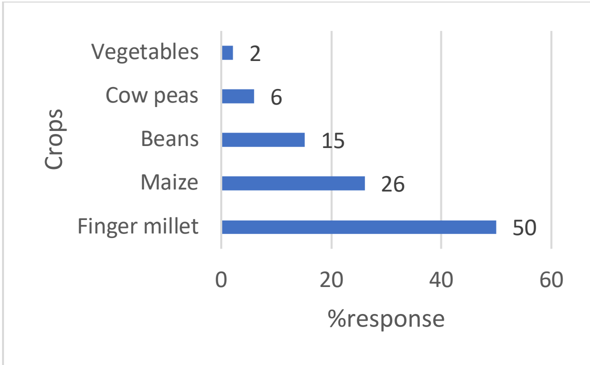
a. Sorghum planting time (n=191)



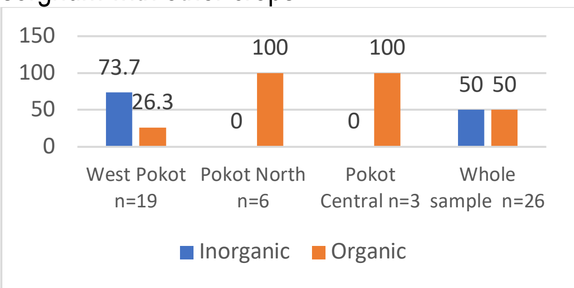
b. Sorghum seedrate per acre (n=277)



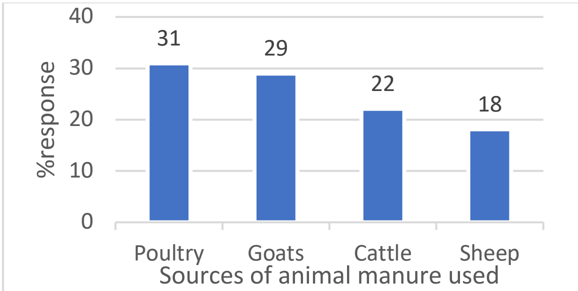
c. Percentage of households who intercrop sorghum with other crops



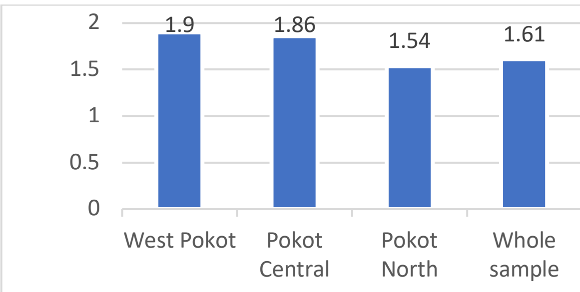
d. Crops intercropped with sorghum (n-174)



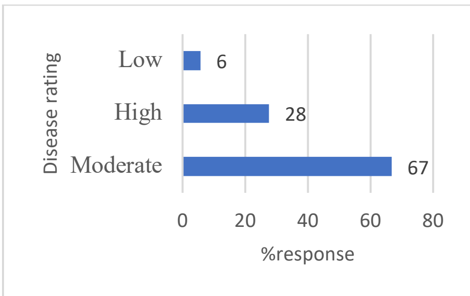
e. Percentage farmers using fertilizer and manure (n=156)



f. Sources of manure for sorghum production (156)



g. Average number of weeding (n=191)



h. Rating pests and diseases affecting sorghum production (n=174)

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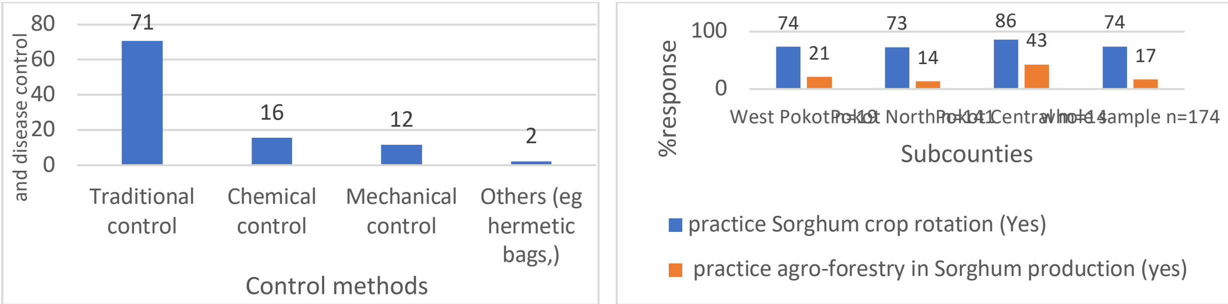

