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Characterization and Analysis of Farming System in the Major Agro-ecologies of West Shewa Zone, Oromia

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Abstract

Agriculture is the most important sector in Ethiopia and it is characterized by low productivity due to different factors. To improve agricultural productivity, it requires detail study on existing farming systems as to scrutinize the gap and help develop intervention strategies. Therefore, this study is done to characterize and analyze the existing farming system, identify the production constraints and further opportunities in the farming system interventions for the study areas. The study focused on primary and secondary data. The primary data were collected through key informants, FGDs and direct interviews. The farming system of the study areas are characterized as mixed farming systems. From the survey result shortage of grazing land, disease, feed shortage, lack of improved breeds, shortage of veterinary medicine and shortage of water were identified as important constraints in livestock production. High transaction cost, market price/demand fluctuation, lack of market information, unorganized marketing system and lack of market linkage were reported as major constraints in livestock marketing. Pests, high cost of inputs, shortage of land, weed infestation, shortage of inputs, low yield, poor quality of seed and poor soil fertility were identified as important crop production constraints. High transaction cost, low price output, lack of market information and lack of market linkage were summarized as major crop marketing constraints. Besides, soil erosion, soil fertility decline, water logging, soil acidity and termite were reported as important constraints in natural resources. Improving livestock productivity through improved breed, forage, control disease and control illegal livestock trade need attention. Additionally, improving crop productivity through IPM, improved varieties, minimizes transaction cost, focus on high value crop, expanding soil and water conservation, strengthening market information and linkage where need the urgent concentration for interventions.

Key words: Crop, farming system, livestock and natural resource

Introduction

Agriculture is the most important sector in Ethiopia: it accounts about 46% of GDP, 80% of export value, and about 73% of employment. This means, it is the largest sector of economic activity in Ethiopia and it continues to the main source livelihood for majority of the country population and increasingly confronted with the pressure from a rapidly growing population and diminishing natural resources (Abate, 2010).

Though, the sector has been characterized by low productivity due to land degradation, low technological inputs, low soil fertility, weak institution linkage, lack of appropriate and effective agricultural policies and strategies (Aklilu, 2015 and Abush *et al*, 2011). Therefore, any attempt to improve agricultural productivity requires a detailed study on existing farming systems.

Farming system is defined as a population of individual farm systems that have broadly similar resource bases, enterprise patterns, household livelihoods and constraints, and for which similar development strategies and interventions would be appropriate and dictated by climate, production goals and cultures of the societies. The classification of developing countries may be varied as available natural resource base, climate, landscape, farm size, tenure and organization, dominant pattern of farm activities and household livelihood. This determines the intensity of production, diversification of crops and other activities (FAO, 2001).

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 and in accordance with the household goals preferences and resources. The Ethiopian agriculture is dominated by about 11.7 million smallholders responsible for about 95 percent of the national agricultural production while large farms contribute only 5 percent of the total production (CSA, 2017)). This shows that the overall economy of the country and the food security of the majority of the population depend on small-scale agriculture.

Farming systems in selected districts of west shewa zone comprise complex production units involving a diversity of mixed crops and livestock in order to meet the multiple objectives of the household. The combination of these activities depends on environmental conditions, resource endowment and the management skills of the farmer. 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. Peasant farmers operate in different agro-ecologies, under different socio-economic conditions, and different constraints.

In this study a classification of the farming systems into homogeneous groups is proposed which allows the analysis of the existing farm organization and the interrelationships among the system's elements and evaluation effects of optimal allocation of farm resources and technological innovations in the areas with the objectives: to characterize and analyze the existing farming system, identify the production constraints and further opportunities in the farming system interventions for the study areas.

Research Methodology

Description of the study areas

The study was focused on selected districts (mandate of Bako Agricultural Research Center) of west shewa zone. Accordingly, the study focused only on five districts; namely: Bako Tibe, Ilu

Gelan and Dano from mid land and Cheliya and Midakegn from high land districts. Finally, Ilu Gelan district from mid land and Cheliya district from high land were selected.

Data Types, Sources and Methods of Data Collection

The study was based on both primary and secondary data. Primary data were collected from the sample farm households using a semi-structural schedule by trained enumerators. Before the actual data collection schedules were pre-tested to make important modification. In order to capture better information of the study areas, qualitative data collection such as focus group discussion and key informants interview were conducted using checklist schedule. Secondary data were also collected from published and unpublished materials from the respective of west shewa zone and districts for a comprehensive report and rational conclusion.

Sampling Design

A multi-stage technique was employed to select sample households from the population. In the first stage, west shewa zone stratified into two agro-ecologies high land (Cheliya and Midakegn) and mid land (Bako Tibe, Ilu Gelan and Dano) that are more homogenous than the total population. In the second stage, from each stratum one district was selected purposively based on crop potential, livestock and natural resources. In the third stage, two kebeles were selected purposively from each district based on crop potential, livestock, natural resources and accessibility. Finally, 105 sample households were selected randomly using probability proportional to size.

Methods of Data Analysis

Descriptive statistics such as mean, standard deviation, frequency and percentage were used to analysis quantitative data gathered from sample households. The qualitative data were analyzed through systematically organizing the information and using perceptions and preferences of farmers during group discussion and key informants' interviews.

Results and Discussions

Socio-economic Characteristics

The average household size across the surveyed households was 7.39 whereas the average adult equivalent was 5.91 using conversion factors which consider age and sex of the member (Storck, *et al.*, 1991). The absolute numbers of household members were converted into adult equivalent, a more objective way of comparing households given the different needs of each household member (Buse and Salathe, 1978). About 4.8% of the sample households were female headed with zero percentage observed in Ilu Gelan district. Regarding technology adoption 28.69% of sample households were model farmers and 71.40% were follower. According to key informants interview model farmers were adopted new technologies early than followers. Over 64.80% of the household heads reported that as medium households in wealth status. Only 12.40% of sample households were rich in wealth status. Majority of the sample households (53.33%) were follow protestant and a least (2.86%) of sample households were follow Muslim in religion (Table 1).

Table 1. Socio-economic characteristics of sample households

Variable		Cheliya (49) Mean	Std. Dev.	Ilu Gelan (56) Mean	Std. Dev.	Total (105) Mean	Std. Dev.
Total family size		7.41	2.30	7.38	2.03	7.39	2.15
Adult equivalent		5.93		5.90		5.91	
		Freq	%	Freq	%	Freq	%
Sex of household head	Male	44	89.80	56	100	100	95.2
	Female	5	10.20	0	0	5	4.8
Wealthy status of household	Rich	9	18.40	4	7.10	13	12.40
	Medium	31	63.30	37	66.10	68	64.80
	Poor	9	18.40	15	26.80	24	22.90
Farmers' category	Model	13	26.50	17	30.40	30	28.60
	Follower	36	73.50	39	69.60	75	71.40
Religion of household head	Muslim	1	2	2	3.60	3	2.86
	Orthodox	27	55.10	9	16.10	36	34.29
	Catholic	9	18.40	1	1.80	10	9.52
	Protestant	12	24.50	44	78.60	56	53.33

Source: Survey results, 2017

Land holding and acquisition methods

Land is the most important asset of sample household in Ethiopia as well as in the study areas. The study indicated land tenure and how land under the farmers control was utilized. The survey result revealed that, the average of 2.04 hectares per farmer was owned by sample households and 1.56 hectares per farmer were cultivated. In the survey sites follow land was not common practice due to shortage of land. The average grazing land, forest land and residential land were summarized in table 2. About 0.42, 0.18 and 0.07 hectares per farmer were allocated for grazing land, forest and residential land, respectively. There was minimum activity on land renting and more than half apply cropping share system during survey period (Table 2).

Table 2. Land ownership (hectare) and acquisition methods of sample households

Land category	Cheliya (49) %	Mean	Std. Dev.	Ilu Gelan (56) %	Mean	Std. Dev.	Total (105) %	Mean	Std. Dev.
Own land	100	1.66	1.62	100	2.37	1.68	100	2.04	1.68
Cultivated land	95.92	1.50	1.50	96.43	2.16	1.57	96.19	1.86	1.56
Grazing land	48.98	0.53	0.48	87.50	0.49	0.39	69.52	0.50	0.42
Forest land	22.45	0.17	0.06	35.71	0.23	0.22	29.52	0.21	0.18
Degraded land	4.08	0.25	0	0	0	0	1.90	0.25	0

Residential land	71.43	0.18	0.08	94.64	0.07	0.07	83.81	0.18	0.07
Rented in/out	20.41	0.57	0.28	14.29	1.22	1.49	17.14	0.86	0.99
Shared in/out	65.31	0.96	0.60	58.93	1.01	0.52	61.90	0.98	0.55

Source: Survey results, 2017

Ownership of farm equipment, communication technology and others

Ownership of production assets is a proxy for households' socio-economic status. These help in increasing farm productivity and assessing the means to disseminate technology information to famers. Households with own with ox-plough, sickle hoe and others[1] farm equipment was the most important to increase farm productivity. The result indicated that on average 100%, 93.90% and 71.40 per farmer ox-plough, sickle and hoe were owned for agricultural activities, respectively. Information technology was more informed and can be used as contact farmers through mobile, radio and TV. About 49.50% sample households own radio while about 64.80% and 5.70% own mobile phone and TV, respectively. This implies that technology information disseminated through radios and mobile phones would reach most of the farmers in the study areas (Table 3).

Table 3. Ownership of farm equipment and information communication technology

Asset	Cheliya (49)		Ilu Gelan (56)		Total (105)	
	Percent	Mean	Percent	Mean	Percent	Mean
Ox-plough	100	1.24 (0.48)	100	1.48 (0.79)	100	1.37 (0.67)
Sickle	93.90	3.17 (1.45)	98.20	3.33 (1.48)	96.20	3.26 (1.46)
Hoe/Jembe	71.40	2.26 (1.62)	83.90	2.70 (1.72)	78.10	2.51 (1.68)
Others	38.80	2.03 (1.19)	44.60	2 (1.22)	52.40	2.02 (1.19)
Radio	46.90	1.09 (0.29)	51.80	1.07 (0.26)	49.50	1.08 (0.27)
Mobile	61.20	1.23 (0.68)	67.90	1.39 (0.94)	64.80	1.32 (0.84)
Television	6.10	1	5.40	1	5.70	1
Tapped water	30.60		16.10		22.90	
Electricity (solar)	59.20		35.70*[2]		46.70*[2]	

*Note: *[2] = only two farmers have hydro/line electricity and numbers in parentheses are standard deviations.*

Source: Survey results, 2017

Livelihood activities of sample households

The farming systems in the west shewa zone were characterized as mixed farming systems. In the mixed farming systems both livestock and crop production take place within the same locality. The major sources of livelihood activities of farmers in study districts were crop

[1] Others= Spade, axe, etc.

production, livestock rearing and off/non-farming. As indicated in table 4, about 100% and 98.10% of sample households' livelihood were depending on crop production and livestock rearing which contributed 59.10% and 27.44% of total annual income, respectively. Besides, off/non-farming activities like crop and livestock trading, daily labors, petty trade, wood craft was additional income and food sources of households. The result indicates that about 53.33% of sample households were participated in off/non-farming activities which contributed 13.46% to annual income generation.

Table 4. Livelihood activities of sample households

Activities	Cheliya (49)		Ilu Gelan (56)		Total (105)	
	Percent	Contribution %	Percent	Contribution %	Percent	Contribution %
Crops	100	57.65	100	60.35	100	59.1
Livestock rearing	100	28.1	96.40	26.87	98.10	27.44
Off/non-farming	59.18	14.25	48.21	12.78	53.33	13.46

Source: Survey results, 2017

Livestock ownership

Livestock ownership is generally regarded as key to rural livelihoods. In contrast to crop production, outputs from livestock are season independent and benefits stream in throughout the year. It is also an asset that can be owned by all the household members regardless of their position in the family. Table 5 presented livestock ownership in terms of herd size and composition. Result shows that a high percentage of the population in the survey areas own cows and oxen types of livestock at 92.40% with 2.11 herd sizes and 88.60% with 2.54 herd sizes, respectively. The result indicated that in the study areas cow and ox keeping were the most important. Sheep and goats were important as income source by the farming population. About 46.70% and 14.30% of sample households own sheep and goats, respectively. Mules, donkey and horses were used for transportation services. About 25.70%, 20% and 9.50% of sample households were owned horses, donkey and mule for means transportation service and income generation source. Analysis of the herd size show that cattle lead in the number kept with average herd sizes of 2.11 and 2.54 TLU for cows and oxen, respectively. This is consistent with other results by Svein (2002) which indicates the relative importance of cattle ownership in Ethiopia which acts as symbol of prosperity. Although chicken was kept by 70.50% of sample households which is more huge than shoats and equines with only 6.70% households keeping improved poultry.

Table 5. Household livestock ownership, proportion of owners, herd sizes (TLU)

Livestock type	Cheliya (49) % h. holds	Cheliya (49) Mean (TLU)	Ilu Gelan (56) % h. holds	Ilu Gelan (56) Mean (TLU)	Total (105) % h. holds	Total (105) Mean (TLU)
Cows	93.9	1.80 (1.29)	91.10	2.39 (1.72)	92.40	2.11 (1.55)
Oxen	89.8	2.33 (1.08)	87.50	2.73 (1.38)	88.60	2.54 (1.26)
Heifers	55.1	1.36 (1.02)	64.30	1.72 (1.41)	60	1.57 (1.27)
Bulls	63.3	0.95 (0.70)	48.20	1.27 (1.14)	55.20	1.09 (0.93)
Calves	75.5	0.38 (0.24)	73.20	0.45 (0.38)	74.30	0.42 (0.32)
Goats	14.3	0.26 (0.19)	14.30	0.23 (0.14)	14.30	0.24 (0.16)
Sheep	67.3	0.47 (0.41)	28.60	0.35 (0.31)	46.70	0.43 (0.38)
Donkeys	24.5	0.91 (0.42)	16.10	0.82 (0.28)	20	0.87 (0.35)
Horses	46.9	2.02 (1.18)	7.10	1.60 (0.8)	25.70	1.97 (1.14)
Mules			17.9	0.70	9.50	0.70
Poultry	77.3*4.1	0.08 (0.07)	64.30*8.9	0.08 (0.06)	70.50*6.7	0.08 (0.06)
Total TLU	100	6.97 (4.82)	100	7.16 (4.41)	100	7.07 (4.58)

*Note: *= Percentage of crossbred poultries and numbers in parentheses are standard deviations.*

Source: Survey results, 2017

Milk productivity and status

Cow milking is the most important asset and income generation sources of sample households. The average milk per day was 1.48 and 1.30 liter at Cheliya and Ilu Gelan districts, respectively. About 93.30% of sample households were reported milk productivity decreased from time to time over last five years due to feed shortage and disease. Result presented in table 6 shows that the lactation period were 8.10 and 7.76 months for Cheliya and Ilu Gelan districts, respectively.

Table 6. Milk productivity and status for the last five years of sample households

Variable	Cheliya (49) N	Cheliya (49) Mean	Ilu Gelan N	Ilu Gelan Mean (56)	Status % decrease	Why milk decreasing over last five years
Milk (lit/day	48	1.48 (0.75)	51	1.30 (0.61)	93.30	➢ Feed shortage (84.60%)
Lactation period (months)	48	8.10 (2.19)	51	7.76 (2.18)		➢ Disease and feed shortage (8.60)

Numbers in parentheses are standard deviations

Source: Survey results, 2017

Livestock production and market constraints

In the study areas livestock was the most important assets in terms of income generation, crop production and as symbol of prosperity. Livestock producers were asked to give their perspectives on most important constraints affecting their livestock farm operations and their responses were summarized in table 7. The three most frequently reported production constraints were disease (96.19%), shortage of grazing land (73.33%) and feed shortage (48.57%). Lack of capital was reported as an important constraint by 25.71% of the households during survey period. Similarly, shortage of veterinary medicine, shortage of water and lack of improved breed were reported as important production constraints by 20.95%, 18.10% and 14.29% of the households keeping cattle, respectively.

Disease and shortage of grazing land were the most important production constraints of shoats and equines. About 52.38% and 49.52% of disease and shortage of grazing land by keeping shoats. Regarding keeping equines about 31.43% and 30.48% of sample households were reported disease and shortage of grazing land as important production constraints, respectively. Disease and feed shortage were as very important production constraints by 66.67% and 16.19% of sample households keeping poultry, respectively.

Table 7. Major livestock production and market constraints of sample households

Production constraints (n=105)	% of households cattle	% of household shoats	% of household equines	% of household poultry
Shortage of grazing land	73.33	49.52	30.48	
Disease	96.19	52.38	31.43	66.67
Shortage of veterinary medicine	20.95	4.76	3.81	
Lack of capital	25.71	3.81		
Lack of improved breed	14.29	2.86		
Feed shortage	48.57	5.71		16.19
Water shortage	18.1	6.67		
Marketing constraints (n=105)				
Market price/demand fluctuation	21.90	14.29	6.67	16.19
Lack of capital	35.24	16.19		10.48
Lack of information	23.81	33.33	9.52	18.10
Lack of market linkage	14.29	28.57	8.57	19.05
Unorganized marketing system	12.38	8.57	7.62	10.48
High transaction cost	71.43	52.38	14.29	23.81

Source: Survey results, 2017

The main marketing problem of livestock were market price/demand fluctuation, lack of capital, lack of market information, lack of market linkage, unorganized marketing system and high transaction cost were summarized in table 7. High transaction cost (71.43%) and lack of capital (35.24%) were reported as main marketing constraints by sample households keeping cattle. Lack of market information and market price/demand fluctuation were reported as important constraints in marketing of cattle. The result indicates that about 23.81% and 21.90% of sample households were reported lack of market information and market price/demand fluctuation, respectively. In the study areas lack of market linkage (14.29%) and unorganized marketing system (12.38) of sample households were reported as constraints in cattle marketing.

As presented in table 7 high transaction cost (52.38%), lack of market information (33.33%) and lack of market linkage (28.57%) were the main constraints reported by sample households keeping shoats. Besides, lack of capital, market price/demand fluctuation and unorganized marketing system were reported as important constraints of shoats marketing.

High transaction cost was the major constraint in equines and poultry marketing. About 14.29% and 23.81% of sample households were reported transaction cost as important constraints in equines and poultry marketing, respectively. Lack of market information, lack of market linkage, unorganized marketing system and market price/demand fluctuation were reported in both equines and poultry marketing as constraints. Lack of capital was constraint in poultry marketing. Generally, in livestock marketing high transaction cost is the most important constraint in cattle, shoats, equines and poultry production.

Common livestock diseases

Important livestock farmers' diseases and parasite as well as their control practices by livestock producers were summarized in table 8. Across the sample, the major common diseases and parasites such as fungal (26.67%), trypanosomiasis (25.71%), pasteyrellosis (23.81%), anthrax (22.86%), mastitis (21.90), black leg (20.95) and foot and mouth were reported. Across the survey about 93.30% of sample households took vaccination and drug against these diseases and parasites.

Table 8. Common livestock diseases and solution of sample households

Common disease	Native name	% of households	% solution taken
Trypanosomiasis	Gandi	25.71	
Black leg	Abba gorbaa	20.95	
Anthrax	Abba sangaa	22.86	
Ticks	Silmi	5.71	93.30
Bloat	Bokoksaa	6.67	
Lump skin	Shifshaafi	9.52	
Lichen	Dhulaandhula	14.29	

Mouth and foot	Madaa milaa fi arrabaa	16.19
Pastevrellosis	Goroorsaa	23.81
Fugel	Dhibee lukkuu	26.67
Dermatophytosis	Bichoo	8.57
Mastitis	Dhibee Harmaa	21.90

Source: Survey results, 2017

Livestock Feeding System

Table 9. Livestock feed sources and feeding system of sample households

Common feed source		Cheliya n=(49)		Ilu Gelan (n=56)		Total (n=105)	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
Own grazing land and crop residue		42	85.71	51	91.10	93	88.57
Communal land and crop residue		7	14.29	2	3.60	9	8.57
Supplementary feed (Fegullo, etc)		9	18.40	6	10.70	15	14.29
Most common crop residue used							
Teff straw		49	100	53	94.64	102	97.14
Stover of maize and sorghum		5	10.20	32	57.14	37	35.24
Wheat and barley straw		17	34.69			17	16.19
Faba bean and field pea straw		3	6.12	12	21.43	15	14.29
Reason used	Preferred by livestock	5	10.2	5	8.9	10	9.52
	No options	26	53.1	23	41.1	49	46.67
	Preferred and no option	18	36.7	25	44.6	43	40.95

Source: Survey results, 2017

Types of livestock feeding systems were summarized in Table 9. Livestock producers practiced three grazing systems and combinations of them. Straw and crop residues were extensively used and animals were grazed on crop stubble due to palatable by livestock and no other feed option for their livestock. About 97.14% and 35.24% of sample households used teff straw and stover of maize and sorghum, respectively. There are no apparent private or public sector efforts in improving the use of crop residues and improved forages by sample households during survey period. Supplementary feed like fagullo and salt were practiced by few farmers during survey period.

Beekeeping practices

Beekeeping practice is common practice rural livelihoods as income generation source and home consumption. Table 10 presented beekeeping practice and major constraint in terms of number and production honey. Result shows that a few percentage of the sample households in the survey areas own traditional types of beehives at 27.62% with 4.52 numbers per farmer beehives. The four most frequently reported constraints were herbicide (28.57%), Shortage of bee forage (20.95%), aunts and wild animals (19.05%) and price fluctuation of honey (13.33%). Shortage of bee (7.62%) was also important constraint by bee production marketing system during survey period.

Table 10. Beekeeping farm practices of sample households

Variable	Cheliya (n=49)		Ilu Gelan (n=56)		Total (n=105)	
	N	Mean	N	Mean	N	Mean
Beehives (traditional)	9	2.67(1.58)	20	5.35(3.53)	29	4.52(4.16)
Honey harvest (kg)	8	15.13(5.69)	20	47.55(48.63)	28	38.29 (33.53)
Unit price of honey (kg^{-1})	8	53.13(10.67)	20	41.10(8.45)	28	44.54(10.51)
Constraints	N	% hhs	N	% hhs	N	% hhs
Aunts and wild animal	5	10.20	15	26.79	20	19.05
Chemical (herbicide)	5	10.20	14	25	30	28.57
Shortage of bee	6	12.24	2	3.57	8	7.62
Shortage of bee forage (forest)	6	12.24	16	28.57	22	20.95
Price fluctuation	2	4.08	12	21.43	14	13.33

Numbers in parentheses are standard deviations

Source: survey results, 2017

Crop pattern and productivity

Cropping patterns adopted by farmers in the study areas depends on agro-ecology factors like climate, soil types, crop types and markets. The major crops produced in selected districts were maize, teff, sorghum and wheat among cereal crops; faba bean, field pea, soybean and nug among pulse and oil crops and potato from horticultural crop (Table 11). The result shows that 99.05% of the sample households were owned farm plots with 3.18 plots per farmer. This implies that land sub-division issues may be disadvantaging for economic of labor and other inputs usage (Fekadu and Bezabih, 2009; Wondimu, 2010). Teff and maize were the most important crops in the study areas which were produced by 92.38% and 69.52% of sample households on 0.86 and 0.88 hectares of land, respectively.

Analysis of crop yields was done separately at the district level and overall which expressed in quintal per hectare as summarize in table 11. The yield of sample households during survey period was below national and regional average (CSA, 2017). This implies that all concerned bodies may work on how to increase the productivity through improved varieties, appropriate inputs recommended of these crops.

In the study areas soil fertility management practices was reported though in medium usage (Table 11). About 75.24% of sample households reported their soil status good depend on their perception. Some of the soil fertility enhancing practices identified includes; conservation tillage, crop residue retention, maize-legume intercropping and cereal-legume rotation, especial in Ilu Gelan district. Soil fertility management has been shows to improve yields more than use of chemical fertilizers (Tchale & Sauer, 2007). Therefore, it implies that improved soil fertility increase crop yield than used appropriate improved inputs.

Table 11. Major crop pattern and productivity of sample households

#plot and crop type	Cheliya (n=49)			Ilu Gelan (n=56)			Total (n=105)		
	% hhs	Mean	Productivity	% hhs	Mean	Productivity	% hhs	Mean	Productivity
#plot	97.96	3.25 (1.82)		100	3.13 (1.31)		99.05	3.18 (1.56)	
Maize	36.73	0.45 (0.37)	30.13 (9.24)	98.21	1.01 (0.64)	32.80 (9.74)	69.52	0.88 (0.63)	32.14 (9.63)
Teff	89.80	0.66 (0.48)	11.36 (3.24)	94.64	1.04 (0.88)	10.40 (3.45)	92.38	0.86 (0.75)	10.83 (3.37)
Sorghum	26.53	0.31 (0.17)	14.46 (7.17)	21.43	0.39 (0.18)	14.50 (5.54)	23.81	0.35 (0.18)	14.48 (6.31)
Wheat	71.43	0.54 (0.32)	18.81 (7.18)	14.29	0.42 (0.36)	22 (9.55)	40.95	0.52 (0.32)	19.41 (7.65)
Barley	55.10	0.57 (0.25)	16.37 (4.81)	3.57	0.63 (0.53)	13.50 (16.26)	27.62	0.56 (0.26)	16.17 (5.61)
Faba bean	42.86	0.30 (0.12)	13.71 (5.52)	7.14	0.28 (0.16)	14(5.16)	23.81	0.29 (0.12)	13.76 (5.36)
Field pea	12.24	0.29 (0.10)	9.69 (3.67)				5.71	0.29 (0.10)	9.67 (3.67)
Potato	34.69	0.33 (0.27)	111 (44.95)	8.93	0.18 (0.07)	78.40 (22.20)	20.95	0.30 (0.25)	103.59 (42.77)
Nug				12.50	0.57 (0.19)	4.57 (0.98)	6.67	0.57 (0.19)	4.57 (0.98)
Soybean				7.14	0.17 (0.07)	15.33 (1.15)	3.81	0.17 (0.07)	15.33 (1.15)
		Frequency	Percent		Frequency	Percent	Frequency	Percent	
Crop land fertility status	Very good	2	4.10		2	3.60	4	3.81	
	Good	38	77.60		41	73.20	79	75.24	
	Poor	8	16.30		13	23.20	21	20	
	Very poor	1	2.04				1	0.95	

Numbers in parentheses are standard deviations

Source: Survey results, 201

Crop land preparation and planting system

The farming systems of smallholders in west shewa zone were predominantly annual crop productions by using similar cropping calendar of rainfall. Table 12 shows that for these annual crop productions, land ploughing frequency, inputs used rate, planting methods and planting period were presented. Land ploughing frequency of plots for major crops average ranges of 4.26 times for wheat to 2 times for nug and field pea. The result shows that ploughing frequency varied among the crops and land soil fertility status. The sample households used inputs like seed and fertilizer (both NPS and Urea) for all crops was below recommendation rate except maize and soya bean, but the seed rate of teff was above recommendation rate. Therefore, below recommendation inputs used can express low productivity. However the seed and fertilizer rate as well as application methods were recommended before a decade. All sample households for all crops use traditional land ploughing and planting using man and oxen power through source of labor.

The majority of producers in both districts planting their crops by row and broadcasting from March to end July. All sample households used row planting method for maize, potato and soya bean and partially for faba bean. Crops like teff, wheat, barley, sorghum, field pea and nug were planted by broadcasting method (Table 12). In addition to low inputs used unsuitable planting methods may be decease crop productivity. The result shows that teff, wheat, barley, faba bean, field pea, nug and soya bean planting times were in June and July. Potato, sorghum and maize planting calendar were ranges of March to end May. In general there is a knowledge gap using inputs appropriate rate and time of application.

Table 12. Crop land preparation and planting system of sample households

Crop type	% hhs holding	Ploughing frequency	Seed rate (kg/ha)	% hhs used Urea	Urea rate (kg/ha)	% hhs used NPS	NPS rate (kg/ha)	Method of planting in % row	Broadcasting	Time planting
Maize	69.52	3.60	25.14	67.62	159.15	67.62	96.48	69.50		May
Teff	92.38	3.93	30.04	32.38	41.91	90.40	54.21		92.38	June-July
Sorghum	23.81	2.20	21.16	4.76	50	7.62	40		23.81	April-May
Wheat	40.95	4.26	95.58	38.10	59.38	40.95	65.58		40.95	June-July
Barley	27.62	4.04	122.69	27.62	72.12	27.62	59.62		27.62	June-July
F/bean	23.81	2.08	94.79	2.86	50	8.57	66.67	3.80	19	June
Field pea	5.71	2	82.22	0	0	0	0		5.71	June
Potato	20.95	2.63	833.11	20.95	90.79	20.95	86.84	20.95		March - April
Nug	6.67	2	10.71	0	0	0	0		6.67	June
Soybean	3.81	2.33	50	3.81	4*	3.81		3.81		June

Recommend research rate	**Maize**	**Teff**	**Sorghum**	**Wheat**	**Barley**	**Faba bean**	**Field pea**	**Potato**	**Nug**	**Soya bean**
Seed (kg/ha)	25	25	25	125-150	125	150-200	120	2,000-2,200		80-100
NPS (kg/ha)	100	100	100	100	100	100	100	195		50
Urea (kg/ha)	150-200	100	100	100	100	25		165		

4=four sachets inoculants per hectare*

Source: Survey results, 2017

Major weed and weeding systems

All crops across the study areas were affected by two or more types of weeds throughout the cropping season. The dominant weeds by different crops frequently observed in crop fields were guizotia scabra spps (*hadaa/tufoo*), bromuss (*Keelloo*) and snowdenia polystarcya (*Mujjaa*. Besides, Oxallis (in teff), avena fatua (in wheat and barley), commelina benghalesis (in maize), raphatum (in field pea) and cuscuta compestris (in nug) were reported as importance weeds in the study districts during survey period.

Weed management options exercised by sample households was typically hand weeding and herbicide like 2-4-D. Hand weeding was conducted throughout crop stage ranges of one time to 3 times depends on crop types and weed infestation. After 2-4-D herbicide application at least one time hand weeding was common in the study areas.

Table 13. Major weed and weeding system of sample households

Crops	% hhs	Type of weed	Freq. of weeding	Methods of weeding	Type of chemical	Rate lit/ha
Maize	73	Guizotia, snowdenia, Bromuss & Commelina	2.84	Hand weeding		
Teff	97	Guizotia, Oxallis & Bromuss	1.07	Hand & chemical	2-4-D	1
Sorghum	23	Guizotia, Oxallis & Snowden	2.30	Hand weeding		
Wheat	43	Guizotia, avena fatua &Raphatum	1.12	Hand & chemical	2-4-D	1
Barley	27	Guizotia and Bromuss	1.04	Hand & chemical	2-4-D	1
Faba bean	22	Guizotia, Bromuss & Snowdenia	1	Hand weeding		
Field pea	9	Guizotia, Bromuss & Raphatum	1	Hand weeding		
Potato	24	Guizotia and snowdenia	3	Hand weeding		
Nug	7	Guizotia and Cuscuta	1	Hand weeding		
Soybean	4	Guizotia and Bromuss	3	Hand weeding		

Source: Survey results, 2017

Crop technology (varieties, fertilizers and application)

The present survey results revealed that majority of farmers have limited access to improved seed except maize. Out of 69.52% about 68.60% of sample households were used maize improved varieties. There is a gap of using improved varieties due to high price of seed, lack of seed, poor seed quality, untimely available except maize and soya bean. This implies that the lack of quality, timely improved varieties with appropriate management may decrease the crop productivity.

Organic fertilizer practice and labor availability

In addition to crop rotation and double cropping practices for soil fertility improvement manure and compost practices were applied in the study areas. The result indicates that about 82.90% of sample households were used manure organic fertilizer and compost organic fertilizer was only applied in Cheliya district (Table 14). This shows that manure organic fertilizer was the most important in the study areas.

In most subsistence farming practice labor source is family members. The survey result shows in table 14 about 74.30% of sample households reported that, there was a labor shortage during planting (50.48%), weeding (34.29) and harvesting (60%). The main mitigation mechanisms exercised by farmers during labor shortage were dabo/jig, labor exchange, employed daily labors and employed permanent labor.

Cropping system

Cropping system of the study areas were summarized in table 14. The term cropping system is crop sequences and the management techniques used on a particular field over a period of years. The result shows that mono cropping, crop rotations and double cropping systems were common cropping systems practiced in the study areas. Mono cropping systems is the most dominant cropping system in the study areas mainly focused on cereal mono-cropping. Result shows that about 48.57% of sample households were applied mono-cropping system especially maize and wheat mono cropping, in Ilu Gelan and Cheliya districts, respectively.

Crop rotation practiced in west shewa zone was cereal with pulse and oil crops and or cereal with cereal for different root depth crops (eg teff-maize-pulse or wheat/barley-maize/sorghum-teff-pulse and oil crops. Besides, double-cropping (sequential cropping) was another common practice applied in the study areas like potato-field pea/barley one after another within a year. According to survey result about 50.48% and 20.95% of sample households were practiced crop rotation and double cropping for soil fertility improvement, crop diversity and double yield advantage. Generally, crop rotation and double cropping were practiced depending on land availability, economic and dietary importance of crop and farmers knowledge on cropping system.

Table 14. Used of improved crop technologies and cropping system of sample households

Crop type	Technology type	Percent used technology (%)			Current status of technology
		Cheliya (n=49)	Ilu Gelan (n=56)	Total (n=105)	
Maize	Improved	36.70	96.40	68.60	68.60

	varieties					
Teff	Improved varieties	6.10	5.40		5.70	5.70
Wheat	Improved varieties	22.40	5.40		13.30	13.30
Potato	Improved varieties	24.50			11.40	11.40
Soybean	Improved varieties		7.14		3.81	3.81
Cropping system					**Advantage**	
Mono-cropping		34.69	60.71	48.57	1. Soil fertility improvement	
Crop rotation		65.31	39.29	50.48	2. Crop diversity	
Double cropping		40.82	3.57	20.95	3. Double advantage	
Organic fertilizer used		**% hhds**	**% hhs**	**Total % hhs**		
Manure		73.50	92.90	82.90		
Manure and compost		26.50		13.30		
Labor shortage		79.60	69.60	74.30		**Mitigation**
➢ Planting		67.35	35.71	50.48		➢ Dabo and labor exchange
➢ Weeding		20.41	46.43	34.29		➢ Employed daily labors
➢ Harvesting		67.35	53.57	60		➢ Employed permanent labor

Source: Survey results, 2017

Major crops production and marketing constraints

An in depth quantitative analysis was undertaken to understand the constraints that inhibit crop production by the farmers. These crop production constraints include pests (disease and insect), high cost of inputs, lack of capital, untimely inputs supply, shortage of land, weed infestation, shortage of inputs, low yield, poor seed quality and poor soil fertility were presented in table 15.

Results presented in table 15 shows that high cost of inputs (60.95%), pests (57.14%), weed infestation (31.43%) and low yield (23.81%) were reported as important constraints in maize production. Majority of the sample households (72.38%) identified low yield as a constraint in teff production. This implies that the issue of low yield is not only widespread in the surveyed zone but is also the most important to the farmers, compared to other constraints faced. Other constraints high cost of inputs (53.33%), weed infestation (47.62%), shortage of inputs [2]

[2] inputs= improved seed, fertilizer and chemicals

(45.71%), and shortage of land (39.05%) were reported as important constraints in teff production.

Wheat, faba bean and barley crops were affected by various constraints like pests, shortage of land, low yield, shortage of inputs and poor soil fertility reported as main constraints. The most important constraint in potato, nug and field pea were pests and low yield as presented in table 15. Generally pests and low yield reported in all crops as main constraint by majority of sampled households.

