

Potential for the production and commercialization of orange-fleshed sweetpotato (OFSP) and high iron bean (HIB) in arid and semi-arid (ASAL) regions in Kenya

A situational study report

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2022**

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List of acronyms and abbreviation

ASAL	Arid and Semi-Arid Lands
CCO	County Crops Officer
CIAT	International Centre for Tropical Agriculture
CIP	International Potato Center
DDS	Dietary Diversity Score
DDBIO	Development and Delivery of Biofortified Crops at scale
FGD	Focus Group Discussions
HDDS	Household Dietary Diversity Score
IEC	Information, Education and Communication
KALRO	Kenya Agricultural and Livestock Organization
KII	Key Informant Interview
MoALF	Ministry of Agriculture, Livestock and Fisheries
MoH	Ministry of Health
OFSP	Orange-fleshed Sweetpotato
PABRA	Pan-Africa Bean Research Alliance
SCAO	Sub-County Agricultural Officer
SCNO	Sub-County Nutrition Officer
SUB	Scaling Up Biofortification
VAD	Vitamin A deficiency
WAO	Ward Agricultural Officer
WFP	World Food Programme
WFSP	White Fleshed Sweetpotato
YFSP	Yellow Fleshed Sweetpotato

Executive summary

The key objective of this study was to use mixed method approaches to understand the opportunities and challenges to enhancing biofortification with a specific focus on orange-fleshed sweetpotato (OFSP) and high iron beans (HIB), in the arid and semi-arid lands (ASAL) of Kenya. In particular, our research focuses on the production, commercialization and utilization potential of OFSP and HIB in four purposively selected counties in the ASAL regions: Baringo, Isiolo, Garissa, and Tana River. Quantitative data from sweetpotato and common bean producers and traders were collected using household and trader level questionnaires, while qualitative data was elicited from community leaders and local experts through focus group discussions (FGDs) and key informant interviews (KIIs). Overall, data were collected from 550 household and 213 trader questionnaires, 23 FGDs, and 31 KIIs to inform our findings.

Household survey

Results from the household surveys indicate there is considerable production of sweetpotato and common beans across the study area: 56% and 65% of the surveyed households cultivating sweetpotato and beans, respectively. However, across the counties, production was heterogenous with Isiolo having higher proportions of households producing each crop, while Garissa had the least. White-fleshed sweetpotato (WFSP) was the most common sweetpotato type cultivated by producing households and much lower number of households were growing yellow-fleshed sweetpotato (YFSP) and OFSP. The International Potato Center (CIP), World Food Programme (WFP), and the Kenya Agriculture and Livestock Research Organization (KALRO), among others, are the primary source for OFSP vine and information on optimal production and use. Most of the planting material distributed was of local sweetpotato varieties obtained through farmer-to-farmer exchange. Among beans, red mottled and sugar beans were the most commonly produced across the study areas.

Average cultivated land per household in the study area was approximately 4.5 acres with 11% allocated to sweetpotato and 25% to common bean production. Most sweetpotato and bean plots were intercropped with maize. Approximately 30% of the sweetpotato and bean plots were treated with inorganic fertilizer or organic manure, while about 35% were watered through irrigation. The most preferred sweetpotato traits were early maturity, high yields, easy to cook and good taste. About 40% and 56% of the household sweetpotato and common bean outputs, respectively, were sold, mostly through farmgate and local markets.

Over 70% of the households surveyed reported being food insecure, with an average dietary diversity score of about 7.4 out of the 12 food groups considered in the study. There is a relatively high level of nutrition

awareness among the surveyed households: 69% and 49% expressed awareness of the dietary importance of vitamin A and iron, respectively.

Traders' survey

Results show that over 90% sweetpotato and bean traders operate at the retail level across the selected counties. Most sweetpotato and bean traders sell between 2-5 types of sweetpotato and beans, respectively; only one trader was selling OFSP, and none was observed selling HIB. About 6% and 9% of the sweetpotato and bean traders had forward links with other actors (e.g., processors, institutions), while about 27% and 17% of these actors, respectively, had backward links with producers and other suppliers. Meanwhile, almost 50% of surveyed sweetpotato traders reported shortages in the produce, with a majority of these sourcing sweetpotato roots from distant counties. Only one out of the 49 and 164 surveyed sweetpotato and bean traders had received training on OFSP and HIB, respectively.

Qualitative study

Findings from KIIs and FGDs reveal that sweetpotato is a relatively new crop in the region, with a recent upward trend in production and consumption. Common bean, on the other hand, is well-known and almost universally consumed across the study area. Some socio-cultural taboos about beans (e.g., flatulence, food for cowards, etc) were noted and may affect production and consumption in some communities. Few households had knowledge of and access to improved sweetpotato and bean varieties. Only a few households, mostly in Tana River and Isiolo counties, reported access to OFSP varieties from CIP, WFP and KALRO. Very few farmers reported having access to agricultural extension services.

Malnutrition was a major concern across the study area and many households reported low intake of foods rich in vitamin A and iron, especially among children and women of reproductive age. However, despite the low intake levels, most households in the sampled areas were knowledgeable about nutritious foods and their benefits to children, expectant, and lactating mothers. Such knowledge was reportedly acquired from community health volunteers, mass media, agriculture extension staff, hospitals, and clinics. Lack of access to such nutritious foods was cited as the main challenge to consumption.

1. Introduction

1.1 Background

Arid and semi-arid lands (ASALs) occupy over 80% of Kenya's landmass and are spread across 29 counties. This region is home to about 30% of the Kenyan population and is characterized by harsh agro-climatic conditions, with annual rainfall ranging between 550mm and 850mm throughout the year, with high rates of evapotranspiration (Kenya Vision 2030 Development Strategy for Northern Kenya). These conditions have been exacerbated by climate change, further worsening the wellbeing of populations residing in the region. As a result, competition for resources in the region is rampant, often leading to conflict and internal displacements. The region is also home to some of the country's poorest infrastructure and is characterized by inadequate social services. All these factors combine to further worsen the economic outcomes of people inhabiting these regions, including food and nutritional insecurity.

Across Kenya, the prevalence of vitamin A deficiency and marginal vitamin A deficiency is 4.5% and 24.2% respectively, according to the Kenya Demographic and Health Survey of 2014. This situation is worse in the ASALs, where the agro-climatic conditions and challenges mentioned above combine to critically curtail access to food. Humanitarian aid, both through the government of Kenya programs and humanitarian organizations such as the World Food Programme (WFP), are critical to the sustenance of livelihoods in these regions. The improvement of food and nutritional security in these regions through sustainable and cost-effective interventions is therefore a critical objective for both the Kenyan government and humanitarian organizations providing humanitarian assistance in these areas.

Towards this end, various interventions aiming to sustainably improve the food security situation in the ASAL regions have been initiated, all with a common theme of using biofortified crops to improve not only access to food but also food that is rich in important micro-nutrients, to combat malnutrition in the targeted populations. The Kenyan government, for example, through the Ministry of Devolution and ASALs, and the State Department for Development of the ASALs, have instigated national food and nutritional security policies targeting the ASALs with biofortification and industrial fortification as key strategies. Similarly, humanitarian agencies, including the World Food Programme (WFP), have more recently started including the Orange-fleshed sweetpotato (OFSP), a Vitamin A biofortified crop rich in beta carotene, in their humanitarian programming, by partnering with institutions like the International Potato Center (CIP). Other biofortified crops, such as the High Iron Beans (HIB), have recently also been introduced into agri-food supply chains with the release of three HIB varieties (i.e., Nyota, Faida and Agaza) and are a potential candidate crop for improving nutrition through the consumption of biofortified foods in the ASALs.

Given the renewed interest in biofortification as a potential sustainable solution to the food and nutrition insecurity problem in the ASALs, this study was carried out to understand the potential for biofortification in the region, with a special focus on OFSP and HIB production and commercialization. The study was carried out as a collaborative effort between the World Food Programme (WFP)-Kenya office, the International Potato Center (CIP), through the Development and Delivery of Biofortified crops at scale (DDBIO) program, and the Alliance of Bioversity International and International Center for Tropical Agriculture (CIAT), through the Pan-Africa Bean Research Alliance (PABRA). The county governments in the three counties of study within the regions i.e., Baringo, Isiolo, Tana River and Garissa, were heavily involved in the study through provision of logistical backstopping and guidance to the field teams.

1.2 Study objectives

The main objective of the study was to understand the potential for biofortification in the study areas, including the production and commercialization of biofortified crops such as the orange-fleshed sweetpotato (OFSP) and high iron beans (HIB), and the utilization of these crops amongst populations living in these areas, so as to guide programming the Scaling Up Biofortification (SUB) efforts. Specifically, the study set out to:

1. To understand how farmers grow and utilize sweetpotato and common beans in the study areas
2. To determine the current sweetpotato and bean varieties and associated good agricultural practices for production.
3. To identify opportunities and challenges associated with sweetpotato and common beans production, commercialization, and utilization to support local farming systems.
4. To characterize sweetpotato and common bean markets, potential markets and market linkages in the study area.
5. To characterize households' nutritional knowledge, attitude and practices (KAP) of Vitamin A intake or biofortified food and micronutrient rich foods in ASAL areas.

2. Methodology

2.1 Study area

A mixed methods approach was used in the study, with quantitative data collected from sweetpotato and beans farmers and traders using semi-structured questionnaires while qualitative data was collected from farming communities using focus group discussions (FGDs) and key informant interviews (KII). The data generation process used in the three approaches is discussed below.

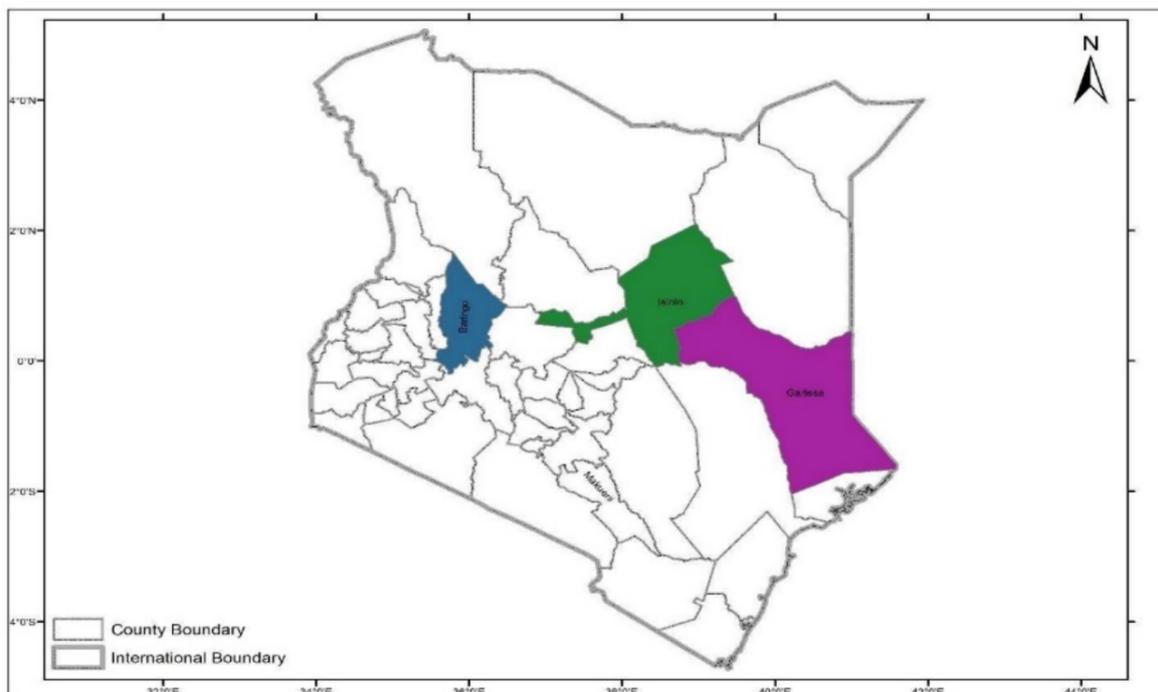


Figure 1: Map of study areas

2.2 Sampling and data

2.2.1 Household and trader survey

A multistage sampling process was used to select final units of study for the household survey. Random proportionate to size method, based on county population sizes, was used to identify number of villages from each of the selected administrative location clusters. Listings of households residing in each of these clusters were then made, with the help of the local leaders and extension officials. Ten households were then randomly selected from each of the selected villages, yielding a total of 550 households distributed across the study counties i.e., 200 in Baringo, 150 in Isiolo, 100 in Tana River and 100 in Garissa (see Table 1).

Table 1: Distribution of household survey sample

County	Sub County	Division	Location	Villages	Households	
Baringo	Mogotio	Mogotio	Olkokwe	3	30	
	Baringo South	Marigat	Perkerra	2	20	
		Mochongoi	Mchongoi	5	50	
		Kabartonjo	Bartolimo	6	60	
	Eldama Ravine	Ravine	Lembus perkerra (Kabiyet)	4	40	
Garissa	Garissa Township	Iftin	Iftin	1	10	
		Galbet	Galbet	3	30	
		Sankuri	Sankuri	3	30	
	Mbalambala	Danyere	Mudey	1	10	
	Fafi	Bura	Bura	1	10	
Isiolo	Garbatulla	Kina	Kinna North	2	20	
			Rapsu	3	30	
			Kinna South	1	10	
	Isiolo	Ngaremara	Attir	1	10	
			Ngaremara	1	10	
		Burat	Kambi Turkana	2	20	
			ElsaNtrim	2	20	
	Tana River	Tana North	Hirimani	Bura	4	40
				Chewani	1	10
				Wachakone	2	10
Tana Delta		Kipini West	Wachu Odha	3	30	
			Ngao	1	10	
Total					550	

Data collected from the households using semi-structured questionnaires was on diverse themes, including household socio-economic and demographic characteristics, general crop production (including sweetpotato and common beans production, utilization and market participation), household food security indicators, as well as knowledge, attitudes and practices regarding micronutrient intake like Vitamin A and iron. The questionnaire was programmed into online data collection tools (CSEntry) and was administered by trained enumerators face-to-face with respondents. The process was backstopped by scientists from the collaborating institutions for quality. Non-parametric methods, including frequencies, proportionate tests and mean comparisons, were used to analyze the data using STATA version 17.

For the trader survey, food markets in an average of 3 sub-counties per each of the four counties were visited, and bean and sweetpotato traders in each market randomly selected for participation in the survey (Table 2). A total of 198 traders across the study sites were interviewed, comprised of 164 bean traders (70% female) and 49 sweetpotato traders (65% female). These traders were distributed across village markets, but also peri-urban markets serving urban populations. It was noted that market spread across the villages was thin, with most of these concentrated in peri-urban areas.

Table 2: Sample distribution of sweetpotato and bean traders

County	Number of traders			Sub-counties
	Female	Male	Total	
Bean traders				
Baringo	26	19	45	Baringo South, Eldama Ravine, Mogotio
Garissa	30	16	46	Balambala, Fafi, Garissa township
Isiolo	38	3	41	Garbatulla, Isiolo
Tana River	20	12	32	Tana Delta, Tana North, Tana River
Total	114	50	164	
Sweetpotato traders				
Baringo	4	3	7	Baringo South, Eldama Ravine, Mogotio
Garissa	5	3	8	Balambala, Fafi, Garissa township
Isiolo	9	3	12	Garbatulla, Isiolo
Tana River	14	8	22	Tana Delta, Tana North, Tana River
Total	32	17	49	

2.2.2 Qualitative methods

Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs) were utilized to collect qualitative data to complement the survey data discussed above. These were also held across the four counties in the randomly selected villages for the household survey. In total, 23 FGDs were conducted, with women and men FGDs conducted separately. The criteria for selecting women participants included 1) women aged 18-49 years and 2) those with at least one child under 5 years of age. This was to facilitate robust discussions on household nutrition knowledge and uptake. Male participants were selected based on whether they practiced sweetpotato and/or beans production in the last 2-3 years. In total, 201 community members participated in the 23 FGDs, with 38% of these being women (Table 3). A pre-prepared guide was used to direct discussions in each FGD, where general information on nutrition knowledge was sought, as well as challenges in the production, utilization and commercialization of biofortified crops such as OFSP and HIB.

Table 3: Breakdown and composition of Focus Group Discussion per county

County		Subcounty	Division	No. of participants	
				Male	Female
Isiolo	1	Garbatulla	Kinna	0	8
	2	Garbatulla	Kinna	7	0
	3	Garbatulla	Kinna	7	0
	4	Garbatulla	Kinna	0	7
	5	Isiolo	Ngaremara	8	0
	6	Isiolo	Ngaremara	10	0
	7	Isiolo	Burat	0	7
	8	Isiolo	Burat	0	12
	9	Isiolo	Burat	12	0
	10	Isiolo	Bulapesa	10	0
Sub-total				54	34
Baringo	1	Baringo North	Kabartonjo	0	
	2	Baringo North	Kabartonjo	12	0
	3	Baringo South	MARIGAT	12	0
	4	Baringo South	Marigat	0	12
Sub-total				24	12
Garissa	1	Balambala	Danyere	0	10
	2	Garissa Township	Sankuri	0	8
	3	Garissa Township	Sankuri	9	0
	4	Balambala	Danyere	8	0
	5	Garissa Township	Iftin	0	7
Sub-total				17	25
Tana River	1	Tana River	Chewani	11	0
	2	Tana North	Hirimani	7	0
	3	Tana North	Hirimani	0	6
	4	Tana River	Chewani	11	0
Sub-total				29	6
Sub-total				124	77
Grand Total				201	

On the other hand, 31 key informant interviews were conducted across the study areas. These aimed at gathering in-depth insights on sweetpotato and bean production and marketing challenges, potential intervention designs in the counties, and possible policy measures to boost biofortification efforts in the region. The KII were conducted community leaders distributed across the study areas (Table 4).

Table 4: Distribution of Key Informants (community leaders) by county

S/No.	Region		Division	Key Informant (Community leaders)		
	County	Sub County		Responsibility	Gender	Age (Years)
1.	Isiolo	Garbatulla	Kinna	Teacher and village elder	Male	56
2.					Male	
3.				Committee member	Female	
4.				Elder/retire agriculture officer	Male	60
5.				Senior chief and community elder	Male	58
6.		Isiolo	Burat	Area manager	Male	47
7.				Sub area Nyumba Kumi		28
8.				Chief		
9.				Assistant chief	Male	47
10.				Group chairlady	Female	47
11.	Baringo	Baringo South	Karbatonjo	Community leader	Male	
12.				Community leader	Female	
13.			Marigat	Village elder	Male	
14.				Village elder	Female	48
15.		Mogotio	Mogotio	Chaiperson Kichamagaa	Female	39
16.		Eldama Ravine	Ravine	Assistant chief	Male	44
17.	Tana River	Tana North	Hirimani	Chief	Male	
18.				Chief	Male	

Additional KII were conducted with county government officials in the ministries of agriculture and health, for additional insights on policy challenges towards enhancing biofortification.

3. Results and discussions

The results emanating from the three different studies are discussed in this section. First, results from the household survey are discussed, followed by those from the trader survey. Finally, qualitative insights from the focus group discussions and the key informant interviews are presented.

3.1 Household survey

3.1.1 Household characteristics

A majority of the interviewed households (58%) were male headed, with the average household head aged 46 years and with an average education level of seven years (Table 5). Baringo had the highest educated household heads while Garissa had the least, at nine and four years of education, respectively. Male household heads had significantly higher education levels compared to the female counterparts, at seven and four years of education, respectively. In terms of income, the average household income for the previous 12 months across the counties was KES35,208, with Garissa having the highest (KES 75,815) while Isiolo county had the least (KES17,259.79). Male-headed households had higher average incomes at KES43,525 compared to their female counterparts at KES23,616.

Table 5: Socio-demographic characteristics of the households

Household characteristics	Baringo (N=189)	Garissa (N=100)	Isiolo (N=155)	Tana River (N=97)	Overall sample
Male-headed households (%)	53	62	57	65	58
Age_household head (years)	48 (14.42)	47 (13.78)	43 (13.64)	48 (12.14)	46 (13.87)
Education_household head (years)	8.7 (4.22)	4.0 (5.18)	5.3 (4.44)	6.7 (4.19)	6.5 (4.81)
Male-headed households	9.8 (3.73)	4.3 (5.17)	6.5 (4.29)	7.2 (4.04)	7.2 (4.69)
Female-headed households	7.4 (4.40)	3.5 (5.23)	3.6 (4.11)	5.9 (4.42)	5.4 (4.78)
Av. household income last 12 months (KES)	20,237 (74727.93)	75,815 (372639.8)	38,496 (68446.86)	17,260 (39859.69)	35208 (171654.3)
Male-headed households	28,456 (9843.51)	96,952 (460610.7)	39,556 (75106.8)	20,711 (42925.89)	43,525 (216776.8)
Female-headed households	10,805 (27604.31)	41,329 (140692.8)	37,067 (58813.96)	10,865 (33093.17)	23,615 (70031.82)
Av. household size (number)	5.4 (1.87)	6.3 (2.59)	5.9 (2.15)	5.9 (2.27)	5.8 (2.19)
Under 5 yrs (%)	76	47	66	57	64
Lactating mothers (%)	26	21	24	28	25
Pregnant women (%)	11	33	21	16	19

Note: Standard deviation in parentheses. Estimates from sample

On the other hand, the average household size was six members, which was evenly spread across the counties. Of this, 64 percent were under five years of age, with Baringo having the highest proportion (76%) of household members under five years of age and Garissa the least (47%). This indicates potential for impact of nutrition interventions targeting children under age five in the study areas. Similarly, proportion of lactating and pregnant women in the study sample was 24 and 19 percent respectively, a further indication of potential for impact of nutrition interventions targeting these population members (Table 5).

In terms of main occupation of household head, approximately 36 percent of these indicated crop farming as the main occupation, with the highest proportion of crop farmers being in Tana River and Garissa, and the least in Baringo (Table 6). About 21 percent of the household heads practiced mixed farming (crop and livestock) as the main occupation, indicating over 50% of the sampled households practiced crop farming, and therefore a potential for the introduction of both orange-fleshed sweetpotato and high iron beans in their production systems. Isiolo had the highest proportion of households practicing crop farming either as a pure or mixed system.

Table 6: Occupation of the household head by county (sample proportions)

Occupation of the household head	Baringo (N=189)	Garissa (N=99)	Isiolo (N=154)	Tana River (N=97)	Overall sample %
Not Working	39.68	26.26	0.00	9.28	20.41
Crop Farming	19.05	46.46	35.71	58.76	35.99
Livestock Farming	1.59	4.04	3.90	0.00	2.41
Mixed Farming (Crop and livestock)	16.93	4.04	42.86	9.28	20.59
Salary earner (eg teacher)	3.70	9.09	0.65	3.09	3.71
Casual wage earner	12.70	2.02	9.74	9.28	9.28
Farm labourer	3.17	0	0.00	6.19	2.23
Business	2.65	7.07	7.14	4.12	5.01
Schooling	0.53	1.01	0.00	0.00	0.37

Note: Estimates from sample

Other important occupation in the study areas were casual work and business, with about nine and five percent of the household heads indicating casual wages and business income, respectively as main sources of livelihoods. Garissa and Isiolo had the highest proportion of household heads.

3.1.2 Sweet potato and bean production and utilization in study area

3.1.2.1 Land allocation to crop production

On average, households across counties operated 4.4 acres that was owned, rented in or borrowed in. The number of acres operated per household in Baringo, Garissa, Isiolo and Tana River counties was about 3, 2, 4 and 10 acres respectively. The average land owned by households across the study areas was about 2.9 acres, with male-headed households owning slightly larger land areas (about 3 acres) compared to their female counterparts who on average owned 2.6 acres (Table 7). Tana River county had largest land ownership, at an average of six acres per household, followed by Isiolo (3.3 acres), Garissa (2.0 acres) and Baringo (1.3 acres), in that order. Of the total land owned, the average cultivated land per household in the overall sample during long and short rain seasons was about four and two acres, respectively. Garissa and Tana River counties had some of the highest cultivated land per household in the long rains, at 8.5 and 7.2 acres respectively, while Isiolo and Baringo had about three and two acres of cultivated land, respectively.

Table 7: Land allocation to crop production by county

	County				Overall sample
	Baringo	Garissa	Isiolo	Tana River	
Average total land operated per household (own, rented in, borrowed in) in acres	3.04	2.04	4.13	10.08	4.43
Average land owned (acres)	1.34	2.03	3.29	5.99	2.86
Long rain season					
Average cultivated land (acres)	1.69	8.53	2.80	7.15	3.79
<i>Proportion allocated to:</i>					
Sweet potato production (%)	8.0	15.2	13.0	8.2	11.1
Bean production (%)	55.4	28.3	28.6	3.4	24.9
Other crops (%)	36.6	56.6	58.4	88.4	64.0
Short rain season					
Average cultivated land (acres)	1.32	2.98	1.89	4.37	2.31
<i>Proportion allocated to:</i>					
Sweet potato production (%)	8.9	13.8	22.1	3.4	13.2
Bean production (%)	35.6	12.8	20.9	62.6	32.3
Allocated to other crops (%)	55.5	73.4	57.0	34.1	54.6

In terms of how the cultivated area was allocated to crop production, a proportion of 11 percent was allocated to sweetpotato production during the long rains, with Garissa leading in this allocation at 15%, and least allocation being in Baringo and Tana River counties at about eight percent allocation in each. On the other hand, the proportion allocated to bean production was much higher, at about 25% across all the counties with a high of 55% in Baringo county and a low of three percent in Tana River County (Table 7). A slightly higher allocation for both sweetpotato and bean production was made during the short rains season compared to the long rains one, at about 13% and 32%, respectively. While the allocation pattern for sweetpotato remained similar to that made during the long rains season, that for bean production differed significantly, with Tana River now having a high of 63% allocation to bean production, compared to three percent during the long rains season.

Across the counties, a higher proportion was allocated to other crops both in the long and short rains season, at 64% and 55%, respectively (Table 7). This indicates a potential to expand the frontier of sweetpotato and bean production beyond current allocations, with the introduction of widely acceptable highly nutritious varieties such as OFSB and HIB.

3.1.2.2 Plot ownership and management

Overall, about 26% and 29% of the sweet potato plots were owned by women and men, respectively, while about 45% were jointly owned by men and women (Table 8). Garissa county had the highest percentage of sweet potato plots solely owned and managed by men. None of the sweet potato plots in Garissa County were solely owned and managed by women indicating a significant gender difference in accessing and controlling productive resources in the region.

Table 8: Sweet potato and bean plot ownership and management by county

	County				Overall sample (%)
	Baringo	Garissa	Isiolo	Tana River	
Sweet potato					
Plot ownership (%)					
Female	32.26	0	21.28	25	25.93
Male	22.58	80	30.85	33.33	28.7
Both	45.16	20	47.87	41.67	45.37
Bean					
Plot ownership (%)					
Female	33.92	20.83	22.22	33.96	29.32
Male	26.9	62.5	31.62	33.96	31.78
Both	39.18	16.67	46.15	32.08	38.9

3.1.2.3 Farming practices in sweetpotato and bean production

Overall, about 68% of households intercropped more than 50% of the plots under sweetpotato, mainly with maize (Table 9). Relatively, fewer households (48%) intercropped bean plots during the long rains season, with Isiolo and Garissa counties having the highest proportion of households practicing intercropping in bean plots. The main intercrop for both sweetpotato and bean plots was maize, with about 83% of the plots being intercropped with the crop. Cassava and cowpeas were the other most common intercrops with about 2.8% of the plots being intercropped with the two crops.

Table 9: Sweetpotato and bean intercrops

	County				Overall sample (%)
	Baringo	Garissa	Isiolo	Tana River	
Sweetpotato plots (Long rains season)					
Intercropped (1=Yes)	82.8	40	58.51	54.17	68.06
Main intercrop (%)					
Maize	98.7	50	36.36	46.15	70.07
Onion	0	50	18.18	0	7.48
Tomatoes	0	0	12.73	0	4.76
Others	1.3	0	32.73	53.85	17.69
Bean plots (Long rains season)					
Intercropped (1=Yes)	46.2	50	51.28	46.3	48.09
Main intercrop (%)					
Maize	91.14	58.33	85	64	82.95
Cassava	2.53	0	0	12	2.84
Cow peas	0	0	0	20	2.84
Others	6.33	41.67	15	4	11.37

About 33 and 24 percent of the surveyed households applied fertilizer on the sweetpotato and bean plots, respectively during the long rains season (Table 10). A further 31 and 28 percent applied manure in the two respective crop plots during the long rains season. Across the counties, Baringo and Isiolo had the highest proportion of households applying fertilizer in sweetpotato and bean plots, respectively with Isiolo also leading in proportion of households applying organic manure in sweetpotato plots. In general, a high proportion of surveyed households seem to practice good soil management practices, through use of either organic or inorganic fertilizer.

Table 10: Soil management practices and irrigation in bean and sweetpotato plots

	Baringo	Garissa	Isiolo	Tana River	Overall sample (%)
Sweetpotato plots (long rain)					
Fertilizer	49.46	20	20.21	25	33.33
Manure (%)	1.08	40	61.7	25	31.02
Irrigation (%)	7.53	40	64.89	25	35.19
Bean plots (Long rains)					
Fertilizer	22.81	50	19.66	26.42	24.11
Manure Application	4.68	33.33	58.97	30.19	27.67
Irrigation	3.51	70.83	83.76	43.4	39.45

On the other hand, about 35 and 39 percent of the surveyed households irrigated sweetpotato and bean plots, respectively, with the Isolo having the highest proportion of households irrigating both sweetpotato and bean plots (Table 10). The least proportion of surveyed households that irrigated either sweetpotato or bean plots were observed in Baringo.

3.1.2.4 Other crops produced in study areas

Other than sweetpotato and common beans, maize and bananas are the other main crops produced across the four counties (Figure 2). For instance, maize is produced by over 70% of the surveyed households, with the highest proportion of these being in Baringo (91%), followed by Tana River (79%) and Isiolo (70%). The least proportion of surveyed households growing any of the crops were observed in Garissa with bananas and maize being the most important crops in the county, grown by about 30 and 24 percent of the surveyed households, respectively.

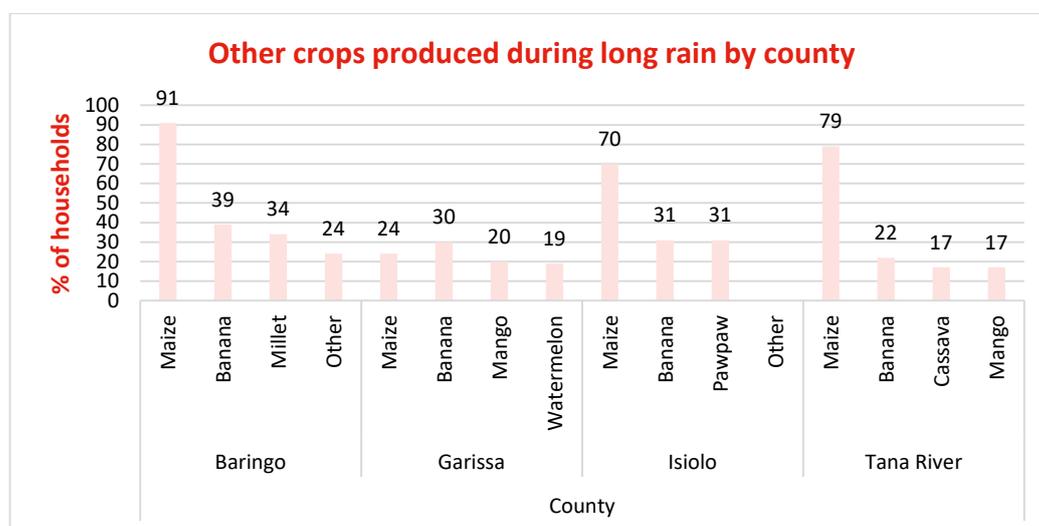


Figure 2: Other crops produced during long rain by county

Other crops besides maize and bananas produced by a small minority of the households in the study area included sorghum, groundnuts, pineapple, sugarcane, rice, sunflower, pawpaw, soybean, tobacco, coffee and tea.

3.1.2.5 Knowledge of sweetpotato and bean varieties in the study area

The common type of sweetpotato known by sampled households across the study areas was white fleshed sweetpotato (WFSP), with only about 19% of these having knowledge about yellow fleshed (YFSP) and Orange-fleshed (OFSP) sweetpotato. Across the counties, the highest proportion of sampled households with knowledge about OFSP were found in Isiolo, with the least found in Baringo (Figure 3).

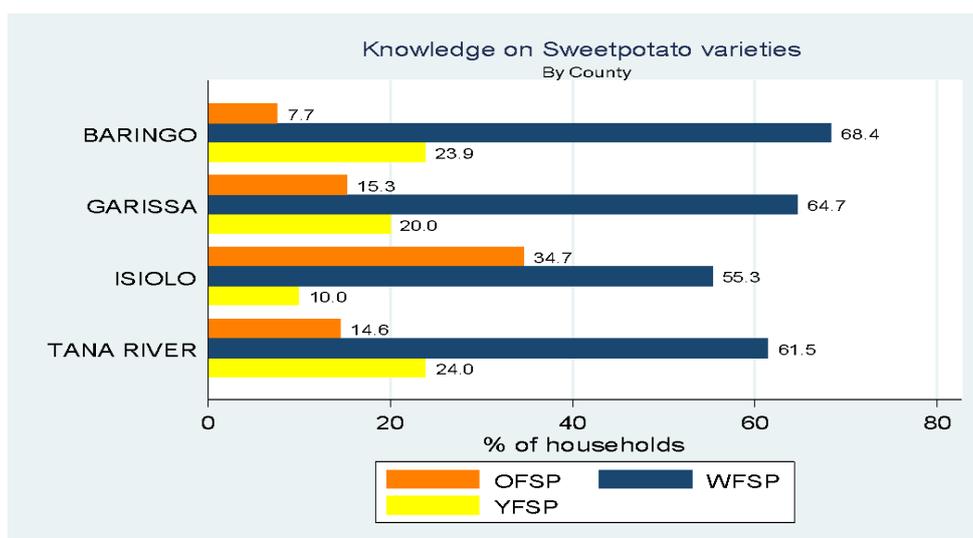


Figure 3: Knowledge on sweet potato types by county

On the other hand, the most popular types of common bean among the surveyed households were the Red mottled and Small Reds, while Sugar bean was the least known bean type (Figure 4). Across the counties, over 70% of surveyed households in Baringo and a further 36% and 34% in Tana River and Garissa counties had knowledge of Red mottled bean, with the bean type being the most popular in these counties. Small Reds was the most common bean type in Isiolo county, with about 32% of the surveyed households in the county having knowledge of the bean type.

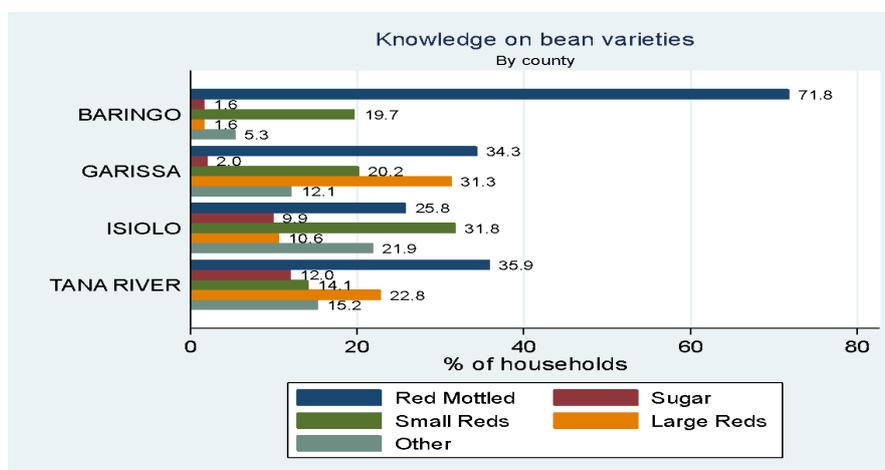


Figure 4: Knowledge on bean types by county

The surveyed households also produced sweetpotato and bean variety types that they had the most knowledge of. For instance, Garissa and Isiolo counties had the highest proportion of sampled households that planted OFSP in both seasons of the 2020/21 production year while Baringo has the least, perhaps due to the late start of OFSP promotion interventions in the county (Figure 5).

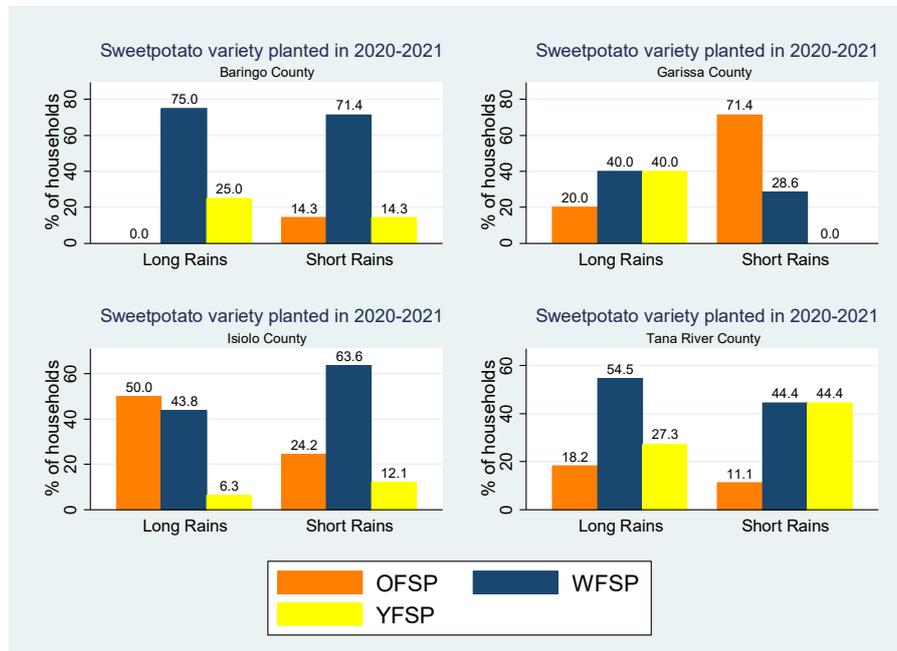


Figure 5: Types of sweetpotato planted in 2020/21

The main source of information on sweetpotato (OFSP) was CIP and WFP interventions in the area, with other intervention partners like KALRO and government agricultural extension being other popular information sources (Figure 6). Farmers also acquired information about OFSP from other sources like peer farmers, churches and schools, indicating positive spillovers of information.

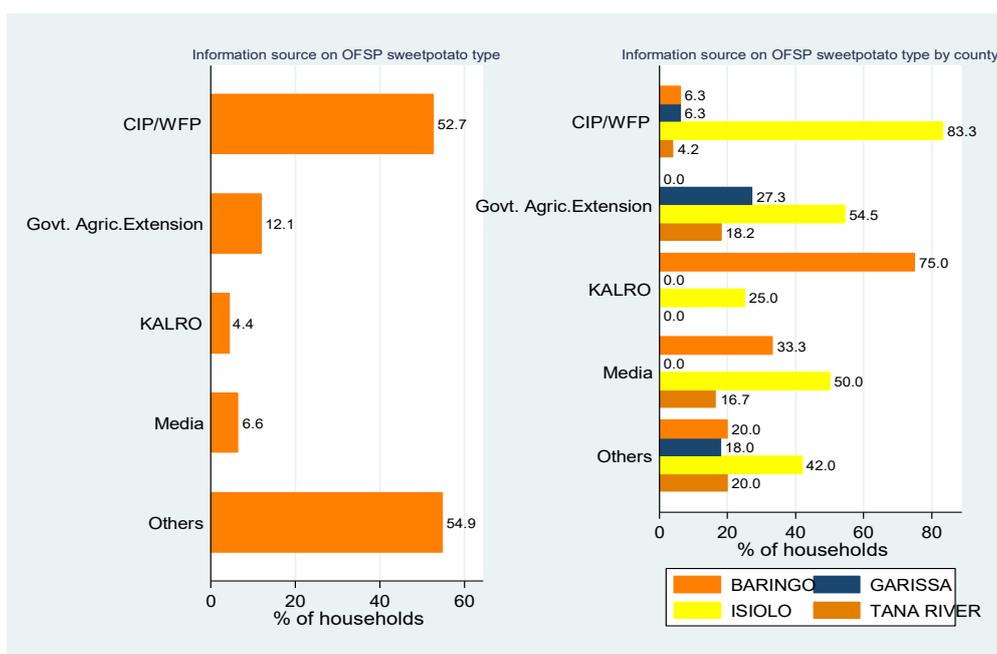


Figure 6: Information source on OFSP sweet potato type

Similarly, most of the information about common bean varieties was from other sources, KALRO, media and government extension. A few households also sourced information about beans from CIP and or WFP. Baringo and Isiolo counties had the highest proportion of households that acquired information about common beans from government agricultural extension and CIP/WFP respectively (Figure 7).