i. Pest and disease control methods (n=148)

j. Crop rotation and agroforestry practices (n=174)

Figure 4: Percentage of households using different agronomic practices

Harvest yield and utilization

a) **Yield levels and quantity consumed**
Sorghum harvesting in WPC is manual. Due to differences in agronomic practices and crop varieties, the sorghum yield varies. The yield ranged from 353kg per acre in West Pokot to 114 kg per acre in Pokot North. The overall average yield for sorghum was about 140kg per acre (Figure **5**a**)**. This is relatively low compared to the potential sorghum productivity in the county. The quantity of sorghum produced varied across sub counties. The highest quantity was produced in West Pokot (903kg) and the least was realized in Pokot North (230 kg per acre) (**F**igure 5a). The overall mean was about 352kg per acre (Figure 5a). Low yield levels in sorghum production systems were echoed by Ndakidemi [22] and this demands promoting yield enhancing technologies including climate-smart practices.

b) **Quantity of sorghum given as gift**
Social responsibility among the Pokot community is relatively culturally strong. Sorghum, which is a traditional crop in WPC, is given as a gift to friends and relatives. It was reported that about 59kg was given out as gifts. The highest quantity of sorghum given away as gifts were in West Pokot followed by Pokot north and the least was in Pokot Central (Figure 5b). This is in line with the study by Gatobu *et al.* [25] on social factors including culture, that influences household food security.

c) **Quantity of sorghum sold**
Income generated from sorghum is an important factor in encouraging farmers to adopt the technologies. The quantity sold varied by sub-counties. The highest quantity sold was about 681kg (West Pokot sub-county) followed by Pokot North (138kg) with an overall mean of 181kg (Figure 5c). The proportion sold ranged from 44% to 53%. The quantity of sorghum sold as a ratio to the quantity produced is an indicator of commercialization and

therefore the need to increase the quantity sold among farmers. Work done by Gebru [21] in Meru county, showed a relatively higher level of commercialization (66%), which was relatively higher that of West Pokot county.

d) **Sorghum produce stored**
Sorghum storage is likened to keeping cash for future use. It is a risk management practice among farming communities. Sorghum stored in Pokot North was 148kg while that in Pokot central was about 65kg per household (Figure 5d). The overall quantity sold per household was 142kg. The proportion sold ranged from 23% in Pokot Central to 35% in Pokot North. This implies that the commercialization level is low in the county.

e) **Proportion of households who blend sorghum**
Sorghum products and by- products can be used in blending other superior products. Over 80% of the respondents indicated that thy blended sorghum with other products (Figure 5e) for diverse use as food and feed [26]. For enhanced shelf-life and revenue blending could be promoted in the county.

f) **Consumable sorghum products made by households**
Households mainly used sorghum grains for *ugali* (56%) and porridge (39%) (Figure 5f). This seems to be a narrow band of types of products utilized compared to the potential products (cake, mandazi, chapati, doughnuts, sausages, and tortilla) available for promotion. This may demand training and promotion of other value-added products like bio-ethanol, syrup, and glucose as indicated by Oyier *et al*. [27] and Njagi *et al.* [28]. Consumption of sorghum products provides proteins, fat, carbohydrates, energy calcium, and iron.

g) **Types of crop products blends from sorghum**
Sorghum crop products and by-products can be utilized in diverse options. The crop products which sorghum was blended with are shown in Figure 5g. The crops sorghum was blended with are finger millet, cassava, and maize. There are four different blends of sorghum with other crops. The popular blend is finger millet *plus* maize (66%) followed by finger millet plus maize plus cassava (18%) and the third was finger millet plus sorghum. Options to use sorghum grains to make industrial products could be enhanced as some of these technologies have been developed. Food fortification is an important component to address nutritional food security in the country in line with the National and Sustainable Development Goals.