According to the survey result presented in table 15 low price of output, lack of capital, lack of market information, lack of market linkage and high transaction cost were reported as important marketing constraints of major crops in the study districts. Lack of market information and high transaction costs were reported as main marketing constraints in major crops produced by the sample households. In general the market access and market related issues of grain were similar in both the study districts. So most of the subsistence farmers were net buyers of crop produced and selling the produce was necessary for fulfillment of short term needs like quantities, prices and market infrastructure (Denning *et al.*, 2009).

Table 15. Major crops production and marketing constraints of sample households

Production constraints (n=105)	Maize % hhs	Teff % hhs	Soybean % hhs	Wheat % hhs	Potato % hhs	Field pea % hhs	Faba bean % hhs	Sorghum % hhs	Barley % hhs	Nug % hhs
Disease and insect	57.14	40.95		29.52	17.14	0.95	20	19.05	23.81	5.71
High cost of inputs	60.95	53.33		10.48	3.81				0.95	
Lack of capital	13.33	13.33		16.19	3.81	2.86	1.90	5.71	5.71	3.81
Untimely input supply	2.86	0.95		14.29					1.90	
Shortage of land	22.86	39.05	0.95	27.62	8.57		8.57	3.81	20.00	4.76
Weed infestation	31.43	47.62	5.71	14.29	2.86		0.95	4.76	0.95	
Shortage of inputs	14.29	45.71	0.95	10.48	0.95	4.76	18.10	15.24	20.95	
Low yield	23.81	72.38	1.90	30.48	10.48	2.86	20	20.00	22.86	7.62
Poor seed quality	4.76									
Poor soil fertility	8.57	18.10		8.57			0.95		0.95	
Marketing constraints (n=105)										
Low price of output	49.52	7.62	0.95	8.57	9.52		1.90	4.76	2.86	0.95
Lack of capital	18.10	17.14		27.62	7.62	6.67	4.76	14.29	15.24	12.38
Lack of information	23.81	33.33	2.86	18.10	17.14	11.43	27.62	18.10	23.81	8.57
Lack of market linkage	12.38	8.57	3.81	10.48	1.90	7.62	8.57	10.48	12.38	4.76
High transaction cost	42.86	61.90		37.14	19.05	14.29	21.90	33.33	23.81	

Source: Survey results, 2017

Forestry and Agro-forestry

According the survey reported the forestry and agro-forestry of the study areas were both natural and plantation and both of them. The result shows that about 34.30% and 32.40% of sample households were grown plantation and both natural and plantation for income generation, soil erosion control, soil improvement and climate balance purpose, respectively.

Table 16. Forest type, status and rainfall pattern for last five years of sample households

Forest type		Cheliya (n=49)		Ilu Gelan (n=56)		Total (n=105)	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
Natural		5	10.20			5	4.80
Plantation		14	28.60	22	39.30	36	34.30
Both		12	24.20	22	39.30	34	32.4
Purpose	Income generation	28	57.14	44	89.80	72	68.57
	Soil erosion control	19	38.78	10	20.41	28	26.67
	Climate balance	7	14.29	9	18.37	16	15.24
	Soil improvement	17	34.69	10	20.41	26	24.76
Status of forest in the last five years	Increase	17	34.70	27	48.20	44	41.90
	Decrease	8	16.30	4	7.10	12	11.40
	Same	16	32.70	19	33.90	35	33.30
Major type of plantation grown	Eucalyptus	14	28.57	18	32.14	32	30.48
	Gravilia	10	20.41	16	28.57	26	24.76
	Getra	2	4.08	2	3.57	4	3.81
	Others	1	2.04	2	3.57	3	2.86
Area used for plantation	Crop land	9	18.40	19	33.90	28	26.70
	Marginal land	5	10.20	3	5.40	8	7.60
	Garden	15	30.61	19	33.90	34	32.38
Rainfall pattern in the last five years							
Early on set and off set		15	30.61	1	1.80	16	15.20
Late on set and early off set		34	69.40	55	98.20	89	84.80

Source: Survey results, 2017

Over the last five years the status of plantation was increase (41.90%) and the same (33.30%) of sample households reported, respectively (Table 16). This implies that different natural rehabilitation practices of the last five years may be increased the plantation. Though, it needs deep analysis of plantation change over time in the study areas. Eucalyptus tree was the dominant one in both districts due to different purposes, especial in terms of income generation following gravilia. Results shows that about 30.48% and 24.76% of the sample households grown eucalyptus tree and gravilia, respectively (Table 16). Majority of the sample households were grown plantation around their home (garden) equally 32.38% and along the farming land equally 26.70%. Only 7.60% of sample households used marginal land for plantation. Though, the result indicates that strategic plan for plantation need attention.

Agriculture in the study areas were dominants in rain fed and it is highly dependent on rainfall on set and off set. According to the survey result about 84.80% sample households were reported as late on set and early off set rainfall. Only about 15.20% of sample households were reported early on set and off set rainfall (Table 16). These results imply that there is rainfall shortage and fluctuation in the study areas.

Soil and water conservation (SWC)

Natural resource is a common property of social arrangement regulating the preservation, maintains and consumption of a common pool resources like forest, soil and water. Soil and water conservation was gotten attention from government to sustainable uses of natural resource. According to the survey result about 61% and 9.50% of sample households were practiced on their land check dam and terraces soil and water conservation, respectively for soil erosion decrease and improved soil fertility. Few farmers were grown gravilia, getra and elephant grass on their soil and water conservation practiced.

The major constraints of natural resources identified by sample households were soil erosion, soil acidity, water logging, soil fertility decline and termite. Result shows that about 81.90% and 61.81% of sample households were reported soil erosion and soil fertility decline as main important constraints, respectively. About 43.81% and 33.33% of sample households were reported water logging and soil acidity as important constraints, respectively. Only 12.38% of sample households were reported termite as constraint in the study areas.

Table 17. Soil and water conservation type and major constraints of sample households

Practices		Cheliya (n=49)		Ilu Gelan (n=56)		Total (n=105)	
		Frequency	Percent	Frequency	Frequency	Percent	Frequency
Type of SWC	Terraces	4	8.20	6	10.70	10	9.50
	Check dam	31	63.30	33	58.90	64	61
Tree/grass grown on SWC	Elephant grass	1	2.04	3	5.36	4	3.81
	Getra	3	4.08	1	1.79	4	3.81
	Gravilia			10	17.90	10	9.52
Purpose of SWC	Soil erosion decrease	30	61.22	36	64.29	66	62.86
	Improve soil fertility	14	28.57	17	30.36	31	29.52
Farmer attitude	Good	33	67.30	40	71.40	73	69.50

Major natural resource constraints	Soil erosion	42	85.71	44	78.57	86	81.90
	Water logging	17	34.69	29	51.79	46	43.81
	Soil fertility decline	22	44.90	43	76.79	65	61.90
	Soil acidity	32	65.31	3	5.36	35	33.33
	Termite	7	14.29	6	10.71	13	12.38

Source: Survey results, 2017

Agricultural extension services

Technology adoption is highly dependent on information access. 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. Asserting the importance of information sources (Lohr and Salomonsson, 2000) noted that information sources rather than subsidies are more effective in encouraging fast adoption. Majority of extension service sources were DAs, research center, NGOs and BoANR. The result shows that 97.14% and 29.52% of sample households were obtained information/ advice services from DAs and BoANR, respectively. Only about 2.86% of sample households were gained extension service from research centers. The extension services were focused on crop production (97.14%), livestock rearing (64.76%) and natural resource (58.10%) managements through training and/advice services. The result indicated that all farmers may obtain services on crop production, livestock rearing and natural resource or one of them.

The government extension was still the major source of information training and advising farmers. More information on varieties with full package was received from the DAs through FTC and field visit model farmers. About 51.43% of sample households were visited demonstration of FTC and model farmers. Regarding to adopted technologies visited about 47.60% was adopted who they visited demonstration. This implies that field day is better than training and advising services in terms of technology adoption.

Table 18. Agricultural Information sources of sample households

Extension service sources		Cheliya (n=49)		Ilu Gelan (n=56)		Total (n=105)	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
Extension service sources	Development Agents	48	97.96	54	96.43	102	97.14
	Research centers	1	2.04	2	3.57	3	2.86
	NOGs	2	4.08			2	1.90
	BoANR	8	16.33	23	41.07	31	29.52
Training/ and	Crop production	48	97.96	54	96.43	102	97.14

advice extension services	Livestock rearing	28	57.14	40	71.43	68	64.76
	Natural resource	25	51.02	36	64.29	61	58.10
Visited demonstration		32	65.31	22	39.29	54	51.43
Practice visited technology		31	63.30	19	33.90	50	47.60

Source: Survey results, 2017

Credit access, sources and constraints

In this study, we analyzed the various credit needs of farmers by district. It is the most important in technology adoption in terms of input purchase. Results presented in table 19 show that about 43.81% of sample households' utilized credit for purchasing inputs (fertilizer, seed and chemical). Fattening and petty trade were importance activities attached to credit. Results show that about 36.19% and 21.90% of sample households were used for fatting and petty trade activities, respectively. The result indicates that there is a big gap for credit access among the rural farmers with viable options for cheaper credit a subject for further investigation.

Disaggregation between the districts shows that a higher percentage who needed credit to buy input following fatting activity. The source of this credit was microfinance like Oromia saving and credit, Eshet and Wasasa share companies. The majority of sample households were reported collateral (42.86%) and high interest rate (9.52%) as important constraints (Table 19).

Table 19. Credit need, sources and constraints of sample households

		Cheliya (n=49)		Ilu Gelan (n=56)		Total (n=105)	
		Frequency	Percent	Frequency	Percent	Frequency	Percent
Credit obtained		19	38.78	27	48.21	46	43.81
Source	Microfinance	19	38.78	27	48.21	46	43.81
Purpose to receive credit	Input purchase	19	38.78	27	48.21	46	43.81
	Fattening	16	32.65	22	39.29	38	36.19
	Petty trade	12	24.49	11	19.64	23	21.90
Major credit constraints	High interest rate	5	10.20	5	8.93	10	9.52
	Collateral	19	38.78	26	46.43	45	42.86

Source: Survey results, 2017

Market and information access

Market access is critical in economic transformation of rural livelihoods. Improving market linkages along the value chain of major crops increases the opportunities and choices of rural farmers and reduces fluctuations between household consumption and income. Efficient integrated value chains, access to markets and other infrastructure help reduce transaction costs thus raising incomes of the rural poor. Results from analysis of the market situation were summarized in table 20. Famer on average access market place 1.25 with average walks of 113.48 minutes. The main mode of transport also analyzed in table 20. Result shows that donkeys and horses were the major transport mode in the study areas. About 92.38% and 52.38% of sample households used donkey and horse for transportation service, respectively. Besides, 9.52% of sample households were used cart for transportation service.

Information flow reduces market imperfections with choices for the type of market of farmers to sell their product. Regarding of market information access about 81.90% of sample households was access market information before selling their product. The main sources of this market information were extension office (DAs), traders, neighbor farmers and cooperatives. The result shows that about 63.81% and 62.86% of sample households were obtained information from neighbor farmers and traders, respectively. About 23.81% and 16.19% sample households were gained information from DAs and cooperatives, respectively. Among these sources neighbor farmers, traders and cooperatives were more preferable by sample households with information reality (Table 20).

Table 20. Market and information access indicators of sample households

Variables		Cheliya (n=49)		Ilu Gelan (n=56)		Total (n=105)	
		Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Market accessible		1.47	0.58	1.05	0.23	1.25	0.48
Distance to market (mins)		118.95	34.67	89.02	47.68	113.43	37.12
		N	%	N	%	N	%
Main mode of transport	Donkey	44	89.80	53	94.64	97	92.38
	Horse	23	46.94	32	57.14	55	52.38
	Cart	3	6.12	7	12.50	10	9.52
Information access	Yes	41	83.67	45	80.36	86	81.90
	No	8	16.33	11	19.64	19	18.10
Source of information	DAs	13	26.53	12	21.43	25	23.81
	Traders	37	75.51	29	51.79	66	62.86
	Neighbor	36	73.47	31	55.36	67	63.81
	Cooperatives	6	12.24	11	19.64	17	16.19
Preferred sources	DAs	10	20.41	7	12.50	17	16.19
	Traders	3	6.12	8	14.29	11	10.48
	Neighbor	21	42.86	14	25.00	35	33.33
	Cooperatives			5	8.93	5	4.76

Source: Survey results, 2017

Conclusions and recommendations

The survey was undertaken in selected districts of west shewa zone of Oromia. Cheliya and Ilu Gelan were selected from 5 selected districts of Bako Agricultural Research Center mandate based on variation in altitude and resource endowment. From the two districts four kebeles and about 105 samples of households were selected for this study. Data collection tools such as interviews, Focus Group Discussions (FGD), key informants' interviews, field observations and document analyses were used by developing questionnaire and checklist. The farming systems in selected districts of west shewa zone were characterized as mixed farming systems. In the mixed farming systems both livestock and crop production take place within the same locality, where the ownership of the crops or land and the livestock is integrated.

Besides, own land shared crop and rented acquisition methods of land systems in the study areas were common practice by farmers. The information technology tools owned by most framers were radio and mobile phone used for technology dissemination. Crop farm activity was the most livelihoods practiced by all sample households following livestock rearing. Off/non-farm activities were the additional livelihoods practice by sample households.

Livestock production is the important assets in the study areas for different purposes including sources of food (milk, meat and byproduct of milk), draught power, transportation service, source of income generation (sale live and byproduct) and manure production for soil fertility improvement. Livestock management practices in the study areas based on traditional knowledge and local breeds. The 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 not common practiced in the study areas by sample households during survey period. Few of farmers were practiced traditional beekeeping with herbicides, shortage of bee forage, aunts and wild, price fluctuation and shortage of bee constraints.

The major problems of livestock production were disease and parasite, shortage of grazing land, shortage of feed, lack of improved breeds, shortage of veterinary medicine, shortage of water and lack of capital. The main livestock marketing constraints were involvements high transaction cost, market price/demand fluctuation, lack of market information, unorganized marketing system and lack of market linkage.

The main livestock diseases were fugal (poultry disease), trypanosomiasis, pastevrellosis, mastitis, anthrax, black leg, mouth and foot, lichen and lamp skin. Majority of the farmers were used vaccination and drug for controlling disease with poor quality and knowledge.

The study areas have endowed favorable climatic condition with wide range diversities of crop production like Maize, sorghum, teff, wheat, barley, faba bean, field peas, soya bean, nug and potato as major crops produced using rainfall. For all crop types produced in the districts average productivity per hectare are below national average productivity. The major cropping systems in the study areas were mono cropping, double cropping and crop rotations systems. The major constraints in crop production were pests (diseases and insects), high cost of inputs, shortage of land, weed infestation, shortage of inputs, low yield, poor quality of seed, lack of capital and poor soil fertility. High transaction cost, low price output, market price/demand fluctuation, lack of market information, lack of capital and lack of market linkage were reported as major crop marketing constraints.

A large number of tree species were observed in natural forest found scattered on farmlands, garden areas as live fences and marginal land as source of income generation, control soil erosion, soil fertility improvement and climate and/ weather change balance. The major constraints of natural resource 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.

In the study areas DAs and BoANR were the most important sources of agricultural information on crop production management, livestock husbandry and natural resource conservation and some market information. Microfinance was the common source of credit for input purchase, fatting and petty trade purposes for households.

Based on the findings of the survey results, the following specific recommendations are made.

Livestock production

1. Enhance livestock productivity and production through breed improvements (improved bull service and/ AI services)
2. Promote improved forage crop through forage research and developments.
3. Control of infectious diseases and parasites by improving veterinary services and vaccine quality control with capacitates indigenous knowledge of community
4. Develop and expands honey productions through introduce and popularize improved apiculture technologies
5. Improve marketing systems of livestock through controlling illegal traders or organized marketing system, strengthens of market information and linkage

Crop production

1. Ensure the provision and supply, distribution of crops technologies and improved agronomics practices for major identified crops (seed, chemical, fertilizer) usages with best quality
2. Capacitates farmers on integrated pest managements (IPM) to control pests (disease and insect) for major crops
3. Capacitates farmers' indigenous knowledge on disease and insect managements for better control of crop pests and weed infestation

4. Strengthen agricultural research on crops disease and quality of seed and fertilizer rate, application methods for similar agro-ecologies to increase crop productivity focus on high value of crop
5. Expanding of infrastructures accessibility such as information, microfinance and transportation facilities needs development intervention to promote the effective marketing of crops and other products

Natural resources

1. Developing and popularizing well adapted multipurpose trees species to the suitable agro-ecologies through development and research interventions base on community knowledge
2. Expanding soil and water conservation practiced by farmers must supported by research to minimize soil erosions and increase soil fertility quality
3. Expand awareness for farmers to use physical and biological soil conservation for soil improvement and increase productivity

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Assessment of Alternative Rural Energy Sources and Technologies in Arsi and W/Arsi Zones

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Abstract

Majority of the world population (80% of the total world) is living in the rural areas but consumes only about 30% of global commercial energy. In rural areas of developing nations, the energy sources for cooking and lighting are traditional sources with more prevalence. Especially in Ethiopia, literatures indicated that more than 94% of the energy sources are from traditional sources. Poverty, lack of availability of modern energy and lack of education are the main causes of this phenomenon. Abundance use of biomass fuel with inefficient stoves caused scarcity of biomass resources in Ethiopia. However, in the study areas, namely Arsi and West Arsi, biomass energy sources and other energy sources and available technologies were not characterized for research and development intervention. Therefore, this research was done with the objectives of characterizing energy resources and available technologies and related constraints in the study areas. Hence, four districts from Arsi and three districts from West Arsi zones were selected and data were collected through FGD, KII and household level survey to address the research objectives. The result of this research revealed that majority of rural households are using biomass fuel (wood, animal dung and crop residues) especially for cooking purposes and there is an expansion of solar cells for lighting purposes. The biogas plant use was under demonstration stages and it was also constrained with high capital investment and its accessory technology (injera stove).Development of energy plants like jathropha is also underway in lowlands of Arsi zone.

Key words: Rural energy, biomass fuel, pure energy, improved cook stoves, Arsi zone

Introduction

More than half of the world population, which is about three billion, has no access to modern sources of energy. These peoples are poor and their predominant energy sources are traditional biomasses (Dawit D. Guta, 2012). Access to efficient and modern energy is extremely crucial for the developing nations to counter the economic and health issues and at the same time with the productive use of energy increase the economic growth and life standard of the poor people. Developing countries have 80% of the world's population but consume only 30% of global commercial energy (Eric Martinot et.al, 2002). A well performing energy system can provide these people with income generating opportunities as well as to escape them from the awful impacts of poverty. Unfortunately, this has not been made possible due to financial issues, lack of resources, ineffective energy policies and energy systems in the developing nations.

Dependency of the people on traditional energy for catering their cooking and lighting energy demands in the developing nations still prevails especially in rural areas. Poverty, lack of availability of modern energy and lack of education are the main causes of this phenomenon. Abundant use of biomass for meeting the demands also brings the scarcity of these resources like fuel wood. However, due to gradual increase in awareness of the people demand for electrification in Ethiopia is increasing to around 20 percent per annum (Samson T., 2016).

Ethiopia's energy consumption as one of developing countries is predominantly based on biomass energy sources. An overwhelming proportion (94%) of the country's energy demand is met by traditional energy sources such as fuel wood, charcoal, branches, dung cakes and agricultural residues and nearly 2 percent of the population of Ethiopia has an access to grid electricity. The balance is met by commercial energy sources such as electricity and petroleum. The most important issue in the energy sector is the supply of household fuels, which is associated with massive deforestation and the resultant land degradation. The increasing scarcity of fuel wood is compounded by Ethiopia's high population growth rate.

Another detriment side of utilizing energy in inefficient way is higher consumption of energy than usually required with disastrous health effects due to smoke.Smith *et al.,* 2000 in their study indicated that fuel wood, roots, agricultural residues and animal dung are all producing high emissions of carbon monoxide, hydrocarbons and particulate matter. Access to modern and clean energy like electricity and efficient cooking technologies to the rural areas in developing world not only provide improved and healthy life style but would also help in reducing harmful environmental effects. Efforts on the all levels are required to counter this situation with effective projects and policies on government level as well as awareness of the uneducated masses in the rural areas of developing world. In general, this research is done to conduct a situation analysis for characterizing the sources of energy and technologies used in rural areas for research and extension intervention.

The main objective of this study was to assess and analyze the existing energy resources in the area while the specific objectives of the study were: to characterize and analyze the existing energy resources,to identify and prioritize challenges and constraints of the energy resources, to identify and prioritize potential opportunities of the energy resources and to identify and prioritize potential research intervention areas to connecting the existing opportunities of the energy resource of the study area

Methodology

Description of the study areas

The researchwas carried out in south-east areas of Oromia regional state. This area of the region is one of the most productive clusters of the region. Two zones namely Arsi and / West Arsi were selected purposively based on accessibility. Each zone was clustered into three based on major agro-ecologies as lowland, midland and highland and sample districts were selected from each cluster.

Arsi zone is divided into twenty-five administrative districts and one administrative town (Asella). It is located in 37N 555133.09766783 856692.23862263 UTM coordinates. The zone has four agro-climatic zones and altitude is the main source of difference. These diverse agro-climatic conditions create wider opportunities of having different vegetation which are sources of biomass energy.

West Arsi zone is also divided into eleven administrative districts and one administrative town (Shashamane which is the capital town of the zone. West-Arsi zone has land area of about 1,177,440 hectares or 12,938 km2. Crop-livestock mixed farming and pastoral and agro-pastoralism are commonly practiced in all highlands, and mid and lowlands. According to data from zonal agricultural development office and discussion held with agriculture and rural development office experts, typical highlands of some districts like Dodola and Adaba and lowlands have both pastoral and agro-pastoral farming system.

Sample and Sampling Methods

On the basis of agro-ecology diversity, representative districts, peasant associations (PAs) and participant farmers were selected using systematic sampling technique. Then, from the identified PAs/villages, representative farmers were randomly selected for group discussion and interviews using systematic sampling procedure. During sampling for focus group discussion and household level interview, age–sex composition, educational status, roles and responsibilities in the community were taken into consideration. A multi-disciplinary team was established to conduct the survey using different PRA tools.

Data types and methods of data collection and analysis

Both primary and secondary data were collected from different sources at different levels. Primary data werecollected through focus group discussion, individual interviews, and formal and informal discussions with farmers, DAs and experts. Focus group discussions, key informant interview and informal discussion were among the employed tools to collect primary data using checklist and semi-structured questionnaire.

Different PRA tools were employed to collect data on different aspects of existing biomass fuel resource of the study area including semi-structured interviews, focus group discussions and personal observations .Focus group discussion was employed to get about the existing biomass fuel resource, prevailing opportunities and constraints, with key informants (farmers, DAs, community leaders). In general, a total of 329 households were sampled from seven districts of which three were from west Arsi and the rest four were from Arsi zone. Around 45 percent and 55 percent of the respondents were from Arsi and west Arsi zone respectively. The collected data was analyzed using appropriate statistical tools to fulfil the objectives of the study. The quantitative data was analyzed using descriptive statistics like mean, standard deviations frequency and t-test using statistical package for social sciences (SPSS) for analysis.
Add the tools for qualitative data analysis

Results and Discussions

Demographic and Socioeconomic Characteristics of the Respondents

Mean age of the respondents was 45.50 years which is within a working age group. Around 5 percent of the households were female headed and the rest 95 percent were male headed. More than 98 percent of the respondents were married while only around one percent of the respondents were widowed. The overall average family size of the households was 7.92 persons per a household while the mean male family members and female family members were 4.27 and 3.64 persons per household respectively (table 1).

Table 1: Demographic and Socioeconomic Variables of the Respondents

Variable	N	Mean	Std. Deviation	Min.	Max
Age	329	45.50	11.99	22	78
Education	329	4.10	3.48	0	11
Totalmale family	329	4.27	2.25	1.00	14.00
Totalfemale family	329	3.64	2.12	0.00	13.00
Total Family	329	7.92	3.53	0	22
	N		**Percent**	**Cumulative percent**	
Male headed	313		95.10	95.10	
Female headed	16		4.9	100	

Married	324	98.5	98.50
Single	1	0.3	98.80
Widowed	4	1.20	100.00

Source, own survey result, 2017

It was tried to balance the sample from each agro-ecological zones. Accordingly, 43.20 percent of the respondents were from highland areas while around 32 percent and 25 percent of the respondents were from mid-highlands and lowlands respectively (table 2)

Table 2: Respondents Distribution across Agro-ecologies

Agro-ecology type	**N**	**percent**	**cumulative percent**
Highland	142	43.2	43.2
Mid-highlands	105	31.9	75.10
Lowland	82	24.9	100

The educational background of the respondents was assessed using years of education. The mean year of education was 4.07 years with standard deviation of 3.48. Family labor force was calculated as man-equivalent of the family members and the mean family labor was 3.59 man-equivalents. Total mean of labor-to-land ratio was calculated to be 4.41 man-equivalents to a hectare of land. That means, on average 4.41 full labors is working on a hectare of land (table 3).

Table 3: Landholding and land use pattern of the sampled respondents in the Study Area

Variable	N	Min.	Max.	Mean	Std. Dev.
Man-equivalent of family labor	329	.60	15.40	3.59	2.05
Rain-fed crop land size	329	.00	8.00	1.40	1.22
Labor to land ratio	323	.16	18.5.00	4.41	11.80
Forest land size	329	.00	1.00	0.02	0.12
Degraded land size	329	.00	1.00	0.02	0.11
Land for residence	329	.00	1.50	0.20	0.20
Total landholding	329	.00	11.00	1.82	1.58
Livestock (TLU)	329	.00	40.85	5.78	5.27
Total annual income	329	100	180,000	19230	2719

Economic Status of the Respondents

Level	Number	Percent	Cumulative percent
Model	50	15.20	15.20
Middle	216	65.70	80.90
Resource poor	63	19.10	100.00

Resource ownership of the respondents

According to local and office of agriculture and natural resource development, the households are generally classified as model, middle level and resource poor farmers in terms of their resource ownership add citation. Accordingly, only 15 percents of the households are classified as model while the rest 65.7% and 19.1% were classified as middle level and resource-poor respectively. The total mean land holding of the households was 1.82ha per a household and the land. Mean family labor was around 3.6 man-equivalents per household. Each household possessed around six (6) units of tropical livestock (table 3).The average annual household income was around 19,000 ETB. Only around seven percent of the households are using electricity and around 69 percent are using mobile phone (table 4).

Table 4: Household facility holding of respondents in Arsi and W/Arsi zones

Facility type	Frequency	percent
Have electricity	22	6.70%
Have telephone	226	68.70%

Major Energy Sources and Energy saving Technology Use patterns in Arsi and West Arsi Zones

All respondent households are using multiple sources of biomass and other energy sources. The household level survey result revealed that the most widely used biomass energy sources were round wood, animal dung, crop residues and branch leaf and twigs (BLT) and each of them were selected by 50.2, 46.5%, 41.3% and 35.3% of the respondents respectively. Around 33% of the respondents buy supplementary energy sources while the rest are using from their own forest trees (mostly eucalyptus tree) farm, crop residues and animal dung. Considerable households are using community forest (around 50.8 percent) for household energy sources. Majority of the households, more than 91 percent of the respondents, fetch biomass energy sources and wives and daughters (the female groups) are the major responsible family members to fetch fire wood and other energy sources each accounting for 82.4% and 59.0% of total respondents (table 5).

Table 5: Energy Sources, technology use and household members' responsibility

No.	**Energy sources**	**Frequency**	**percent**
1.	Round wood	165	50.2
2.	Animal dung	153	46.5
3.	Crop residues	182	55.3
4.	Use forest as household energy sources	167	50.8
5.	Husband is responsible to fetch firewood	183	55.6
6.	Wife is responsible to fetch firewood	271	82.4
7.	Daughters are responsible to fetch firewood	194	59.0
8.	Boys responsible	157	47.7
9.	Have improved cooking stove	38	11.60

10. Use 3-stone open cooking stove	274	83.30
11. Use enclosed clay stove	4	1.20
12. Have separate cooking room (kitchen)	212	64.40
13. Use any technology that improve efficiency of biomass	71	21.60

Source: own survey result, 2018

Trend in use of biomass energy sources was assessed through household individual interview. Since the last five years wood (specially the round ones) was the most commonly and extensively used energy source that was ranked as first and followed by animal dung and crop residues with amount of 56.2%, 42.6% and 35.6% respectively (table 5).

Table 6: Energy use patterns across major agro-ecologies

Energy source	Highland	Mid-highland	Low-land	χ^2	Total
Firewood	137(96.5)[a]	98(93.3)	70(85.4)	9.6***	
Charcoal	38(26.8)	59(56.2)	9(11)	46.51***	305(92.7%)
Animal dung	115(81)	73(69.5)	48(58.5)	13.3***	106(32.2%)
Liquid petroleum gas	28(19.7)	33(31.4)	49(59.8)	37.7***	110(33.4%)
Biogas	4(2.8)	1(1.0)	0(0)	3	5(1.50%)
Crop residue	25(17.6)	79(75.2)	78(95.1)	152***	182(55.3%)
Electricity	7(4.9)	11(10.5)	3(3.7)	4.47*	21(6.4%)
Solar cell	59(41.5)	40(38.1)	7(8.5)	28***	106(32.2%)

[a]numbers in parenthesis are % of particular energy source users from population in the particular agro-ecology

*, *** chi-square is significant at 90% and 99% level of significance

The use of firewood is high in all agro-ecologies with minimum great value in lowland areas. The result from table 6 revealed that around 97% of highland respondents are using firewood while in lowland area it is little lower to 85%. The use of crop residue as household energy source is also highest in low land where it is the main energy source for 95% of the households. The higher rate of use of crop residue in low land areas may be due the nature of crops residue that have higher biomass outputs like maize and sorghum stalks. The use of liquid petroleum gas for house lightening is common all areas but it is highly practiced in lowland areas (around 60%). In highland areas, the culture of using solar cell for lightening is increasing through time (42%) and substituting liquid petroleum gas. Given the potential of solar energy, though higher proportion of solar cell use was expected in lowland areas, the result was reversed may be due to low income of the households in lowland areas compared to highlands and mid-highlands.

Table7: energy sources and technologies used for household lighting

Tech used for light	Frequency	Percent	Cumulative
1. Electric	21	6.4	6.4
2. Solar	91	27.7	34.1
3. Torch	46	14.0	48.1

4. Biogas	1	.3	48.4
5. Kerosene	170	51.67	100.0
Total	329	100.0	100.0

Source: own survey result, 2017

As it is revealed in table 7, majority of the households are using kerosene for lighting purpose which is around 52 percent of total households. The use of small scale solar cell was also much considerable, which is about 28 percent of the total households.

Households' kitchen use characteristics

More than 64 percent of the respondent households have separate cooking rooms (kitchens) facilities while the rest have no separate rooms for cooking purposes and the use of improved technologies (improved cook stoves) are very limited and only 11.6 percent of the households are using improved cook stoves called *mirt/gonzie* for *injera* baking which are proven to save biomass energy. During focus group discussion respondents explained that they even can cook outside home in open air during the winter period. In general, only around 22 percent of the respondents are using improved cook technologies like *mirt* (for injera baking) and charcoal saving stoves for stew and coffee making (table 5). The result from Arsi zone's office of energy also shows that the percent of households using improved cook stove are only 10% and it is almost the same with that of survey result.

Household Energy Consumption and their determinant factors in Study Area

Estimate of household's daily and annual energy consumption was assessed during survey and presented in table 8. As expected the major sources of biomass fuel were fuel round wood, crop residue and animal dung. The average annual consumption of biomass fuel per a household was 759.20Kg (which is 2.08Kg per day per household) of wet fuel wood, 620.50Kg of dry fuel wood (1.70Kg per day), and 430.70Kg of dry crop residue (1.18Kg/day). Nearly a liter of kerosene is being consumed per month per each household mainly for house lightening purpose.

Table 8: Annual Household Energy Consumption

Energy sources	Daily Consumption	Annual Consumption
1. Round fuel wood (Kg)	1.89	689.85
2. Branch Leaf and Twigs	0.83	301.13
3. Crop residue	0.83	301.13
4. Animal dung	0.88	319.38
5. Charcoal	0.24	87.6
6. Kerosene (lit.)	0.03	10.95
7. Electricity (KWh)	0.09	32.85

The amount and type of energy sources and use of improved cook stove technologies are determined by different socioeconomic factors. The use of improved cook stoves like improved biomass saving "*injera* baking" stoves, solar panels and electricity were highly determined by households' income amount. The mean income(birr) for ICS, solar energy panel and electricity users were 30521.88, 31208.83 and 31,615.00 while they were 18014.4, 12794.21 and 18600.85

for non-users with t-value significant at 95, 99 and 90 percent of probability respectively (table 9).

Table 9: Income and choice of energy technologies

Variable		Improved cook stove	Solar panel	Electricity
Income for:	Users	30521.88	31208.83	31615.00
	Non-users	18014.40	12794.21	18600.85
	t-value	2.49**	6.18***	2.10*

The choice of cooking or lightening energy sources was influenced by other factors like family size, age land holding and livestock possession. As an indicator, households' daily fuel wood and animal dung consumption were regressed against different socioeconomic variables like natural logarithm transformed income, family size, man-equivalent family labor, livestock possession in TLU, age of respondent and landholding size of the households. The amount of fuel wood consumption was significantly and positively influenced by family size and livestock possession (TLU) while it was negatively influenced by natural logarithm of income and man-equivalent of family labor. The amount of animal dung used was also positively and significantly influenced by landholding and negatively by family labor.

The results from table 9 and 10 reveal that as household income increases, there is a shift from traditional energy sources and combustion technologies to modern and improved and efficient technologies. The amount of daily fuel wood consumption was negatively affected by the amount of household income which shows that there is a shift from traditional energy sources to modern ones like electricity and solar. This result is similar with Bansal et al. (2013) in rural India, Chaudhuri and Pfaff (2003) in Pakistan, Heltberg (2005) in Guatemala and Nlom and Karimov (2014) in northern Cameroon which shows that household income is one of the main factors in choosing fuels for cooking. Ouedraogo (2006) in his findings while analyzing urban households cooking fuel choice in Ouagadougou, Burkina Faso, he reported that the fuel wood utilization rate decreases with increasing household income. Similarly, research findings by Arthur *et al*. (2010), shows that households' wealth determines the transition from biomass to electricity in Mozambique. The amount of daily animal dung use was also affected negatively by amount of income and it was positively affected by size of livestock population.

From table 10 it can be understood that daily fuel wood (kg) consumption was positively and significantly affected by total household family size and man-equivalent of household family labor (t-value of 2.33 and 2.01 respectively). The result is similar with the assumption of more family members and family labor availability will facilitate fetching firewood from forest. The daily animal dung consumption (Kg) of a household was also positively and significantly affected by total livestock unit possession (TLU) and landholding (t-values of 3.64 and 2.0 respectively). The more landholding of a household may help a household to possess more livestock and the more livestock possession ultimately facilitates more access to animal dung for consumption as energy source.