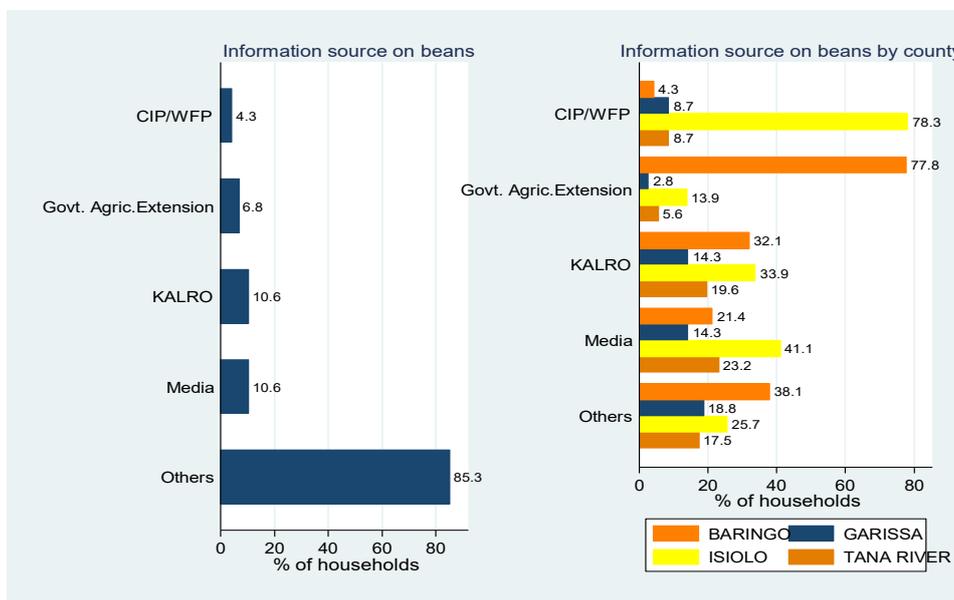


Figure 7: Information sources on common beans

3.1.2.6 Sweetpotato and beans seed use

Majority of the households across the counties used local sweetpotato vines, with Isiolo having the highest proportion of farmers using improved sweetpotato vines (Figure 8). The situation was similar for bean production, with a majority of the households using local seeds, with a significant proportion (16%) using new improved seed. The Isiolo producers were diversified in seed use, with 37% and 39% of the farmers using local and improved seed, respectively, while a further 23% used new improved recycled seed.

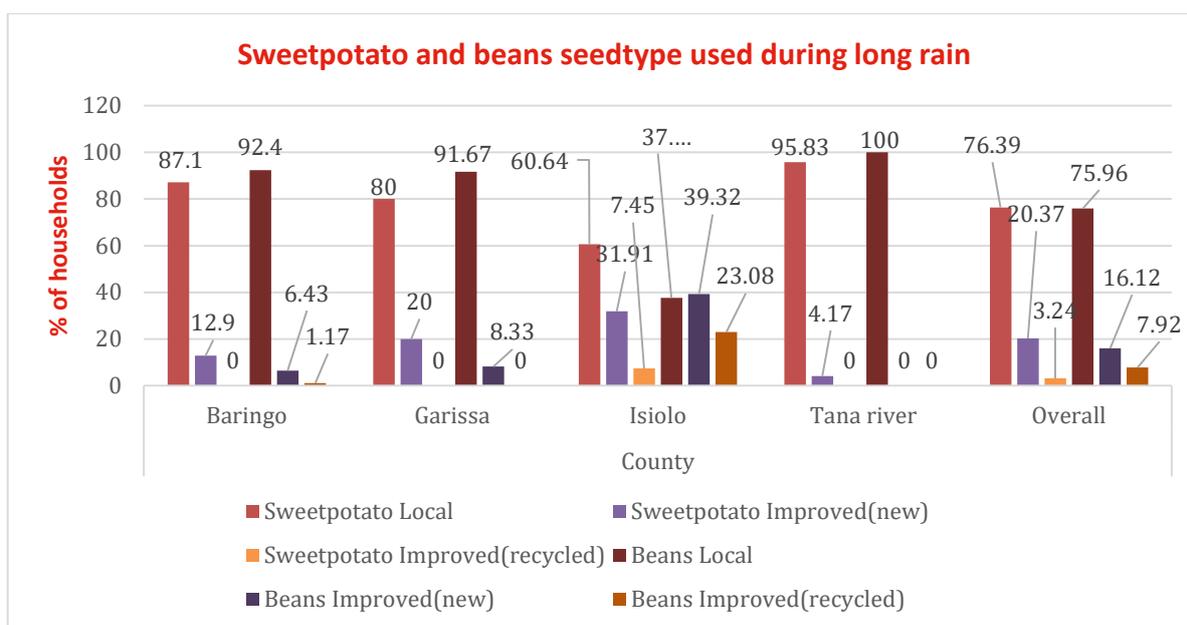


Figure 8: Sweetpotato and bean seed type used during long rain by county

In terms of seed acquisition, WFSP vines were mostly acquired from other farmers, indicating farmer to farmer exchange while OFSP was mostly acquired from KALRO and agricultural extension. A significant percentage of OFSP vines across the counties was also acquired through farmer-to-farmer exchange, indicating a potential for the spread of the technology in intervention areas (Figure 9).

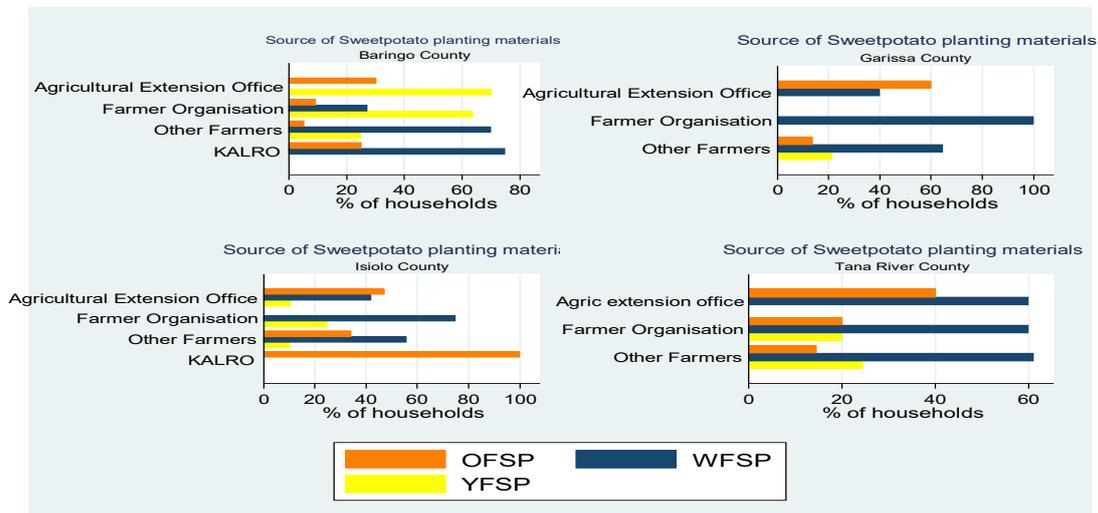


Figure 9: Source of sweet potato vines by county

On the other hand, the main sources of bean seed were agricultural extension, other farmers, and farmer organizations (Figure 10). Seed for Large Reds was mostly sourced from other farmers, while that for Red Mottled was sourced from different sources across the study counties, majority of these being agricultural extension and farmer organizations. Meanwhile, farmers in Isiolo county obtained Sugar beans from farmer organizations.

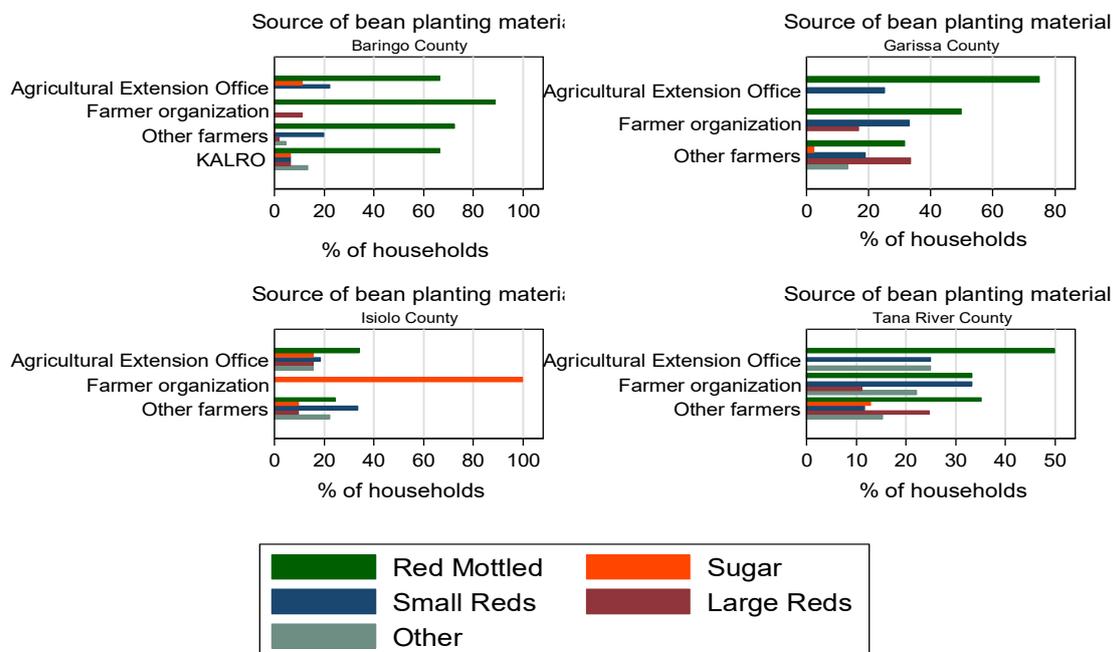


Figure 10: Source of bean seeds by county

3.1.2.7 Sweetpotato and bean outputs and productivity

Figure 11 presents results on household production and consumption of sweetpotato and beans in the study region. About 56 and 65 percent of the surveyed households grew sweetpotato and beans, respectively in the previous two years, with Isiolo having over 88 percent proportion of both sweetpotato and beans growers, the highest across the surveyed counties. On average, 65 and 99 percent of the surveyed households across the counties consumed sweetpotato and beans in the previous two months, respectively. The consumption of sweetpotato varied across the counties, with the highest being in Isiolo (85%) followed by Tana River (73%) while the least consuming proportion was in Garissa at 48 percent. On the other hand, there was an almost universal consumption of beans across the study areas, with over 98% of all surveyed households in all the counties indicating consumption of beans in the previous two months.

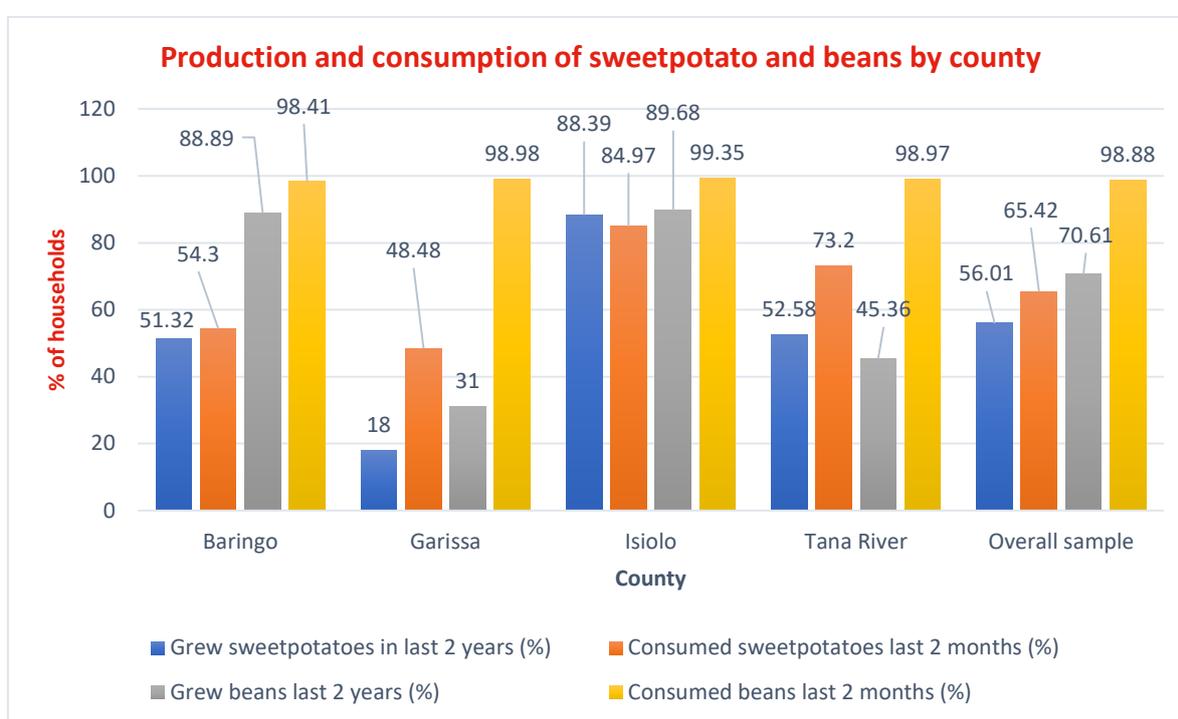


Figure 11: Production and consumption of sweetpotato and beans by county

In terms of productivity, data from the 2020/21 production year show that the average productivity of sweetpotato across the counties was about 283 Kg/acre and 234 Kg/acre, during the long and short rains seasons, respectively (Table 11). Baringo had the highest productivity for the crop at 313Kg/acre with Garissa having the least productivity at about 102Kg/acre, both for the for the long rains season. On the other hand, Isiolo achieved the highest bean productivity averaging 181Kg/acre, compared to a low of 14Kg/acre realized in Garissa. Variability in productivity across the two seasons was least for sweetpotato, with higher outputs being realized in the short rains season for beans, compared to the long rains season. The findings are consistent with the previous studies (WFP,2018: Tedesco & Stathers,2015) on beans and sweet potatoes indicating low production quantities per acre against an average of 1.5-3ton/ha (beans in ASAL regions) and 10-20 ton/ha (sweetpotato), respectively.

Table 11: Sweetpotato and bean production per acre by county

	County				Overall sample
	Baringo	Garissa	Isiolo	Tana River	
Sweet Potato					
Kg/ acre_ Long rains	312.7	102.2	282.5	267.8	282.6
Kg/acre_ Short rains	266.1	49.5	239.6	290.5	234.6
Beans					
Kg/acre_ Long rains	93.0	14.3	181.1	101.0	118.1
Kg/acre_ Short rains	173	18.8	168	142.7	148.0

Note: Estimates from sample

The high proportion of beans production and consumption across the study counties is an indicator of an entry point towards interventions for the production of high iron beans, with an expected high acceptability of the technology. Similarly, high proportion of consuming households, even in areas of low production (for example Garissa) indicates potential for the success of market-oriented interventions aimed at boosting utilization through market linkages with neighboring counties of high production (e.g., Isiolo). This is also true for sweetpotato production, with high proportions of consuming households, even in areas of low proportions producing and low productivity potential, such as Garissa.

3.1.2.8 Sweet potato and beans utilization

The average quantity of sweet potato and beans produced per household across the counties was about 80 Kgs and 53 Kgs, respectively (Table 12). Out of this, 49%, 8% and 43% of the sweetpotato output was consumed, given out and sold, respectively, while 38% of the beans output was consumed, 56% sold and the rest given out. There was a noted high market participation for sweetpotato across the counties, with household sales across all the counties averaging over 40% of the total output, except in Tana River where the proportion of output that was sold was about 38%. This is a clear indication of a potential for the commercialization of sweetpotato across the counties.

Table 12: Utilization of sweet potato and beans by county

Long rain season	County				Overall sample
	Baringo	Garissa	Isiolo	Tana River	
Sweet potato					
Average quantity produced (Kg)	97.50	30.20	99.12	64.63	79.63
<i>Proportion utilized as:</i>					
Consumed (%)	57.10	44.30	38.78	51.75	48.89
Given out (%)	2.75	10.99	12.90	10.72	8.11
Sold (%)	40.15	44.70	48.33	37.53	43.00
Beans					
Average quantity Produced (Kg)	61.71	5.64	95.75	19.24	53.48
<i>Proportion utilized (%)</i>					
Consumed	48.94	40.60	26.08	58.23	37.65
Given out	3.34	10.64	7.48	14.12	6.30
Sold	47.72	48.76	66.44	27.65	56.05

Note: Estimates from sample

Similarly, sales for beans outputs were high across the counties, with households in Isiolo, Baringo and Garissa selling over 40% of their bean outputs. The least bean sales were registered in Tana River where only 28 percent of the output was sold, with a majority of this going to consumption (Table 12).

Table 13: Utilization of sweet potato and bean types and by county

Long rain	County				Overall sample
	Baringo	Garissa	Isiolo	Tana river	
Sweet potato					
Average quantity sold (Kg)	43.52	56.25	63.46	47.06	51.32
<i>Proportions sold</i>					
OFSP (%)	81.37	62.96	77.52	75.01	77.65
WFSP (%)	12.01	37.04	22.48	10.80	17.91
YFSP (%)	6.63	0.00	0.00	14.20	4.44
Beans					
Average quantity sold (Kg)	59.85	55.00	104.90	22.43	75.43
<i>Proportions sold</i>					
Red mottled (%)	77.72	45.45	86.54	87.69	82.85
Sugar (%)	7.28	54.55	11.94	2.62	10.77
Small red (%)	14.10	0.00	1.52	0.00	5.77
Large red (%)	0.90	0.00	0.00	9.69	0.62

Note: Estimates from the sample

Of the total sweetpotato sales, the most sold sweetpotato varieties among sampled households were the Orange-fleshed and the white fleshed sweetpotato varieties at 78% and 18%, respectively (Table 13). On the other hand, the Red Mottled bean variety was the widely marketed bean variety, accounting for over 80% of all household bean sales, followed by Sugar variety which accounted for about 11 % of the total bean sales and the least being large Reds (0.62%).

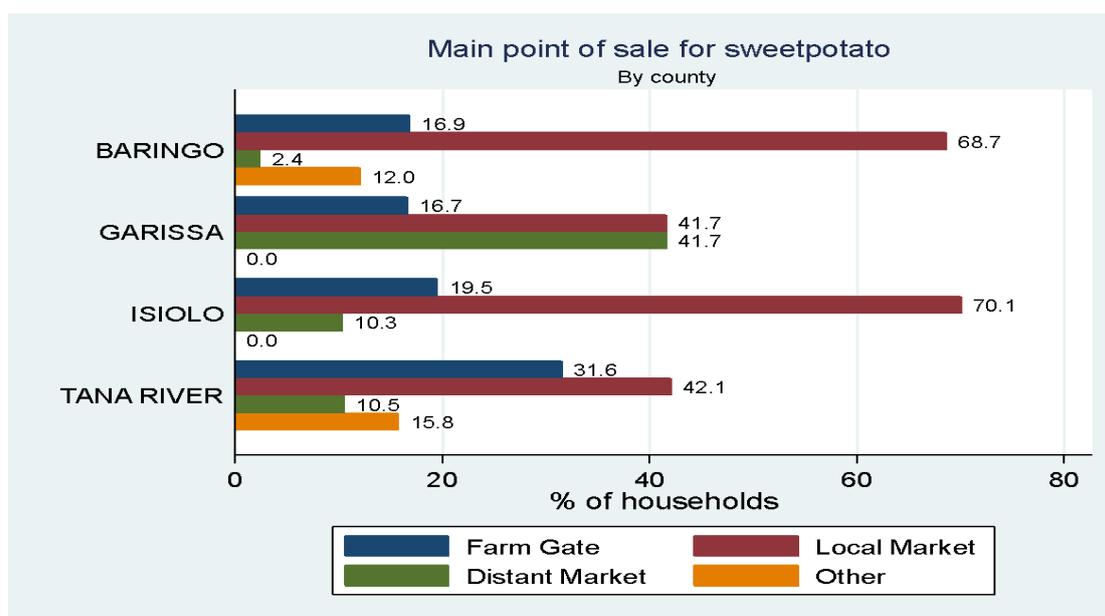


Figure 12: Main point of sweet potato sale by county

In terms of marketing, the main point of sale for sweetpotato was the local market, with farm gate being the second most popular point of sale, across the counties. Some sweetpotato farmers also sold to distant markets, especially in Garissa, an indication of thin markets in the county (Figure 12).

Table 14: Average selling price of sweet potato and beans

Long rain season	County				Overall sample
	Baringo	Garissa	Isiolo	Tana River	
Sweet potato					
Price per Kg (KES)	57.5	53.8	72.3	104.9	71.1
Beans					
Price per Kg (KES)	94.1	150	101.8	98.2	99.8

A kilogram of sweetpotato fetched about 71 shillings across the counties, with the highest price of Ksh105/kg registered in Tana River County and the lowest in Garissa County at Ksh54/kg (Table 14). On the other hand, a kilogram of beans was sold for 100 shillings, with the higher price registered in Garissa County at Ksh150/Kg, followed by Isiolo and Tana River counties where a Kilogram was sold for about Ksh102 and Ksh 100, respectively. The lowest bean price was observed in Baringo county at about Ksh94/Kg.

3.1.3 Sweetpotato and bean variety and trait preferences

3.1.3.1 Sweetpotato variety trait preferences

A clear elicitation of variety preferences was not possible, given the low knowledge of sweetpotato varieties in the study areas. However, respondents were asked to indicate the main types of sweetpotato (i.e., OFSP, YFSP and WFSP) they preferred and the traits that made these preferable. Across the variety types and study areas, early maturity, high yields, and good taste were the most important traits, with early maturing varieties being the most preferred, an indication of preference for varieties suitable for the harsh growing conditions in the areas (Figure 13). Yellow fleshed sweetpotato varieties were also preferred as they cooked easily.

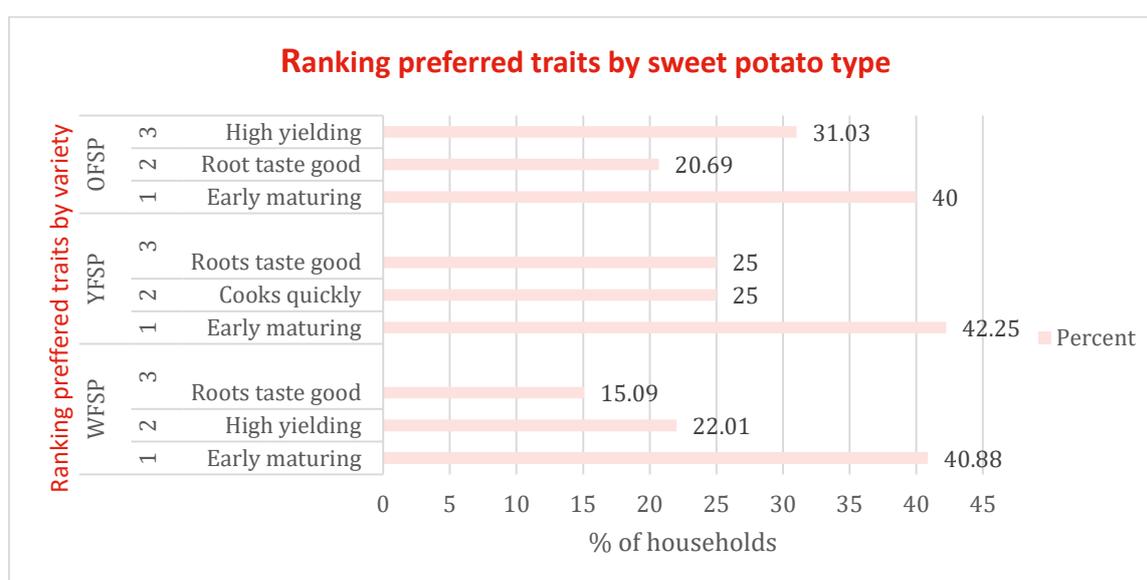


Figure 13: Ranking traits of frequently utilized sweet potato variety

Preferred sweet potato traits by different counties are shown in Table 15. In Baringo and Isiolo counties, farmers preferred more planting and production traits such as early maturing and high yielding. In Garissa and Tana River, the households preferred more cooking traits such as cooks quickly and roots tastes good.

Table 15: Sweetpotato variety trait preference across the study areas

County	Rank	WFSP	YFSP	OFSP
		Trait	Trait	Trait
Baringo	1	Early maturing, variety has some roots in less than 4 months	Early maturing, variety has some roots in less than 4 months	Medium size
	2	High yielding	Cooks quickly	Yellow fleshed
	3	Cooks quickly	Root taste good	
Garissa	1	Cooks quickly	Cooks quickly	Early maturing, variety has some roots in less than 4 months
	2	Roots tastes good	Other	Resist diseases
	3	Very sugary	Vines spread out when/medium size	High yielding
Isiolo	1	Early maturing, variety has some roots in less than 4 months	Early maturing, variety has some roots in less than 4 months	Early maturing, variety has some roots in less than 4 months
	2	High yielding	High yielding	Roots taste good
	3	Roots taste good	Roots taste good	High yielding
Tana River	1	Cooks quickly	Cooks quickly	Cooks quickly
	2	Roots taste good	High yielding	Very little sugar
	3	Very sugary	Roots taste good/other	High yielding

Development of biofortified sweetpotato varieties therefore need to consider these traits, for high acceptability and adoption. In addition to the nutrition gains, breeding programs should also prioritize agronomic traits such as early maturity, organoleptic traits such as good taste, and cooking traits such as easily cooked roots. The latter also has some gender implications, as women are mostly the ones involved in meal preparations, hence this will reduce drudgery.

3.1.3.2 Bean variety trait preferences

Overall, most households preferred Red Mottled bean variety due to the readily available market, pest/disease resistance and high yields. On the other hand, Small Reds variety was preferred by most households due to good taste, high yield and seed availability. A significant proportion of households also produced Large Reds mainly due to high market price, good taste and a readily available market and disease/pest resistance (Figure 14).

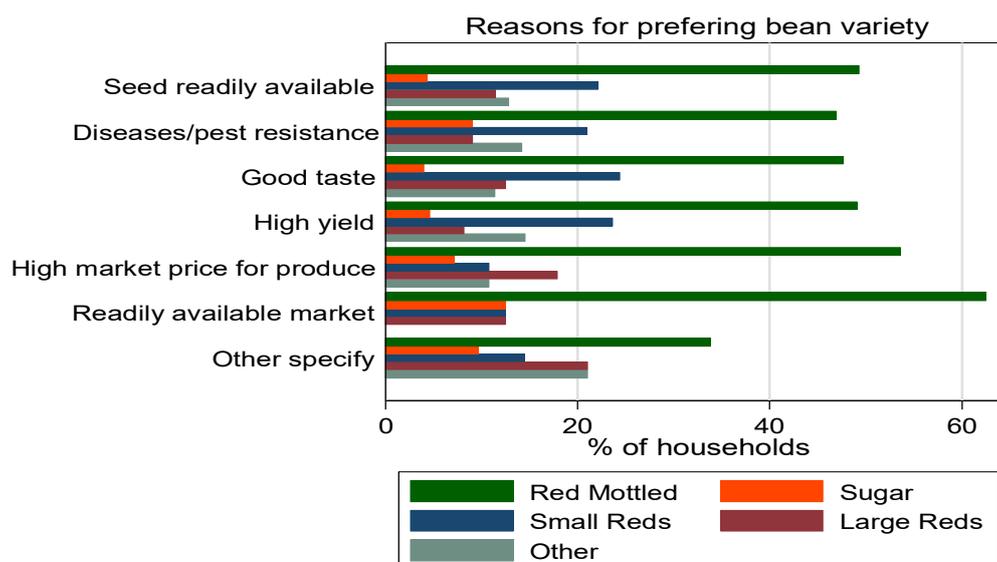


Figure 14: Reason for preferring bean variety in production

Two bean varieties were the most preferred across the study areas (frequently utilized bean types) i.e., Red mottled and white bean. The two varieties are used in this section to understand the most preferred traits, that made these varieties most preferable. Across the counties, early maturity, good taste, and high yields were the most common preferred traits, with low flatulence, swelling when cooked, and cooks easily were also other preferred traits by producing households across the study areas (Table 16).

Table 16: Ranking traits of frequently utilized bean types by county

County	Rank	Red mottled	White bean
		Trait	Trait
Baringo	1	Early maturing	Early maturing
	2	High yielding	High yielding
	3	No or less gas/flatulence/taste good	No or less gas/flatulence
Garissa	1	Cooks quickly	Cooks quickly
	2	Tastes good	Tastes good
	3	No or less gas/flatulence	Swells when cooked/no gas
Isiolo	1	Early maturing	Early maturing
	2	High yielding	High yielding
	3	Tastes good	Tastes good
Tana River	1	Cooks quickly	Tastes good
	2	Tastes good	Cooks quickly
	3	Swells when cooked	No or less gas/flatulence

3.1.4 Household asset ownership

3.1.4.1 Livestock assets

Tropical Livestock unit (TLU¹) was calculated from the total number of livestock owned by each household for each class of livestock (Njuki *et. al.*, 2011). The TLUs for all classes of livestock were aggregated to derive Total Livestock Holding (TLH) for each household. On average, the total number of livestock per households (TLU) in Baringo, Garissa, Isiolo and Tana River counties was 4, 7, 13 and 1 respectively (Table 17). Isiolo county had the highest number of cows, heifers and bulls among the counties. Garissa county had the highest number of goats compared to other counties.

Table 17: Livestock ownership by county

Livestock type	Bull	Cow	Heifer	Calves	Oxen	Goats	Sheep	Donkey	Pig	Chicken	Duck/Turkey	Rabbit	Other	TLH
County	TLU	TLU	TLU	TLU	TLU	TLU	TLU	TLU	TLU	TLU	TLU	TLU		
Baringo	2.4	3.4	1.2	0.9	2.8	1.9	1.4	1.5	0	0.2	0.3	0.06	2	3.66
Garissa	2.4	6.2	1.6	0.6	0	5.2	2.1	1.7	0	0.06	0	0	10	7.04
Isiolo	4.4	13.3	4.6	2	0	4.8	2.9	1.7	1.5	0.13	0.15	0.28	30	12.85
Tana River	1.2	5.3	2.3	0	0	1.9	1.1	0.8	0.6	0.10	0.12	0	0	1.31

Note: TLU =Tropical Livestock Unit, TLH =Total Livestock Holding

Variation in ownership of different classes of livestock could partially explain the variation in production of crops, income levels and dietary diversity across counties due to access to manure and livestock products.

3.1.4.2 Physical assets

Principal component analysis technique was used to group the number of assets owned by each household in the sample. Five components (categories) were selected with eigen value greater than 1 after which assets were grouped in their respective classes based on the loading factor (greater than 0.30. The first category (irrigation assets) comprised of sprayer pump, water pump and generator. The second group included farm equipment/tools such as ox-plough, ox-cart, machete/panga and hoe. The third category comprised of communication assets such as television, radio/cassette and mobile phone while the fourth comprised of transport equipment such as bicycle, motorcycle and tractor. The fifth category included other assets.

Overall, most households owned farm equipment/tools (98%) followed by communication (96%), irrigation (33%), transport (23%), and the least being other assets (9%).

¹ To calculate the TLU for each class of livestock, the number of livestock owned was multiplied by a conversion factor specific to that class. For instance, one mature cow was assumed to be equivalent to 1 TLU. The conversion factor for heifer, calves, bull and oxen was 0.78, 0.43, 1.2 and 1.42 respectively. TLU for poultry, rabbits, duck/turkey, donkey and pigs was 0.04, 0.04, 0.03, 0.8 and 0.3 respectively.

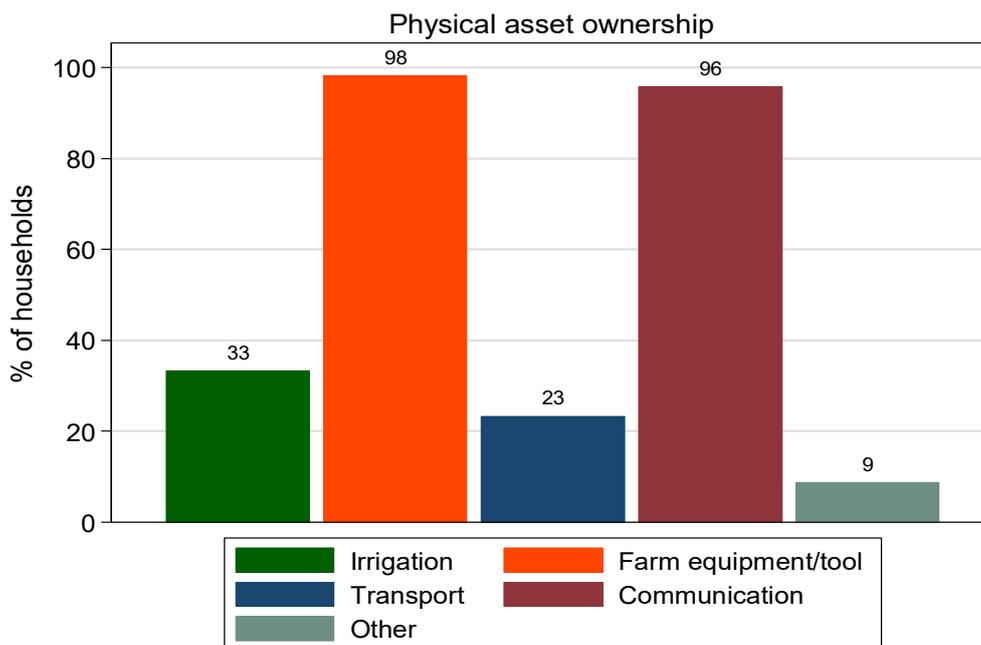


Figure 15: Physical asset ownership

Ownership of physical assets varied from one county to another. Most households across counties owned farm equipment/tools followed by communication, irrigation and transport assets and the least being other assets (Figure 16). Baringo and Isiolo counties had the highest proportion of households who owned farm equipment, communication, and other assets (Figure 16). Limited access to transportation assets could hinder delivery of produce to the market for households located far from point of sale.

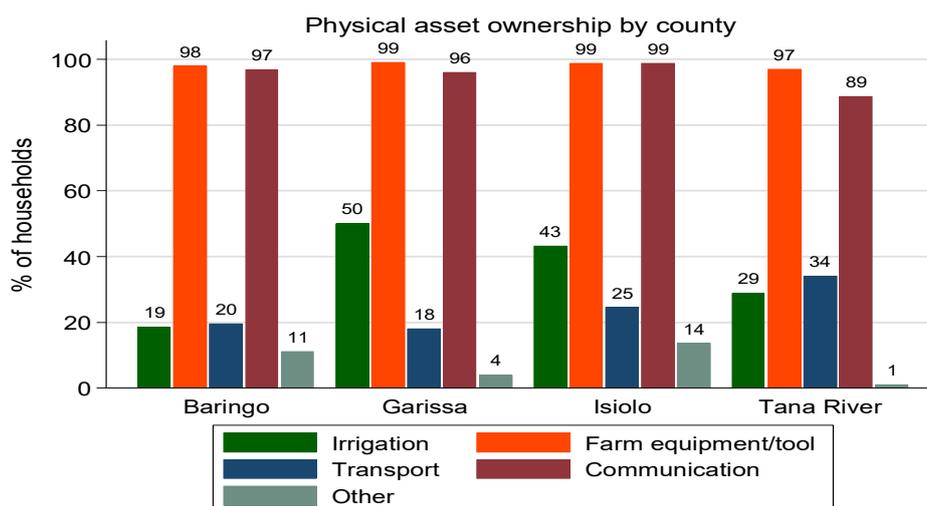


Figure 16: Physical asset ownership by county

3.1.4.3 Financial assets

The average total annual income earned per household in 2020-2021 ranged from a low of KES 10,513 in Tana River County to a high of KES39,459 in Baringo county (Figure 17).

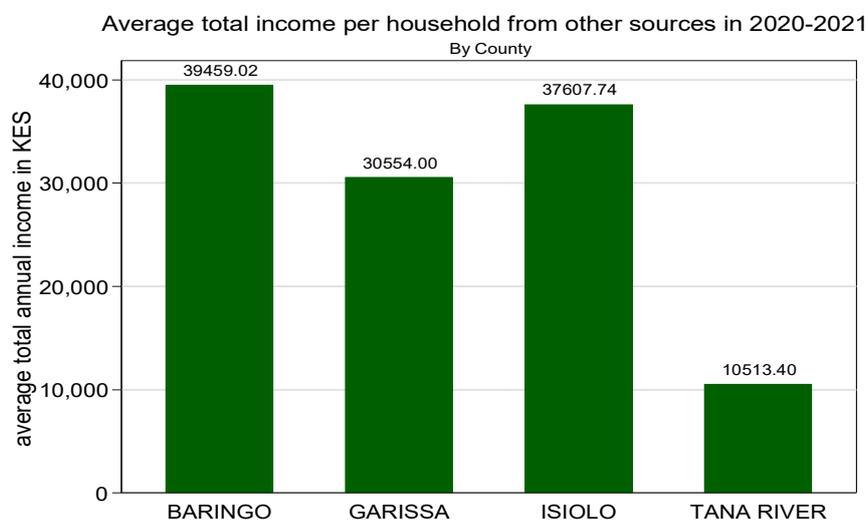


Figure 17: Average household annual income by county

Households in Garissa and Isiolo counties earned an average annual income of over KES 30,000, with households in Isiolo on average earning KES 37,608 and those in Garissa earning KES 30,554 (Figure 17).

With respect to gender, male-headed households (KES 38,538.7) earned relatively more income than female-headed (KES 23,108.25) counterparts in the same year. Across counties, Baringo and Isiolo counties had the highest average total annual income earned by female and male led households, respectively, while Tana River had the least (Figure 18).

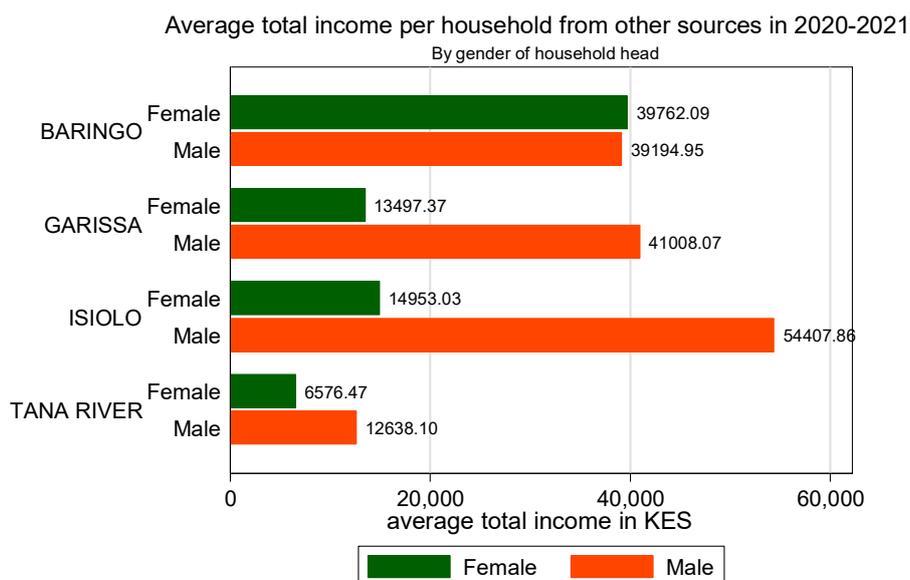


Figure 18: Average total income from other sources by gender and county

Business and rental income were the main sources of income for households across the counties, with business being the leading source in Baringo, Garissa and Isiolo counties and rental income being the leading source in Tana River and second in Baringo. Combined crop and livestock farming is also a significant source of income across the counties, and especially in Baringo and Isiolo counties. In Baringo, livestock farming is more important in terms of household income, compared to crop farming, while the opposite is true for Isiolo (Table 18).

Table 18: Average total income by source and county

Source of Income (Average total in KES)	County				Overall sample (Average total in KES)
	Baringo	Garissa	Isiolo	Tana River	
Crop farming	5,853.70	4,240	19,703.23	2,807.22	8,977.17
Livestock farming	20,098.62	1,670	7,946.45	1,627.84	9,898.78
Mixed farming	25,952.33	5,910	27,649.68	4,435.05	18,875.95
Rental	56,366.67	0	10,500	30,000	36,683.33
Business	70,805.18	88,536.36	39,500	18,244.44	57,465.06
Employment	43,49.08	9,150	4,141.96	3,175.26	4,966.68
Other income	18,94.18	5,755	2,622.58	901.03	2,638.45

Though significantly smaller in comparison with the other counties, farming is also important in Tana River, more than it is in Garissa County, indicating potential for the production of sweet potato and beans in the county. On the other hand, Garissa has the least potential for crop farming, with most households in the county relying on business and employment income (Table 18).

3.1.4.4 Physical amenities

Across the study area, most households (57%) lived in non-permanent houses. Baringo, Isiolo and Tana all had over 50% of their households living in non-permanent housing, with Garissa having the highest proportion of households (70%) living in permanent housing (Table 19). In this case, housing was considered permanent if it had stone or brick walling material, cemented floor and the roofing was made of iron sheets or other. A house was considered non-permanent if the walling material was earth, roofing was grass/straw and the floor was earth (Table 19).

Majority of the households used stream/spring as the main source of water during both rain and dry season (Table 19). Baringo had the highest percentage of household who relied on stream/spring water during both seasons. More than 50% of households in Garissa relied on Tap water during both seasons. A small minority of households in Tana River used water from well during both seasons. On average, household across counties spent about 16- and 19-minutes sourcing water during rain and dry season respectively. Across the counties, households in Baringo and Tana River counties spent the most time i.e., over 20 minutes sourcing for water during the dry season while those in Baringo and Garissa spent over 17 minutes sourcing for water in the rainy season. Most households across the study areas had access to pit latrines, with a significant number using bush latrines. This trend was replicated across all the counties (Table 19).

Table 19: Household access to physical amenities by county

	County				Overall sample
	Baringo	Garissa	Isiolo	Tana River	
Type of housing (%)					
Permanent	34.39	70.00	36.77	41.24	42.88
Non-permanent	65.61	30.00	63.23	58.76	57.12
Source of drinking water-rainy season					
Stream/spring	36.70	33.12	33.12	11.70	25.56
Well	0.00	0.00	8.44	30.85	7.84
Tap	18.62	52.00	22.73	2.13	23.13
Storage tank	15.96	11.00	8.44	11.70	12.13
Rain water	16.49	3.00	9.74	13.83	11.57
Borehole	11.70	12.00	17.53	10.64	13.25
Other	0.53	16.00	0.00	19.15	6.53
Source of drinking water-dry season					
Stream/spring	52.13	5.00	33.12	10.64	30.60
Well	1.60	0.00	12.34	32.98	9.89
Tap	20.21	52.00	22.08	1.06	23.32
Storage tank	4.79	12.00	9.74	22.34	10.63
Rain water	0.00	2.00	0.65	2.13	0.93
Borehole	20.21	11.00	22.08	8.51	16.98
Other	1.06	18.00	0.00	22.34	7.65
Distance to source of water					
Rainy season (average walking minutes)	17.93	19.99	8.81	15.51	15.27
Dry season (average walking minutes)	24.86	17.26	9.93	21.45	18.55
Type of toilet					
Pit latrine	86.17	85.00	83.12	75.53	83.21
Flush	1.06	3.00	0.65	3.19	1.68
Bush	12.77	12.00	16.23	21.28	15.11
Main means of transport					
Bicycle	1.60	0.65	1.00	10.64	2.80
Public transport	67.02	67.00	18.83	15.96	44.22
Motorbike	26.06	31.00	68.83	68.09	46.64
Own vehicle	0.00	1.30	1.00	0.00	0.56
Other	5.32	0.00	10.39	5.32	5.78

Other than public transport, motorbikes dominated the mode of transport across the counties, pointing to the emergence of “boda boda” as means of transport in these areas where infrastructure is poor (Table 19).