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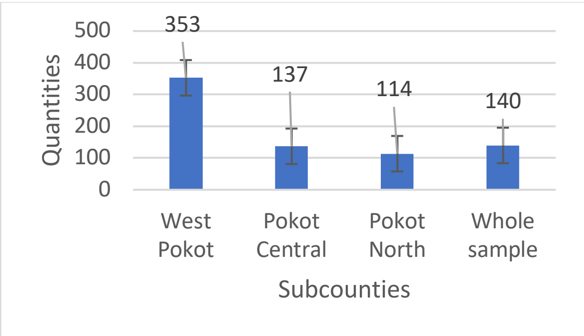
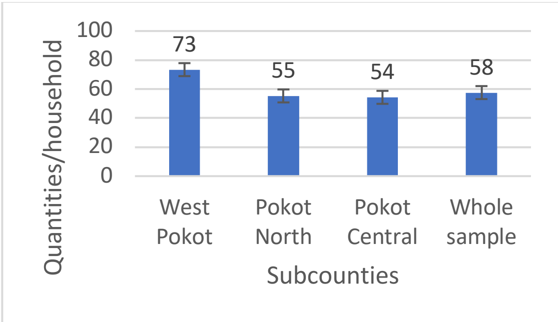
h) Challenges in sorghum production

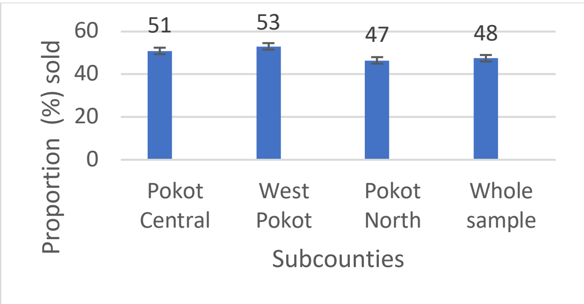
Households cited a number of challenges that negatively influenced the upgrading of the sorghum value chain. The majority of respondents cited pest and disease/pests (33%) as key problems followed by lack of equipment /machines (20%), for mechanization and lack of processing equipment (20%), plus inaccessibility to improved varieties (14%) (Figure 5h). Similar challenges have been observed in other regions Oyier *et al*. [27] and Njagi *et al*. [28]. If these challenges are addressed by relevant institutions, then productivity along the sorghum value chain may be enhanced.



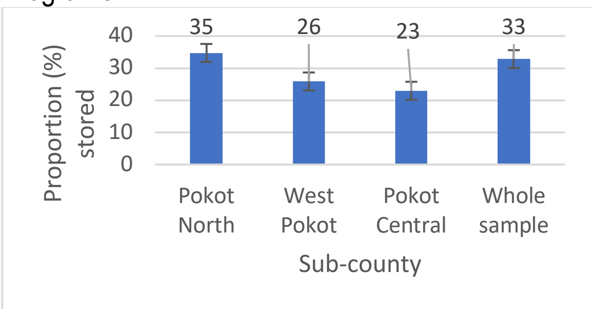
a. Yield levels in kg/acre



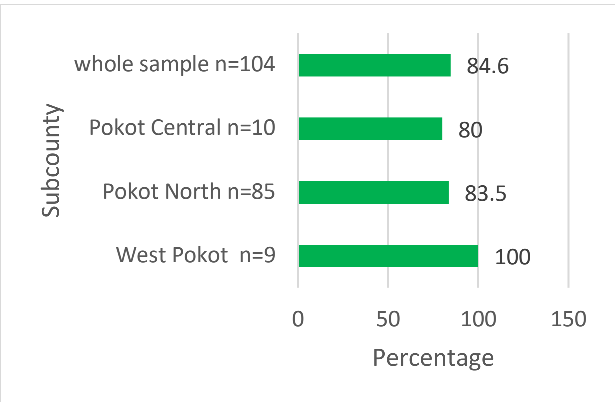
b. Quantity of sorghum given away free/gift in kilograms