Table 10: OLS result for fuel wood and animal dung use in Arsi and w/Arsi zones

Dependent =daily fuel wood (Kg)			Dependent variable =daily animal dung (Kg)		
Variables	B	t-value	Variables	B	t-value
Constant	5.62	3.41**	Constant	2.37	2.41*
Family size	0.19	2.33*	LnIncome	-0.08	-1.30
Family labor	0.16	2.01*	Age	0.08	1.35
Livestock (TLU)	0.07	1.10	Landholding	0.12	2.0*
LnIncome	-0.11	-1.74*	family labor	-0.15	-2.41**
Age	-0.20	3.65	TLU	0.89	3.64***
F-value 2.381			F-value =2.27		
Adjusted R^2 = 0.017			Adjusted R^2 =0.015		

**, *significant at 5 and 10% probability level

Constraints and opportunities of existing energy resources in Arsi and W/Arsi zones

The major energy types under use are commonly biomass sources from different sources majorly woods, animal dung crop residue and others. From result of focus group discussion with all stakeholders at different stages, the rate of deforestation due to use of biomass as a source of household bio-fuel is higher than rate of reforestation in Ethiopia (there is unbalanced utilization of forest). The expansion of agricultural land is also one of the most important causes of deforestation and as a result in most districts where this survey was conducted, every marginal land was distributed as a farmland and deforested. Other studies done by different authors also revealed the same result. For instance, the research by Gessesse and Christiansson (2008) in South-central Rift Valley and Bedru (2006) in central and southern Rift Valley of Ethiopia show the impact of farmland expansion on deforestation. Furthermore, as it is known in a mixed farming system the livestock and crop production are supplementary and byproducts from one enterprises is an input for the other and vice-versa. But due to the lack of fuel-wood from forest everything from livestock or crop production goes to fire and the fertility of soil is highly affected.

Only few households are using solar cells for lighting but compared to its starting time, the overall 32 percent of respondents is not insignificant number (table 6). The overall use of electricity use is only 6 percent which insignificant and limited to villages which are somehow condensed. Grid rural electrification is difficult due to high cost of initial investment since the population is scattered. Moreover, the attempt to improve the efficiency of the biomass through use of improved technologies like improved cook stove is not effective.

Good energy utilization opportunities in study areas are that there is gradual increase in rural households' awareness on importance of clear energy and health related problems of using biomass energy sources with open inefficient technologies which is creating demand for improved technologies. This will in turn make the duty of demonstrating technologies easier for both research centers and development practitioners. Moreover, the rural households understand the effects of using biomass in unsafe ways and deforestation and there is good start in biological conservation (afforesting the degraded land) and this will rehabilitate the stock of biomass in general. For instance, the respondents were asked whether they know the corresponding effects of using firewood/other biomasses in open stoves or over utilization of forest in unsafe and improper ways for cooking on health, environment (deforestation, rain pattern, time of raining, amount of rain we receive, etc and almost 70 percent of the respondents answered that they know it but they don't have an alternatives to improve their ways of living.

An attention given by Federal Government of Ethiopia for energy development and distribution is which is supported by good energy policy and involvement of different NGOs such as solar energy foundation (German NGO), Hunde working in Oromia on biogas installation and other working on varies energy alternatives are also the aother opportunities. Ministry of Water Irrigation and Electricity is also investing on energy plant plantation like jatropha in potential areas like Merti, Jeju and Gololcha districts of Arsi zone which is an additional opportunity for development of clean energy in the study area.

Limitations in Use of Improved Technologies: Key Challenges

Even though there is an attempt to demonstrate and disseminate improved cooking stoves like mirt, gonzie and others, it is not as per the plan due to budget shortage, continuous structural changes in development offices and mandates of rural development agents. Previously, natural resource conservation experts at village level were responsible for conservation of forest and dissemination of improved cook stoves at village level but currently since the dissemination of improved cook stoves responsibility is shifted to mineral, water and energy offices at different level, and they don't have representative development agents down level (village), it becomes a forgotten business at PA level.

The lower use of improved cook stoves is associated to many socioeconomic and institutional issues. The first critical reason was lack of awareness on effects of traditional energy using on health amount of biomass to be consumed and natural resource degradation (specially both backyard and natural forest). The second reason for low use of ICS was technology supply shortage. Even though there an attempt to organize ICS producing microenterprises in most districts, the production and distribution are limited to urban and peri-urban areas where there is alternative energy sources and this is due to poor access to infrastructure and logistics.

The third reason for lower adoption (dissemination) of ICS was low purchasing power of the users due to low income. The other reasons for low dissemination of the technologies reported by rural energy offices at zonal and district level were lack of logistics and budget shortage.

The use of biogas is still at demonstration stage by different NGOs and government projects and the number of plants constructed so far is still insignificant. Oromia Biogas Construction Unit is constructing biogas for farmers in cost sharing mode and there are also some NGOs like Hunde Oromo which are funding full cost of the project. According to reports from zonal offices of energy only 849 and 329 bio-gases were constructed in Arsi and w/Arsi zones respectively. Major constraints in biogas dissemination are affordability (expensiveness of the technology), lack of technical gap from constructors (due to this it was reported that most biogas plants are not functional and this goes to 25-30%), and lack of awareness from users side on advantages of biogas's bi-product (slurry), and incompleteness of the technology (there is no *mitad*which widely used for baking of *injera* and other food and it is only used for stew and coffee making and lightening purpose). But currently there is solar cell for lightening purpose as an option and absence of this stove is a critical problem to be solved by research.

Literatures revealed that, being a thirteen-month shine country, the potential solar energy in Ethiopia is 5.5 Kw/M^2 and less than 1 percent was exploited so far (Dereje D., 2013). But the use of solar energyfor lightening purpose is constrained bytechnical gap of users and forged product of (fraudulently reproduced fake/copied products) solar cells which are imported illegally. The supply from government side with collaboration of Ethiopian Development Bank has no consistency and not accessible when farmers demand. In most cases there is no or too limited after sales services. From the result of KII and FGD it was identified that there is no trained technicians to train users even how to install and there is no maintenance service in case of any damages. The report from assessment done by solar energy foundation in 2006 also revealed that these abovementioned constraints were main challenges in solar cell use business (Samson T., 2016). The assessment made at national level described the main challenge in the sector as shortage of hard currency for import, shortage of finance both at local and abroad, bad product quality in the market and inappropriate competition, and fake and coped product import due to lack of national standard and control.

Conclusions and Recommendations

In general existing energy source potentials, technologies available in the study areas use status of different types of energy and opportunities in using different alternatives of clean energy sources were identified. From the result of the study it revealed that the majority of the households are still using poor sources of energy both for cooking (like firewood and animal dung in open air) and lightening purposes like kerosene lamps. The use of improved cook stoves was also found to be at a very low rate while the use of other technologies likes biogas plants, solar cell and electricity were constrained by income, awareness and availability. To tackle the constraints/challenges and exhaustively exploit the existing opportunities of energy resources in the study areas, the following recommendations are formulated

With at hand existing technologies both research and development bodies need to work on demonstration and pre-scaling up of the improved cook stoves, organizing technical and operational trainings for users and local technicians on solar energy apparatus and biogas utilizations. This will increase the awareness of the households on importance of using clean energy and how to use/operate the improved energy source technologies at their home. Local technicians equipped with skill and knowledge of these technologies can also boost the confidence of rural households to invest on such technologies. The study area specially the lowland areas of Arsi are ideal sources of solar energy. For example Dera district was one of the nationally recommended sites for solar PV development in Ethiopia. In addition, districts like Merti, Gololcha, Jeju and zuway-dugda from Arsi zone and Shalla and Arsi Negelle from w/Arsi zone are examples of districts with higher potential for solar energy.

Therefore, demonstration of existing ones and researching on different solar cooking technologies is crucial work of research centers to make use of this large renewable energy resource. Developing "*injera mitad*"/Stove for biogas which was started by Asella agricultural engineering research center, development of energy plant like jatropha processing technologies and efficient technology for jatropha oil combustion are areas which need research intervention in near future. There are also potential small scale hydropower generation units in the study area. For example, in Arsi zone currently there are seven water mills that can be used for electrical energy generation purpose. Therefore, designing and developing appropriate water turbine for these small scale hydropower should be also one of the research area.

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Analysing Adoption of Improved lowland Sorghum Varieties in East Hararghe Zone, Oromia Region, Ethiopia

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Abstract

Considering recent climate changes, sorghum production could reduce the expected food shortages. Not all local sorghum and improved varieties are equally valued by farmers for yield and other related components to be adopted. The main objectives of this study is aims at assessing benefits of improved sorghum, identify factors influencing adoption and adoption level of improved sorghum and identify farmers' criteria for evaluation of sorghum varieties in Fadis and Babile districts. Both primary and secondary data were collected for the study. The data were collected by means of a semi-structured questionnaire from 140 sample respondents during *the period between* December 2017 and January 2018 when farmers harvested their sorghum. *The study implemented binary logit and Tobit regression model to analysis factors affecting adoption and adoption level of improved sorghum variety, respectively. Binary logit results also revealed that adoption of improved sorghum was significantly influenced by six explanatory variables. Age of respondent, education, labour force, livestock, market distance and access to extension are significant variables which affect adoption of sorghum. Tobit regression model results revealed that educational, market distance, farm size, family size, livestock and yield of sorghum were variables influencing the adoption level of sorghum varieties. During group discussion they replied Badukani and Kufanzik are local sorghum variety that are early matured and resist to striga weeds in the study area. It shows the major sorghum variety attributes driving rapid adoption are drought tolerance, yield, stalk high, striga resistance and the variety's ability to fetch a higher price.*

Key words: Improves sorghum, Adoption, Logit regression, Tobit regression

Introduction

Sorghum [Sorghum bicolor (L.) Moench] is the fifth most important cereal grain after maize, rice, wheat and barley in the world (FAOSTAT 2017). It has been cultivated for centuries as a staple food crop in much of sub-Saharan Africa and Asia. It has remarkably wide adaptation and tolerates high temperatures and drought stress. Considering recent climate changes, sorghum production could reduce the expected food shortages (Abdalla and Gamar 2011). In developing countries, including Ethiopia, more than 500 million people consume sorghum as their principal food source (Burke et al. 2013).

In Ethiopia a total of 4.34 million tons of sorghum is being produced per annum. The mean yield level in the country is estimated at 2.4 t ha^{-1}. The crop is the major food cereal after maize and tef in terms of number of growers, area coverage and grain production in the country (FAOSTAT 2017). Sorghum stalks are used as feed for animals, and as housing and fencing material. The crop is highly adapted to the lowland and drier parts of Ethiopia owing to its considerable drought resilience. Efforts have also been made to develop early maturing sorghum varieties that are adapted to areas where regular moisture scarcity is detrimental to sorghum production. In Ethiopia, more than 51 early maturing sorghum varieties are currently available for use in such environments (ABoA 2017; SARC 2017).

In Ethiopia sorghum remains a subsistence crop with limited industrial value. It is the third most important cereal next to tef and maize on the basis of area cultivated and production amount (CSA, 2016).In Ethiopia from 2013 to 2014, sorghum total production and area coverage increased from 3.83 to 4.34 million tons and from 1.68 to 1.83 million hectares, in that order (FAOSTAT, 2017). Sorghum has become the most important crop because of its ability to grow under arid and semi-arid conditions. In Ethiopia about 1.9 million hectares of land is devoted to sorghum production every year. About 4.34 million tons of grain is produced with mean productivity of 2.4 t ha $^{-1}$ per annum exclusively by about 5 million smallholder farmers (CSA 2015).

In Eastern Hararghe zone out of the total cereal cropped area of 212,298.05 ha, sorghum crop account for about 63percent (134708.26 ha), of the annually cropped land. Regarding production, out of the total cereal crop 4,524,075.45 quintal, sorghum crop account for about 58.6 percent (2,652,781.44 quintal), of the annually obtained yield (CSA, 2016). In eastern Ethiopia sorghum is an important food crop and staple local diet. It is produced not only for its grains but also for its use as a source of animal feed, fuel wood and construction material. It is grown mainly under rain fed condition. Fedis and Babile districts of Eastern Hararghe are characterized by low, erratic and poorly distributed rainfall pattern and high temperature. Sorghum grown in eastern lowland areas of Fedis and Babile are subject to unpredictable drought, either at the beginning or, in the middle or towards the end of the growing season. Because drought causes major yield constraint in the eastern Ethiopia, farmers are forced to look for local and released sorghum that can give relatively high yield under drought conditions. The average yield in East Hararghe is currently 19.69 quintal ha^{-1} (CSA, 2016).

To address farmers' problems, and enhance productivity of the farmers' land, Fedis Agricultural Research Center has made a considerable effort in increasing the production of sorghum by focusing on low land areas to adapt different improved crop varieties in low land areas of Eastern Hararghe since 2011. Fedis Agricultural Research Center has tested and released improved sorghum variety that suited to Eastern Hararghe low land area. Among sorghum varieties distributed to the area includes striga tolerant (Gedo, Abshir, Hormat, and Gubiye), and early maturing (Teshale, Misiker, Meko, and Raya) seed varieties are distributed in the target area. More than 3412.5 quintal of improved sorghum variety produced and disseminated by fades agricultural research center in addition to sorghum disseminated through different organizations such as office of agriculture, Research center, University, and NGOs. However, the entry of improved sorghum varieties into the farming system has been slow, where extensive sorghum production was practiced in the drought prone areas. In addition, the promoted varieties are not equally preferred and adopted by farmers in the area.

Generally, adoption and continuous use of the promoted varieties is far from being widespread of improved sorghum in the target area. To expand improved and farmers demanded local sorghum variety, it is very important to identify the farmers' criteria in evaluation of sorghum variety. Adoption status of these varieties is not yet assessed in the study area. Hence, this study is aims at assessing benefits of improved sorghum, identify factors influencing adoption and adoption level of improved sorghum and identify farmers' criteria for evaluation of improved sorghum varieties in the study area.

Methodology

Description of study area

The study was conducted in lowland districts of east Hararghe zone. The lowlands of east Hararghe zone are known by striga infestation and drought prone, and to offset the effect of striga and drought, improved lowland sorghum varieties are being promoted and disseminated for the farmers through different organizations such as Research Center, Office of agriculture, cooperative farmers University, and NGOs the study area.

The agro climatic range of the Zone includes lowland (*kolla*, 30-40%), midland (*weyna dega*, 35-45%) and highland areas (*dega*, 15-20%). Annual rainfall averages range from below 700 mm for the lower *kolla* to nearly 1,200 mm for the highland. The variability of rainfall from year to year and it's often uneven distribution during the growing seasons give place to a wide range of climatic hazards which farmers have to deal with (EHZAO, 2011).

Based on the 2007 Census conducted by the Central Statistical Agency of Ethiopia (CSA), the Zone had a total population of 2,723,850, which is increased by 48.79% over the 1994 census, of whom 1,383,198 are male and 1,340,652 are female. The main socio-economic activity in the area is mixed farming (crop production and animal husbandry). Moreover, the main crops grown in the area include maize, sorghum, groundnut, *khat*, coffee, haricot bean, and different vegetables. Livestock husbandry includes cattle, sheep, goats; chicken camel and donkey are common. Mainly this study was undertaken in Fadis and Babile districts of eastern Hararghe zone. Fedis and Babile districts of Eastern Hararghe are characterized by low, erratic and poorly distributed rainfall pattern and high temperature. Sorghum grown in eastern lowland areas of Fedis and Babile are subject to unpredictable drought, either at the beginning or, in the middle or towards the end of the growing season.

Sampling procedure and sample size

For the study, an adopter of sorghum varieties was defined as a farmer who grew at least one improved sorghum variety for two consecutive cropping seasons. Initially, Fades and Babile District were purposively selected because it has a high sorghum production, high dissemination of improved sorghum varieties and sorghum technology has been introduced. Following this a two stage sampling procedure was employed to select sample respondents. In the first stage six PAs were selected from Fades and Babile districts using random sampling method. In the second stage, from list of households obtained from district level sample respondents from each kebele were selected based on probability proportional to sample size (PPS) sampling technique. From the 6 kebeles selected, data were collected by means of a semi-structured questionnaire from 140 sample respondents during the period between December 2017 and January 2018 when farmers harvested their sorghum. At the end 82 adopters (28 from Fades and 54 from Babile) and 58 non-adopters (34 from Fades and 24 from Babile) districts were interviewed.

Source of data and method of data collection

The major sources of primary data were farmers, experts and development agents. Primary data was collected from farmers through individual interviews and focus group discussions using questionnaire and checklist. In addition, field observations on farmers' practices were conducted to supplement primary data collected through individual interviews. Secondary information was obtained from research center, zonal agricultural office and district office through reviewing documents.

Method of data analysis

The collected data was analyzed using both descriptive statistics and econometric model analysis. Since the collected data comprise of both qualitative and quantitative data, different analytical techniques was used to examine the collected data. The econometric models include logit and tobit regression model. Descriptive statistics such as frequency and means was computed for different variables.

Econometrics analysis

In this study logit model was used to analysis factor affecting adoption of improved sorghum verities in the study area. For the study, an adopter of sorghum varieties was defined as a farmer who grew at least one improved sorghum variety for two consecutive cropping seasons. Formation of the model was influenced by a number of working hypotheses. It was hypothesized that a farmer's decision to adopt or reject a new technology at any time is influenced by the combined (simultaneous) effect of a number of factors related to the farmer's objectives and constraints (CIMMYT, 1993).

In this study, a tobit model was used to analysis the factors affecting the adoption level which is based on ratio of land allocated to improved sorghum. The basic assumption is that a farmer first test and adopts improved varieties by planting it on part of his or her land designated for production. A tobit model (McDonald and Moffitt 1980; Maddala 1983) that tests the factors affecting the incidence and intensity of adoption can be specified as follows:

$Y_t = X_t\beta + U_t$ *if* $X_t\beta + U_t > 0$

if $X_t\beta + U_t \leq 0, \quad t = 1,2,\ldots,$

Where:

Y_t= the expected amount of land allocated to improved sorghum used at a given stimulus level X_t; N = number of observations; Xt = vector of independent variables; β = vector of unknown coefficients and U_t= independently distributed error term assumed to be normal with zero mean and constant variance σ^2.

X_t is the index reflecting the combined effect of independent X variables that prevent or promote adoption.

The index level $X_t$can be specified as:

$X_t = \beta_0 + \beta_1 X_1 + \ldots + \beta_i X_i + \varepsilon_i$ Where: β_0 = constant;

$X_1 \ldots + X_i$ =socioeconomic variables such as age, education, farm size, labour, farm income, access to extension services, variety characteristics of farmers prefers, etc., ε_i= error term. Several variables were hypothesized to influence the allocation of land to improved sorghum varieties used. The model was estimated using the maximum likelihood method. The model was estimated using STATA Software.

Results and discussions

Descriptive statistics results

Households' Demographic and Socio-economic Characteristics

As mentioned in the methodology parts the descriptive parts of the analysis is used to describe characteristics of the sample respondent. Table 1 shows descriptive statistics results of sample household based on adoption of improved sorghum variety. In the study area the average age of all sample respondents was 40.7. On average adopter household head have 39.32 years while that of non-adopter of improved sorghum variety have 42.78 year. There is a significant difference in their age years. The survey results showed that mean difference between adopter households of improved sorghum variety and non-adopters were found to be significant at 5 percent significance level based on household head age in years. Similarly, the average year of formal schooling of adopter is around grade 3 while that of non-adopter of improved sorghum variety is around grade 1.The mean difference of the two groups is statistically significant at 1 percent of probability level. It shows that, on average adopter household have more year of formal schooling compared to that of non-adopters of improved sorghum varieties.

Table 1.Demographic Characteristics sample households

All Variables	All sample HH(N= 140)		Adopter HH(N=82)		Non-Adopter HH(N=58)		Mean Difference	
	Mean	SD	Mean	SD	Mean	SD	Mean	T-Value
Age of HH	40.7	9.56	39.32	9.99	42.78	8.59	3.46	2.13**
Education of HH	2.46	2.72	3.17	3.1	1.47	1.61	1.71	3.84***
Family Size	6.02	2.1	6.19	1.96	5.78	2.29	0.42	1.16
Labor force	3.1	1.3	3.3	1.37	2.8	1.25	0.49	2.14**

Source: Own survey result,

Education of household head: The average year of formal schooling of adopter is grade 3 and that non-adopter is grade 1.The mean difference of the two groups is statistically significant at 1 percent of probability level. It shows that, on average adopter households have more year of formal schooling compared to non-adopter of improved sorghum variety in the study area. Similarly, adopter household have more number of labor force compared to non-adopters. The average number of labor force of adopters was 3 persons and that of non-adopter is around 2 persons. The result showed that, the mean difference between numbers of labor forces of adopters and non-adopters were also found to be significant at 5% significance level.

Table 2.Descrtion of resource and institutional variable for respondents

All Variables	All sample HH(N= 140)		Adopter HH(N=82)		Non-Adopter HH(N=58)		Mean Difference	
	Mean	SD	Mean	SD	Mean	SD	Mean	T-Value
Locl Sorgm Lratio	0.55	0.36	0.36	0.34	0.78	0.25	0.4	7.7***
local Sorgm land	0.48	0.36	0.4	0.36	0.6	0.33	0.20	3.4***
Livestock(TLU)	2.15	1.5	2.44	1.44	1.75	1.54	0.68	2.7***
Farm size in ha	0.98	0.56	1.1	0.57	0.83	0.52	0.25	2.7***
Farm Experience	25.7	10.6	24.9	11.4	26.8	9.3	1.9	1.1
Fod Short Month	4.74	1.72	4.5	1.6	5.1	1.8	0.54	1.8**
Market distance	7.96	4.32	6.36	2.42	10.23	5.33	3.87	5.8***

Source: Own survey result,

Farm size: Farm size refers to the total area of farm land that a farm household owned in hectares. In agriculture, land is one of the major factors of production. The average cultivated land of all sample respondents was 0.9 ha. On average adopter household have 1 ha while non-adopter have 0.8ha. There is a significant difference in their cultivated land size. The survey results showed that mean difference between adopters and non-adopters of improved sorghum was found to be significant at 1percent significance level based on cultivated land.

Livestock number: Livestock is very important asset in farm household. In this study, the average livestock holding of sampled household is 1.89 in TLU. On average adopter households have 2.4 while that of non-adopter of improved sorghum is 1.75 in TLU. Adopter households have larger livestock compared to non-adopter households. The survey result revealed that, the mean difference between adopter of improved sorghum and non-adopter household was significant at 1percent level of significance based livestock holding in tropical livestock unit.

Farming experience: The mean difference between adopter and non-adopters of improved sorghum variety was found to be significant at 5 percent based on farming experience. This is expected because more experienced farmers may have better skills and access to new information about improved technologies. It could also imply that knowledge gained over time from working in uncertain production environment may help in evaluating information thereby influencing their adoption decision.

Market distance: As indicated in Table 2, the average distance of respondent from nearby market is around 8 Kilometres for respondent in the study area. The mean distance of the adopters' respondent was found to be 6 kilometres while that of non-adopters was around 10 kilometres. The mean difference between adopters and non-adopters was found to be statistically significant at 1% of probability level in the study area.

Table 3.Descriotion of socioeconomic characteristics of sample households

All Variables	All sample HH(N= 140)		Adopter HH(N=82)		Non-Adopter HH(N=58)		Mean Difference	
	Mean	SD	Mean	SD	Mean	SD	Mean	T-Value
Farm Income	27127	16005	33066	15891	18730	11974	14335	5.8***
Local sorgm yield	5.67	3.93	4.64	4.00	7.12	3.36	2.47	3.8***
Qty Produced	8.97	5.83	9.51	6.12	8.22	5.36	1.28	1.3
Sold Lvstk Income	5592	7251	9413	7286	190	1444	9223	9.5***
Qty Prodced Value	6721	5210	7516	6023	5598	3529	1918	2.2**
Cash Crop Value	5783	7657	5810	7446	5743	8012	6676	0.1

Source: Own survey result,

The total farm income derived from all source of income including activities like sold animal and crop product with their by-product. Household's farm income position and resource ownership was found to be important in adoption of improved farm technology. The average annual farm income of the sample households was 27,127 Ethiopian Birr (ETB). On average adopters had higher annual farm income which is about 33,066 Ethiopian birr as compared to non-adopters that have on average 18,730 Ethiopian birr. Analysis of annual mean difference of farm income between adopters and non adopters had also indicated that there was significant mean difference) at 1% significance level. Concerning this variable, most empirical study shows that the effect of farm income on household's adoption decision is positive and significant. On the contrary, low income and resource poor farmer face difficulty to adopt and increase level of use. Value of quantity produced, income from sold livestock and quantity of local sorghum yield are variable that shows significant mean difference at 1 percent level.

Table 4. Description of sample respondents based on sex of respondents

		Household Categories		Total
		Non-Adopter	Adopter	
Female	Count	12	13	25
	% within Household categories on adoption	20.7	15.9	17.9
	% of Total	8.6	9.3	17.9
Male	Count	46	69	115
	% within Household categories on adoption	79.3	84.1	82.1
	% of Total	32.9	49.3	82.1
Total	Count	58	82	140
	% within Household categories on adoption	100	100	100
	% of Total	41.4	58.6	100
	Chi^2 = 0.54, p-value = 0.46, DF=1			

Source: Own survey result,

Descriptive results revealed that Sex of the household head is an important variable influencing the adoption decision. Based on sex of respondents during survey, female adopters of improved sorghum variety in the area is account for about 15.9 percent of the total adopter of improved sorghum and male adopter accounts for 84.1; while out of the respondents that non-adopter improved sorghum variety is 20.7 percent of non-adopters are female and 79.3 percent of non-adopters are male. However the difference shown by cross tabulation chi-square test shows insignificant and the association between sex of household respondents and adoption characteristics of the sample respondents was not found to be significant.

Table 5. Access to agricultural Extension service for respondents

Access to Extension for respondents		Household categories on adoption		Total
		Non-adopter	Adopter	
Not Access	Count	29	21	50
	% within Household categories on adoption	50	25.6	35.7
Yes	Count	29	61	90
	% within Household categories on adoption	50	74.4	64.3
Total	Count	58	82	140
	% within Household categories on adoption	100	100	100
	Chi^2 = 8.80, p-value = 0.003, DF=1			

Source: Own survey result

As results of the table 5 above, out of total sample respondents that adopt improved sorghum variety, respondents that access extension service are account for 74.4 percent while other group that do not access extension service account for 25.6 percent. On the other hand, out of total sample respondents that do not adopt improved sorghum variety, respondents that access extension service are account for 50 percent while other group that do not access extension service account for 50 percent. It was revealed that, comparison of the two groups depicted that proportion of respondents that access agricultural extension and adoption of improved sorghum are related. This difference is shown by cross tabulation chi-square test that is found to be significant and the association between access to agricultural extension and adoption characteristics of the sample respondents was found to be significant at 1 percent probability level. Farmers that have access to extension agents and can obtain information regarding agricultural inputs such as improved sorghum seed can help farmers to adopt agricultural technology. Hence, farmers' access agricultural extension service plays pivotal role in agricultural information utilization on adoption of improved sorghum technology. When farmers practically observe a new practice they can weigh the advantage and disadvantages of the new technology.

Table 6. Main source farm income

Main source of income		Household categories on adoption		Total
		Non-adopter	Adopter	
Chat	Count	32	30	62
	% within Household categories on adoption	55.2	36.6	44.3
Groundnut	Count	20	21	41
	% within Household categories on adoption	34.5	25.6	29.3
Livestock	Count	2	7	9
	% within Household categories on adoption	3.4	8.5	6.4
Khat trading	Count	0	1	1
	% within Household categories on adoption	0	1.2	0.7
Livestock trading	Count	0	17	17
	% within Household categories on adoption	0	20.7	12.1
Cattle Fattening	Count	4	6	10
	% within Household categories on adoption	6.9	7.3	7.1
Total	Count	58	82	140
	%within Household categories on adoption	100	100	100
	$Chi^2 = 17.67$, p-value = 0.003, DF=5			

Source: Own survey result,

In moisture stress area of Eastern Hararghe zone, farmers use different source of income generating activity to diversify their source of income. The descriptive result presented in table 6 above revealed that, out of total non-adopters of improved sorghum variety, sample respondents that use chat as main source of income account for 55.2 percent while other source of income account for 34.5 percent, 3.4 percent and 6.9 percent from groundnut production, livestock production and cattle fattening as main source of income generating activity, respectively. On the other hand, out of total adopter of improved sorghum variety, adopter respondents that use chat as main source of income account for 36.6 percent while other source of main income accounts for 25.6 percent, 8.5 percent, 1.2 percent, 20.7 percent and 7.3 percent from groundnut production, livestock production, chat trading, livestock trading and cattle fattening as main source of income generating activity, respectively. It was revealed that, comparison of the two groups depicted that a higher proportion of adopter respondents that use more main source income are adopters of improved sorghum variety than that of non-adopter. This difference is shown by cross tabulation chi-square test that found to be statistically significant and the association between main source of farm household income and adoption characteristics of the sample respondents was found to be statistically significant at 1 percent probability level.

Table 7. Main farm production Constraints

Main farm production Constraints		Household categories		Total
		Non-adopter	Adopter	
Oxen shortage	Count	10	12	22
	% within Household categories on adoption	17.2	14.6	15.7
Labor shortage	Count	4	9	13
	% within Household categories on adoption	6.9	11	9.3
Disease	Count	7	6	13
	% within Household categories on adoption	12.1	7.3	9.3
Drought	Count	29	41	70
	% within Household categories on adoption	50	50	50
Striga	Count	6	11	17
	% within Household categories on adoption	10.3	13.4	12.1
Lack of chemical	Count	0	3	3
	% within Household categories on adoption	0	3.7	2.1
Land shortage	Count	2	0	2
	% within Household categories on adoption	3.4	0	1.4
Total	Count	58	82	140
	% within Household categories on adoption	100	100	100
	Chi^2 = 6.79, p-value = 0.34, DF=6			

Source: Own survey result,

In the study area, farmers are facing different agricultural production constraints that challenging them in one or other ways. The descriptive result presented in table 7 above revealed that, out of total non-adopter s of improved sorghum variety, sample respondents that replied oxen shortage as main production constraints account for 17.2 percent and drought accounts for 50 percent, while other farm production constraints account for 6.9 percent, 12.1 percent, 10.3 percent and 3.4 percent as labor shortage, disease, weed and shortage of farm land as main constraints for agricultural production, respectively. On the other hand, out of total adopters of improved sorghum variety, sample respondents that replied oxen shortage as main production constraints account for 14.6 percent and drought as 50 percent, while other group account for 11 percent, 7.3 percent, 13.4 percent and 3.7 percent as labor shortage, disease, weed and protection chemical as main constraints of agricultural production, respectively. It was revealed that, comparison of the two groups depicted that proportion of respondents that faced different agricultural production constraints to non-adopter and that of adopter of improved sorghum variety are almost equal. This difference is shown by cross tabulation chi-square test that is found to be insignificant and the association between main agricultural production constraints and adoption characteristics of the sample respondents was found to be insignificant. This implies that, sample respondents are facing similar agricultural production constraints even if the level of challenge differs between both groups.

Analysis of Farmers' criteria for evaluation of sorghum varieties

In many cases researchers' criteria for evaluation of new improved sorghum variety are much different from those of farmers. Then, farmers were asked to list and rank most important sorghum characteristics, which are taken into consideration while evaluating sorghum varieties. Even though, crop yield is the most important trait in sorghum variety evaluation, most farmers indicated that drought resistance, early maturity, stalk high and good fodder yields for their livestock are also the most important traits considered while evaluating sorghum by the farmers. In evaluation of the sorghum variety adopters of the improved sorghum were included. Non-adopters were not able to evaluate traits of improved sorghum since most of them did not know their important traits. So the evaluation criteria was listed and ranked by improved sorghum adopters because, they know the trait of both local and improved sorghum variety.

Table 8. Main criteria for evaluation of sorghum varieties ranked by adopters farmers

Sorghum characters		Local sorghum		Improved sorghum	
		Adopter	Rank	Adopter	Rank
	Count	5		11	3rd
Higher sale price	% within household categories	6.1		13.4	
	Count	3		14	2nd
Early maturity	% within household categories	3.7		17.1	
	Count	11	3rd	10	4th
Crop yield	% within household categories	13.4		12.2	
	Count	12	2nd	6	
Drought resistance	% within household categories	14.6		7.3	
	Count	9	5th	9	5th
Feed quality	% within household categories	11		11	
	Count	4		16	1st
Straiga resistance	% within household categories	4.9		19.5	
	Count	9		7	6th
Food taste	% within household categories	11		8.5	
	Count	10	4th	2	
Disease resistance	% within household categories	12.2		2.4	
	Count	6		4	
Swell on cooking	% within household categories	7.3		4.9	
	Count	13	1st	3	
Stalk high	% within household categories	15.9		3.7	
	Count	82		82	
Total	% within household categories	100		100	

Source: Own survey results,

Not all local sorghum and improved varieties are equally valued by farmers for yield and other related components and seed attributes. The result of ratings shows that the improved sorghum was superior to the local sorghum mainly in terms of *straiga* resistance, early maturity, higher seed sale price and crop yield, whereas the local sorghum varieties were superior to the improved sorghum variety with respect to stalk high for construction and fodder yield, resistance to drought and crop yield. The group discussion held with farmers revealed that the reasons for adopting improved sorghum varieties is that improved varieties can yield better when there is very shortage of rainfall, have good taste and required by GOs, NGOs as well as by the farmers in market. Local varieties are preferred for their better yield when there is enough rainfall and fertile soil even in presence of *straiga* manifestation. The quality and quantity of fodder of local varieties are better, they resist harsh environment (e.g. insect, disease and drought resistance), and require less crop management.

This result shows that evaluating sorghum based on yield and profit is not enough, but giving due attention to other traits of sorghum like high of the stalk for animal feed and construction material is also necessary to increase the probability of adoption of sorghum varieties. Evidence further indicates that the major sorghum variety attributes driving rapid adoption are drought tolerance, yield, stalk high, *striga* resistance and the variety's ability to fetch a higher price as in table 8 above.

Table 9. Major opportunity for improved sorghum variety adoption by adopters

		Adopter	Rank
	Count	15	
No answer	% within Household categories on adoption	18.3	
	Count	19	
Provided seed	% within Household categories on adoption	23.2	2nd
	Count	21	
Higher seed sale price	% within Household categories on adoption	25.6	1st
	Count	14	
Higher seed demand	% within Household categories on adoption	17.1	3rd
	Count	6	
Nearer to extension service	% within Household categories on adoption	7.3	5th
	Count	7	
Its management simplicity	% within Household categories on adoption	8.5	4th
	Count	82	
Total	% within Household categories on adoption	100	

Source: Own survey result,

As it was explained in the above table adopter replied that main opportunity to adopt improved sorghum was higher seed sale price. There is wide variability of yield and the prices at which sorghum is sold by adopter of improved sorghum variety for NGO and as emergence seed by GOs as main buyers (at the time of the survey) buy at 12-13ETB/Kg, local farmers buy as low as 10ETB/kg depending on the desperation of the seller and time of cultivation, while at cultivation time and higher demand for seed its price can be increased.

Table 10. Source of market information for improved seed by adopters

Information		Adopter	Rank
	Count	13	
No information	% within Household categories on adoption	15.9	
	Count	39	
Development agents	% within Household categories on adoption	47.6	1st
	Count	20	
Farmers	% within Household categories on adoption	24.4	2nd
	Count	1	
Woreda and Kebele Experts	% within Household categories on adoption	1.2	4th
	Count	9	
Neighbour	% within Household categories on adoption	11	3rd
	Count	82	
Total	% within Household categories on adoption	100	

Source: Own survey result,

Market information is a dummy variable taking 1 if the respondents had access to market information and zero otherwise. Access to market information makes farmers aware of and has a better understanding of improved agricultural technologies, which can facilitate change in the behaviour of farmers and ultimately lead to a decision to technology adoption. The descriptive results revealed that, based on source of market information for improved sorghum variety, sample respondents that dot accessed market information in the area is account for about 15.9 percent of the total improved sorghum adopters; while other group of the respondents that accessed market information from development agents accounts for 47.6 percent of adopters farmers in the area table 10. Similarly, it showed that, sample respondents that accessed market information from other farmers and their neighbours account for about 24.4 and 11 percent of the adopters, respectively.