Access to physical amenities varied across county (Table 20). Overall, the average distance to all weather road, public health center, community health worker, vine multiplier and irrigation source was 58.9, 49.7, 47.4, 36.8, 55.5 and 28 walking minutes respectively. Households in Tana River (60.8) and Baringo (60.3) spent more in accessing nearest market center (Table 20). This could be a barrier to production due to challenges in accessing essential farm inputs, information/knowledge and buyers. On the other, households in Garissa county were located near a market center which could influence consumption due to ease of access to farm produce.

Table 20: Average Distance to physical amenities

Variable	Baringo (N=189)	Garissa (N=100)	Isiolo (N=154)	Tana River (N=97)	Overall Sample
Distance to nearest market center (walking minutes)	60.3	54.4	58.8	60.8	58.9
Distance to nearest all weather road (walking minutes)	54.1	36.7	36.4	75.8	49.7
Distance to the nearest public health center (walking minutes)	45.7	41.5	32.4	80.8	47.4
Distance to the nearest community health worker (walking minutes)	39.4	34.8	19.5	63.3	36.8
Distance to the nearest vine multiplier (walking minutes)	70.8	68.4	36.0	71.3	55.5
Distance to the nearest irrigation water source (river/swamp/stream) (walking minutes)	33.5	35.2	15.1	30.7	28.0

Households in Tana River county took more time to access the physical amenities compared to the other counties which could influence production and consumption due to limited access to reliable knowledge/information, market and farm inputs. On the other hand, households in Isiolo county were near all-weather road (36.7 min), public health center (32.4 min), community health worker (19.5 min), vine multiplier (36 min) and irrigation water source (15.1 min) respectively. This could lead to increased production and consumption due to ease of access to information, market, farm inputs and water for irrigation (Table 20).

3.1.5 Household food security

Several measures were used as indicators for household food security. These included the household food insecurity access scale, household dietary diversity, and food consumption frequency. These are discussed in detail below, including results on each indicator as observed from the study.

3.1.5.1 Household Food Insecurity Access Scale

Several approaches were used to assess the food security situation across the counties in this study. First, the Household Food Insecurity Access Scale (HFIAS) was used to assess the severity of food insecurity in the study areas using four main indicators namely; access related conditions, access related domains, access scale score and access prevalence, following Coates *et. al.*, (2007). Nine questions were asked to the respondent to elicit a household's food insecurity experience in terms of anxiety and uncertainty with respect to food access, food insufficiency in terms of quantity and quality, and reductions in food intake, with a timeframe of the previous four weeks. A standard scoring procedure was used with 1 point for occurrence and 0 for non-occurrence, while frequency scores ranged from 0 to 3 (0 for non-occurrence; 1 for once or twice in the past four weeks; 2 for three to ten times in the past four weeks; and 3 for often – more than ten times in the past four weeks).

Table 21: Household food insecurity prevalence by County

	N	All	Baringo	Garissa	Isiolo	Tana River	Prob>F
Average Household Food Insecurity Access Scale Score (HFIAS)	541	8.392 (7.427)	7.011 (7.302)	3.280 (4.928)	10.974 (6.948)	12.227 (6.841)	0.000 .
Proportion of food Secure households	381	0.013 (0.114)	0.016 (0.127)	0.051 (0.223)	0.008 (0.088)	0.000 (0.000)	0.114 .
Proportion of mildly food insecure households	381	0.034 (0.182)	0.057 (0.233)	0.051 (0.223)	0.031 (0.173)	0.000 (0.000)	0.141 .
Proportion of moderately Food Insecure households	381	0.168 (0.374)	0.179 (0.385)	0.231 (0.427)	0.131 (0.338)	0.180 (0.386)	0.464 .
Proportion of severely food insecure households	381	0.785 (0.412)	0.748 (0.436)	0.667 (0.478)	0.831 (0.376)	0.820 (0.386)	0.090 .

The Household Food Insecurity Access Scale Score (ranging from 0 to 27) was computed by summing all the frequency responses rarely-1, sometimes-2, often-3 for all the 9-food insecurity related conditions as described above. The higher the score, the more food insecurity(access) experienced by the household. The lower the score, the more food secure the household. On average, the overall household food insecurity access scale score was 8.4. Tana River had the highest household food insecurity access scale score of 12, followed by Isiolo 11, Baringo 7.1 (Table 21). Garissa had the lowest food insecurity access score of 3.3 indicating lower food insecurity incidence in the county. In terms of gender, female headed household had on a lower food insecurity score of 7.7 than their male counterparts (9.3).

Further, the Household Food Insecurity Access Prevalence (HFIAP) was determined first by computing a variable for food insecurity access using a set of questions according to Coates *et al.*, 2007. The HFIAP is a categorical indicator of the household food insecurity (access) status. The households were the classified as food secure (1), mildly food insecure (2), moderately food insecure (3) and severely food insecure (4) based on their response (occurrence and frequency of occurrence) to the nine-household food insecurity access- related conditions (Coates *et al.*, 2007). A household was considered food secure if it experienced none of the food insecurity conditions or just experienced worry, but rarely. Mildly food insecure household on the other hand, experienced conditions in anxiety/uncertainty (sometimes/often) and insufficient quality (rarely) domains but it does not experience conditions associated with insufficient food intake and its consequences domain. Household that experienced insufficient quality conditions (sometimes/often), and had reduced quantity of food intake (rarely/sometimes) but never experienced any of three most severe conditions was classified as moderately food insecure household. Finally, any household which experienced three most severe insufficient food intake related conditions even once in the last four weeks was considered severely food insecure.

Overall, 79% of the households were severely food insecure (Table 21), while 17% and 3% were moderately and mildly food insecure, respectively. Only about 1% of the households were food secure. The proportion of severely food insecure households across all the counties was over 65%, with the highest being in Isiolo and Tana River at 83% and 82%, respectively and the lowest in Garissa at 67%.

3.1.5.2 Household Dietary Diversity

Household Dietary Diversity Score (HDDS) was determined according to Swindale & Bilinsky (2006). First a 24-hour recall of the different foods that had been consumed by a reference child (a child below 5 years of age) and/or reference woman (pregnant or lactating women) was elicited from the respondent familiar with household cooking. A total of 12 food groups were considered and assigned responses (1=consumed and 0=otherwise). The food groups consisted of starch, roots/tubers, pulses, dairy, eggs, meats, fish, vegetables, fruits, fats, sugars and condiments (spices).

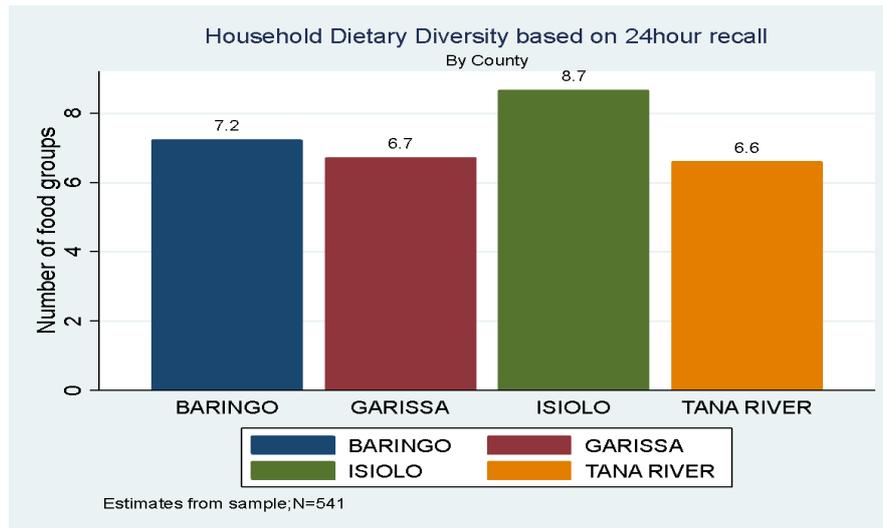


Figure 19: Average Household Dietary Diversity Score (24-hour recall) by county

A summation of the responses was done and divided by the number of households to determine Household Dietary Diversity Score (HDDS). The score ranged from 0-12 with 0 indicating a low dietary diversity and 12 indicating high dietary diversity. An increase in dietary diversity score indicates an improvement in household's diet (Swindale & Bilinsky, 2006). According to Momanyi *et al.* (2019), a dietary diversity score less than 4 is considered to be low, 4-6 moderate diversity score and greater than 6 high dietary diversity score. Majority of the households in the study area had high dietary diverse score (greater than 6). The overall average Household Dietary Diversity Score across the study area was 7.4. The average number of food groups consumed by households in various counties ranged from 6.6 to 8.7 (Figure 19). Isiolo county had the highest average Household Dietary Diversity Score (8.7) followed by Baringo (7.2). Both Garissa and Tana River counties had average Household Dietary Diversity Score of 6.7 and 6.6 respectively. On average, female-headed and male-headed headed households consumed 7.5 and 7.4 food groups respectively.

3.1.5.3 Food Frequency Consumption

Food frequency consumption was determined using the Food Consumption Score Nutritional Quality Analysis guideline (2015) developed by the World Food Programme. First different food types were aggregated into 9 food groups as shown in Table 22. In each of the food group, a summation of the frequency value for each of the food type was done. The frequency values ranged from 0 representing the food-type was not consumed to 7 representing food type was consumed daily. The frequency scores were then classified into 3 categories where 1 represent never consumed (0 time), 2 consumed sometimes (1-6 times) and 3 consumed at least daily (7 times and more) to determine food frequency consumption (WFP,2015). The average frequency of consumption for main staples which included cereals and tubers was 13 indicating a high frequency of consumption of more than once in a day (Table 22). Consumption of other food groups was low across the study areas, with only vegetables being the other food category consumed almost daily.

Table 22: Frequency of food consumption by reference child/woman

Food groups	Reference group			
	Child (N=323)		Woman (N=535)	
	Freq-score (average)	Frequency* consumption category	Freq. score (average)	Frequency* consumption category
Main staples	12.67	3	12.57	3
Pulses and nuts	3.48	2	3.57	2
Vegetables	5.66	2	6.20	2
Fruits	2.03	2	1.67	2
Meat/Fish/eggs	2.57	2	2.78	2
Milk	4.36	2	3.16	2
Sugar	1.76	2	1.76	2
Oil	3.26	2	3.1	2
Salt	3.33	2	3.73	2

Note: 1= never consumed; 2= Consumed sometimes; 3 = Consumed at least daily (7 times or more)

Table 23 shows frequency of consumption of different food groups by county. All the counties at least consumed main staples more than once a day. More staples, vegetables and pulses were consumed in Baringo at least once a. Households in Isiolo consumed pulses and nuts, vegetables and milk than once. Garissa and Tana River had relatively lower average food consumption frequency in all the food groups compared to other counties.

Table 23: Frequency of food consumption by reference child /woman by county

County	Baringo				Garissa				Isiolo				Tana River			
	Child (N=143)		Woman (N=187)		Child (N=47)		Woman(N=100)		Child (N=87)		Woman (N=154)		Child (N=46)		Woman (N=94)	
Reference group	Freq score	Frequency*	Freq score	Frequency*	Freq score	Frequency*	Freq score	Frequency*	Freq score	Frequency*	Freq score	Frequency*	Freq score	Freq. category*	Freq score	Frequency*
Main staples	13.8	3	14.0	3	8.6	3	10.8	3	13.8	3	13.2	3	11.1	3	10.7	3
Pulses and nuts	3.7	2	4.2	2	2.8	2	3.6	2	3.8	2	3.4	2	2.8	2	2.7	2
Vegetables	6.7	3	7.6	3	2.7	2	4.1	2	6.3	3	6.6	3	4.3	2	5.1	2
Fruits	2.0	2	1.5	2	1.0	2	1.3	2	3.0	2	2.4	2	1.4	2	1.3	2
Meat/Fish/eggs	2.3	2	2.3	2	1.6	2	2.4	2	3.3	2	3.2	2	2.8	2	3.4	2
Milk	4.8	2	2.9	2	2.8	2	2.4	2	5.3	2	4.5	2	2.9	2	2.2	2
Sugar	2.0	2	2.3	2	1.2	2	1.5	2	1.8	2	1.6	2	1.5	2	1.3	2
Oil	3.5	2	3.6	2	1.7	2	2.2	2	4.3	2	3.7	2	2.2	2	2.1	2
Salt	2.9	2	3.3	2	3.1	2	3.8	2	4.3	2	4.4	2	3.1	2	3.5	2

Note*: 1= never consumed; 2= Consumed sometimes (1-6 times); 3=consumed at least daily (7 times or more)

3.1.6 Nutrition Knowledge, Attitude and Practices (KAP)

3.1.6.1 Vitamin A and Iron knowledge

Respondents were asked about their knowledge of Vitamin A and iron in the study areas. A high percentage of the sampled households had heard about Vitamin A and iron, owing to the WFP/CIP interventions in the study areas towards boosting nutritional knowledge (Figure 20). While this knowledge is high among sampled households, it does not necessarily reflect the general population situation, owing to the sampling framework that targeted areas of WFP/CIP interventions. However, this is an indicator of the success of such interventions, and rationale for out-scaling to the other pockets of the populations in ASAL areas with high levels of malnutrition.

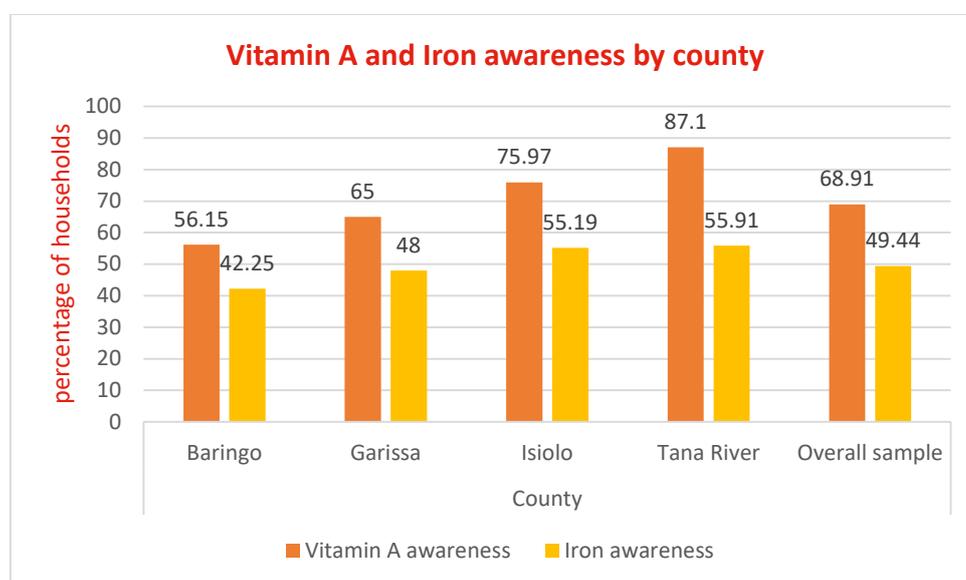


Figure 20: Vitamin A and iron awareness by county

Specifically, the proportion of households aware of vitamin A and iron across the study sample was 69% and 49% respectively, with vitamin A awareness being higher (71%) for female-headed households compared to male-headed counterparts (68%). This could be attributed to the intervention strategy of targeting women, as agents of change within the households for nutritious food intake. Across the counties, Vitamin A awareness was very high among the sampled households in Tana River and Isiolo counties at 87% and 76%, respectively, while Baringo had the least proportion of same with Vitamin A awareness at 56%, perhaps owing to the early stage of nutrition awareness interventions in the county (Figure 21).

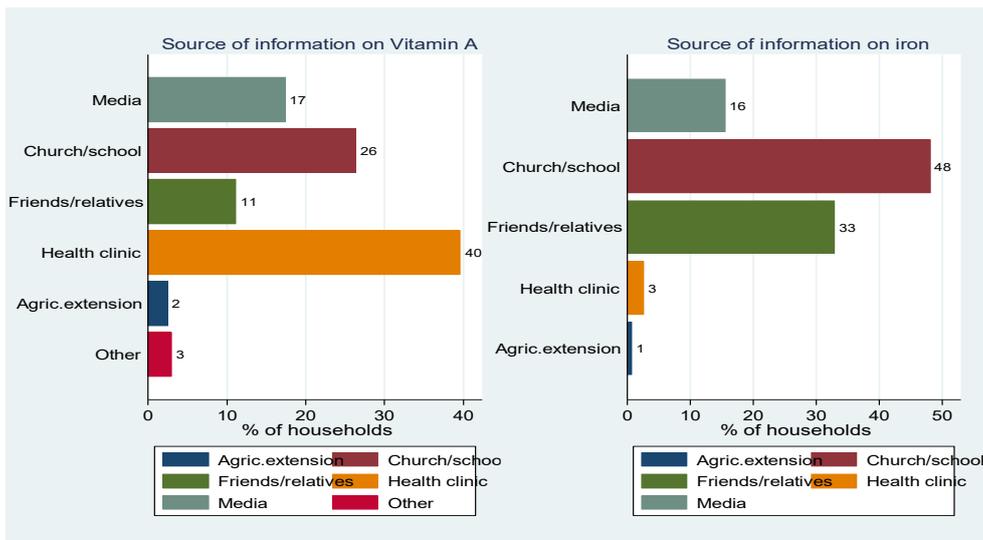


Figure 21: Information sources on Vitamin A and iron

Across the counties, the main sources of nutrition information on vitamin A were health clinics (40%), government agricultural extension (2%), media (17%), church and schools (26%), and friends and relatives (11%). For iron, households acquired information from church and schools (48%), friends and relatives (33%), media (16%) and health clinic (3%). The last two indicate positive spillovers of nutrition awareness interventions, given that these interventions have focused on the first three modes of information dissemination, and therefore a potential for achieving impact at scale.

Households across counties had diversified sources of nutrition information (Figure 22). Most households in Baringo, Garissa and Tana River sourced information on vitamin A and iron from health clinic, church and schools and as friends/relatives. A significant proportion of the households in Baringo, Isiolo and Tana River counties acquired nutrition information from media.

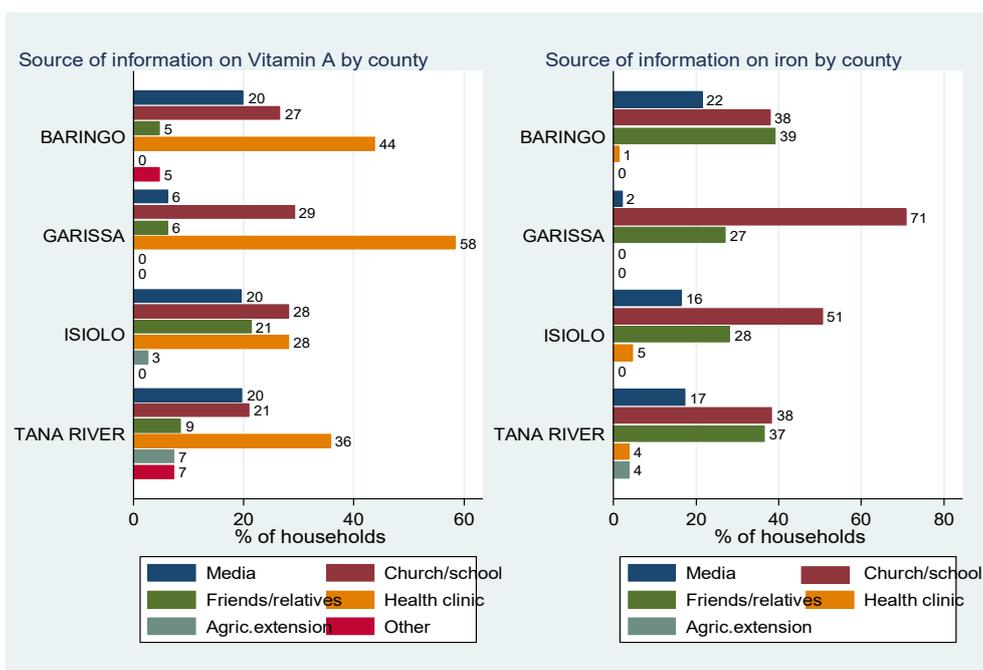


Figure 22: Source of information on vitamin A and iron by county

Very few households acquired nutrition information from agricultural extension officers compared to other sources (Figure 22).

3.1.6.2 Infant and young children feeding practices

Numerous indicators developed by the World Health Organization and United Nations Children’s Fund (2021) were used to describe Infants and young children feeding and care practices among households in the study area (Table 24). The results shows that more than 80% of the infants born in the last 1 year were ever breastfed. Majority of the children/infants ever breastfed came from Baringo and Isiolo counties while Garissa had the least. Most households (77%) across counties practiced continued breastfeeding of children aged 12 to 24 months indicating awareness of the importance of continued breastfeeding awareness in the study region. About 33% and 67% of the households in Baringo and Garissa exclusively breast feed children under six months. On the contrary, none of the households in Isiolo and Tana River counties practiced exclusive breastfeeding for children under six months (Table 24). With respect to complementary feeding, about 40% of the children aged 6 to 8 months were introduced to solid/semi solid or soft food in line with the recommendations of WHO Global strategy for young children feeding. However, none of the households in Tana River introduced solid or soft food to children at the age of 6 to 8 months. More than 50% of the young children aged 6 to 23 months were fed milk at least two feeds a day. Baringo and Isiolo counties had proportion of households that fed milk to infants while Tana River had the least. This could be attributed to high number of livestock such as cows, goats and sheep owned by households in the counties increasing availability of milk. Only a small minority of the households fed sweet beverage such as juice to young children across the study area (Table 24).

Table 24: Infant and young children feeding practices by county

Indicators	County				Overall sample
	Baringo	Garissa	Isiolo	Tana River	
Breastfeeding (%)					
Ever breastfed (24 months and below)	27.27	1.82	27.27	13.64	84.62
Continued breastfeeding 12-23 months (%)	100.00	100.00	50.00	100.00	77.78
Exclusive Breastfeeding (under six months)	33.33	66.67	0	0	100.00
Complementary feeding (%)					
Introduction of solid, semi-solid and soft food (6-8 months)	25	50	25	0	40
Minimum milk feeding frequency for non-breast -feeding children (6-23 months)	48.21	12.50	32.14	7.14	58.95
Sweet beverage consumption (6-23 months)	8.11	6.25	12.50	0.00	7.45
Infant/young children care (%)					
Number of hours child left in adult care	3	1	3	2	2
Number of hours child was left in childcare	2	1	2	1	2

Note: Estimates from survey sample

The average number of hours that children aged between 6-23 months had been left with an adult and childcare giver were 2 hours in the overall sample. Baringo and Isiolo counties had the highest number of hours a child was cared for by an adult and other child (Table 24).

Most of the households were aware of the different signs of undernutrition and they included, lack of energy, become ill easily, loss of weight, slow growth (Figure 23).

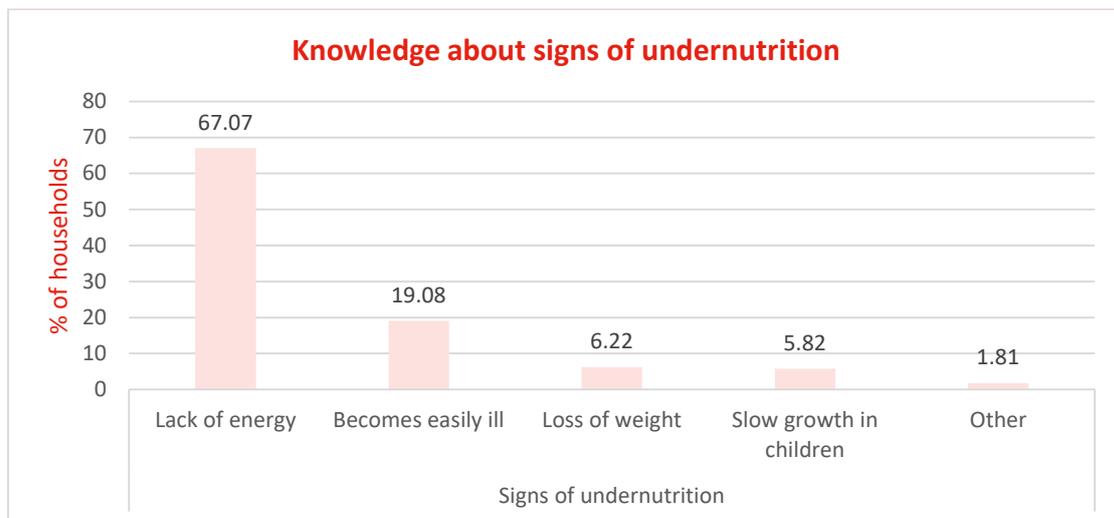


Figure 23: Signs of under nutrition

Insufficient food was cited as the most important reason for undernourishment as shown in Figure 24 Other factors attributed to undernourishment included insufficient nutrients in foods and diseases.

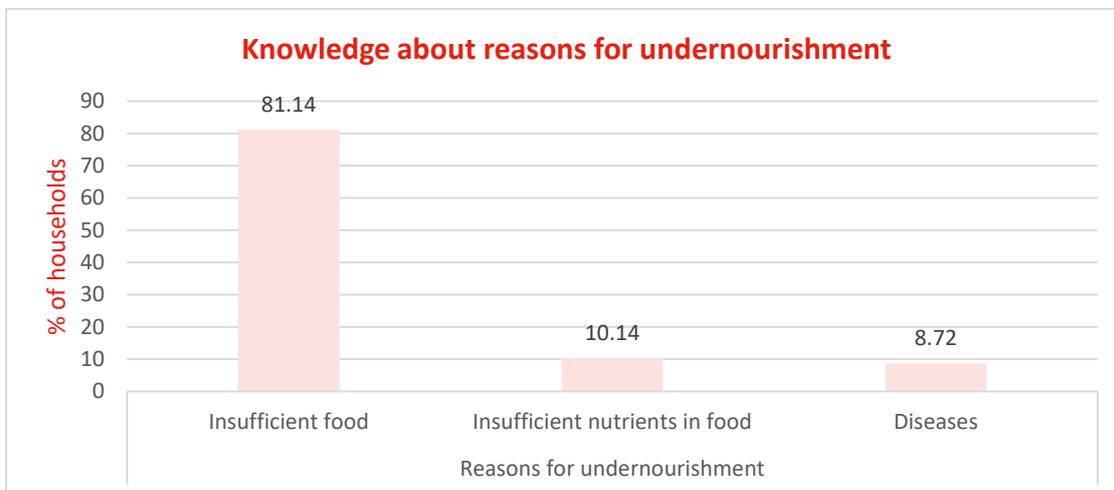


Figure 24: Reasons for undernutrition

More than 50 percent of the households were aware of the three basic food group (Table 25). Baringo (68%) and Isiolo (60%) had the highest proportions of households who knew about the three basic food groups. The most common food group know by more than 60 percent of the household was all energy giving/body building food group while protective foods were the least across the study area.

Table 25: Food types known to care givers

	Baringo	Garissa	Isiolo	Tana River	Overall sample
Whether care giver know the 3 basic food groups (%) Yes	68	32	60	35	53
If none is mentioned (%)	12	6	1	17	8
All energy giving/body building (%)	76	28	70	30	63
Energy giving/body building (%)	4	13	8	23	8
Body building/Protective (%)	3	25	5	10	7
Energy giving/protective (%)	0	6	5	0	3
Energy giving (%)	1	12	3	13	5
Body building (%)	5	6	5	7	5
Protective foods (%)	0	3	2	0	1

With respect to feeding pregnant women, more than 40% of the households across counties indicated that pregnant women should be fed more food (Table 26).

Table 26: Feeding frequency for pregnant women

	Baringo	Garissa	Isiolo	Tana River	Overall sample
Much less (%)	32	14	6	12	17
Somewhat less (%)	10	3	9	3	7
The same (%)	11	25	27	27	22
More (%)	43	48	54	51	49
A lot more (%)	3	10	4	7	5

A few households across the study area reported that men consumed (35%) and discussed OFSP (22%). Isiolo and Tana River counties had the highest proportions of households while Baringo had the least (Figure 25).

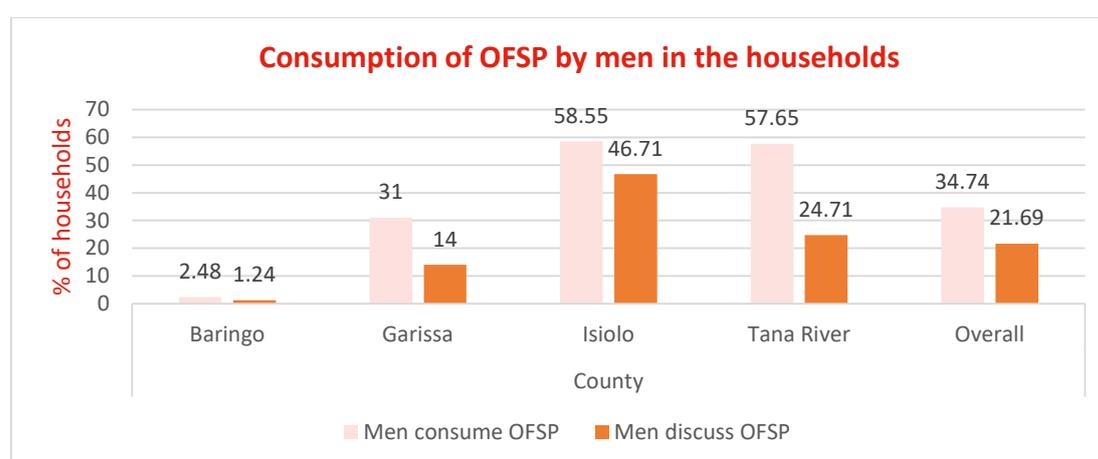


Figure 25: Consumption and discussion of OFSP by men

3.1.6.3 Water, Sanitation & Hygiene (WASH)

Most households (86%) disposed waste for the children under five-years in a latrine (Table 27). A few households threw outside (7%) and buried it under the earth (5%). Majority of the households who disposed of the waste in latrine were from Isiolo and Baringo counties as shown in Table 83.

Regarding disposal of other domestic waste, 36.85% of the households threw outside, 19.19% in a separate open pit, 16.31% in a compost pit and 14.78% in a separate covered pit. Most households across counties threw other domestic waste outside apart from Garissa where it was disposed of in a covered pit. Majority of the households practiced proper hygiene and waste disposal (Table 27). Most households washed hands before food preparation (94%), eating (99%), feeding child (91%), after visiting toilet (97%), after cleaning child waste (94%) and animal waste (85%).

Table 27: Waste disposal and hygienic practices by county

		County				Overall Sample (%)
		Baringo	Garissa	Isiolo	Tana River	
Disposing waste for children under 5 years (%)	Latrine (%)	86.79	85.00	90.79	78.65	86.2
	Just throw outside	5.66	8.00	7.24	8.99	7.20
	Bury under the earth	5.66	6.00	0.66	10.11	5.00
	Burning and covering	0.00	0.00	1.32	1.12	0.6
	Other	1.89	1.00	0.00	1.12	1.00
Disposal of other domestic waste (%)	In a separate pit and keep cover	7.78	20.00	18.42	16.85	14.78
	In a separate pit and do not keep cover	4.44	33.00	27.63	19.10	19.19
	Just throw outside	53.33	25.00	34.21	21.35	36.85
	Keep in compost pit	17.78	11.00	15.79	20.22	16.31
	Others (specify)	16.67	11.00	3.95	22.47	12.86
Washing hands						
Wash hands before preparation of food	Yes (%)	88.52	95.00	99.34	95.51	94.08
Wash hands before eating	Yes (%)	97.81	100.00	99.34	100.00	99.05
Wash hands before feeding child	Yes (%)	83.61	96.00	89.89	89.89	91.03
Wash hands After visiting the toilet	Yes (%)	97.81	98.00	98.03	93.26	97.14
Wash hands After cleaning child's waste	Yes (%)	86.89	99.00	97.37	96.63	93.89
Wash hands after cleaning animal waste	Yes (%)	74.32	91.00	96.05	82.02	85.11

3.2 Traders Survey

3.2.1 Bean traders

3.2.1.1 Bean business and business owner information

A majority (65%) of the bean traders are over 35 years of age and this is replicated across the counties except in Tana River where 53% of the traders were youth. The average age of the traders is 41 years, ranging from a mean of 38 in Tana River to 43 in Garissa. Male traders are significantly more educated than female traders having taken an average of 10 years in school as compared 8 years by the latter ($p=0.0052$). In terms of the level of education, a majority of the bean traders attained either secondary (41%) or primary (31%) level of education. In Baringo 22% of the traders had attained a tertiary level of education while Garissa County had the least educated traders with 48% not having attained any formal level of education. This could be partially explained by the fact that majority of the traders in Garissa are female and are generally less educated than their male counterparts (Table 28).

With regard to traders' experience in bean businesses, the average number of years in bean trade for the traders is nine, ranging from five in Tana River to 11 in Baringo. About 70% of the traders indicated that beans were their primary source of business income. Traders in Isiolo had the highest reliance on beans as a source of business income at 95% while those in Garissa had the least (48%).

Table 28: Socio-economic characteristics of bean traders

	Baringo (N=45)	Garissa (N=46)	Isiolo (N=41)	Tana River (N=32)	Overall sample (N=164)
Sex					
Female	57.8	65.2	92.7	62.5	69.5
Male	42.2	34.8	7.3	37.5	30.5
Age category of traders (%)					
35& below	37.8	28.3	26.8	53.1	35.4
Over 35	62.2	71.7	73.2	46.9	64.6
Age in years (mean)					
Female	42.1	44.2	42.3	38.3	42.1
Male	38.5	40.4	46.7	38.1	39.5
Total	40.6	42.8	42.7	38.2	41.3
Years in school (mean)					
Female	11.1	4.2	7.0	10.4	7.8
Male	11.2	8.1	7.0	11.9	10.1
Total	11.2	5.6	7.0	11.0	8.5
Level of education attained (%)					
None	2.2	47.8	17.1	0.0	18.3
Primary	20.0	17.4	53.7	34.4	30.5
Secondary	55.6	26.1	29.3	56.3	40.9
Tertiary	22.2	8.7	0.0	9.4	10.4
Number of years in bean trade					
Mean (years)	10.6	9.2	9.1	5.2	8.8
Median	7.0	5.0	5.0	5.0	5.0
Location of traders (%)					
Urban	51.1	67.4	80.5	87.5	70.1
Rural	48.9	32.6	19.5	12.5	29.9
Is bean trade primary source of business income? (%)					
% Yes	71.1	47.8	95.1	56.3	67.7

The larger majority of bean traders operate at retail scale with 91% of the businesses being retail businesses; and compared to women traders slightly more men (16%) operate wholesale businesses (Pearson chi2 (2) = 0.032).

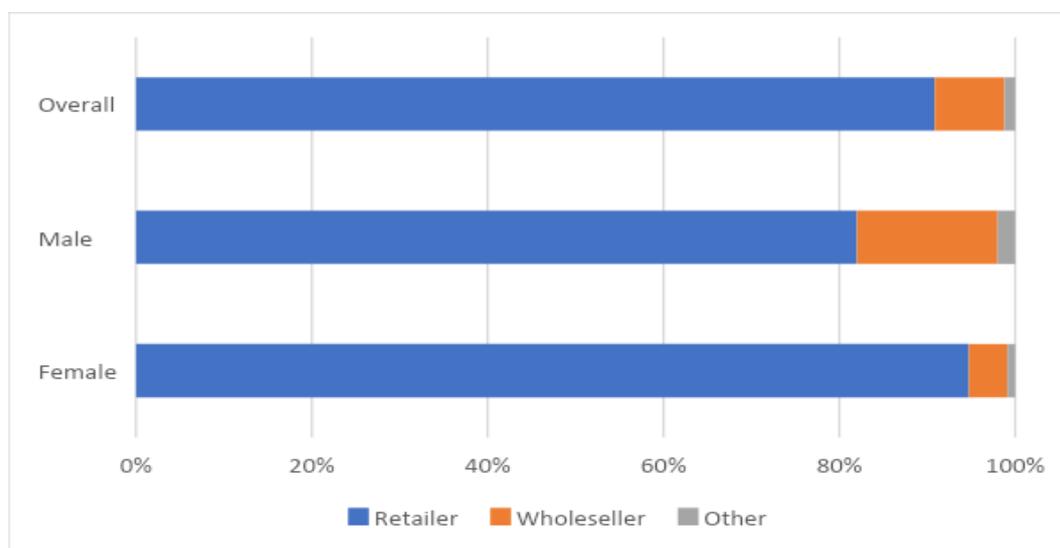


Figure 26: Type of bean trader

3.2.1.2 Market Information and Structure

Only a small minority of about 4 % of the traders have active membership in commodity marketing organizations, all of whom are female (Table 29).

Table 29: Membership of bean traders in commodity marketing organizations

	Female	Male	Total
No	93.86	100	95.73
Yes	6.14	0	4.27

Pearson chi2(1) = 3.2071 Pr = 0.073

Table 30 and 31 show the scale of average daily operation for beans. Overall, the traders sell about 22 kilograms of beans per day, with male traders selling an average 42 kg per day, which is more than three times the average quantity sold by female traders (13 kg per day). This could be associated with the fact that there was a large proportion male trader who trade on wholesale basis than their female counterparts.

Table 30: Average quantity of beans sold per day, by sex of trader

	Obs	Mean	Median	Std. Dev.	p>t
Female	111	12.86	5	22.95	0.0019
Male	49	41.84	10	90.66	
Overall	160	21.73	6	55.00	

Retail traders sold an average of 16 kilograms per day while wholesalers sold 86 kilograms per day.

Table 31: Average quantity of beans sold per day, by type of trader

	Obs	Mean	Median	Std. Dev.	Min	Max
Wholesaler	13	85.8	50	118.5	10	450
Retailer	145	15.9	5	41.9	1	450
Other	2	27.5	27.5	31.8	5	50

The bean traders sold an average of two bean types with the number per trader ranging from one to five. Both male and female traders sold an average of two bean types ($p=0.0677$). (Table 32).

Table 32: Number of varieties of beans sold per trader

	Obs	Mean	Std. Dev.	Min	Max
Female	111	2.2	1.036753	1	5
Male	48	1.9	0.831292	1	4
Overall	159	2.1	0.98714	1	5

About 23% of wholesale traders indicated that they had binding agreements with produce suppliers while only 15% of retailers had such supply agreements (Fig 27). By gender, a slightly higher proportion of male traders (22%) had binding supply agreements compared to women traders (14%).

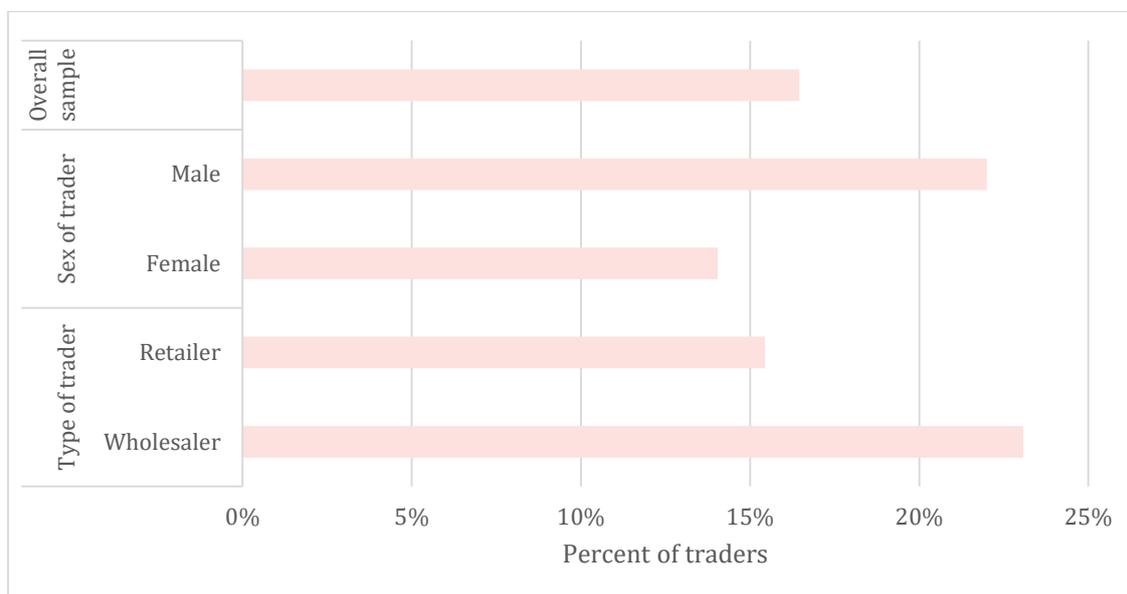


Figure 27: Proportion of bean traders with binding supply agreements

Table 33 shows a summary of the type of suppliers with whom the bean traders had supply agreements. Individual smallholder consumers are the most common accounting for 44% of the traders who had such supply agreements.

Table 33: Type of suppliers with whom bean traders had supply agreements

	Frequency	Percent
Individual smallholder farmers	12	44.44
Group of smallholder farmers	3	11.11
Producer associations	2	7.41
Large-scale farmers	3	11.11
Other	7	25.93

In a majority of the supply agreements (74%), the buyer/trader sets the price (Figure 28).

