International Journal of Management and Fuzzy Systems
2020; 6(2): 14-28
http://www.sciencepublishinggroup.com/j/ijmfs
doi: 10.11648/j.ijmfs.20200602.11
ISSN: 2575-4939 (Print); ISSN: 2575-4947 (Online)

Farming System Characterization and Analysis of East Wollega Zone, Oromia, Ethiopia

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To cite this article:
Kifle Degefa, Getachew Biru, Galmessa Abebe. Farming System Characterization and Analysis of East Wollega Zone, Oromia, Ethiopia. *International Journal of Management and Fuzzy Systems.* Vol. 6, No. 2, 2020, pp. 14-28. doi: 10.11648/j.ijmfs.20200602.11

Received: May 30, 2020; **Accepted**: June 15, 2020; **Published**: August 4, 2020

Abstract: The study was characterizing and analyze the existing farming system and identify the production and marketing constraints of the East Wollega zone with cross-sectional data of 156 sample respondents. The farming system of the study area is characterized as mixed farming systems with 56.21% and 28.44% contribution of crop and livestock, respectively for livelihood activities. The survey result shows that low productivity, shortage/lack of improved varieties, weed infestation, high cost of inputs was identified as main important constraints in crop production while high transaction cost, lack of marketing linkage, low price of output and shortage of market information were reported as main constraints in crop marketing. Disease, feed shortage, grazing land shortage, and lack of improved breed were identified as main important constraints in livestock production whereas high transaction cost, low price output, shortage of market information, unorganized marketing system, and lack of market linkage were reported as main livestock marketing constraints. Besides, soil erosion, soil fertility decline, waterlogging, soil acidity, and termite were reported as the main important constraints in natural resources. To improving crop and livestock productivity access improved varieties and breed, capacitate farmers' awareness on the disease, minimizes transaction cost, focus on the high-value crops, expanding soil and water conservation, strengthening market information and linkage where must the urgent concentration for interventions.

Keywords: Crop, Farming System, East Wollega, Livestock and Natural Resource

1. Introduction

Small-scale crop-livestock integrated farming systems represent the integration of grain and animal production [1] which is a large fraction of the rural population in the region in general [2] and the East Wollega zone in specific which is a mixed farming system [3, 4]. Crop production and livestock rearing contribute significantly to the livelihoods of the smallholder farmers [5, 6]. Except for maize majority of crops grown in the zone are local varieties and the method of production is majorly oxen plow which is hearted from the farmers' ancestors [3]. The substance farmers in the zone usually manage a complex whole farm system of at least several enterprises that are not known with market-oriented crop production and the subsistence production is dominated in the zone [4]. Local cattle are the predominant breeds reared in the area and market-oriented dairy and meat production are rarely practiced in the zone [3].

Crop, livestock, and natural resource production and productivity are constrained by ecological, technical, and economic limitations in the major agro-ecologies of Ethiopia [7]. These constraints call for an identification and analysis farming system that aids to identify the point of intervention in development works to enhance production and productivity of crop, livestock, and natural resources [8].

A farming system is a unique and reasonably stable arrangement of farming enterprises that a household manages according to well-defined practices in response to the physical, biological and socio-economic environment with household goals preferences and resources [9]. It is comprising complex production units involving a diversity of mixed crops and livestock in order to meet the multiple objectives of the household [10] which is similar to the study zone [4].

Understanding the interdependence of the elements of the farming system and maintaining the balance in the complex

set of farmer's objectives are relevant to outlining promising development strategies for such systems [11]. The classification of developing countries may be varied as an available natural resource base, climate, landscape, farm size, tenure and organization, the dominant pattern of farm activities, and household livelihood [12].

Therefore, this farming system characterized is important to identify and analyzed the intensity of production, diversification of crops, other activities and major constraints of the study area with to characterize and analyze the existing farming system of major agro-ecologies and identify the production constraints of the farming system for further development and research interventions of the study zone.

2. Research Methodology

2.1. Description of the Study Area

The study was conducted in East Wollega zone which is one of the zones of Oromia National Regional State that comprises 17 districts. The total land area of the zone is about 14,102.50 km^2 which accounts for about 3.88% of the total area of the National Regional State of Oromia and has 1,199,444 rural populations [3].

East Wollega zone is characterized by three major agro-ecologies include highland (13%), midland (57%), and lowland (30%) with hilly, undulating, and rolling topographical features. It's altitude ranges between 1000 and 2798 meters above sea level with the mean annual rainfall ranging between 1400 mm and 2200 mm. The main rainy season runs from the months of May to September. The soil types are clay and red sandy clay. Tef, barley, wheat, faba bean, sesame, groundnut, field pea, maize, sorghum, finger millet, potato, tomato, hot-pepper, and nug are some major crops grown in the zone [3].

2.2. Sampling Techniques

A multi-stage sampling procedure was employed to select representative sample respondents. In the first stage, Diga, Jima Arjo, and Boneya Boshe districts were selected purposively depending on their representativeness on the existing socio-economic, socio-cultural, and agro-ecological diversities of the targeted population of the zone. On the second stage, the kebeles were stratified based on farmers farming system cluster to capture the existing socio-economic, socio-cultural, and agro-ecological diversities of the targeted population. On the third stage, eight kebeles (two from highland, four from midland and two from lowland) kebeles were selected purposively from farming system cluster with the consultation of experts from each district's based on the existing socio-economic, socio-cultural, and agro-ecological diversities of the targeted population of each district. Finally, 156 sample respondents were selected randomly from strata based on proportional probability size.

2.3. Types of Data

Both primary and secondary data were collected and analysed for the study. Secondary data were collected from Zonal Finance and Economic Development Office and Agricultural and Natural Resource Development Office at zone and districts using comprehensive and well-prepared checklists and soft copies of these data were also collected from respective offices. The household interview and Focused Group Discussion (FGD) using PRA tools were undertaken by researchers from different disciplines that include crop, livestock, natural resource, socio-economics, and extension research teams.