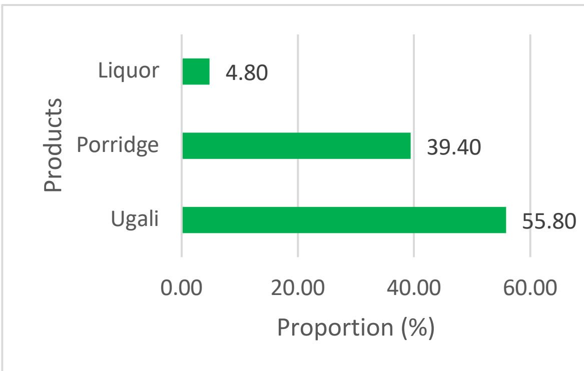
c. Proportion (%) of qty of sorghum sold by Households



d. Percentage of sorghum stored



e. Percentage of households who blend sorghum



f. Consumable sorghum products made by households

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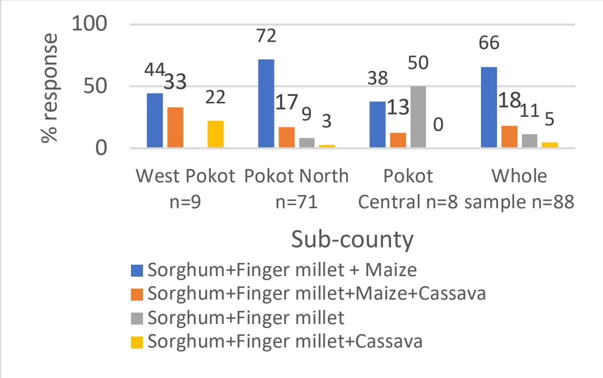
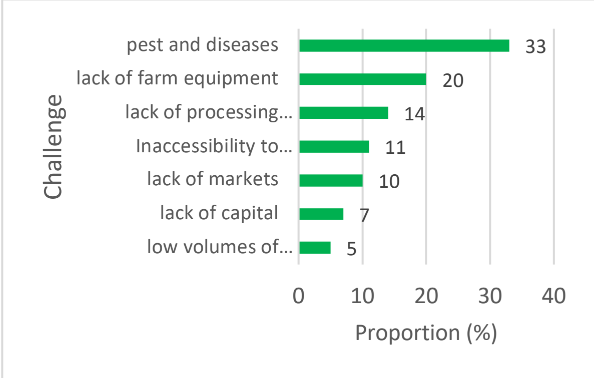


g. Percentage response of the blends of sorghum and other crop products



h Response sorghum problems faced by farmers

Figure 5: Percentage of households using different agronomic practices

CONCLUSION AND RECOMMENDATIONS FOR DEVELOPMENT

Based on the results of this study though a significant proportion of farmers grew sorghum, the adoption of TIMPs was low, the majority of farmers sampled grew sorghum (64%). Several factors negatively influence sorghum production and these include quantity sold, prices, inaccessibility to improved varieties, pest &disease/pests, lack of equipment/machines and lack of processing equipment. There was suboptimal adoption of agronomic practices, post-harvest management, and processing/value addition practices.

Farmers made a few rudimentary value-added products from sorghum such as *ugali*, *uji*, and liquor. Farmers are, therefore, encouraged to widen value-added products made from sorghum e.g. sorghum cake, mandazi, chapati cake, and crisps. The lowly adopted technologies including improved varieties need to be developed and promoted.

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Table 1: **Average acreage and proportion of land allocated to sorghum in West Pokot county**

Sub-County	n	Mean	Std	Minimum	Maximum
		Acreage			
Pokot North	156	0.80	.45	.20	4.00
Pokot Central	14	0.36	.34	.10	1.00
West Pokot	12	0.32	.27	.10	1.00
Whole sample	182	0.73	.46	.10	4.00
Proportion (%) of acreage to total land size					
Pokot North	156	25.76	21.55	.87	100.00
Pokot Central	14	18.43	13.09	.67	45.00
West Pokot	21	9.69	16.57	0.00	50.00
Whole sample	191	23.46	21.14	0.00	100.00

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