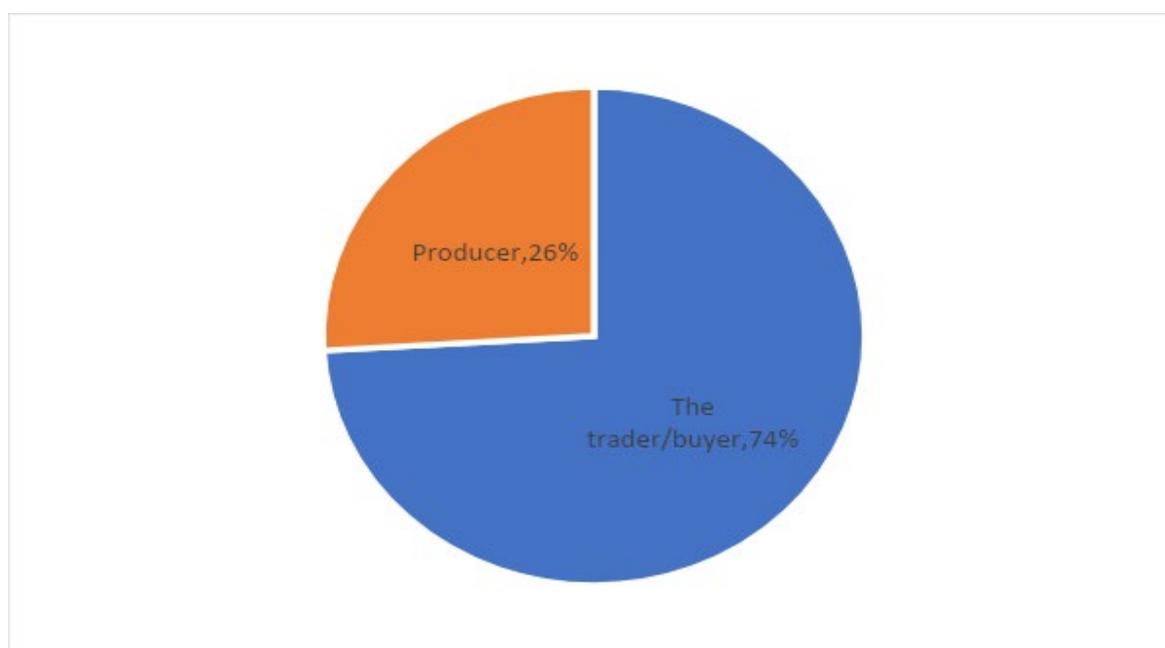


Figure 28: Who sets the price in the supply agreement

On the sale side, 15% of wholesalers had binding agreements with buyers compared to 7% of retailers. Across gender, the difference between men and women traders was minimal with 9% and 10% of female and male traders respectively having sale agreements with buyers of beans (Figure 29).

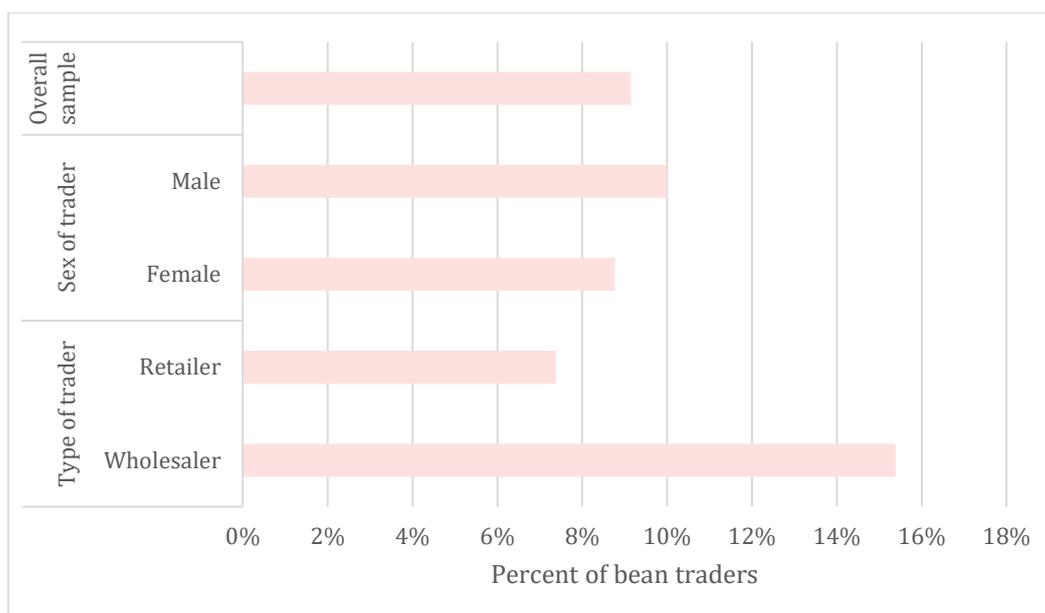


Figure 29: Proportion of bean traders who had binding sale agreements

Table 34 shows the proportion of bean traders using various types of weighing scales. The physical balance is the most commonly used type of scale by 42% of the traders followed by the platform/spring balance (31%). While female traders are inclined towards the physical balance (47%), more male traders used the platform or spring balance (44%) and digital electronic weighing machines (26%).

Table 34: Type of weighing scale used by bean traders

	Female	Male	Overall
	% of traders		
Physical balance	47.4	30.0	42.1
Electronic/digital	21.9	26.0	23.2
Platform/spring balance	24.6	44.0	30.5
No weighing balance	6.1	0.0	4.3

Pearson chi2(3) = 10.1183 Pr = 0.018

The larger majority (96%) of the markets visited are open the whole market day. In Isiolo however, about 10% of the markets are not permanent in the sense that they open for a few hours in a day (Table 35).

Table 35: Market duration

County	Few hours		Whole day	
	Frequency	%	Frequency	%
Baringo	1	2.22	44	97.78
Garissa	2	4.35	44	95.65
Isiolo	4	9.76	37	90.24
Tana River	0	0	32	100
Total	7	4.27	157	95.73

3.2.1.3 Bean Prices

Bean traders were asked to list the different bean types that each had sold within a 12-month period. For each bean type selected they indicated the price at which they bought and sold. Figure 30, and Table 36 present the average bean purchase and selling prices. Yellow bean types were the most expensive type of beans in terms of both buying and selling prices. The prices spiked in the months of February and September possibly due to supply and demand dynamics. Figure 30 shows that the buying and selling prices move together leaving sellers with an almost constant margin throughout the year for both yellow and red mottled beans.

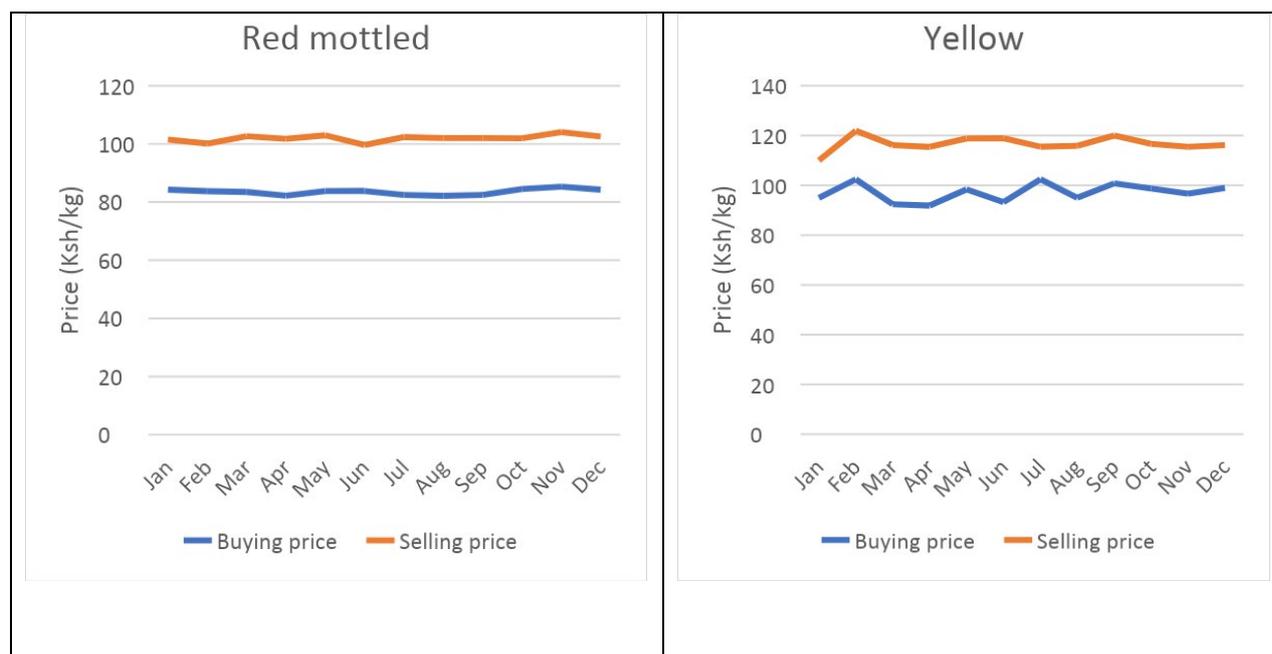


Figure 30: Average buying and selling price trends for main bean types

The annual average buying price of yellow beans ranges from Ksh 84 per kilogram in Isiolo to Ksh 108 in Garissa, while the selling price ranges from 102 in Baringo to Ksh 130 in Tana River with an average of Ksh 117 in the pooled data. Sugar beans had the highest margins of Ksh 24/kg, buying and selling at Ksh 87 and 101 respectively, while Pinto beans had the lowest margin of Ksh 14. Generally, Isiolo has the lowest prices compared to other counties.

Table 36: Average bean purchase and selling prices (Ksh/kg) by county

	Baringo		Garissa		Isiolo		Tana River		Overall	
	Buy	Sell	Buy	Sell	Buy	Sell	Buy	Sell	Buy	Sell
Red mottled	74	95	91	109	76	92	84	102	84	102
White	80	120			65	79			65	80
Red kidney	85	122	92	108	72	88	75	100	81	101
Small red	76	101			80	101	70	100	79	101
Yellow	87	102	108	127	84	109	103	130	97	117
Pinto	93	126	100	150	77	91	97	111	87	101
White speckled/sugar	85	109			80	104	70	100	81	105

Women bought and sold red mottled bean types at significantly higher prices than men traders. Men on the other hand received higher prices for red kidney, yellow and pinto beans (Table 37).

Table 37: Average bean purchase and selling prices (Ksh/kg) by sex of trader

	Buying prices			Buying prices		
	Female	Male	p>t	Female	Male	p>t
Red mottled	86	80	0.0000	104	98	0.0000
White	65	75	0.1983	79	120	
Red kidney	75	90	0.0219	97	108	0.0488
Small red	79	76	0.6091	102	95	0.0925
Yellow	97	99	0.3233	115	123	0.0139
Pinto	85	98	0.0016	98	118	0.0001
Sugar	80	81	0.6614	101	111	0.0083

Table 38 shows the average prices at which traders sold beans designated for use as seed against grain prices. The prices for seed are generally higher compared to the prices for grain owing to the work that goes into sorting, grading and keeping the seed separate from mixing with other varieties/grains. The yellow beans have the highest seed prices at Ksh 133 per kg and are followed by white, and pinto beans. Bean seed prices were reported by 48% of the traders indicating that almost half of the bean traders sold some beans for use as seed.

Table 38: Comparison between selling prices for grain and seed

	Mean price (Ksh/kg)		
	Grain	Seed	p>t
Red mottled	102	111	0.0001
White	80	130	0.0000
Red kidney	101	114	0.0373
Small red	101	106	0.1874
Yellow	117	133	0.0000
Pinto	101	124	0.0012
White speckled/sugar	105	95	0.1470

3.2.1.4 Bean Business Performance and Risks

The red mottled bean types were the most preferred by consumers with 68% of traders indicating them to be the most demanded type. This is followed by yellow beans at 15% and pinto beans at 7% (Table 39).

Table 39: Most preferred bean type by consumers

	Baringo	Garissa	Isiolo	Tana River	Overall
	% of traders				
Red mottled	91.1	95.7	26.8	50.0	68.3
Yellow	8.9	2.2	17.1	37.5	14.6
Pinto	0.0	0.0	19.5	9.4	6.7
White	0.0	0.0	12.2	0.0	3.1
Small red	0.0	0.0	9.8	0.0	2.4
White speckled/sugar	0.0	0.0	7.3	0.0	1.8
Red kidney	0.0	2.2	0.0	3.1	1.2
No response	0.0	0.0	7.3	0.0	1.8

According to 50% of the male respondents, the demand for high iron beans has increased over the past 2 years (Table 40). This is in comparison to 33% of female traders who indicated such an increase. The perceived change in demand for other beans was not statistically different between male and female traders. By county however, traders in Baringo had the highest incidence of increase in demand for both high iron beans and other beans (56%), followed by Isiolo (46%).

Table 40: Traders’ perception on whether demand for HIB and other beans has increased in the past 2 years

	High iron beans		Other beans	
	% yes	chi	% yes	chi
Sex of trader				
Female	33.33	4.0809**	35.09	0.711
Male	50		42	
County				
Baringo	55.56	15.4922***	55.56	17.9576***
Garissa	17.39		15.22	
Isiolo	46.34		46.34	
Tana River	34.38		31.25	
Overall	38.41		37.2	

3.2.1.5 Bean Supply and Sales

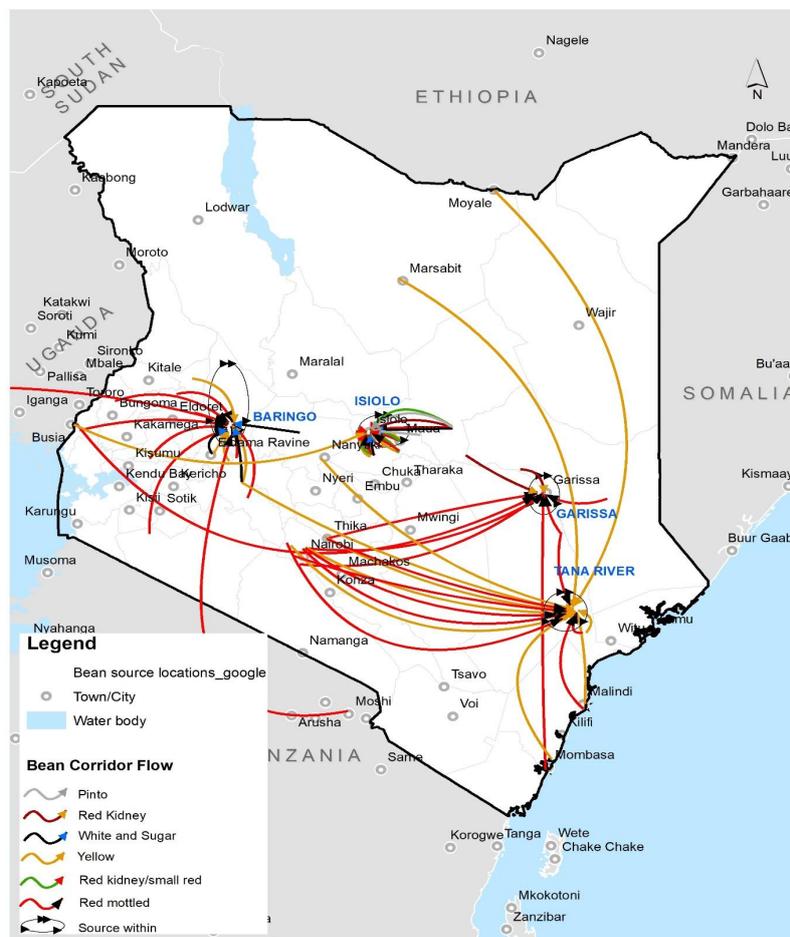


Figure 31: Map of bean source locations

Figure 31 is a map of the source locations of beans sold in the surveyed counties. Most of the beans sold in Isiolo² were sourced from relatively closer locations within the county (Garbatula) and from neighboring counties of the larger Meru area including Maua, Tigania and Imenti, which are major bean production hubs in Kenya. In Baringo beans were sourced further afield with incidences of imports of red-mottled beans from Uganda and Tanzania and others from the production hubs of Western Kenya. Beans sold in Garissa and Tana River are mostly sourced from Nairobi area and the coastal towns of Mombasa, Kilifi and Malindi, an indication that they could have originated from other production hubs within the country and beyond. Nairobi and Mombasa double as a major bean distribution and consumption hubs. The main mode of transport used to supply beans to traders is large trucks/lorries for most of the counties except Isiolo where the beans is ferried mostly on motorcycles (Figure 32). This could be an indication that in Baringo, Isiolo and Tana River the beans are sourced from far flung areas and transported to the markets in bulk.

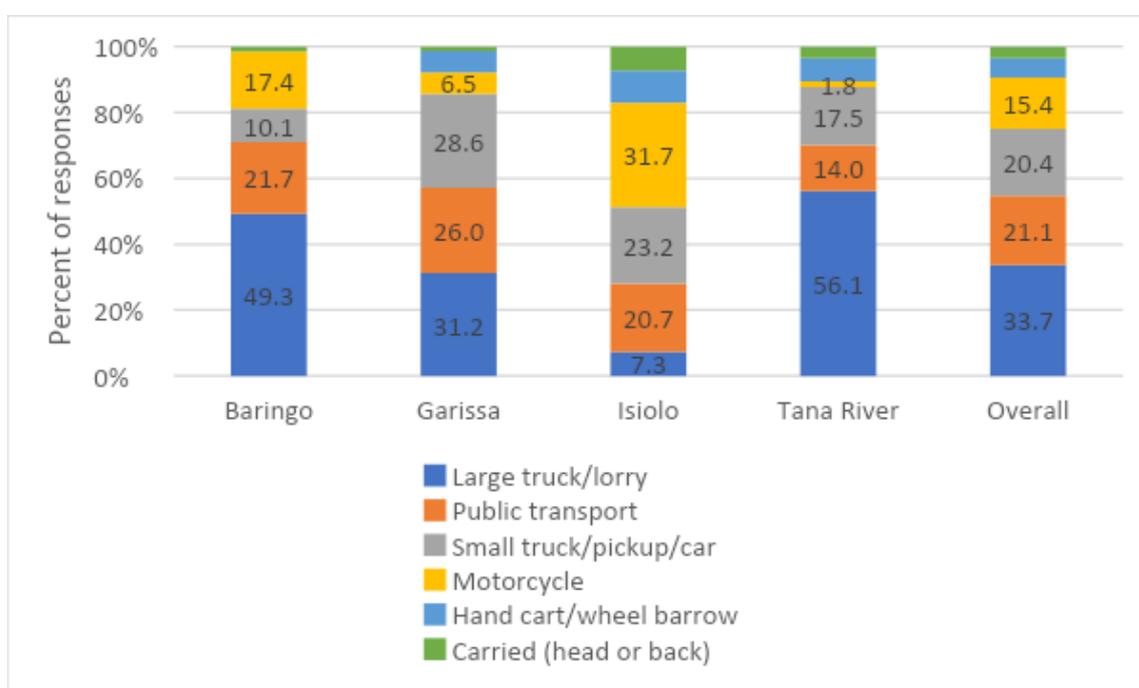


Figure 32: Main mode of transport used to supply beans

Tables 41 - 44 show the average volumes of beans sold over a four-month period between July and October 2020 and the associated value/revenue earned. Over the period, each trader sold an average of 1.56 tonnes of red mottled beans and 1.68 tonnes of red kidney beans. These were followed by yellow beans with an average of 0.84 tonnes per trader. Traders in Baringo and Tana River sold higher volumes on average compared to those in Garissa and Isiolo.

² See appendix 1 for a zoomed in map of the source locations of beans sold in Isiolo County

Table 41: Quantity of beans sold (mean kg) July- October 2020, by county

	Baringo			Garissa			Isiolo			Tana River			Overall		
	N	Mean kg	Total kg	N	Mean kg	Total kg	n	Mean kg	Total kg	n	Mean kg	Total kg	n	Mean kg	Total kg
Red mottled	42	2051	86157	23	1067	24545	11	254	2790	12	1998	23980	88	1562	137472
White							1	100	100			0	1	100	100
Red kidney	2	1255	2510	2	425	850	2	15	30	5	3025	15125	11	1683	18515
Small red	5	1336	6680				10	294	2940			0	15	641	9620
Yellow	10	1411	14110	12	760	9115	14	154	2150	12	1263	15159	48	844	40534
Pinto	1	1500	1500				11	203	2233	9	597	5370	21	433	9103
White speckled/sugar	1	1000	1000				2	108	215			0	3	405	1215
Total	61		111957	37		34510	51		10458	38		59634	187		216559

Despite women traders having almost double the number of transactions as the male traders, the total volume of beans sold by women traders (118 MT) is quite close to that sold by men traders (99 MT). This is in line with the larger size of transactions by male traders and the fact that some sell on wholesale basis while none of the women traders sell at wholesale. Women traders dominate in the sale of red kidney, small reds and yellow beans while men moved higher volumes of red mottled beans (Table 42).

Table 42: Quantity of beans sold (mean kg) July- October 2020, by sex of trader

Bean type	Female			Male			Overall sample		
	N	Mean kg	Total kg	N	Mean kg	Total kg	N	Mean kg	Total kg
Red mottled	51	1,250	63,727	37	1,993	73,745	88	1,562	137,472
White	1	100	100			-	1	100	100
Red kidney	6	2,515	15,090	5	685	3,425	11	1,683	18,515
Small red	12	629	7,550	3	690	2,070	15	641	9,620
Yellow	34	786	26,714	14	987	13,820	48	844	40,534
Pinto	16	287	4,593	5	902	4,510	21	433	9,103
White speckled/sugar	2	108	215	1	1,000	1,000	3	405	1,215
Total	122		117,989	65		98,570	187		216,559

The amount of revenue realized from the sale of beans between July and October 2020 follows closely the quantities of beans sold as presented in Table 43 and Table 44. Red kidney beans had the highest average revenue of Ksh 1745,64 per trader followed by red mottled and yellow beans whose values were 155,852 and 101577 respectively. Women traders moved a total value of USD 116, 425 while men sold beans worth USD 95,367.

Table 43: Value of beans traded (mean Ksh) July – October 2020, by county

Bean type	Baringo			Garissa			Isiolo			Tana river			Overall		
	N	Mean Ksh	Total Ksh	N	Mean Ksh	Total Ksh	N	Mean Ksh	Total Ksh	N	Mean Ksh	Total Ksh	N	Mean Ksh	Total Ksh
Red mottled	42	197,695	8,303,169	23	113,870	2,619,001	11	25,000	275,000	12	209,817	2,517,800	88	155,852	13,714,967
White			-			-	1	6,000	6,000			-	1	6,000	6,000
Red kidney	2	150,600	301,200	2	50,500	101,000	2	1,500	3,000	5	303,000	1,515,000	11	174,564	1,920,200
Small red	5	140,160	700,800			-	10	26,190	261,900			-	15	64,180	962,700
Yellow	10	153,310	1,533,100	12	100,717	1,208,600	14	18,804	263,250	12	155,895	1,870,740	48	101,577	4,875,691
Pinto	1	225,000	225,000			-	11	17,564	193,200	9	70,956	638,600	21	50,324	1,056,800
White speckled/sugar	1	100,000	100,000			-	2	12,675	25,350			-	3	41,783	125,350
Total value (USD)			104,330			36,716			9,605			61,141			211,792

Table 44: Value of beans traded (mean Ksh) July – October 2020, by county

Bean type	Female			Male		
	N	Mean Ksh	Total Ksh	N	Mean Ksh	Total Ksh
Red mottled	51	127,570	6,506,070	37	194,835	7,208,899
White	1	6,000	6,000			-
Red kidney	6	251,700	1,510,200	5	82,000	410,000
Small red	12	60,350	724,200	3	79,500	238,500
Yellow	34	93,481	3,178,340	14	121,239	1,697,350
Pinto	16	31,706	507,300	5	109,900	549,500
White speckled/sugar	2	12,675	25,350	1	100,000	100,000
Total value (USD)			116,425			95,367

On average female traders have a higher customer base compared to male traders. This is in concurrence with the fact that male traders generally operated at a larger scale with fewer but bigger transactions compared to female traders. Female traders reported having an average of 10 men customers and 22 women customers over the four-month period between July and October 2020, while male traders had an average of 8 and 15 men and women customers respectively. It's also worth noting that generally there are more women bean customers (19) than men (9) as reported by the traders (Table 45).

Table 45: Average customer base July - October 2020

Gender of trader	Gender of customer		Total
	Men	Women	
Female	10	22	31
Male	8	15	22
Overall	9	19	27

3.2.1.6 Costs, risks and losses in bean business

To run the bean business, a majority (80%) of the traders incurred transportation costs. Other costs incurred include market entry fees especially by female traders (38%), storage (33% of female traders) and loading/offloading (33% of male traders).

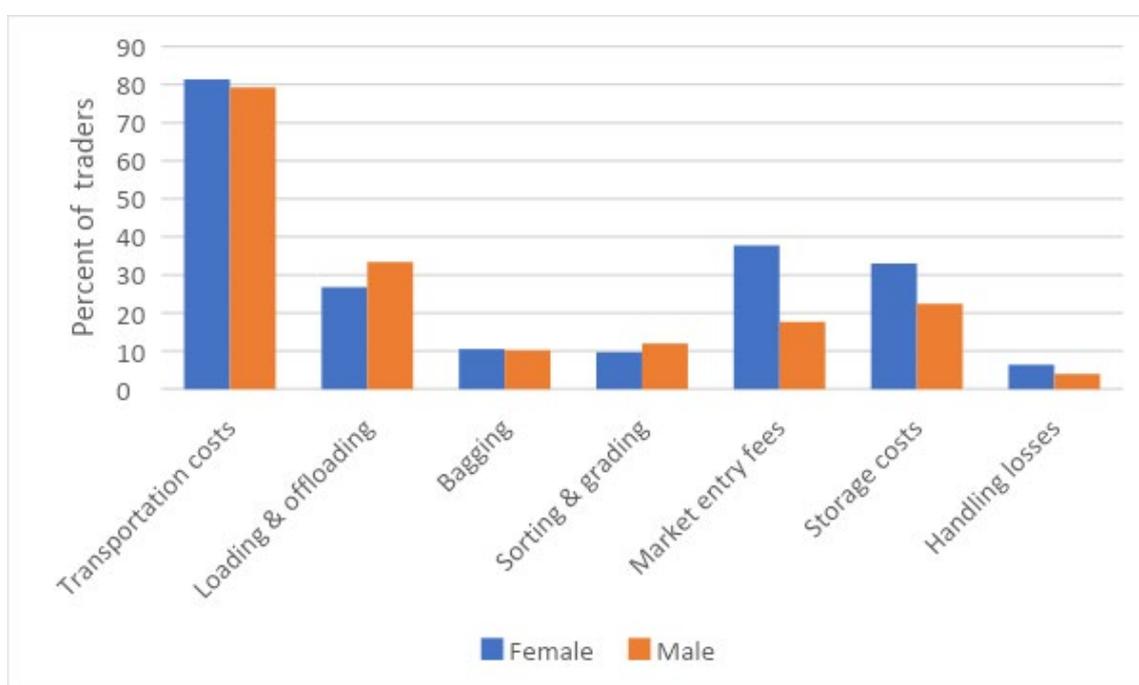


Figure 33: Proportion of bean traders that incurred various types of costs

Transportation cost is the single most costly expense overall. It is closely followed by storage and handling losses (Table 46). By gender however, male traders incur almost double the amount (Ksh 4056) in transport costs as the female traders incur (Ksh 2092). This could be related to the scale of operation where more male traders operate wholesale business compared to women traders. Male traders also spend more on storage costs (Ksh 3059) than female traders (Ksh 2197).

Table 46: Average amount of costs incurred (Ksh)

	Female		Male		Overall Sample	
	N	Mean Ksh	N	Mean Ksh	N	Mean Ksh
Transportation costs	94	2092	42	4056	136	2698
Loading and offloading	29	782	16	1369	45	990
Bagging	11	1677	2	1000	13	1573
Sorting and grading	9	597	6	532	15	571
Market entry fees	43	531	9	606	52	544
Storage costs	39	2197	11	3059	50	2386
Handling losses	7	2064	2	2025	9	2056

Losses in business contribute to a lower profitability. In the bean business, more female traders reported to have incurred different types of business losses compared to male traders, with the exception of transportation losses. For instance, 19% of female traders incurred marketing losses while only 10% of male traders incurred this type of loss. Storage losses follow a similar trend (Figure 34).

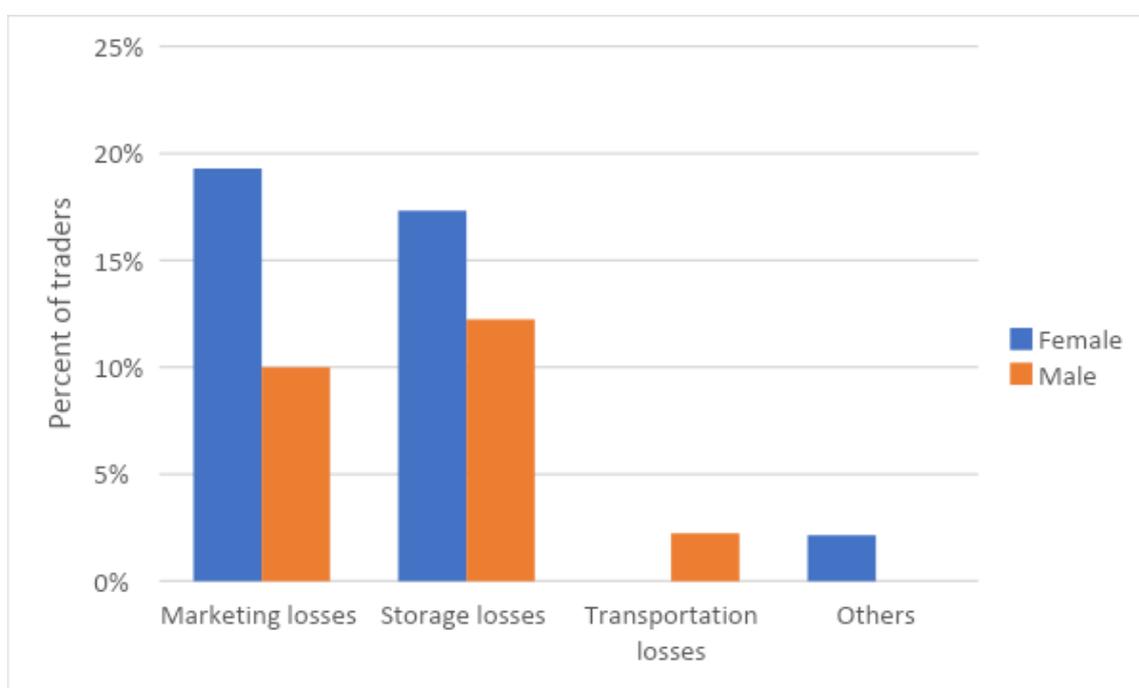


Figure 34: Proportion of bean traders incurring various types of business losses

In terms of the severity of the losses incurred, most bean traders rated the losses in the low (46%) and medium (44%) categories (Figure 35).

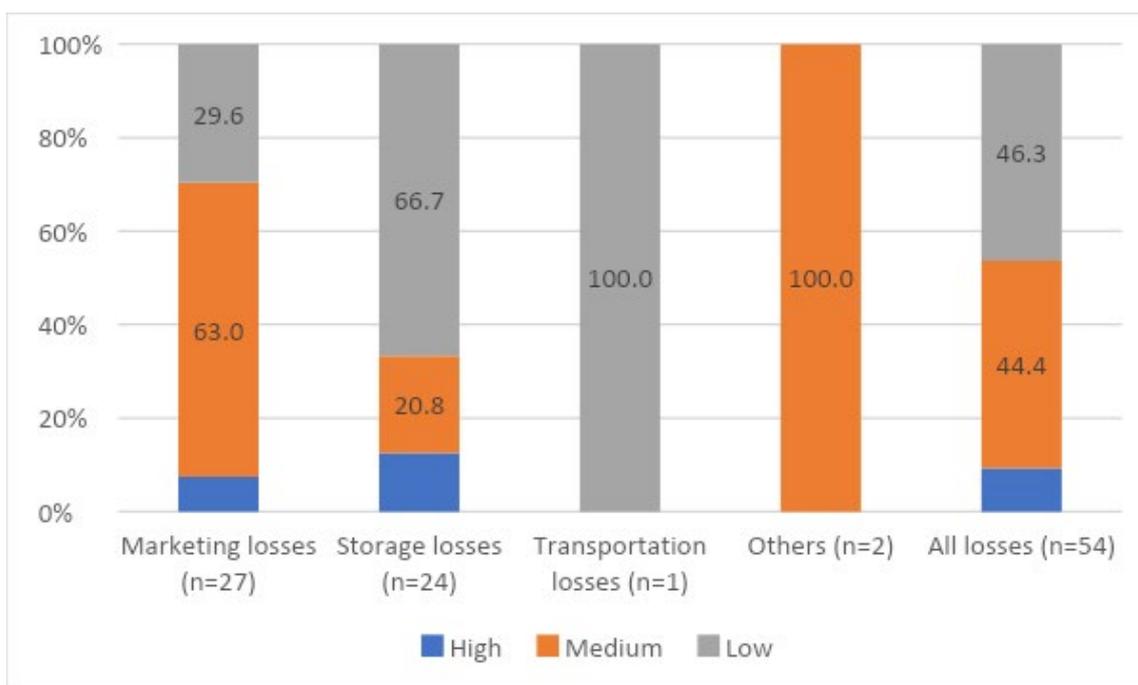


Figure 35: Severity of losses incurred in bean business

Among the traders that reported having incurred marketing losses, the amount of loss was estimated at 14% of the stock. Similarly, 10% of the stock was lost during transportation and 8% during storage (Table 47). Given the sale margins which average 24%, these losses present a huge effect on the profitability of the affected bean enterprises. When extrapolated to the whole sample, however, the average proportions of volume lost to marketing is 2.3%, storage losses 1.2% while transportation and others are both less than 0.1 percentage points.

Table 47: Percentage of bean stock lost

Type of losses	N	Mean %
Marketing losses	27	13.78
Storage losses	24	7.93
Transportation losses	1	10.00
Others	2	5.50

3.2.1.7 Bean business capacity

Data shows that none of the bean traders has received training on biofortified crops and only 1% (2 out of 164) bean traders reported to have received information on high iron beans. This presents an opportunity for capacity building on the benefits and opportunities of high iron beans to both the traders and consumers.

3.2.1.8 Bean seed buying signals and management practices

Bean traders were asked to indicate how they manage bean grain for purposes of selling it as seed and how they know when a buyer is intending to buy beans for use as seed. Figure 36 shows the proportion (%) of traders using various seed management practices while Figure 37 shows the percent of yes responses to each of the seed buying signals.

According to Figure 36 the most commonly used seed management practice is keeping freshly harvested stock separately. This is employed by 47% of female the traders. Keeping each variety separately/pure and sorting out waste and bad grain are the other commonly used practices. Traders also differentiate bean for seed from that for consumption by price differentiation, which could be a result of the sorting, grading and cleaning. Overall, more women appear to apply the various seed management practices compared to men.

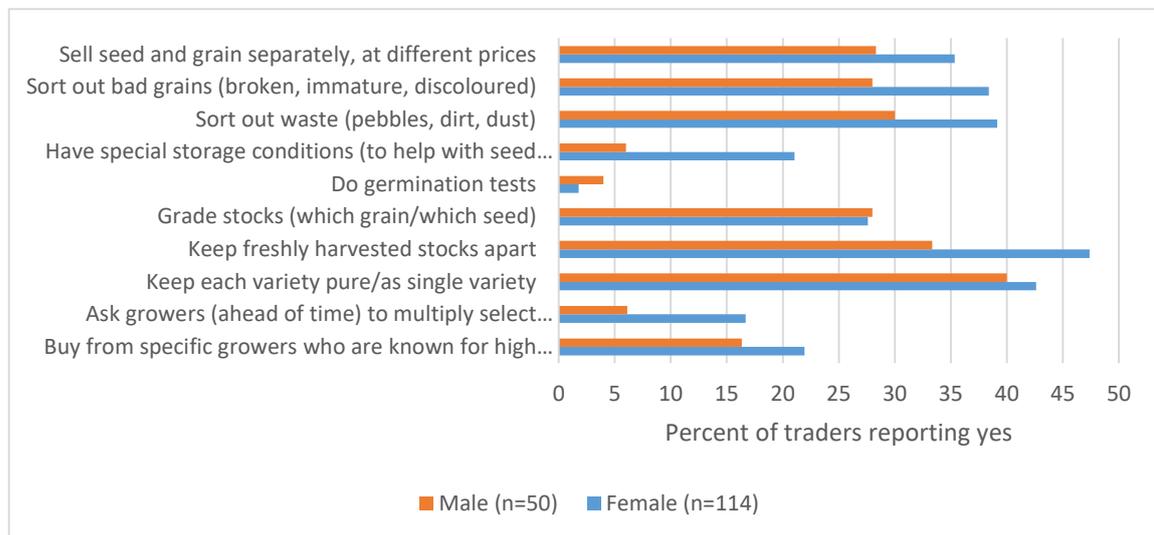


Figure 36: Seed management practices

With regard to bean seed buying signals by bean customers, the most common signal that indicates to a trader that the buyer is seeking to buy beans for planting is when they seek out specific varieties by name which are suitable for planting (55%). Other buyers explicitly say that they want to buy seed (53%) while others ask for a particular quantity (50%). Generally, for most of the signals there was a higher proportion of female traders who indicated that they apply to their bean buyers than male traders (Figure 37).

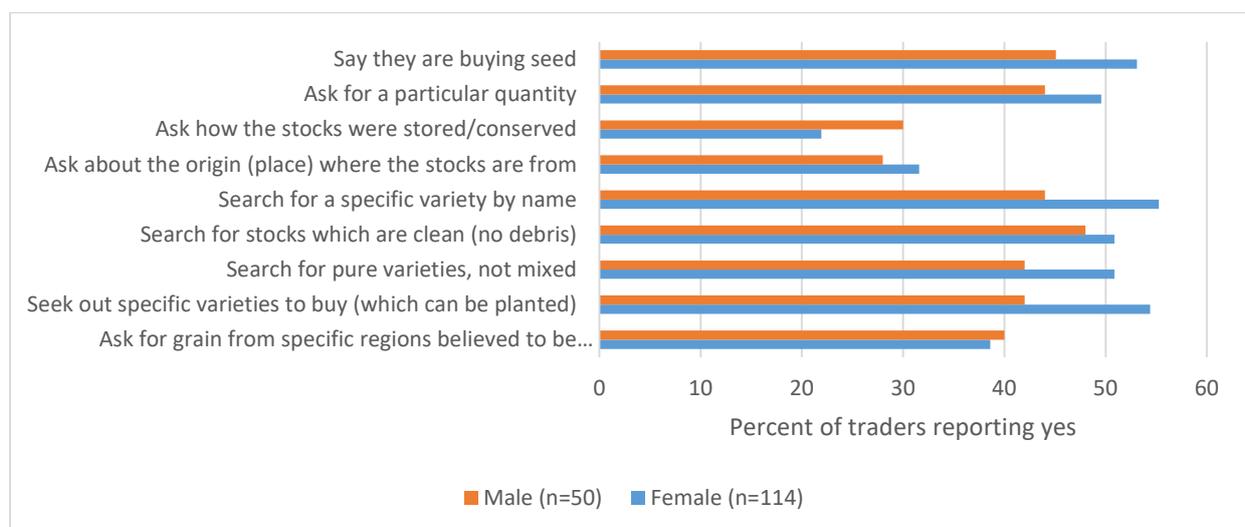


Figure 37: Bean seed buying signals

3.2.2 Sweetpotato traders

3.2.2.1 Sweetpotato business and business owner information

Table 48 summarizes the socio-economic characteristics of the sweetpotato traders. A majority fall in the over 35 category with a mean age of 43 years. The male traders are slightly more educated with 12 years of schooling compared to females (8 years) and 9 years overall. This translates to 53% of traders having attained secondary level of education. Only Baringo County had some sweetpotato traders with a tertiary level of education (14%). The average duration of experience in sweetpotato trade is 7 years and 57% of the traders indicated it to be their primary source of business income. The majority of the traders (78%) are located in urban markets.

Table 48: Socio-economic characteristics of sweetpotato traders

	Baringo	Garissa	Isiolo	Tana River	Overall sample
Sex (%)					
Female	57.1	62.5	75.0	63.6	65.3
Male	42.9	37.5	25.0	36.4	34.7
Age category of traders (%)					
35& below	14.3	50.0	16.7	27.3	26.5
Over 35	85.7	50.0	83.3	72.7	73.5
Age in years (mean)					
Female	48.5	39.8	46.0	42.4	43.8
Male	44.3	35.3	38.7	44.0	41.6
Total	46.7	38.1	44.2	43.0	43.0
Years in school (mean)					
Female	6.8	7.2	6.2	10.0	8.1
Male	12.3	10.7	12.0	11.5	11.6
Total	9.1	8.5	7.7	10.5	9.3
Level of education attained (%)					
None	14.3	25.0	8.3	0.0	8.2
Primary	28.6	12.5	58.3	36.4	36.7
Secondary	42.9	62.5	33.3	63.6	53.1
Tertiary	14.3	0.0	0.0	0.0	2.0
Number of years in sweetpotato trade					
Mean (years)	6.4	5.6	7.0	6.8	6.6
Median	4.0	3.5	5.5	5.5	5.0
Location of traders (%)					
Urban	57.1	100.0	50.0	90.9	77.6
Rural	42.9	0.0	50.0	9.1	22.5
Is sweet potato trade primary source of business income? (%)					
% Yes	57.1	50.0	83.3	45.5	57.1

A vast majority (94%) of the sweetpotato traders operate retail businesses and this equally so for both male and female traders.