Among the primary data collected household demographic features, the socio-economic situation of the household, household's resource endowment, household livelihood activities, households' resource allocation pattern, interaction and relationship between different components of the farming system, access to institutional support services access to market, households' use of modern inputs and farming system constraints of production in the zone.

2.4. Method of Data Collection

The primary data were collected from the sampled households and key informants. A focused group discussion was undertaken using PRA tools to collect pre-hand qualitative data. After analysing the qualitative data, the team identified parameters to be quantified and then the team prepared the household survey questionnaire. Finally, a formal survey was undertaken from 156 sample respondents.

2.5. Methods of Data Analysis

On spot, qualitative data analysis was made for data collected during focused group discussion and quantitative data were analysed using STATA software and the results are presented in descriptive statistics such as minimum, maximum, mean, standard deviation, frequency, and percentage and pairwise rank analysis were employed based on the type of data.

3. Results and Discussion

3.1. General Respondents

3.1.1. Farm Implements and Communication

Ownership of farm implements is help in Ethiopian agriculture which focused on oxen power and weeding and hoeing led by labors force. The result indicated that about 89.10%, 62.20%, and 77.60 of respondents were had ox-plow, sickle, and hoe on average 1.50, 3.50, and 3.20 owned for agricultural activities, respectively. Information technology was more informed and can be used as contact farmers through mobile, radio, and TV. About 50.60%, 55.80, and 3.20% of respondents had a radio, mobile, and TV which used as technology information dissemination to farmers (Table 1). These communication assets used as successful information sources for technology innovations [13].

Table 1. *Farm implements and communication of respondents.*

Farm implements	N	%hhs	Mean	Infrastructures	N	%hhs	Mean
Ox-plough	139	89.10	1.50 (0.60)	Radio	79	50.60	1.10 (0.20)
Sickle	97	62.20	3.50 (3.20)	Mobile	87	55.80	1.40 (1)
Hoe/Jembe	121	77.60	3.20 (2.70)	Television	5	3.20	1
Others	60	38.50	2.20 (1.30)				

Numbers in parentheses are standard deviations.
Source: own computation (2017).

3.1.2. Livelihoods and Income Sources

Crops remain to be a dominant economic activity and source of livelihood in the three agro-ecologies with 97.14%, 86.08%, and 69.05% of respondents were participated in highland, midland, and lowland agro-ecologies, respectively. The annual income contribution from crops was 54.55%, 60%, and 62.59 in highland, midland, and lowland agro-ecologies, respectively following livestock rearing. Opportunities to diversify income from beekeeping and off/non-farm activities were reported by respondents. About 22.86%, 21.52% and 9.52% of respondents have participated in beekeeping income-generating activities in highland, midland and lowland agro-ecologies with 12.50%, 8.75%, and 5.50% annual income contribution, respectively. Besides, around 17.14%, 2.53%, and 7.14% of respondents have participated in highland, midland, and lowland agro-ecologies with 12.50%, 40%, and 21% of annual income contribution, respectively (Table 2). The majority of Ethiopian farmers of incomes were generated from crops and livestock activities [14, 15].

Table 2. *Livelihood activities and percent of annual income contribution of respondents.*

Income sources	Highland (n=35)		Midland (n=79)		Lowland (n=42)	
	%hhs	Income (%)	%hhs	Income (%)	%hhs	Income (%)
Crops	97.14	54.55	86.08	60	69.05	62.59
Livestock	88.57	36.67	73.42	29.56	59.52	26.96
Beekeeping	22.86	12.50	21.52	8.75	9.52	5.50
Off/non-farm activities	17.14	12.50	2.53	40	7.14	21

Source: own computation (2017).

3.1.3. Land Ownership

Land tenure and how the land under the farmers' control was utilized were observed in the study. All the results in table 3 show that an average of 2.06 hectares of owned cultivated land was allocated for rain-fed system and irrigation systems.

Table 3. *Land allocated in hectare for different crops produced by respondents.*

Variables (N=156)	N	Percent	Min.	Max.	Mean
Total own land	139	89.10	0.02	12	2.41 (2.21)
Total own cultivable land	134	85.90	0.125	11	2.06 (1.86)
Total own land allocated for crops (rain fed)	127	81.41	0.01	10	1.75 (1.52)
Total own land allocated for crops (irrigated)	21	13.46	0.13	1	0.37 (0.21)

Source: own computation (2017).

The majority of the respondents were practiced rain-fed system (81.41%), an average on 1.75 hectares of land, and only 13.46% of respondents were practiced irrigation, an average on 0.37 hectares of land operated during the survey period. Sample respondents have practiced irrigation for crop production from lowland and highland farming clusters (Table 3) which similar to [16].

3.2. Crop Farming System

3.2.1. Major Crops Grown and Productivity

Cropping system of the zone is characterized as no fallow land for crop production because of land shortage in all types of farming system clusters and intercropping is really practiced in the lowland areas largely maize with haricot bean. Crop cultivation in the study area mainly depends on the rain-fed system. Cropping patterns adopted by farmers in the study areas were summarized in table 4. Maize, tef, finger millet, nug, hot-pepper, and potato were the most important crops in the three farm clusters while wheat, barley, faba bean, and field pea were grown only in highland and midland agro-ecologies.

