Journal of Innovative Agriculture

Research Article
DOI: https://doi.org/10.37446/jinagri/rsa/10.3.2023.1-21

Analysis on crop-livestock and agro-pastoral farming system

Asmera Adicha*, Dawit Darcho, Gideon Ermias, Kutoya Kuse, Zeynu Kelifa

Southern Agricultural Research Institute, Jinka Agricultural Research Center, Agricultural Economics and Gender Researchers, SNNPR, Jinka, Ethiopia.

Received: 06 March 2023
Accepted: 12 August 2023
Published: 30 September 2023

***Correspondence**
Asmera Adicha
asmera05@gmail.com

Volume: 10
Issue: 3
Pages: 1-21

Identifying the current farming system is important for different agricultural policy implementation as climate variability changed the farming system in the study area. Hence, this study aimed to analyze the current farming system of crop-livestock and agro-pastoral areas in the south omo zone. A multistage sampling method was used to select 240 sample respondents from the study districts. Descriptive statistics and narrative approaches were used to analyze data. The result indicated that there was a dominance of crop production (63.3%) and supportive livestock production (36.7%) in crop-livestock farming system whereas in agro pastoral farming livestock dominates (72.5%) with supportive crop production (27.5%). The result also indicated that the main livestock production constraints for farmers and agro-pastorals in the area are extensive drought and erratic rainfall, diseases, shortage of veterinary medicine, feed and water shortage. Moreover, the survey result shows that poor soil fertility management, low inputs use, pests (diseases and insects), delay of input supply and high costs are the main impediments in crop production for farmers and agro-pastorals in the area. The major constraints of natural resources in the study are soil fertility decline, land shortage due to fragmentation of land for their children and deforestation. Therefore, it needs more attention to reverse the mentioned major constraints so as to enhance production and productivity. Timely supply of improved inputs, improved forage, methods of disease control and intensifying natural resource management and creating better awareness on physical and biological soil management are critical for improvements of soil to enhance productivity.

Key words: *agro-pastoral, crop, farmers, farming system, livestock*

INTRODUCTION

It is known that agriculture is the mainstay of the national economy in Ethiopia despite its low level of development and contributes about 85% of employment opportunities and more than 70% of total export earnings and 43% of GDP (MoARD, 2015). Food producers, both pastoralists and farmers, are an integral part of the broader farming systems in Ethiopia. They support the livelihoods of a majority of the population, both on and off farms; hence they play an important role in the ongoing economic transformation. Smallholders operating one or more parcels of land, ranging from less than 0.25 ha to 25 ha of land on rare occasions, represent the majority of farmers in Ethiopia (Taffesse et al., 2011). Ethiopia's agricultural sector is highly diverse and subject to change due to different factors such as climate and population growth. Consequently, competition for available land, water, energy, and other inputs increases posing pressure on the rural population's livelihoods and food security. Thus, the existing whole farm systems approach varies as the consideration of farmers ' perceptions and the extension process varies including dynamic elements in the farming environment (Dixon et al., 2001).

Southern Nation Nationality and Peoples Region (SNNPR) is one of the largest regions in Ethiopia, accounting for more than 10 percent of the country's land area and one fifth of the country's population. Of this amount, around 10% are estimated to live in urban areas and the rest 90% are residents in rural areas depending on crop production and livestock raising (Zerssa et al., 2021). The majority of farmers in SNNPR of Ethiopia are smallholders, producing mostly for their own consumption. They are estimated to generate 95% of total production for the main crops (cereals, pulses, oilseeds, vegetables, root crops, fruits, and cash crops). The lack of site-specific fertile soil management, poor soil fertility circumstances, declining soil fertility, minimal fertilizer use, cultivating of steep slopes, absence of better varieties, inappropriate agronomic procedures, lack of weed and pest control, lack of rain, lack of cultivars suitable for different seasons, post-harvest loss, and other biological and environmental factors all contributed to the mean yield of the crops being less than the optimal level in all landscape views (Alemu et al., 2016; Ahmed, 2017).

The livestock production system is mainly extensive in pastoral and agro-pastorals areas and local breeds are predominant and are characterized by low milk production (Roberts & Azzarri, 2014). Therefore, in order to develop demand driven agricultural technology and promote climate smart agriculture and market-oriented production system in the region, farming system characterization is detrimental. Moreover, dynamism in the farming system: shifting to agro forestry system, vegetable, and root and tuber crop-based farming and change in income source, changing livelihood options and lack of updated information on farming and production systems highly demands farming system characterization study. A study conducted by Emana et al. (2015) in West Shewa zone is located in Oromia National Regional State and, Gurage and Hadiya zones and Yem-Special district located in the Southern Nations, Nationalities and Peoples Region (SNNPR) was limited only to characterization of Vegetable Production and Marketing Systems. Thus, there is literature gap and also lack of studies regarding the current farming system in the south omo zone of southern Ethiopia. Hence, this study was initiated to assess existing farming systems with regard to existing agriculture related policy directions and extension services and to identify and prioritize major constraints limiting further agricultural production and productivity.

MATERIALS AND METHODS

To meet the objectives of this study, the qualitative and quantitative data were collected from both primary and secondary data sources through data collection instruments such as observation, key informant interviews, focus group discussions and pre-tested structured questionnaires. A focus group guide questions were set and data was collected from 10 members (5 model farmers, three youth and two females) to have a clue in the overall scenario. A multistage sampling method was used to select districts and sample kebele based on farming practices (crop-livestock and agro pastoral system). Accordingly, two districts were selected with the discussion of zonal agriculture offices and from each district, two kebeles were selected based on agro ecology and farming practices. A total of 240 sample households were selected from the sample kebele using the recent lists of households in the respective kebeles as a sampling frame and applying probability proportional to size (PPS) to determine the sample size from each kebele and then simple random sampling techniques to get the required sample. The collected data was analyzed by using descriptive statistics such as mean, standard deviations, percentages and frequency tables to summarize the socio-economic and demographic characteristics related to sample respondents. Narrative approach was employed to describe the details of the farming system in the study area.

RESULTS AND DISCUSSION

Socioeconomic and Household characteristics

Table 1 describes the socio-economic and household characteristics of sample respondents. Consequently, about 95% of sample households were male headed households and 5% were female headed households in Debub Ari whereas 94.17% of sample households were male headed households and 5.83% were female headed households in the Malle district. About 63.3% of respondents revealed that the share of crop production is beyond 75% and about 36.7% confirmed that livestock production is 25% of their livelihood means in Debub Ari district. About 72.5% of respondents revealed that the share of livestock is beyond 75% and about 27.5% confirmed that crop production as 25% of their livelihood means in the Malle district. This indicates that crop production is dominant in mixed farming and livestock production is dominant in agro pastoral areas of the study area. Sample household heads age, education, family size and land holding are supposed to be a vital characteristic that limits the willingness of household heads to receive novel ideas and technologies. The respondents have a mean age of 38.5, and 38.7 years, mean family size of 8-person, mean of schooling of grade 3 and mean farm size of 10 and 7 timad in Debub Ari and Malle districts, respectively.

Table 1. Socioeconomic and household characteristics of households

Attributes		Farming (Debub Ari =120)	Agro pastoral (Malle =120)
		Frequency (%)	**Frequency (%)**
Sex	Male	114(95)	113(94.17)
	Female	6(5)	7(5.83)
Share	Crop >75%	76(63.3)	33(27.5)
	Livestock >75%	44(36.7)	87(72.5)
Variables		**Mean (St. Deviation)**	**Mean (St. Deviation)**
Age		38.5(10.68)	38.7(10.2)
Family size		7.88(3.52)	7.67(2.77)
Education level		2.78(3.59)	2.96(3.59)
Farm size(timad)		9.94(4.67)	7.15(3.42)

Source: Own survey result, 2021

Access to Land Resources

Land ownership and how the land under the farmers' and agro pastoral use particulars was observed. The findings in the Table 2 shows that a mean of 9.94 and 7.15 timad of owned in Debub Ari and Malle districts respectively. Of the total land owned, land covered by annual crop, perennial crop, grazing/browsing and allocated for multipurpose was in Debub Ari are 6.38, 1.88, 1.04 and 0.64 timad respectively. Higher land holding is observed Debub Ari 1st and Malle district last implying sample respondents mean land holding per household in order of land size in timad. In Malle district land covered by annual crop, perennial crop, grazing/browsing and allocated for multipurpose are 5.01, 1.36, 0.79 and 0 timad respectively. In all study districts land is covered by annual crop but there is some good practice of planting perennial crops in Debub Ari district. As revealed in the group discussion land holding over time is decreasing in Debub Ari and Malle districts are mostly due to land fragmentation for their children.