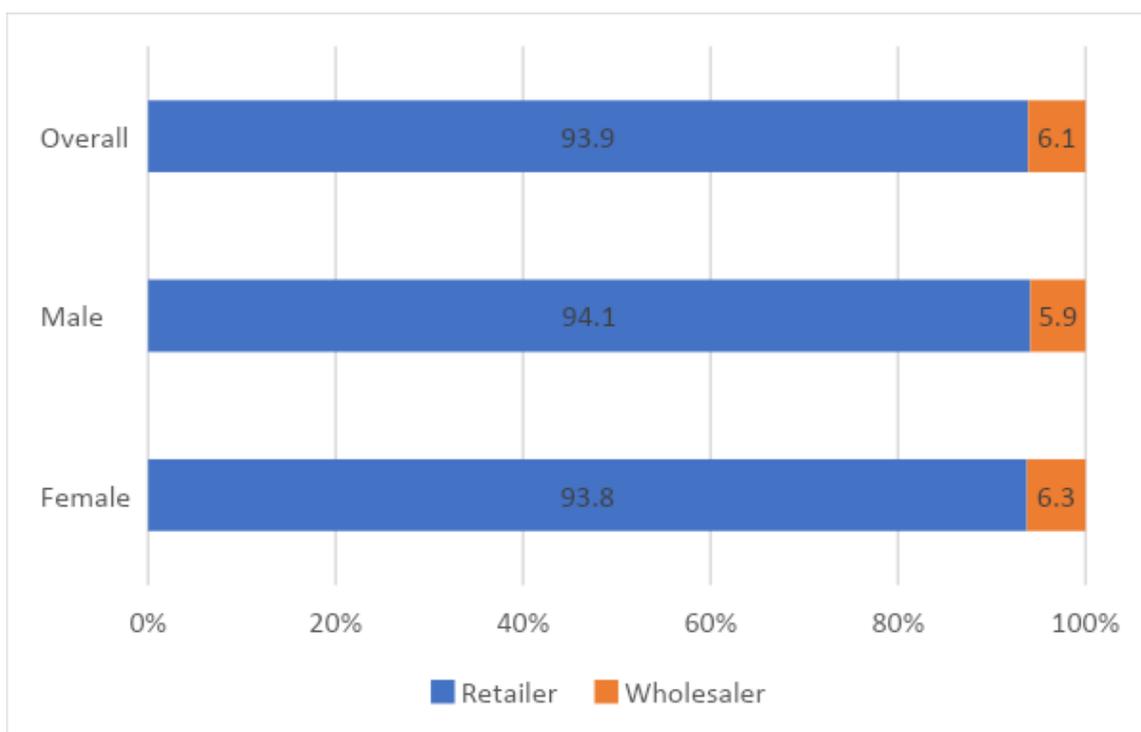


Figure 38:Type of sweetpotato trader

3.2.2.2 Sweetpotato market information and structure

Membership in commodity marketing organizations presents an opportunity for getting market information and linkages with buyers. Close to 24% of the male sweetpotato traders were members of commodity marketing organizations against a paltry 6% of the female traders (Table 49).

Table 49: Membership of sweetpotato traders in commodity marketing organizations

	Female	Male	Total
No	93.75	76.47	87.76
Yes	6.25	23.53	12.24

Pearson chi2(1) = 3.0848 Pr = 0.079

The average scale of daily operation was estimated at 19 kilograms per day and there were no major differences across gender (Table 50).

Table 50: Average quantity (KGs) of sweetpotato sold per day

Gender of trader	N	Mean	Median	Std. Dev.	p>t
Female	30	17.4	10	22.04491	0.5764
Male	17	21.4	15	24.93963	
Overall	47	18.9	10	22.94339	

Over the 12- month period female sweetpotato traders sold between one and three varieties/types of sweetpotatoes (Table 51). For the male traders the range is one to two varieties. Most of the traders however sold only one variety/type (mean = 1.3).

Table 51: Number of sweetpotato varieties sold per trader

Gender of trader	Obs	Mean	Std. Dev.	Min	Max
Female	32	1.3	0.581121	1	3
Male	17	1.4	0.4925922	1	2
Overall	49	1.3	0.5478778	1	3

Pre-arranged binding supply agreements help traders to be assured of supply of market demanded produce at the right quantities and time. Producers on the other benefit from having an assured market at a pre-determined price. Among the wholesale traders 33% had binding supply agreements while among the retailer 26% had such agreements. Across gender more than double the proportion of male traders (41%) had supply agreements compared to 19% of female sweetpotato traders (Figure 39).



Figure 39: Proportion of sweetpotato traders with binding supply agreements

The supply agreements were mostly held with individual smallholder farmers (69%) and large-scale farmers (15%).

Table 52: Type of suppliers with whom sweetpotato traders had supply agreements

Type of supplier	Frequency	Percent
Individual smallholder farmers	9	69.23
Group of smallholder farmers	1	7.69
Large-scale farmers	2	15.38
Other	1	7.69

In a majority of the cases (69%) traders/buyers of produce set the price in the agreement. All the purchase agreements for sweetpotatoes were in the form of oral contracts (Figure 40).

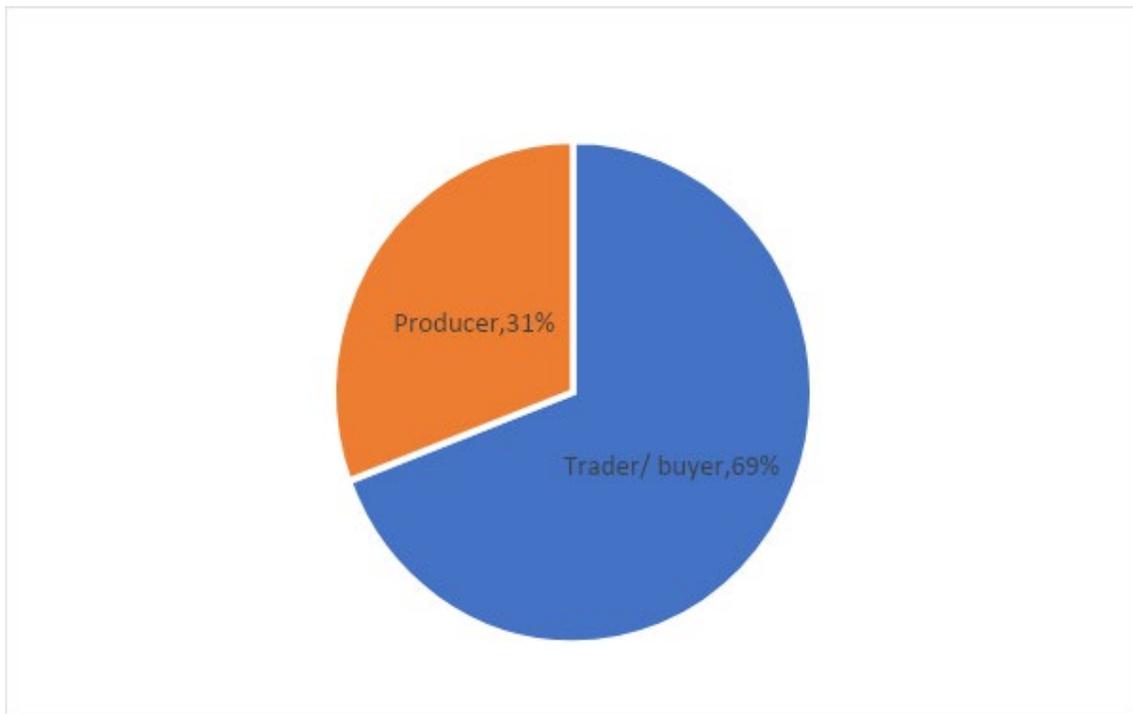


Figure 40: Who sets the price in the supply agreements

A small number (3 out of 49) of sweetpotato traders, all of which were retailers, had binding sale agreements with buyers. Similar to the case of purchase agreements, a higher proportion of male traders had such agreements (12%) compared to female traders (3%).

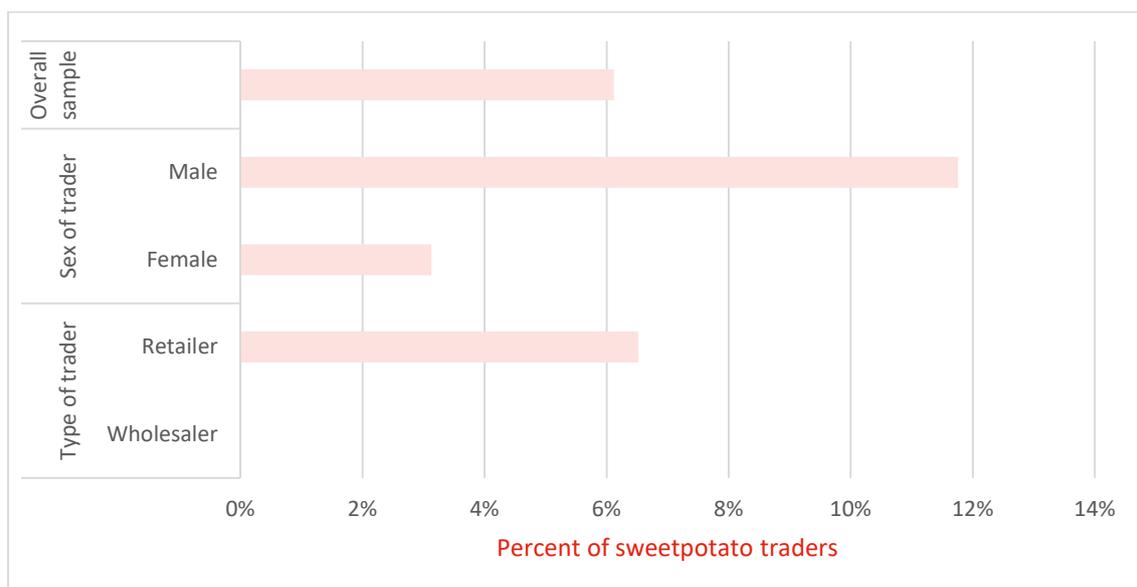


Figure 41: Proportion of sweet potato traders with binding sale agreements

Overall, 33% of sweet potato traders used electronic/ digital scales while 25% did not use any type of weighing machine (Table 53).

Table 53: Type of weighing scale used by sweet potato traders

	Female (N=32)	Male (N=17)	Overall (N=49)
	% of traders		
Physical balance	18.8	23.5	20.4
Electronic/digital	31.3	35.3	32.7
Platform/spring balance	21.9	23.5	22.5
No weighing balance	28.1	17.7	24.5

A vast majority (94%) of the sweetpotato traders are located in markets that operate on a whole day basis. This is replicated across all the counties with Baringo and Garissa markets being 100 percent whole day.

Table 54: Sweetpotato market duration

	Few hours		Whole day	
	Frequency	%	Frequency	%
Baringo	0.0	0.0	7.0	100.0
Garissa	0.0	0.0	8.0	100.0
Isiolo	1.0	8.3	11.0	91.7
Tana River	2.0	9.1	20.0	90.9
Total	3.0	6.1	46.0	93.9

3.2.2.3 Sweetpotato prices

Sweetpotato traders were asked to list the types of sweet potatoes they traded in over a 12-month period. For each of the types selected they were to indicate the buying and selling prices for each month in which it was traded. Figure 16 shows the monthly buying and selling price trends for the commonly traded types³ of sweetpotatoes in our sample namely; yellow fleshed, white fleshed and orange-fleshed sweetpotatoes. The selling price of white fleshed sweetpotatoes, which is the costliest of the three, ranged from Ksh 96 to Ksh 122 per kilogram with the lowest price recorded in the months of April and November while the highest was in February. The prices for yellow fleshed sweetpotatoes were generally higher than those of orange-fleshed sweetpotatoes in the early months of the year (January to April for buying prices) after which there was a switch. The price switch occurred in August for selling prices. This could be as result of demand and supply or other market dynamics.

³ Very few observations of purple fleshed sweet potatoes were recorded in 2 counties and in only 3 out of 12 months.

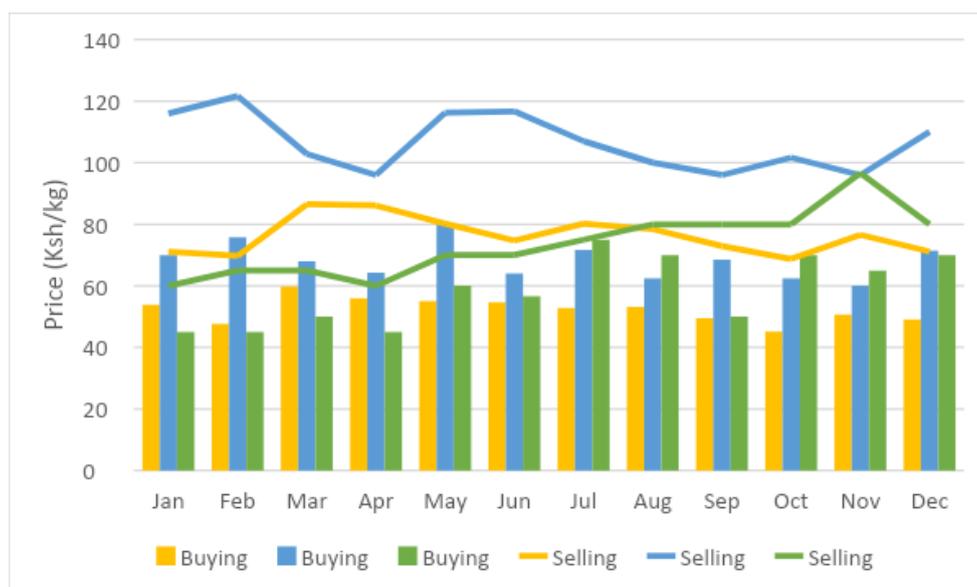


Figure 42: Average buying and selling price trends for sweetpotatoes

Purple fleshed sweetpotatoes (sold on a few occasions in Isiolo and Tana River counties and) were the more costly in terms of both buying and selling prices with an average annual buying price of Ksh 75 and selling price of Ksh 143 per kilogram. White fleshed sweetpotatoes come second in terms of cost with an annual average price of Ksh 69 buying and Ksh 107/kg selling. The prices of yellow fleshed and orange-fleshed sweetpotatoes overlap with the latter having the lowest margins between Ksh 59 – 73 per kilogram.

Table 55: Average sweetpotato purchase and selling prices (Ksh/kg) by county

	Baringo		Garissa		Isiolo		Tana River		Overall	
	Buy	Sell	Buy	Sell	Buy	Sell	Buy	Sell	Buy	Sell
Yellow-Fleshed SP (YFSP)	42	68	54	67	49	82	55	85	53	77
White-Fleshed SP (WFSP)	69	107			67	107	90	110	69	107
Orange-Fleshed SP (OFSP)			100	120	63	79	40	54	59	73
Purple-Fleshed SP (PFSP)					73	150	80	120	75	143

3.2.2.4 Sweetpotato business performance and risks

About half of the traders experienced shortages in sweetpotato supply during the year (Figure 43).

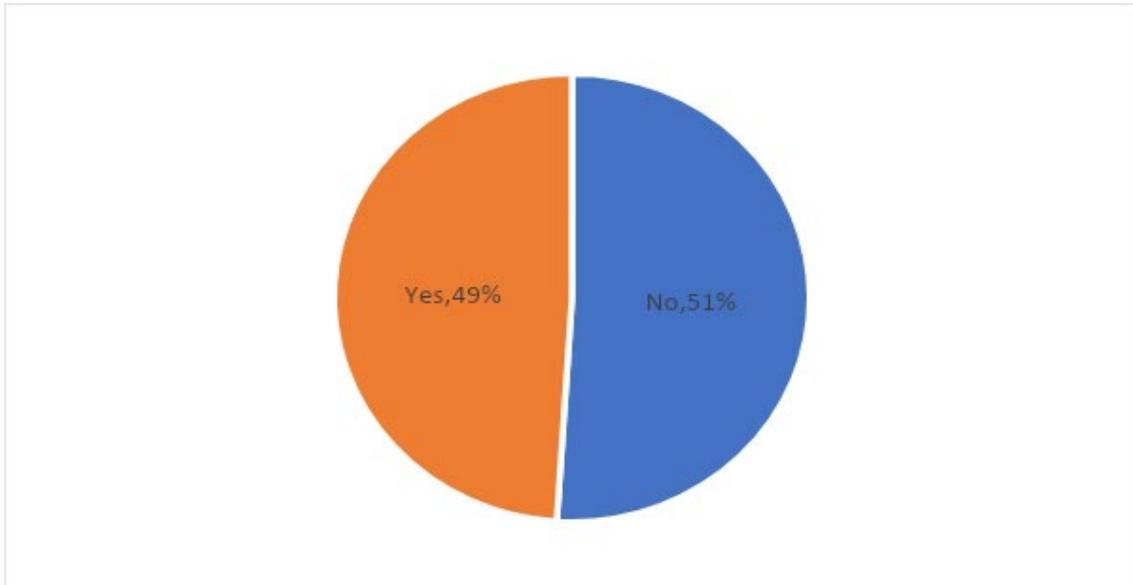


Figure 43: Proportion of sweetpotato traders who experienced supply shortages

The main reason for the shortages was lack of sufficient supply of sweetpotatoes and breakdown in supply lines probably resulting from disruptions associated with the Covid-19 pandemic.

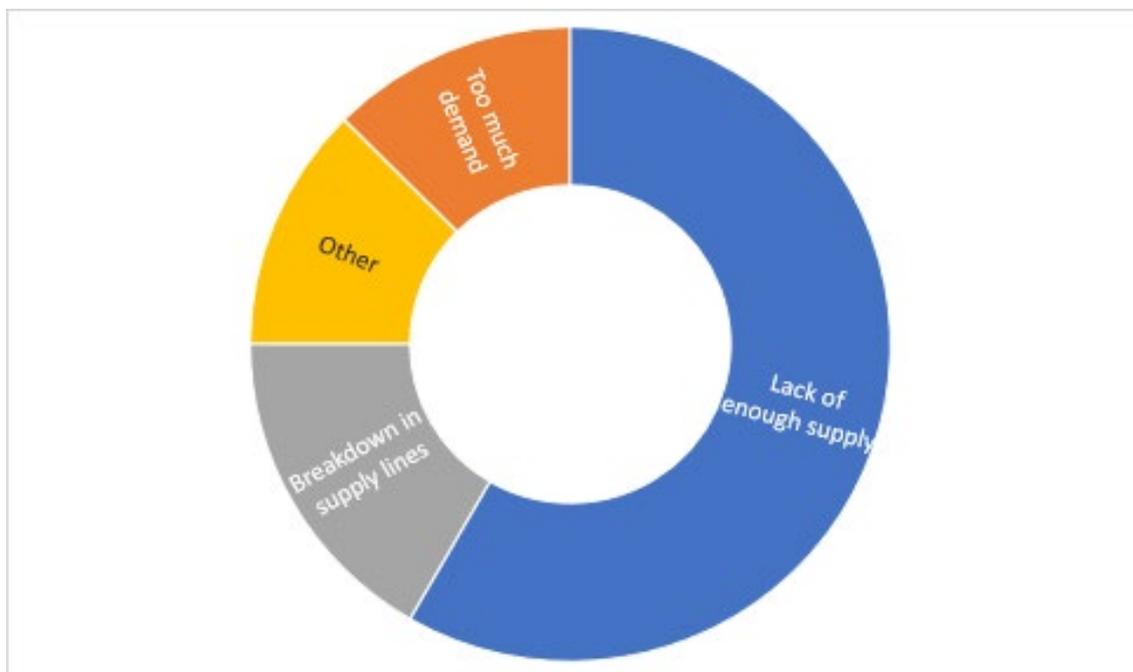


Figure 44: Main reason for the supply shortages

Traders were asked to indicate the three most preferred sweetpotato types by their consumers. The yellow-fleshed sweetpotato emerged the first most preferred type of sweetpotato by consumers (69%). This was followed by the white-fleshed sweetpotato (20%) and orange-fleshed sweetpotato (6%) came a distant third.

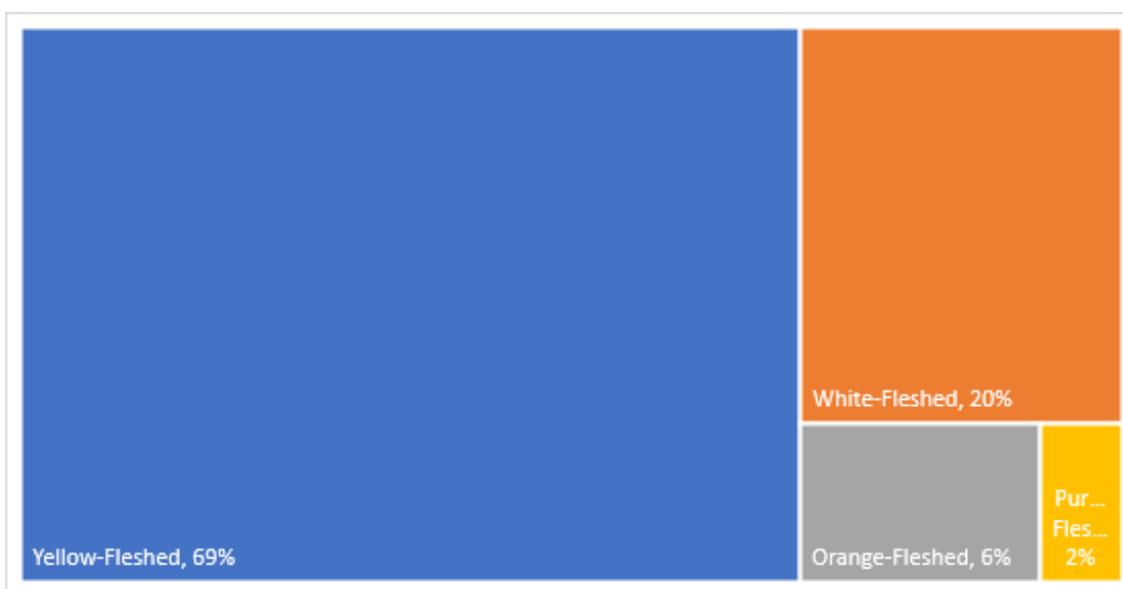


Figure 45: Most preferred type of sweet potato

Table 56 shows the most preferred sweet potato across the counties. In Isiolo County, the Orange-fleshed sweet potato is most preferred by a considerable proportion (16.7%) of consumers.

Table 56: Most preferred type of sweet potato by county

	Baringo	Garissa	Isiolo	Tana River	Overall sample
Yellow-Fleshed SP	85.7	87.5	25.0	81.8	69.4
White-Fleshed SP	14.3	12.5	50.0	9.1	20.4
Orange-Fleshed SP	0.0	0.0	16.7	4.6	6.1
Purple-Fleshed SP	0.0	0.0	0.0	4.6	2.0
No response	0.0	0.0	8.3	0.0	2.0
N	7	8	12	22	49

According to 22% and 31% of the traders the demand for orange-fleshed sweetpotatoes and other types of potatoes, respectively, has increased over the past two years. Isiolo County recorded an increase in demand by 50% and 58% of the traders for OFSP and other types of sweetpotatoes respectively. Among the male traders, 29% and 30% reported an increase in demand.

Table 57: Traders' perception on whether the demand for OFSP and other sweetpotatoes has increased over past 2 years

Change in demand	OFSP % of traders	Other sweet potato
Increased	22.45	30.61
Not increased	77.55	69.39

Pearson chi2(1) = 0.8376 Pr = 0.360

3.2.2.5 Sweetpotato supply and sales

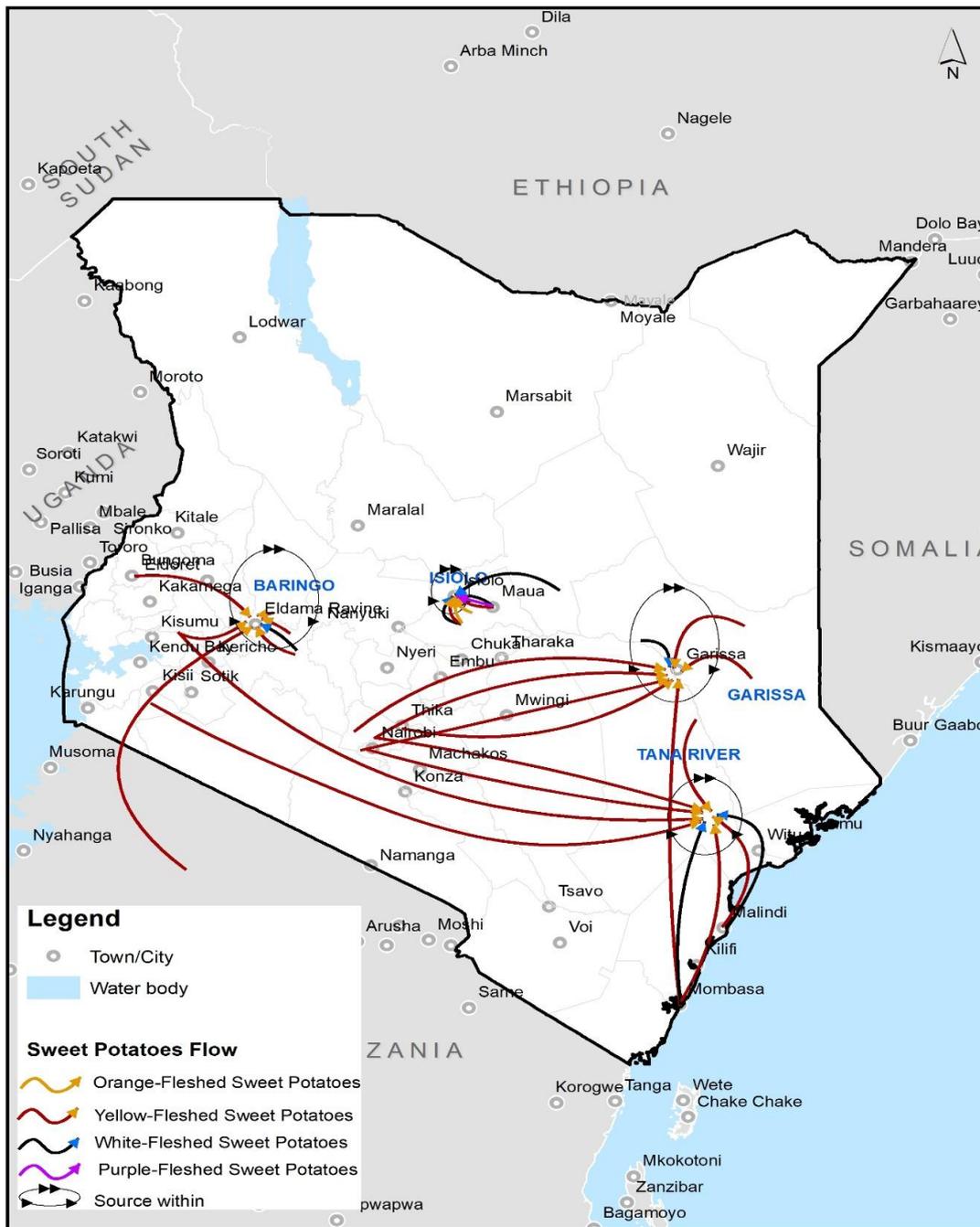


Figure 46: Map of sweetpotato source locations

The sweet potatoes sold in markets in Isiolo were sourced from within the county and other neighboring counties of Meru and Maua⁴. Traders in the other counties however sourced sweetpotatoes from further distances; for example, yellow and white fleshed sweetpotatoes consumed in Tana river were sourced from Mombasa, Kilifi, Malindi, Nairobi and Western Kenya (Figure 46).

⁴ See annex 2 for a detailed map of source locations of sweet potatoes sold in Isiolo County

The main means of transport for sweet potatoes is large trucks/lorries (27%), small trucks (25%) and motorcycles (25%).

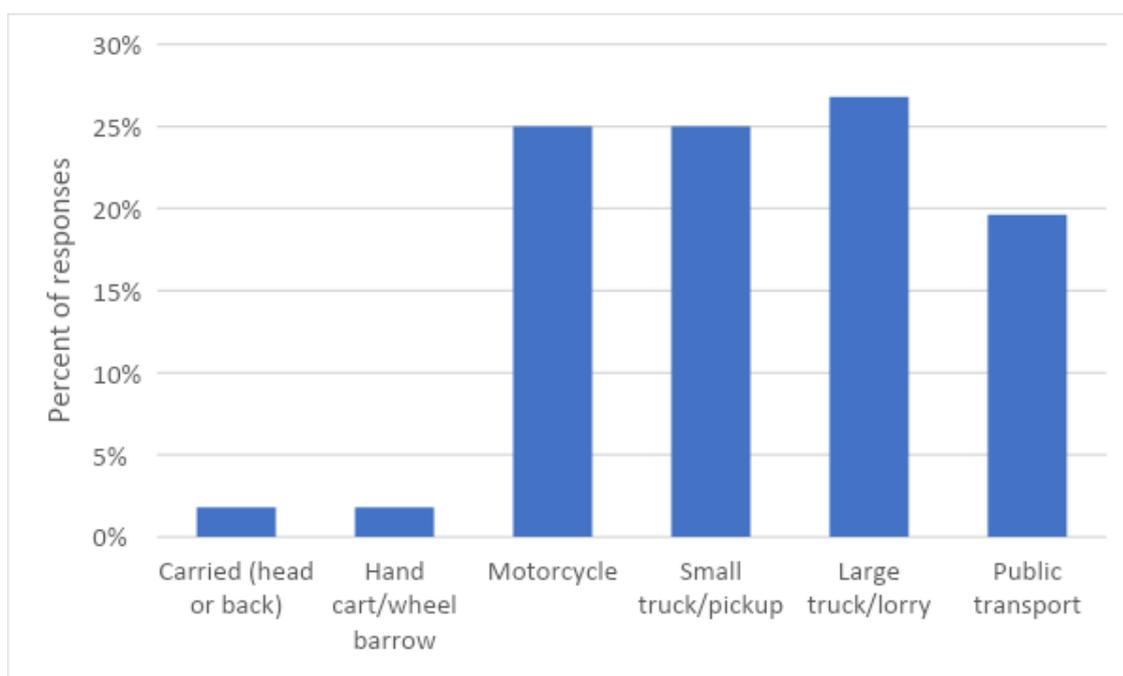


Figure 47: Main transport means for supply of sweetpotatoes

Tables 58 and 59 summarize the volumes of sweetpotatoes sold over a four-month period between July and October 2020 and the values in Ksh. On average, the volume of white fleshed sweetpotatoes sold between July and October 2020 was about 8.1 tons per trader while that of yellow-fleshed sweetpotatoes was close to 3 tons. The total sample of sweetpotato traders moved about 70 MT within the period.

Table 58: Quantity of sweetpotato sold (mean kg) July- October 2020

	Baringo			Garissa			Tana river			Overall		
	n	Mean kg	Total kg	n	Mean kg	Total kg	n	Mean kg	Total kg	n	Mean kg	Total kg
Yellow fleshed	4	5725	22900	4	3185	12739	8	1183	9460	16	2819	45099
White fleshed	1	19200	19200	1	5000	5000	1	200	200	3	8133	24400
Purple fleshed							1	500	500	1	500	500
Total			42100			17739			10160		11452	69999

*Only 20 observations had data on quantity of sweetpotato sold, none from Isiolo and no data on OFSP

The mean revenue obtained from sale of white fleshed sweetpotatoes between July – October 2020 is Ksh 1.42 million while that of yellow-fleshed sweetpotatoes is Ksh 370,077. Traders in Baringo had higher revenues based on the volume of trade they generated.

Table 59: Value of sweetpotato traded (mean Ksh) July – October 2020, by county

	Baringo			Garissa			Tana river			Overall		
	n	Mean Ksh	Total Ksh	n	Mean Ksh	Total Ksh	n	Mean Ksh	Total Ksh	n	Mean Ksh	Total Ksh
Yellow fleshed	4	427,625	1,710,500	4	282,733	1,130,930	8	96,975	775,800	16	226,077	3,617,230
White fleshed	1	1,536,000	1,536,000	1	400,000	400,000	1	24,000	24,000	3	653,333	1,960,000
Purple fleshed							1	60,000	60,000	1	60,000	60,000
Total value (USD)			30,341			14,308			8,036			52,684

A total revenue of USD 52,684 was generated from the sale of sweetpotatoes between July and October 2020. The bulk of this accrues to male traders who sold sweetpotatoes worth USD 40,471. Women traders seem to have only participated in the sale of yellow-fleshed sweetpotatoes (Table 60).

Table 60: Value of sweetpotato traded (mean Ksh) July – October 2020, by sex of trader

	Female			Male			Overall		
	N	Mean Ksh	Total Ksh	N	Mean Ksh	Total Ksh	N	Mean Ksh	Total Ksh
Yellow fleshed	10	130,680	1,306,800	6	385,072	2,310,430	16	226,077	3,617,230
White fleshed			-	3	653,333	1,960,000	3	653,333	1,960,000
Purple fleshed				1	60,000	60,000	1	60,000	60,000
Total value (USD)			12,213			40,471			52,684

There are generally more women sweetpotato customers than men to both male and female traders. Additionally, female traders have a higher customer base than male traders.

Table 61: Average sweetpotato customer base July- October 2020

Gender of trader	Gender of customer		
	Men	Women	Total
Female	6.6	16.7	23.8
Male	3.3	11.5	14.8
Overall	5.0	14.2	19.5

3.2.2.6 Costs, risks and losses in sweetpotato business

Transport costs were the most common type of costs incurred by 85% and 88% of female and male traders respectively. For the other costs including loading and offloading, bagging, sorting and grading and storage costs there was a larger proportion of the female traders incurring these costs.

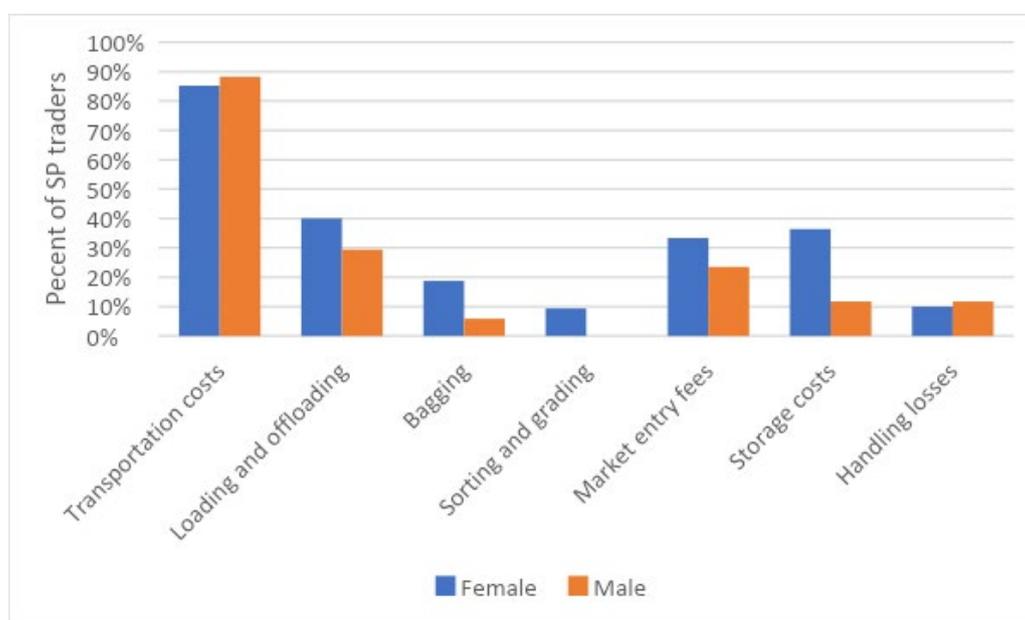


Figure 48: Proportion of sweetpotato traders that incurred various costs

In terms of the magnitude of costs incurred, storage, transportation and market entry fees were the more costly averaging but 10 dollars per trader. Male traders generally reported higher amounts compared to female traders.

Table 62: Average amount of costs incurred (Ksh) in sweetpotato business

Type of cost	Female		Male		Overall	
	N	Mean Ksh	n	Mean Ksh	n	Mean Ksh
Transportation costs	27	911	12	1,154	39	986
Loading and offloading	12	415	5	1,770	17	814
Bagging	6	542	1	2,100	7	764
Sorting and grading	3	373			3	373
Market entry fees	11	756	4	1,530	15	963
Storage costs	11	697	2	3,250	13	1,090
Handling losses	2	800	1	200	3	600

Marketing and storage losses were the more common types of losses incurred in the sweet potato business with 25% and 24% of female traders incurring these losses. Among the male traders, the proportion is 18% for both types of losses. Only male traders (7%) reported transportation losses.

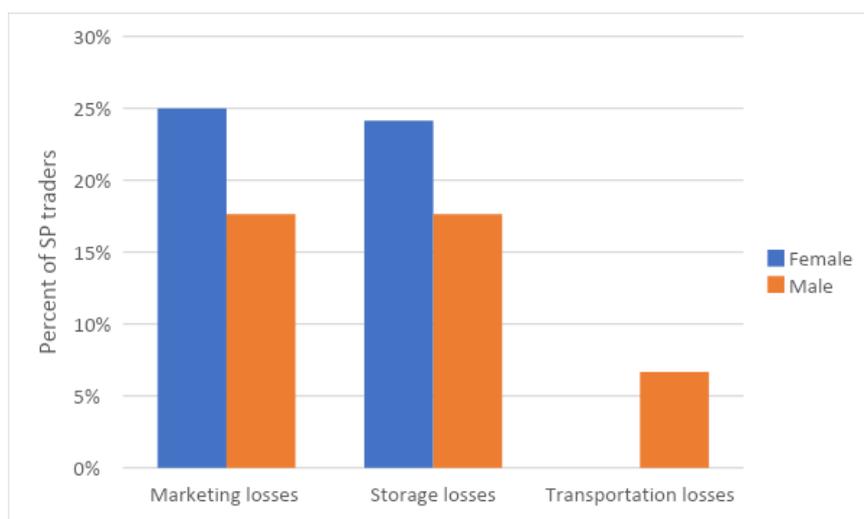


Figure 49: Proportion (%) of sweetpotato traders who incurred losses

Overall, the severity of the losses was rated low with 59% of incidences of loss in this category.

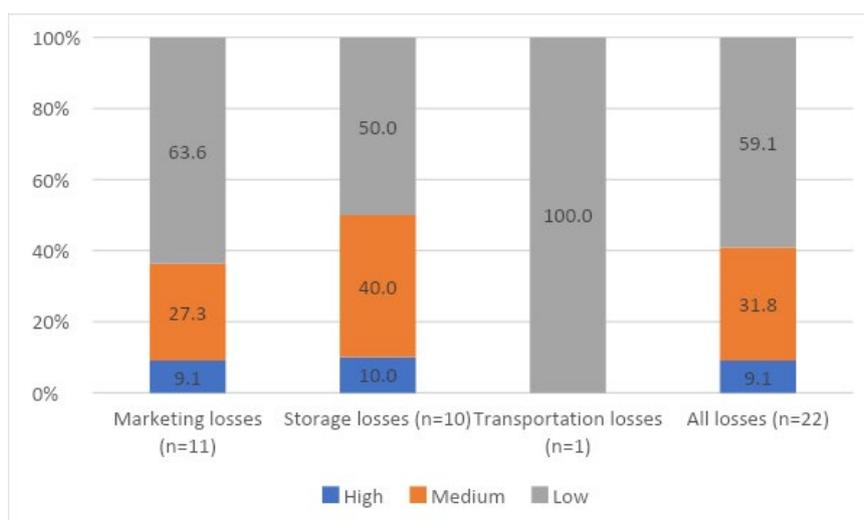


Figure 50: Severity of losses in sweetpotato business

Table 63 shows a summary of the proportion of sweetpotato stock lost. Marketing losses account for an average of 9% while storage losses account for 8%. Only one trader incurred transportation losses losing 12% of the stock.

Table 63: Percentage of sweetpotato stock lost

Type of loss	N	Mean (%)
Marketing losses	11	8.8
Storage losses	10	8.2
Transportation losses	1	12.0

3.2.2.7 Sweetpotato business capacity

Only one out of 49 sweetpotato traders had received training on biofortified crops. This may be an indication of potential for awareness creation on the importance of consuming biofortified crops including OFSP.

3.3. Qualitative study insights

3.3.1 Socio-demographic characteristics of FGD participants

The average age of participants from Isiolo, Tana River and Garissa was 41 years, while that for Baringo was 39 years. Generally male participants were older than their female counterparts (Table 88). Seventy one percent of the participants who attained secondary education in Baringo county were male, while no female participant had attained primary level education in Tana River County. Garissa county had the highest percentage of illiterate participants (74%), with the proportion of illiterate men and women being almost equal. The FGDs in Isiolo and Baringo had participants who had attained university/college education, though in the minority (2% and 3% respectively).

Table 64: Socio-demographic characteristics of FGD participants

	County			
	Isiolo	Baringo	Tana River	Garissa
Average age (years)				
Male	45	44	45	45
Female	37	31	37	37
Education Level (%)				
University/college	2	3	0	0
Male	4	4	0	0
Female	0	0	0	0
Secondary	19	64	22	7
Male	35	71	22	6
Female	3	50	0	8
Primary	64	30	67	19
Male	52	25	67	18
Female	76	42	0	20
Illiterate	15	3	11	74
Male	9	0	11	76
Female	21	8	0	72
Occupation				
Fulltime employee (%)	2	6	6	10
Male	2	8	6	0
Female	0	0	0	16
Part-time employee (%)	3	25	6	2
Male	4	34	6	0
Female	0	8	0	4
Self-employed (%)	25	22	11	0
Male	4	8	11	0
Female	47	50	0	0
Farmer (%)	59	44	77	86
Male	76	50	77	94
Female	43	34	0	80
Other (%)	11	3	0	2
Male	14	0	0	6
Female	10	8	0	0

Farming was an occupation undertaken by majority of the FGD participants, followed by being self-employed, then part-time employment then being employed on a full-time basis. The highest proportion of farmers were found in Garissa (86%), followed by Tana River (77%), then by Isiolo (59%). Overall, there were more male than female farmers (Table 64).