Table 4. *Major crops grown with their productivity in major Agro-ecology by respondents.*

Crops	Highland (n=35)			Midland (n=79)			Lowland (n=42)		
	%hhs grown	Area (ha)	Yield (Qt/ha)	%hhs grown	Area (ha)	Yield (Qt/ha)	%hhs grown	Area (ha)	Yield (Qt/ha)
Maize	62.86	0.42	28.70	92.41	0.91	37.78	83.33	0.89	38.78
Tef	85.71	0.58	11.01	58.23	0.51	9.31	23.81	0.38	7.31
Wheat	60	0.56	18.70	11.39	0.24	16.69	-	-	-
Finger millet	22.86	0.27	16.13	20.25	0.45	17.13	21.43	0.36	19.25
Barley	60	0.41	18.25	10.13	0.17	15.23	-	-	-
Sorghum	-	-	19.30	59.49	0.53	24.82	83.33	0.68	24.82
Faba bean	14.29	0.32	10	3.80	0.25	9.76	-	-	-
Field pea	8.57	0.24	6.37	1.27	0.13	7.67	-	-	-
Nug	5.71	0.32	6.5	53.16	0.43	7.52	21.43	0.41	8.43
Ground nut	-	-	-	5.06	0.45	11.12	30.95	0.23	12.21
Sesame	-	-	-	3.80	0.25	4.32	14.29	0.34	5.23
Hot-pepper	5.71	0.13	11.42	11.39	0.41	12.43	16.67	0.38	15.42
Potato	37.14	0.23	113.23	11.39	0.16	107.32	4.76	0.13	67.12
Tomato	-	-	-	6.33	0.13	45.67	7.14	0.13	76.23

Source: own computation (2017).

The result indicated some crops like sorghum, sesame, groundnut, and tomato were mostly grown in midland and low land agro-ecologies. These indicated that all major crops were grown in midland agro-ecology (Table 4). In three agro-ecologies maize and tef were grown by large respondents and covered large land related to the other crops. Besides, wheat and barley crops were grown in highland agro-ecology by the majority of respondents on large coverage of land while sorghum, sorghum, and nug were grown in midland and lowland agro-ecologies. From the result, we concluded that cereal mono-cropping is the major farming practice in all three agro-ecologies.

Analysis of crop yields was done separately at the farming system cluster and overall which expressed in quintal per hectare as summarized in table 4. The yield of sample respondents during the survey period was below the national and regional average [17]. This low yield characterized by poor soil fertility with poor soil management [18, 19], poor agronomic practices and knowledge gap of fertilizers use [20-22], and lack of capital to purchase inputs [23].

3.2.2. Land Ploughing and Inputs Used of Major crops

The farming systems of smallholders in East Wollega zone were predominantly annual crop productions by using rainfall with traditional land plowing and planting methods. Land plowing frequency of plots for major crops depending on the nature of crops and soil fertility status. This plowing field management can dramatically affect soil conditions [24]. The majority of farmers plowing their fields ranges of 2-4 times depending on the crop. The planting date ranges from March with potato to August by rain-fed system and September to December by irrigation like potato and tomato crops (Table A1).

Soil fertility decline, the application of fertilizers is essential to ensure good yield is among the major problems that decrease the productivity of crops yields for producers with field management include included planting date [25], control pests and disease, responsive plant and soil [26, 27], and moisture availability [28]. Among the mitigation strategies used for yield boost, the application of inorganic fertilizer (Urea and NPS) was used in the zone (Table A2). The result shows that for all major crops the farmers were used inorganic fertilizer below recommendation. This result consists of [29] which directly affected yields. The producers used low inputs due to purchasing power, poor awareness on recommendation amount, importance, and in all crops apply below recommendation rate except maize seed rate [30]. The application of inorganic fertilizers and seed for maize is close to the recommended which is 100 kg of NPS and 150-200 kg of urea in all farming system clusters (Table A2).

3.2.3. Improved Seed Used by Respondents

In this situation, different organizations including research institutes provide farmers to adopt a technology (variety) in their fields. The adoption of new technology act to improve households' welfare than local technology [10]. This study explored the adoption gap between improved varieties and planting methods. This implies that the majority of respondents used local varieties with broadcasting planting methods (Table 5). Local variety with traditional planting methods declines crop yield [31, 32].

The result shows that, majority of crops grown in the areas dominated by local varieties and broadcasting planting methods (Table 5). Maize, tef, sorghum, finger millet, wheat, and potato crops were used improved varieties partially. Among the maize varieties BH-546, BH-660, BH-661, limu, and shone were widely grown. Comparison across the farming clusters BH-660 and BH-661 were adopted at the highland farming cluster while BH-546, BH-660, BH-661, limu, and shone were widely adopted at the midland and lowland farming clusters. Among the tef varieties kena, guduru, and Quncho were adopted and used widely. Finger millet like boneya and addis-01 varieties were practiced by farmers.

Table 5. *Percentage of respondents used improved technologies.*

Crops	High land (35)		Midland (79)		Lowland (42)	
	Improved varieties	Row planting	Improved varieties	Row planting	Improved varieties	Row planting
Maize	77.27	98.21	93.15	97.96	48.57	97.78
Tef	40.00	**	15.22	6.52	30.00	30
Wheat	33.33	**	22.22	44.44	*	**
Finger millet	*	**	12.50	**	33.33	**
Sorghum	*	**	*	8.51	*	17.14
Field pea	*	66.67	*	**	*	**
Ground nut	*	**	*	100	*	100
Pepper	*	100	*	100	*	100
Potato	30.77	100	22.22	100	*	100
Tomato	*	**	6.33	100	*	100

*is local variety and ** broadcasting method.
Source: own computation (2017).

To understand the adoption of other crops there is an adoption gap and the farmers were used local varieties which characterized by low productivity. These local varieties with traditional planting (broadcasting) result in low yield. This gap of new varieties may be due high price of seed, lack of seed, poor seed quality, and untimely available [33, 34].

3.2.4. Major Weeds for Major Crops and Management Practices

Weed management can be an enormous significance increase yield of the crop [35]. The dominant weeds frequently observed in crop fields were Guizotia scabra spps, Bromuss spp, Snowdenia polystarcya, Commelina benghalesis, Oalis, Eleusine indica, Avena fatua, Raphatum spp, and Grass spp were reported as important weeds in the study areas during the survey period (Table 6).

Weed management options exercised by respondents were typically hand weeding and herbicide like 2-4-D. Hand weeding was conducted throughout crop stage ranges of 1-3 times depends on crop types and weed infestation. After 2-4-D herbicide application, at least one-time hand weeding was commonly practiced in the study areas (Table 6).