Table 11. Description of adoption experience, maturity period and sorghum land

Variable	Mean	Std. Dev.	Min	Max
Adoption Exp	3.43	1.12	1	7
Improve Sorgm land	0.49	0.29	0.13	1
Maturity duration	3.02	0.11	3	4

Source: Own survey result

The mean adoption experience of the sample respondents was 3.4 years with the range from 1 to 7 year (Table 11). On average, the sample respondents have replied that improved sorghum variety have 3 month maturity period with the range from 3 to 4 month. Area allocated for improved sorghum variety was found to be ranged from 0.13 to 1 hectare with an average size of about 0.49 hectares. It is the land area allocated by farmers to improved sorghum variety. The small area planted to the new cultivars indicates that farmers are still at the experimenting stage of the adoption process

Reason for discontinuing adoption of improved sorghum variety

The most important production constraints affecting sorghum production include drought stress, unavailability and unaffordability of improved production package, lack of an improved seed system, a lack of farmer preferred improved varieties and poor soil fertility.

Table 12. Main reason for discontinuing adoption of improved sorghum variety

Reason for discontinuing adoption	Percent
Seed was not available on time	4.9
The production was unsatisfactory	6.1
Insufficient crop residue for feed	3.7
Shorter stalk for fire and construction	4.9
Total	19.517

Source: Own survey results,

In the study area there are some improved sorghum adopters that stated adoption and discontinued adoption. Out of 82 farmers who adopted improved sorghum 16 (19.5 %) farmers discontinued using improved sorghum varieties. Most adopters' discontinued using improved sorghum due to lack of improved seeds, the production of improved sorghum was unsatisfactory and shorter stalk of improved sorghum for fire and construction. This might have discouraged to continue using improved sorghum.

Group Discussion

Group discussion was undertaken while data collection in the study area. In Fadis districts, 44 farmers were participated on group discussion during data collection. Out of 44 participants 19 of them ware female. Similarly, in Babile Districts 46 farmers were participated on group discussion and out of these 11 participants were female. In these area, *Wagare*, *Badukani* and *kufanzik* sorghum varieties are some of the local sorghum that farmers ware used to cultivate for period of time. However due drought caused by climate change and *straiga* manifestation in the area, the yield fluctuation become a series problem. So, the group discussion held with farmers revealed that the reasons for adopting improved sorghum varieties is that improved varieties can yield better when there is very shortage of rainfall, have good taste and required by GOs and NGOs as well as by the farmers in areas. Local varieties are preferred for their better yield when there is enough rainfall and fertile soil even in presence of *straiga* manifestation. Similarly, farmers participated on group discussion replied that *Badukani* and *Kufanzik* are local sorghum that are early matured and resist striga weeds in the study area. Both sorghum varieties can be harvested within three month and the main source of local seed is own saving and farmers seed exchange among themselves.

On the other hand, Birhan, Hormat, Gedo, Raya Gobiye, Abshir tashale and mako are some of improved sorghum variety found in this study area. These varieties are Abshir, Gobiye, Meko and Tashale that are most of the time provided by research center ,GOs and NGO office of the area where as most of these varieties are provided by Fadis agricultural research center. Regarding food prepared from the sorghum Birhan, Meko and Gubiye are selected by female as best food taste. Similarly male participants were selected Meko at fisrt because of higher yielding, drought tolerant and early maturity of the sorghum. Then Birhan and Gubiye also selected by male participants next to Meko. However, farmers replied that cultivation of these sorghum varieties are constrained in the area due to birds problem and stalk height for feed.

Econometrics analysis results

Factors affecting adoption of improved lowland sorghum varieties

Adoption is defined as a mental process in which an individual passes through a series of stages from first hearing about an innovation, called an awareness stage, to collecting information about the technology's perceived benefits in terms of its profitability and fit into the farmer's operation, the evaluation stage. For the study, an adopter of sorghum varieties was defined as a farmer who grew at least one improved sorghum variety for two consecutive cropping seasons. Before proceeding to analysis factor affecting adoption of improved lowland sorghum varieties, Variance Inflation Factor (VIF) was applied to test for the presence of strong multicollinearity problem among the explanatory variables. There was no explanatory variable dropped from the estimated model since no serious problem of multicollinearity was detected from the VIF results. Similarly, heteroscedasticity was tested by using Breusch-Pagen test. This test resulted in rejection of the existence of heteroscedasticity hypothesis as (p= 0.246) using STATA 11. The pseudo- R^2 indicates how well the regressors explain the adoption probability.

Table 13. Logistic regression results for factor affecting adoption of lowland sorghum variety

AdoptStatus	Coef.	Odds Ratio	Std. Erer	Z
Age of HH	-0.082	0.92	0.041	-1.85*
Sex of HH	-0.056	0.95	0.533	-0.1
Education of HH	0.205	1.23	0.142	1.77*
Market Distance	-0.262	0.77	0.052	-3.84***
Family Size	0.011	1.01	0.133	0.08
Labor Force	0.424	1.53	0.309	2.1**
Farm Size	0.491	1.63	0.720	1.12
Farm Experience	0.020	1.02	0.037	0.55
Livestock	0.402	1.49	0.266	2.26**
Access to Extension	0.935	2.55	1.268	1.88*
Constant	1.640		1.699	0.97
Number of obs = 140			Prob > chi^2	0

LR chi2(10)	= 64.56	Pseudo-R^2	0.3399
Log likelihood	= -62.69		

Source: own survey results. ***, ** and * means significant at the 1%, 5% and 10 % probability levels, respectively

It was found that adoption of improved lowland sorghum varieties was significantly influenced by six explanatory variables. Age of household head, education level, labour force in family member, size of livestock in tropical livestock unit, market distance and access to agricultural extension service are significant variables which affect adoption of improved lowland sorghum varieties. Age of household head shows negative relation with adoption of improved sorghum. This implies that an increase in age of household head tends to decrease adoption of improved sorghum variety. Age influences adoption negatively. Older people are risk averters and more conservatism is thought to be their characteristic and therefore age would negatively contribute to the adoption of improved agricultural technologies.As the age of household head increase the probability of household adoption of improved lowland sorghum varieties decreases. The interpretation of the odds ratio also implies that if other factors are held constant, the odds ratio in favor of adoption of improved lowland sorghum decrease by a factor of 0.92 as age of household head increase by one year(Table 13).

In Ethiopia, as in most of other developing countries, labour is one of the most extensively used inputs of agricultural production. These are household member found between age of 15 and 64 year. Furthermore, family is the major and sole source of agricultural labour. Households with large number of economically active members have more number of agricultural labours. Adoption of improved lowland sorghum requires large number of labour force in rural area. Households that have larger number of working group members were more likely to be included in adoption of improved lowland sorghum varieties in the study area. As it is revealed from estimation of the logit regression analysis indicate that, adoption of improved lowland sorghum has a positive and statistically significant association with use of higher labour, most likely due to the higher level of labour requirement during management and cultivation activities involved during crop production. The interpretation of the odds ratio also implies that if other factors are held constant, the odds ratio in favour of adoption of improved sorghum increases by factor of 1.53 as number working family member increase by one person.

Households who have larger number of livestock in tropical livestock unit were more likely to be included in the adoption of improved sorghum. This variable was found to influence adoption of improved sorghum varieties positively and significantly. The implication of the result was that livestock are an important source of cash in rural areas to allow purchase of important farm input, chemical and other management that can be used to increase the production of improved sorghum and other farm technologies. Farmers who have large number of livestock might consider their asset base as a mechanism of insuring any risk associated with use of improved farm input and technologies. Given this potential contribution of livestock to sustainable household farm input supply and cash generation, they encourage adoption of improved lowland sorghum varieties. The odds ratio of 1.49 implies that, other things kept constant, the odds ratio in favor of adoption of improved lowland sorghum varieties increases by a factor of 1.49 for each increase in livestock in TLU (Table 13). This implies that livestock holding has an influence on the adoption of improved lowland sorghum in different areas.

As it was indicated in the (Table 13) the results of logit regression model revealed that market distance from farmer residence is one of the variables that affected adoption of improved lowland sorghum varies. This is a continuous independent variable measured in kilometre. The closer a household to the nearest urban center, the lesser would be transportation costs and better access to market information and facilities for agricultural input. Berhanu and Moti (2010) found out negative relationship between market participation and distance to the nearest urban market center. Therefore, households who are at far away from urban center are hypothesized to affected adoption of improved lowland sorghum varies negatively and significantly. The odds ratio of 0.77 implies that, other things kept constant, the odds ratio in favor of adoption of improved lowland sorghum varieties decrease by a factor of 0.77 as market distance increase by kilometre.

Access extension service is a dummy independent variable taking the value 1 if a household had access to extension services and 0 otherwise. It is expected that farm extension service widens household knowledge with regard to use of best farm technology that enhance household agricultural production activity. Agricultural extension services are expected to enhance households' skills and knowledge, link households with technology. Access to extension services on adoption of sorghum such as planting and managing of improved sorghum and other best practice in agricultural activity by households positively and significantly affected adoption of improved lowland sorghum varies at less than 10 percent probability level. Holding other things constant, the odds ratio in favor of adoption of improved sorghum varieties increases by a factor of 2.55 as a household has access to extension service. The probable reason for this was that farmers who had active participation in all extension activities were well informed about the benefits of improved sorghum variety production technology, which motivated farmers to utilize the improved farm technology.

Factors affecting the level of Adoption of Improved lowland sorghum varieties

The level of adoption of improved sorghum varieties by farmers in the study area was also examined, using the Tobit model statistical analysis. The adoption level of improved sorghum was measured in terms of land ratio allocated to improved sorghum variety by farmers as (**Adoptlevel**). The study revealed that some socio-economic factors, such as educational level, market distance, farm size, household size, livestock in TLU and yield of improved sorghum (Table 14) were significant variables influencing the adoption level of improved sorghum varieties by farmers in the study area.

Table 14. Maximum Likelihood Estimates of the Tobit Model for level of adoption

Adoptlevel		Coef.	Std. Erer	t-value
Age of HH		-0.007	0.006	-1.09
Sex of HH		0.020	0.102	0.2
Education of HH		0.034	0.014	2.41**
Market Distance		-0.050	0.011	-4.42***
Family Size		0.034	0.020	1.68**
Labor Force		0.028	0.032	0.86
Farm Size		0.190	0.065	2.91***
Farm Experience		-0.003	0.006	-0.58
Livestock		0.053	0.026	2.02**
Access to Extension		0.129	0.083	1.56
Yield of sorghum		0.108	0.006	16.7***
Constant		0.111	0.248	0.45
/sigma		0.386	0.032	
Number of obs	= 140		Prob > chi^2	0
LR chi2(11)	= 71.98		Pseudo R^2	0.33
Log likelihood	= -72.12			

Source: own survey results. ***, ** and * means significant at the 1%, 5% and 10 % Probability levels, respectively

Level of Education: Model results show that the level of education of the respondents was a very important factor that influenced the level of adoption of improved sorghum variety in the study area. There is a positive and significant relationship between level of education and level of adoption of improved sorghum varieties in the study area. This also indicated that adopters were more educated than non-adopters, and better educated farmers show a better positive response to improved technology adoption. This suggests that being literate would improve access to information, capable to interpret the information, easily understand and analyze the situation better than illiterate farmers.

Market distance: Distance to the nearest market center which represents the distance in kilo meter from the farm to the nearest market center where the farmer acquires, inputs and sell farm product. Results in Table 14 revealed that distance to market had a negative and significant influence on the level of adoption of improved sorghum variety by farmers at less than 5 percent significant level. The negative sign of the coefficient implies that farmers who live closer to the market are more likely to adopt the new technology and are also more likely to use more of the technology compared to farmers who live farther away from the market. It suggests that the level of adopting improved sorghum varieties declines as the distance from market center increases. The probable reason for this was that farmers who have more access to input and output markets had access to market information such as price information on different production input and output. The possible reason might be farmers nearer to market center have access to production inputs and. Besides, they were accessing agricultural inputs to purchase and the incentive to output market than those at far distant. As market distance increases, farmers may incur more costs for transport spends time and energy.

Family size: Results in Table 14 also reveal a positive and significant relationship between Family size and the level of adoption of improved sorghum varieties in the study area. The value was significant at 5% level of probability. Family size can create certain demand which may motivate the adoption of new practices or technologies that would increase the farmers' need as a means of meeting these demands. Furthermore, household size has the effect of encouraging farmers to improve their earning capacity because some family members would tolerate certain levels of unfavorable conditions created by channeling family resources into investment in improved technologies.

Livestock size: Households who have larger number of livestock in tropical livestock unit were more likely to be included in the adoption of improved sorghum variety. The model output shows that livestock holding is statistically and positively significant at less than 5% level. This implies that livestock holding of farmers positively affects the respondents' economic status and adoption of improved sorghum variety. The implication of the result was that livestock are an important source of cash in rural areas to allow purchase of farm input, protection chemical and other management that can be used to increase agricultural production. Farmers who have large number of livestock might consider their asset base as a mechanism of insuring any risk associated with adoption of improved farm technology. Given this potential contribution of livestock to sustainable household farm input supply and cash generation, they encourage adoption of improved sorghum varieties in the study area.

Farm size: Farm size or land holding is perhaps the single most important resource as it is a base for any economic activities especially in rural and agricultural sector. Farm size influences households' decision to adopt or not to adopt new technologies.The model result also shows positive and significant relationship between size of farm holding and the level of improved sorghum adoption. The regression value was positive and significant at 1% level of probability. Farm size has bearing on the capacity of farmers to adopt improved technologies and new farm practices. Farmers with large farm size can afford to devote part of their farms for improved sorghum production without affecting the total land left for the production of the other crops compared to small land holders. Farmers operating large farm holdings tend to have greater financial resources, incentives and access to information, hence more land allocated to improved technologies .Adequate size of crop land holding is one of the requirements for adoption of improved agricultural technologies. Farmer who has large farm size has more income, risk bearing ability and has higher probability to adopt new crop technologies. The probable reason for this was a farmer with larger farm size means relatively harvest more thus more money flow into the family.

Yield of improved sorghum: The results also revealed a positive and significant relationship between yield of improved sorghum variety and the level of adoption of improved sorghum. The higher the yield from a crop variety, the higher will be the marginal returns to seed, and hence higher opportunity to increase level of adoption. The result was significant at 5% level of probability (Table 14). Yield is a one the measure of sorghum performance. Crop varieties that have high capacity to yield high stands a better chance of being adopted as well as being used intensively by farmers.

Conclusions and Recommendations

Considering recent climate changes, sorghum production could reduce the expected food shortages. Not all local sorghum and improved varieties are equally valued by farmers for yield and other related components to be adopted. Based on the empirical findings reported in this paper, the following conclusion and recommendations are forwarded. The main objectives of this study is aims at assessing benefits of improved sorghum, identify factors influencing adoption and adoption level of improved sorghum and identify farmers' criteria for evaluation of sorghum varietiesin Fades and Babile districts. Both primary and secondary data were collected for the study. The data were collected by means of a semi-structured questionnaire from 140 sample respondents between December 2017 and January 2018 when farmers were harvested their sorghum. Descriptive results show that households' farm income and resource ownership was found to be important in adoption of improved farm technology. The average annual farm income of the sample households was 27,127 Ethiopian Birr (ETB). On average adopters had higher annual farm income which is about 33,066 Ethiopian birr as compared to non-adopters that have on average 18,730 Ethiopian birr. Analysis of annual mean difference of farm income between adopters and non adopters had also indicated that there was significant mean difference at 1% significance level.

The study implemented both binary logit and Tobit model to analysis factors affecting adoption and adoption level of improved sorghum variety. Logit regression result also revealed that adoption is significantly influenced by six explanatory variables. Age, education level, labor force, livestock size, market distance and access to agricultural extension are significant variables which affect adoption of improved sorghum. Similarly, Tobit model estimation also revealed that adoption level is significantly influenced by five explanatory variables. It revealed that educational level, market distance, farm size, household size, livestock and yield of improved sorghum were significant variables influencing the adoption level of improved sorghum.

In Fades district 44(19 females) were participated on group discussion. Similarly, in Babile Districts 46(11 females) farmers were participated on group discussion and interviewed with the participation of kebele level developmental agents and researchers from Fades Agricultural

Research Center. Farmers participated on group discussion replied that Badukani and Kufanzik are local sorghum variety that are early matured and resist striga weeds in the study area.

Households that have larger number of working group members were more likely to be included in adoption of improved lowland sorghum varieties in the study area. As it is revealed from estimation of the logit regression analysis indicate that, adoption of improved lowland sorghum has a positive and statistically significant association with use of higher labour, most likely due to the higher level of labour requirement during management and cultivation activities involved during crop production. The interpretation of the odds ratio also implies that if other factors are held constant, the odds ratio in favour of adoption of improved sorghum increases by factor of 1.53 as number working family member increase by one person.

Households who have larger number of livestock in tropical livestock unit were more likely to be included in the adoption of improved sorghum. This variable was found to influence adoption of improved sorghum varieties positively and significantly. The odds ratio of 1.49 implies that, other things kept constant, the odds ratio in favor of adoption of improved lowland sorghum varieties increases by a factor of 1.49 for each increase in livestock in TLU. The implication of the result was that livestock are an important source of cash in rural areas to allow purchase of important farm input, chemical and other management that can be used to increase the production of improved sorghum and other farm technologies. Farmers who have large number of livestock might consider their asset base as a mechanism of insuring any risk associated with use of improved farm technologies. Therefore, it is concluded that development partner should focus on strengthening capacity of household through providing facilities in the direction of asset building like livestock purchase thought revolve funding system.

Results indicate that the major sorghum variety attributes driving rapid adoption are drought tolerance, yield, stalk high, *striga* resistance, stalk high and the variety's ability to fetch a higher price. It also concluded that evaluating sorghum based on yield and profit is not enough, but giving due attention to other traits of sorghum like high of the stalk for animal feed and construction material is also necessary to increase the probability of adoption of sorghum varieties.

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Characterization and Analysis of Farming System in Eastern Hararghe Zone, Oromia National Regional State, Ethiopia

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Abstract

Characterization and analysis of existing farming systems was conducted in the Zone with specific objectives of characterizing and identifying farming systems, and identifying and prioritizing major constraints of the identified farming systems in the study area.The study was used Participatory Rural Appraisals (PRA) approach to collect and generate the required data. The study used PRA tools which included household survey, focus group discussions, pair-wise ranking, and field observation. Multi-stage sampling techniques used to select representative districts and peasant associations (PAs).A total of 329 randomly selected farm householders for household survey and atonal 26 focus group discussion (FGDs) also involved in the PRA study. The survey used a participatory research approach, participatory rural appraisal (PRA) tools such as reviewing secondary data, household survey and focus-group discussions (FGDs) were used to collect primary and secondary data from farm households/agro pastoralists. The collected data were analyzed using descriptive statistics and PRA tools such as pair-wise rankings. The result of PRA indicates that based on agro-ecology and major livelihood sources of farmers/agro pastoralist, five major farming typologies such as Chat/Maize highland mixed farming system (CMHMFS), Sorghum/maize/cash crops midland mixed farming system (SMCMMFS), Coffee/maize mixed farming system (CMMFS), Sorghum/groundnut lowland mixed farming system (SGLMFS) and Agro pastoral/pastoral farming system (APPFS) were identified in the Zone. Results of PRA study revealed that the main crop production constraints were lack of improved crop varieties and cultivable land shortage were identified as the first limiting factor followed by insect pests, shortage of improved seeds supply, farm inputs (pesticides, fertilizers), erratic rainfall distribution/drought, soil fertility declining and extension service availability in decreasing order of priority.Similarly, livestock production in study area is constrained by ultimate animal feed shortage, drought, limited and deteriorated grazing land due to expansion of crop cultivation and limited improved forage production due to lack of adaptive and productive improved forage species that compatible to the existing farming practices has been highly affecting livestock production in farming system areas. Drought, declining of soil fertility, depletion of natural forests and deforestation were main constraints to natural resources. Hence, there is need for research, development and institutional interventions to alleviate the identified constraints to crop, and livestock production, natural resources and socioeconomic in the study area through holistic approach.

Key words: *Characterization, farming system, Eastern Hararghe Zone, Oromia*

Introduction

Agriculture is the dominant economic activity and primary source of livelihood of the community of the East Hararghe Zone. In the Zone, the farmers are conducting agricultural production activities in different agro-climatic, environmental, socio-economic and institutional conditions. Agriculture constitutes complex production activities involving growing diversity of crops, and rearing livestock in order to meet the multiple needs of the households.

Even though the farmers are growing a diversity of crops, and livestock production, and their productivity is determined by multiple factors such as limited resources availability, population growth, environmental conditions/climate change, socioeconomic and institutional conditions (market, services, policies,) and aavailability and use of improved technologies). However, these conditions may not be with the farmers' as it is, they will change over time, and affecting the livelihood of the farmers. To response the change, the farmers will be forced to change cropping systems, management practices, resource use pattern. Hence, understanding of the change through conducting farming system research is a prerequisite, and that is why the characterization and analysis of farming system in Eastern Hararghe Zone was initiated.

Farming systems research is an approach for generating appropriate information/technologies for studying existing farming systems. It involves understanding of the existing farming systems in specific geographical areas, understanding of production practices and constraints at local conditions, understanding how a system works implies knowing the parts (crop, livestock interactions), and to the environment, and guiding to generate best fit technologies to local conditions (Dillon, Plucknet and Vallaeys, 1978). Farming system is defined as a population of individual farm systems that have broadly similar resource bases, enterprise patterns, household livelihoods and constraints, and for which similar development strategies and interventions would be appropriate (FAO, 2007). Hence, it is required to prioritize agricultural production constraints to ensure sustainability in a given area.

Eastern Hararghe Zone (EHZ) is well known for their climatic hazards and resulted frequent agricultural production failures. The farmers operate in different agro-climatic zones and under different socio-economic conditions, and are confronted with multiple constraints. In order to response constraints and improve the productivity, Oromiya Agricultural Research Institute has gone a long way to establish Fadis Agricultural Research Center in the area .However, information on agricultural production systems, constraints, and priority areas is very limited. To materialize, Fadis Agricultural Research Center plan, it is very important to analyze the farming system of the area. In this line, characterization and analysis of farming systems was conducted with the overall objective of characterize and analyze the existing farming systems.

Objectives of the study

The general objective of this study is to characterize and analyze the existing farming systems of the East Hararghe Zone. The specific objectives includes:-

1. To characterize and analyze farming systems of the Eastern Hararghe Zone,
2. To identify and prioritize farming systems constraints and opportunities of the study area,

3. To identify and prioritize research and development interventions areas for the study area.

Methodology

Description of the study area

East Hararge zone is located at eastern part of Oromia Regional State, Ethiopia. Geographically, the Zone is situated between $7^{0}32^{1}$ to $9^{0}44^{1}$ North latitude and 41^{0} $10^{1}$to $43^{0}16^{1}$ East longitudes with the total area of about 26311 km2 and its altitude ranges from 500 to 3405 m.a.s.l. The total area of the zone is 24,392.91 Km^2. Agro climatically; the Zone is characterized by lowlands (60.32%), midlands (32.24%) and highlands (7.44%). East Hararghe is characterised by plateaus, rugged mountains, deep gorges and flat plains. The annual rainfall of the zone ranges between 400 to 1010 mm, and the temperature also ranges between 14 to 25^{o}c (EHZ FEDO, 2017).

Based on the 2007 census, the total population of the zone projected to 3,490,222 in the year 2017. Out of which 314927 (9.02 %) accounts for urban population while the remaining 3175295 (90.08 %)are residents of rural areas. The crude population density of the zone is about 132.67 persons/Km^2 of an area in the year 2016 (EHZ FEDO, 2017).

From the total area of the zone, forest & wood land the highest share about (34.16%) followed by degraded land (28.33 %), and cultivated land (22.9%).

Table.1. Land use pattern of pattern of EHZ

No	Land Use	Area (km^2)	%
1	Cultivated land	6048.83	22.9
3	Pastor (grazing) land	1083.92	4.12
4	Forest & wood land	8986.65	34.16
5	Shrub & bush land	1110.21	4.22
6	Degraded land	7452.48	28.33
7	Land used for social purposes	1625.83	6.18
Total		**26308**	**100.0**

Source: EHOALD, 2017

Agriculture is base of livelihood of the residents of the zone. It is characterized with smallholders peasant farming system that involves mixed farming, both crop and animal production. Rain fed farming common, with limited irrigation farming. Different types of crops from cereals, pulses, oilseed, vegetables, fruits and cash crops such as coffee and chat are produced. The main crops grown are sorghum, maize, wheat, haricot bean, groundnut, potato, hot pepper, while cattle, sheep, goats, camels, chickens and donkeys are the major livestock species kept (East Hararghe Zone Agriculture and Natural Resource Office, 2017). Livestock plays a great role in the social and economic life of the people of East Hararge zone. Livestock production is undertaken together with crop in mid-highlands and semi-pastoral areas of the zone. In some areas, livestock productionundertaken solely by pastoral communities and use as the sole main stay for their livelihood. Cattle, sheep, goats, camels, and donkey mules are the major livestock kept in the area (EHZFECO, 2017).

Even though, agriculture is the dominant economic activity and the base of livelihood for the residents of the zone, a diverse range of constraints limiting the productivity of sectors in the area.

As a result, achieving food security is still a major challenge in the area. To solve these constraints, it imperative to analyze and understand the local conditions though conducting farming System research, Hence, FARC has planned and conducted farming system research in Zone with the objectives to identify and prioritize major productions constraints and suggest possible solution.

Farm typologies and sampling procedures

The survey used a participatory research approach, participatory rural appraisal (PRA). Prior to going into the field survey, a team consisting of researchers and experts was established at zonal level. Accordingly, the study conducted by multidisciplinary team of researchers from different disciplines and experts. Multi-stage sampling techniques used to select representative districts, peasant associations (PAs) and farm households.

Initially, in consultation of experts and secondary data were collected and reviewed at zonal level Based on collected and reviewed data, and in consultation with experts, EHZ was stratified into major five farm typologies based on agro-ecological conditions and major livelihood activities. Based on consultation of experts and reviewed data, EHZ clustered into five major farm typologies based on agro ecology and livelihood activities. Initially, based on traditional agro-ecological, the study area was stratified into three sub-areas: highland, midland and lowland areas. The farming systems, however, have evolved in response to multiple factors, not always strictly agro-climatic conditions and often with leading economic activities and major livelihood sources have also influence the existing farming systems in a given area. Based on this, East Hararghe Zone was stratified into five major sub farming systems; namely Chat Maize/Sorghum highland mixed farming (CMHMFS), Sorghum/Maize cash crops midland mixed farming system (SMCMMFS), Coffee/ Maize mixed farming system (CMMFS), Sorghum-Groundnut lowland mixed farming (SGLMFS) and Agro pastoral and Pastoral farming system (APPFS). Then, from the identified farm typologies, sample districts were purposively selected.

From each farming system, representative districts were randomly selected and from each district representative peasant associations (PAs) were randomly selected. Accordingly, the study was conducted during 2017 agricultural year in nine districts of East Hararghe. Deder district representing Chat Maize/Sorghum highland mixed farming (CMHMFS),Goro Gutu and Kersa districts representing Sorghum/Maize-cash crops Midland mixed farming (SMCMMFS), MelkaBalo representing Coffee/ Maize mixed farming system (CMMFS), Fedis and Gursum from Sorghum-Groundnut lowland mixed farming (SGLMFS) and Gola Oda, Midhagaa Tola and Chinaksen representing Agro pastoral and Pastoral farming system (APPLFS). Finally, farm households/agro pastoralists were randomly selected based on PPC, and bringing the sample size to 329 farm households/agro pastoralists. In addition, farm households/agro pastoralists groups having 20 to 25members were selected and established for group discussions using systematic sampling procedure, and atotal of 26 groups were established to collect primary data using group discussions.

Method of data collection

Participatory rural appraisal (PRA) method was used to collect both primary and secondary data from different sources using semi-structured questioners and checklists. The PRA tools used included semi-structured interviews and focus-group discussions (FGDs) were conducted to collect primary data from farm households/agro pastoralists.

Reviewing secondary data: secondary data were collected from East Hararge Zone Agriculture & Natural Resource Office, Districts Office of Agriculture and natural resource, and East Hararge Zone Finance & Economic Development Office using checklists. This was to obtain background information on the existing farming system before conducting the PRA survey.

Semi-structured interviews: primary data were collected from farm households using semi-structured questioners. A total of 329 randomly selected farm householders/agro pastoralists were interviewed. The farm householders/agro pastoralists were interviewed on socio-economic and demographic characteristics, major crops produced; area allocated input use, constraints of crop, livestock production, natural resources management, and marketing problems.

Focus group discussion (FGDs): a total 26 FGDs were conducted to collect primary data from groups and key informants.

Method of data analysis

Quantitative data were analyzed using descriptive statistics like mean, standard deviations frequency, percentage, chi-square and t-test using Statistical Package for Social Sciences (SPSS) version 20 for analysis. Qualitative data were analyzed using Participatory Rural Appraisal (PRA) tools such as pair-wise ranking and qualitative manner.

Results and discussions

Classification/Identification of Farming System Typologies in the Study Area

The farming system of the East Hararghe Zone was broadly classified into five major farming system typologies based on agro-ecological and climatic conditions/factors and dominant pattern of farm activities and household livelihoods. The major farming system typologies of the EHZ:

1. Chat/Maize highland mixed farming system (CMHMFS)
2. Sorghum/maize/cash crops midland mixed farming system (SMCMMFS)
3. Coffee/maize mixed farming system (CMMFS)
4. Sorghum/groundnut lowland mixed farming system (SGLMFS)
5. Agro pastoral and pastoral farming systems (APPFS)

Description of the farming system typologies of the study area

Chat-Maize/Sorghum highland mixed farming system (CMHMFS)

This farming system was located in highland dominated areas of Dadar, Badano, Melkabalo, Meta, Goromuxi, Gurawa, Haramaya, Kersa and Kombolcha districts of East Hararghe Zone. The area occupies the western and central highlands of the zone with total area coverage of 1957.3 Km^2 that constitutes 7.67% of the total area of the zone. The area contains a total population of about 1,247,441that constitutes 35.74% of the total population of the zone. It is located within an altitude ranges from 2300-3200 meters above sea level. The annual rainfall of the region ranges from 1200 mm to 2000 mm. The temperature of the area ranges from 10^0C to 15^0C.Major soils types exist in this area are sandy loam, clay, clay loam, loam and sandy. The area is drained by both perennial and seasonal rivers, streams and some area is found within the Wabi-Shebele drainage basin. Large cereals (maize, sorghum) and chat is the main livelihood sources for these population followed by livestock production.

Sorghum/Maize-Cash crops midland mixed farming system (SMCMMFS)

This farming system is found in midland dominated areas of Kersa, Goro Gutu, Haramaya, Kombolcha, Jarso, Meta and Kurfa Chale districts of the Zone.It is located in the Northwestern and central midlands of the zone with total area coverage of 2359.79 km^2 that accounts for 8.97% of the total area of the zone. It is located within an altitude ranges from 1400-2200 meters above sea level. The annual rainfall of the area ranges from 600 to 1000 mm. The mean annual temperature of the area ranges from 15^0C to 20^0C.The physical feature of this area is characterized by dissected plateaus, mountains, hills, plains, gorges and valleys. The area is mainly drained by streams, springs, lakes, rivers, and partly lies and drained by Wabi-Shebele and Awash drainage basins. The major soil types the area is black, clay loamy, sandy loamy, clay, loam, salt loam, sandy and black clay soils. From the total population of the zone, based the projection of 2007 census in 2017 about 1,342,197 (38.46%) live in this area. The area is known for its combination of crop and livestock farming. Cereals (sorghum, maize, wheat) and cash crops such as vegetables, Chat and coffee production is the main livelihood sources for these population followed by livestock production.

Coffee/maize/sorghum mixed farming system (CMMFS)

It is located in the Northwestern and central midlands of the zone with total area coverage of 2359.79 km^2 that accounts for 8.97% of the total area of the zone. It is located within an altitude ranges from 1600-2200 meters above sea level. The annual rainfall of the region ranges from 600 to 1000 mm. The mean annual temperature of the area ranges from 15^0C to 20^0C. This farming system is found in mid-highlands and moist lowlands of Bedano, Deder, Melkabalo, Gurawa, Kersa, GoroGutu, Haramaya, Kombolcha, Jarso, Meta, MelkaBalo and Kurfa Chale districts of the Zone.The physical feature of this area is characterized by mountains, hills, gorges and valleys. The area is mainly drained by streams, springs, lakes, rivers, and partly lies and drained by Wabi-Shebele and Awash drainage basins. The major soil types the area is black, clay loamy, sandy loamy, clay, loam, sandy and black clay soils. From the total population of the zone, based the projection of 2007 census in 2017 about 1,342,197 (38.46%) live in this area. Cereals (maize, sorghum, wheat, Barley), coffee, Chat and vegetables are the main livelihood sources in this area.

Sorghum-groundnut lowland mixed farming system (SGLMFS)

It is found in lowland dominated areas of Fadis, Gursum, Babile and some part Melkabalo districts of the Zone. It covers an area of approximately 7243.33km^2 and accounts for 27.53% of the total area of the zone. This area represents a typical moisture stress lowland area and receiving an annual rainfall between 410 and 820 mm with an attitude ranging from 900 to1500 meter above sea level. The average annual temperature of the area is varying between 20^0c and 25^0c. Topographically, this area is predominantly characterized and mainly explained by plains, few isolated hills, plateaus, mountains and rift valleys including gorges. In addition, this area is lies within Wabi-Shebele drainage basin. The major soil types covered this area is clay, clay loam and black soils. From the total population of the zone, about 460,749 (13.20%) live in this area. Crop production is the major livelihood option. Cereals (sorghum, maize) and oil crops (groundnut, sesame) is the main livelihood sources for these population followed by livestock production. This area is characterized with arid and semi arid climatic condition with unreliable and erratic rainfall.

Agro Pastoral/Pastoral farming system (APPFS)

It is found in dry lowland dominated areas of Midaga Tola, Gola Oda, Mayu Muluke, Kumbi and Chinaksen districts of the zone. This region is found in the southeastern of the zone bordering Bale zone, Somali Regional State and northern parts zone bordering Dire Dawa Administrative Council. This farming system covers an area of 11,320.01Km^2 and accounts for 46.41% of the total area of the zone. This area represents a typical moisture stress dry lowland areas receiving an annual rainfall between 200 and 820 mm with an attitude ranging from 500 to1700 m.a.s.l. The average annual temperature of the area is varying between 20^0c and 37^0c.Topographically, this area is predominantly characterized by plains, isolated hills, few plateaus, mountains valleys as well as gorges. The major soil types covered this area is clay, clay loam and black soils. About 433,951 inhabits that constitutes about 12.43% of the total population of the zone live in this area. It characterized with arid and semi arid climatic condition with unreliable and erratic rainfall distribution. Livestock production is the main livelihood of the community and they are also engaged in crop and livestock farming in the area.