3.3.2 Description of the communities

Isiolo county

Key informants from Isiolo county provided a background of their communities in terms of ethnicity, population, the wealth categories prevalent in the study areas and the crops that were grown by the community. The major tribes in the study area of Isiolo county were reported to be Sakuye, Turkana, Dorobo, Borana and Somali. Most of the community members are engaged in pastoralism and agro-pastoralism (Table 65). A few farmers grow vegetables and horticultural crops while others run small businesses. It was evident that the key informants from Kambi Turkana provided different estimates of the population and tribes residing in their community.

Table 65: Ethnicity, population, and livelihood activities of the communities in Isiolo County

Village/gender of key informant	Ethnicity	Description
Gubadida (Male)	Borana (25% to 30%) Sakuye (60% to 75%) Meru (10%)	<ul style="list-style-type: none"> - Population of the community is 500 people living in 70 households. 60% of the population are females, while 40% are male. - According to the key informant, the Borana are pastoralists and very few are agro-pastoralists. - The main occupation/livelihood of the community is rearing livestock and farming of onions, tomatoes, beans, pawpaw, banana, and maize
Madina (Female & Female)	Boran (40%) Sakuye (60%)	<ul style="list-style-type: none"> - This community has a population of 150 people living in 30 households - This community was described as peace loving by the key informant. The main activities in this community are livestock rearing and farming. - Crops grown in the area include onions, pawpaw, maize, green grams, cow peas. The community rears cattle, goats, sheep, and poultry
Kambi Turkana (Nadunguro) (Female)	Turkana (92%), Somali (1%), Meru and Kikuyu (5%), Kamba (1%) Samburu (1%).	<ul style="list-style-type: none"> - The community is composed of 1,200 people living in 200 households. - Four percent of the community engage in small business. They sell their food commodities in Ngarendare and Leparua markets. - The rest of the community are composed of casual laborer's (80%), farmers (6%) and livestock keepers (10%)
Kambi Turkana (Nadunguro) (Male)	Borana (5%), Somali (30%) Dorobo (15%), Turkana (35%) Meru (5%), Samburu (8%), Others (2%)	<ul style="list-style-type: none"> - The population of this community is 12,000 people who live in 2,100 households. - Livelihood activities include pastoralism (80%, agro-pastoralism along Isiolo river, Ngarendare and Lewa springs (15%) and running small businesses (5%)
Kambi Turkana (Nadunguro) (Male)	Turkana (90%) Somali (10%)	<ul style="list-style-type: none"> - This community has a population of 1,200 people residing in 200 households. The community is composed of pure pastoralists (30%), agro-traders (40%), employed (10%), agro-pastoralists (20%). - Thirty percent of the population is male while 70% are female

Leparua (Female & Male)	Ndorobo (95%) Turkana (1%) Samburu 3% Meru (1%)	<ul style="list-style-type: none"> - Number of households in this community is 516 and the population is 3,800. Livelihood activities include pastoralism (50%) and agro-pastoralism (50%). - The key informant noted pastoralists are turning to agro-pastoralism due to climate change. - Crops grown include maize, beans, kales, spinach, sweet potato, cassava, sugarcane, guava, pawpaws, mangoes, and citrus fruits. Livestock kept include goats, sheep, cattle, and poultry. Small businesses usually run by women
Charabdisha (Male)	Borana 30% Sakuye 70%	<ul style="list-style-type: none"> - The population of the community is 1200 living in 200 households. - Their livelihood activities include agro-pastoralism (30%), trade in livestock, keeping of retail shops (50%) and pastoralism (20%).

Key informants from Isiolo were asked to describe the wealth categories of the communities residing in their areas of jurisdiction as show in Table 66. The results indicate that 60% of the community were categorized as poor while a small minority were considered rich.

Table 66: Wealth categories of communities represented in Isiolo

Division	Wealth category
Kinna	<ul style="list-style-type: none"> - Kole: 70% are very poor, of whom 40% are females and 30% are males. Ufirabul: 25% poor of whom 15% are females and 10% males - Thures: 5% rich of whom 2% are females and 3% males - They have a constant category of Ufirabul, they are neither very poor nor very rich. Permanent houses belong to people employed by the government
Burat	<ul style="list-style-type: none"> - Key informant from this division classified the rich as 20% to 30% of the population who own 100 goats and over 50 heads of cattle - The employed (middle class) were classified as 10% to 30% of the population by one key informant, while another classified them as 60% of the population - The poor comprised majority at 60% to 70% of the population - The very poor comprised 10% to 20% of the population and owned a maximum of two goats and no poultry.

According to a key informant from Isiolo (a crops officer), nearly all crops grown in the study area are irrigated due to erratic rainfall patterns experienced in the county. Irrigation is done using water from river Isiolo, Ewaso Ngiro and Kinna. Crops grown in the county through irrigation are tomatoes, onions, kales, spinach, green grams, cowpeas, maize, capsicum, beans, pawpaw, mangoes. Sweet potatoes are being introduced in the county. The three most important crops in the community were listed by FGD participants as maize, beans, and sweet potato (Table 67). Other crops listed were tomatoes, onions and kales and spinach. The reasons given for their importance are outlined Table 67.

Table 67: Top three important crops grown by the community in Isiolo

Important crops in community	Why important	Important for whom
1. Maize	<ul style="list-style-type: none"> - It is used to cook ugali, muthokoi, porridge, and githeri and it can also be roasted - It can be milled into flour and cooked by pastoralists while on migration - It grows fast without being attacked by pests and diseases. - It is income generating - The stalks are used as fodder and to make silage - Maize provides food security for families - It can be used as wind breaks - It is affordable to grow 	<ul style="list-style-type: none"> - Important for the whole family because they are energy giving foods and healthy foods for the development of strong bodies - Important for livestock as fodder
2. Beans	<ul style="list-style-type: none"> - Fast growth and early maturity - Cooks quickly and is a nutritious alternative to meat - are a source of income and can be a cash crop - They make good food and stew for all types of meals i.e., ugali, rice, chapati - They enrich the soil by fixing nitrogen 	<ul style="list-style-type: none"> - Important for the whole family because they are energy giving foods and healthy foods for the development of strong bodies - Expectant mothers
3. Sweet potato	<ul style="list-style-type: none"> - It is eaten with tea for breakfast - It can be mashed with githeri - Can be used to generate income - It cooks quickly - It is soft hence good for feeding children - It is early maturing 	<ul style="list-style-type: none"> - Important for whole family because they are energy giving foods, healthy foods for strong bodies

FGD participants in Attir and Waso area villages (Isiolo county) listed onions and tomatoes as one of the top three crops grown by their community because they are considered as cash crops that can be used to generate income to meet education costs and pay hospital bills. They also stated that it is impossible to cook any food without the two vegetables. Kales were also grown by FGD participants in Kilimani, Nkaika, and Ntirim villages because they are tasty and rich in vitamins.

Baringo county

According to Key informants from Baringo, the common tribes found in selected regions included Tugen, Kalenjin, Ichamus and Turkana (Table 68). Bortolimo is mainly inhabited by the Tugen community who are small scale farmers mostly engage in mixed farming. Somoko village has a total of about 131 households. Perkerra, on the other hand, has about 750 households. Most inhabitants depend on the Perkerra irrigation scheme for income. Other community members have formal employment.

Table 68: Ethnicity of the communities in Baringo county

Location	Village	Ethnicity
Bortolimo	Somoko	Tugen
Perkerra	Labo 2/Ndambul B	Tugen- 60% to 75%, Ichamus (20%), Turkana (15%), Pokot-3% to 5% Njems-12%, Numbians- 10%. Kipsigis, Kikuyu, Luyha
Mochongoi	Keon	Tugen- 96%, Njems- 2%, Pokot-1%, Turkana- 1%
Olkokwe		100% Kalenjin. No other ethnicity
Lembus Perkerra	Kabiyet	Kalenjin

The common farming practices in the areas represented in the study as articulated by FGD participants was mixed cropping. Farmers in Bartolimo practiced rain fed agriculture while those in Perkerra engaged in irrigated farming (Table 69).

Table 69: Farming practices in Baringo

FGD/village	Farming practice and who does the activity	Proportion of community who farm individually, in groups or household plots?
Bartolimo (Female)	Mixed cropping/intercropping along contours. Farming is carried out during long rain season and short rain season. Farming is done by females and males in all households	80% to 100% of the households farm together on shared household plots
Bortolimo (Male)	Mixed farming/intercropping. Mono-cropping is common for sweet potatoes. Most women do participate in production of sweet potatoes and beans. Farming is done household plots rather than in groups because of reduced farm sizes	
Ndambul (Male)	Irrigated farming of maize and vegetables. Crops are planted in ridges. Farming is done throughout the year through irrigation. Farming is mainly done by men as irrigation activities are tedious. Farming is done in individual plots by households. Activities undertaken by men include digging furrows and ridges. Women do the planting.	100% of farmers farm on shared household plots
Labos Vill 2 or Ndambul (4 Female)	Females and males from all age groups participate in irrigated farming. Farming is done on individual household plots. Men Prepare ridges Women plant and weed the crop.	100% of farmers farm on shared household plots

FGD participants indicated that the most important crop in their village was maize, followed by beans then millet and horticultural crops. The reasons provided for their preference were that the foods served as cash crops and met the food security needs of the households. The foods were important to all members of the household and community (Table 70).

Table 70: Important crops among the communities in Baringo

FGDs/village	Important crops in the community?	Why are the crops important
Bartolimo (Female)	1. Maize 2. Beans 3. Millet	Staple food crops Easy to grow Well adapted to the climatic conditions
Bortolimo (Male)	1. Maize 2. Beans 3. Millet	They are the main staple food in the community
Ndambul (Male)	1. Maize 2. Horticulture crops e.g. Vegetables, Tomatoes, Paw Paws. 3. Green grams	They act as cash crops and food crops
Labos Vill 2 or Ndambul (4 Female)	1. Maize 2. Beans 3. Horticulture crops	They are food and cash crops

Tana River county

In Tana River, the Key informants (chiefs) from Bura location reported that the population of Bura ranges between 8,000 to 15,000 people who reside in 3,000 to 7,200 households. There are 42 tribes found in Bura. The main ethnic group are the Somali (80%) who are Pastoralists and agro-pastoralists. The agro-pastoralists farm along Tana River. There are more females than males in Bura, where 45% of the population is male and 55% is female. According to key informants, the crops grown in the county include bananas, kales, mangoes, maize, cowpeas, green grams, and watermelon. However, FGD participants listed the three most important crops grown in the community as maize, beans, and green grams (Table 71).

Table 71: Top three important crops grown in Tana River

Subcounty	Three important crops	Why important	Important for whom
Tana River (Male)	1. Green grams 2. Maize 3. Tomatoes	Maize is important because it generates income and contributes to household food security. Income earned from selling maize can be used to buy other varieties of food Tomatoes are a source of income because they have a high market demand	Everyone, but especially for young children, women, and men of all ages
Tana River North (Male)	1. Beans 2. Maize 3. Rice	They have a high demand in the market	Everyone, children, women, and men
Tana River North (Female)	1. Rice 2. Beans 3. Maize Flour	Energy giving foods	Consumed by men, women, and children
Tana River (Male)	1. Green grams 2. Beans 3. Maize	They generate income which is used for buying medicine and pay school fees	Everyone in the community especially women and children under 5 years

According to key informants, the wealth category of the inhabitants of Bura can be categorized as 65% to 70% of the population being poor and the wealthy comprising 30% to 48% of the population. Farming is done in groups on large tracts of land subdivided into individual plots. FGDs with male participants held in Village 4 stated that men farm in group plots, while women farm individually in separate plots. Participants from the FGDs held in Makere village stated that farming is done by a family unit on a household plot. They do not have separate plots for men and women. Most of the farmers in the study site practice mixed cropping (Table 72).

Table 72: Farming practices in Tana River

Subcounty/ Key informant	Farming practice	Who does the practice
Tana River	Mixed cropping, intercropping	Both men and women from age 25-49 years and men from age 25-60 years
Tana River North	Intercropping, nursery establishment, minimum tillage to reduce use of herbicides, irrigation	Men from age 20-49. Women are mostly involved in harvesting. Men are involved in tilling the land, harvesting, and marketing. Their culture dictates that men do the hard work while women take on lighter farm work because they are the primary caregivers of the family
Tana River North	Intercropping, weeding, use of manure, construction of ridges as canals for irrigation	Men and women. men do most of the work like tilling the land and constructing furrows. Women prune weeds, sow seeds and harvest. Selling of crops is also done mostly small scale by women
Tana River	Practice irrigated farming, therefore planting is not seasonal	Men and women

Residents of Tana River practice irrigated farming using water from river Tana. The river is also a source of water for the Holla irrigation scheme. The farmers use generator to pump water to the farms where earth canals have been dug to channel water to the crops. Farming labor and protection of the crops from wildlife such as hippos is done communally. Farming communally saves costs such as money used for labor, to purchase water pumps, to pump water for irrigation and for security.

Garissa County

The most important crops grown in the community according to FGD participants from Garissa were maize, tomatoes, beans, and rice. These crops were said to be important because they not only provided food to the household, but they were also a source of income. The participants reported to use the income generated from selling the crops to buy other nutritious foods, to pay school fees and to meet medical expenses. These crops were said to be especially important to children, lactating mothers, and the elderly. Other crops grown in the county included maize, cowpeas, green grams, onion, amaranth, kales, black night shade, watermelon, mangoes, and bananas.

All FGD participants reported to farm as a group as opposed to individually. The groups farmed on household plots and in group plots. When asked what proportion of men and women farm on separate plots, all FGD participants stated that both men and women farm together on the same plot. One male FGD participant from Debi 1 village in Danyere location said, *'We own plots as mixed groups, people from one family. We don't use gender to divide the farms, but we divide it through families as a whole not men and women. We give farming plots as per family based not on gender. We may have some plots owned by women maybe if the husband dies but for now i have never heard of gender.'* They stated that farming as a group made farming easier and affordable since costs are shared. Farming skills and expertise were also said to be combined for enhanced farm productivity. They reported that farming in groups made it easier to access extension services and to protect their crops from wildlife.

3.3.3 Sweetpotato and bean production and consumption in study area

3.3.3.1 Overall sweetpotato and bean production and consumption

The highest percentage of sweetpotato growers were found among the FGDs participants held in Isiolo (57%) and Tana River (56%) while Garissa had the least of these (Figure 51). With respect to beans, Baringo (94%) and Isiolo (88%) had the highest proportion of FGD participants who engaged in bean production while Garissa had the least (10%).

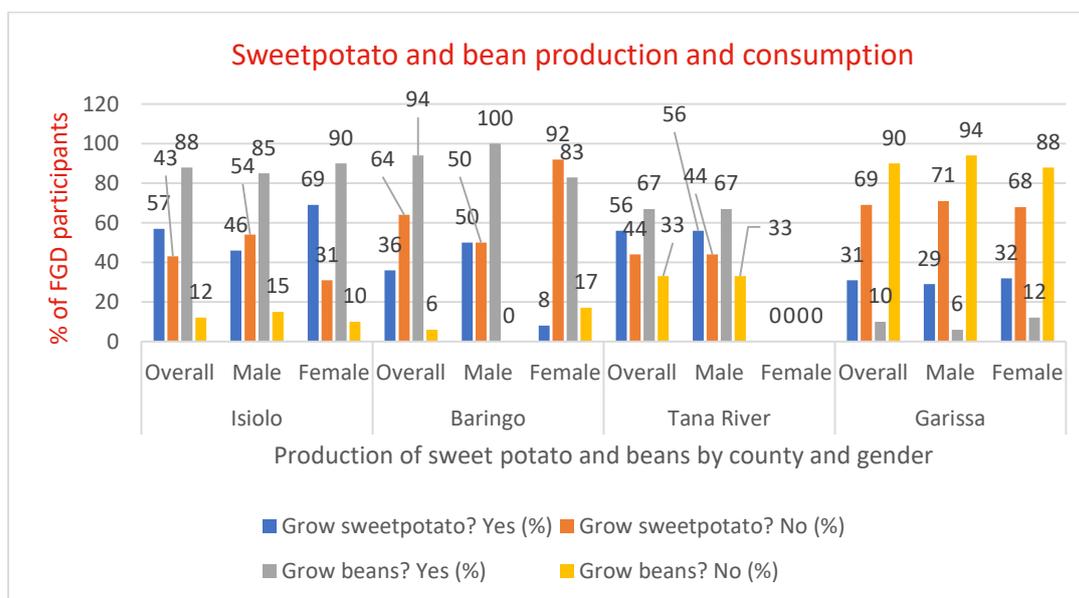


Figure 51: Production of sweetpotato and beans by FGD participants

Farmers in Baringo county had the highest years of experience in growing sweetpotato and beans (Table 73). They had spent an average of 14 and 15 years growing the crops respectively. This can be explained by the fact that FGD participants in Baringo county were old, some being 70 and 85 years old, with the average age of those who indicated they grew sweet potato being 58 years old. Farmers in Tana River and Garissa counties had the least experience (in years) in sweetpotato and beans production. They all had less than one year experience in growing the crops (Table 73).

Table 73: Years of experience in sweetpotato and beans production

County		Years of experience in production	
		Sweet potato (Years)	Beans (Years)
Isiolo	Overall	4	5
	Male	3	5
	Female	4	5
Baringo	Overall	14	15
	Male	15	20
	Female	1	2
Tana River	Overall	0.7	0.6
	Male	0.7	0.6
	Female	0	0
Garissa	Overall	0.5	0.5
	Male	0.5	0.5
	Female	0.6	0.6

3.3.3.2 In-depth insights on sweetpotato production and consumption by county

Sweetpotato production by county

Isiolo county

According to the key informants from Isiolo, sweetpotato is a relatively new crop in the county. The agriculture and nutrition officer estimated that 15% to 30% of agro-pastoralists grow sweetpotato. However, key informants who were community leaders from Madina and Leparua villages indicated that 60% and 80% of the community grow sweetpotato, respectively. FGD participants were asked whether men and women farmed in plots together or separately. Both male and female FGDs in Jillo Dima East (60% of men and 10% of women) reported that farming is done in individual residential plots due to difficulties in accessing water for irrigation. However, group members farm together in group plots. FGD participants in Jillo Dima East added that there was no difference between the proportion of men and women farming on separate plots. In Attir, farming was reported to be done in individual plots but cash crops such as tomatoes and onions are grown by farmers in groups. In Ntirim and Waso area, farming is done in individually owned plots. In Almach and Nkaika farming is solely done by women.

Households which sourced sweetpotato from outside and within the community differed by village (Table 74). Key informants from Gubadida (community leader) and Madina (senior chief) reported that 90% and 95% of the community respectively obtained their sweetpotatoes from within the village, while the rest of the community members sourced from outside the community. In Leparua, the key informants (chairlady of a group and assistant chief) also reported different proportions of population who sourced roots from within (100% and 60%) and outside (0% and 40%) the community. It was evident that key informants from the same village provided different estimates of the percentage of sweetpotato from outside and within the community.

Table 74: Sources of sweetpotatoes roots in Isiolo

Village/Key informants	% of sweetpotato from outside and inside community	Are people buying more or less sweetpotato compared to 5 years ago?
Gubadida (Male) Community leader	Outside, 10% Within, 90%	- People are beginning to buy more due to the introduction of new nutritious varieties
Gubadida (Male) Village elder	Outside, 80% Within, 20%	- There are more consumers than producers in this community. However, the number of producers has increased in the last five years - More people are buying sweetpotato because its benefits are being experienced by community members
Kambi Turkana (Nadunguro) (Female) Nyumba Kumi	Outside, 80% Within, 20%	- More farmers are growing sweet potato than in last 5 years
Kambi Turkana (Nadunguro) (Male) Area Manager	Outside, 70% Within, 30%	- People are buying more due to healthier eating habits and lifestyles of the community. Knowledge of sweetpotato has also increased
Kambi Turkana (Nadunguro) (Male) Chief Burat	Outside, 80% Within, 20%	- Not indicated
Leparua (Female) Chairlady of groups	Outside, 0% Within, 100%	- The community access all their sweetpotato from their farms or borrow from friends. There is no sale of sweetpotato
Leparua (Male) Assistant chief	Outside, 40% Within, 60%	- People are buying less sweetpotato as compared to five years ago because the number of people growing them is increasing
Charabdisha (Male) Agriculture officer	Outside, 40% Within, 60%	- People are buying more sweetpotato now as compared to five years ago due to a change in eating habits to more healthier diets and its nutritional value
Madina (Male) Senior chief	Outside, 5% Within, 95%	- Very little purchase from outside the community for the last five years

No clear trend was observed on whether there was an overall increase or decrease in the purchase of sweetpotato across the study sites in Isiolo county. Increase or decrease in purchase of sweetpotato over the last year was unique to the respective communities. Communities that grew sweet potato such as those living in Leparua and Madina purchased very few or no sweetpotato from outside their communities. With respect to production practices, majority of the respondents across the study area stated that sweet potato was grown as a monocrop and under irrigation, while the minority intercropped it with maize (Table 75). FGD participants in Kilimani reported that they were not engaged in sweet potato production.

Table 75: Sweetpotato production practices in Isiolo

Farming practice	How practice was done	By whom
Vine acquisition	- Vines were sought from neighbors at a cost and sometimes free of charge	Mostly women
Land preparation	- Land preparation involved land clearing, digging, and ridging. Digging was done either manually, by use of ox ploughs or tractors. Tractors were only hired when funds permitted	Mostly by men because they are strong. Women and children only assisted when required
Planting	- Maize is intercropped with sweet potato or grown as a mono crop. Maize is planted before sweet potato to avoid the maize from being covered by sweet potato and for diversification of crops grown on the same area of land	Men and women
Watering	- Watering was done during the day by women and at night by men or hired labour	Men, women, children and hired labour
Weeding		Mostly women and children
Harvesting		All family members

In Almach and Nkaika, farming was solely done by women. Interestingly, respondents from the male FGD held in Almach village stated that land preparation was done by women because men are pastoralists and are therefore not interested in farming. On the other hand, farming in Nkaika was done mainly by women because men were reported to be slow in embracing agriculture. Men in Jilo Dima East intercropped sweet potato with maize, while women grew it as a mono crop. Watering seemed to be an activity undertaken at night by some communities such as Nkaika and Ntirim. This could have been done in a bid to address water shortage for irrigation. It is possible that the water pressure was higher at night when there were fewer users, than during the day. Night watering was done by men because of security reasons. In Atir village, planting was said to be done by women because men cannot bend for too long.

Interviews with key informants affirmed the gender roles for each sweetpotato activity. Light tasks such as planting were done by women and heavy tasks such as ploughing, by men. The key informant in Gubadida stated that *'All farming is done by men, but women do assist occasionally. It is the tradition of the community for women not to be involved in farming activities apart from sales. Single ladies can do themselves or hire male casual labour.'* The key informants stated that sweet potato is planted in ridges in pure stands or intercropped with maize along the hedges. Crop rotation is sometimes done with crops such as onions, kales, spinach, and beans. Planting is done throughout the year because sweet potato is mostly grown under irrigation. During land preparation ploughing can be done manually or by use of a tractor. Casual laborers are sometimes hired when finances allow or when sweetpotato are harvested all at once for the market. The key informant from Kambi Turkana reported that ridging is done by men because *'it is shameful for a woman to hold a jembe.'*

Key informants mentioned that improved sweetpotato varieties have positive agronomic attributes such as early maturity compared to local varieties, high yields, disease and pest resistance and drought tolerance. Key informants also stated that sweet potato is not a seasonal crop because it can be grown under irrigation and it can be harvested piecemeal. They added that they can be used to generate household income. From a health perspective, the key informants noted that sweet potatoes are good for diabetic patients. They are rich in Vitamin A which is good for eyesight, Beta carotene and Iron. These nutrients mitigate malnutrition. The improved varieties were also reported to have a faster cooking time, delicious, filling, and easy to mash which is important when preparing food for infants.

However, key informants reported that very few farmers have access to the new sweetpotato varieties leaving farmers to grow local varieties. The sweet potato found in markets in Isiolo are mostly from Meru county. The key informant In Kambi Turkana reported that "*the community had access to new sweet potatoes varieties. But only few farmers received the vines the farmers received Irene and Kabonde varieties.*" Key informants also reported that Kabonde and Irene varieties were grown in Leparua and Kinna South village. Participants in Madina village grew Orange-fleshed SweetPotato (OFSP), White Fleshed SweetPotato (WFSP) and Yellow Fleshed SweetPotato (YFSP). In Gubadida village, the World Food Program (WFP) is reported to have introduced a pink fleshed sweetpotato variety.

Some FGD participants reported growing improved sweetpotato varieties. For example, participants from the FGD held in Attir grew Irene and Kabonde varieties which they stated were introduced by CIP and Ministry of Agriculture, Livestock and Fisheries. The FGD participant noted that '*These varieties do not have fiber, are not too sweet or sugary, and we were taught that they can be used by diabetics. The leaves can be used as vegetables. They mature in about three months and do not require a lot of water.*' Irene and Kabonde varieties were also grown by FGD participants in Nkaika. They were introduced by WFP and Ministry of Agriculture, Livestock and Fisheries.

Baringo county

Key informants and FGD participants stated that sweetpotato was mostly grown as a monocrop in small scale using rain fed agriculture, by middle income farmers. About 30% of the community across the study sites were reported to grow sweetpotato. Farmers with high incomes in Bortolimo and Perkerra were not reported to grow sweetpotato because they were engaged in other businesses. Women headed households in Perkerra did not grow sweetpotato because they do not own farms. They participate in activities that earn more income such as seed maize production. The youth and men from Lembus Perkerra did not grow sweetpotato because they did not know the importance and nutritional value of sweet potato (Table 76)

Table 76: Sweetpotato production practices in Baringo

Key informant/ Location	How sweetpotato are grown	Who grows sweetpotatoes?	Who doesn't grow sweetpotato?
Olkolwe	Grown mainly during long rains. Intercropped with perennial crops (Fruit trees e.g., Bananas and Mangoes.) The perennial crops act as cover crops Planted as a pure stand on ridges	Grown by 10%-30% of the population Women headed households who mainly grow OFSP It is grown by elderly (men and women)	The wealthy
Bortolimo	Grown as a monocrop	20% of the community	Men and wealthy farmers
Perkerra,	Grown in small plots Planted separately or intercropped with pawpaw's. Planted during long rains	1% to 30% of the community	Women headed households Wealthy farmers
Community leader	SP as a monocrop in small land areas	20% of the population. Women and Children living in households with small land sizes	
Mochongoi	Grown in pure stand	10%	Mostly men
Lembus Perkerra	Planted as a pure stand but on small scale	10% Average income earners in the community grow	Young people and men

Key informants and FGD participants were asked whether they had access to new sweetpotato varieties. Nearly all respondents indicated that the county had no access to sweet potato varieties. Only two respondents, a key informant from Somoko and an FDG participant from Bortolimo village reported to have access to sweet potato varieties. The varieties in Somoko village included Kabonde and Irene varieties, SPK 004 bulked by KALRO Njoro and Egerton University and yellow fleshed sweet potato.

According to the key informants (community leaders), about 40% to 80% of community members across the FGD study sites sourced their sweet potato from within the community. Overall, the participants from Perkerra and Muchongoi noted that there has been no change in the purchase of sweet potato compared to five years (Table 77). However, participants from Olkolwe reported that there was a decline in the purchase of sweet potato compared to five years ago (Table 77). Some of the reasons provided by FGD participants for the decline is the distance to the market and lack of awareness on the nutritional benefits of sweet potato. In Lembus Perkerra the key informants who were community leaders reported that the community does not know the importance and nutritional value of sweet potato. They added that women are the only ones who seemed interested in growing sweetpotato.

Table 77: Source and trend in purchase of sweetpotato in Baringo

Key informant/ location	% of SP from outside and inside community	Are people buying more or less compared to 5 years ago?
Perkerra,	Within community, 80% Outside the community, 20%	There has been no change in the purchase of sweet potato in the last 5 years. Small scale purchases
Mochongoi	Within community, 40% Outside the community, 60%	There has been no change in the purchase of sweet potato in the last five years because no one has created awareness about it
Olkolwe,	Within community, 80% Outside the community, 20%	People are currently buying more compared to five years ago because they know its benefits e.g., nutrition and health benefits
Lembus perkerra	Within community, 50% Outside the community, 50%	<i>'People are buying less than 5 years ago because it is far from the village where they can buy.'</i> Another participant added <i>'They have reduced for the last five years because of lack of funds and time to go to town to buy it.'</i>

The county crops officer observed that the community has not fully embraced growing the OFSP. This has resulted in the importation of sweet potato from Western and Elgeyo Marakwet. They added that less sweet potato is currently being traded compared to five years ago because its overall production has decreased. The major challenges limiting the use of improved sweet potato varieties were mentioned as unavailability of planting materials, insufficient knowledge by farmers on sweet potato and the importance of new varieties and lack of training on new sweet potato varieties.

Tana River county

According to key informants who were agriculture experts in the county, sweetpotato is mostly planted as a monocrop in ridges, but some farmers intercrop it with beans, maize, cowpeas, and cereals. Key informants differed on the percentage of the population that grow sweet potato in the study area. Some indicated that less than 5% grow it while others put the estimate at between 10% and 30%. Key informants reported that the community has not accessed new sweet potato varieties. The YFSP and WFSP are the most common varieties. Planting is done at the onset for the long rains. At harvest, some sweet potatoes are not harvested, and their vines are left to dry up. The tubers which were left unharvested sprout during the onset of the short rains. Sweet potato grown under irrigation is planted along the edges of the riverbank by the Pokomos and Malakota. In such cases it becomes a perennial crop. Some farmers plant sweet potato as a cover crop to control weeds in cereals. In this approach, the vines are used as a vegetable and as animal feed for sick and lactating animals.

Garissa county

According to Sub County Agricultural Officer, County Crops Officer and Ward Agricultural Officer (Key Informants), sweet potatoes were recently introduced in the study area. They are grown throughout the year and intercropped with other crops such as maize, bananas and cereals. They are usually planted in ridges or used as a cover crop (Table 78).

Table 78: Farming practices and division of roles in sweetpotato production in Garissa

Division/FGD	Farming practice	Who does the practice
Danyere (Female)	Planting is done in ridges Intercropping	Planting is done by both males and females. Women play the pivotal role because they are more available for farming than men. Farming is done in group plots
Sankuri (Female)	Mixed cropping Mono cropping Irrigated farming	Males and females and sometimes children. Farming is done in household plots. However, 70% of the farming is done by women
Sankuri (Male)	Mixed farming Intercropping Crop rotation	Everyone in the household except the elderly Group farming
Danyere (Male)	Use of ridges Intercropping Ploughing by use of tractors	Males and females. Farming is done in group plots
Iftin (Female)	Crop irrigation using canals Planting in ridges Intercropping.	Hired labour Both men and women, but men do the bulk of the farming activities

When intercropped with maize, one line of sweet potato is planted after every after every 3 rows of maize. Farmers farming along the river irrigate sweet potato. Pests and fungal diseases are prevalent between May to July. The growing season for OFSP is January to March and July to September.

Analysis of the data revealed that access to sweetpotato varieties is unique to a particular community or village. All key informants confirmed that the county has access to sweet potato varieties which included OFSP and WFSP. However, the proportion of people in the community who grew sweet potato varied between key informants, with two key informants estimating the proportion to be between 50% and 55%, while another, less than 1%. A similar trend for varying proportions of the community that grows sweet potato was observed with FGD participants.

Female and male participants from the FGDs held in Mudey reported that they grow OFSP that was introduced by the Ministry of Agriculture and WFP. Female participants from the FGD held in Ifitin location reported that OFSP was a new variety brought by WFP and the Department of Agriculture. They grow Kabonde and Irene varieties for home consumption and sale. They stated that *'OFSP is a wonder variety that we have never known before because it has more nutrients and for those of us who use this variety we have learnt and experienced difference in our bodies. Whenever we consume this variety, it will give you more energy and you cannot feel hungry for a long time.'* Female participants in the FGD held in Sankuri location stated that they have no access to new sweetpotato varieties but would like to be trained on their production. Their male counterparts had a similar response with one stating that *'the only time I heard about sweetpotato which was yellow in color is when I was in Nairobi. It really tastes good. I have never heard of any sweet potato, I only know [Irish] potatoes.'*

Key informants explained that for those farmers who did not grow sweetpotato it was because they lacked the knowledge to do so and the vines for planting. Men, youth, and the rich were reported not to grow sweet potato because they preferred to grow high value crops such as watermelon and rice. The key informants added that the community is willing to grow new sweetpotato varieties but require capacity building on the same.

Use of improved sweetpotato varieties

Isiolo county

Key informants were asked to provide the challenges that limited use of sweetpotato by the community. The major challenges mentioned by key informants and FGD participants included inadequate knowledge on the importance, nutritional benefits and agronomy of sweetpotato, insufficient supply of certified sweet potato vines for planting and inadequate water for irrigation (Table 79).

Table 79: Challenges limiting the use of improved sweetpotato varieties in Isiolo

Key informants/Division	Challenges limiting use of improved sweetpotato
Nutrition/agricultural officer	<ul style="list-style-type: none"> • Accessing the certified vines • Inadequate knowledge on agronomic practices and nutritional benefit of sweet potato • Inadequate water for irrigation • Effects of climate change such as floods and drought • Locust invasion • Poor access to finance
Kinna	<ul style="list-style-type: none"> • Erratic rains • Cultural beliefs or myths • Negative perspective that producing sweet potato increases the burden of labour • Sweet potato is not valued as a food crop • Wildlife menace. Elephants love sweet potato
Burat	<ul style="list-style-type: none"> • No access to new sweet potatoes varieties • Inadequate water for irrigation • Inadequate planting materials • Animal pests such as rodents and porcupines, rats, moles, squirrels • Pests especially during a drought • The varieties grown are not drought tolerant • Lack of knowledge on the importance, agronomy, and nutritional benefits of sweet potato • Low market prices during a sweet potato glut
Ngaremara	<ul style="list-style-type: none"> • Elephants and grazing livestock destroy the crop • Water shortage forcing farmers to water the crops at night • Shortage of vines • Theft of sweet potato while growing in the field

Men and youth were reported not to grow sweet potato because it is not a high value crop, Cushites and Nilotes are mostly pastoralists and do not farm their land and lack of interest due to inadequate knowledge. The key informants provided some suggestion on how the challenges could be addressed. One of the suggestions was building the capacity of extension workers on the importance of sweet potato and its agronomy. Holding cooking demonstrations and value addition of sweet potato were found important. Seed bulking by selected individual farmers was suggested as a means of promoting decentralized sweet potato vine multipliers who can produce certified vines which can be sold to other farmers. In this regard, it was suggested that clean OFSP planting materials can be sourced from CIP and WFP. In addressing the challenge of access to water for irrigation, the key

informant from Gubadida was hopeful that the water furrows constructed by WFP will alleviate the water shortage problem and reduce siltation. It was suggested that provision of adequate water for irrigation, livestock and domestic use can be achieved through the construction of a dam, drilling of a borehole or use of a pump, to pump water from rivers to the point of use. A key informant from Madina village suggested the erection of more electric fences to control elephants and that Kenya Wildlife Service employs more staff to maintain the electric fence to keep away wild animals from their farms. Lastly, poor access to finance can be addressed through social protection programmes such as cash transfers and village savings and loans associations.

Baringo county

The main challenges that hindered the use of improved sweetpotato varieties by respondents included lack of planting materials, insufficient knowledge on new sweet potato varieties, competing uses for irrigation water between sweet potato and other crops, pests such as rodents, uncertainty of the vitamin A content of the new varieties, lack of suitable soil and unreliable rainfall. Respondents were asked to provide some suggestions on how the challenges they mentioned could be addressed. The nutrition officer indicated that the Ministry of Health should continue to provide the community with Vitamin A supplements in the form of tablets. Establishment of bulking sites as well as training and demonstrations were suggested as ways to provide certified planting material and build the capacity of the community on sweetpotato production. Planting of traditional sweetpotato varieties was mentioned as a solution to address shortage of certified planting material. Further, the nutrition officer suggested that WFP continue to provide certified planting materials to farming communities in Baringo.

Tana River county

According to key informants, the common sweetpotato varieties are YFSP, WFSP and OFSP. The agriculture expert reported that there are varieties from KALRO Mtwapa such as Mtwapa-8 which is performing well. It is being tested in field trials and farmers are yet to adopt it. There is also a variety called *Kitufulo* which is not fibrous and is sweet. Once it is planted, you can continue harvesting it for a long time provided one does not interfere with the tubers. Some participants from focus groups affirmed that they have received new sweetpotato varieties. Participants from Makere village stated that they grow OFSP, Irene, Kabonde which were introduced by WFP and CIP in April 2021. They are yet to harvest them. They reported that they established a distribution point for vines from the sweetpotato varieties by planting them in nursery beds. Male participants from the FGD held in Village 4 stated that they got their varieties which they described as being yellow on the inside and red on the outside from agriculture extension officers. Their female counterparts however reported that they have not had access to new sweetpotato varieties. The male FGD in Makere reported that they are vine multipliers in their village. When asked what they knew about OFSP some participants stated that it is a new variety that is very sweet, high in vitamin A, early maturing since it only takes four months to reach maturity and it is easy to cook. They added that they are good for children, expectant mothers, and the elderly. One key informant however stated that *'the community does not understand the difference between sweetpotato and Irish potato.'*

Challenges limiting the use of improved sweetpotato as mentioned by key informants who were community leaders (chiefs) were reported as lack of vines, insufficient knowledge about the importance and agronomy of sweetpotato and climate change which has caused recurring floods and drought. Other challenges were cited as the negative attitude of the Somalis towards farming, wild animals such as pigs and warthogs that damage the crop, grazers such as livestock that feed on the vines and diseases that attack the crop. Poor soil fertility and weeds such as the Mathenge tree (*Prosopis juliflora*) which infiltrates the farm were also mentioned as challenges. Agriculture experts in the county mentioned challenges such as pests which included potato weevils, aphids and nematodes that attack the crop, language barrier between extension officers and the community, low literacy levels within the community, logistical challenges that makes reaching farmers difficult, the high cost of sweetpotato in the market and the fact that some varieties were reported to cause stomach upsets. One key informant mentioned that vines were not readily available especially for WFSP, YFSP, OFSP, while another added that preparing sweetpotato ridges for planting the sweet potato was very labor intensive. Lastly, the existing land ownership structure was reported to pose a challenge to women farmers especially because men are the main decision makers at the households.

Focus group participants observed that the new varieties have a high-water requirement. They also stated that they experience challenges such as pests and diseases and wildlife that destroy their crop. As one participant put it *'The problem we have experienced on this new varieties was it needs a lot of water for irrigation also wildlife eats this Kabonde and destroys our Kabonde. The other challenge we fear pests and diseases to destroy our new variety and we don't have enough money to buy pesticides.'* Another challenge that was noted was insufficient knowledge on new sweetpotato varieties within the community. This they stated, led to a low demand of sweetpotato within the community because the varieties are unfamiliar to them hence, they prefer to purchase other crops.

Garissa county

Key informants and FGD participants stated that the major challenges that limited the use of sweetpotato varieties were:

- Insufficient knowledge of sweetpotato value chain by farmers, traders, and agriculture extension officers
- Poor marketing networks
- Limited supply of sweetpotato vines
- Poor soils which resulted in small, sweetpotatoes
- No water for irrigation
- High cost of irrigation
- Wildlife menace (warthogs and monkeys)
- Unsteady supply of sweet potato in the market
- Pests and diseases - common pests being locusts and nematodes

Suggestions to overcome the challenges included building the capacity of the community on sweet potato production, the development and/or deployment of disease and drought tolerant varieties, improving the availability of sweetpotato vines, improving security on the farm against wildlife and use of water conservation techniques while growing sweetpotato.

Sweetpotato consumption by county

Isiolo county

FGD participants stated that sweetpotatoes are eaten by women, children, and the elderly because they are sweet, soft, and easy to swallow. Key informants and FGD participants concurred that sweet potato was popular as a breakfast meal consumed boiled, throughout the year. Its consumption does not vary by season or time of year because it is grown under irrigation. However, the change in consumption of sweet potato over the past five years seemed to vary by village. The nutrition officer pointed out that overall, consumption of sweetpotato in Isiolo county has had little change over the past five years due to little information available to consumers on its nutritional benefits. This statement was supported by a key informant from Leparua who stated that there was no change in consumption of sweet potato over the last five years. The key informant from Kambi Turkana stated that sweet potato consumption had decreased over the last five years. The decrease in consumption was attributed to shortage of irrigation water which had forced farmers to relocate to other areas thus abandoning their farms.

On the contrary, key informants such as the officer from the state department of agriculture stated that *'the consumption [of sweet potato] is increasing since its introduction in 2020 as people learn its nutritional value'*. Another key informant from Gubadida added that *'sweetpotato production has increased for the last five years due to many turning to farming because of drought which results to loss of livestock.'* A chief in Burat also stated that *'people are buying more sweet potato now as compared to five years ago because of the changes in eating habits and lifestyles of the communities. Their knowledge on sweet potato has also increased'* while another informant from Leparua posited that *'consumption [of sweet potato] has increased for the last five years from once a month to once a week.'* The proportion of sweet potato used for home consumption, selling and other uses varied by village, irrespective of the ethnicity and social segregation of the families in the community. It was evident that farmers gave out some of their harvests as gifts to their neighbors. Charabdisha village had the highest proportion of sweet potato produced for the market, followed by Madina (30%). The percentage of sweet potato used for home consumption ranged between 60% and 70% (Table 80).