Table 6. *Major weeds of major crops and their management practices.*

Crops	Major weeds	Major control methods	Weeding frequency
Maize	Guizotia, snowden, Bromuss spp and Commelina	Hand weeding	Two to four times hand weeding
Teff	Guizotia, oxalis, Bromuss spp, grass spp and Commelina	Hand weeding and chemical (2-4-D) application	Mainly once with chemical and two times by hand
Wheat	Guizotia, Oat (Avena fatua) and Raphatum spp	Hand weeding and chemical (2-4-D) application	Mainly one-two with chemical and three times by hand
Sorghum	Guizotia, Snowden and Oxalis	Hand weeding	One to three times
Finger Millet	Eleusine indica, Guizotia, Bromuss spp and Grass spp	Hand weeding and chemical (2-4-D) application	Mainly once and also twice

Source: own computation (2017).

3.2.5. Major Crop Production Constraints

An in-depth quantitative analysis was undertaken to understand the constraints that inhibit crop production of the respondents in three farming clusters. The major crops production constraints include low productivity (91.14%), shortage/lack of improved seed (88.57%), weed infestation (82.86%), high cost of improved seed (77.14%), high cost of fertilizer (71.43%), pests (disease (60%) and insect (54.29%) were the main constraints in the highland farming cluster which ranked ranges of 1-7 ranks (Table 7). These constraints indicate that in the farming clusters inadequate awareness of the technologies and poor management skills which contribute to low productivity and profitability which are consists of [36-38].

Table 7. *Major crops production constraints of respondents.*

Crop production constraints	Highland (n=35)			Midland (n=79)			Lowland (n=42)		
	N	%hhs	Rank	N	% hhs	Rank	N	%hhs	Rank
Disease	21	60.00	6	43	54.43	7	27	64.29	7
Insects	19	54.29	7	34	43.04		25	59.52	
Termite	12	34.29		53	67.09	4	28	66.67	6
High cost of improved seed	27	77.14	4	62	78.48	2	32	76.19	3
High cost of fertilizer	25	71.43	5	64	81.01	1	35	83.33	2
Shortage/lack of improved seed	31	88.57	2	52	65.82	5	29	69.05	5
Shortage of land	17	48.57		23	29.114		13	30.95	
Lack of capital	15	42.86		27	34.177		22	52.38	

Crop production constraints	Highland (n=35)			Midland (n=79)			Lowland (n=42)		
	N	%hhs	Rank	N	% hhs	Rank	N	%hhs	Rank
Low productivity	32	91.43	1	37	46.835		19	45.24	
Weed infestation	29	82.86	3	55	69.62	3	31	73.81	4
Poor soil fertility	11	31.43		51	64.56	6	40	95.24	1

Source: own computation (2017).

3.2.6. Major Crops Marketing Constraints

The measurable analysis was undertaken to understand the constraints that inhibit crop marketing of the respondents in three farming clusters that were identified and ranked in table 8. The major crops marketing constraints include lack marketing linkage (65.71%), low price of grain (62.86%), high transaction cost (51.43%), lack of capital (42.86%), and shortage of market information (37.14%) of respondents were reported as main constraints in three farming clusters (Table 8). This result indicates that there are net buyers of crop produced and selling the produce challenges is necessary for the fulfillment of short term needs like quantities, prices and market infrastructure [39].

Table 8. *Major crops marketing constraints of respondents.*

Crops marketing constraints	Highland (n=35)			Midland (n=79)			Lowland (n=42)		
	N	%hhs	Rank	N	%hhs	Rank	N	%hhs	Rank
Lack of capital	15	42.86	4	27	34.177	5	22	52.38	4
Low price of output	22	62.86	2	59	74.684	2	26	61.90	2
Shortage of market information	13	37.14	5	49	62.025	4	18	42.86	5
Lack of market linkage	23	65.71	1	72	91.139	1	37	88.10	1
High transaction cost	18	51.43	3	54	68.354	3	23	54.76	3

Source: own computation (2017).

Market access is an opportunity to adopt new technologies which have major implication for household production [40] and food security [41]. In general, access to markets tended to decrease household dependence on any specific resource. It means households with access to markets required less land and livestock for ensuring food security than those without it [42]. Access to output markets has also played a critical role in supporting high and stable economic returns to production, alleviating vulnerabilities to shocks and providing opportunities to buy and sell crops, and access non-farm work [43].

3.3. Livestock Production Farming System

3.3.1. Livestock Ownership

A high percentage of the population in the survey areas own cows, oxen, heifers, calves, shoats and poultry types of livestock were the major livestock in three farming clusters and summarized in table 9. About 80.00% with 2.46 TLU herd size and 82.86% with 2.86 TLU herd sizes cows and oxen rearing highland farming cluster, respectively (Table 9). From total respondents, 72.15% with 2.70 TLU herd size and 75.95% with 3.12 TLU herd size cows and oxen rearing midland farming cluster while 59.52% with 2.24 TLU herd size and 73.81% with 3.00 TLU herd sizes cows and oxen rearing lowland farming cluster, respectively (Table 9).

Sheep and goats are important as an income source by the farming population. About 80% with 0.23, 44.30% with 0.23, and 47.62% with 0.35 TLU heard the size of shoats owned in highland, midland and lowland farming, respectively (Table 9). Donkeys and horses were used for transportation services. About 31.43%, 41.77%, and 28.57% of respondents were have owned donkey for means transportation service and income generation sources in highland, midland, and lowland farming clusters, respectively (Table 9). Although chicken (local and improved) breeds kept by 60%, 60.76%, and 59.52% of respondents in highland, midland, and lowland farming clusters (Table 9).