Table 2. Summary of description of the farming typologies of East Hararghe Zone

Main characteristics	Farming system typologies				
	CMHMFS	SMCMMFS	CMMFS	SGLMFS	APPFS
Locations	Western and central	North western and central	Western, North western and central		Southeastern and Northern part
Districts delineated to the identified farming typologies	Dadar, Badano, Meta, Melkabalo, Goromuxi, Gurawa, Haramaya, and Kombolcha	Kersa, Goro Gutu, Haramaya,KombolchaJarso, Meta, M/ Balo K/ Chale	Bedano, Deder, MelkaBalo,Gurawa, Meta, K/Chale	Babile, Fadis, Gursum M/Balo	G/ Oda, Mayu, Midaga, Kumbi and Chinaksen
Area Km^2 (% of Zone)	1957.3(7.67%)	2359.79 (8.97%)	1512.79(6.4%)	7243(27.53%)	11,320(46.41%)
Population (% of Zone)	29.74%	28.46%	16.20%	13.20%	12.43%
Average rainfall(mm)	1200-2000	600 -1000	600 -1000	410- 820	200-820
Altitude (m.a.s.l)	2300-3200	1600-2200	1600-2000	900 -1500	500 -1700
Main source of livelihoods	Chat/maize/sorghum	Sorghum/cash crops/cattle	Coffee/maize/cattle	Sorghum/groundnut/ cattle	Cattle and goats/sorghum

Socioeconomic characteristics of the respondents by farm typologies

The result indicates that out of the total sample households, about 93.35% were male-headed household farmers and the remaining were for female headed households (Table 3).From the result, the participation of female farmers in agricultural production and decision making is low in all farming systems of the study area. The mean age of the overall sample households heads was 40.58 years and statistically not significant among farm typologies(Table 3). The mean schooling years of the total sample households was 3.54 years of schooling with a statistically significant mean difference among the farming types at 1% probability level. The household heads from chat-maize/sorghum mixed highland, sorghum/maize midland mixed and coffee/maize based mixed farming systems have relatively better level of education than sorghum-groundnut lowland mixed and agro pastoral and pastoral farming systems of the study area (Table 3). The average land holding of the overall sample household heads was 0.65 hectare which varies across the farming typologies. The average land holding of chat-maize/sorghum mixed highland, sorghum/maize-perishables mixed midland, coffee/maize based mixed farming, sorghum-groundnut lowland mixed and agro pastoral households has found to be 0.39, 0.46, 0.36, 0.74 and 0.96 hectare, respectively with statistically significant mean difference at 1% probability level (Table 3). The result indicates that the farmers in lowland and agro pastoral areas possess relatively larger land holdings than farmers in the chat/maize highland mixed farming. As a consequence of growing population farm land holding is small in midlands and highlands of the study areas.

The survey result indicates that the mean family size of the total sample households was 6.48 persons in the study area. Chat-Maize/Sorghum highland, sorghum/maize-Cash/Perishables Midland and Coffee/Maize based Mixed Farming Systemsfarm households have relatively larger family sizes than Cereal/Sorghum-Groundnut lowland mixed and agro pastoral households with mean difference being statistically significant at 5% significance level (Table 3). Regarding family labour force in ME, it was found that there are on average, the total labor force was 2.32 ME. The result indicates that there are relatively larger number of labour force for Chat-Maize/Sorghum highland mixed farming system (CMHMFS), Sorghum/Maize-Cash crops midland mixed farming system (SMCMMFS) and Coffee/Maize mixed farming system (CMMFS) areas than Sorghum/groundnut lowland mixed and agro pastoral areas, with statistically significant among the farm types at 1% level of significance. In the Sorghum-Groundnut lowland mixed farming system, and Agro Pastoral/Pastoral farming system areas, during FGDs the participant farmers noted that young people are migrating to the neighboring districts, Harar and Dire Dawa cities to search of employment opportunities.

Livestock holding is another key indicator of the variance for farm households in the identified farm types. Livestock production is the main contributors to livelihoods of the communities in lowland mixed and agro pastoral/Pastoral farming system areas, livestock. The survey result indicates that on average, the total sample households own 3.44 units of livestock in terms of tropical livestock unit (Table 3). The households of sorghum/groundnut lowland mixed and agro pastoral areas owned relatively larger number of livestock unit than chat/maize highland, sorghum/maize midland mixed, and coffee /maize based farming areas, with statistically significant among the farming at 1%level of significance. This mainly due to limited availability of feed resources such as limiting the availability of grazing land, and the available land is mainly utilized for crop production in highland and midland farming areas. Farm households in the study areas earn cash income from sales of crops, livestock and their products, and off/non-farm employment opportunities. The survey results show that the total household annual income from all sources was 20,590 birr with difference being statistically significant at 5% level (Table 3). On average, higher annual income was observed in sorghum/maize-perishable crops midland mixed farming (25,070 birr per year), followed by 21274 and 15450 birr per year for coffee/maize midland and chat/maize highland mixed farming systems, respectively.

Table 3. Socioeconomic characteristics sample respondents by farming typologies

Variables	Farming system typologies					
	CMHMFS (n=82)	SMCMMFS n=78)	CMMFS (45)	SGLMFS (N=64)	APPFS (n=60)	Overall (n=329)
Sex of HH (male head)	95.27	91.84	86.49	89.70	94.31	93.35
Age of HH head (years)	42.78(8.61)	38.7(9.45)	40.7(9.14)	40.47(10.13	40.60(8.12)	40.58(9.23)
Education level	3.92(3.29)	4.72(3.62)	4.6(3.52)	2.38 (3.16)	2.03(3.07)	2.54(3.17)**
Land holding (ha)	0.39(0.21)	0.46(0.29)	0.36(0.39)	0.74 (0.48)	0.96(0.77)	0.65(0.53)*
Family size	7.35(2.91)	7.05(2.99)	6.05(2.69)	5.78 (1.88)	5.24(1.96)	6.48 (2.27)*
Labor force for farming(ME)	1.67(0.89)	1.81(0.77)	1.72(1.36)	2.86(1.14)	1.32(1.27)	2.28(1.17)*
Total family labor force(ME)	3.84(1.39)	3.02(1.47)	2.14(1.23)	3.61(1.27)	2.51(1.30)	2.32(1.73)**
Livestock holding(TLU)	2.27 (2.16)	2.31(3.64)	2.20(2.46)	3.64 (5.46)	4.56 (0.84)	3.44 (5.46)**
Farming experience in years	21.64(9.52)	20.37(9.17)	21.34(9.37)	20.47(8.71)	17.44(6.46)	21.48(8.56)**
Annual income (Birr, 000)	15.45(11.60)	25.64(22.81)	21.274(32)	12.52 (8.24)	10.63 (7.61)	20.58(18.45)**

Result: survey result, 2017 Note: *= significant at 1%, **=significant at 5%, Numbers in parenthesis is SD

Access to institutional support system

The household survey result indicates that larger proportions of the total households had accessed extension services in groups or individually with difference in frequency of contact.

Out of the total households, about 82.25% had accessed to extension services (Table 4). The farming system for access to extension services shows that relatively low percentage of access to extension services were reported in agro pastoral and pastoral farming system. The average frequency of extension contact in number was 44 per year. The FGD farmers also reported as the major gap in access to extension services include delivering limited services and limited/lack of conducting knowledge transfer through training and pre-extension demonstration at FTCs. The result further indicated that out of total respondents, about 20.69% of respondents participated on FTC based training and demonstration in the study areas (Table 4).The average walking distances from farmers' residences to the farmers training center (FTC) was found to be 1.78 km in the study area. With regard to memberships to cooperative, about 57.83 % of the total respondents were members of the farmers' cooperatives in the study area. On average the respondents traveled 10.17 km to sell their products to the nearest market center (Table 4).

The higher number of memberships was observed in coffee-maize based midland mixed farming followed by chat-maize highland mixed farming where as relatively low membership was observed in agro pastoral and pastoral farming systems. The FGDs participant farmers were discouraged about membership of farmers cooperatives. They pointed out that the cooperatives are established for providing input and output marketing services to members of the community. The survey result indicates that from the total respondents, on average, about 91.73% of respondents did not use credit services available in their area. The result of the study further indicates that from the total respondents, on average about 53.09% of respondents obtained market information from different sources in the study areas (Table 4).

Table 4. Sample respondents access to institutional support by farming typologies

Description	Farming system typologies					
	CMSHM (n=82)	SMCMM (n=78)	CMMMFS (45)	SGLMFS (N=64)	APPFS (n=60)	Overall (n=329)
Access to extension services(%, yes)	79.66	91.89	90.46	90.28	65.71	82.25**
Frequency of extension contact /year	52	55	51	43	28	44*
Cooperative membership (%, yes)	65.31	64.20	84.50	58	43.79	57.83**
Access to credit services(%, no)	93.59	87.62	85.60	90	95.7	91.73
FTC based demonstration(%, yes)	25.80	21.20	20.65	23.20	15.13	20.69**
Access to market information(%, yes)	46.49	55.84	45.80	62.92	47.10	53.09**
Distance to nearest market (km)	8.31	6.73	9.74	5.80	18.95	10.17*
Distance to FTC(km)	1.73.	2.26	2.36	1.96	3.25	1.78**

Source: Survey result, 2017

Agricultural and livelihood activities: Crop production by farming typologies

Major crops cultivated and cropping systems

In Chat-Maize/Sorghum highland mixed farming system (CMHMFS), crop production is an important livelihood activity for the farmers and is mainly based on rain-fed agriculture. The area is characterized by intensive cropping system such as intercropping (annual crops with perennial, annual with annual crop) and relay cropping system. The major crop types grown in this farming typology are maize, sorghum, wheat, barley and teff from cereal crops. Haricot bean, faba bean and field peas are among pulse crops grown in the area. Horticultural crops like potato, garlic, sweet potato and apple are grown in this farming system in this area. Maize, sorghum, wheat and barley are grown largely to satisfy the food consumption needs of the families whereas potato, garlic, coffee and chat are commonly grown for sale to generate cash income for the family in the area.

The survey result showed that the average area of land allocated by the farm households for major crops and it revealed that Chat has a lion share followed by maize and sorghum in this farming system. According to the survey results, on average, about 20.30% of the total area under maize production followed by sorghum, barley and wheat during the 2017 production year in this farming system. From pulse crops, faba bean is the most favorable in this farming typology and it accounts for about 5.25% of the total land followed by haricot bean covering about 3.38% of total land. The average area of land allocated for potato, coffee, and chat production was reported to be about 10.15%, 3.38% and 23.69% respectively in this farming system (Table 5).

In Sorghum/Maize midland mixed farming system (SMCMMFS), the major cereal crops produced in this area, sorghum, maize and wheat as food crops. In addition to food crops, the farmers also grow cash crops such as vegetables (potato, cabbage, onion, shollo, lettuce, carrot, garlic, tomato, sweet potato, and beet root), and pulse crops such as haricot bean, faba bean and lentils, and linseed from oilseeds are produced and Khat are important and permanent cash crops grown in the area. The production of sorghum, maize, wheat, teff, potato, onion, coffee and Khat is heavily dependent on rainfall while the horticultural crops are mainly produced using rain fed and irrigation in the area. Survey result shows that sorghum (0.14 ha) has a lion share followed by potato, maize and Chat in this farming system (Table 5).

In Coffee/Maize Mixed Farming System (CMMFS), coffee is the main crop grown in this area followed by Chat, maize, sorghum and wheat. In addition, haricot bean, potato, cabbage is also grown in the area. Coffee and Chat are the predominant cash crops in the area. The survey result indicates that the average area of land allocated for coffee was 0.13 ha (Table 5). Cropping systems practiced in this area are sole, mixed, intercropping, and double and relay cropping systems. The area has a bi-modal rainfall pattern and, as a result, some farmers practice double cropping where barley/potato is grown following the rainfall flash in the spring and then wheat/Faba bean is grown during the main season. Few farmers also practice relay planting of pulse (chickpea) and spice (fenugreek) under maize in this area. In Sorghum/maize-groundnut lowland mixed farming system (SGLMFS), crop production is the major livelihood option for this area. The major cereal crops that are produced in the area are maize and sorghum. In addition to cereal crops produced, pulse and oil crops such as haricot bean, ground nut and sesame are produced. Regarding fruits and vegetables, onion, tomato, chili pepper, papaya and mango are the major ones that are grown in the area. In limited areas where have irrigation water, the farmers produce maize using rainfall during main season, and after harvesting of maize, they grow tomato, chili pepper and onion using irrigation during the dry season. According to the survey results, on average, 0.320 ha of land was allocated for sorghum followed by groundnut (0.24 ha) and maize (0.14 ha) in this farming system.

In Agro Pastoral and Pastoral Farming System (APPFS)**, l**ivestock keeping/rearing is the main livelihood sources of the agro pastoral communities followed by crop production. Pastoralists that were shifted agro pastoral and farmers settled from mid-highland areas are practiced crop production in the area. The agro-pastoralists are practicing crop production and major crops cultivated are sorghum and maize for household consumption, whereas, groundnut and haricot bean are produced both for household consumption and market. Mono cropping of sorghum, maize and is a common practice in the area. Intercropping of sorghum and maize with haricot bean and groundnut are also practiced in this area**.** The survey results, as presented in Table 5 indicated that the average area of land allocated for sorghum was 0.26 ha followed by groundnut (0.24ha), maize (0.20 ha) and haricot bean (0.13ha). Drought, weed infestation, and conflict are main challenging the livelihood of the community in this farming system.

Table 5. Major crops cultivated and cropping system by farming typologies in 2017

Type of crops	Farm typologies									
	CMHMFS		SMMMFS		CMMFS		SGLMFS		APPFS	
	Mean(ha)	%	Mean(ha)	%	Mean(ha)	%	Mean(ha)	%	Mean(h	%
Sorghum	0.1	16.92	0.14	28.90	0.1	16.67	0.32	34.30	0.26	32.50
Maize	0.12	20.30	0.11	16.42	0.12	20.00	0.14	15.01	0.21	26.25
Wheat	0.031	5.25	0.06	8.96	0.04	6.67	0.013	1.39	0	0
Barley	0.04	6.77	0	0	0.01	2.67	0	0.00	0	0
Faba bean	0.03	5.08	0	0	0.02	3.33	0	0.00	0	0
Field Pea	0.01	1.69	0	0	0	0.00	0	0.00	0	0
Haricot bean	0.02	3.38	0.01	1.49	0.01	1.97	0.1	10.72	0.13	16.25
Ground nut	0	0	0	0	0	0.00	0.26	30.72	0.21	25.00
Potato	0.06	10.15	0.13	19.40	0.07	11.67	0	0.00	0	0
Cabbage	0.02	3.38	0.06	8.96	0	0.00	0	0.00	0	0
Onion	0	0	0.01	1.49	0	0.00	0.04	4.29	0	0
Tomato	0	0	0	0	0	0.00	0.02	2.14	0	0
Coffee	0.02	3.38	0.03	4.48	0.13	21.67	0	0.00	0	0
Chat	0.14	23.69	0.12	17.91	0.1	16.67	0.06	6.43	0	0

Sources: Computed from Survey result, 2017

In CMCHMFS, information obtained from the Zonal Agriculture and Natural Resource Office indicated that from the total cultivated area of 22643 ha in 2016/2017 cropping season, about 5803 ha (25.63%), 4634 ha (20.34%), 4243 ha (18.62%) and 2240 ha(10%) were covered by maize, sorghum, barley and wheat crops respectively (Table 6). The productivity of maize was 23.99 quintals per ha and the productivity of sorghum, wheat, barley and teff was 16.21, 13.29, 10.87 and 8.47quintals per ha, respectively in this area (Table 6). In SMCMMFS, from the total area of land 65769 ha that were covered by different crops, 30707 ha (46.56%), 14664 ha (22.23%), 12956 ha (19.64%), 1502 ha (2.28%) and 5940 ha (9%) were covered by sorghum, maize, groundnut, vegetable fruits and Khat, respectively (Table 6). In SGLMFS, from the total area of land 65,848 ha that were covered by different crops, about 33246 ha (50.49%), 22695 ha (34.47%), 8000 ha (12.15%), and 1540 ha (2.34%) were covered by sorghum, maize, groundnut and Khat, respectively. From this in terms of area of coverage, sorghum takes a lion share followed by maize in the area. The productivity of crops per ha is 6.67 quintals for sorghum, 12.42 quintals for maize, 8.45 quintals for haricot bean and 6.81 quintals for groundnut respectively(Table 6).

Table 6. Area under cultivated crops and productivity in 2017 by farm typologies

Type of crop	Farming system typologies									
	CMHMFS		SMMMFS		SGLMFS		CMMFS		APPFS	
	Area (ha)	Productivity (qt/ha)	Area (ha)	Productivit y (qt/ha)	Area (ha)	Productivity (qt/ha)	Area (ha)	Productivit y (qt/ha)	Area (ha)	Productivity (qt/ha)
Cereals										
Maize	5803	23.99	8857	27.65	14664	17.15	4860	20.80	2269 5	12.42
Sorghum	4634	16.21	11046	21.39	30707	6.04	3480	14.50	3324 6	6.66
Wheat	2240	13.29	2497	22.20	NA	NA	1265	23.00	NA	NA
Barley	4243	10.87	1548	13.62	NA	NA	158	14.60	NA	NA
Teff	1469	8.47	NA	NA	NA	NA	NA	NA	NA	NA
Outs	NA	NA	210	11.11	NA	NA	NA	NA	NA	NA
Pulses										
Faba bean	872	11.00	552	12.20	NA	NA	350	10.25	NA	NA
Field Pea	628	9.00	250	12.6	NA	NA	220	12.6	NA	NA
Chick Pea	196	11.00	9189	6.85	NA	NA	170	6.85	NA	NA
Haricot bean	3189	9.84	1825	8.27	68	4	200	7.91	367	8.45
Lentils	193	16.33	175	3.74	NA	NA	NA	NA	NA	NA
Peas	126	7	288	6.48	NA	NA	167	5.80	NA	NA
Oilseeds										
Groundnut	NA	NA	29	5.32	12956	7.13	NA	NA	8000	6.81
Sesame	NA	NA	NA	NA	323	5.48	NA	NA	743.5	4.58
Linseed	NA	NA	198.5	4.91	NA	NA	190	4.62	NA	NA
Vegetables										
Potato	1881	186.44	5680	205.06	NA	NA	381	164.50	NA	AN

Onion	217.5	77.07	2500	64.0	391	37.54	NA	NA	NA	NA
Cabbage	237	473.01	317	460.39	NA	NA	123	450.83	NA	NA
Garlic	178	145.40	110	133.68	NA	NA	NA	NA	NA	NA
S/potato	567	60.00	378	68.32	426	80	260	72.80	NA	NA
Tomato	185	92.96	NA	NA	590	130.42	NA	NA	NA	NA
Fruit and other crops										
Mangos	50	65.40	NA	NA	140	62.80	NA	NA	NA	NA
Papayas	50.5	67.6	NA	NA	NA	NA	NA	NA	NA	NA
Banana	226	67.4	NA	NA	NA	NA	NA	NA	NA	NA
Coffee	835	4.5	730	3.61	NA	NA	38673	4.70	NA	NA
Chat	8600	74.80	21088	70.66	5940	62.48	12864	68.30	1540	50.20
Sugarcane	180	78.0	NA	NA	NA	NA	NA	NA	NA	NA

Source: Estimated from Zonal Finance and Economic Development Office, 2017, NA= Not Available

Use of improved crop technologies

Use of improved seeds of crop varieties

The farmers obtain seeds of crops that they grown from different sources. For sorghum, maize, haricot bean and groundnut, own/recycled seeds, farmers and local market are common source. While improved seeds of sorghum, maize, haricot bean, tomato, papaya and mango, farmers obtained from Office of agriculture, University, Unions, and Research center. The survey result indicates that improved maize seed varieties such as BH-660, BH-661, BH 540 and BH-543 in highland mixed areas and BH-140, Pioneer (PHB-3253), PHB-30-G19 (Shone), BH543 and Awasa-511 in midland areas were accessed. In sorghum/groundnut lowland mixed and Agro pastoral areas, Melkasa serious such as Melkasa-2 and Melkasa-4 varieties are commonly cultivated in the areas. Regarding improved wheat variety, Kekeba, Pavon and Jafferson were cultivated in the area in lowland mixed farming areas whereas varieties such as HAR1685 (Kubsa), HAR710, Digalu, Dekeba, Dandea, Tuse and Hidase in highland and midland mixed farming area.

The survey result indicates in the Figure 1 low use of improved variety was reported for sorghum and groundnut production, no area under cultivation using improved variety for sorghum in Chat /maize/sorghum highlands of mixed farming (CMHMFS) and CMMMFS. In SMCMMFS, SGLMFS, APPFS farming systems, only 6%, 20% and 11% of area under cultivation was resulted from the use of improved variety for this crop, respectively. Similarly, only 16.35% and 11% of area under cultivation was reported from the use of improved variety for groundnut in SGLMFS and APPFS respectively. This low level of use could be mainly due to unavailability of the improved varieties, supply shortage and/or the available technologies might have not reached the farmers adequately and timely. Relatively higher percentage of maize production was through the use of improved variety was reported in SMPMMFS (52%) followed by SGLMFS (40%) farming systems while the lowest was reported in CMMMFS (32%). The survey result also indicates that on average out of total area of land under wheat production, relatively higher percentage of wheat production area was under the use of improved variety in SMPMMFS (50%) followed by CMSHMFS(47%) farming systems while the lowest was reported in SGLMFS (6%)and the rest was covered by local varieties of wheat. The survey result further indicates that area under improved seed of potato varieties, reported about 43.50% and 32% in SMPMMFS and CMSHMFS respectively. The largest area to which improved seeds used was under coffee estimated about37.49% and 23.48% in CMMMFS and SMPMMFS respectively.

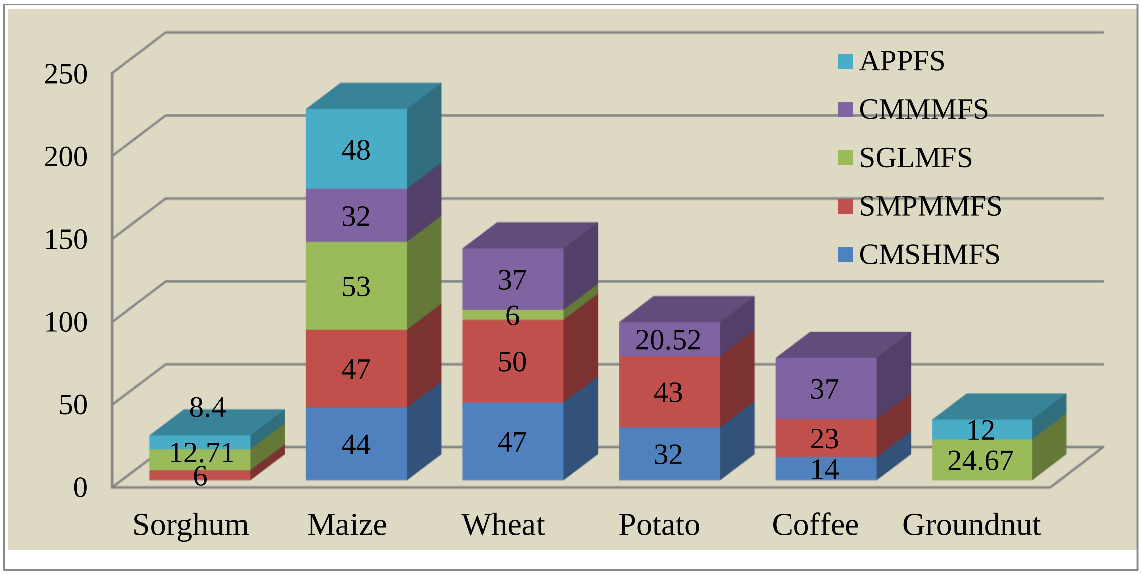

Figure 1. Use of improved seeds of crop varieties (%) in the study area

Crop production and soil fertility management practices

Soil fertility depletion due to deforestation, soil erosion, lack of crop rotation, limited use of manure and lack of cereal-legume rotations, complete removal of crop residue leading toultimately resulting in low crop productivity in the area. However, the problem is more severe in highland and midland mixed farming areas where, crop production is undertake intensively. To address these problems, the farmers use different kinds of soil fertility management practices in all of the study areas. The inorganic fertilizers applied by farmers are NPS and Urea for maintaining soil fertility and improve crop productivity in the study areas. The PRA study indicate that the farmers use inorganic and organic fertilizers, conservation practices and cropping practices to maintain soil fertility in the study areas. The farmers mentioned that application of fertilizers at the rate and time of time of application is determined by availability of moisture. In SMPMMFS and CMSHMFS, on average about 45% and 40% respondents applied inorganic fertilizers to sorghum respectively. In CMSHMFS relatively the highest percentage of respondents, 89% of the respondents applied fertilizers to maize fields followed by SMPMMFS. In CMSHMFS, 76% of the wheat growers use fertilizers for wheat production.

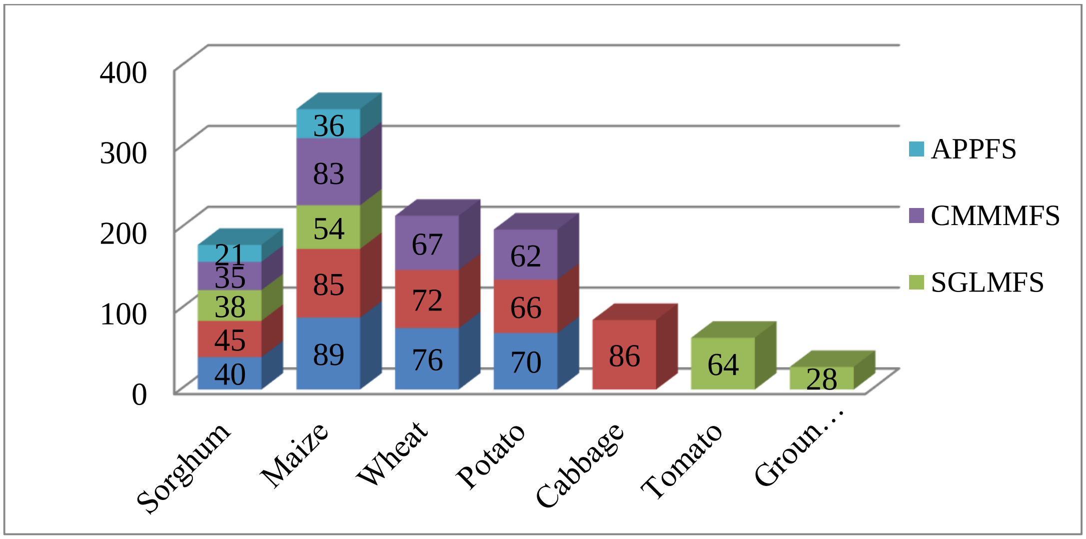

Figure 2. Inorganic fertilizer use by sample respondents (%) in the study area

Regarding application of organic fertilizers, the farmers use manure to maintain soil fertility. According to FGD farmers in the highland and midland mixed farm types, the use manure common for all crops types but the rate of use increases for cash crops such as potato, cabbage, coffee and Khat fields. Likewise, in lowland mixed and agro pastoral areas, the farmers are applied to maize, sorghum and tomato. The perpetration and use of compost is not common in all farm type and but in highland and midland mixed areas some farmers use for vegetable and maize fields. Manure application is also common in the area. Its preparation is performed dominantly by female while male are responsible for transporting to the field and its application.

Agronomic practices

All farmers use oxen plowing for land preparation. The land is tilled 2-4 times until it gets ready for seed sowing depending on crop types, moisture and nature of land. Major constraints of land preparation and planting as mentioned by the key informants are erratic nature of rainfall, shortage of farm implements and labor. The sources of power for farm operations are human labour and animal in the area.

In highland and midland areas, due to practicing intensive cropping systems, human and animal powers are the main sources for farm operation but in some part of midlands, and lowland and agro pastoral areas, combination of animal and machineries powers used. Land preparations are done using hand hoe and oxen ploughs in highland and midland areas whereas in lowland areas, land preparations particularly primary and secondary tillage are conducted using tractor and the third one is by ox-plow. Broad casting and hand drilling is common planting of all crops due to lack of row planter for different crops in the study areas. Both broadcasting and row planting are practiced in the all of study area. Harvesting and threshing of major crops grown in all farm types are done using human labor and animal trampling is common. The FGD farmers' lack of access to row planter for major crops and harvest and postharvest technologies such as threshing machine for maize, sorghum and wheat are the main problems in the areas.

Pest infestation and management practices

During PRA survey major crop disease and insect pests that affect the crop productivity such as weeds

Weeds infestation:-*striga, parthenium, Orobanche, Amaranthus, Cocklebur, Spotted spurge cyprus spp, lantnana camara* are the major weeds species that were prevalent in almost all farming systems.

Disease:-The major diseases reported by PRA farmers are *Curly top virus*, blight, bacterial wilt and *fruit decay/Tuta Absulata* on tomato, honeydew and head smut on sorghum and maize, rust on wheat, onion and potato,rot root on groundnut, *Fruit decay,* Powdery mildew, anthracnose on mango and avocado, bacterial wilt and white mold on banana,down mildew on onion, and late blight on potato, leaf blight and powder mildow on common bean, Frost on chat and potato, Moulds on chat, Coffee Berry Disease (CBD), die-back and leaf rust is causing severe damage and important yield reductions on coffee in coffee production potential farming. There is no resistant variety adapted to the agro-climatic conditions.

Insect Pests: Army worm, stalk borer and American Fall Army Worm were the most prevalent and caused damage to crops in the areas, Termite on maize in lowland areas, aphids on cabbage, sorghum, maize and haricot beans, grain weevils on different crops, rodents, bird and wild animals attack on sorghum. These pests attack crops at different growing stages such as at beginning of germination, vegetative stage, at flowering stage and grain filling stage of the crops. As a result crop production has low yields due to occurrence of these pests and lack of proper disease management practice.

Table 7 Major crop pests in the study area by farm typologies

Type of pests	Farm typologies				
	CMHMFS	SMCMMFS	SGLMFS	CMMMFS	APPFS
Weeds	Striga, Partinium , Digitaria, lantanakamara crop fields and grazing land	Striga, Partinium, Digitari Amaranthus, Cocklebur, Amaranthus hybrida	Striga Partinium Digitaria Orobanche	Striga Partinium Digitaria Coach grass	Striga Partinium Digitaria Orobanche
Insect pests	Armyworm and Stack borer on maize and sorghumCutworm on maize, wheat Earth worm, Weevils, American Fall army worm	Stackbroker serious on maize and sorghum *Spider mite*, Aphide and Leaf minor (Tuta absuluta) on potato, American Fall army worm	Stack borer serious on maize and sorghum, American Fall army worm	Armywor m and Stack borer on maize and sorghum	Stack borer serious on maize and sorghum

Diseases	Bacterial wilt on Banana, Anthracnose on mango and avocado, Late blight and on potato Yellow and sripe rust on wheat Coffe beary disease Rust on garlic serious Leaf spot, Storage pests (grain weevils, rodents), leaf blight and powder mildow on common bean, Honeydew on sorghum	Late blight on potato, Aphids on cabbage Yellow and stripe rust on wheat Coffee berry disease, Leaf rust and wilt on coffee *Powdery mildew, Down mildew and Early blight on tomato* - Coffee Berry Disease (CBD), die-back and leaf rust Honeydew on sorghum	Root rot on groundnut Head smut on sorghum, *Powdery mildew,, Down mildew and* *Early blight on tomato, powdery mildew and* Anthracnose on mango, Leaf rust and rot root on groundnut	-Coffee Berry Disease (CBD), -Die-back Leaf rust.	Root rot on groundnut Head smut on sorghum

Source: PRA survey, 2017

Major constraints to crop production by farm typologies

During PRA study, the participant farmers and agro pastoralists were identified several constraints that limit crop production in the study area and ranked them by farm typologies (Table 9).Shortage of improved seeds supply, inappropriate crop management practice, lack of improved varieties, farm inputs (pesticides, fertilizers), insect pests and disease, weed infestation, cultivable land shortage and erratic rainfall distribution/drought are mentioned among others.

Shortage of improved seeds supply was ranked fist in sorghum/maize/cash crops midland mixed farming system (SMCMMFS), Agro pastoral/pastoral farming system (APPFS) and second in Chat/Maize highland mixed farming system (CMHMFS) and Sorghum/groundnut lowland mixed farming system (SGLMFS) and third in Coffee/maize mixed farming system (CMMFS) by PRA farmers in the study area (Table 9).Supply shortage of improved varieties and poor quality (maize, sorghum, wheat). The participants of the PRA strongly mentioned that shortage of improved seeds supply was the most important constraints to crop production in the study area. Supply shortage of improved varieties, and poor quality seed (ungraded, not clean, poor germination) and lack of seed sources for high-value crops such as vegetables and fruit. As a result farmers use local varieties which are low yield and susceptible to pests. The situation more severs for cash crops such as groundnut, tomato, onion, hot pepper and lack of grafted seedlings for fruit crops. The FGD farmers noted improved tomato, onion, and mango yields are low due to lack of/limited use of improved varieties of these crops. As a result farmers use local varieties which are susceptible to pests, and few farmers used improved varieties which were supplied by office of agriculture and NGOs. Generally, only a few farmers used improved seeds of cereals, oil crops, pulse vegetable and fruit crops, the majority of the farmers used local varieties in all farming systems.

The result of FGD farmers and field observation indicates that inappropriate crop management practices such as improper time of planting, spacing, lack of use of recommended rate of inputs, improper plant density due to weak extension services problems that affect crop production. It was ranked third in APPFS, fourth in CMMFS, fifth in CMHMFS and SGLMFS, and sixth in SMCMMFS in the study area. The participants reported that weak extension service on use of improved crop technologies, and this related to existence of weak extension and farmers participation on improved technology demonstration were also noted as major problems of the farmers in the study area.

Lack of improved varieties was ranked fist in Chat/Maize highland mixed farming system (CMHMFS) and Sorghum/groundnut lowland mixed farming system (SGLMFS) and Agro pastoral/pastoral farming system (APPFS) whereas second in Sorghum/maize/cash crops midland mixed farming system (SMCMMFS)and Coffee/maize mixed farming system (CMMFS) by PRA farmers in the study area (Table 9).Lack improved varieties for most food and horticultural crops are a major limitation to increasing crop production in the study area. During PRA study, the participant farmers noted that lack of improved varieties for sorghum, barley, wheat, maize, pulse crops such as fababean, haricot bean, and oilseed crops such as groundnut, for fruit and vegetable crops, and coffee, was the major limiting factors in crop production in the study area.

Low utilization of agricultural/farm inputs was ranked third in SGLMFS and fourth in CMHMFS, SMCMMFS, CMMFS and APPFS by PRA farmers in the study area (Table 9).The PRA farmers reported that inadequate use of agricultural inputs such as seeds, fertilizers and pesticides due to unable to access nearby, not timely available and unaffordable (high price) as a major crop production constraint in the study area. This leads to inadequate use of fertilizers due to high price and moisture stress affect crop production in the study area.

Insect pests: -the PRA farmers were ranked second in CMHMFS, SGLMFS and CMMFS where as third in SMCMMFS and APPFS by the PRA farmers in the study areas (Table 9). The participant farmers listed and reported that insect pests such as stalk borer, cutworm, Army worm , Grain weevils on different crops, Rodents, bird and wild animals, Spider mite on potato, Aphids on cabbage,and Fruit fly on mango as the major constraints to crop production in the study area.