Table 2. Land ownership and use particulars

Land ownership and use in timad (mean/standard deviation)	**Districts**	
	Debub Ari	Malle
Total land owned	9.94(4.67)	7.15(3.42)
Land covered by annual crops	6.38(4.05)	5.01(3.24)
Land covered by perennial crops	1.88(0.84)	1.36(0.95)
Land allocated for grazing/browsing	1.04(0.45)	0.79(0.33)
Land allocated for multipurpose trees	0.64(0.28)	0

Source: Own survey result, 2021

Crop production System

Major crops grown and production season

Crop production in the zone is categorized as none fallow lands in mainly Debub Ari and Malle districts because of land shortage and fragmentation land for their children, and Intercropping is experienced in the areas mainly maize with haricot bean.

Table 3. Crops grown and production particulars

Crop types	**District**							
	Debub Ari(n=120)				**Malle(n=120)**			
	Production season (frequency of responses)				Production season(frequency of responses)			
	Belg	Meher	Irrigation	Both Belg & Meher	Belg	Meher	Irrigation	Both Belg & Meher
Maize	2	2	0	116	3	22	0	95
Sorghum	0	2	0	42	3	11	0	67
Common bean	2	2	0	82	3	22	0	89
Groundnut	0	0	0	11	1	1	0	41
Finger millet	0	0	0	4	1	0	0	2
Banana			Perennial					

Source: Own survey result, 2021

The production system of the crop is based on the rain fed system in Debub Ari and Malle districts. The major types of crops cultivated under rain fed/irrigation: cereal crops (maize, sorghum, wheat and barley), Pulses crops (haricot bean and faba bean), fruit and vegetables

(mango, avocado, onion and tomato), Root or tuber crops (enset and cassava) and Cash crop (coffee and cardamom). Cropping forms accepted by farmers and agro pastorals in the research site are described above in Table 3. The cropping season of crops in the study areas are Belg, Meher and both Belg and Meher seasons, whereby farmers/agro pastoral produce their main crops by rain fed and they have a tiny traditional irrigation practice for vegetables in dry Bega season. As discussion made with farmers in the study areas cropping calendar for wheat and barley is Meher seasons, while maize, sorghum, common bean, onion and tomato are mostly grown both in Belg and Meher season. The main production season for major crops like maize, sorghum and common bean in the study areas are both Belg and Meher seasons and there is no irrigation based an opportunistic rain fed cultivation.

Land allocated for major crop production

The mean land allocated for major crops is provided in Table 4 and shows that 7.53 and 2.32 timad for maize in Debub Ari and Malle districts. This implies that more land is allocated for maize in Debub Ari district than Malle district. The mean land allocated for sorghum was 1.98 and 1.69 timad in Debub Ari and Malle districts. Whereas common bean produced in Debub Ari and Malle with mean land holding of 2.2 and 1.54 timad, respectively. Intercropping, relay cropping and crop rotation are practiced for some instances in both Debub and Malle districts.

Table 4. Area allocated for crop production

Crop type	Debub Ari	Malle
	Area allocated(timad)	
Maize	7.53	2.32
Sorghum	1.98	1.69
Common bean	2.20	1.54
Groundnut	1.23	1.19
Finger millet	2.73	2.00
Banana	1.01	0.21

Source: Own survey result, 2021

Trends of production for major food crops (2017-2021) in South Omo zone

Comparing predictions of post-harvest agricultural productivity for a few key agricultural commodities from the period (2017–2021) has been undertaken.

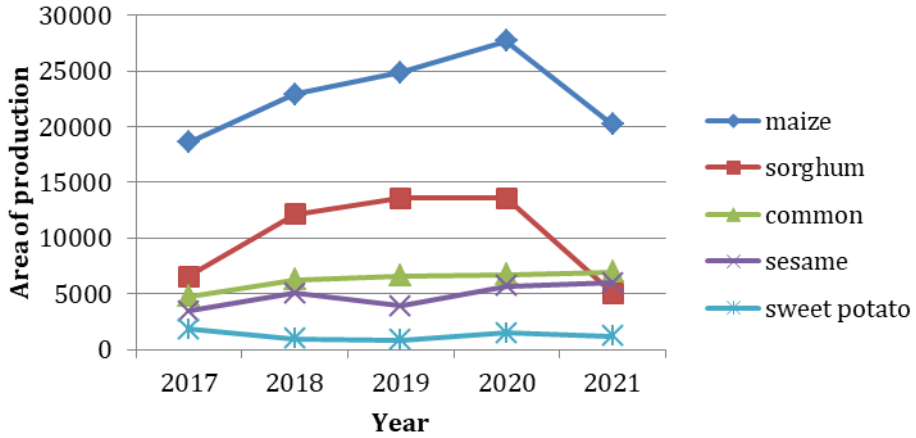

Figure 1. Trend of area coverage of major food crops

Source: own calculation from zone agricultural office information (2017-2021)

The comparisons are thought to provide insight into how much of the over-year predicted rise of the amount of production over last year's forecast is caused by increased cropped area or because of the achievement of boosted crop yield or the contribution of both contributed to the rise of each year production, but increased crop yield taken up the lion's share, so as to largely show the path, the degree of variation, and the extent of step the agricultural sectors in the South Omo zone bringing up on the hierarchy of change to market oriented agriculture from its primary existence and back ward initial point. Consequently, as shown in the Figure 1 below area of production and the post-harvest crop productivity predictions of selected vital food crops over the year varies. The mean area of maize in the year 2017 was 19000ha and increased in the years 2018, 2019, 2020 but decreased in the year 2021. On the other hand, the mean area of sorghum was highly increased and recently turned back ward due to extensive drought.

Since the rainfall was erratic in the South Omo zone for the last five years' crop-growing season, the (2017-2021) crop production has shown an unstable increment in estimated cropped productivity. The mean yield of major crops in the year 2017-2021 in the zone was shown in Figure 2 below as the lowest productivity in 2019 and 2021 in all food crops and the highest productivity in 2020. It shows that the mean productivity of maize was 31.87, 28.67, 31.33, 31.94 and 28.97 quintals per hectare in 2017-2021. Recently the productivity of maize in the zone is decreased as a result of drought and decreased fertility of the land. The mean productivity of sweet potatoes was 230, 197, 183, 276 and 245 quintals per hectare in 2017-2021, which is somehow good and climate smart.