Table 9. *Household livestock ownership, proportion of owners and herd sizes (TLU)*

Livestock type	Highland (n=35)			Midland (n=79)			Lowland (n=42)		
	N	%hhs	Mean	N	%hhs	Mean	N	%hhs	Mean
Cows	28*[3]	80.00	2.46 (1.55)	57	72.15	2.70 (2.20)	25	59.52	2.24 (1.36)
Oxen	29	82.86	2.86 (1.43)	60	75.95	3.12 (1.84)	31	73.81	3.00 (1.84)
Heifers	15	42.86	1.21 (0.62)	44	55.70	1.62 (1.60)	19	45.24	1.58 (0.90)
Calves	23	65.71	0.50 (0.21)	54	68.35	0.56 (0.36)	20	47.62	0.57 (0.32)
Sheep and goats	28	80.00	0.23 (0.27)	35	44.30	0.23 (0.20)	20	47.62	0.35 (0.35)
Donkeys	11	31.43	1.02 (0.48)	33	41.77	1.02 (0.43)	12	28.57	0.88 (0.32)
Horses	6	17.14	1.28 (0.45)	11	13.92	1.27 (0.47)	3	7.14	1.47 (0.64)
Poultry	21*[6]	60.00	0.10 (0.03)	48*[22]	60.76	0.11 (0.05)	25*[8]	59.52	0.12 (0.06)
Total TLU	33	94.29	9.66 (5.04)	63	81.01	10.63 (7.15)	35	83.33	9.86 (5.44)

Note: *= Percentage of crossbred breed and numbers in parentheses are standard deviations.
Source: own computation (2017).

Generally, livestock ownership is regarded as key to rural livelihoods which are sources of power and fertilizer for crop production, supply human food, transportation, income generation sources, and wealth communication [44, 45]. Moreover, the role of oxen availability played in the timely adequate cropland preparation could contribute to increasing food-feed crop production [46]. This integrated crop-livestock farming in the study area is often assumed to lead to synergies between crop and livestock production, thereby improving the overall productivity and resilience of agricultural production. Besides, using manure is also an important variable for the rural household's land productivity enhancement by improving soil fertility [47].

3.3.2. Livestock Feeds and Feeding System

Livestock producers practiced three grazing systems including own grazing land, crop residues, and communal land and combinations of them (Table 10) which are the same as [48, 49]. Straw (tef, barley, wheat, bean, pea) and Stover of maize and sorghum were extensively used by the majority of respondents due to palatable by livestock and no other feed option for their livestock.

Table 10. *Livestock feed sources and feeding system of respondents*

Common feeds and source	N	%hhs	Improved forage practiced		N	%hhs
Own grazing land	109	77.30	Practiced	Yes	41	26.30
Crop residues	114	80.90		No	115	73.70
Communal land	45	31.90	Forage types	Alfalfa and Rhodes	9	22.00
Supplementary feed (Fegullo, etc)	33	23.40		Elephant grass	28	68.20
Most common crop residue used				Others	4	9.80
Straw (barley, tef, wheat and finger millet)	106	75.20	Area used for forage	Homestead	13	31.70
Stover of maize and sorghum	64	45.40		On soil conservation	6	14.60
Faba bean and field pea straw	7	5.00		On farm	22	53.70

Source: own computation (2017).

About 77.30%, 80.90%, and 31.40% of respondents used own grazing land, crop residues, and communal land, respectively (Table 10). The result revealed that about 26.30% of respondents have been practicing improved forages including alfalfa, Rhodes, and elephant grass by private and public sectors by respondents during survey period on soil conservation and around the homestead (Table 10).

3.3.3. Livestock Production Constraints

Livestock producers were asked to give their perspectives on the most important constraints affecting their livestock farm operations and their responses were summarized in table 11. These livestock production constraints include disease (trypanosomiasis, blackleg, anthrax, pasteurellosis and mastitis lichen, leg and foot and mouth and dermatophytosis), feed shortage, lack of capital, shortage of grazing land, lack of improved breed, water shortage, shortage of veterinary medicine, shortage of awareness in production constraints were reported in three farming clusters which are similar to [50-52].

Disease (80%), Shortage of grazing land (77.14), feed shortage (71.43%), lack of improved breed (65.71%), and lack of capital (60%) were reported as main important constraints and ranked one to five on livestock production in the highland farming cluster (Table 11).

The result shows that shortage of grazing land (84.81%), disease (77.22%), lack of improved breed (65.82%), shortage of awareness (59.49%), and feed shortage (56.96%) were reported as important constraints and ranked one to five on livestock production in the midland farming cluster. In the lowland farming cluster shortage of grazing land (83.33%), disease (76.19%), feed shortage (69.05%), lack of improved breed (64.29%), and shortage of veterinary medicine (52.38%) were reported as important constraints and ranked one to five on livestock production in the lowland farming cluster. This result reveals that disease, feed shortage, and lack of improved breed reported as three major constraints in three farming clusters (Table 11).

Table 11. *Major livestock production and market constraints of respondents.*

Livestock marketing constraints	Highland (n=35)			Midland (n=79)			Lowland (n=42)		
	N	%hhs	Rank	N	%hhs	Rank	N	%hhs	Rank
Disease	28	80.00	1	61	77.22	2	32	76.19	2
Feed shortage	25	71.43	3	45	56.96	5	29	69.05	3
Lack of capital	21	60.00	5	15	18.99		19	45.24	
Shortage of grazing land	27	77.14	2	67	84.81	1	35	83.33	1
Lack of improved breed	23	65.71	4	52	65.82	3	27	64.29	4
Water shortage	14	40.00		23	29.11		18	42.86	
Shortage of veterinary medicine	17	48.57		34	43.04		22	52.38	5
Shortage of awareness	19	54.29		47	59.49	4	20	47.62	

Source: own computation (2017).

3.3.4. Livestock Marketing Constraints

The livestock marketing constraints include market/demand fluctuation, price fluctuation, low live animal price, shortage of market information, lack of marketing linkage, unorganized marketing system, and high transaction cost in marketing constraints were reported in three farming clusters that are consistent of [53, 54].