Crop disease:-the PRA participant farmers ranked second in SMCMMFS, third in CMHMFS, SMCMMFS, CMMFS and SGLMFS whereas ranked fifth in APPFS (Table 9). The major diseases reported by PRA farmers are *h*oneydew and head smut on sorghum and maize, *Curly top virus*, blight, bacterial wilt and *fruit decay/Tuta Absulata* on tomato, Powdery mildew, anthracnose on mango and avocado, Honeydew and head smut on sorghum and maize, Down mildew on onion, Late blight on potato, Frost on chat and potato, and Moulds on chat, and

Coffee Berry Disease (CBD) and die-back on coffee causing severe damage important yield reductions on crop production in the identified farming systems.

The PRA participants noted that insect pests like stockbroker on maize and sorghum, cutworm on maize and wheat, and diseases like late blight and on potato, yellow and stripe rust on wheat, rust on garlic are serious factors affecting growth and production of the crops in the area.
Pests and diseases are the most frequently stressed problems in the majority of the farming systems.Moreover, production of wheatand potato are also affected by rust and blight diseases, respectively.

Weed infestation was ranked second in SGLMFS andAPPFS as a bottleneck for crop production (Table 9).Among *weed, striga, parthenium, Amaranthus, Orobanche and lantnana camara* are the most common and major weeds species that were reported by the farmers in study areas.Cultivable land shortage was ranked first in CMSHMFS, SMCMMFS and CMMFS, third and fifth in SGLMFS and APPFS respectively (Table 9). Shortage of cultivable land is becoming more and more severe in the face of an ever increasing population in the mid-highland areas and the land resource tends to fail to support the farming community need. The problem severs in midland and highland area due to high population with nature of the topography and lack of alternative employment opportunities. This leads to shrinking of individual landholdings.

Erratic rainfall distribution/drought was ranked first in SGLMFS and APPFS in constraining productivity of crops (Table 8). The farmers noted that for the last five to ten years- shortage and erratic distribution, Variability (start in late or early), affecting the regular farm activities such as land preparation, planting, cultivation and fertilizers application, causing under use inputs and resulting in crop failure and low production, and in recent years, crop production using early rainfall. According to farmers, rainfall shortage and variability was ranked first in constraining productivity of crops in the area. It should be understood that with risk factors high for climatic hazards and/or pest and diseases, the overall risk taking increases considerably with high production costs.

Table 8. Matrix scores and pair wise ranking for crop production constraintsby farm typologies

Major constraints	**Farm typologies**				
	CMHMFS	SMCMMFS	CMMFS	SGLMFS	APPFS
	Score(rank)	Score(rank)	Score(rank)	Score(rank)	Score(rank)
Shortage of improved seeds supply	7(2nd)	8(1st)	6(3th)	7(2nd)	8(1st)
Inappropriate crop management	4(5th)	4(6th)	5(4th)	4(5th)	6(3rd)
Lack of improved varieties	8(1st)	7(2nd)	7(2nd)	8(1st)	8(1nd)
Farm inputs (pesticides, fertilizers)	5(4rd)	5(4th)	5(4nd)	6(3rd)	5(4th)

Insect pests	7(2nd)	6(3rd)	7(2th)	7(2nd)	6(3rd)
Crop disease	6(3th)	7(2nd)	6(3rd)	6(3rd)	4(5th)
Weed infestation	3(6th)	3(6th)	1(8th)	7(2nd)	7(2nd)
Cultivable land shortage	8(1st)	8(1nd)	8(1st)	6(3th)	4(5th)
Erratic rainfall distribution/drought	7(2rd)	6(3nd)	7(2nd)	8(1st)	8(1st)

Source: PRA survey result, 2017

Harvest and postharvest related constraints to crop production

High storage losses due to storage pests (weevils) on haricot bean, sorghum, and maize and causes high post harvest losses. Threshing problem- sever for major cereal crops, transportation-exposed farmers to high cost, lack harvesting technologies-the problem was sever for horticultural crops. Pershability crop produces-sever for cash crops and lack harvesting technologies-the problem was severing for horticultural crops. Table 9 indicates that lack of improved threshing; harvesting, high storage losses due to occurrence of storage pests (weevils), and transportation access problem due to inadequate infrastructural facilities such as lack of transportation facilities/road access and high cost transport are challenging the farmers in the study areas.

Table 9. Matrix scores and pair wise ranking for harvest & post harvest crop related constraints

Harvest and post harvest problems	Farm typologies				
	CMSHMFS	SMCMMFS	SGLMFS	CMMMFS	APPFS
	Score(rank)	Score(rank)	Score(rank)	Score(rank)	Score(rank)
Lack harvesting technologies	1(4th)	1(4th)	3(2nd)	3(2nd)	2(3rd)
Threshing problem	3(2nd)	4(1st)	4(1st)	4(1st)	3(2nd)
Transportation	2(3rd)	2(3rd)	3(2nd)	2(3rd)	4(1st)
High storage losses	4(1st)	4(1st)	2(3rd)	0(5th)	1(4th)
Perishability crop produces	3(2nd)	3(2nd)	4(1st)	0(5th)	2(3rd)

Source: PRA survey result, 2017

Marketing and marketing systems related constraints by farm typologies

During PRA study, the participant farmers were identified and prioritized major marketing constraints existed in the identified (Table 10).The predominant marketing constraints are low price of agricultural products for cash crops (horticultural crops, coffee and Khat), high price of agricultural inputs such as improved seeds, fertilizers, herbicides, lack of market access server for farmers in areas far from roads and the urban market, cash shortage for inputs due to poor of saving culture and the inadequate access to credit services, lack of market information due to institutional problems, lack of road facility, price fluctuations/low price for coffee product , payment problems which not paid for the producers when they need and high price of agricultural inputs.

Table 10. Matrix scores and pair wise ranking of crop marketing related constraints

Marketing constraints	Farm typologies				
	CMSHMFS	SMPMMFS	LCSMGSF	CCSF	APPSF
	Score(rank)	Score(rank)	Score(rank)	Score(rank)	Score(rank)
High price of inputs	4(2nd)	4(2nd)	5(1st)	3(3rd)	3(3rd)
Low prices for cash crops	5(1st)	5(1st)	4(2nd)	5(1st)	4(2nd)
Cash shortage for inputs	3(3rd)	3(3rd)	5(1st)	2(4th)	4(2nd)
Lack of market access	3(3rd)	2(4rth)	3(3rd)	4(2nd)	5(1st)
Lack of access to credit	1(5th)	1(5th)	2(4th))	1(5th)	1(5th)
Lack of market information	2(4th)	1(5th)	1(5th)	2(4th)	2(4th)

Source: PRA survey result, 2017

Listock production system

Livestock types and populationtrend in the farming systems

Livestock production is an important source of income and means of livelihood activity in crop-livestock mixed and agro pastoral areas of the east Hararghe zone. Livestock production is undertaken together with crop production in mixed and agro pastoral areas and solely by pastoral areas. However, the number of livestock owned and its contribution to the livelihood of the farmers are varying in these areas. In the east Hararghe zone, integrating crop and livestock production is a common phenomenon and also there is a close interaction between the enterprises but the interaction decreases from highland to agro pastoral/pastoral areas. Crop provides feed to the livestock during wet and dry seasons and livestock also proved traction power and manure to sustain soil fertility. Livestock such as cattle, goat, sheep, donkey, camel, poultry, horses, mule and beehive in the study areas have been kept for different purposes.

In highland and midland mixed farming areas, FGDs participants noted that cattle are mainly kept for cash income (selling live animals and their products), saving, source of manure for soil fertility management, and draught power for land prepartion and threshing of crops. In lowland mixed farming areas, cattle are primarily kept for draught power, cash income and savings, and threshing of crops. In all of farming systems, the main purpose of rearing sheep and goats is for immediate cash, as source of meat and milk and manure to improve soil fertility. In the all of farming systems, donkeys are kept for transportation. In highland and midland mixed area, house and mule are used for transportation and crop threshing.

The livestock production is a means and dominant livelihood of the agro pastoralists in the area. The agro pastoralists are engaged in cattle, goats, sheep, camel, donkeys, and poultry rearing for supporting and sustaining their livelihoods. The cattle, sheep, goat and camel are a major source of income by selling their products. The milk, egg, meat, and manure are the important products of the livestock.The camel and donkey are also reared and used mainly for transporting of crop products, woods for charcoal, water and other goods. The poultry production is also practiced by farmers in the area.

The beekeeping production is also practiced by the farmers in the area. Livestock serves as a source of food, for draft power in agricultural activities especially for land plowing, service for transportation, as a source of natural fertilizer, as a means of wealth accumulation and economic benefits (source of cash income). Livestock service as a source of prestige in the social life of the pastoralists and semi-pastoralists. In addition the pastoral community that were found in the arid lower low lands use animal production as the sole main stay for their livelihood to coop against the adverse rain shortage through nomadic life style.

Livestock plays a great role in the social and economic life of the people of East Hararge zone. Livestock serves as a source of food, for draft power in agricultural activities especially for land plowing, service for transportation, as a source of natural fertilizer, as a means of wealth accumulation and economic benefits (source of cash income). In addition the pastoral community that were found in the arid lower low lands use animal production as the sole main stay for their lively hood to coop against the adverse rain shortage through nomadic life style. Livestock constitute a major economic factor in the pastoral and agro-pastoral communities.

Livestock play also a central role in determining the wealth and social status of pastoralists and agro-pastoralists. In both production systems, the principal motive for keeping cattle and camels is for milk production. During dry season and under drought conditions, camels are the main sources of milk because milk from cattle and goats is relatively scarce. Goat milk is highly appreciated by livestock owners and it is mainly fed to children and is also considered to have a medicinal value. Meat production is the other important reason for keeping the livestock. Both pastoral and agro-pastoral households slaughter cattle and camel on special occasions like when community leaders and elders in the society die. Camel meat is highly appreciated by pastoralists. In both pastoral and agro-pastoral systems, small ruminants (sheep and goats) are important cash sources. Small ruminants can be easily liquidated o meet immediate cash requirements. Camels and donkeys are used to move the household and its goods and chattels when changing camps in the pastoral system and as pack animals in the agro-pastoral system.

Livestock holding and distribution

The livestock distribution among the farming systems indicates that livestock unit owned increase from mixed mid-highlands to agro-pastoral areas, and more livestock units are found at the in Sorghum/groundnut lowland mixed farming system (SGLMFS)and Agro pastoral/pastoral farming system (APPFS)farming and herds are dominated by cattle in all identified farming systems (Table 11). The number of total livestock units kept by farmers in the Chat/Maize highland mixed farming system (CMHMFS) are lower (2.55TLU) than the rest of farming systems (Table 11). This may be due to farm land, shortage of grazing land and other feed sources in the highland area. The highest cattle possession was found in sorghum/groundnut lowland mixed farming system (SGLMFS) and Agro pastoral/pastoral farming system (APPFS of the study area.

Cattle is the most important type of livestock which constitute about 42.16%, 39%, 49.08%, 48% and 52.15% in Chat/Maize highland mixed farming system (CMHMFS), Sorghum/maize/cash crops midland mixed farming system (SMCMMFS),Coffee/maize mixed farming system (CMMFS),Sorghum/groundnut lowland mixed farming system (SGLMFS) and APPFS of the study areas, respectively (Table 11).

Small ruminants (goat and sheep)

Constitute a large percentage of the total livestock units. They are 28.63%, 31.83%, 38.65, 27.51% and 30% in Chat/Maize highland mixed farming system (CMHMFS), Sorghum/maize/cash crops midland mixed farming system (SMCMMFS), CMMFS) Sorghum/groundnut lowland mixed farming system (SGLMFS) and Agro pastoral/pastoral farming system (APPFS)of the study areas, respectively (Table 11).Sheep are most widely concentrated in the highland and midland farming systems while goats are predominantly found in lowland and agro pastoral areas. The study indicates that large percentage of sheep (18.43%) and goat (24.85%) found in highland and agro pastoral farming systems of the study areas, respectively.

Camel is predominantly found in lowland and agro pastoral areas and serves as the mainlivelihoods for pastoral/agro-pastoral communities. The camel constitutes about 24% and 26.76% of the total livestock unit in the Sorghum/groundnut lowland mixed farming system (SGLMFS) and Agro pastoral/pastoral farming system (APPFS)of the study areas, respectively (Table 11).

Equine (donkey, horses and mules) are the most important means of transportation in farm and non-farm activities (petty trading); productive and reproductive activities and both for human and agricultural products in the study area. In highland and midland areas, donkey plays a significant role in transporting cash crops such as vegetables and chat from farm fields to main road and sometimes to the market places where as in lowland and agro pastoral areas transporting charcoal and fuel wood to the market and collecting water from a distance for drinking and cleaning.

Poultry the survey result indicates that the respondent households have about 6 chickens on average. Poultry production is commonly practiced in area; though it received low attention due to social attitude on poultry consumption. Besides wildlife attack, access to improved breed is very low. Similarly, prevalence of various poultry diseases is also commonly breakout in most of study areas.

Table 11. Average livestock holding by farm typologies

Livestock types	Farming system typologies									
	CMHMFS		SMCMMFS		CMMMFS		SGLMFS		APPFS	
	TLU	%	TLU	%	TLU	%	TLU	%	TLU	%
Cattle	1.33	42.16	1.74	39.01	1.60	49.08	2.02	48.10	2.98	52.15
Sheep	0.47	18.43	0.51	14.37	0.42	12.88	0.24	5.24	0.81	3.18

Goat	0.26	10.20	0.62	17.46	0.84	25.77	1.02	22.27	1.64	24.85
Donkey	0.15	5.88	0.17	10.42	0.15	4.60	0.14	2.84	0.19	2.42
Horses	0.19	7.45	0.01	4.79	0.02	0.61	0.01	0.44	0	0.00
Mules	0.11	4.31	0.03	0.85	0.02	0.61	0.01	0.22	0	0.00
Camels	0	0.00	0.05	1.41	0.0	0.00	1.1	24.02	1.87	26.76
Poultry	0.04	1.57	0.16	1.69	0.21	6.44	0.23	3.87	0.11	3.64
Total (TLU)	2.55	100	3.55	100	3.55	100	4.58	100.0	6.6	100.00

Source: PRA survey report, 2017

Based on the information collected from livestock and fishery development office, the total livestock population is estimated to be about 89089. Among the livestock population in highland mixed farming, cattle accounts the highest (140, 2660) followed by oxen and improved cows which is 80,738 and 323 respectively.Out of this total population, the goat constitutes about 43.8% followed by sheep (18.8%), poultry (14.6%), cattle (14%) and others constitute about 9% in the area.

Secondary data collected from livestock and fishery development office indicated that the total livestock population in the highland mixed farming system is estimated to be about 410,914 of livestock and among the livestock, cattle accounts the highest population (169,553) followed by sheep and goat which is 148673 and 57364, respectively. Similarly in midland mixed farming system areas, Out of the total livestock population, the cattle constitute about 188,816 followed by goat and sheep which are 125598 and 48233, respectively. In lowland mixed and Agro pastoral/Pastoral farming systems of the study areas had the highest population of all livestock species types are kept in lowland mixed and Agro pastoral/Pastoral farming systems of the study areas and the areas also has the highest population of cattle followed by goat and sheep (Table 12).

Regarding breed types, the population cattle are dominated by indigenous breeds in all of the farming systems. Ssecondary data collected from office of livestock and fishery development, and pastoral offices indicted that indigenous cattle breeds are the dominant types of cattle breed kept in all of the study areas.However, only few improved cattle breedssuch as Holstein Friesian, Jersy, Borena and Horobreeds are kept in midland, lowland and agropstoral areas.Midland areas had the highest population of improved breeds as compared to the others and the number of improved cattle breeds kept by farmers is dicrease from highland to agropastoaral farming systems (Table 13). During focus group discussions, the farmers noticed that feed shortage and adaptability isthe major reasons for not adopting cross breed cattle in the aareas. The farmers also prefered dairy breeds like Borana and Ogaden rather than exotic breed for their better production potential and good adaptability than the local breed in the area.

The situation is similar for poultry production; local chicken breeds are the dominant types of the breeds and FGDs farmers also reported that poultry production using local breeds is common but some farmers has improved breeds. They also prefered improved breeds for their productivity but access to improved breeds are a problem in the areas. Regarding apiculture production, practiced commonly in lowland and agro pastoral farming areas using both traditional and modern hives. However, agro pastoral/Pastoral farming areashad the highest population of honey bee colonies followed by lowland mixed farming system. It was also observed that the areas practicing apiculture production using both traditional and modern bee hives but lowland mixed farming areas had relatively large number of modern bee hives as compared to agro pastoral/Pastoral areas (Table 12). Generally, improved breeds of cattle and poultry, and modern bee hives are not expanding in all of the farming systems of the study areas.

Table 12. Livestock type and population by farming system typologies

Livestock types	Farming system typologies			
	CMSHMFS	SMCMMFS	SGLMFS	APPFS
Cattle	169553	188816(300*)	192842(175*)	365075(55*)
Goat	57364	125598	162132	281969
Sheep	148673	48233	55539	228296
Donkey	25291	29346	25416	35063
Horse	2019	274	NA	NA
Mule	703	49	10	NA
Camel	2905	606	17999	27206
Poultry	4,406	69368	89178	310997
Honey bee colonies	NA	NA	6580(336**)	14703(52**)

Source: Livestock development office, 2017, *Crossbred or improved breed, **modern beehives

Livestock production systems and productivity

Livestock production is characterized by low productivity due to lack of inputs like breeds, improved forage and services. The result of study indicates that the average milk yield of indigenous breed is various from 1 to 2.5, and 1 to 3 liters per day in mixedhighland and midland areas, respectively. Similarly, the average milk yield of indigenous breed in lowland mixed and Agro pastoral/Pastoral farming areas is various from 1 to 2, and 1 to 1.5 liters per day, respectively. The result indicates that relatively higher milk productivity in the in the areas of highland and midland mixed could be related to the management levels and feed availability. In many cases, the lowland areas have been characterized by relatively low milk productivity due to drought. On the other hand the FGDs farmers reported that the average milk yield from improved breeds are varies from 10 to 15 in highland and midland mixed farming areas and 8 to 10 liters per day in lowland mixed and Agro pastoral/Pastoral farming areas. However, the number of farmers has been practicing improved dairy production using improved breeds are very limited in the study areas. Therefore, it needs efforts on all aspects of the dairy cows like feed and health can improve the production and productivity. With regard to poultry, the mean annual egg production of indigenous and improved breed varies from 60 to 70 and 160 to 175 in highland and midland mixed farming areas, respectively. In lowland mixed and Agro pastoral/Pastoral farming areas, the mean annual egg production of indigenous and improved breed varies from 48 to 55 and 155 to 180, respectively.

Moreover, The PRA participant farmers reported that amount honey harvest depends on availability of good rainfall, there is ample pollen and nectar source of bee forage in these areas, and if the case the quantity of honey harvested from traditional hives per year varies from 3 to5 kg in lowland mixed and Agro pastoral/Pastoral farming areas whereas the quantity of honey harvested from modern bee hives per year was 12 and 10 kg in lowland mixed and Agro pastoral/Pastoral farming areas, respectively. The PRA participant farmers noted that livestock population and their productivity has been decreasing over time as compared the past time mainly due to drought, shortage of feed resources, particularly in dry seasons, water shortage, shortage of bee forage, deteriorating grazing lands and weak of extension service.

Table13. Livestock productivity in the study area by farm typologies

Livestock types	Farming system typologies				
	CMSHMFS	SMCMMFS	CMMMFS	SGLMFS	APPFS
Cattle, indigenous(lit, milk)	1 to 2.5	1 to 3	1 to 3	1 to 1.5	1 to 1.5
Cattle, crossbreed(lit, milk/year)	10-15	10-15	10-15	10-12	10-12
Chicken, indigenous (No, eggs)	55	60	50	75	70
Chicken, improved(No, eggs)	180	220	210	250	200
Honey from traditional hives (kg)	3-5	3-5	3-5	3-4	3-4
Honey from transitional hives (kg)	-	-	-	-	-
Honey from modern hives(kg)	-	-	-	12	10

Source: PRA survey report, 2017

Livestock managementsystem

Animal feed sources and feeding system

Livestock feed sources in the East Hararghe zone are crop residues, thinning out crops and up-rooted weeds and green grasses from farm fields, private /communal grazing, aftermath grazing, browse tress and bush/ shrub, improved forages and industrial byproducts. These feed resources are not uniformly distributed in all farming systems of the study area and because of rainfall variability and severe droughts, feed shortage is the common phenomenon in the zone. The degree of feed shortage varies from farming system to farming system and it is so critical in the lowland mixed and agro pastoralist/ pastoralists than in the highland and midland mixed farming systems of the Zone. The sources of animal feed are elephant grass, crop residue, bushes and shrubs (for goats). Free grazing at feet of mountains is an important method of feeding livestock. The major available crop residues for livestock feed are sorghum stalks, maize stalks and cobs, straws of wheat and barley; and dry leaves of sorghum and maize. Weeds, thinned crop plants (maize and sorghum), lower older leaves of sorghum and maize and elephant grass fed through the cut and carry system are important sources of green feed for livestock.

Household survey and Participatory rural appraisal (PRA) was conducted to collect information on the existing animal feed sources and feeding system in the highland and midland, lowland mixed and agro pastoral areas. The results revealed that in the highland and midland areas, there is shortage of free grazing land and during wet and dry season the farm land covered by annual and perennial crops. Hence, the major livestock feeds available in the areas include thinning out crops, crops leafs, up-rooted weeds and green grasses from farm fields feed through cut and carry system, small private grazing land near the homestead and at the boarder/edge of croplands, free grazing at feet of mountains is an important method of feeding livestock free grazing of grasses and browses trees at feet of mountains and road side are the main source of animal feed during the wet season. Crop residues are abundantly available at the beginning of the dry season following the harvest and threshing of cereal and pulse crops. However, the abundant crop residues right after harvest and threshing is used wastefully by animals on the farm due to lack of proper conservation and feeding systems.

Moreover, some farmers have engaged in dairy and fattening practices, used industrial by-products such as wheat barn. Regarding improved forage feeds, there are also improved forages such as elephant grass cow peas, sesbania & leucaenia also used by some farmers in the areas. During dry season, various crop residues, mainly cereals crop residues such as sorghum and maize stalks, wheat and barley straws, dried sorghum and maize leaves, grass hay, vegetable crops such as potato, cabbage, and sweet potato leaves are commonly used as feed sources for cattle during the dry season. In addition, small private grazing near homestead and at the edge of croplands, free grazing grasses and browses trees at feet of mountains and road sides and industrial by-product such as wheat bran are also the main sources of animal feeds in the highland and midland mixed farming areas. Fodder conservation for the dry season is a common practice. In addition, the FGD farmers mentioned that few farmers used industrial by product such as wheat bran for milk cow, goat and fattening bull during dry season. The high cost of the industrial by-products, few farmers rarely used it for animals affected by feed shortage during the dry season. Moreover, some farmers used improved forages such as elephant grass and susbania sesban, is used for milk cow, calf and fattening bull during dry season.

Furthermore, FGD results and secondary information and household survey conducted in lowland mixed and agro pastoral/pastoral farming systems indicated that, private natural pasture, natural pasture/communal grazing, thinned out crops and up-rooted weeds, crop residues, aftermath grazing, hay, bush and shrubs, forages and industrial byproducts are the major feed sources for the lowland mixed farming households whereas natural pasture/communal grazing and bush/shrub is the major feed sources for the agro pastoralist/ pastoralists farming system. Grazing of natural pasture constitutes the main source of animal feed throughout the year in both farming systems. Morevore, improved forages such as elephant grass and industrial by product such as wheat bran, are used for milk cow and fattening bull during dry season in the lowland mixed farming areas. However, forages, crop residues and industrial byproducts are not widely used in the agro pastoralist/ pastoralists farming system. In most part of lowland and agro pastoral areas, there is no grazing land shortage and farmers practice free grazing feeding system. During dry season the communities practice transhumance (seasonal migration of livestock to distance place for searching of feed and water)

Agro-pastoralists are using grazing resources, mainly bush land, on a large-scale in animal husbandry. Their livestock herds are predominantly comprise cattle and goats. However, during FGDs, the farmers noticed that animal are suffering from feed shortage problem due to moisture stress and drought, overgrazing of existing grazing land, shrinkage of grazing land due to weed and bush invasion (bush encroachment, unpalatable shrubs) were identified as the major problems in related with feed resource availability in the area. As a result, the agro-pastoralists and pastoralists have been facing pronounced feed shortage in the dry season and always forced to migrate seasonally from place to place to feed their livestock. Generally, agro-pastoralists and pastoralists believe that shortage of feed has resulted in livestock malnutrition, weak physical condition and less yields (milk, meat, lower market values) and reduced reproductive capacity. The participants also it is important to focus on animals have high resilience to high temperature and drought conditions such as camel, goats, and donkeys.

Watering and housing management

Water sources for livestock drinking vary from place to place. During PRA study observed that in highland and midland mixed farming systems areas the main source of water for animals are springs, rivers and surface water during wet season (June to September/October), farmers water their livestock by taking animals to the areas of water point and fetching water from the sources by donkey for milking cows, fattening cattle and calves while private and communal ponds, well and springs are used as a source of drinking water during dry season (November to May). In all areas the FGDs participant farmers pointed out that water shortage is a problem, especially during dry season, however, the problem is sever in lowland mixed and agro pastoral areas. In highland and midland mixed farming systems areas, springs are mostly the source of water and in lowland mixed and agro pastoral areas wells are developed as source of water. The housing of livestock differs in the identified farming systems, in highland and midland mixed farming systems, they used separate barns followed by family houses, while in lowland mixed and agro pastoral areas mainly corrals followed by separate barns. In highland and midland mixed farming systems, animals such as cattle and equine are kept in traditional barn constructed near the house or attached with the main house or fence separately built near by the main house, and the farmers keep their animals in single species or mixed in these houses, while the housing system for milk cow, small ruminants, calves and chickens are housed in one corner of the family dwelling or attached with the main house. Mature cattle and camel are kept fences during the night to protect them from predators and frost while small ruminants, calves are kept in house separately built near by the main house attached with the main house in lowland mixed and agro pastoral areas.

Breeding management

Natural uncontrolled mating was the predominant breeding method for all livestock species of in almost all study areas but during wet season, majority of farmers practiced controlled mating for their cows. However during dry season breeding bulls are freely used, to serve own and neighbor herds. This showed that controlled and planned mating is not the most common practice in the study areas. Therefore, awareness should be created in these areas for planned and controlled mating to synchronize delivery of calves in seasons of better feed availability. Farmers have traditional knowledge of detecting heat period of their cow by observing some symptoms and they make their cows to mate with bull they preferred. Some farmers are practiced controlled mating for cattle, sheep and goat for obtaining better milk yield, fast growth and adaptability to local condition. In lowland mixed and agro pastoral areas, uncontrolled natural mating is the most common breeding system used by pastoral areas for their animals. Regarding bull services and AI (artificial insemination) breeding systems, the farmers are not practiced in all farming system areas due to lack of awareness, expert is not is there when they request and failure due to knowledge gap. An artificial insemination service has been practiced in these areas by supported hormonal synchronization. However the efficiency and effectiveness of AI service is nil, even farmers miss perceived this service as it makes infertile cattle in almost all areas of the study sites. The PRA discussions the main problems and non-effectiveness of AI in these areas were distance to AI station, and technically poor AI technicians.

Livestock diseases and parasites

Major livestock diseases type, distribution, their symptoms and severity identified by the farmers during PRA study are summarized in the following Table15.The result of the FGDs and reviewed secondary data indicates that Anthrax, Blackleg, Haemorhagics septicemia, Foot and Mouth disease, Lumpy Skin Disease and Pasteurellosis are the most prevalent diseases on cattle in almost all locations of the study areas. Mastitis was also noticed by the FGD farmers as health problem of improved dairy cows particularly in lowland and agro pastoral areas. The reviewed of secondary data indicated that in 2016 cropping season, a total of 39729 number of livestock affected by these diseases in the study areas. Moreover, diarrhea, bloat and emergency disease on cattle were reported by the farmers as a problem. In addition to the diseases, parasites such as Fasciolosis, ticks, lice, mites and leech are major parasites found in the study areas on cattle (Table 15). Livestock diseases are another potential hazard. The major diseases affect in the zone are Pasteurellosis (affects cattle and goats), anthrax and internal and external parasites that affect all type of livestock every year.

Moreover, the study indicated that anthrax, Pasturolisis, Circling disease, Foot and Mouth Disease and Diarrhea were the major prevalent diseases on sheep and goats. Similarly

Inflammation and emergency diseases/sudden death on camel and African horse sickness on equines (horses, mules & donkey) were the major prevalent diseases identified in the study areas. Furthermore, Poultry disease such as New Castle Disease (NCD) and Fowl cholera and parasites such as mites and lice on poultry were the prevalent factors affecting poultry production and productivity in the study areas.

The FGD farmers and Key informant interview mentioned that livestock assets are declining from year to year due to recurrent prevalence of diseases and vector become increasing, availability of feed scarcity and animals are feedingpoising invensive weeds and plants which are all the consequences of the prevailing climate change in the study areas. Regarding animal health/veterinary service, there were Veterinary Clinics and health posts were available in the majority of the study areas at district level, but the farmers reported that the available animal health/veterinary services are to be inefficient in providing quality services such as vaccination and treatment services to the level that is required by the communities. The veterinary services or the veterinary personnel highly depend on the availability of facilities such as veterinary equipment; drugs, tablets and other facilities shortage are a major challenge to deliver animal health services.

Table 15. Major livestock diseases and parasites in the study area

Livestock types	**Major type of livestock disease**	**Symptoms**	**Treatments**
Cattle	Blackleg (Abagorba)	Fever	vacination
	Antrax(Abasanga)	Fever	vacination
	Pasteurolosis (Gororsa)	Inflammation of body, fever	Skin burning
	Diarrhea	Loose apatite and diarrha	Balanced diet,
	Bloat	Bloat and loose apetite	
	Mastitis(Jigoo)		
	Fasciolosis		
	Haemorhagics septicemia		
	Foot and mouth disease	Animals cannot move, loose the appetite	Feed honey & garlic, vaccination
	Lumpy Skin Disease	Affecting skin and change skin color	
	Emergency disease	Paralyze and sudden death	vaccination
Sheep and goat	Anthrax	Fever	vaccination
	Pasteurolosis (Gororsa)		
	Bloat		
	Diarrhea		
	Circling disease/naanneessa		
	Foot and mouth disease		
	Fasciolosis		
Camel	Inflammantion	Bloating, fever, eye sickness	

	Emergency disease	Sudden death of camel	
Donkey	African horse sickness		
Poultry	New castle disease		Giving tablet
	Fowl cholera		
Apiculture	Wax mouth		

Source: PRA survey and EHZ Office Agriculture, 2017

Livestock production constraints by farm typologies

Cattle and small ruminant production constraints

In Highland and midland mixed farming system areas, animal feed shortage is the most dominat one in both farming systems but its severity increase with alatitude of livestock was identified during the Participatory rural appraisal (PRA) study as the first limiting factor followed by lack of improved cattle and sheep and goat breeds, water shortage, low market proce of animals and diseases in order of priority (Table 16). The problem of feed shoratge is highly releted to availablity and distribution of private and grazing land among the farming systems as a result low prodctivity of animals observed which tend to declini with incresearing feed shortage.

The FGD participant farmers reported that the ultimate animal feed shortage become an increasing problem for animal rearing due to rapidly increasing human population and land degradation, farm land shortage, drought, limited and deteriorated grazing land due to expansion of crop cultivation and limited improved forage production due to lack of adaptive and productive improved forage species that compatible to the existing farming practices has been highly affecting livestock production in both farming system areas. The major livestock feed sources in both areas were crop residues but poor quality and lack of feed management technologies such crop residue treatments contributing for low productivities of animals in the areas. In areas, feed processing activities such as chopping of green materials and urea treatment of crop residues are not practiced in study areas. In addition, the FGDs farmers noted that some farmers were commonly used industrial by-products such as wheat bran particularly for their dairy cows and fattening cattle and goat. However, the farmers claimed that high price and poor quality of the byproducts challenging them. Besides, lack of knowledge, insufficient institutional support and limited extension service in terms of dairy fattening feeds and improved feeding management were major constraints for enhancing of the animal feed availability in the both areas.

Participatory rural appraisal (PRA) was conducted in highland and midland mixed farming system of East Hararghe Zone further revealed that lack of improved breeds(dairy, goat, and sheep) due to limited supply and high price of improved breeds, lack of improved and adaptable breeds, non efficiency and effectiveness of AI service, low market price of animals and free market problem, and water shortage due to drought are the second most important constraints to animal production by low level of animal production and economic damage on the farmers in the in areas. In addition, prevalence of animal diseases due to climate change and availability of limitedveterinary service s was mentioned as constraint to animal production in both areas. The problem of shortage of capital, labor shortage, knowledge gap and lack of technologies were moderately contribution to low level animal productivity in both areas, Though the respondents are eager to improve the productivity of their local animals through crossbreeding using artificial insemination (AI) so far they do not have access to the service. In lowland mixed farming areas indicated that animal feed and water shortage were identified to be the main problems to animal rearing followed by animal diseases and parasites, lack of improved breeds, low market price of the animal, lack of scientific knowledge of livestock were indicated to be major limitations to livestock production.

In the case of agropastoral/pastotal areas, the reduction in livestock ownership might be attributed to drought, which caused crop failure, shortage of feed and scarcity of water. The major causes of death of livestock are drought, shortage of water, feed, animal diseases, predators and livestock feeding on toxic plants due to feed shortage, which they do not usually take. One indicator of this is that pastoralists have little market outlet to sell their animals or are forced to sell them at lower prices and illegal market. The farmers noted that the price for livestock fall dramatically in periods of drought since nobody wants to buy drought affected animals. The agropastoralists/pastotalists reportedthat diseases, water scarcity, shortage of feed, range land degradation and lack of market outlet are major constraints. Range degradation, water and feed scarcity are drought sensitive constraints. diseases and predators that cause huge livestock losses, Black leg, Anthrax, Foot and Mouth Disease, Botulism, Parasitic gastro-enteritis, liver disease and Camel pox are important livestock diseases mentioned in order of importance.

Even if there is aboundent animal feeds such as grazing and browsing , animal feedshortage due to drought, declining of grazing land due to farm land expansion as settlement of farmers from highland areas, bush encoechement/invasive weeds and plants,and water shortage due to drought were identified to be the main problem followed by animal diseases problem due to transhumant nature of agropastoralists/pastotalists, veternery service problems and drug supply shortage, breed shortage and low market price due to distance and transportation related issues and lack of knowledge and awareness on improved husbandry practices were the main constraints to agropastoralists/pastotalist as reported by the participants during the PRA study. In addition, the FGDs participants mentioned that the problems contributing for decreasing of animal productivity in agropastoral and pastotal areas are conflict between agropastoral and pastotal and farmers settled from highland areas, lowquality of animale due to large herdsand access to veternery service to agropastoralists also a problem due to as agro pastoralists are moving from place to place for searching animal feed and water.