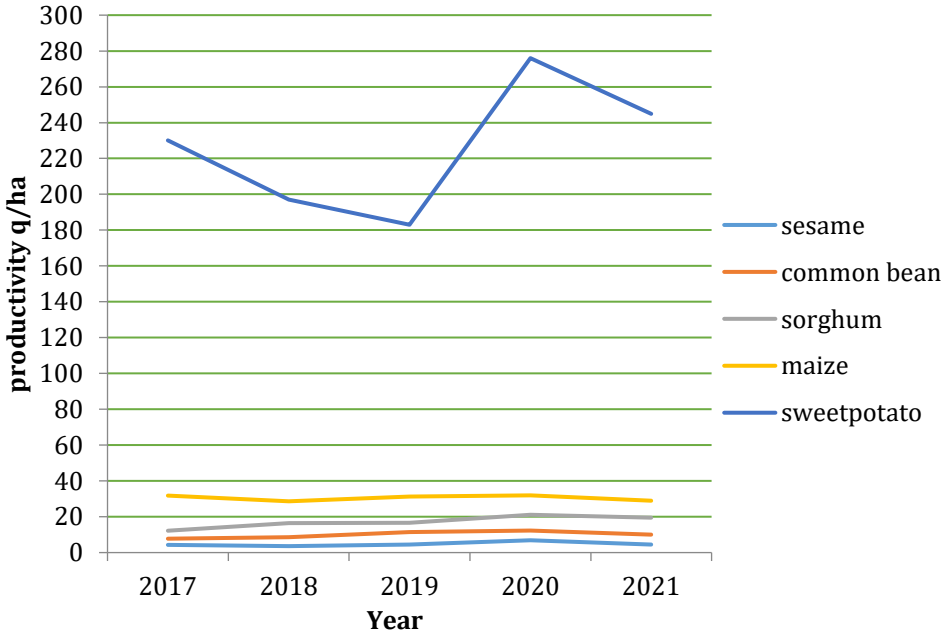

Figure 2. Trend of productivity of major food crops (q/ha)
Source: own calculation from zone agricultural office information (2017-2021)

Crop production inputs use practices

Agriculture is cultivation practices whereby giving subsequent inputs such as seeds, fertilizers, and pesticides, etc. A seed is considered the basic input for enhancing agricultural production and productivity. However, these important inputs are not easily accessible for farmers, agro

pastoralists and pastorals in the study area. The efficiency of all other agricultural inputs, such as fertilizers, pesticides, and irrigation, etc., as well as the impact of agro-climatic conditions, is mainly determined by the quality of the seed used. The farmers do not have access to improved seeds and they widely use the local varieties since the improved seeds are very expensive (IFPRI, 2009). Therefore, ensuring the availability of quality seeds for enabling farmers to achieve higher agricultural production is a strategic requirement. As revealed in focus group discussion with farmers and agro pastorals they pointed that the price of fertile is very inflated and also due to climate variability they faced productivity decline.

Input use practices for crop farming in Debub Ari and Malle districts

As one of the factors to boost yield, the application of inorganic fertilizer (Urea and NPS) was used in both Debub Ari and Malle districts. The result shows that for all major crops the farmers and agro pastorals were used inorganic fertilizer below recommendation which might affect yields. As mentioned in the group discussion, the producers used low inputs due to the higher price of fertilizer and unknown rainfall distribution and the application of fertilizer is also mainly for maize and sorghum. The application of inorganic fertilizers for maize is 77.75 kg of NPS and 66.62 kg of urea in Debub Ari and 40.83kg of NPS and 39.17kg of urea in Malle district. On the other hand, the application of inorganic fertilizers for sorghum is 37.5 kg of NPS and 37.5 kg of urea in Debub Ari and 50kg of NPS and 50kg of urea in Malle district. Fertilizer application for other crops such as common bean, groundnut, finger millet and others were not practiced in the study areas. Fungicides and herbicides are not used by sample respondents in the areas. Compost as fertilizer is not practiced by sample respondents but animal dung is used as fertilizer in sampled areas of Debub Ari woreda. Some chemicals like insecticide were used in both Debub Ari and Malle district. The application of insecticide for maize is 1.05 liter in Debub Ari and 1.95 liter in Malle district (Table 5).

Table 5. Input use practices for crop farming

Crop type Average	Debub Ari (120) Fertilizer use (kg/ha)		Insecticide (liter)	Malle (120) Fertilizer use (kg/ha)		Insecticide (liter)
	NPS	Urea	1.05	NPS	Urea	1.95
Maize	77.75	66.62		40.83	39.17	
Sorghum	37.5	37.5	-	50	50	-
Common bean	-	-	-	-	-	-
Groundnut	-	-	-	-	-	-
Finger millet	-	-	-	-	-	-
Banana	-	-	-	-	-	-

Source: Own survey result, 2021

Crop technology use practices

The study districts were dominantly annual crop producers by using rainfall with traditional land plowing and planting methods. Land preparation in the study area is mainly done by oxen and hand digging, and the frequency of tillage is determined by crop type, soil type and oxen availability. Planting methods in the study are raw and broadcasting. In the study area wheat, barely, and common bean are planted at the third frequency of tillage. As shown in Table 6 below, the mean frequency of plowing for maize, sorghum, common bean and groundnut are 3, 2.35, 2.59 and 2 times in the Debub Ari district. The mean frequency of plowing for maize, sorghum, common bean and groundnut are 3, 2.96, 0 and 2.42 times in Malle district. To sum up, the majority of farmers and agro pastorals plowing their fields in a mean range of 2-3 times depending on the crop. About 87.5% and 85% of respondents plant maize crops using raw planting methods in Debub Ari and Malle districts, respectively. This indicates that maize is

mainly planted using the raw planting methods and the technology is well adopted. On the other hand, about 91.3% and 77.78% of respondent's plant sorghum by broadcasting in Debub Ari and Malle districts, respectively. This indicates that sorghum is mainly planted using the broadcasting planting method and the technology is not well adopted in the area. Planting methods for common bean, groundnut and finger millet in the study areas are dominantly broadcasting. Regarding awareness of improved variety and use of improved variety in both district for maize and sorghum is good but for common bean, groundnut and finger millet is not well demonstrated. Finger millet and common bean are not dominantly produced in Malle district, whereas finger millet is not produced by sample respondents of Debub Ari district.

Table 6. Crop technology use practices

Districts	Crop type	Frequency of plowing	Planting method (%)			aware of improved variety		Use of improved variety		still using improved variety	
		Mean	Broadcast	Row	Both	Yes	No	Yes	No	Yes	No
Debub Ari	Maize	3	12.5	87.5	0	100	0	96.7	3.3	99.1	0.9
	Sorghum	2.35	91.3	8.7	0	69.1	31.9	72.3	27.7	100	0
	Common bean	2.59	52.94	14.7	32.4	44.8	55.2	42.9	57.1	91.7	8.33
	Groundnut	2	100	0	0	0	100	-	-	-	-
Malle	Maize	3	15	85	0	100	0	81.7	18.3	90.8	9.18
	Sorghum	2.96	77.78	22.2	0	0	100	-	-	-	-
	Common bean	0	-	-	-	0	100	-	-	-	-
	Groundnut	2.42	66.67	33.3	0	9.1	90.9	9.1	90.9	100	0

Source: Own survey result, 2021

Table 7. Types, Source and Benefits of crop technology

Districts	Crop type	Benefit of improved variety			Source of improved variety seeds			Types of improved varieties used
		HI	SI	NC	E	FF	MOA	
Debub Ari	Maize	40	57.5	2.5	67.5	3.33	29.17	BH140, BH661
	Sorghum	19.44	80.56	0	63.64	33.33	3.03	Lalo, Dano, and Gubiye
	Common bean	33.33	66.67	0	53.33	1.33	45.34	Hawassa dume
	Groundnut	-	-	-	-	-	-	-
Malle	Maize	61.67	38.33	0	53.33	15	31.67	BH140, M2 & M4
	Sorghum	-	-	-	-	-	-	
	Common bean	-	-	-	-	-	-	
	Groundnut	0	100	0	25	75	-	-

Note: HI = highly improving, SI = slowly improving, NC = no change, E=Extension, FF= Farmer to farmer /own saved, MOA= provided free by Minster of Agriculture

Source: Own survey result, 2021

As shown in the Table 7, about 40, 57.5 and 2.5 % of respondents revealed that benefit of improved maize was highly improving, slowly improving and no change, respectively in Debub Ari district. About 61.67 and 38.33 % of respondents revealed that the benefit of improved maize was highly improving and slowly improving, respectively in Malle district. About 19.44, 80.56 % and 33.33, 66.675 of respondents revealed that the benefit of improved sorghum and common bean was highly improving and slowly improving, respectively in Debub Ari district.