Table 12. *Major livestock marketing constraints of respondents.*

Livestock marketing constraints	Highland (n=35)			Midland (n=79)			Lowland (n=42)		
	N	% hhs	Rank	N	% hhs	Rank	N	%hhs	Rank
Market/demand fluctuation	18	51.43	5	49	62.03	4	17	40.48	
Price fluctuation	22	62.86	3	29	36.71		31	73.81	3
Low price	20	57.14	4	32	40.51		25	59.52	5
Shortage of information	16	45.71		57	72.15	3	26	61.90	4
Lack of market linkage	11	31.43		69	87.34	1	33	78.57	2
Unorganized marketing system	31	88.57	1	59	74.68	2	37	88.10	1
High transaction cost	26	74.29	2	46	58.23	5	23	54.76	

Source: own computation (2017).

In highland farming cluster unorganized marketing system (88.57%), high transaction cost (74.29%), price fluctuation (62.86%), low live animal price, and market/demand fluctuation were reported by respondents as top five livestock marketing constraints (Table 12). In midland farming cluster lack of marketing linkage (87.34%), unorganized marketing system (74.68%), shortage of marketing information (72.15%), market/demand fluctuation (62.03%), and high transaction cost (58.23%) were reported by respondents as livestock marketing constraints and ranked as top five (Table 12). In lowland farming cluster unorganized marketing system (88.10%), lack of marketing linkage (78.57%), price fluctuation (73.81%), shortage of marketing information (61.90%), low live animal price (59.52%), and high transaction cost (54.23%) were reported by respondents as top five livestock marketing constraints (Table 12).

Generally, the result indicated that lack of marketing linkage, shortage of market information, unorganized marketing system, and high transaction costs of the subsistence farmers, which reported as the most important constraint in cattle, shoats, equines, and poultry marketing in three farming clusters. These challenges net buyers of crop produced and selling the products are necessary for the fulfillment of short-term needs like quantities, prices, and market infrastructure [55].

3.4. Beekeeping Practice

Beekeeping is a common practice of the rural livelihoods as income generation source and home consumption [56, 57]. Table 13 presented beekeeping practice and major constraint in terms of number and production honey. The result shows that a few percentages of the respondents in the survey areas own traditional types of beehives at 29.49% with 16.30 numbers per farmer beehives.

Table 13. *Beekeeping farm practices of respondents.*

Bee hives and honey	N	%hhs	Mean	Constraints (n=156)	N	%hhs
Own beehives (n=156)	49	31.4		Aunts and wild animal	34	21.79
Traditional beehives (n=46)	46	29.49	16.3 (12.7)	Chemical (herbicide)	45	28.85
Modern beehives (n=46)	6	3.85	2.0 (0.9)	Lack of awareness	34	21.79
Honey harvest (traditional in kg)	46	29.49	67.1 (15.5)	Shortage of bee forage	26	16.67
Honey harvest (modern in kg)	5	3.21	29.4 (17.2	Low price of honey	31	19.87
Unit price of honey (kg-1)	38	24.36	43.6 (13.5)	Market fluctuation	15	9.62

Source: own computation (2017).

The five most frequently reported constraints were herbicide (28.85%), aunts and wild animals (21.79%), lack of awareness (21.79%), low price of honey (19.87%), and shortage of bee forage (16.67%), were the most important constraint by bee production and marketing system during the survey period (Table 13) which are consist to [58-60].

3.5. Natural Resources Practices

A natural resource is a material that comes from the Earth and in its raw or "natural" state is of value for one reason or another. Natural resource management is taking care of natural resources such as land, water. It's about the long-term implications of actions - thinking about the future and not just about now. The goal is sustainability - balancing social (people and communities), economic (money and jobs), and environmental (land, water, air, and living things) factors [61]. These natural resources divided into agroforestry and soil and water conservation.

3.5.1. Forestry and Agroforestry Practices

According to the survey report, forestry and agroforestry of the study areas were both natural, plantation, and its combination of them (Table 14). The result showed that about 82.10% and 10.40% of respondents conducted plantation and its combination of them for income generation, soil erosion control, soil improvement, and climate balance

purpose, respectively (Table 14).

Table 14. *Forestry and rainfall pattern for last five years of respondents.*

	Response	N	%hhs
Plantation and forest practiced in the area (n=156)	Yes	106	68.90
	No	50	31.10
Forest type (n=106)	Natural*	8	7.5
	Plantation	87	82.10
	Both	11	10.40
Purposes of plantation and natural forest (n=106)	Income generation	92	86.8
	Soil erosion control	86	81.1
	Soil improvement (legume and shrubs trees)	87	82.1
	Weather balance (temperature)	43	40.6

*natural forest which planted by a group for conservation purpose and different trees grown by nature.
Source: own computation (2017).

Eucalyptus tree was the dominant tree in both districts due to different purposes, especially in terms of income generation following gravilia. The majority of the respondents have conducted plantation around their home (garden), along with the farming land and marginal land for plantation without a strategic plan for plantation.

3.5.2. Major Forestry and Agroforestry Constraints

The respondents reported that population increase, shortage of land for plantation, livestock grazing system (open grazing), lack of seedling, and termite infestation are the major forestry constraints [62]. This result shows that about 39.70%, 35.30%, and 25.00% of respondents were reported due to increase population, shortage of land, and open grazing as the main important constraints, respectively. About 19.90% and 16.70% of respondents were reported as lack of seedling and termite as important constraints, respectively (Table 15).

Table 15. *Major of forestry constraints of respondents.*

Constraints (n=156)	N	%hhs
Over population	62	39.70
Termite infestation	26	16.70
Lack of seedling	31	19.90
Livestock grazing system	39	25.00

Source: own computation (2017).

3.5.3. Soil and Water Conservation (SWC) Practices

A natural resource is a common property of social arrangement regulating the preservation, maintains and consumption of common-pool resources like forest, soil, and water was gotten attention from the government to sustainable uses of natural resources [61]. The majority of respondents were practiced different soil and water conservation for different purposes (Table 16) which are similar to [63].

Table 16. *Soil and water conservation type and major constraints of respondents.*

Soil and water conservation		N	%hhs
Practiced (n=156)	Yes	125	80.10
	No	31	19.90
Soil and water conservation types (n=125)	Terraces	56	44.80
	Check dam	59	47.20
	Grasses	15	12.00
	Multipurpose trees	25	20.00
Purposes of soil and water conservation (n=125)	Reduce soil erosion	113	90.40
	Increase soil moisture	53	42.40
	Improve soil fertility	109	87.20
	Climate balance	19	15.20

Source: own computation (2017).