Table 16. Matrix scores and pair wise ranking for cattle and small ruminant production constraints

Major constraints	Farm typologies				
	CMSHMFS	SMPMF	CMMFS	SGLMFS	APPFS
	Score (rank)	Score (rank)	Score (rank)	Score (rank)	Score (rank)
Shortage of animal feed	7(1st)	7(1st)	7(1st)	7(1st)	6(2nd)
Lack of improved breeds	6(2nd)	6(2nd)	6(2nd)	5(3rd)	5(3rd)
Animal disease and parasites	5(3rd)	5(3rd)	4(4th)	6(2nd)	7(1st)
Water shortage	6(2nd)	6(2nd)	6(2nd)	7(1st)	7(1st)
Lack of market outlet	4(4th)	4(3)	3(5th)	5(3rd)	5(3rd)
Low price of animal	7(1st)	7(2nd)	7(1st)	6(2nd)	6(2nd)
Shortage of capital	3(5th)	3(5th)	3(5th)	4(4th)	4(4th)
Lack of knowledge	2(6th)	2(6th)	2(6th)	3(5th)	3(5th)

Source: PRA survey result, 2017

Poultry production constraints

Poultry production is an important source of immediate income (sale of product and live birds) particularly for women in all of the farming systems of the study areas. The importance of keeping the chickens is for consumption of meat and eggs and as sources of income. The poultry production and management practices in all the farming systems are mainly at backyard and based on the traditional knowledge of the farmers. The result indicates that the highest poultry breed proportion was found in agro pastoralist followed by lowland mixed farming areas. According to CSA report also indicates that the estimated number of poultry population in East Hararghe zone was about 1,564,569 which about 97.64% of the total poultry are indigenous breeds and only 2.36% is improved breeds (CSA, 2016).

Major constraints of poultry production identified and prioritized by PRA study conducted in CMHMFS, SMMMFS, SGLMFS and APPFS of the Zone as indicated in Table 18.The constraints more or less similar across the farming systems and as a result summarized and presented in Table17. Shortage of improved poultry breeds/lack of adaptive exotic poultry breeds and poultry diseases and parasites(*NCD , fowl Cholera, fowl typhoid, fungil)*were ranked first as main constraints to poultry production followed by high price of improved breeds,inadequate management practice, Lack of veterinary service and unavailability of balanced diet were indicated to be major constraints to poultry production in highland and midland mixed farming systems of the study area(table 18).Shortage of improved poultry breeds/ lack of adaptive exotic poultry breeds and Poultry diseases and parasites was first ranked poultry production constraints followed by lack of veterinary services(vaccine and medicine were not available nearby the farmers) and inadequate management practice(housing, feeding, veterinary) and the third ranked constraints werelack of balanced feed /diet and high price of improved breeds and lack of considering as an alternative business were also reported as a constraint to poultry production in Lowland mixed and Agro pastoral farming of the study areas.

Table 17. Matrix scores and pair wise ranking for poultry production constraints

Major constraints to poultry	Farm typologies			
	CMSHMFS	SMCMMFS	SGLMFS	APPFS
	Score(rank)	Score(rank)	Score(rank)	Score(rank)
Shortage/Lack of improved breeds	6(1st)	6(1st)	6(1st)	5(2nd)
Poultry diseases and parasites	5(2nd)	5(2nd)	6(1st)	6(1st)
Lack of veterinary services	4(3rd)	4(3rd)	5(2nd)	5(2nd)
Unavailability of balanced diet	3(4th)	2(5th)	3(4th)	1(6th))
High price of improved breeds	6(1st)	4(3rd)	4(3rd)	3(4th)
Inadequate management practice	2(2nd)	1(6th)	1(1st)	2(5th)
Shortage of capital	4(3rd)	3(4th)	5(2nd)	4(3rd)

Source: PRA survey result, 2017

Apiculture/beekeeping production constraints

The farmers and agro pastoralists are also practicing honey bee production in the study areas using backyard production system. The purpose of beekeeping is to produce honey and the honey is used for different proposes such as for consumption, medicinal and income generation. The beekeepers practicing beekeeping using commonly traditional hives and limited farmers used transition and modern beehives in the stud areas. The secondary data collected from office of livestock and fishery development office the Zone indicates the number of traditional, transition and modern beehives in the Zone indicated in the following.

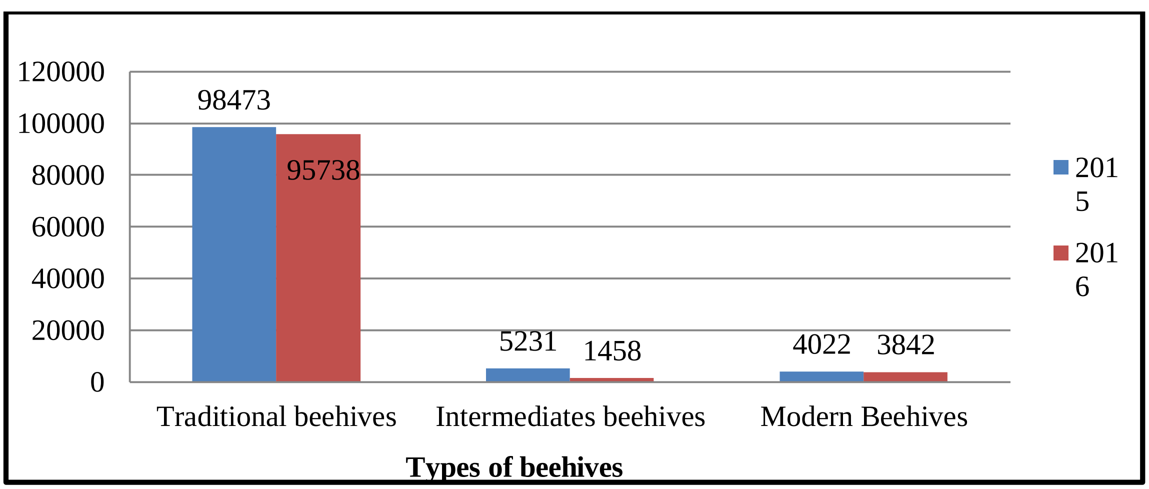

Figure 4. Number of beehives in east hararghe Zone during 2015 and 2016

During PRA survey the participant farmers reported that the bee colonies and their production has decreasing trend over the years due to prevalence of disease, decreasing of natural bee forages and flowers due to deforestation and prevailing of drought in the study areas. The bee enemies such as wax moth, birds, small ant, honey badger and butter fly are commonly attached the bee colonies.

Bee keeping management practices like protecting, fencing feeding, watering, fencing and protecting from enemies, honey marketing, and cleaning of the areas are the responsibility of women and sometimes children while hive construction, seeking colonies, colony transferring and honey harvesting are mainly done by male in the study areas. The main feed source in the study areas is natural trees such as cordial Africana, Olea Africana and Acacia. During feed shortage particularly, during dry season supplementary feeds are providing such as barley flour and sugar dissolved with water. Honey is commonly harvested one in year starting from at the beginning of September to October and sometimes extending to November based on the availability of rainfall. Absconding is the main problem to bee keepers in the study area and starting from December to March due to disease prevalence and feed problem.

In all farming systems more or less have similar/common problems that limit beekeeping production in the study areas. The participants of the PRA study reported that prevalence of disease such as wax mouth and parasites, pesticides use for different crops, declining of natural bee forages and flowers due to deforestation and drought, declining of bee colony and colony absconding due to drought were main constraints to beekeeping production in all farming systems of the study areas. moreover, the participants also mentioned that limited knowledge in use of modern beehives, lack of improved bee technologies and promotion such as improved bee forages(annual, perennial trees) and colony multiplication technologies/techniques((limited skills and techniques on colony multiplication) and lack of considering as an alternative business also identified as a limiting factors in all study areas. The PRA farmers prioritized that drought; disease, shortage of bee forage and water, pesticides use, absconding, high price of modern hives and its accessories, and limited extension service were reported to be major constraints to honeybee production in the areas.

Table 18. Matrix scores and pair wise ranking for apiculture production constraints

Major constraints to poultry	Farm typologies			
	CMSHMFS	SMCMMFS	SGLMFS	APPFS
	Score(rank)	Score(rank)	Score(rank)	Score(rank)
Drought	6(2nd)	6(2nd)	7(1st)	7(1st)
Shortage of bee forages	5(3rd)	5(3rd)	6(2nd)	6(2nd)
Diseases and parasites	5(3rd)	5(3rd)	6(2nd)	7(1st)
Pesticide use	7(1st)	7(1st)	4(4th)	4(4th)
Absconding	3(5th)	3(5th)	5(3rd)	5(3rd)
High price of modern hives	4(4th)	4(4th)	1(1st)	1(1st)

Limited extension services	2(6th)	2(6th)	3(5th)	3(5th)
Lack of hive and its accessories	5(3rd)	5(3rd)	2(6th)	2(6th)

Source: PRA survey result, 2017

Major natural resources and managements

The Participatory rural appraisal (PRA) The results revealed that various natural resources such as farm land, water, communal and private grazing land, forests and minerals such as rocks and sands are indigenous trees and shrubs mainly in area closures, sand, wild lives, stone that can be used for construction, rivers, and arable land are available as a resource in the study areas. The distribution of these resources are varies along the agro ecologies and farming systems. In the highland and midland areas, land resource use intensively for crop and livestock production and it is used and managed under individual ownership in the areas.

During FDGs farmers noted that landholding that can be used for crop production and grazing are declining over time, and becoming limited resource in the area. As a result declining of farm land and grazing land becoming challenging the farmers due to high population pressure, deforestation soil erosion and fertility depletion are the major constraints. In lowland and agro pastoral areas, resources such as farm land, grazing land and water are considered as common-property resources. The availability of abundant flat and fertile land is an opportunity for agro pastoral areas. Agro-pastoralists are using grazing resources, mainly bush land, on a large-scale in animal husbandry. Their livestock herds are predominantly comprise cattle and goats. They move their livestock for part of the year following grazing opportunities and water availability. However, during conduction FGDs the participants noticed that recurrent drought and declining of pasture land availability due to expansion of crop production by settled farmers from highland areas are challenging the livelihood of lowland farmers’ agro pastoralist/pastoral communities in the study area.

During Focus Group Discussions (FGDs farmers identify major soil types available in the areas. Accordingly in highland and midland areas, sandy loam, clay loam, black, loam, sandy and clay are the major soil types identified by the farmers while sandy, clay, clay loam and black are soil types found in lowland areas. These soil types vary in their properties and management requirements. The farmers in the study areas also perceive black and brown soils as fertile soils. The FGD farmers reported that soil erosion and declining of soil fertility were identified to be among the major environmental constraints in all the study areas. However, the extent of soil erosion is relatively less in lowland and agro pastoral areas. In highland and midland areas, land degradation/soil erosion due to high runoff/flood, deforestation and gulley formation the major environmental constraints were identified by the farmers particularly in Highland and midland areas. Deforestation, soil erosion and fertility depletion ultimately resulting crop low productivity the areas.

Soil and water conservation practices

The result of the FGDs indicates that gully erosion, sheet and rill erosion is constraining their agricultural activities in highland, midland and lowland areas. However, the distribution of such types of erosion varies in highland, midland and lowland areas. Sheet erosion is the dominant form of erosion occurring in. However, it is more serious where the vegetation cover is severely depleted especially in cultivated land highland, midland and lowland areas. The major constraints of sheet erosion is that, its invisibility and lack of clear immediate effect makes the land users to under estimate its long term impact. Rill erosion occurs in all areas of all areas and is also the important form of erosion. In fact, in almost all of the areas where sheet erosion is occurring one would find symptoms of rill formation.

Gully erosion is a serious problem in highland and midland areas due to topography. Gully formations have devastated most areas in the highland and midland due to the topography is of the land of area is undulated. Soil erosion-s gully erosion and sheet erosion are common erosion types observed in this lead to land degradation that causes losses of top soil and farm land through floods/run off. Particularly in highland and midland areas, gullies and sheet erosion are widely observed in the fields. The major causes of soil erosion identified by the FGDs farmers conducted in were deforestation, complete removal of crop residue and high run off. However, the farmers practicing various conservation practices such as soil bund, stone bund, check dam, drainage ditch, planting different trees and grasses on soil bunds particularly in highland and midland areas.

Moreover, environmental rehabilitations through area closures of degraded watershed are widely practiced. The most commonly used types of bio-physical measures of conservation include: soil bunds, terraces and check-dams, cut off drains, watershed management, construction of bunds, terraces, biological measures like Elephant grass is being utilized for stabilization physical soil conservation measures and animal feed elephant grass strips (commonly used).Although there is large variation among the farmers and proper use of fertilizers, most farmers apply NPS/DAP, urea and farmyard manure to improve productivity of the major crops grown in theareas.According to farmers, the limited use of fertilizers is mainly due to moisture stress, high purchasing cost and low responsive to fertilizer application and yield advantage of local crop varieties.

Water sources and managements practices

The FGD participants reported the water resources as scarce resources in all of the study areas. The participants were identified water resources such as seasonal rivers, pond, hand pump, tape water springs, shallow well, deep well, hand dug well, motorized water schemes and seasonal lakes are major sources of water used for different purpose in all farming systems of the study areas used for domestic and irrigation purpose by local communities. The focus group interviews and key informant surveys revealed that the In the past years, there are rivers, springs in the area but now all dry out due to climate change –rainfall shortage, and now farmers find out water from ground. Rivers such as Besule, Ramis, galansadi, lage-gaba, burka barka, mumich and Golu Rivers among others have large areas of potentially irrigable land from these the rivers of use for irrigation in highlands. Rivers like River and springs are serving for irrigation and livestock drinking purposes in midlands.

In lowland and agro pastoral areas, rivers such as Erer and Mojo and Daketa revers,springs, ponds(water collected in pond during wet season) and deep wells are sources of water in the lowland mixed and agro pastoral areas. During group discussion the participants loudly reported that these sources of water rapidly decline and some of them are dried due to over utilization and drought as a result water shortage is the major limiting factor for lowland mixed and agro pastoral communities. Especially during dry season they are forced to move more than 5 to 30kms in lowland mixed areas and up to 60 kms in agro pastoral and pastoral areas to search water for their livestock and fetch water domestic use. This lowland mixed areas women and donkey play a significant role. The water supply during rainy season is also not potable because most of the populations use ponds collecting at wet season used as a source of water for drinking. Generally, shortage of portable water, quality problem of ground water, lack of water availability for human and animals particularly in lowland and agro pastoral areas, lack of water quality assessment, and in some areas water points are far away from the users are major challenging to the communities of lowland mixed and agro pastoral areas.

Access to irrigation

For areas like East Hararghe Zone access to irrigation is crucial to boost agricultural production and livelihood of the farmers particularly for lowland mixed and agro pastoral areas which are commonly affected by rainfall variability/drought. The major irrigation water sources, streams and springs, rivers and hand dug well are common in highland and midland parts of the study areas while are common in lowland and agro pastoral areas. Based on the data from East Hararghe zone, traditional small stream and spring diversion, modern schemes, hand dug wells, pumps and pond are types of irrigation commonly used by the farmers in the zone. Those farmers located in highland and midland mixed farming areas use developed irrigation schemes constructed by government and non government organizations and those in lowland and agro pastoral areas farmers living near to the river use traditional irrigation such as diversion of rivers and ponds used for production of vegetable crops.

The result of FGDs and with key informants, depletion of water sources over time due to over utilization and drought/rainfall shortage, water scheme management problems, increasing non-functionality of irrigation schemes and limited irrigation extension service were reported as major constraints that affects the efficiency and sustainability of the existing schemes. In addition, limited availability of technological packages suitable for local conditions and farming systems, limited knowledge of farmers on irrigation water management leads to loss of water and limited knowledge and skill of farmers on volume of irrigation water required for a specific crop are the main limiting factors to use the existing water efficiently in all of the study areas. The result of household survey and FGDs indicates that decreasing of water resource was major constraints of irrigation in the areas.

Agro forestry

In the study areas, natural and manmade forests and agro forestry practices were identified during the PRA study. However, its distribution varies from farming to farming depending on the variation in attitude, climate conditions and population density. The FGDs farmers identified and reported that forests as scarce common property resources in all farming systems. The study identified that the availability of natural and manmade forests that are protected by government, scattered forests with few indigenous tree species are found on hill sides of mountains and trees and shrubs are planted on community managed area enclosures.

During FGDs the participants were analyzed the forest condition, they said that before 15 years ago, there are abundant natural forests and grasses lands and its coverage is becoming declining over the years. The forests are damaged by the communities due to severe deforestation for expansion of farm land and grazing land, and high population. However, in recent years, the forest coverage are becoming improving due to efforts made by the government and communities through watershed management intervention as a result in some areas the communities are benefiting from the area closures through cattle fattening, beekeeping and producing fruit crops. The participants also perceived that the as a result of protection and watershed management intervention, massive tree planting, the coverage of the forest land is become improving from year to year in the study areas..

In the study areas of highland midland areas, there are natural and manmade forests which consists of Podocarpus Gracilior (zigbaa), Juniperus Procera (Tid), *Cordia, Acacia,* Grafilia, detarescordina, elubritas, podocarpus, Olea Africana, Eucalyptus tree and Acacia, shrub and bush land are grown. Similarly, in lowland and agro pastoral areas, there are forest area, consisting of acacia woodland and shrub and bush. In addition, As agro forestry practices, indigenous tree, fodder trees, fruit trees such as mango, papaya were grown by households on their farmland and scattered for fodder, fuel wood, construction materials, food products, improving soil fertility and soil erosion control and cash income. In highland and midland areas, Cardia Africana and absinica are the among the most preferred indigenous trees for timber production while in lowland areas Acaciaoerfota is the most preferred tree and used it for house construction, animal feed, charcoal and shade, some farmers are planting Eucalyptus tree at the edge of the farm land or marginal land and crop land for the purpose income generation. Drought, limited management and follow up for planted trees and deforestation for charcoal and fire wood for energy sources are challenging the afforestation efforts. Firewood, charcoal and crop residues are the major source of energy source. This situation shows that there is major dependence on natural forest and crop residue that aggravates the destruction of forest resources and depletion of soil fertility. In order to conserve the natural resources efforts should be made to introduce fuel saving devices and promote alternative energy supply in the areas.

Major constraints to natural resources management

The FGD farmers in all of the study areas identified that deforestation, depletion of water resources, land shortage, erratic distribution of rainfall/variability/drought, depletion of soil fertility; soil erosion, grazing land shortage, and flood were main constraints for the sustained crop and livestock production in the areas. The participants of the PRA discussion in each of the farming systems identified several challenges to natural resources and ranked them using pair-wise ranking Tables xx. In highland mixed farming areas, deforestation and shortage of farm land holding were identified as the first limiting factor followed by depletion of water resources, rainfall variability/drought due to climate change, soil fertility depletion and soil erosion, declining of grazing land and flood as constraint to natural resources use in sustainable way (Table 19).

In the case of midland mixed farming system areas, depletion of water resources (ground water, irrigation) and erratic distribution of rainfall/variability/drought were identified to be the main problems followed by deforestation and shortage of farm land holding, soil fertility depletion, soil erosion and shortage of grazing land as priority constraints to natural constraints. The result of PRA study further indicates that depletion of water resources/water shortage and drought were ranked in first in lowland mixed and agro pastoral areas followed by deforestation, grazing land shortage, soil fertility depletion and shortage of farm land hold were main constraints for using natural researches in sustainable way.

Table 19. Matrix scores and pair wise ranking natural resources related constraints

Major constraints	Farm typologies				
	CMSHMFS	SMCMMFS	CMMFS	SGLMFS	APPFS
	Score(rank)	Score(rank)	Score(rank)	Score(rank)	Score(rank)
Deforestation	3(3rd)	4(2nd)	4(2nd)	3(3rd)	3(3rd)
Depletion of water resources	4(2nd)	5(1st)	5(1st)	5(1st)	5(1st)
Climate/temperature change	5(1st)	5(1st)	5(1st)	5(1st)	5(1st)
Soil fertility depletion	3(3rd)	3(3rd)	3(3rd)	2(4th)	2(4th)
Soil erosion	4(2nd)	4(2th)	4(2nd)	3(3rd)	3(3rd)
Declining of grazing land	2(4th)	2(4th)	2(4th)	1(5th)	1(5th)

Source: PRA survey result, 2017

Gender Roles in Agricultural Production

Gender roles in crop production and management practices

The PRA study conducted in the study area indicates that the gender roles in major cereal and vegetable crops production activities. Table xx indicates that males play a dominant role in cereal crop production activities such as land preparation and, manure collection and transportation, sowing/planting, fertilizer application, weeding, harvesting and threshing. However, females are exclusively involved in transporting harvested crops to threshing place. Regarding to vegetable production, similarly, male farmers play a key role in vegetable crops production and management tasks such as land clearing and preparation, sowing/planting and disease management. They are also responsible for harvesting and collection of marketable products, and selling vegetable products**.** Females in vegetable production are typically involved in marketable vegetable product collection during vegetable harvesting.

The PRA study conducted in further indicated that gender roles in crop production activities. Accordingly, females are responsible for transporting of cereal crops to threshing and storage places, while males are responsible for land clearing and preparation, sowing and fertilizer application, pest and disease management and intercultural practices. However, cereal crop production activities related to decision making on types of crop planted, weeding, manure preparation and application, harvesting and threshing, and decision on amount sold and marketing is the responsibility of both female and male farmers in the study area. Regarding to vegetable production, females are responsible for seed collection and preparation, weeding and harvesting and collection, while males are responsible for land clearing and preparation, sowing/planting and disease management. On the other hand, both male and female farmers play equal roles in marketing of vegetable produces. Land preparation includes land clearance, hand tillage and oxen ploughing, men take full responsibility.

Gender roles in livestock production and management practices

Livestock production, managing of the cattle is done equally by men and women, while managing dairy products is more often done by women. Women are more involved in poultry and taking care of small ruminants. The results of the PRA study revealed that females often have a predominant role in managing cattle, sheep, goats and poultry production practices in the study area that are sale of their products was the major source of income and easy to manage by females within the homestead areas. Tasks such as barn cleaning and sanitation, milking cows and selling of animal products of cattle, fattened bull, sheep and goats were exclusively performed by females. However, feed collection, feeding and watering, barn construction, disease identification and health care, breeding management and selling of live cattle, sheep and goats belonging to both female and male farmers in the study area. Sale and purchase of livestock, fodder collection, feeding, watering and caring for sick animals was primarily the responsibilities of men. Children assist in almost all activities. Women involvement in cattle, sheep, goat, and poultry management activities was found to be high. Thus, strong and effective extension needs to be in place to empower women in decision making.

Agricultural engineering technologies and constraints

Farm power sources

Farm power is an essential input in agriculture for timely operating of different types of farm operations such as primary and secondary tillage, weeding, row-making, planting, harvesting, threshing,, cleaning, transporting and other post harvest operation. In all of study areas, the major sources of farm power used for tillage, cultivation, harvesting, threshing, cleaning and transportation is human (women, men and children) and draft animal (bullocks, camels, horses, mules and donkeys). The result of the PRA study indicates that the main power sources are human and animal power all operations starting from land preparation through cultivation, harvesting and storing were performed using human and animal power. However, in highland midland areas, human labor and animal power(oxen) commonly used due to small land size, their land sloppy, growing perennial and annual crops together and practicing soil and water conservation. Donkey, mule and horse used for threshing. Similarly, in lowland mixed and agro pastoral areas, draft animals and human provided a large part of the power requirements for any agricultural operations. But limited farmers used tractor as farm power sources for operating primary tillage.

Farm tools and implements

Land preparation for sorghum and maize crops is carried out using oxen plough (oxen plough maresha), whilst for vegetables and perennials and garden crops (homesteads) digging or hoeing tools are used. In highland and midland areas, land preparation is usually performed using traditional implements such hand hoe, oxen-plough, and hand tools using human labour for the purpose of moisture conservation and weed control.In agricultural activities, land preparation is the main operation undertaken in the fields. However, the fact is that farm fields are not well prepared and row based production is limited particularly in lowland mixed areas not practiced which reduces the possibility of proper weed control over the planted area. As a result, the soil moisture conservation and distribution system is significantly affected and also heavy loss of rain water occurs particularly in lowland areas. In addition, poor plant population is observed crop fields, due to in some areas over us e of seed rate and poor seed germination, particularly in lowland and agro pastoral areas. This significantly affects crop yields. The level of weed infestation is also high in poorly prepared farm land. As a result, additional labor is required for intercultural practices and weed control activities.

The FGD farmers mentioned that land preparation is done using traditional tools such as hand hoe and oxen plow which is not ease their work load and finish the operation at time. In all study areas, improved farm implements are not used due to lack of availability of the implements by near of the farmers. Farmers limited awareness on the availability of improved implements, limited extension services on the use of improved farm implements for different operations and limited capacity of technology multiplication and distribution.

Row planting technologies: For seeds and fertilizer application farmers are commonly used traditional row planting/sowing in includes hand dropping and broad casting crops grown particularly for cereal crops. The FGD farmers noted that planting/sowing of crops such as maize, sorghum and wheat in row is done using family labour. Sowing in row is very tidies, consumes time, labor and unevenly applied seed and fertilizer rate and reduces the crop yield. There is no animal drawn row planter/sow equipment available in all of study areas.

Post harvest handling and processing technologies

Farmers thresh and shell their crops using traditional threshing and shelling methods such as animal trampling and bit using human labor which is takes long time, post harvest losses and low quality. Transportation and storage technologies are those technologies which are used for transporting agricultural products, fertilizers, chemicals, animal products and others from one place to other by using human and animal power. Dominantly farmers used manually and traditionally by equines for transporting their agricultural products and no one uses animal drawn cart. Storage is necessary for keeping and maintaining grains to ensure household food supply. However, the famers commonly use traditional storages such as pit, underground and sack which have no guarantee protection against major storage pests such as weevils, rodents and insects.

The FGD farmers also reported that storage is a problem in the areas and the grain of sorghum, maize wheat, and haricot bean grain is affected by weevils. The mentioned that limited farmers used metal silo and Sack provided by office agriculture and natural resource and NGOs for grain storage areas. There is similar situation for vegetables and fruits storage and processing technologies in all study areas.The FGD farmers reported that the major constraints to agriculture engineering technologies are lack of developing suitable to local conditions, limited promotion of improved farm tools, row planter, and fertilizer application equipment threshing machines, post harvest technologies are the major limiting factors among the others. Post harvest handling, which includes different activities like sorting, storing, transportation, is done by the farmers themselves or traders or brokers. For chat crops such as potato, onion and chat, if produces are sold at the farm gate which is the case in all aforementioned activities are performed by the buyer (traders or broker). Most of the farmers use sacks, underground storage and ground floor of their residential house as a store. There are high postharvest losses due to improper harvesting, handling, packaging and poor facilities to market. Means of transportation varies among farming systems but predominately producers use pack animals and vehicles.

Energy sources

In rural areas, fire wood, charcoal and crop residue are the major source of energy. Availability and use of modern energy supply sources especially electricity is very limited in East Hararge zone. Special until new there is no any electric in some districts such as Meyu Muluke, Gola odaand Kumbi. In urban areas, firewood and charcoal are the major source of Energy followed by fuel and electric energy. Urban population also depends upon firewood and charcoal for their domestic energy supply have increased from time to time for that the availability of firewood and charcoal have reduced due to the significant decrease in forest coverage in the zone. This situation shows that there is major dependence on natural forest and crop residue that aggravates the destruction of forest resources and depletion of soil fertility. In order to conserve the natural resources efforts should be made to introduce fuel saving devices and promote alternative energy supply. As to modern energy sources, the supply of modern energy sources are limited. The situation of modern energy sources specifically electric and fuel is stated in detain as follows.

Electric energy is one of the modern sources of energy for large and small-scale industries and domestic use such as cooking and providing light. Hence, the use of electric power plays a great role for natural resource conservation as it replaces wood and charcoal to great extent. However, the majority of the resident of East Hararge zone does not have electric power. According to East Hararge administrative zone Office for planning and Economic development (EHZOPED) indicates that from 541 rural kebeles, only 128 Rural Kebeles in the zone have access to electric service from hydroelectric power. In order to conserve the natural resources efforts should be made to introduce fuel saving technologies and promote alternative energy supply in the areas.

Transport and communication

Transport and communication are the most important elements for the economic development of any country of Region. They serve as a blood veins in transporting goods and services from production sector to consumption sector and vice-versa. Furthermore, they facilitate economic and social interactions between regions and people. From this point of view, attempts have been made to assess the transport situation in East Hararge zone. In the year 2015/2016 there was 180.5kms of asphalt road from Harar to West Hararge zone boundary. all weather rural road and a total of 2551kms of all Weather road exist in east Hararghe zone. Before two years while in the 2015 &2016 all Weather road exist in east Hararghe zone 5444km & 5591.18km.The length of asphalt and all weather gravel roads together results a road density of the zone to about 96.94/km^2 of asphalt and all weather roads Per 1000 Km^2 of an area in the zone. URAP road development program that is aimed to connecting the villages to main roads and districts capital is being under taken extensively and this will radically boost the road density of the zone and ultimately contribute to rapid socio economic development.

Potential opportunities for improving crop and livestock production in Chat/maize highland, Sorghum/cash crops and Coffee/maize mixed farming systems

- Availability of favorable conditions for the production of different crops and liestock production,
- Availability of favorable condition for the production of best quality coffee and horticultural crops that are marketable and exported to neighboring countries somalia,

Djubuiti, potential for vegetables and pulse crops production that it has become major source of income for many farmers in high land. There are also favorable conditions for poultry, beekeeping and fattening cattle. Availability of multiple cropping practices like intercropping of pulses with cereals,

- Availability of crop residues after crop harvest are potential feed resources that could be used for enhancing the productivity of the livestock
- Availabilities of Universities such Haramaya University, and availability of locally adapted livestock breeds such the cattle, goat and sheep breeds that have good potential for high growth rate is also another opportunity for enhancing livestock production and productivity by applying appropriate feeding and management practices.
- Moreover, the proximity to domestic and export market on main highway offer another advantage for accessing agricultural inputs and for marketing agricultural products.. proximity to big cities like Dire dawa,Jigjiga and Harar is also another potential
- Availability of wildlife, and tourism for tourist attraction places
- Availability of perennial rivers that can services for modern irrigational purpose, ground water resource which can be used for irrigation, land area that can services for agricultural investments in wereda's such as Rare laga ramis ,Dire adam boru, jalluu, potention for coffee production, availability of miniral deposits such as Gold ,Charcol stone, conistruction stone,Sprite,Gravel,Limestone, and tourist places such as GOda wanji,Hot water In the area , there is a large amount of minerals.

Potential opportunities for improving crop and livestock production in the Sorghum/groundnut mixed farming and Agropastoralist/pastoralist farming systems

- Availability of diverse agro-climate which provides wide opportunities for livestock and crop production and land use advantage.
- Availability of marketing possibilities for domestic and expoert market,
- Availability of cultivable land for the production of different cereal crops
- Utilization of water harvesting techniques; spring development and afforestation
- Favorable conditions for the production of best quality groundnuts and sesame
- Availability of cultivable land that suitable for agricultural practice,
- Availability of underground water resources, and under use it for irrigation
- Livestock population and potential
- Favorable conditions for the production of livestock and poultry.
- There is also place of tourist
- Availability of mineral deposits used for different purposes
- place of tourist such as endowed with
- Tourism- there are a diverse topography and landscape, wildlife, natural forest, wildlife, caves and hot spring that provides a wide range of opportunity for attraction of tourists.

Conclusion and Recommendations

This study was aimed at analyzing farming systems of the East Hararghe Zone. The specific objectives of the study include characterizing and identifying farming systems, and identifying and prioritizing constraints of the identified farming systems in the study area.Participatory Rural Appraisals (PRA) approach was used to collect and generate data from both primary and secondary sources. The study used PRA tools which included household survey, reviewing secondary data, focus group discussions, pair-wise ranking, and field observation. Multi-stage sampling techniques used to select representative districts and peasant associations (PAs).A total of 329 randomly selected farm householders for household survey and also atotal 26Focus group discussion (FGDs) also involved in the PRA study. The collected data were analyzed using descriptive statistics and PRA tools such as pair-wise rankings. The result of PRA indicates that based on agro-ecology and major livelihood sources of farmers/agro pastoralist, five major farming typologies such as Maize/Sorghum/Chat of the highland areas of mixed farming system (CMHMFS), Sorghum/Maize perishable crops of the Midland areas of mixed farming system (SMCMMFS),Sorghum/Groundnut of the lowland areas of mixed farming system (SGLFS),Coffee/Maize mixed farming system (SGLFS) and Agro pastoral/pastoral of the dry lowland areas (APDLFS) were identified in the Zone.

Results of PRA study revealed that the main crop production constraints were lack of improved varieties and cultivable land shortage were identified as the first limiting factor followed by insect pests, shortage of improved seeds supply, farm inputs (pesticides, fertilizers), erratic rainfall distribution/drought, soil fertility declining and extension service availability in decreasing order of priority.Similarly, livestock production in study area is constrained by ultimate animal feed shortage, drought, limited and deteriorated grazing land due to expansion of crop cultivation and limited improved forage production due to lack of adaptive and productive improved forage species that compatible to the existing farming practices has been highly affecting livestock production in farming system areas. Drought, declining of soil fertility, depletion of natural forests and deforestation were main constraints to natural resources. Hence, there is need for research, development and institutional interventions to alleviate the identified constraints to crop, and livestock production, natural resources and socioeconomic in the study area through holistic approach.

Based on the findings of the study, the following recommendations are given

Crop production

Shortage/lack of improved varieties for maize, sorghum, wheat, barley and teff is severe in mid-highland area, introduce and promote improved varieties (high yielding, disease resistance),Improvement and introduction of improved varieties (high yielding, early maturing, tolerant to moisture stress,/drought and disease) in lowland to mid-highland areas, Sorghum and maize improvement/adaptation and introduction (high quality in nutrient, high yielding, drought and disease) in lowland to mid-highland areas, Introduce and promote efficient cropping systems for diversifying and intensifying crop production in the area'Improvement and introduction land races of sorghum varieties (early maturing and disease) in lowland to mid-highland areas, Introduce and promote improved agronomic practices for sorghum, maize, wheat, teff, Promotion of integrated pest management for controlling of pests of cereal,increasing cropping intensity will be a key strategy , Short duration pulses, oilseeds and other high value crops will find their definite niche as sequential or intercrops, rather than replacing the major cereal crops having higher yield stability, intensive diversified complementary cropping systems would enable small and marginal farmers to utilize limited land and water resources in more efficient manner. Strengthening and capacitating farmers organizations for input and output marketing and creating linkages with value chain actors is need attention.

Lack of improved varieties for pulse and oilseed crops were the major limiting factors in crop production in the study area(Lowlands, midlands and highlands),Improvement/adaptation and introduction (high yielding, drought and disease) for lowland to mid-highland areas haricot bean both food and market type, Faba bean, chickpea, groundnut Introduce and promote efficient cropping systems for pulse and oilseed crops, Introduce and promote improved agronomic practices for haricot bean, promotion of integrated pest management for controlling of pests of cereal.