Table 80: Sweetpotato production and utilization in Isiolo

Village	How much sweetpotato is used for home consumption, selling, other products?
Gubadida	20% for sale either raw/cooked (boiled) sold through hawking 70% house consumption 10% given to relatives/neighbors
Charabdisha	Out of 10kgs of sweet potato: 60% for sale in the market 30% for home consumption 10% given to friends, relatives, and neighbors
Madina	30% for sale in markets 50% home consumption 20% given to friends, relatives, and neighbors as gifts
Kambi Turkana	20% for sale 60% home consumption 20% given to friends, relatives, and neighbors as gifts
Leparua	10% for sale 60% home consumption 30% given to friends, relatives, and neighbors as gifts

Baringo county

Key informants in Marigat, Mochongoi, Mogotio and Eldama Ravine divisions indicated that the respective communities consume 90% to 100% of the sweet potato they grow (Table 81). Sweet potato was reported to be consumed seasonally. It is mostly available during the rainy season. It is consumed with tea during breakfast, but few eat it for lunch.

Table 81: Sweetpotato consumption and sale in Baringo

Division	How much sweetpotato is used for home consumption, selling, other products?
Marigat	100% home consumption because it is planted in small land areas Other products: Beans- 8 bags: 3 bags used at home 5 bags for sale. Tomatoes- small percentage used at home most of it is sold. Vegetables- small percentage used at home, the rest is sold. Seed maize 100% for sale; pawpaw 100% for sale; Bananas 100% for sale.
Mochongoi	90% of sweet potato is used for home consumption, 10% for sale. Other products: Maize- Consumed- 40%, sold-60%; Beans consumed 70%, sold 30%; Wheat consumed 5%, sold 95%.
Mogotio	100% are planted for home consumption. Other products: Maize home consumption 60% for sale 40%; beans home consumption 80% for sale 20%; millet home consumption 30% for sale 70%; vegetables home consumption 80% for sale 20%; fruits home consumption 90% for sale 10%
Ravine	60% of sweet potato is used for home consumption 40% for sale. Other products: Maize consumed 30% sold 70%, beans consumed 60% sold 40%

In particular, the county crops officer reported that harvesting of sweet potato is done piecemeal and it is consumed by everyone in the community daily. The officer added that value addition is nascent within the community presenting an opportunity to build the capacity of community members on various processing and preservation techniques for sweet potato. This finding is supported by the fact that all FGD participants reported that they are not using any processing and preservation techniques for sweet potato. From the analysis of the data, it was evident that change in sweet potato consumption over the last five years varied by community. This implies that trends in consumption of sweetpotato are unique to a village or community. Sweet potato consumption in Kabiyeet and Keon villages were reported to have remained the same over the last five years, while in Ndambul, it was reported to have increased.

In Somoko village the community leader reported that sweet potato is consumed occasionally and mostly bought by many households from local centers. This sentiment was supported by the nutrition officer who stated that sweetpotato is consumed seasonally during harvesting season of the year. A village elder from Perkerra added that an average household consumes half a sack of sweet potato per year and 30Kgs of sweet potato are sold per household each year. The nutrition officer reported that young children do not consume sweet potato and that the county has not had access to new varieties. They plant the local ones such as the purple and white varieties. The officer added that consumption of sweet potato is increasing and that if the community is educated about sweet potato production and nutritional benefits, more of them will embrace it.

FGD participants indicated that sweet potato is consumed by all family members who include women, children, and lactating mothers because it is a nutritious and energy giving food. The county crops officer stated that community members are becoming more sensitive towards natural foods, resulting in an increase in the consumption of sweet potato. The crop is also now more available in the market. The community leader from Somoko reported that more people are buying sweet potato compared to the last five years because *'the community has realized that sweet potatoes are high in nutrition. Richer households consume more sweet potato compared to poor families.'* In addition, the nutrition officer intimated that people are embracing traditional and organic foods as a way of mitigating lifestyle diseases.

Tana River county

According to key informants, even though sweetpotato is not grown by most of the communities in the study area, it is consumed by 5% to 70% of the population. Only about 15% of the harvest is sold in the market. This means that the deficit has to be imported from other neighboring towns. Sweet potato consumption has increased in the last five years due to an increase in population. Its consumption is seasonal where it dips during the dry season. Sweet potato is consumed during the holy month of Ramadhan as a delicacy. During this time, the demand for sweet potato is very high. It is consumed mostly boiled by the elderly, children, women, and the youth in learning institutions for breakfast and lunch. Some households use the leaves as vegetables. Not everybody can afford to purchase sweet potato especially in the urban centers due to its high cost. All FGD participants reported that they did not process or preserve sweet potato. A key informant who was the nutrition officer stated that the community does not use any technologies to store sweet potato. The informant added that farmers are not processing and storing sweet potato leaves for use during a drought.

Garissa county

Key informants stated that less than 5% of the community consume sweetpotato. Expectant mothers, women, and children below ten years of age consume sweet potato mostly for breakfast, with some people preferring it to bread. Most FGD participants consumed their sweet potato boiled, roasted or as a sauce. They added that sweetpotato is consumed because they are sweet, soft, and nutritious. The wealthy consume it because they can afford it. One key informant stated that sweet potato is mostly consumed by people living in rural areas as opposed to urban centers. This could be because sweetpotato was reported to be scarce in the market.

3.3.3.3 In-depth insights on bean production and consumption by county

Bean production and consumption

Isiolo county

Key informants and FGD participants were asked to describe how they grew beans (Table 82). Most of the tasks were done by both men and women and in some cases youths/children were involved. However, some activities were gender specific such as land preparation and planting mostly done by men and women respectively.

Table 82: Farming practices in bean production in Isiolo

Activity	How activity is done	By whom
Seed acquisition	Seeds are bought from the market, groceries in Kinna, Meru or Maua	Women
Land preparation	Done before the onset of the rains. Activities done are bush clearing, ploughing, and making of basins (Jarubas). Ploughing is done manually, using ox-plough or a tractor if one can afford	Mostly men as it is considered hard work. Women do it when men are not available. Women mostly hire men to do land preparation, casual labour
Planting	Done before the onset of the rains Intercropped with maize or grown as a pure stand When intercropped one line of maize is planted after three rows of beans. Sunflower can be planted along the edges Planting is done anytime of the year because beans are mostly grown under irrigation Planting is done using machetes in basins (Jarubas)	Mostly by women because they are skilled and thus faster. Planting is also considered a woman's job and because men cannot bend for too long. However, men and the youth also participate. In some cases, 'harambee' planting is done by all community members
Growing	Spraying against pests	Mostly by men because women are involved in cooking which does not go well with chemicals. Chemicals can be harmful to mothers who are expectant, breastfeeding or those who prepare meals for their families
Watering	Beans are mostly irrigated. Heavy hoes are used to direct water onto the ridges/molds	Both men and women
Weeding	Done using ox-drawn plough. Women follow behind the plough to raise the fallen beans. Hoes or machetes are also used	Women, men, and children when not in school and casuals
Harvesting	Uprooting	Women, men, youth, children
Threshing	Beating the dried harvested beans with heavy sticks	Youth, children, and women. Men sometimes assist because it requires strength
Winnowing		Solely by children and women. Men support financially by hiring labor

In addition to information provided by FGD participants on gender roles for activities involved in growing beans, key informants added that rain fed beans are planted during the short (March-April) and long rain season (October-November). Ridging is done if the beans are to be irrigated. If the beans are to grow under rainfed conditions, they are planted on flat ground. It was reported that generally, beans do not perform well in Kinna and WFP was to carry out soil testing to investigate the cause of the low productivity. The key informants stated that planting of beans is done by women because men cannot bend for a long time. Beans are generally intercropped with maize, spinach, and onions because it is a legume which fixes nitrogen into the soil. Weeding is done by both men and women at the end of March and in October. Harvesting starts in December and ends in January for beans grown during the short rains and in April/May for the beans grown during the long rain season. According to the key informants from Leparua and Madina beans grown under irrigation do not perform as well as those grown under rainfed conditions. The reasons for the difference however were not provided.

The key informant from Gubadida stated that spraying of beans is done against pests such as aphids and for the application of foliar feed. Single women hire men to carry out the spraying. Like sweet potatoes, watering of beans is done during the day by women and at night by men for the same reasons stated earlier. The key informant from Gubadida added that Irrigation of beans is done when the rains cease. Irrigation is done through flooding by men. Single women hire men to water their plots. Once the harvested beans get to the homestead, the work going forward (winnowing, packing, and storing) is carried out by women. After the beans have been sold, husbands and wives consult each other on how to spend the money.

According to key informants, beans are grown by 70% of farmers in Isiolo County. The proportion of farmers who grow beans varies by location covered in the study areas as indicated in Table 83 Key informants from Leparua reported that all farmers in their community grow beans. The acreage in which they grew beans, or the quantity of harvest was however not indicated. It was evident that key informants who were from the same village provided different estimates for the proportion of farmers who grew beans.

Table 83: Proportion of farmers growing beans in Isiolo

Key informant/village	How many farmers grow beans (%)	Who doesn't grow beans	Why don't they grow beans
Agriculture officer:	Grown by over 70% of the agro-pastoralists	30%	Frequent droughts
Gubadida (Male)	42% local varieties	58%	They are pastoralists, others do not have the skills to farm and do not know the nutritional benefits of beans
Gubadida (Male)	50%	50%	Lack of knowledge by all the community members
Madina (Female)	100%	N/A	
Madina (Male)	20%	80%	Lack of knowledge on the agronomy of beans Many engage in irrigated farming, but beans are not regarded as a priority crop for irrigation
Kambi Turkana (Nadunguro) (Female)	60%	40%	High poverty levels-many are away searching for casual labour to earn a living and hence have no time for agriculture
Kambi Turkana (Nadunguro) (Male)	30%	70%	Challenges in accessing water for irrigation, others are pastoralists and do not farm, while other do not know the nutritional benefits of beans
Kambi Turkana (Nadunguro) (Male)	100%		
Leparua (Female)	100%	N/A	
Leparua (Male)	100%	0%	
Charabdisha (Male)	35%		

Focus group participants were asked whether they have access to new bean varieties. Only participants from two out of five focus groups indicated that they had, although they did not provide the names of the varieties. The two were from the FGDs held in Kone Kalo A& B and Almach. Only one key informant who was an agriculture officer confirmed that they have new bean variety called Nyota. FGD participants reported that 60% to 80% of beans are sourced from outside their communities. Overall, the findings indicate that people are buying more beans compared to five years ago (Table 84).

Table 84: Source and trend in purchase of beans in Isiolo

Key informants/Village	% of beans from outside and inside community	Are people buying more or less compared to 5 years ago?
Gubadida (Male)	Outside, 75%, Within, 25%	Yes
Gubadida (Male)	Outside, 70% Within, 30%	Yes Cheap source of protein
Kambi Turkana (Nadunguro) (Female)	Outside, 70%, Within, 30%.	Yes
Kambi Turkana (Nadunguro) (Male)	Outside, 70% Within, 30%	No Decreased, few farmers are growing it
Kambi Turkana (Nadunguro) (Male)	Outside, 60% Within, 40%	Yes This was a purely pastoralist community. They are now slowly taking p farming. People are buying more beans as they change their diets
Leparua (Female)	Outside, 80% Within, 20%	Yes Because the population is growing. They appreciate beans due to their nutritional benefits and diverse usage
Leparua (Male)	Outside, 60% Within, 40%	Yes Population is increasing and the production of beans is not increasing proportionately
Charabdisha (Male)	Outside, 60% Within, 40%	Yes People are consuming more and production is low, hence buying more compared to five years ago.
Madina (Male)	Outside, 60% Within, 40%	Yes Production is reducing

The key informant who was a nutrition officer stated that 80% of farmers in Isiolo county consume beans. Beans were said to be consumed throughout the year by key informants irrespective of ethnicity, gender and age. They were said to be purchased from the market and grocery stores when the harvests from their farms were depleted. Beans were reported to be made into a stew and consumed with ugali, rice and chapati. They were also mixed with maize to make githeri. Key informants stated that the consumption of beans has increased in the past five years because recurrent drought has negatively affected the pastoralists way of life, forcing some of them to embrace agro-pastoralism.

In addition, more farmers are growing beans because they are realizing its nutritional benefit as a cheap source of protein. Key informants stated that 10% to 30% of the beans grown by farmers were sold, (apart from male FGD Gubadida village where 70% were sold). Fifty to 100% of the beans grown in the study area were reported to be consumed at the household level, with a few being given as a gift to friends and neighbors. It was also evident that key informants from the same village provided different estimates for the various uses of beans (Table 85).

Table 85: Production and utilization of beans in Isiolo

Key informant/village	Percentage of beans used for home consumption, for sale and given as a gift
Gubadida (male)	20% for sale 60% household consumption 20% given out
Gubadida (male)	70% for sale 30% home consumption 0% given out to friends
Madina (male)	20% for sale 60% consumed at home 20% given out to friends
Madina (male)	0% for sale 100% home consumption Due to low production and productivity what is grown is consumed by the families.
Kambi Turkana (Nadunguro) (male)	30% for sale 60% household consumption 10% given out to friends
Leparua (female)	10% for sale 80% home consumption 10% given out
Leparua (male)	10% for sale 70% home consumption 20% gifts to neighbors/friends
Charabdisha/Kinna (male)	Out of 10 kgs of beans: 30% for sale in the market 60% for home consumption 10% for free donation
Burat (Nadunguro) (male)	30% sale 50% home consumption 20% gifts

Baringo county

Key informants and FGD participants stated that beans are grown during long and short rains. They are intercropped with maize or pawpaw. Beans were reported to be mostly grown by women. Men who were reported not to grow beans did so because they considered it a low-income generating crop. Thus, people who were considered wealthy did not grow beans. According to key informants who were agriculture experts, beans are grown during both short and long rains, intercropped with maize. They are harvested between June and July if they were planted during the long rains, and between November and December if they were planted during the short rains. Monocropping of beans is done by large scale farmers. Beans are grown by 70% to 99% of the community, mostly women. Like sweet potato, farmers who do not grow beans are men and wealthy farmers who prefer to invest in small businesses as opposed to growing beans. FGD participants reported similar trends in bean production, where they estimated that 70% to 90% of farmers in the community grow beans. Men and the wealthy were reported not to grow beans because they considered them a low value crop.

Overall, key informants and FGD participants stated that the county has had no access to new bean varieties. Only participants from Bartolimo reported growing newly introduced bean varieties in the area which included Rose coco, yellow beans and Saitoti (red mottled) which they purchased from the market. Most of the beans in Mogotio were reported to be obtained from within the community, while in Perkerra, 75% source their beans from outside their community (Table 86).

Table 86: Source of beans in Isiolo

Key informant/ Location	% of beans from outside and inside community	Are people buying more or less compared to 5 years ago?
Perkerra	Within community, 25% Outside community 75%	People are buying more due to an increase in population
Mogotio	Within community, 70% Outside community, 30%	Community members are buying less because most of them are growing it. However, there has been a change in the last five years due to drought, pests, and diseases. The quality of seeds is poor hence less production
Lembus/Perkerra	100% of the beans come from the community.	People are not buying beans because they plant it in their farms. People are self-sufficient in bean production

Key informants in Marigat reported that 30% of households sell an average of two bags of beans per year. Beans are a good source of food and income because they take a short time to reach maturity. Respondents who planted new bean varieties stated that they are high yielding, mature early and are less acidic to consumers. According to key informants, beans are mostly consumed mixed with maize, daily throughout the year (Table 87). Consumption is not dependent on growing seasons. The elderly, those with ulcers and heartburn and the wealthy were reported not to consume beans.

Table 87: Bean consumption and sale

FGD/ Location	How much beans are used for home consumption, selling, other products?	How often different products from beans consumed?	How has this changed in the past 5 years?
Perkerra	Out of eight harvested bags, 3 bags are consumed at the household, five bags are sold	Daily	
Mochongoi	70% of beans used for home consumption, 30% for sale	Beans consumed daily	It is the same for the last five years, but its consumption is increasing in households
Olkokwe	80% of beans are for home consumption, 20% are for sale	Daily	Currently more people consume it because they have known nutritional value
Lembus/ Perkerra	60% of beans used for home consumption, 40% are sold	Beans are consumed daily	No changes in the last five years

The nutrition officer reported that the county has had no access to new bean varieties. Farmers only plant the traditional varieties. A community leader in Somoko reported that households consume 50kgs of beans per year. The consumption was slightly different in Ndambul where the key informant reported that one bag of beans is consumed per household each year. In terms of change in consumption of beans over the last five years, the key informant from Ndambul reported that the increase in population has resulted in an increased demand for beans.

Tana River county

Key informants stated that beans are not commonly grown in the areas represented in the study. Less than 15% of the population grow it. Where they are grown, it is rarely as a monocrop. It is intercropped with maize soon after the growing maize has been weeded or just after the maize has been harvested. Nyayo, Wairimu and KAT56 (KARI) and Fuwi are the most common bean varieties grown by women above 35 years. Generally, the community doesn't grow HIB and does not have access to many new bean varieties. This was confirmed by FGDs who also added that they grow Nyayo (red mottled beans) and sura mbaya (pinto) varieties.

Key informants reported that 80% to 90% of the population consume beans daily, throughout the year. Beans are consumed more than any other legume grown by the community. Beans are also consumed with ugali or rice mixed with vegetables such as Amaranthus. One of the favorite meals for Somalis is chapati and beans and it is eaten as a delicacy during Ramadhan. Everybody consumes beans except the elderly and those with ulcers. Consumption of beans was said to have increased over the last five years due to increasing population.

Agriculture experts mentioned that they have access to new common bean varieties such as KAT56 (KARI) sura mbaya, Nyayo, and Rose coco. Other types of beans available include soya beans, lima beans, broad beans and Njahi (dolikos lablab). Broad beans which were reported to have grown 'accidentally' were said to be very sweet. The key informant wondered why they were not common in Tana River, yet they are sweeter than any other bean he has tasted. Sura mbaya was reported not to cause flatulence once eaten. Soya bean was said to cook easily but was very expensive in the market. Participants in all FGDs reported that they have never heard about High Iron Beans (HIB).

Garissa county

Key informants reported that beans are grown by 20% to 55% of the community in the study sites, as a monocrop or intercropped with maize. The acreage under beans was reported to vary between 1.5 acres and 18 acres depending on whether the beans were grown by individual farmers or by a group of farmers, where farmers in groups planted beans in large acreages. Due to the incidence of fungal diseases which are mostly prevalent between May and July, the farmers alternate the seasons in which monocropping is done. Farmers who do not grow beans grow cowpeas, green grams, tomatoes, onions and eggplant because they have a high market demand.

Key informants reported that farmers do not have access to new bean varieties. Only one key informant stated that the county has access to a new bean variety in the area called Sura mbaya (pinto beans). A similar finding was observed with FGD participants most of whom reported to not be familiar with new bean varieties.

Key informants stated that beans are consumed daily by about 90% of the population throughout the year everyone in the community. Beans were reported to be consumed in a manner of ways such as boiled and mixed with maize, fried, and eaten with rice or boiled and mixed with potatoes, onions, tomatoes, and green vegetables like spinach. The consumption of beans was reported to have increased over the years with increased population.

Use of improved bean varieties

Isiolo county

FGD participants and key informants discussed challenges that limited the use of improved beans. No access or shortage of bean seeds was the most common challenge, followed by erratic rainfall which sometimes forced the farmers to irrigate their beans. Inadequate water for irrigation meant that some farmers would have to water their crops at night when the water supply and pressure was more. The key informant from Kinna division observed that *'farmers believe beans do not do well under irrigation. they feel it is burdensome [irrigating the beans] and does not earn income.'* This is especially so during a glut of the produce in the market, where the prices of beans fall to unprofitable levels. Wild animals such as elephants and livestock and insufficient knowledge on the agronomy of beans were mentioned as other challenges.

Possible solutions for the challenges mentioned by study participants included availing improved bean varieties to farmers, construction of dams, drilling of boreholes or the use of water pumps to pump water from rivers to suitable storage to improve water supply in the communities for home consumption, livestock and irrigation. Building the capacity of the community on the agronomy and nutritional benefits of beans was also suggested as well building the communities capacity on the benefits of new bean varieties and their agronomy. Reporting incidences of human wildlife conflict to KWS was one of the ways of combating destruction of crops by wildlife.

Baringo county

The most cited challenges that limited the use of improved beans by the community were lack of knowledge of new improved varieties and their importance as well as inadequate information on where to source the improved bean varieties. Other challenges mentioned by respondents included high cost of improved bean seeds, lack of training on new varieties, grazing of the beans by livestock because their farms are not fenced, lack of suitable soil to grow beans, drought or too much rainfall that damages the beans growing on their farms.

A unique challenge cited by the county crops officer was that *'there is suspicion between the differences between Biofortified food and GMOs.'* Suggestions for addressing the challenges included capacity building through demonstrations, provision of starter seed capital to purchase new seed varieties and linking farmers to the market.

Tana River county

Agricultural experts and key informants listed the challenges that limited the use of improved bean varieties which were similar to those reported for sweet potato. This included language barrier especially in rural areas, low literacy levels, vast area to be covered by extension agents which presents logistical challenges, climate change, lack of awareness on improved beans and their benefits, the Mathenge plant (*proprosis juliflora*) which takes over arable land, and general poor attitude towards farming. Agronomic challenges included low bean production, flower abortion, pests such as bean fly, diseases such as bean rust and wild animals.

Garissa county

The challenges that limited the consumption of beans as listed by respondents were like those of sweet potato namely:

- Insufficient knowledge of High Iron Beans (HIB) and other new bean varieties
- Poor marketing networks
- Limited supply of improved bean seeds
- Poor soils
- Climate change effects such as drought and floods
- Pests and diseases - common pests being locusts and nematodes

Many FGD participants stated that they have never heard of HIB. They were only familiar with local varieties.

3.3.4 Access to agricultural extension services

Isiolo county

Challenges that hinder the delivery of information on new crop varieties and crop management practices were highlighted by a key informant from the Isiolo county state department of agriculture. The key informant stated that access to extension information by farmers is low due to inadequate numbers of agriculture extension staff. Isiolo county is vast making it difficult for the limited number of extension staff to reach farmers. Insufficient logistical support in terms of transport facilitation for field visits further exacerbates this challenge. Agro dealers who sometimes offer extension support to farmers are mostly located in town centers.

The key informant reported that awareness creation of OFSP has resulted in over 50% of farmers having access to information on OFSP. The key informant stated that *'WFP has extensively and exhaustively targeted the information to the farmers'* and added that *'the county agriculture extension office has received information on the benefits of biofortified crops through CIP and WFP in conjunction with research institutions such as KALRO and institutions of higher learning such as Egerton University and JKUAT.'* Websites and the state department of agriculture were also mentioned as sources of information on biofortified crops. The key informant reported that information on biofortified crops forms part of agriculture extension package to farmers, however the extent of knowledge about biofortified crops and their benefits by farmers remains low. In this regard, capacity building of extension officers and farmers on biofortified crops such as OFSP, HIB and maize is required due to persistent acute malnutrition reported in the county.

Baringo county

The county crops officer reported that extension services are limited due to low staffing. The government has not increased the number of extension officers and many have retired. Those currently in service are approaching retirement. Only about 40% of farmers in Baringo county are reached with new extension information. This has resulted in farmers not being well informed about the benefits of biofortified crops. The crops officer affirmed that farmers would benefit from training on biofortified crops in particular beans, OFSP and Vitamin A rich cassava. Challenges in availing information on new varieties and crop management practices were listed by the crop officer as the vast area to be covered by few extension staff who have limited resources to facilitate their movement and limited collaboration between research and extension. The officer reported that the county agriculture office has received information about the benefits of biofortified crops which forms part of extension information delivered to farmers. The source of this knowledge was reported to be from Egerton university and Kenya Agricultural and Livestock Research Organization (KALRO). However, the key informant pointed out that there was limited information that covered OFSP and HIB. Interest in receiving more information on biofortified crops was expressed by the crops officer to build a critical data base of information that can be disseminated to other stakeholders.

Tana River county

Key informants stated that extension services are not sufficient for farmers. The demand driven approach to the provision of extension services means that farmers should seek out extension service providers as opposed to waiting for the extension officers to visit their farms impromptu. The key informants stated that building the capacity of farmers in a group rather than individually helps to address this challenge and saves time and resources. In regards as to whether county agriculture extension officers have received information about the benefits of biofortified crops, the key informants had varying responses. The key informant who was a crops officer reported not to have received any information or training and that farmers are not aware of the benefits of biofortified crops. However, the SCAO affirmed that information on biofortified crops has been provided by WFP, KARI and KALRO on OFSP, HIB, maize and cowpeas and they are interested in receiving more information including value addition. The key informants who had not received any information on biofortified crops reported that the information was not part of extension information provided to farmers because they lacked sufficient technical information on biofortified crops.

Key informants and FGD participants listed the following challenges in availing information on new varieties and crop management practices.

- Insufficient number of extension staff some of whom are approaching retirement age
- Few local nutritionists
- Language barrier
- Logistical challenges due to the vast area to be covered. WFP is providing support, but it is not sufficient
- Most farmers are illiterate. Very many farmers are elderly and cannot easily comprehend the agronomic practices being communicated
- Insufficient time to conduct field demonstrations
- Low uptake of technologies by farmers

Some of the beliefs were that beans do not grow in the area and that biofortified foods are GMOs. The beliefs could have influenced production and consumption of beans/biofortified foods.

Garissa county

According to key informants' agricultural extension services are available but not sufficient to cover all farmers. This makes it difficult to access farmers. The extension staff were also reported to be approaching retirement age and new staff are yet to be recruited to replace them. One key informant estimated the number of farmers in the county as 20,000 and the ratio of farmers to extension officers as 300:1. Extension officers were also reported to have a gap in knowledge in emerging trends in agriculture and require their capacity built in this regard. Logistical challenges are also reported due to the vast areas to be covered. The poor road network and insecurity in some areas further exacerbates the situation. The low literacy rates in the county have resulted in low adoption rates of new technologies.

According to key informants, the county agriculture extension office is yet to receive information about the benefits of biofortified crops. They reported that their knowledge about biofortified crops is very low, terming it as an emerging agricultural technology. One key informant stated that *'farmers are more knowledgeable [on the issue of new sweet potato varieties] and we are playing catch up.'* This means that information on biofortified crops and their benefits is not part of extension information. The key informants stated that they would be interested in obtaining more information on biofortified crops so that they can in turn train farmers about them.

3.3.5 Knowledge and attitudes towards biofortified crops

Isiolo county

The key informant who was a nutrition officer stated that 90% of the population is not aware of biofortified foods and that the county has not received any information on biofortified crops. However, the officer reported that he would be interested in receiving further training and information on these foods. He recommended trainings, community dialogue and holding barazas as avenues to inform the population about biofortified foods. Most FGD participants indicated that they were familiar with biofortified foods. However, when probed to provide examples of biofortified foods, the crops they mentioned were not necessarily biofortified but a list of nutritious foods. These included fruits and vegetables. They also did not provide any information when asked what they knew about High Iron Beans (HIB).

Some FGD participants in Kambi Turkana were familiar with OFSP. They mentioned that *'It is food for all especially children and has benefits such as Vitamin A.'* Another participant in the FGD held in Gubadia stated that OFSP is *'Soft when eating, its leaves are used as vegetables, it is rich in Vitamin A, it can be eaten raw or boiled and is easily mashed for children and even the malnourished . . . it can be dried, mashed and flour mixed with wheat flour for baking.'* The FGD participants did not link OFSP to biofortified foods. It is therefore evident that building the capacity of the community on biofortified foods is important.

All FGD participants did not know about HIB, with some stating that they have never heard of them. They therefore did not articulate their health benefits when asked to do so. Some FGD participants however reported to know the health benefits of consuming OFSP. All male FDG participants in Rapsu, 20% of female participants in ElsaNtrim and 30% of FGD participants in Attir reported to know the benefits of consuming OFSP sweet potato. They mentioned that OFSP enhance food security, strengthens the body, contain vitamin A, and are good for pregnant, lactating mothers and young children. They added that they make one feel full for a long period of time. Male participants in the FGD held in ElsaNtrim stated that OFSP are good for maintaining healthy eyes and cognitive development.

Participants of FGDs were asked in which form they utilize OFSP and HIB and whether they utilize processing and preservation techniques for sweet potato. As reported earlier, participants in all FGDs were not familiar with HIBs. However, some participants in FGDs held in Kone Kalo A&B and Almach village, familiar with OFSP, reported to consume them after boiling, mashing, or frying. Focus group participants suggested that planting materials (OFSP vines and HIB) should be provided to farmers by the government and NGOs for planting. They added that they should be bulked to increase their availability within the community. Construction of dams, digging of boreholes and the purchase and installation of water storage tanks were suggested to increase the availability and accessibility of water for irrigation and use at the household. Capacity building of the community on growing and utilizing OFSP and HIB was also suggested. To combat the wildlife menace, FGD participants suggested that the Kenya Wildlife Service (KWS) averts human wildlife conflict by taking necessary measures required to keep wildlife out of their farms.

Baringo county

All FGD members across the study sites reported that they did not know about Vitamin A micronutrient rich biofortified foods and crops. Very few mentioned fruits such as oranges, mangoes, pawpaw and vegetables as natural foods rich in vitamins and micronutrients. All FGDs reported to know nothing about OFSP and HIB and stated that they are not growing either of the crops. The primary reasons provided was difficulty in accessing the planting materials and lack of knowledge. All FGD participants apart from female focus group in Ndambul, agreed that it is important for children under five, pregnant and lactating women to consume vitamin A and iron rich foods. They stated that vitamin A was important for good health, protection of children against diseases, and growth. The participants in the FGD in Ndambul reported not to know the importance of vitamin A and iron rich foods. None of the FGD participants reported to know about nutritional cooking demonstrations using OFSP and beans, nutrition education about using OFSP and beans for feeding infants and young children, individual nutrition counselling programs on the use of OFSP and beans or received training on any aspects of sweet potato and bean production and processing.

Tana River county

Asked whether people were aware of the benefits of biofortified foods, the key informants stated that most people cannot differentiate between biofortified and non-biofortified crops or food. One key informant said that *'biofortified crops is a new concept, majority are illiterate and are not aware. County officers have also not received any training on the benefits of biofortified crops, but they would be interested to be trained on maize, cowpeas and rice.'* The officers stated that the best way to inform the community about biofortified crops would be through local radio stations, digital print (that is youth friendly), pamphlets, posters and brochures, mother to mother support groups, barazas, Farmer Field Schools, agricultural shows, Farmer Organizations, and through community health workers who can pass the information to the community. FGD participants knowledge about biofortified foods and crops was mixed, with some being familiar while others unfamiliar with the crops. Those who affirmed that they were aware of biofortified foods and crops mentioned foods rich in micronutrients and vitamins. These foods were not necessarily biofortified.

Garissa county

All FGD participants reported to know about biofortified foods. However, when asked to provide some examples of biofortified foods, they listed meat, milk, kales, amaranthus (mchicha), tomatoes, cabbages, carrots, mangoes, beans, green grams, meat, and citrus fruits. They stated that mangoes contain vitamin A, citrus fruits are rich in vitamin C and milk is rich in vitamin B. When asked what they know about HIB and biofortified foods, two FGDs reported to know nothing about biofortified foods. The remaining three FGDs responded that OFSP prevent infection and makes skin healthy. They added that they are used as a source of food and income. All FGD participants reported that they are not familiar with HIB.

FGD participants stated that they were ready and willing to consume OFSP and HIB, provided some suggestions on how access to OFSP and HIB could be improved. They suggested that sweet potato vines are made more readily available, regular refresher trainings for the farmers to enhance their productivity of OFSP and HIB, the provision of inputs to support their production of OFSP and HIB such as pesticides and farming tools, construction of a permanent irrigation canal, mass production of the crops, regular monitoring of their progress. None of the participants reported to use processing and preservation techniques for sweet potato or beans.

3.3.6 Health and nutrition

Isiolo county

The nutrition officer affirmed that malnutrition is a problem in the county and reported that 50% of the population suffered from malnutrition. Rural areas of Isiolo are affected more than the urban areas. The population most vulnerable to malnutrition were stated as children, pregnant and lactating mothers. The nutrition officer reported that vitamin A deficiency is not an issue in the county, but iron deficiency is. Iron deficiency affects 25% of the population with most vulnerable being pregnant women and women of reproductive age. The main source of Vitamin A in the community was indicated as green vegetables, mangoes, pawpaw, carrots, while the sources for iron were green vegetables and local beans.

When asked what they knew about nutrient deficiency, FGD participants stated that it means lack of important nutrients in the body, being sickly, lack of strength to farm, feeling weak, being anemic, fainting and ultimately death, having brain problems, being inactive and lazy, having deficiency diseases like kwashiorkor and marasmus, low body immunity, poor health, poor growth, and loss of weight. All FGD participants agreed that it is important for children under five and pregnant women to consume iron rich foods. The reasons given were for *'the formation of enough blood in the body especially for expectant mothers and children'*, for strong and healthy bodies, for the health of lactating and pregnant mothers, for increased milk production for lactating mothers and to boost the immunity of children and expectant mothers.

When asked whether they believe that women between 15 and 49 years of age and lactating women should eat more nutritious foods including biofortified OFSP and HIB, all FGD participants responded in the affirmative. They all agreed that doing so would be beneficial for good health and immunity, reproduction, and milk production by lactating mothers. However, it was observed that in five out of ten focus groups less than half of the participants reported to have access to nutritious foods. Some of the challenges that prevented them from accessing nutritious foods included insufficient funds to purchase nutritious foods, insufficient knowledge on the importance of nutritious foods and erratic rainfall that resulted in insufficient water to grow nutritious foods (Table 88).

Table 88: Challenges in accessing nutritious foods

FGD/Location	% with access	Challenge
Kinna North (Female)	40	Insufficient funds to purchase nutritious foods
Kinna North (Male)	30	Lack of nutritional knowledge
Rapsu (Male)	30	Lack of knowledge on nutrition
Rapsu (Female)		Lack of knowledge on nutrition Wildlife menace
Ngaremara (Male)	30	Lack of irrigation water Poverty Cattle rustling
Attir (Male)	80	Low incomes - poverty or low wages
Kilimani (Female)	40	High poverty levels due to low incomes Lack of irrigation water
ElsaNtrim (Female)	50	Inadequate knowledge on nutritious foods Poverty
ElsaNtrim (Male)	30	Poverty due to low incomes Inadequate water for farming. They cannot afford to purchase fuel to run generators Erratic rains
Waso area (Male)	70	Lack of adequate water for farming Low household income

Suggested solutions for the challenges they mentioned included providing women with seed capital or grants to start income generating activities, such as beekeeping, that would provide them with finances to purchase nutritious foods. Building the capacity of the communities on the importance of nutritious foods, provision of drought tolerant fast-growing planting material for nutritious crops such as vegetable and sweet potato were mentioned as other possible solutions. Cattle rustling was reported to make the communities poor, reducing their ability to purchase nutritious foods. It was believed that solving this problem will leave the communities in a better position to purchase nutritious foods. Provision of water for irrigation was mentioned as a solution to insufficient water for growing nutritious foods. Digging boreholes and shallow wells and repairing damaged boreholes were ways of improving access to water for irrigation. Suggestions for addressing the wildlife menace were provided as the erection of an electric fence to keep away wildlife from destroying their crops. Lastly, the FGD participants suggested the provision of cash transfer by the government and NGOs to enable them to purchase nutritious foods.

Key informants mentioned the various ways members of the community gathered knowledge about nutritious foods, health, hygiene, and safe drinking water. Some of the sources were

- Community Health Volunteers (CHVs)
- Mass media – radio and TV
- Nutrition health centers and dispensaries
- Mother and child support groups
- Agriculture extension staff
- Agricultural meeting/trainings
- Chief barazas
- Non-Governmental Organizations (NGOs)
- Schools

- Church seminars
- Friends
- God given knowledge

Organizations involved in disseminating this information included, Ministry of Health, Health department of the county Government, NGOs such as Living Good, WFP, Caritas, Catholic Relief Service (CRS) and Action Aid. All FGD participants except those from the FGD held in Almach reported that they have never practiced cooking using OFSP and HIB or practiced nutritional education using OFSP and HIBs for infants and young ones. All FGD participants reported to have never practiced individual counseling program on the use of OFSP and beans or been trained on production and processing of OFSP and beans. However, all FGD participants affirmed that they tried in giving nutritious foods to children under five years old. The types of foods eaten at the households and the ones given to children under five years of age are outlined in Table 89.

Table 89: Types of nutritious foods consumed by adults and children under five years

FGD/Location	Types of nutritious foods consumed at the household	Foods consumed by children under 5 years
Kinna North (Female)	Rice, beans, ugali, vegetables, kales	Porridge from maize meal and milk, fruits, milk
Kinna North (Male)	Rice, ugali, milk, fruits e.g., mangoes, bananas, pawpaws, guava. Vegetables e.g., tomatoes, spinach, kales	Beans, sweet potato, mashed together, milk
Rapsu (Male)	Rice, beans, ugali, githeri, vegetables e.g. cabbages, kales, green grams, milk in tea, with ugali	Mashed sweetpotato, beans mashed with Irish potatoes, milk bananas, meat
Rapsu (Female)	ugali and milk, rice and beans, kales, pawpaw, watermelon, avocado, mangoes	Mashed bananas, beans, sweet potato, pawpaw, eggs breastfeeding up to two years
Ngaremara (Male)	Ugali and vegetables such as kales and spinach, spaghetti with beans [Wairimu variety], rice with beans, Irish potatoes and tomatoes, eggs	Bananas, milk, avocados, Irish potatoes, pumpkins, spinach, green grams
Attir (Male)	Kales, cowpeas, tomatoes, ugali	Bananas, sweet potato, cowpeas, milk
Kilimani (Female)	Rice, chapati, ugali spinach and kales, and githeri	Banana mixed with potatoes and spinach, rice, porridge, ugali
ElsaNtrim (Female)	Beans, rice, kales, githeri, ugali with vegetables and meat	Milk, porridge, eggs, vegetables, breastfeeding exclusively for six months, pumpkins, bananas, mashed Irish potatoes
ElsaNtrim (Male)	Ugali with greens/vegetables, githeri, carrots, tomatoes, ugali with milk, beans	Milk, vegetables, ugali in milk
Waso area (Male)	Githeri with spinach, kales, cowpeas, rice with vegetables e.g., kales., ugali with greens or beans	Ugali with milk, Irish potatoes mashed with bananas, porridge composed of millet, sorghum and maize, fruits-pawpaw, oranges

The most common foods consumed at the household are ugali, rice, beans, githeri, milk, fruits, and vegetables. Children under five years consumed cow's milk, beans, cooked banana, pumpkin, Irish potato, and sweetpotato. All FGD participants agreed that sweetpotato improves the eyesight for children under five years old (Table 90).

Table 90: Use of sweetpotato for children’s health, eyesight, and cognitive development

FGD/Location	Agree sweetpotato improves <5 children’s health and eyesight?	Agree sweet potato improves <5 children’s cognitive development
Kinna North (Female)	Yes, <i>‘good health and hence strong for controlling disease infection’</i>	Do not know
Kinna North (Male)	Yes <i>‘but do not know much about it’</i>	Do not know
Rapsu (Male)		Do not know
Rapsu (Female)	Yes	Yes
Ngaremara (Male)	Yes	Yes
Attir (Male)	Yes. <i>“Like carrots and it has Vitamin A which helps in eyesight.”</i>	Yes
Kilimani (Female)	Yes <i>Rich in vitamin A</i>	Yes
ElsaNtrim (Female)	Yes <i>It contains vitamin A</i>	Yes
ElsaNtrim (Male)	Yes	Yes
Waso area (Male)	Yes	Yes

However, all participants in three out of the ten focus groups were unsure about sweet potatoes ability to improve the cognitive development of children under five years of age.

Baringo county

The nutrition officer reported that malnutrition is an issue in Baringo county. According to the nutrition officer, about 9% (and 20% in Tiaty) of the population suffer from malnutrition. Children under five years old, pregnant, and lactating women in rural areas and those living in informal settlements were reported to be the most vulnerable. An upcoming problem of over nutrition in the town centers was reported by the nutrition officer that, about 3% of the population was described as overweight. Vitamin A deficiency was also reported as a concern in the county with children under five years and those with chronic illnesses being vulnerable. The Key informant also reported that forty one percent of the population suffered from Vitamin A deficiency and 33%, most of whom were children, were reported to be marginally deficient.

Iron deficiency was also reported as a problem in the county with women of reproductive age and teenage girls being the most vulnerable. It was reported by the nutrition officer that sixty percent of women and girls were suffering from iron deficiency. When asked whether they have access to nutritious food, most of the FGD participants stated that they do not always have access (Table 91). Reasons provided for their inability to access nutritious foods were low incomes which limited their ability to access the foods that were viewed as expensive and low production of nutritious foods.

Table 91: Access to nutritious foods

Location/FGD	Do HH have access to nutritious food?	Challenges	Solutions
Bartolimo (Females)	Not all	Low-income Low Production	Community members to participate in Income Generating Activities (IGAs) Households to practice use of fertilizer and manure
Bartolimo (Males)	30% of households access nutritious food	Low-income Low food production	Assistance to empower the community members Training on good agronomic practices Support on improved varieties of various crops
Ndambul (Male)	40% of households access nutritious food	Low income Lack of Knowledge on nutritious food	Provision of seed and support in terms of training. Household to engage in IGAs
Labos vill 2/Ndambul (Females)	Not always	Low Incomes Low productivity Nutritious foods are expensive	Community members participate in IGAs Training communities on IGAs

FGD participants were knowledgeable about nutrient deficiency. They reported to receive this information during hospital visitations and through community health workers, clinics, and chiefs (Table 92).