3.5.4. Major Soil and Water Conservation Constraints

The major constraints of natural resources identified by respondents were soil erosion, soil acidity, water-logging, soil fertility decline, and termite [63]. The result shows that about 71.20%, 62.20%, and 69.20% of respondents were reported soil acidity, soil erosion, and poor soil fertility as the main important constraints, respectively. About 33.30% and 24.40% of respondents were reported water lack of land and termite as important constraints, respectively. Only 12.38% of respondents were reported water-logging as a constraint in the study areas (Table 17). To increase smallholder productivity, the government has enacted aspiring plans to develop and extend new high yielder seeds, fertilizers, and natural resource management practices including irrigation [64, 65]. These show that the households who were using improved seed varieties, inorganic chemical fertilizer, and natural resource management practice was higher compared with other agricultural technologies [66].

Table 17. *Soil and water conservation type and major constraints of respondents.*

Major constraints (n=156)	N	%hhs
Soil erosion	97	62.20
Termite	38	24.40
Water logging	27	17.30
Soil acidity	111	71.20
Lack of land	52	33.30
Poor soil fertility	108	69.20

Source: own computation (2017).

3.6. Institutional Setting

3.6.1. Agricultural Extension Services

Technology adoption is highly dependent on information access [67]. The type of information to disseminate to farmers and the sources of that information are critical in speeding up the rate of adoption of new technology [68]. Asserting the importance of information sources rather than subsidies are more effective in encouraging fast adoption and boost productivity growth [69].

Table 18. *Agricultural Information sources of respondents.*

Description		N	%hhs
Extension service sources	Development Agents	142	91.03
	Research centers	7	4.90
	NOGs	21	13.46
	BoANR	41	26.28
Training/ and advice extension services	Crop production	141	90.38
	Livestock rearing	97	62.18
	Natural resource	119	76.28
	Market service	26	16.67

Source: own computation (2017).

The majority of extension service sources were DAs, BoANR, NGOs, and research centers used as mean information sources. The result shows that 91.03% and 26.28% of respondents were obtained information or advice services from DAs and BoANR, respectively. Only about 4.90% of respondents were gained extension service from research centers (Table 18). The extension services were focused on crop production (90.38%), livestock rearing (62.18%), and natural resource (76.28%) managements through training and/advice services (Table 18). The result indicates that all farmers may obtain services on crop production, livestock rearing, and natural resource, and only insufficient information was given on marketing services which are similar to [70]. Besides, the government extension was still the major source of information training and advising farmers. More information on varieties with the full package was received from the DAs through FTC and field visit model farmers.

3.6.2. Credit Utilization

In this study, we analyzed the various credit needs of farmers by the districts. It is the most important in technology adoption in terms of input purchase [71, 72]. Results presented in table 19 about 43.40% of respondents utilized credit for purchasing inputs (fertilizer, seed, and chemical), purchase food items, fattening, and petty trade were important activities attached to credit. The result shows that about 42.90% and 38.10% of respondents were used for fattening and purchasing fertilizer for agriculture activities, respectively (Table 19). The result indicates that there is a big gap for credit access among rural farmers with viable options for cheaper credit a subject for further investigation. The majority of respondents were reported collateral (42.86%) and high-interest rate (9.52%) as important constraints (Table 19).

Table 19. *Credit utilization and constraints of respondents.*

Credit service access (n=156)		Frequency	Percent of households
		145	**92.90**
Credit service received (n=145)		63	43.40
Purpose of credit (n=63)	Purchase fertilizer	24	38.10
	Purchase food items (grain and others)	6	9.50
	Petty trade	7	11.10
	Buy livestock (fattening, others)	27	42.90
Major constraints (n=63)	Repayment time	16	25.40
	High interest	27	42.90
	Collateral	47	74.60
	Limited/shortage money	20	31.70

Source: own computation (2017).

3.6.3. Market Access

Market access is critical in the economic transformation of rural livelihoods. Improving market linkages along the value chain of major crops increase the opportunities and choices of rural farmers and reduce fluctuations between household consumption and income [36, 37]. Efficient integrated value chains, access to markets and other infrastructure help reduce transaction costs thus raising incomes of the rural poor [38].

Farmer on average access market place 1.80 with average

walks of 188.10 minutes (Table A3). The main mode of transport commonly used for the commodity was on foot-walking, donkeys, horses, carts, and cars. About 80.10% and 28.20% of respondents used walking (foot) and a donkey for transportation service, respectively. Using these transport modes farmers preferred cooperatives, small traders, and collectors to sell their products.

Information flow reduces market imperfections with choices for the type of market of farmers to sell their products [73]. Regarding market information access about 65.40% of respondents were accessed market information before selling their products. The main sources of this market information were extension office (DAs), traders, neighbor farmers, visit the market place, cooperatives, and radio (Table A3). The result shows that about 63.81% and 62.86% of respondents were obtained information from neighbor farmers and traders, respectively. About 33.03% and 30.40% of respondents have gained information by visiting the market before supply their grain to the market and DAs, respectively and these information sources were preferable by respondents.

4. Conclusion and Recommendations

A mixed farming system in the study zone is important in rural smallholder farmers. In all crop types produced in the districts average productivity per hectare is below national average productivity due to different constraints. This low productivity comes due to poor soil fertility management, low inputs use, poor knowledge of farmers on-field management, poor weed management, old varieties with old planting methods. Majority of farmers were suffering by pests (diseases and insects), high cost of inputs (seed and fertilized), shortage of land, weed infestation, shortage or lack of improved varieties, poor soil fertility and termite as major crop production constraints while high transaction cost, low price output, shortage of market information and lack of market linkage were also reported as major crop marketing constraints.