Moreover, about 67.5, 3.33, 29.17% of maize, 63.64, 33.33, 3.03% of sorghum and 53.33, 1.33, 45.34% of common bean seeds were obtained from extension, farmer to farmer seed exchange system and free support by governmental and non-governmental organizations respectively in Debub Ari district. In the Malle district about 53.33, 15, 31.67% of maize and 25, 75, 0% of ground nut seed was provided by extension, farmer to farmer seed exchange system and free support by governmental and non-governmental organizations respectively. Some improved crop varieties are maize varieties (BH140, BH661, M2 and M4), sorghum (Lalo, Dano, and Gubiye) and common bean (Hawassa dume) in both districts.

Livestock Production System

Livestock Ownership

The major types of livestock found in study areas are cattle, shoat, poultry, donkey, camel (Dasenech district) and horse (Debub Ari). As revealed in focus group discussions and key informant interviews with woreda and kebele experts, elders, model farmer/agro pastorals the main source for the local livestock technology/breeds are their own stock and markets whereas for the improved livestock technologies/breeds; markets, extension, Jinka agricultural research center and NGOs. The local livestock breeds are dominant in the study areas but there are also some improved breeds such as Holstein Fersia, Jersey and Borana breeds. The type of sheep breed in the area is more of local but now Bonga sheep (Debub Ari) breeds are introduced and crossed with local breeds. There are both local and improved chicken breeds in the area.

Table 8. livestock types reared in the study area

Livestock types owned	Districts/Woreda's	
	Debub Ari	Malle
	Mean (Standard deviation)	Mean (Standard deviation)
Oxen	4.6(3.6)	2.3(1.3)
Cow	3.3(3.1)	2.4(2.3)
Bull	2.4(1.9)	2(1.4)
Heifer	3.2(2.7)	2.02(1.03)
Chicken	10.7(6.5)	5.2(2.7)
Cross chicken	5.3(2.5)	3.3(1.03)
Sheep	3.4(4.03)	2.6(1.3)
Goat	5.8(5.2)	4.8(2.9)

Source: Own survey result, 2021

In the study districts livestock major livestock reared are oxen, cows, bulls, heifer, chicken, sheep and goats. The average oxen, cows, bull and heifer, owned by respondent household in Debub Ari woreda were 4.6 oxen, 3.3 cows, 2.4 bull and 3.2 heifers respectively with standard deviation of 3.6 oxen, 3.1 cows, 1.9 bulls and 2.7 heifers respectively which relatively higher compared to the other study woreda's. Chickens were categorized in to local chicken and cross breed chicken. The average local chickens owned by the sample respondents in the study area woreda's were 10.7 and 5.2 chicken for Debub Ari and Malle districts respectively with standard deviation of 6.5 and 2.7 chicken respectively. The mean cross breed chicken in the study area were 5.3 and 3.3 chickens in Debub Ari and Malle woreda respectively. Shoats was categorized in to sheep and goats. According to the survey result the average sheep owned by sample respondent in Debub Ari woreda were 3.4 sheep and 5.8 goats with corresponding standard deviation of 4.03 sheep and 5.2 goats, respectively. The average sheep owned by

sample respondent in Malle woreda were 2.6 sheep and 4.8 goats with corresponding standard deviation of 1.3 sheep and 2.9 goats, respectively (Table 8).

Livestock feed technologies

Livestock feed in the study districts are mainly grazing by their own farm and communal land, and crop residues. However, about 79.17 and 82.5% of respondents raised feed shortage is a problem and 20.82 and 17.5 % reported feed shortage as not a problem in Debub Ari and Malle districts, respectively.

Table 9. Animal feed technologies

		Districts			
		Debub Ari		Malle	
Feed shortage problem		Frequency	Percent	Frequency	Percent
	yes, it is serious	35	29.17	19	15.8
	yes, sometimes	60	50.0	80	66.7
	No	25	20.83	21	17.5
Districts	Sources of feed	Uses of this feeds (Frequency /percent)		Ranking the use of this feeds (Frequency /percent)		
		Yes	No	Most important	More Important	Important
Debub Ari	Grazing in the field	99(82.5)	21(17.5)	92(92.93)	7(7.07)	0
	Green feed (cut and carry system)	68(56.7)	52(43.3)	11(16.2)	13(19.1)	44(64.7)
	Hay making	13(10.8)	105(87.5)	4(3.3)	4(3.3)	5(4.2)
	Crop residues	97(80.8)	21(17.5)	14(11.7)	69(57.5)	9(7.5)
	Concentrates of different types	8(6.7)	110(91.7)	4(3.3)	3(2.5)	1(0.8)
	Improved forage	3(2.5)	115(95.8)	-	1(0.8)	2(1.7)
	Local beverage products (Atela)	82(68.3)	36(30.0)	40(33.3)	29(24.2)	13(10.8)
Malle	Grazing in the field	113(94.2)	7(5.8)	93(77.5)	12(10)	8(6.7)
	Green feed (cut and carry system)	67(55.8)	53(44.2)	43(35.9)	19(15.8)	6(4.1)
	Hay making	53(44.2)	67(55.8)	7(5.8)	25(20.8)	21(17.5)
	Crop residues	95(79.2)	25(20.8)	49(49.2)	13(10.8)	23(19.2)
	Concentrates of different types	5(4.2)	115(95.8)	1(0.8)	2(1.7)	2(1.7)
	Improved forage	35(39.2)	85(70.8)	4(3.3)	25(20.8)	6(5)
	Local beverage products (Atela)	8(6.7)	112(93.3)	3(2.5)	3(2.5)	2(1.7)

Source: Own survey result, 2021

Sources of feed in the Debub Ari district were the practice of grazing in the field (82.5%), Green feed (cut and carry system) (56.7%), Hay making (10.8%), Crop residues (80.8), Concentrates of different types (6.7), Improved forage (2.5) and Local beverage products (Atela)(68.3%), and in the Malle district about 94.2, 55.8, 44.2,79.2, 4.2, 39.2 and 6.7% of respondents practice of grazing in the field, Green feed (cut and carry system), Hay making, Crop residues, Concentrates of different types, Improved forage and Local beverage products (Atela) respectively. Grazing in the field is ranked as the most important in both districts. About 92.93

and 77.5 % of respondents revealed the use of grazing in the field feed source as most important in Debub Ari and Malle districts, respectively (Table 9).

Improved feed use and awareness

The status of the improved forage is at its rudimentary stage with few introductions of grass species like elephant, desho and panicum. The utilization practice of improved forage is increasing at decreasing rates due to low access to improved forage seeds, low awareness on production and profitability of forage, and shortage of land. In both Debub Ari and Malle district improved desho and elephant grass are not well demonstrated and about 3% and 26.7% of respondents have awareness in Debub Ari and about 18.3% and 46.7% of respondents have awareness in Malle district (Table 10).

Table 10. Improved feed use and awareness

Districts	Improved feed		Aware of feed / forage	Use of feed/forage	Frequency (%)
			Frequency (%)		
Debub Ari	Desho grass	Yes	4(3.3)	Yes, still using	2(1.7)
		No	116(96.7)	Yes, but now discount.	3(2.5)
	Elephant grass	Yes	32(26.7)	Yes, still using	15(12.5)
		No	88(73.3)	Yes, but now discount.	6(5.0)
Malle	Desho grass	Yes	22(18.3)	Yes, still using	20(16.7)
		No	98(81.7)	Yes, but now discount.	2(1.7)
	Elephant grass	Yes	56(46.7)	Yes, still using	51(42.5)
		No	64(53.3)	Yes, but now discount.	15(12.5)

Source: Own survey result, 2021

Livestock health technologies and breeding

As discussion made with key informants the main challenges for livestock production and management in the study area are diseases (trypanosomiasis, blackleg, anthrax, leg and foot and mouth and dermatophytosis), shortage of veterinary medicine and weak vet services. The death of livestock is lack of/fewer veterinary services and support of extension agents on timely vaccination. As shown in the Table 11, about 97.5 and 90% of respondents confirmed that livestock disease occurs often or sometimes in Debub Ari and Malle districts, respectively. When their livestock get sick, they treat traditionally (33.3%), take to vet clinic (61.8%) and do nothing (4.9%) in Debub Ari district and treat traditionally (15%), take to vet clinic (77.5%) and do nothing (6.7%) in Malle district. About 80 and 83.3% of respondents get vaccination services for cattle and goat in Debub Ari and Malle districts, respectively.