Table 92: Knowledge about nutrient deficiency

FGD/Village	What do you know about nutrient deficiency?	How do you gather knowledge about nutritious healthy food?
Bartolimo (Females)	Causes low immunity and stunted growth in children Results in slow learners for children	From Public Health Personnel while attending clinics for mothers USAID Project
Bartolimo (Males)	Malnutrition, rickets, shortage of blood, kwashiorkor	Attending women clinics and when visiting hospital
Ndambul (Male)	Lack of enough food, kwashiorkor, children with brown hair, malnutrition	From community members, Community Health Volunteers, chief barazas, church, main media, social media
Labos vill 2/Ndambul (Females)	Shortage of blood, malnutrition, stunted growth for children	Community health workers, public health, USAID, attending clinics by mothers, trainings and barazas

FGD participants indicated that the nutritious foods they consumed were githeri, ugali, vegetables and meat. They also reported that households try to provide nutritious foods to children under five years old such as milk and fruits. However, when asked in which form, they utilize HIB, they seem to have misinterpreted HIB with the traditional bean varieties (Table 93).

Table 93: Types and forms of nutritious food

FGD Village	Types of nutritional food that households eat?	HH make effort to give nutritious food to children <5 years	Form in which HIBs are utilized	Form in Which OFSP utilized
Bartolimo (Females)	Ugali, Githeri (Maize cooked with Beans), Cassava, Fruits, Porridge	Yes: Milk	Beans are cooked with maize. 90% consume beans when cooked with maize.	In raw form, boiled or roasted
Bartolimo (Males)	Githeri, Ugali, vegetables, meat	Yes: Fruits, milk	Beans cooked with maize and rice	Boiling for sweet potatoes
Ndambul (Male)	Ugali, vegetables, tea, meat	Yes: milk, fruits.	Cooked with maize, potato, or rice	Boiling
Labos vill 2/Ndambul (Females)	Ugali, vegetables, githeri, Porridge	No: feed on what is available, milk	70% of community members consume beans with maize	OFSP is utilized as boiled and consumed with tea

FGD participants agreed that sweet potato including biofortified varieties improve children under five health and eyesight development. All FGDs apart from the female FGD in Bartolimo agreed that sweet potato including biofortified varieties improve children's cognitive development. However, not all FGD participants reported to know about the benefits of consuming sweet potato and beans. All males in the Bartolimo FGD and females in the Ndambul FGD reported to know the benefits of consuming sweet potato and beans, while no female participant in Bartolimo and 17% of male participants in Ndambul knew about the benefits of consuming sweet potato and beans (Table 94).

Table 94: Benefits of consuming sweetpotato including biofortified varieties

FGD	Do you agree sweetpotato including biofortified varieties improve under 5 children's health and eyesight development?	Do you agree sweetpotato including bio fortified varieties improve children's cognitive development	Do you know the health benefits of consuming sweetpotato and beans
Bartolimo (Females)	Yes	Not aware	No, 0% All do not Know
Bartolimo (Males)	Yes 'Beans are body building foods. Protect the child against diseases.'	Yes 'Makes the children active in their development.'	Yes, 100%
Ndambul (Male)	Yes 'Help in developing good eyesight'	Yes 'Helps in cognitive development of children as it is rich in micronutrients,'	Yes, 17% 'Development of bones, proper growth, development of blood cells'
Labos vill 2/Ndambul (Females)	Yes	Yes 'Improve children's health'	Yes 100% 'Protects the body against diseases and provides good health'

The nutrition officer stated that the main food sources of vitamin A in the county are vegetables with dark green leaves, fruits, pawpaw, carrots, eggs, and cooking fat. The main sources of iron were mentioned as beans, millet, animal products such as heart and kidney, and iron supplements for pregnant women. The key informant stated that most of the community is not aware of the benefits of biofortified crops because they have not been promoted in the county. However, the county nutrition office reported to have received information on the benefits of biofortified crops such as the OFSP. This information was made available by WFP and the National Nutrition and Dietary Unit program. The nutrition officer expressed interest in receiving further training on biofortified crops to promote their consumption. According to the officer, the best way to inform the community about biofortified crops would be through organized groups such as mother to mother support groups, farmer field days and local radio stations (FMs), extension services and health facilities.

FGD participants provided suggestions on improving access to OFSP and HIB as well as other nutritional foods for better nutritional status of children and mothers in the community. These included:

- The Ministry of Agriculture should provide planting materials for OFSP and HIB
- Training and demonstration by agriculture officers on good agronomic practices of these crops
- The Ministry of Agriculture should support soil analysis for the community to know the right crops to grow
- Subsidize prices for planting materials and seeds
- County to support farmers with starter seeds
- More research on nutritious foods
- Ministry of agriculture to link with research institutions in availing of nutritious food varieties
- Provision of exchange visits to farmers

Tana River county

FGD participants were asked what they knew about nutrient deficiency. They responded that it meant being thin, pale, sickly and weak. Children with low appetite, slow growth, low iron, and a big stomach (kwashiorkor) were nutrient deficient. Key informants agreed that malnutrition is a problem in the county. The most vulnerable population are children aged 6 to 59 months old, expectant mothers with more than half of the women being affected as well as poor households due to their poor access to iron rich foods. Children under five years of age were reported to be prone to infections. The proportion of the population that suffers from malnutrition were estimated to be 27% of the population, 13.1% of whom are children. Main food sources for Vitamin A were listed as mangoes, meat, vegetables, pawpaw and oranges, vitamin A supplements and green leafy vegetables. The nutrition officer stated that vitamin A deficiency is not a problem in the area because the population gets supplements regularly. However, the nutrition officer affirmed that vitamin A deficiency is a problem affecting less than 5% of the population and it is not easily detected prior to infection.

When asked whether they had access to nutritious food, few FGD participants agreed. The nutritious foods that FGD respondents listed included spinach, kales, ugali, rice, beans, bananas, mangoes, and meat. When asked whether it is important for children under five and pregnant women to consume vitamin A and iron rich foods, all FGD participants responded in the affirmative. They said vitamin A is important for immunity, eyesight, energy levels and general good health. Iron was said to be important for reducing anemia in expectant and lactating mothers.

The challenges in accessing nutritious food were stated as high cost, drought, and the town centers where nutritious foods can be purchased being too far away. Another challenge was the pastoralist way of life gets in the way of accessing nutritious food leaving the only food available as meat and milk. Possible solutions to these challenges mentioned were for government and development partners to encourage pastoralists to take up agriculture so that they can grow nutritious foods and provide planting materials such as seeds and vines, support to purchase the inputs required to grow nutritious foods such as water pumps for irrigation, fertilizers, and farming tools.

Participants from all FGDs reported that they tried to give nutritious foods to children under five. They fed their under-five years old with porridge mixed with rice, groundnuts, wheat, and beans. Spinach, kales milk, beans, yoghurt, porridge mixed with groundnuts, maize, rice, and meat were other crops fed to children under five years old. Some FGD participants stated that they fed they're under five years old children with camel milk which they believe boosts their immunity and growth. Most FGD participants agreed that women between 15 to 49 years of age, lactating mothers should eat nutritious foods and that sweet potato improves the eyesight and cognitive development of children under five years of age (Table 95).

Table 95: Benefits of nutritious foods

FGD/ Location	Do you agree that women between 15-49 & lactating women should eat nutritious food	Agree SP var improve <5 children's health and eyesight?	Agree SP var improve <5 children's cognitive dev?
Makere (Male)	YES Prevents anemia for pregnant and lactating women	YES OFSP have high levels of vitamin A that improves health and eyesight development for children under 5 years and it also increases /boosts immunity.	YES OFSP has high nutrients especially vitamin A that improves the growth and development of young children
Makere (Male)	YES To boost their blood and general health	YES Vitamin A is important for eyesight and growth and development	YES it helps children in growth and development
Bura (Male)	YES They should take nutritious food to prevent diseases, like lack of blood and malnutrition	Don't know	Don't know
Bura (Female)	YES To prevent diseases, low blood levels and malnutrition. Helps in boosting immunity	Don't know	Don't know

Main food sources for iron were listed as spinach, kales, meat and Amaranthus. FGD participants provided some suggestions to improve access to nutritious foods. Interestingly, only male participants (43%) from the FGD held in Makere village reported to have practiced cooking using OFSP and beans. They also learned how to cook OFSP mixed with other vegetables and how to prepare chapatis, as well as a sauce from sweet potato made by boiling it then mixing it with tomatoes and onions. They also learnt how to prepare beans with vegetables, sorghum, and sweet potato and how to make a sauce for chapati. The training, which the participants found useful, was provided by WFP Staff, nutritionists, and agricultural extension officers.

All FGD participants stated that they have never practiced individual counseling program on the use of OFSP and beans. However, the FGD participants from Makere indicated that they had been trained on nutrition education about OFSP and beans for feeding infants and young ones where they learned that sweet potato should be boiled then blended and mixed with porridge and fed to young children. FGD participants stated that they obtain information about nutritious food, health, hygiene and safe water from the radio and community health workers. Organizations involved in providing this knowledge were the Ministry of Health WFP, World Vision, and the Red cross (Table 96).

Table 96: Source of information on health, nutrition, and hygiene

Sub county	How gather knowledge about nutritious food, health, hygiene, safe water etc.	Which organizations are involved in providing such info?
Tana River	Community health workers Radio	Ministry of Health World Vision Islamic teaching to practice good hygiene
Tana River North	Radio Health workers	
Tana River North	Health workers Health centers	
Tana River	Community Health workers, Radio	WFP, World Vision, Ministry of Health, Red Cross

Garissa county

All FGD participants agreed that women between 15 to 49 years of age and lactating mothers should eat nutritious food. The reasons they provided were nutritious foods help lactating mothers with milk production, boosts immunity, makes them healthy and strong and protects them from minor ailments. In Mudey location, only 20% of the female FGD participants reported to know the benefits of consuming sweet potatoes, while 50% of their male counterparts reported to know the benefits. In Sankuri location all male participants did not know about the benefits. Lastly, in Iftin location all female participants reported to know about the benefits. All FGD participants agreed that it is important for children under five years, expectant and lactating mothers to consume foods rich in vitamin A. They stated that vitamin A increases their blood levels and their immunity, and it is important for good health, strength, and growth. It helps lactating mothers increase their milk production and prevents anemia.

Participants from all FGD affirmed that they try to give nutritious foods to children under five years old. The nutritious foods included porridge, milk, sweet potato, rice with beans, mashed potatoes, meat and biofortified porridge which was a mix of beans, groundnuts, and maize. The nutritious foods eaten by adults included foods such as rice, beans, onions, tomatoes, ugali, kales, pancakes, eggs, chapati, anjera, milk, beans, mandazi, porridge, maize, and cowpeas. Three out of five focus groups reported to have practiced nutritional education using OFSP and beans for their young ones. The trainings were provided by Ministry of Agriculture (MoA), WFP, and the department of Nutrition. Participants found the trainings useful as they were taught new cooking methods for infants (Table 97).

Table 97: Capacity building on biofortified foods

FGD	Have you practiced nutritional education using OFSP and beans for infants & young ones?	Who provided the service or training?	Was the training useful?	What did you learn that you are practicing now?
Danyere (Female)	Yes	MoALF & WFP	Yes	New skills in cooking methods i.e., with other ingredients
Sankuri (Female)	No	No	No	No
Sankuri (Male)	No	No	No	No
Danyere (Male)	Yes	MoALF, WFP, nutrition Dept of the Ministry of Health	Yes	Proper cooking methods of OFSP and beans, importance of OFSP and beans for infants and young children
Iftin (Female)	Yes	WFP, health department of the Ministry of Health	Yes	

None of the FGD participants reported to have practiced individual counselling program on use of OFSP and beans.

The FGD participants described nutrient deficiency as being prone to infections because of poor eating habits such as eating food low in iron and vitamins. Children with nutrient deficiency were said to have low weight, look stunted and weak, and lacked vitamins and nutrients. They were also said to have loose skin and sullen eyes. Nutrient deficiency they said, can lead to malnutrition and kwashiorkor. When asked whether they agree that sweet potato varieties improve the eyesight and health of children under five years old, most FGD participants were unsure. However, one female participant from Iftin location stated that *'I experienced eye problems but by the time I had access to OFSP and consumed them every morning as breakfast, my eyesight improved and now I can see well. So, the OFSP is very important for everyone.'* Nearly all FGD participants did not know whether sweet potato improves the cognitive development of children under five.

FGD participants stated that they have access to nutritious food. However, they reported that they face challenges that hinder them from accessing nutritious food. These included:

- Inadequate farm productivity which was further compounded by the locust invasion
- Poor market
- The main market being far away hence food is not fresh
- Transport cost to the market is high, increasing the cost of accessing nutritious food
- Nutritious food is expensive
- Lack of information on nutritious food
- Poor transport network
- Unreliable food availability

Suggested solutions provided by the FGD respondents to overcome these challenges included educating the community on food production techniques and skills, build the communities capacity in dealing with locust invasion, improving food supply in the local markets to reduce travel to distant markets in search of nutritious foods, increasing production of nutritious foods within the community, improving the road network to ensure food is delivered faster, providing cash transfers or vouchers to collect vegetables from market, improving access to vines for planting, HIB seeds and pesticides from CIP and WFP and educating mothers on nutritional feeding for themselves and their children. They also suggested periodic nutritional training through for example, cooking demonstrations.

3.3.7 Hygienic practices

Isiolo county

Asked what they knew about hygiene practices, majority of the FGD participants mentioned practices that related to good body hygiene such as washing hands before cooking, after visiting the toilet or after changing children, cutting nails, and regularly having a bath. Other practices included keeping their houses clean, cleaning utensils, washing their clothes, and disinfecting their bodies. Hygiene practices that related to food included washing fruits and vegetables before cooking and eating, using clean and safe drinking water, eating healthy food, and storing food safely. Keeping their surroundings clean by cleaning their homes and compound were regarded as important health practices, like constructing a toilet in the homestead, using toilets, and having a designated area or pit to dispose of household waste. Lastly, FGD participants suggested that it was important to avoid contracting diseases such as COVID-19, cholera and other '*diseases of the dirt*' and build the bodies immunity through good hygiene practices. However, analysis of the data revealed that even though a majority of FGD participants knew about hygiene practices not all of them implemented the practices due to constraints such as insufficient knowledge about hygiene practices, poor access to safe drinking water, lack of toilets, age, and poverty (Table 98).

Table 98: Hygienic practices

FGD	Do Household practice good hygiene?	Reasons for not practicing	Solution
FGD/Location	Yes, 70% No, 30%	Age, they are aged	Being assisted by younger ones
Kinna North (Female)	Yes, 40% No, 60%	Due to poor accessibility to water and lack of knowledge on good hygiene	Water storage tanks for both home use and farm use in irrigation even for kitchen garden. Training on good hygiene practices
Kinna North (Male)	Yes, 10% No, 90%		Building the capacity of the community on good hygiene Provision of safe drinking water Assistance in construction of home toilets
Rapsu (Male)	Yes, 10% No, 90%	Poor access to toilets	Capacity building Assistance in construction of home toilets
Rapsu (Female)	No, 100%	Lack of water	Provision of water by repairing the borehole pumping system in the area

Ngaremara (Male)	Yes, 70% No, 30%	Elderly do not have the strength to construct toilets Poverty	Cash for the elderly so that they can hire casual labor to maintain health hygiene. Support from community members
Attir (Male)	Yes, 60% No, 40%	High poverty levels Low income Inadequate water from boreholes	Support the community with building material for the toilets, installation of water pipes-piping of water to homes. Drilling of boreholes
Kilimani (Female)	Yes, 80% No, 20%	Ignorance	Capacity building/training on importance of hygiene, Enforcement of laws towards good hygiene practices of having toilets in homesteads
ElsaNtrim (Female)	Yes, 70% No, 30%	Poverty Ignorance	Capacity building on hygiene, Law enforcement on good hygiene.
ElsaNtrim (Male)	Yes, 90% No, 10%	Ignorance, lack of understanding and knowledge of hygiene	Capacity building on hygiene

The participants suggested capacity building of the community on good health and hygiene practices, construction of toilets in homesteads, provision of water to homesteads through drilling or repair of boreholes and supporting the elderly to access toilet facilities (Table 78). FGD participants were asked if they knew the health benefits of hygiene and practice. Eighty percent to 100% of FGD participants reported to know about the benefits which they mentioned as prevention of amoeba, diarrhea, water borne diseases and cholera, good for healthy bodies and growth and boosts immunity. Good hygiene practice was also reported to command respect from the community. Focus group participants were asked whether they practiced good health and hygiene.

Baringo county

FGD participants were asked what they knew about good hygiene practices. Their responses outlined in Table 99 can be summarized as boiling drinking water, washing hands regularly and cleaning the house and environment. Use of toilets was only mentioned by male participants of the FGD held in Bartolimo village.

Table 99: Knowledge on hygienic practices

FGD	What do you know about Hygiene Practice?
Bartolimo (Females)	Boiling of drinking water Clean kitchen and utensils Regular washing of hands Washing of fruits from market before washing
Bartolimo (Males)	Cleanliness, clean compound, use of toilets, boiling of water, washing hands regularly
Ndambul (Male)	Cleanliness, regular washing of kitchen, using toilets, handwashing, cleaning of environment
Labos vill 2/Ndambul (Females)	Handwashing, cleaning the house and environment, cleaning bushes, clean air

All FGD participants indicated that they understood the health benefits of hygiene and practice in order that they stay healthy, prevent spread of disease, reduce infections, for healthy living and for strong bones. Some participants in the Ndambul FGD linked good hygiene to the prevention of contracting COVID-19. All female participants of the FGD held in Ndambul and 30% of male participants in the FGD held in Bartolimo stated that they follow health hygiene and drink safe water. They agreed that the critical times for handwashing included before and after eating, after changing toddlers, after visiting the toilet, after work and before cooking.

Tana River county

All FGD participants reported to follow health hygiene practices. The critical times at which they washed their hands included before praying, before and after eating, after visiting the toilet and before food preparation and before breast feeding. All FGD participants reported to know the health benefits of good hygiene practice. They stated that good hygiene reduces infections and waterborne diseases like cholera, typhoid and that a clean environment is beneficial to one's psychological well-being. Challenges limiting good hygiene practice were mentioned by FGD participants as:

- insufficient training on good hygiene
- lack of clean water
- poor access to sanitation facilities such as toilets

To address these challenges, FGD participants suggested better water supply that is safe for consumption, provision of water guard and chlorine to treat water.

Garissa county

FGD participants reported that they practiced personal hygiene by having a bath, washing hands after using the toilet, wearing good and clean clothes, cleaning children, and cutting nails. They also emphasized the importance of maintaining environmental hygiene by keeping the environment clean and proper waste disposal and construction of proper toilets. All FGD participants reported to practice good hygiene by washing their hands at critical times such as after using the toilet, after praying, after cleaning the bathroom, and before and after eating. They also washed vegetables before cooking and treated water before drinking.

All FGD participants acknowledged that they know the benefits of health hygiene practice. The benefits included a healthy environment, increased lifespan, improved health status of families and it ensures that there are no communicable disease outbreaks in the community such as cholera. Most respondents reported to gather information about nutritious food, health, and hygiene from organizations such as the Ministry of Agriculture, World Food Program and World Vision. Other avenues included the county nutritionists, the radio, seminars, Islamic teachings, community health workers and the health center. The Ministry of Health was also reported to create awareness to the community about hygiene, twice in a month. However, FGD participants reported to face challenges that hindered them from practicing good hygiene such as lack of safe drinking water, inadequate sanitation facilities and insufficient knowledge on hygiene practices (Table 100).

Table 100: Challenges in adopting hygienic practices in Garissa

Division/FGD	Challenge	Solution
Danyere (Female)	Lack of safe clean water Limited knowledge on hygiene by the community	Provide safe clean water Regular health promotions
Sankuri (Female)	Challenges are insufficient water, Lack of knowledge Lack of toilets	Increased water supply Capacity building on hygiene practices Construction of latrines
Sankuri (Male)	Lack of toilets Insufficient water Language barrier Ignorance Lack of trainings Lack of IEC (Information, Education and Communication) materials	Help in construction of latrines Provision of health facility in the area
Danyere (Male)	Inadequate sanitation facilities Lack of public health staff	
Iftin (Female)	Lack of training on good hygiene practices Poor toilet infrastructure Lack of clean water	Construct toilets Better water supply for the community and safe for consumption

Regarding access to drinking water, one FGD participant from Iftin reported that *'the only challenge we have here is drinking safe water. The water is from the Tana River and that is the one we are using for drinking and it's not safe and for us we do not have cash to buy water guards and chlorine to make the water safe.'*

3.3.8 Women empowerment

Isiolo county

Most participants perceived women empowerment as empowering women financially through business enterprises that were focused on income generating activities such as kitchen gardens and poultry keeping. They also viewed it as a means of enabling women to be part of groups such as table banking groups. Empowered women were those who had access to water and were happy (Table 101).

Table 101: Women empowerment

Village	Gender*	Understanding of women empowerment (women empowerment is....)
Jilo Dima East	F	Assisting women in businesses
Jilo Dima East	F	Assisting women with seed capital for businesses, purchase, and installation of water storage tanks for use in the household and kitchen garden, irrigation for production for home and the market. Women having their own business e.g., poultry keeping. Assisting women with vegetable seeds for their kitchen gardens
Kone Kalo A&B	M	Women taking part in decision making
Kone Kalo A&B	F	Healthy women are happy women. Women having businesses, supporting women farmers to access market for farm produce, training women on how to do business
Almach	F	Starting and running a business, having income generating activities, being active in a merry-go-round

Attir	M	Support women to start business e.g., goat trading, being involved in income generating activities they may be interested in, making families happy
Kilimani	M	Funds for small businesses, support of women groups, financial assistance for individual enterprises
Nkaika	F	Getting grants for women, getting interest free loans for many activities for income generation, capacity building on business management and entrepreneurship, supporting women is supporting families,
Ntirim	F	Women joining groups, women supporting men in the family, empowered women mean empowered families and communities, supporting women with money that they can use for table banking
Waso area	M	Supporting/funding women to be involved in table banking and merry go round, investment by women

*Note: F=Female, M=Male

FGD participants were asked whether they know the benefits of women empowerment (Table 102). Interestingly, all members of one female FGD did not know the benefits. This highlights the need for capacity building around this area.

Table 102: Knowledge of health benefits of women empowerment

Village	Gender of FGD participants*	%	Reflections
Jilo Dima East	F	0%	
Kone Kalo A&B	M	43%	'It improves nutritious eating in the family and empowered women are role models to other women in the community.'
Kone Kalo A&B	F	100%	
Almach	F	25%	
Attir	M	50%	"Empowering women provides benefits to the family such as extra source of financial income for meeting health emergencies, buying food and paying school fees. The man of the household can therefore concentrate on making investments for the family.'
Kilimani	M	100%	
Nkaika	F	100%	'Supporting or empowering women is same as empowering families and the community.'
Ntirim	F	50%	'Empowering women means improved nutrition and incomes for women and their families including men. Empowered women are involved in decisions such as selling land.'
Waso area	M		'Empowering women is empowering families including men. They are rational in their spending and investing. It improves the livelihood of families. Women know how to spend for the benefit of families.'

*Note: F=Female, M=Male

It is interesting to note that some male FGD participants had positive reflections and perceptions about women empowerment. FGDs participants were asked to state any challenges regarding women empowerment and suggest some solutions. The biggest challenge that was perceived to hinder women empowerment was poverty, followed by customs and beliefs. FGD participants suggested financial assistance for women by government and non-government bodies to support women enterprises, capacity building on financial literacy and capacity building of both women and men on the meaning and importance of women empowerment (Table 103).

Table 103: Challenges of women empowerment

S/No.	Challenges	Suggested solutions
1	Poverty and low family incomes in the families which hinders their ability to purchase materials that would support their farming enterprises such as water tanks and pipes for irrigation	<ul style="list-style-type: none"> - Cash transfers especially for poor families - Provision of irrigation water for sustainable farming by women - Provision of water storage tanks for irrigation to produce vegetables in kitchen gardens for sale - External support of women to start income generating activities e.g., poultry, beekeeping
2	Financial illiteracy which makes marketing of farm produce poor	<ul style="list-style-type: none"> - Capacity building on business management - Financial support to groups and individual women - Provision of farm inputs-seeds, tools - Improving markets of farm produce by networking to establish markets
3	Lack of support from government and NGOs	<ul style="list-style-type: none"> - Funding from women organizations support businesses and investments for their families
4	Customs and beliefs-following Samburu culture e.g., FGM, men against capacity building of women.	<ul style="list-style-type: none"> - Training of men on importance of women empowerment and decision making as well as bad customs and beliefs that hinder women empowerment - Conducting dialogue between wives and husbands at the household level - Training women on their rights for advocacy purposes

A Female FGD participant mentioned that *'men fear empowered women because they will be sat on or they will start having loose morals. Men insist women have to be home by 4.00 pm and light fires as indication that they are home.'* On the other hand, a male FGD participant stated that *'empowered women think they do not require men and that is why there are many single mothers in the community.'* Another male participant believed *'women become dangerous, violent and demeaning to men (or husbands) when they are empowered. Women decide even to keep themselves as single women or mothers once they are empowered.'* From these discussions, it is evident that women empowerment is an emotive topic. Building the capacity of the community on this topic will go a long way in ensuring development of the whole family by ensuring gender equality, poverty reduction and inclusive economic growth.

Baringo county

FGD participants' views on women empowerment revolved around financial support to women, capacity building and belonging to a social or table banking group (Table 104). A participant from the male FGD in Bartolimo lamented that *'the government has forgotten boy child'* perhaps in his view, the government has focused on empowering the girl child at the expense of the boy child.

Table 104: Knowledge on women empowerment

FGD	What do you know about woman Empowerment?	How many know of the benefits of women empowerment?
Bartolimo (Females)	Support to women Table banking Provision of farming inputs to women	25% For the households' development
Bartolimo (Males)	Education of women Support of women by government	40%
Ndambul (Male)	Social groups Support of women with loans and equipment Training women on health issues Table banking	25% Reduced dependency of members of the household on men To provide support for families
Labos vill 2/Ndambul (Females)	Group formations Support of women with loans for IGA Table banking	100% Improves incomes of households Provides financial support to households Maintains good family relationships

Some of the FGDs did know much about the benefits if women empowerment. For example, only 25% of male and female FGDs in Ndambul and Bartolimo respectively knew about the benefits of women empowerment. Some of the benefits were listed as good family relationships and increases the financial muscle of the household.

Tana River county

FGD participants were asked what they knew about women empowerment. Most perceived it as educating women, enabling them to participate in leadership and in decision making, respecting them, and supporting them in and outside the household (Table 105).

Table 105: Knowledge, benefits, and challenge of women empowerment

Village	What know about women empowerment?	Benefits of women empowerment	Challenges of women empowerment
Makere (Males)	It is educating women, giving chance to participate in leadership, respecting the women, giving their rights.	They take care of the families and helps the work in the home, like food prep. She sets goals for the family; she helps to raise good kids.	In our society, women are supposed to be submissive and non-vocal- that is the norm of our community
Village 4 (Males)	Educating them. Giving them position.	She makes most of the decision. She brings up a good family. She helps to raise good kids. She sets goals for family.	Not educating young girls, early marriages, cultural beliefs and not giving them a chance to lead others.
Village 4 (Females)	Educating young girls, letting women make decisions in the house, open businesses for them, give animals, pay dowry.	Makes good decisions, great leader for women like Women representative [government position]	Early marriages, school dropouts, low enrolment to school, cultural beliefs, lack of education
Makere (Females)	Educating them, giving support either in household or outside, giving them opportunities		Lack of knowledge on importance of women empowerment. Not educating young girls, Early marriage, cultural beliefs

Most of the benefits of women empowerment mentioned by the FGD participants were found to be at the household level. To them, women empowerment meant a well taken care of home and well brought up children. However, a female participant in Village 4 mentioned that an empowered woman is a great leader who can make decisions. Challenges of attaining women empowerment were mentioned as culture where women are cultured to be submissive, early marriage and not prioritizing education for girls. Suggestions to overcome these challenges included giving women power by educating the girl child, building the capacity of women on leadership and the girls on their rights.

Strong cultural traditions and different levels of education may get into the way of achieving women empowerment. According to FGD participants, women empowerment can at times result in misunderstanding between family members and lack of trust between spouses (Table 106).

Table 106: Challenges of women empowerment and suggested solutions

FGD	Challenges regarding women empowerment and decision making in households in the community	Suggested solutions
Bartolimo (Females)	Different levels of education between spouses	Training of community on women empowerment
Bartolimo (Males)	Culture	Sensitization and mindset change for households
Ndambul (Male)	Culture where one gender does most of the household chores Drug abuse	Sensitization of households on importance of women empowerment. Support community on mindset change
Labos vill 2/Ndambul (Females)	Culture, male dominance in decision making	Women and men need to be educated on women empowerment

FGD participants outlined some solutions to the challenges such as causing a mindset change at the household level by sensitizing them about women empowerment and its benefits.

Garissa

FGDs described women empowerment as women development, supporting women agenda, financial support to women, educating women on various issues including nutrition for children and their families, fighting against FGM, valuing women, and considering their opinions, women’s rights in the society and building on their entrepreneurial skills. FGD participants appreciated the health benefits of women empowerment. They stated that women empowerment will result in economic empowerment of the community and improve the family status by improving their livelihoods. This, they said, results in families eating more nutritious foods. Empowered women have improved decision-making capacity at the household level and makes them feel independent. A female participant from Iftin stated that *‘If you empower women, you empower the society.’* The challenges that hinder women empowerment were mentioned as:

- High illiteracy levels
- Too many household chores for women
- Insufficient entrepreneurial knowledge
- Lack of financial support in form of grants

- Few opportunities for capacity building on decision making skills (leadership)
- Lack of knowledge on the importance of women empowerment
- Lack of proper skills to empower women
- Religious factors and culture

A female participant from the FGD held in Ifin stated that *'Somalis we don't give women powers like educating them giving them opportunities. What we think is if women are given power, they can harass the men and our religion says women are not supposed to be outside of their homes, they are supposed to be at home and not to go outside.'* Suggestions on overcoming these challenges included educating more women in the society, sharing of the household responsibilities between males and females, providing grants for women and building their capacity on financial management, entrepreneurial and leadership skills, addressing the restrictions surrounding women regarding cultural and religious beliefs.

4. Extended summary and conclusions

This study utilizes a mixed methods approach to understand the potential for biofortification in the arid and semi-arid lands (ASALs) of Kenya, using four purposively selected counties from the region. Key insights emanating from the study are instrumental in guiding program interventions aimed at enhancing utilization of biofortification in the region.

4.1 Household survey findings

The household survey found that about 56 and 65 percent of the surveyed households had grown sweetpotato and common beans, respectively during the 2020/21 production year. Isiolo County had the highest percentage of both sweetpotato and common bean growers, with Garissa County having the least of both. This shows a potential for the sustainable production of both Orange-fleshed sweetpotato (OFSP) and High Iron Beans (HIB) in the area. Strategies to enhance utilization of these biofortified crops in regions of low production potential, for example Garissa, are however important. Results on consumption show relatively high proportions of surveyed households across the counties consume sweetpotato, with almost a universal consumption of common beans across all the counties. This indicates important entry points for the promotion of OFSP and HIB, with a high potential for acceptance of the biofortified crops, conditional on disentangling other potential constraints to utilization identified in the study and discussed later in this section.

Across counties, the most known and cultivated sweetpotato type was WFSP, with a significant proportion of the sampled households having heard of the OFSP. Most of the households who knew about OFSP had gotten the information either from government agencies such as government agricultural extension and research institutions like KALRO, with WFP and CIP also being significant sources of information through their direct interventions. Information spillovers through schools and churches were also important in informing populations in intervention areas about OFSP, signifying potential for impact at scale of the targeted interventions. On the other hand, Red Mottled and sugar beans were the most common bean types across study region. Biofortification of such or similar varieties will meet high acceptance in the regions.

While the use of good agricultural practices, including soil fertility management is low in the region, this is not unique in the larger sub-Saharan Africa (SSA) region. Interventions aimed at boosting production of biofortified crops in the region also need be accompanied by extension advice on best agricultural practices, and especially climate smart agriculture, given the regions frequent exposure to drought.

In terms of utilization of produced outputs, there is almost an equal allocation of sweetpotato outputs to household consumption (49 percent) and sales (43 percent), with rest being given away. This scenario was also replicated for beans, with about 56 percent of produced output being sold. This indicates a high level of commercialization of the two crops, and a potential commercialization of OFSP and HIB in the region, especially when these are marketed as high value nutritious crops. The high commercialization may also indicate few alternatives for income earning activities, and higher allocation of produced outputs to sales may deprive producing households the much-needed nutrition. Interventions aimed at achieving higher OFSP and HIB commercialization therefore need also be tempered with those enlightening the communities on benefits of consuming these crop outputs at the household level.

Across the study areas, variety trait preferences were largely similar, which is not surprising given that these fall under similar agro-ecological conditions. The most preferred sweetpotato trait was early maturing, with taste and easiness of cooking being other key preferred traits. Given the harsh growing conditions in the areas, OFSP varieties need be bred for the closely related traits of drought tolerance and early maturity. Similarly, good tasting OFSP roots will ensure higher acceptability and widescale adoption and utilization, while roots that cook easy are desirable as these save on scarce resources like biomass for cooking and women labor in cooking, thus reducing drudgery. Drought resistant and early maturing HIB varieties are also desirable in these regions, to ensure crop survival and meet biofortification targets.

Sweetpotato vines were mostly disseminated for free across households, with a significant proportion of bean producers also receiving free local seed from neighbors. For higher biofortification outcomes, interventions aimed at disentangling OSFP and HIB vine and seed access are crucial. This includes intensifying decentralized vine multipliers across the study areas and linking these with national research institutions such as KALRO. A major reason for farmer-to-farmer exchange of seed is affordability as well as ease of access. Such interventions should therefore aim at creating convenience in accessing vines and seed, through local multipliers and seed outlets, at affordable costs.

In terms of household asset ownership, a high proportion of the surveyed households have high livestock ownership, pointing to the potential of integrated production systems. Livestock could be important sources of manure for soil fertility in the production of sweetpotato and beans, while the residue from these crops could be important sources of animal feed. In particular, OFSP vines have been shown to contain important nutrients for livestock. Most households across the study area were also found to own communication assets, including phones and radio. Such assets could be important conduits of information aimed at boosting biofortification, for example nutrition information and extension on OFSP and HIB. While households in the region are endowed in land, this is largely unsuitable for production due to climatic conditions. Some irrigation was observed across the counties, with most of this observed in Isiolo. With interventions aimed at boosting irrigation, the owned land areas could be turned into productive areas. Sweetpotato and beans still have low allocations of the arable land, however, and sensitization could be used to achieve higher allocations.

Over 70 percent of the households in the study area are food insecure. Enhancing biofortification in the region is therefore paramount. Such interventions however need to take food systems perspective, with consumption of other food groups also encouraged. This could include the sweetpotato-bean-livestock production systems mentioned before, with livestock being used for higher crop productivity and crop residue/vines for feed, for higher dietary diversity scores. Similarly, interventions to enhance commercialization through higher productivity and market access also open up affordability of other food types, thereby enhancing dietary diversity.

In terms of nutrition knowledge, a high proportion of the interviewed households were aware of Vitamin A (69%) and Iron (49%), which is an indicator of the success of WFP-CIP led interventions in the area to raise nutrition awareness. It's important to note however that these numbers refer to sampled areas that had benefited from such interventions and is not be indicative of the entire region's nutritional awareness (the qualitative insights discussed in the report by county may be a more suitable indicator of the larger picture). However, this is a pointer into the importance of scaling out the interventions to other areas in the region. awareness (48% vs 51%). Given the critical role of iron and vitamin A in under five children and women of reproductive age efforts such as trainings to increase awareness of these nutrients are needed.

4.2 Trader survey findings

The trader survey found that a majority of the sweetpotato and bean traders within the study area operated at retail level, with each sweetpotato and bean trader selling up to three and five different types of sweetpotato and beans. This was the case across the four counties and presents an opportunity for the introduction of both orange-fleshed sweetpotato (OFSP) and high iron beans in the markets.

In terms of market linkages, minimal forward linkages were observed for both sweetpotato and bean traders, with only six and nine percent of these having binding sale agreements with buyers, respectively. On the other hand, significant backward linkages were observed, with about 27% and 17% of the sweetpotato and bean traders, respectively having binding supply agreements with sellers. Where these exist, most supply of produce is direct from farmers, an indication of relatively short value chains for both sweet potatoes and beans, and therefore a potential for both higher margins for OFSP and HIB producing farmers.

Few traders sold OFSP with none of the bean traders being observed selling HIB. Information flow on the biofortified crops across traders was also low, with only one trader each indicating to have received information on high iron beans and OFSP. Only one out of 49 sweet potato traders had received training on OFSP indicating potential for awareness creation on the benefits of OFSP. To enhance biofortification, market-oriented interventions are important, to enable traders to incorporate OFSP and HIB in their merchandise. Such interventions should aim at providing nutrition-sensitive information on OFSP and HIB to traders, as potential high value crops that would attract sustained demand. Linking up traders with producing farmers will also disentangle market information constraints. This includes linkages of traders in counties of deficit production, such as Garissa with those in counties of high production potential, for example Isiolo. This would improve utilization across all the ASAL regions, while also improving incomes of producer farmers.

The results also show that about half of the sweetpotato traders reported shortages, with the bulk of this attributed to lack of sufficient supply. Supply chain analyses show that traders in most of the counties, except Isiolo, acquire roots and beans from distant counties, while other got these from outside the country. Market interventions, as described above, would allow for integration and lower shortages. Other supply-side interventions like more access to vines for producers and access to extension on best agricultural practices would increase farmers productivity and surplus for the market.

4.3 Qualitative study insights

Communities represented in the study from Isiolo, Tana River and Garissa counties were composed of pastoralists and agro-pastoralists. The community in Baringo county practiced a mixture of rainfed and irrigated farming as part of the Perkerra irrigation scheme. Overall findings from the study indicate that sweet potato was a relatively new crop in the areas represented in the study, grown as a monocrop, or intercropped with maize, beans, fruit trees, vegetables among other crops, and grown in ridges, mostly under irrigation, among these intercrops. Similarly, beans were either grown as a monocrop or intercropped with maize and were either rainfed or irrigated (mostly irrigated particularly in Isiolo and Tana River counties). Compared to sweetpotato, beans were grown by most of the communities represented in the study. site.

Key informants across the study areas knew the benefits of growing improved sweetpotato and bean varieties, such as early maturity, high yields, disease and pest resistance, drought tolerance and acknowledged their nutritional benefits as well income generating potential. However, they indicated that farmers did not have access to improved varieties. Improved sweetpotato varieties found in these areas included Irene, Kabonde, SPK 004, Mtwapa-8. Some of the sources for these varieties were KALRO-Njoro, Egerton University, KALRO-Mtwapa, with WFP and CIP being main intervention partners spearheading these. On the other hand, bean varieties grown in various counties in the study area included Rose coco, Saitoti, Nyayo, Wairimu, KAT56 (KARI), Fuwi red mottled bean, sura mbaya (pinto) and Lima beans. Most of these varieties were purchased from the market.

Sweetpotato and beans were reportedly consumed by all household members across the study sites, with the demand in some counties being high at certain times than others, for example during holy month of Ramadhan. There were however some taboos in some communities against growing, processing or consuming sweetpotato and beans; some believed sweetpotato is a food eaten by cowards and children, and increases labor burden, while others believed that beans cannot not grow in their area and that it causes flatulence and should not be eaten by men. Similarly, majority of the FGD participants across the study areas were not conversant with the meaning of biofortified foods, with all FGD participants and some key informants unfamiliar with High Iron Beans. There was a negative conception of biofortified crops as genetically engineered crops. Sensitization efforts are therefore needed in such areas to overcome such beliefs. However, it was found that sweetpotato consumption had increased across the study areas over the previous five years, with increasing population and changing livelihoods, e.g., pastoralists turning to farming and diets (embrace of healthier diets) being the main reasons advanced for the observed trend.

Challenges limiting use of improved sweetpotato and beans seeds included low access to improved planting material, insufficient knowledge on agronomic practices and nutritional benefit of sweetpotato and beans, inadequate water for irrigating, and competing needs for irrigation water among different crops and livestock. Some of the suggested solutions towards these included: building capacity of extension workers and enlightening the communities in the region on the importance of sweetpotato, including best production practices; decentralized vine multiplication through decentralized sweetpotato vine multipliers; adequate irrigation water by digging boreholes and shallow wells; and control of wildlife through erection of electric fences. Overall, access to extension information by farmers was rated as very low. On the other hand, key informant cited insufficient logistical support as a key reason for insufficient supply of extension in the region. Some of the activities for supporting biofortification as cited by key informants included support in the use of extension materials such as newsletters and pamphlets, radio, farmer field days, bulk SMS, and digital apps.

Malnutrition was reported as a concern across the study area with children under five years old, pregnant, and lactating women in rural areas and those living in informal settlements being the most vulnerable. About 41% of the population in regions of study were reported to suffer from Vitamin A deficiency, with 33% of these being children. Iron deficiency was also reported as a problem in the county with women of reproductive age and teenage girls being the most vulnerable; Sixty percent of women and girls across the study areas were reported to suffer from iron deficiency. In terms of nutrition knowledge.

Overall, FGD participants across the study sites reported to be familiar with nutritious foods and their benefits to children, expectant and lactating mothers. They all affirmed that sweetpotato improves children's health and eyesight, but few were unsure about its ability to improve the cognitive development of children under five years old. This knowledge was reportedly gathered from Community Health Volunteers, mass media, agriculture extension staff, hospitals, and clinics. As much they were familiar with nutritious foods, majority of them reported that they did not have access to nutritious foods. The reasons included insufficient funds to purchase nutritious foods, and erratic rainfall that resulted in insufficient water to grow nutritious foods. Another reason provided was the pastoralist way of life where most of the food available during migration is meat and milk. It was suggested that access to nutritious foods could be improved through: the Ministry of Agriculture providing planting materials for OFSP and HIB; county support to farmers with starter seeds and funds to purchase the inputs required to grow nutritious foods such as water pumps for irrigation, fertilizers and farming tools; subsidized prices for planting materials and seeds; trainings and demonstrations by agriculture officers on good agronomic practices of these crops; and encouragement by government and development partners to pastoralists to take up agriculture.

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