Livestock production is also the most important for different purposes including sources of food (milk, meat, and a byproduct of milk), draught power, transportation service, source of income generation (sale life and byproduct), and manure production for soil fertility improvement. In the livestock management practices, feed resources commonly used in the study areas were primarily natural pasture (communal and own grazing), crop residues, and purchased supplementary feed. Improved forage crop was practiced in the study areas by limited respondents during the survey period. The small number of farmers were practicing traditional beekeeping and herbicides, shortage of bee forage, aunts and wild, price fluctuation, and shortage of bee were identified as major bee constraints.

The major problems of livestock production were disease and parasite (Trypanosomiasis, pasteurellosis, mastitis, anthrax, blackleg, mouth and foot, lichen and lamp skin), shortage of grazing land, shortage of feed, lack of improved breeds, shortage of veterinary medicine and shortage of awareness while high transaction cost, market price/demand fluctuation, lack of market information, unorganized marketing system, and lack of market linkage.

A large number of tree species were observed in the natural forest found scattered on farmlands, garden areas as live fences and marginal land as a source of income generation, control soil erosion, and soil fertility improvement. The major constraints of natural resources which accountable for productivity, decreasing were soil erosion, termite attack, soil acidity, soil fertility decline, water-logging, and lack of sustainable land management caused by over-cultivation, overgrazing, and deforestation. Finally, the following recommendations need more attention from responsible bodies are: (1) enhance production and productivity of crops supply improved inputs, capacitates farmers' awareness on inputs recommendation, field management including integrated pest management (IPM) to control pests and strengthen marketing linkage; (2) access improved breed, improved forage, livestock management, methods of control disease infection and improving marketing linkage; and (3) expanding natural resource conservation and more awareness on use physical and biological soil conservation more critical for soil improvement and increase productivity.

Appendix

Table A1. *Crop land frequency ploughing and planting times of respondents.*

Crops	High land (n=35)			Planting (sowing) time	Midland (n=79)		
	Ploughing frequency				Ploughing frequency		
	Min.	Max.	Mean		Min.	Max.	Mean
Maize	2	4	3.28	April-May	1	5	3.58
Tef	3	5	4.00	Last June- 1st August	2	6	4.33
Wheat	3	6	4.29	Last June- 1st August	4	5	4.56
Millet	2	4	3.38	Last May-June	2	5	3.38
Barley	2	4	3.05	May- 1st June	2	4	3.13
Sorghum					1	4	2.15
Bean	2	3	2.33	Last June- 1st July	2	3	2.67
Pea	2	3	2.45	Last June- 1st July	2	3	2.54

Crops	High land (n=35)			Planting (sowing) time	Midland (n=79)		
	Ploughing frequency				Ploughing frequency		
	Min.	Max.	Mean		Min.	Max.	Mean
Nug	2	3	2.5	June-July	1	3	2.75
G/nut					2	2	2.00
Sesame					2	3	2.23
Pepper					4	5	4.50
Potato	2	5	3.50	April	1	5	3.00
Tomato					2	5	3.65

Table A1. *Continued.*

Crops	Midland (n=79)	Lowland (n=42)			
	Planting (sowing) time	Ploughing frequency			Planting (sowing) time
		Min.	Max.	Mean	
Maize	May- 1st June	2	5	2.83	May
Tef	Last Jun-July	3	6	3.70	July- 1st August
Wheat	Last Jun-1st Aug				
Millet	Jun- 1st July	2	4	2.78	June-July
Barley	May- 1st June				
Sorghum	Last March-May	1	4	1.80	Last March-May
Bean	June-July				
Pea	June-July				
Nug	June-July	1	4	2.22	June-July
G/nut	May-June	2	3	2.14	May-June
Sesame	May- 1st June	1	4	2.17	May- 1st June
Pepper	May- 1st June	2	4	2.50	May- 1st June
Potato	March & Sept.-Nov.	2	4	2.87	April
Tomato	November-December	3	4	3.12	November-December

Source: own computation (2017).

Table A2. *Major Crops with their inorganic fertilizers and seed rate used of respondents.*

	Highland (n=35)			Midland (n=79)					
	%hhs	Urea (%)	Rate-kg/ha	%hhs	Urea (%)	Rate-kg/ha	NPS (%)	Rate-kg/ha	Seed-kg/ha
Maize	62.86	72.73	125s	92.41	83.56	124	83.56	94	24.67
Tef	85.71	40	30	58.23	45.65	36	60.87	37	33.40
Wheat	60	57.14	34	11.39	77.78	25	88.89	63	110
Barley	60	33.33	40	10.13	25	50	37.5	50	148.75
Sorghum	-	-	-	59.494	0	0	6.383	50	14.87
Millet	22.86	12.5	50	20.25	31.25	41	37.50	63	20.31
Pepper	5.71	5.71	50	6.33	60	50	60	100	*
Maize	83.56	94	24.67	83.33	57.14	111	57.14	92	24.31
Tef	60.87	37	33.40	23.81	20	50	20	50	33.40
Wheat	88.89	63	110	-	-	-	-	-	-
Barley	37.5	50	148.75	-	-	-	-	-	-
Sorghum	6.383	50	14.87	83.333	0	0	5.714	50	14.81
Millet	37.50	63	20.31	21.43	11.11	25	11.11	50	20.31
Pepper	60	100	*	14.29	50	50	50	50	*

*= not estimated by farmers.

Table A3. *Marketing access and mode transportation of respondents.*

Variables		Mean	Std. Dev.	Market information sources and preferable		N	% of hhs
Market access in the area		1.80	0. 80	Information access (n=156)		102	65.40
Distance to market (mins)		188.10	114.60	Information sources	Das	31	30.40
Sample (n=156)		N	%		Traders	7	6.90
Main mode of transport (n=156)	Foot	125	80.10		Neighbor farmers	16	15.70
	Car	27	17.30		Visit market	34	33.30
	Donkey	44	28.20		Radio	6	5.90
	Horse	23	14.70		Cooperatives	8	7.80
	Cart	33	21.20				

Source: own computation (2017).

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