The main problem to health services in Debub Ari and Malle districts are do not get veterinarians easily (36.7%), weak service from animal health clinics (21.7%), distant to animal health clinics (16.7%) and less efficiency of tablets/drugs (15%); frequent occurrences of animal diseases (35.8%), weak service from animal health clinics (25.8%), less efficiency of tablets/drugs (14.2%) and lack of knowledge about disease & control (9.2%) respectively. Breeding of cows in three districts are mainly improved bull service (uncontrolled mating) and local bull service (uncontrolled mating). But the dominant one is local bull service (uncontrolled mating) in Debub Ari (85.8%) and Malle district (71.7%).

Table 11. Animal health technologies and breeding

Items		Districts			
		Debub Ari		Malle	
		Frequency	%	Frequency	%
Livestock disease problem	Yes, it occurs often	46	38.3	12	10.0
	Yes, but it occurs only sometimes	71	59.2	96	80.0
	No, it is not a problem	3	2.5	12	10.0
Livestock get sick	Treat traditionally	34	33.3	18	15.0
	Take to vet clinic	63	61.8	93	77.5
	Do nothing	5	4.9	8	6.7
Get vaccination services	Yes	96	80.0	100	83.3
	No	24	20.0	20	16.7
Livestock type getting vaccination	Cattle	94	97.9	88	73.3
	Shoat	2	2.1	14	11.7
Problem to health services	Distant to animal health clinics	20	16.7	6	5.0
	weak service from animal health clinics	26	21.7	31	25.8
	Frequent occurrences of animal diseases	5	4.2	43	35.8
	Lack of knowledge about disease & control	2	1.7	11	9.2
	Do not get veterinarians easily"	44	36.7	4	3.3
	Less efficiency of tablets/drugs"	18	15.0	17	14.2
	No money to purchase drugs"	2	1.7	8	6.7
Breeding of cows	Improved bull service (uncontrolled mating)	17	14.2	34	28.3
	Local bull service (uncontrolled mating)	103	85.8	86	71.7

Source: Own survey result, 2021

Table 12. Animal housing and watering

		Districts			
		Debub Ari		Malle	
		Frequency	Percent	Frequency	Percent
Types of housing	Animal barn/caraal	68	56.7	65	54.2
	Non-barn fence	52	43.3	55	45.8
Keep animals	According to cattle type	114	95	114	95.0
	Together all cattle	6	5	6	5
Sources of water for animals	River	118	98.3	116	96.7
	Pond	2	1.7	4	3.3
Frequency of water livestock	Once a day	65	56.7	117	97.5
	Twice a day	55	55	3	2.5

Source: Own survey result, 2021

Livestock housing and watering

Housing is essential for livestock production and productivity. Livestock in the study areas are usually kept in the open and fence with no roofing. Types of housing in the study districts are animal barn/caraal and non-barn fence. About 56.7% and 43.3% of respondents keep their animal in animal barn/caraal and non-barn fence respectively in Debub Ari districts. In Malle districts about 54.2% and 45.8% of respondents keep their animal in animal barn/caraal and non-barn fence respectively. They keep animals according cattle type and together all cattle in the study districts. About 95% of respondents keep animals according cattle type in both Debub and Malle districts keep animal together all cattle. Source of water for their animal is river and about 98.3 and 96.7% of respondents get water from river in Debub Ari and Malle districts. Frequency of watering livestock in the study areas were one to two times a day (Table 12).

Natural resource Management

Soil and Water Conservation practices

In Debub Ari and Malle districts there is a problem of land degradation due to inappropriate land use systems, erosion, and deforestation. As a result, the land of farmers/agro pastoralists was susceptible to soil erosion and it causes loss of upper fertile soil. In response to these problems introduced physical and biological structures such as tracing mostly practiced ones are soil bund, stone bunds and bench terraces and as well desho and elephant grass demonstrations to some extent in the districts. However, there is a gap in the maintenance and sustainability of soil and water conservation practices. In both Debub Ari and Malle districts the community participation in soil and water conservation structures is increasing from time to time and it has greater importance on protecting losses of soil and water. Still soil and water conservation activities have been done in communal degraded lands or in mountains area but not practiced by individual farmers/agro pastoralists land. Some individual farmers/ agro pastoralists planted desho and elephant grass to conserve soil and to use it as feed for livestock.

As presented in the Table 13, in Debub Ari district about 51.7% of respondents revealed that they practice physical SWC on farm land whereas about 48.3% do not practice but they participate in communal mountainous areas. Thus, the physical SWC structures practiced are soil bund (51.7%), stone bund (32.2%) and half-moon (16.1%). On the other hand, in the Malle district about 45% of respondents reported that they practice physical SWC on their individual farm land whereas about 55% do not but practice physical SWC on degraded communal lands and agro pastoralists training center. Thus, the physical SWC structures practiced are soil bund (77.8%), stone bund (20.4%) and Half-moon (1.8%).

Table 13. Physical SWC practice in the area

Attributes of SWC		Districts			
		Debub Ari		Malle	
		Frequency	%	Frequency	%
Practice of physical SWC	Yes	62	51.7	54	45
	No	58	48.3	66	55
Types of physical SWC	Soil bund	32	51.7	42	77.8
	Stone bund	20	32.2	11	20.4
	half-moon	10	16.1	1	1.8

Source: own survey, 2021

In the Debub Ari and Malle districts 69.2% and 61.6% of respondents reported physical SWC on their farm land were not supported by biological stabilizers but 30.8 % and 38.4% tried to support physical SWC with biological stabilizers respectively. However, physical SWC structures on communal land were supported by biological stabilizers. About 43.2% and 0% of sample respondents revealed that they haven't observed change or the benefit of making biological stabilizers because on their farm land physical SWC is not supported by biological stabilizers but 13.5%, 43.2% and 92.3% and 7.7% of respondents said that supporting physical SWC by biological stabilizers is becoming highly and slowly improving in Debub Ari and Malle districts respectively (Table 14).

Table 14. Supporting physical SWC by biological stabilizers and its benefits

Districts	**Debub Ari**		**Malle**	
	Physical SWC supported with biological stabilizers			
Attributes	**Frequency**	**%**	**Frequency**	**%**
Yes	20	16.7	26	21.7
No	83	69.2	74	61.6
Yes, but partially	17	14.1	20	16.7
Attributes	Frequency	%	Frequency	%
Highly improving	5	13.5	24	92.3
Slowly improving	16	43.2	2	7.7
Not good	7	18.9	0	-
No change	9	24.3	0	-

Source: Own survey, 2021

Climate change (vulnerability)

Climate change poses serious threats to agricultural sustainability and poverty alleviation in the poorest and most vulnerable regions as impacts affect the dependence on rain fed agriculture, results to increased level of poverty, low level of human and physical capital development, inequitable land distribution and poor infrastructure development (Ikehi et al., 2014). Climate change is the most serious problem in the study areas in the form of drought, lack or insufficiency of rainfall.

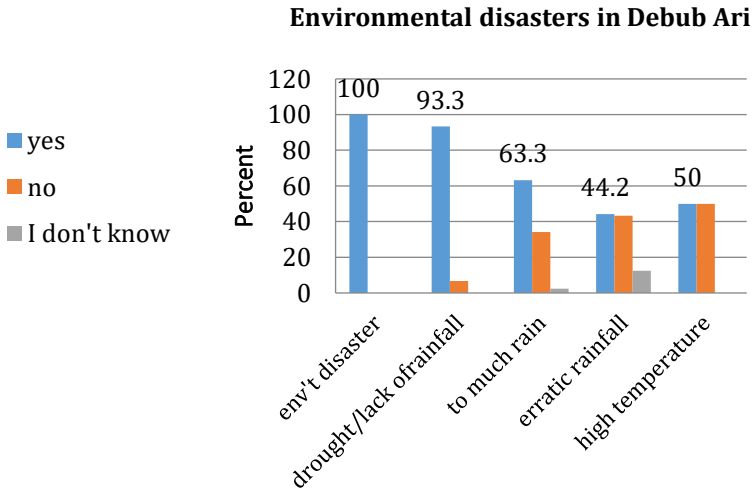

Figure 3. Environmental disasters in Debub Ari district

Erratic rainfall (late start, early ceasing, excesses rain) are mainly challenge for both crop and livestock production. Due to climate variability famers or agro pastoralists are challenge to plant crops as the seasons were changed. As revealed in focus group discussion with pastoral/agro pastoral groups there is recurrent drought, erratic rainfall patterns, and high temperatures which had been induced crop and livestock losses in the year, 2017/2018. Also, they raised climate change has direct effects on their livestock productivity and changes on the availability of fodder and pastures. During drought season they search for water and move to a place where there is available grazing land. As presented in the figure 3 above, all respondents agreed that there are environmental disasters in Debub Ari district since the last 10 years. About 93.3% of respondents revealed that extensive drought or lack of rainfall is one the main environment disaster in the area. In the last ten years there was several climatic variability effects observed and among those the most common in the area are too much rainfall (63.3%), erratic rainfall (44.2%) and high temperature (50%).

In the Malle district all respondents confirmed that the environmental disaster and the effect of it challenged the life of agro pastoralist. In the research location, rainfall had a direct impact on the population of animals. One such direct connection, according to the locals, is between milk and meat production. Additionally, it was claimed that animals grew during good seasons and perished during extended dry spells. Due to less pasture, the study area's established reduced rainfall pattern has resulted in a net decrease in the number of animals. During the area's reported regular drought cycles, livestock did sell for low prices. The population of the main livestock has decreased over the study period, with cattle and shoat being the most affected, it was thus discovered. As the number of cattle decreased, their output, which is closely tied, also decreased, thus hurting the agro pastoralists' means of subsistence. This has a direct influence on food availability, and residents of the study area get government food assistance. According to Farauta et al. (2011), climate change is a role in food price crises, and its effects on agriculture in developing nations are predicted to worsen. As presented in the figure 4 below, about 86.7% of respondents revealed that extensive drought or lack of rainfall is one the main environment disaster in the area. In the last ten years there were several climatic variability effects have been observed and among those the most common in the area are too much rainfall (55.8%), erratic rainfall (45.8%) and high temperature (53.5%).

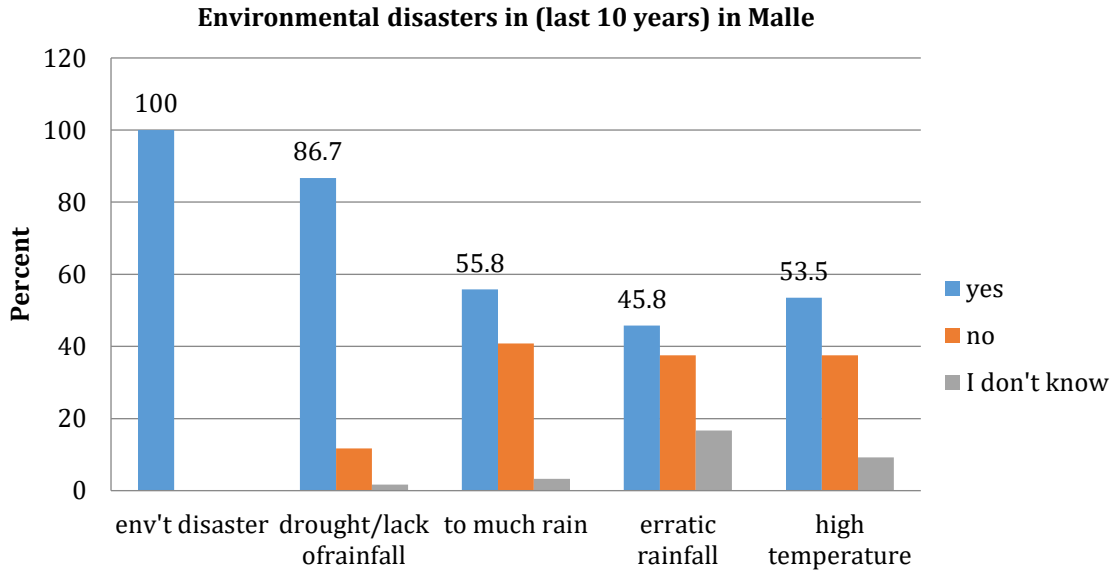

Figure 4. Environmental disasters in Malle district

Coping Mechanism to address environmental change

This study was also interested in establishing the coping mechanisms employed by the farmers, agro pastoral, pastoral households to cope with climate variability. On this, the respondents were asked to indicate whether there were strategies they devised to survive or reduce the impact of climate variability. Asked which coping mechanisms they employed, the respondents outlined a number of strategies among them receiving food aid, livestock sell, bought food, borrowing money from relatives/traders and temporary migration were major mentioned. In Debub Ari district the farmer's main coping mechanisms are livestock sell, bought food, grain storage and borrowing whereas agro-pastoralists in Malle receive food aid, bought food, sell livestock and temporary migrations. As presented in the Figures 5 & 6 below about 60.8% (sold livestock), 57.5% (bought food) and 46.7% (borrow money from relatives) of respondents pointed that these as the priority coping mechanism in Debub Ari district whereas about 87.5% (do nothing and bought food), 85.8% (migrate town temporarily), 73.3% (sold livestock) and 71.3% (get food aid) of respondents pointed that these as the priority coping mechanism in Malle district. In both districts sell of livestock and bought food is one most common coping mechanism to the environmental change. However, agro pastorals were not able to respond to the environmental change and do nothing.

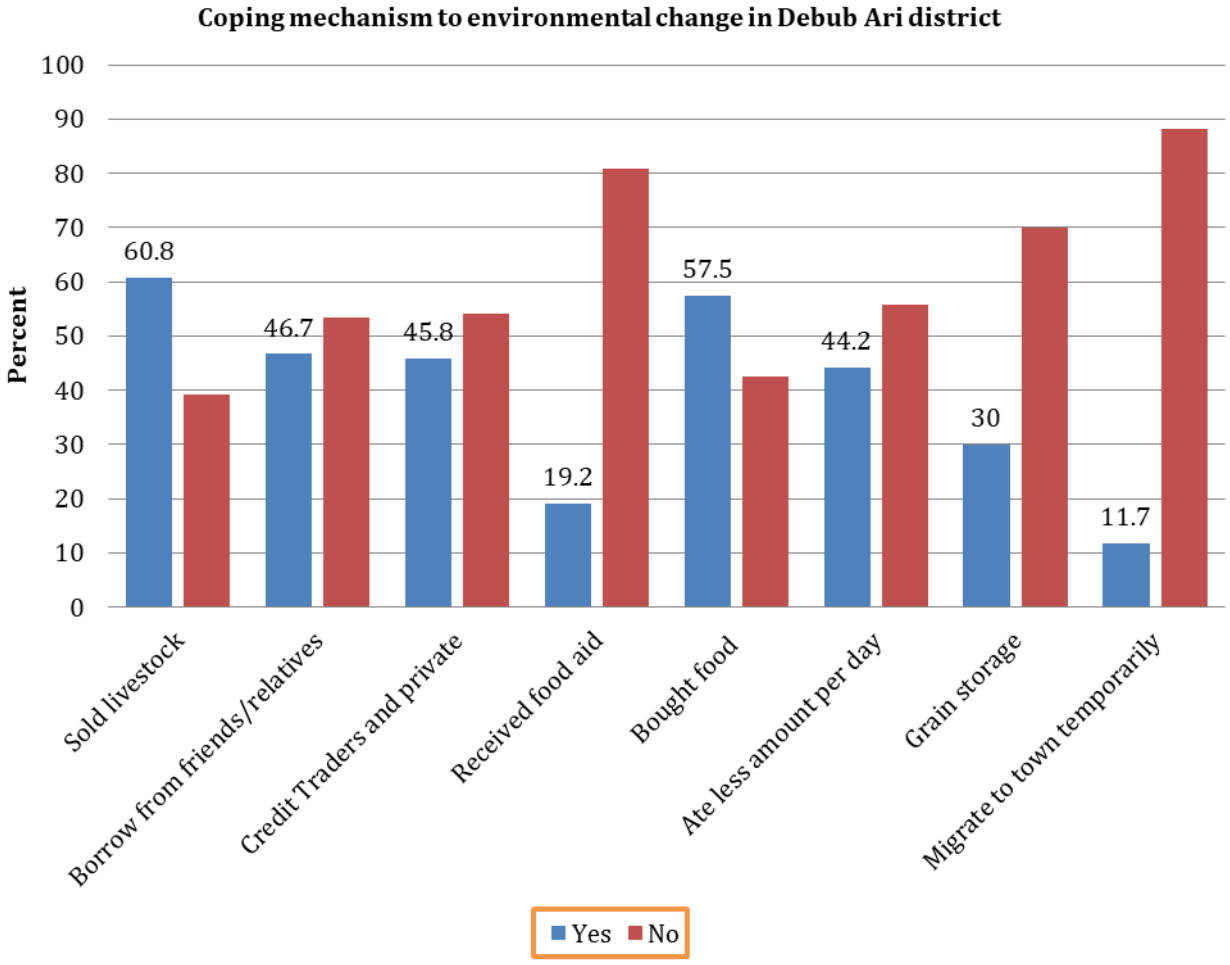

Figure 5. Coping mechanism to environmental change in Debub Ari district

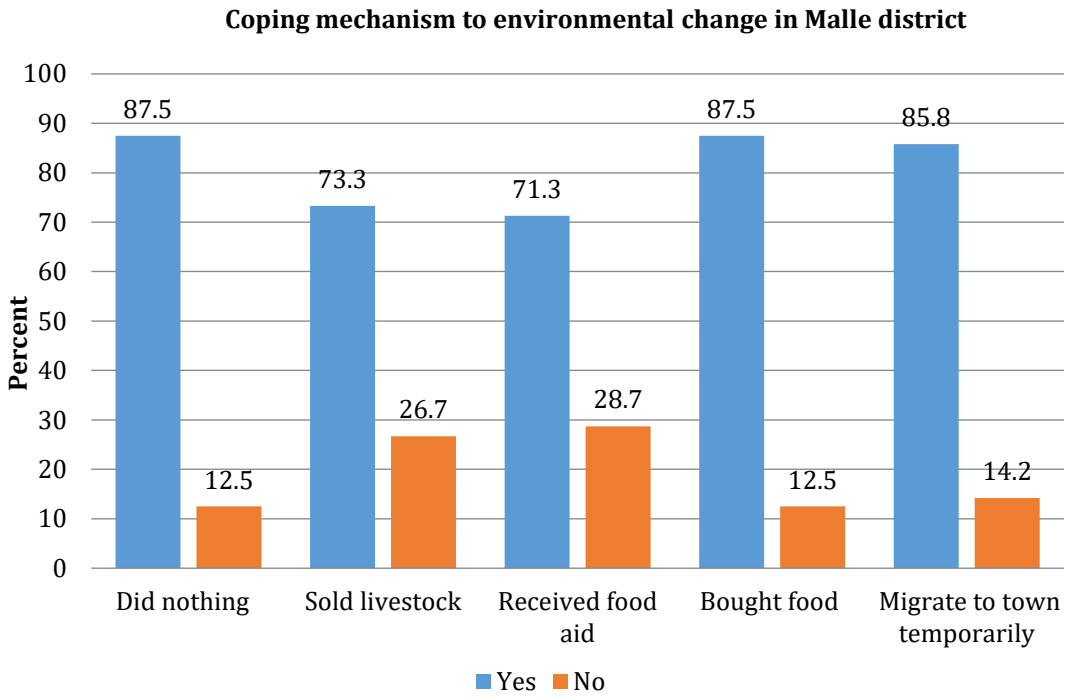

Figure 6. Coping mechanism to environmental change in Malle district

Adaptation strategies to environmental change

A change in weather conditions could influence the type of crops grown or animals reared. For farmers and agro pastorals to adapt to the impacts of environmental change, those (farmers and agro pastorals) that are currently experiencing warmer environments due to shift or drastic rise in temperature should shift to planting of crops that can survive in the current trend in their places. As shown in Table 15 below shows about 44.2 and 48.3% of respondents do not have any adaptation strategies but more than 50% of respondents in all district practice some adaptation mechanism like changing crop type, animal breeds, decreasing livestock number, engage in irrigation and off-farm income sources.

Table 15 . Adaptation strategies

Items on Adaptation strategies		Districts			
		Debub Ari		Malle	
		Frequency	Percent	Frequency	Percent
No adaptation mechanism	Yes	53	44.2	58	48.3
Change crop type	Yes	30	25	61	50.8
Change crop varieties	Yes	15	12.5	52	43.3
Change animal breeds/forage	Yes	5	4.2	0	0
Decrease number of livestock owned	Yes	101	84.2	62	51.7
Engage on irrigation	Yes	11	9.2	15	12.5
Engage in off -farm employment	Yes	96	80	60	50

Source: own survey, 2021

Agricultural extension system

Access to extension services (agricultural technologies and practices) have been improved over time due to result-oriented extension approach in which farmers/agro pastoralists could see the yield difference of introduced technologies compared to the local one. Now a day farmers in the area adopted agricultural technologies which can give a high yield over the local. Information sources about improved agricultural technologies are DAs, farmer to farmer communication, model farmers' field visits, and experience sharing in the Woreda. Moreover, most of farmers are open to use new agricultural technologies but still, agro-pastoralist is waiting for free seed and fertilizer, and also external support from either the Woreda government or NGOs. Nearly in all districts about more than 885% of respondents get extension services but the level of satisfaction varies in each district. The level of satisfaction with extension in Debub Ari (90.7%) and Malle district (89%) is medium as revealed by sample respondents (Figure 7).

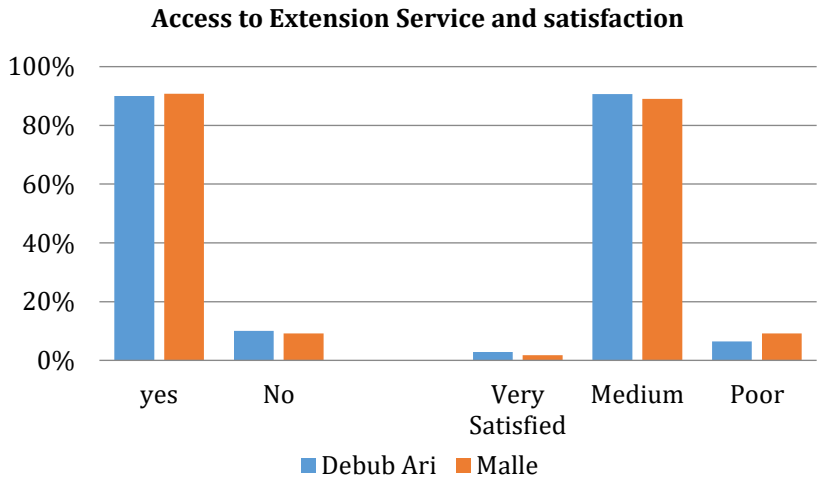

Figure 7. Access to extension services

Major constraints to livelihood improvement in the study area

The major constraints of livelihood improvement in the study area are presented in the Table 16. Extensive drought and erratic rainfall are the first constraint affecting both crop and livestock production in the study areas. Shortage of rainfall and the frequently recurring drought in the area is a major cause for reduced crop, livestock and forage production. The second constraint associated with livelihood improvement is shortage of food or food deficiency which is associated with loss of crops and livestock due to climate variability. Delay of agricultural inputs such as seed, fertilizer, forage seed and animal drugs cause farmers and agro pastoral/pastorals not to produce crops with erratic rainfall distribution and ineffective vet service delivery for livestock production in the study areas. For instance, a month delay of inputs enables farmers and agro pastoral/pastorals not plant crops and deny forage production because rainfall distribution is unpredictable. Accessibility, quality, and efficient regular delivery of services are in particular lacking. According to a group discussion with experts, farmers, agro-pastoralists, and pastoralists about the quality and dependability of drugs, many veterinary drugs are given out without a veterinarian's prescription or inspection, typically due to the distance between clinics and health posts or the lack of adequate services in existing

clinics. Due to the imbalance between the number of health staff and the livestock population as well as the amount of vaccine and livestock population, vaccination coverage was mostly inadequate and a sizable portion of the cattle were left unvaccinated. Particularly the regularity of vaccinations was unpopular with pastoralists and agro pastoralists. In terms of accessibility, price, and quality metrics, the existing animal health care delivery by both public sectors and private retailers was usually inadequate. Animal health and productivity are severely impacted by a lack of feed and water as well as the harsh local climate. Furthermore, the accompanying animal deaths in the research areas are a very serious issue, particularly in the agro-pastoral and pastoral areas of the zone.

Table 16. Major constraints to livelihood improvement in the study area

Major constraints to livelihood improvement	Frequency	Percent	Rank
Drought or lack of rainfall	18	18.6	1
Lack of food or shortage	14	14.4	2
Livestock disease and weak vet services	12	12.4	4
Feed shortage	9	9.3	5
Delay inputs	16	16.5	3
Heavy flood	6	6.2	8
Irrigation water access problem	8	8.2	6
Weak extension support	7	7.2	7
Lack of infrastructure	5	5.2	9
Weak access to improved technologies	2	2.1	10

Source: own survey, 2021

CONCLUSION

A farming system in the South Omo zone is mainly based on dominant livestock and supportive crop in agro pastoral areas and dominant crop and supportive livestock production in mixed farming areas. The average productivity per hectare for major crops produced in the study areas is less than the national mean productivity due to limitations such as poor soil fertility management, low inputs use and erratic rainfall. Pests (diseases and insects), high input costs (seed and fertilizer), a lack of land, and delays in input supplies (seed and fertilizer) were the main causes of hardship for farmers and agro-pastoralists. The primary resource that agro pastoralists in the study site depend on for their livelihood is livestock. All of the agro pastoralist groups in the study area raise multiple species of animals, primarily goats, cattle, and sheep, where they can benefit from the various ways that the various animal species have adapted to diseases, a lack of food and water, drought, and a variety of products that can be produced from the animals. In the research areas, natural pasture (both communal and private grazing) was the main source of feed for livestock management practices. Improved forage production in the research areas is practiced by limited respondents. The main impediments of livestock production were drought, disease and parasites, shortage of feed and shortage of veterinary medicine. The major constraints of natural resources in the study are soil fertility decline, land shortage due to fragmentation of land for their children and deforestation. Therefore, it needs more attention to reverse the mentioned major constraints so as to enhance agricultural production and productivity. Timely supply of improved inputs(seed/fertilizer), improved forage, methods of disease control and intensifying natural resource management and creating better awareness on physical and biological soil management are critical for improvements of soil and enhances productivity.

ACKNOWLEDGMENTS

The authors would like to thank Southern Agricultural Research Institute and Jinka Agricultural Research Center for logistics support. Authors also express their great appreciation to Malle and Debub Ari woreda experts, kebele administrative and farmers and agro-pastorals who involve in this research study.

AUTHOR CONTRIBUTIONS

Mr. Asmera Adicha wrote and edited the entire manuscript in addition to writing the proposal, securing the funding, and conducting the research and data collection. Mr. Dawit Darcho, Gedion Ermias, Kutoya Kusse and Zeynu Kelifa involved in data collection, data entry and draft analysis of this research report.

COMPETING INTERESTS

The authors declare they have no conflict of interest. The manuscript has not been submitted for publication in other journal.

ETHICS APPROVAL

Not applicable

REFERENCES

Ahmed, M. (2017). Factors affecting sweet potato production in crop–livestock farming systems in Ethiopia. Norwegian university of Life Science. Master's Thesis, Department of Plant Sciences. Mekelle Ethiopia and Norway.

Alemu, L., Tekalign, M., Wassie, H., & Hailu, Sh. (2016). Characterization of Farming Systems in Kedida Gamela, Kacha Bira and Damboya Woredas (Administrative Districts) in Southern Ethiopia, Hawassa University, School of Plant and Horticulture Science, Ethiopia, Agricultural Transformation Agency (ATA), Ethiopia, International Food Policy Research Institute (IFPRI). *Journal of Biology, Agriculture and Healthcare,* 6(9), 1-16.

Emana, B., Afari-Sefa, V., Dinssa, F., Ayana, A., Balemi, T., & Temesgen, M. (2015). Characterization and assessment of vegetable production and marketing systems in the humid tropics of Ethiopia. *Quarterly Journal of International Agriculture, 54*(2), 163-187.

Dixon, J., Gulliver, A., & Gibbon, D (2001). Farming systems and poverty: Improving farmers' livelihoods in a changing world (English). Food and Agriculture Organization and World Bank Group. www.fao.org/ farming systems/.

Farauta, B. K., Egbule, C. I., Idrisa, Y. L., & Agu, V. C. (2011). Perception of climate change and adaptation strategies in Northern Nigeria: an empirical assessment. Retrieved 23rd March, 2012 from http://unfec.inc/2860.php.

IFPRI (2009). A Study in Support of the Mars Food Action of the European Union. The Cereal Availability in Ethiopia, 2007/08. Final Technical Report of the Project submitted to the European Commission Joint Research Centre. Institute for the Protection and the Security of the Citizen, Fermi, Italy.

Ikehi, M. E., Onu, F. M., Ifeanyieze, F. O., & Paradang, S. P. (2014). Farming families and climate change issues in Niger Delta Region of Nigeria: extent of impact and adaptation strategies. *Journal of Agricultural Sciences, 5*(1), 1140-1151. http://dx.doi.org/10.4236/as.2014.512124.

MoARD. (2015). Ethiopia's Agriculture Sector Policy and Investment Framework: Ten Year Road Map (2010-2020), Draft, Addis Ababa, Ethiopia.

Roberts, Cl., & Azzarri, C. (2014). "Ethiopia Agricultural Snapshot 2011/12," Working Paper, Harvest Choice International Food Policy Research Institute (IFPRI).

Taffesse, A. S., Dorosh, P., & Asrat, S. (2011). Crop production in Ethiopia: Regional Patterns and Trends. Ethiopia Strategy Support Program II (ESSP II) ESSP II Working Paper No. 0016.

Zerssa, G., Feyssa, D., Kim, D. G., & Eichler-Löbermann, B. (2021). Challenges of smallholder farming in Ethiopia and opportunities by adopting climate-smart agriculture. *Asssssgriculture, 11*(3), 192.