- Improvement and introduction of improved varieties (high yielding, resistant to disease)-tomato, hot/chile pepper, red and white onion, cabbage, carrot, potato, beetroot, w/potato
- Improvement and introduction improved varieties for fruit crops (Mango, Papaya, Avocado, Banana, ,
- Promotion of integrated pest management for controlling disease and Improvement and introduction of improved coffee varieties (high yielding, drought, tolerant, resistant to disease, early mature)
- Expansion of basic grains production in areas far from roads and the urban market, intensification of horticultural production in areas close to roads and the urban market

Livestock production

- Improvement and introduction improved forages for their high quality and biomass,
- Improvement and introduction improved enhancing communal grazing land
- Introduction of proper animal feeds treatment, and improvement of the nutritional quality and preservation of existing feeds such as crop residues
- Integration of crop and forage legumes for animal feed production and soil conservation,
- Introduction and promotion of improved breeds (crossbred) and local cows with better production potential along with other improved dairy
- Expansion of veterinary service and use of proper animal husbandry
- Improving access to crossbred animals through A.I (Artificial Insemination) by crossing the indigenous animals with the improved dairy breeds or use of improved dairy bull service

- ➢ Use of Artificial Insemination and supply of improved breeds
- ➢ Improve management of existing cattle breeds (in terms of feed, vaccine and treatment) to enhance the productivity of local breeds,
- ➢ Enhancing the capacity of veterinary technician both technically and materially will help in controlling the outbreak of the diseases in the study area,

Natural resources management

- Introduction and promotion proper soil fertility improvement technologies and other agronomic management practices
- Development and introduction of integrated application of farmyard manure and chemical fertilizers for improving soil fertility, and yields of crops
- Development and introduction of integrated farmyard manure and compost application to improve soil fertility, and yields of crops
- Development and introduction of integrated nutrient management practices and rate and timing of nitrogen fertilizer on the yields of major crops measures, and practicing multiple cropping practices like intercropping of pulses with cereals,
- Integrated soil and water conservation (physical and biological conservations)
- Strengthening the indigenous agro forestry practices through research intervention
- Development and introduction of improved irrigation technologies for enhancing farmers' irrigation water use efficiency
- Development and introduction water management practices for for enhancing crop production
- Development and dissemination of water saving technologies
- Water management strategies for major crops due to climate change
- Development and introduction of multi-purpose tree species and suitable for indigenous agro forestry
- Development and introduction of integrated soil and water conservation technologies
- Introduction and promotion of tree species that are well adapted to the agro-ecologies to respond for climate change problem,
- Development and promotion of soil fertility management options for highland and midland mixed farming areas
- Development and promotion of soil fertility management options for sorghum/groundnut and agro pastoralist farming systems

Agricultural engineering research

- Development of post-harvest technology and post-harvest management systems for cereals, pulses, oil seeds, vegetables and fruits,
- Development of suitable, seeding, seedling and fertilizer application equipment
- Development and promotion of harvesting and threshing machineries for major crops
- Development and promotion of row planters, threshers/shellers and decorticators

- Improved soil and water conservation and irrigation water efficient utilization technologies,
- Storage structures,, milk processing, honey processing, animal feed processing and carts for farm product transportation
- Small-scale animal feed processing and poultry house
- Alternative source of energy should be used for house hold consumption to save natural resources.
- Alternative energy sources for house hold consumption, which can contribute toward environment protection shall be taken
- The source of income for rural households should be diversified in lowland areas

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Characterization of Farming System in the Major Agro-Ecology of Kellem Wollega Zone, Oromia National Regional State of Ethiopia

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Abstract

This research attempted to analyze farming systems characterization of major agro-ecologies of selected districts of Kellem Wollega Zone. The data were collected from both primary and secondary sources where the primary data for were generated structured questionnaire, Focus Group Discussions and key informant interview. The primary data was collected from total of 128 households' heads and analyzed using STATA 13 software. The farming systems in the Kellem Wollega Zone was characterized as mixed farming systems, in which both livestock and crop production take place within the same locality. The major cropping systems in the study area are mono cropping, intercropping, double cropping and crop rotations systems. The major constraints of crop production in selected districts were disease and pest problem, land shortage and soil fertility declines, termite problem, shortage of improved varieties, weather fluctuation, high input cost, shortages of agro-chemicals and weed problems. In the study area, livestock production is also an important source of income and means of livelihood and kept for its multifunctional role such as food for the family, draught power, transport, income generation and manure production for soil fertility management. The feed resources in the selected districts were primarily natural pasture (communal and own grazing), cultivated forages, crop residues and purchased feed. Additionally, farmers are cultivating elephant grass, rhodus grass, desho grasses and cow pea as the most important improved forage. The major problems of livestock production were disease and parasite, shortage of animal feed and improved forage, lack of improved breed, shortage of veterinary service and AI services, wild animals and lack of grazing land. Policy implications drawn from the study findings suggested to improve the inputs supply system of improved quality and quantity of improved varieties, ensures supply and distribution of crops technologies and improved agronomics practices, capacitates farmers' indigenous knowledge , improving production and productivity of crops and livestock, expanding awareness for farmers in physical and biological soil conservation and expanding accessibility of market infrastructures and strengthening supportive institutions.

Key words: *Farming systems; Characterization, Crops; Livestock; Natural resources*

Introduction

Agriculture is the most important sector in Ethiopia; it accounts for 46% of GDP, 80% of export value, and about 73% of employment. The sector still remains largely dominated by rain-fed subsistence farming by smallholders who cultivate an average land holding of less than a hectare. Although agriculture has a long history in the country's economy, development of the sector has been hampered by a range of constrains which include land degradation, low technological inputs, weak institutions, and lack of appropriate and effective agricultural policies and strategies (Aklilu, 2015).Agriculture is the largest sector of economic activity in Ethiopia and it continues to the main source livelihood for majority of the country population. Being the dominant sector, the economic growth of the country depends on the performance of its agriculture. There is a great interdependence in Ethiopia between agricultural and non–agricultural sectors. Subsistence agriculture is a highly risky and uncertain venture. It is made even more so by the factor that human lives are at stake. In regions where farms are extremely small and cultivation is dependent on the uncertainties of variable rain fall, average output will be low and in poor years, the very peasant and his and family will be exposed to the very real danger of starvation. In such circumstances, the main motivating force in the peasant's life may be the maximization not of income but of his/her family chances of survival.

Farming system typologies are dictated by climate, production goals and culture with a farming system being described as a unit consisting of a human group (usually a household) and the resources it manages in its environment, involving the direct production of plant and/or animal products (FAO, 1990).A farming system is defined as a population of individual farm systems that have broadly similar resource bases, enterprise patterns, household livelihoods and constraints, and for which similar development strategies and interventions would be appropriate. Depending on the scale of the analysis, a farming system can encompass a few dozen or many millions of households" (FAO and WB, 2001). According to FAO (2011)farming systems classification is based on the following criteria: available natural resource base, including water, land, grazing areas and forest; climate, of which altitude is one important determinant; landscape, including slope; farm size, tenure and organization; and dominant pattern of farm activities and household livelihoods, including field crops, livestock, trees, aquaculture, hunting and gathering, processing and off-farm activities. In addition, account is taken of the main technologies used, as they determine the intensity of production and integration of crops, livestock and other activities (FAO, 2011).A farming systems framework was used to organize and analyses primary empirical data to track how farming systems in the study areas have evolved over time. Such an approach recognizes the biophysical production system, made up of crops, climate, soils etc., the management system, including people, values, goals, knowledge, resources and decision making and the social, economic and institutional context in which they are situated. Using such a framework enabled the analysis of the interconnectedness and interdependence of components simultaneously influencing farming systems, yet operating across a range of spatial scales (e.g., climate, labour, markets, knowledge etc) (Dixon et al, 2014)

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 and in accordance with the household goals preferences and resources. These factors combine to influence the output and production methods. Farming system is described as a unit consisting of a human group (usually a household) and the resources it manages in its environment, involving the direct production of plant and/or animal products. Typology of farming system is dictated by climate, production goals and culture of a society. This classification of the farming situations of developing regions may be as varied as – available natural resource base, climate, landscape, farm size, tenure and organization, dominant pattern of farm activities and household livelihoods, which determine the intensity of production and integration of crops, livestock and other activities In this study, farming systems are characterized based on farm characteristics especially reflecting the level of integration of livestock and crop production which is relevant to the diversity of farms in the study area.

Agriculture in Ethiopia has experienced steady growth since 2004. Though the overall trend is encouraging, both in terms of overall agricultural production and productivity, the sector suffer from major structural problems. Despite an average investment close to 13% of the total expenditure, Ethiopian agriculture remains low input, low-value and subsistence oriented, and is vulnerable to frequent climatic shocks. The agricultural sector in Ethiopia is being increasingly confronted with the pressure from a rapidly growing population and diminishing natural resources (Mulugeta, 2004; Abate, 2010). Kellem Wollega Zone has endowed favorable climatic condition with wide range varieties of crop production rearing livestock.

According to Kellem Wollega (KWZBANR,2016), the major crops produced in the zone are maize, sorghum, teff, wheat, barley, finger millet, rice, faba bean, field pea, haricot bean, lentil, chickpea, soya bean, Niger seed, sesame, rape seed and ground nut and the major challenges of agricultural production of the zone are disease, insect pests, high input cost, shortage of improved technologies, weed damage, termite, soil infertility, land degradation, soil erosion, deforestation and weather fluctuation. In Kellem Wollega Livestock plays significant role in the economy of the zone in general and household particular. Every household keeps livestock such as cattle, sheep, goats, horse, donkey and poultry.

The major problems of livestock production in the zone are disease and parasite, shortage of animal feed and improved forage, lack of improved breed, shortage of veterinary service and AI services, wild animals and lack of grazing land. Any effort to improve agricultural productivity requires a detailed study on existing farming systems. Results of such studies help to look for alternatives to the existing farming systems and there by identify the effects of various activities (crop and livestock) on farm plans. Therefore, the aim of this research was to characterize the farming system and identify the major agricultural productions constraints by assessing farming system, attitude of farmers towards new farming methods, the farmers' knowledge about crops, livestock and natural resource management systems, major constraints and solutions taken by the farmers regarding constraints of agricultural production.

General objective

To characterize and analysis farming systems in major agro-ecologies in the Kellem Wollega Zone.

Specific Objectives

- ✓ To understand and identify the challenges and opportunities of agricultural production in the Zone
- ✓ To identify and prioritize major crops, livestock and natural resource sub-sectors in the zone
- ✓ To assess available technologies to improve agricultural production in the Zone
- ✓ To document key constraints and direct relevant research interventions

Methodology

Description of Study Area

Farming system characterization survey was undertaken in Kellem Wollega Zone of Oromia National Regional State. Kellem Wollega Zone is one of the current 21 zones of Oromia Regional national State. Kellem Wollega has got its unique name from the particular place called 'Kellem' which is now located in Gidami District. The capital town of the zone is Dembi Dolloo. Dembi Dollo town has distance of about 652 km from Addis Ababa. Kellem Wollega extends from 8^{o}10'58"N-9^{o}21'53"N latitude and 34^{o}07'37"E-35^{o}26'53"E longitude. Kellem Wollega zone has characterized with different features like highland, lowlands and rugged areas. The relative location of the zone can be determined as West Wollega on North and East, Benishangul Gumuz in North-West, Ilubabor zone in South and South-East, Gambela in West and South-West, and Sudan in the West.

The land size of the zone is estimated to be 10,488 square Kms. The central part of the zone has the altitudinal range of 1500 meters to 2500 meters which extends to the north and eastern part of the zone. Most part of the Kellem Wollega zone ranges between 500 meters to 1500 meters. The lowest part is located towards the Sudan Border in Gidami district below 500 meter in area called Waro koyan. Mean annual temperature of the zone varies from 15^{o}c to over 25^{o}c.The mean annual rainfall of the eastern high lands range from 1800-2000mm, while in the central plateaus range between 1600-1800mm and in the remaining parts of the zone it becomes between 1200-1600mm and becomes less than 1200mm in the southwestern parts of the zone.

The major soil types of Kellem Wollega zone are acrisols, Nitosols, Eutric Fluvisols, Distric Histosols, and Vertisols. At present, the Zone has 12 woredas out of which one is urban and the other left are rural woredas. From total of 12 districts of the zone, the three districts namely Yemalogi Welel ,Seyo, and Dale Sedi were selected purposively to represents highlands, midlands and lowland agro-ecology respectively (KWANRMO, 2016). These districts were selected for this study with the consultation of Zonal Agricultural and Natural Resource Management Bureau to represent the major agro-ecology of Kellem Wollega Zone.

Description of selected district

Sayo district

Seyo is one of 12 districts of Kellem Wollega Zone. Astronomically the district is located between $8^0$12'-$8^0$44' North latitude and $34^0$41'-$35^0$00' East longitude. It is bounded by Gambela Regional State in the South, Ilubabor Zone in the South East, Hawa Galan and Yemalogi Welel district in the North and East and Anfilo district in the West and North West. The district has a total area of 1,278 square km. Total human population of the district was estimated at 127,643 of whom 70,812 was male and 56,831 was female (SWANRMO, 2016). The district has a total of 26 kebeles. From total rural kebele, 9 of them categorized to highland agro-ecology, 7 mid highland agro-ecology and 8 kebeles allocated to lowlands agro-ecology. The altitude of the woreda varies from 1100 meters to 2750 meters above sea level. It receives average annual rainfall of 1050 mm and range from 600mm to 1500mm. Seyo district has an average annual temperature of 19^0c and range of 10^0c-28^0c. In terms of agro-ecology, the district were categorized as Dega (34.6%), Weina Dega (26.9%) and Lowland (Kola) (38.5%) (SWANRO, 2016). Soils types in the district are predominantly sandy loam, clay loam and silty loam. According to information obtained from woredas offices land use systems of the districts were categorized as arable land 64,328.06 ha, cultivated land 37,178ha, forest land 3,491.5ha, grazing land 3,491.5ha and others land is about 52,360ha from total of 129,100 hectare.

Yemalogi Welel district

Yemalogi Welel is one of 12 districts of Kellem Wollega Zone. Yemalogi Welel is located in the Northern part of Kellem Wollega 42 Km away from the capital of the Zone, i.e. Dembi Dollo. The capital city of this district is known as Tedjo. Yemalogi Welel is bounded by Hawa Galan District, from the South Seyo and Anfilo, in the West Gidami, in the North West Jimma Horro and Gawo Kebele in the North East Dale Wabera district. The district has a total area of 551.15 square km. Total human population of the district was estimated at 64,605 of whom 29,308 was male and 35,297 was female. Of the total households 96.1% is rural agricultural households and 3.9% is urban population (YWWANRO, 2016).The district has 15 (fifteen) kebeles and one urban center. From total rural kebele, 6 of them categorized to highland agro ecology, 6 mid highland agro-ecology and 3 kebeles allocated to lowlands agro-ecology. The altitude of the Woreda varies from 1500 meters to 3335 meters above sea level. It receives average annual rainfall of 1675 mm and range from 825 mm to 2500 mm. Yemalogi Welel district has an average annual temperature of 21^0c and range from 18^0c-24^0c. In terms of agro-ecology, the district is categorized as Dega (40%), Weina Dega (40%) and Lowland (Kola) (20%) (YWWANRO, 2016). According to information obtained from key informants interviews of woredas soils types in the district are predominantly loam soil (86%), Sandy soil (4%) and Clay Soil (10%). The land use systems of the districts were categorized as arable land 18,080.04 ha, cultivated land 18,095 ha, forest land 8,718.64 ha, grazing land 985 ha and others land is about 9,272.65 ha from total of 55,151 hectare of land.

Dale Sadi district

Dale Sadi is one of 12 districts of kellem Wollega Zone. Dale Sedi is located in Southern part of Kellem Wollega Zone at a distance of 89 km away from zonal capital (i.e. Dembi Dollo town). It is bounded by Ilubabor Zone in the South, Dale Wabera district in the West, Lalo Kile district in the East and Ayira district of West Wollega zone in north. The district has a total area of 694.18 square km. The capital city of this district is known as Haro Sebu (Alem Teferi). Total human population of the district was estimated at 103672 of whom 54570 was male and 49102 was female. Of the total households 85.5% was rural agricultural households and 14.5% was urban population (DSWANRO, 2016). At present, the district has 30 administrative sub divisions out of which 27 kebeles was rural and the remaining 3 kebeles was urban centers. The altitude of the woreda varies from 1400 meters to 2000 meters above sea level. It receives average annual rainfall of 1225 mm and range from 1150 mm to 1300mm. Dale Sedi district has an average annual temperature of 23^0c. In terms of agro-ecology, the district was categorized as Weina Dega (60%) and Lowland (Kola) (40%) (DSWWANRO, 2016). There is no reliable data regarding soil types in the district, however, some key informants responds that black (loam top) soil with a mixture of red ones was dominants one. According to information obtained from woredas offices land use systems of the districts was categorized as arable land 22,180 ha, coffee land 19,228ha, forest land 8,235ha, grazing land 9036ha and others land is about 10,738.62ha from total of 69,418 hectare of land.

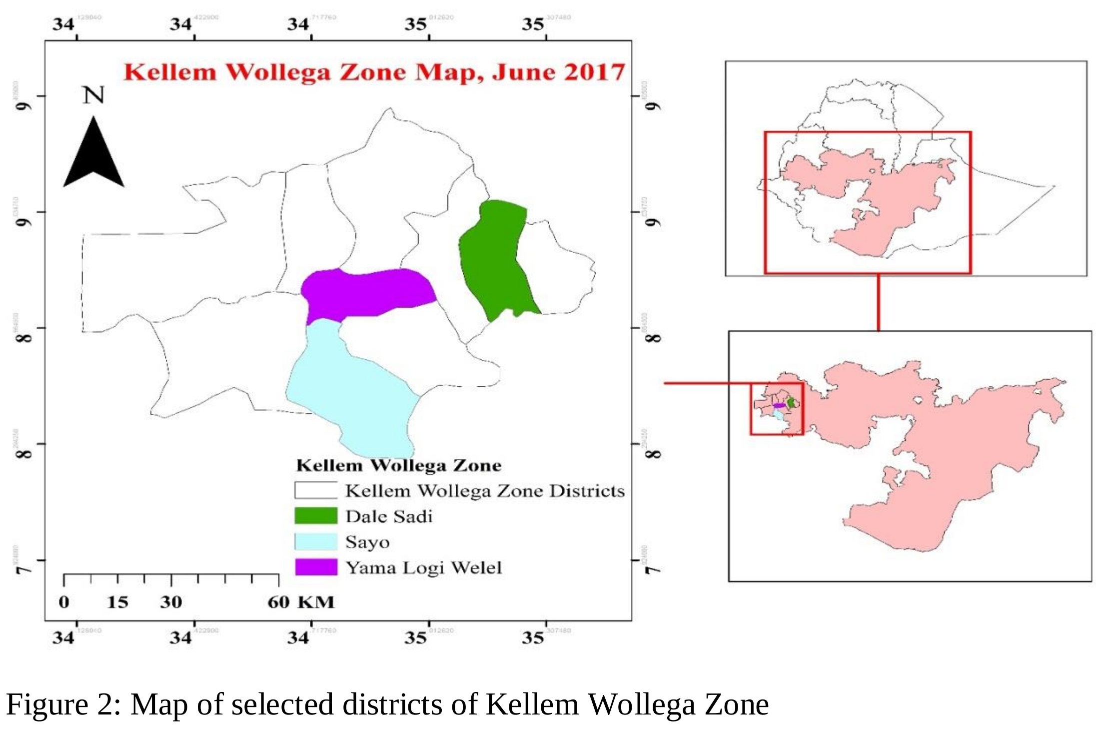

Figure 2: Map of selected districts of Kellem Wollega Zone

Sampling technique and sample size

A team of five members comprising HSARC staff conducted the survey using structured questionnaires with individual interview method. Three stages random sampling procedure was used for the selection of sample household heads. In the first stage, three representatives' districts namely Yemalogi Welel, Sayo and Dale Sadi districts were selected purposively from highland, midlands and lowlands agro-ecology, respectively, out of 12 districts of Kellem Wollega Zone. In the second stage, a total of six kebeles from three selected districts were selected. The districts and kebeles were selected in a participatory manner through discussions with zonal and district experts to ensure that the samples were fairly representative with respect to the agricultural production potential while addressing the study objectives. In the last stage, from six kebeles about 128 samples of household heads were randomly selected and surveyed. Besides, focus group discussion was conducted which held with 15-20 farmers in each selected kebeles.

Table 1: List of study sites

No.	District	Kebeles	Number of sampled households
1	Dale Sadi	Mender-14	20
		W/Wale Suchi	20
2	Seyo	Tabor	21
		Aleku Gambi	26
3	Yemalogi Welel	Burqa Welel	21
		Lomicha Cebel	20
Total			128

Source: Own survey results, 2016.

Types of Data and Methods of Data Collection

For this study both primary and secondary data were used. The secondary data was explored from different sources including Kellem Wollega Zone and selected district Bureaus of Agriculture, Kellem Wollega Zonal and selected district livestock and Fisher resource developments, Central Statistical Authority (CSA) and literatures. On the other hand, separate questionnaires and checklists were prepared and employed to collect primary data from farmers and key informants. The study was employed cross-sectional data collection tools because it is better and more effective for obtaining information about the current status or the immediate past of the case under study. It is also appropriate and suitable to use data collection tools such as questionnaires, interviews, Focus Group Discussions, key informants interviews, field observations, and document analyses. The data collection survey and focus group discussions were undertaken in 2016. Both quantitative (questionnaire, secondary documents) and qualitative data collection instruments (FGD), key informant interviews (KII), and field observations) have been used. The formal survey was undertaken through formal interviews with personal interviews with a structured questionnaire were administered. Before data collection, the questionnaire was pre-tested on ten farmers to evaluate the appropriateness of the design, clarity and interpretation of the questions, relevance of the questions and to estimate time required for an interview. Subsequently, appropriate modifications and corrections were made on the questionnaire. The questionnaire covered different topics in order to capture relevant information related to the study objectives. In both types of data information on the socio-economic aspects of farm households including household characteristics, farm resources and source of income for the smallholders and agricultural production constraints with special emphasis on crop and livestock production, and natural resources.

Method of data analysis

After data was collected from both primary and secondary sources, it was analyzed using different methods of data analysis. Before analysis, quantitative data gathered using the survey was coded and entered into statistical software known as Statistical Package for Social Sciences (SPSS -20).The data generated through questionnaires, focus group discussion; formal and informal discussions were analyzed and interpreted qualitatively and quantitatively. The data analysis was carried out using the STATA-13 software. The quantitative data were first recorded and organized in a SPSS. Simple descriptive statistical methods such as average, percentage, standard deviation, and frequency distribution were used. In addition to this, descriptive tools such as tables, and pie chart were used to present data. The qualitative data analysis was used to see the relationships between the variables and they were then analyzed through systematically organizing the information and giving attention to local situations, opinions, perceptions and preferences of households and institutions operating in the district.

Results and Discussions

The results discussed in this paper was focus mainly on farming systems in the Kellem Wollega Zones characterized in the arable areas of Western Oromia.

Socio-Economic Characteristics of Sampled Households

As shown in Table 2, out of total households heads interviewed about 96.09 percent was male headed while 3.91 percent was female headed households. Education empowers people, strengthens their abilities to meet their wishes and increase their productivity and potential to improve their quality of life. In terms of education, the survey results show that about 15.63% of the sampled household heads was illiterate, 7.81% was able to read and write, 71.09% attended formal education (1-8 grades), 4.69% was attended formal education (9-12 grades) and 0.787% of sampled household was holds Diploma and above formal education. The average age of sampled farm household heads was 42.54 year with a range of 18 to 80 years. A family size ranging between 1 and 14 is witnessed in the selected farming households. The available data indicates that average family size in each household is 6.23 (Table 2).

Table 2: Socio-economic characteristics of sampled producers of Kellem Wollega Zone

Variables		Dale Sadi		Seyo		Yemalogi Welel		Total	
		Freq	%	Freq	%	Freq	%	Freq	%
Sex	Male	40	100	44	93.62	39	95.12	123	96.09
	Female			3	6.38	2	4.88	5	3.91
Education	Illiterate	8	20.0	2	4.26	10	24.39	20	15.63
	Read and write	4	10.00	4	8.51	2	4,88	10	7.81
	Formal education(1-8)	28	70	37	78.72	26	63.41	91	71.09
	Formal education(9-12)			3	6.38	3	7.32	6	4.69
	Diploma and above			1	2.13			1	0.78
		Dalle Sadi		Seyo		Yemalogi Welel		Total	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age (year)		38.67	10.57	47.29	14.99	40.87	12.91	42.54	13.49
Family size (number)		5.4	1.62	6.06	1.95	7.24	2.15	6.23	2.05

Source: Own survey results, 2016.

Land Size and Allocated Pattern

One of the most important factors that influence crop production is resource endowment, availability of land for crop production and livestock rearing. Land is the basic asset of the sample farmers. The survey revealed that the mean cultivated land size of sampled households were 0.96, 0.92 and 1.57 hectares in Dalle Sadi, Seyo and Yemalogi Welel districts, respectively. Cultivated land size was more in Yemalogi Welel than in Dalle Sadi and Seyo. As depicted in Table 3, also that average land allocated for coffee production were 0.42, 0.27 and 0.58 hectares in Dalle Sadi, Seyo and Yemalogi Welel, respectively, while average grazing land size of sampled households were 0.24, 0.17 and 0.57 hectares of land in Dalle Sadi, Seyo and Yemalogi Welel districts, respectively. The average forest land sizes of sampled households were 0.30, 0.21 and 0.42 hectares in Dalle Sadi, Seyo and Yemalogi Welel districts, respectively. Average degraded land size in Yemalogi Welel was higher than the two districts this may due to slope steepness of the land in the district than other two districts and which exposed to erosion and soil fertility decline. Average irrigable land size was 0.23, 0.13 and 0.37 hectares in Dalle Sadi, Seyo and Yemalogi Welel districts, respectively (Table 3).

Table 3: Average land size of selected households

Item	Dalle Sadi		Seyo		Yemalogi Welel		Total		
	Mean	SD	Mean	SD	Mean	SD	Obs	Mean	SD
Cultivated land (ha)	0.96	0.53	0.92	0.53	1.57	1.35	127	1.14	0.92
Coffee land (ha)	0.42	0.27	0.27	0.46	0.58	0.65	108	0.42	0.49
Grazing land (ha)	0.24	0.14	0.17	0.12	0.57	0.62	45	0.34	0.42
Frost land size (ha)	0.30	0.20	0.21	0.14	0.42	0.33	29	0.32	0.25
Degraded land (ha)	0.25	0.17	0.12	0.04	0.41	0.10	21	0.28	0.16
Residential land (ha)	0.14	0.08	0.15	0.13	0.19	0.10	118	0.16	0.11

Fallow land (ha)	0.18	0.10	0.25	-	0.46	0.27	14	0.37	0.26
Irrigable land (ha)	0.23	0.17	0.13	0.09	0.37	0.17	19	0.21	0.16
Shared land (ha)	0.28	0.28	0.44	0.27	0.5	-	13	0.38	0.27
Total farm (ha)	1.82	0.98	1.47	0.88	5.54	17.8	128	2.88	10.19

Source: Own survey results, 2016.

Farming systems and means of livelihood

The farming systems in the Kellem Wollega Zone was characterized as mixed farming systems. In the mixed farming systems both livestock and crop production take place within the same locality, where the ownership of the crops or land and the livestock is integrated. Survey results from Focus Group Discussions indicated that a major source of income generation of producers in selected districts has been crop production and followed by livestock production. Some farmers also participate on non/off-farm income activities like daily laborer, petty trade, guarding and cattle and sheep fattening and sale.

Crop production

Major Crops Produced Under rain fed In Selected Districts

It is clear that crop production pattern of an area depends mainly on agro-ecology factors namely climate, soil types, crops types, community crop production habit and also marketing factors. Kellem Wollega Zone has endowed favorable climatic condition with wide range varieties of crop production. Maize, sorghum, teff, wheat, barley, finger millet, rice, faba bean, field pea, haricot bean, lentil, chickpea, soya bean, Niger seed, sesame, rape seed and ground nut are some of the major crops produced in the zone (KWZBANR,2016). According to Focus Group Discussion survey results the major crops produced in selected districts are maize, sorghum, finger millet, teff, barely, wheat and rice among cereal crops; haricot bean, faba bean, field pea, chickpea and ground nut among pulse crops; sesame, noug, soybean and linseed among oil crops (Table 4). As indicated in Table 4, sweet potato, potato, sugarcane, onion, garlic, anchote, beet root and carrot were the major root and tuber crops produced, whereas, hot pepper, cabbages and tomatoes were the major vegetables crop produced in selected district. The major fruits crops produced in selected districts were mango, banana, papaya, orange, avocado and lemon, whereas, coffee, ginger, fenugreek, black cumin, turmeric, Cordamom and white cumin were among spices crops produced.

Table 4: Major crops produced in under rain fed selected districts

Crop category	**Type of major crops produced**		
	Dalle Sadi	**Seyo**	**Yemalogi Welel**
Cereals	**Rank**	**Rank**	**Rank**
	Maize	Maize	Maize
	Sorghum	Sorghum	Sorghum
	Finger Millet	Wheat	Finger Millet

	Teff	Finger Millet	Wheat
	Rice	Teff	Teff
		Barley	Barley
Pulse crops			
	Haricot bean	Haricot bean	Faba bean
	Faba bean	Faba bean	Haricot bean
	Chick pea	Field pea	Field pea
	Field pea	Chick pea	Chick pea
	Ground nut		Ground nut
Oil crops			
	Noug	Linseed	Sesame
	Soybean	Noug	Noug
	Linseed	Sesame	Soybean
		Soybean	Linseed
Root & Tuber			
	Sweet potato	Potato	Sweet Potato
	Sugar cane	Carrot	Potato
	Potato	Garlic	Garlic
	Red root	Sugarcane	Anchote
	Carrot	Sweet Potato	Onion
	Onion	Onion	Carrot
Vegetables			
	Hot Pepper	Hot Pepper	hot pepper
	Cabbage	Cabbage	Cabbage
	Tomato	Tomato	Tomato
Fruit Crops			
	Mango	Banana	Banana
	Banana	Mango	Mango
	Papaya	Avocado	Avocado
	Orange	Orange	Papaya
	Avocado	Lemon	Orange
	Lemon	Papaya	Lemon
Coffee and Spice			
	Coffee	Coffee	Coffee
	Ginger	Ginger	Ginger
	Fenugreek	Fenugreek	Turmeric
	Black cumin	Cordamom	Cordamom
	Turmeric	Black Cumin	Black cumin
	Cordamom	Turmeric	Fenugreek
	White cumin		

Source: Own survey results, 2016. (The crop is ranked as the major produced by farmers)

Cropping systems and pattern

The term cropping system refers to the crops and crop sequences and the management techniques used on a particular field over a period of years. The major cropping systems in the study area was mono cropping, intercropping, double cropping and crop rotations systems.

i) Mono cropping

Mono cropping is the practice of incessantly cultivating the same type of crop on the same piece of land year after year. Mono cropping systems is the most dominant cropping system in the study area. For example, maize and sorghum farming is common in all three district.

ii) Double cropping

Double-cropping (also known as sequential cropping) is the practice of planting a second crop immediately following the harvest of a first crop, thus harvesting two crops from the same field in one year. According to data obtain from focus group discussion, planting of chick pea, haricot bean and barley after maize and potato; faba bean, barley after haricot bean; haricot bean, faba bean and field pea after barley are common practices.

iii) Intercropping

The other dominant cropping system in the studies districts is inter-cropping. The most common type of intercropping in the area is intercropping of maize with haricot bean, cabbage, anchote, pumpkin, or potato. Intercropping of coffee with ginger, haricot bean or Anchote with cabbage and linseed are also practiced.

iv) Crop rotation

Crop rotations, as a primary aspect of cropping systems, have received considerable attention in recent years. Crop rotation practiced in Kellem Wollega Zone was cereal with pulse and oil crops, cereal with cereal, cereal with horticultural crops and pulse with horticulture crops.

Productivity and area coverage major crops under rainfed

Productivity of crops is affected by multitude of challenges, including limited use of improved technologies, biotic and abiotic factors, low quality of crop products, lack of access to markets and limited/no access to credit. The productivity is output per unit hectare depends on the types of seed used (local and improved), fertilizer type and rates applied, labor and the management practices, environmental and edaphic factors. Table 5 shows productivity of the main crops cultivated during main cropping season/meher period of 2015/16 in selected district of Kellem Wollega Zone. The average productivity of maize were 38.01, 37.62 and 30.08quintals per hectare at Dalle Sedi, Seyo and Yemalogi Welel districts, respectively, in 2015/16 main production season. The mean average yields of maize crop was above national yield in Dalle Sadi and Seyo districts and below average national yield in Yemalogi Welel district (CSA, 2016). The reason below average national yield in Yemalogi Welel district was due to shortage of improved technologies and high soil erosion due to slope steepness of land in that district relative to others two districts. Average productivity of sorghum was highest in Seyo district which is 25.56 qt/ha relative to others two districts, this may due to usage of improved technologies and good management practices relatives to the two districts. The survey results also revealed that productivity of finger millet were 19.48, 17.38 and 12.55quintals per hectare in Dalle Sadi, Seyo and Yemalogi Welel districts respectively, in 2015/16 main production season. The mean average yields of finger millet was below national yield (22.30qt/ha) in all three districts (CSA, 2016). This may due to lack of improved variety in the study area. Average productivity of haricot bean is 13.86, 13.25 and 11.23quintal per hectare in Dalle Sadi, Seyo and Yemalogi Welel districts respectively, in 2015/16 main production season (Table 5). For all crop types produced in three districts average productivity per hectare are above and below national average productivity. For these crops average national productivity were below national average productivity attention should must be given to improved productivity by improving soil fertility management, usage of improved technologies and appropriate agronomic management practiced. The summaries of productivity of major crops are indicated in Table 5.

Table 5: Summary of Crop Productivity and area coverage produced under rainfall in selected districts

Crop type	**Dalle Sadi**		**Seyo**		**Yemalogi Welel**	
	Average area allocated (ha)	Average yield (Qt/ha)	Average area (ha)	Average yield (Qt/ha)	Average area (ha)	Average yield (Qt/ha)
Maize	0.22	38.01	0.26	37.62	0.51	30.08
Sorghum	0.29	23.04	0.75	25.56	0.36	17.88
Finger millet	0.28	19.48	0.10	17.38	0.42	12.55
Wheat	-	-	0.19	17.83	0.24	9.22
Teff	0.30	7.443	0.16	6.59	0.37	6.13
Haricot bean	0.12	13.86	0.14	13.25	0.35	11.23
Faba bean	0.11	11.72	0.12	10.66	0.25	8.97
Field pea	0.03	33.3	0.11	5.52	0.16	8.16
Sesame	0.25	4			0.21	3.81
Noug	0.24	5.83	0.04	6	0.08	10.1
Soybean	0.12	13.64			0.16	9.4
Linseed	0.01	25	0.06	6.24	0.02	39
Chickpea	0.19	6.215	0.07	11.62	0.23	2.75
Pepper (dry fruit matter)	0.15	28.25	0.06	24.43	0.22	20.15
Anchote	0.03	100.91	0.04	32	0.06	36.75
Sweet potato	0.05	39.1	0.12	43.75	0.04	10.5
Coffee	0.41	12.51	0.27	17.81	0.50	12.206

Source: Own survey results, 2016.

Agricultural calendar for major crops and method of planting/sowing

The farming systems of smallholders in Kellem Wollega Zone was predominantly annual crop productions, following the similar cropping calendar for these crops, both in main rainy season (meher) or short rainy season (belg). The common practices performed for these annual crops were plowing, sowing, weeding, harvesting, and threshing. Preparation of plots usually starts in the beginning of March and most crops are sown from April to August. However, because of crop variety and soil type, variations may appear in crop calendar for particular crops. The major crops calendar of maize, sorghum, barely, haricot bean, potato, sweet potato and coffee as shown in (Table 6); Land preparation (March-April), planting (May-August), weeding (June-September), harvesting (November-January) and threshing (December- February). All farm activities sowing, harvesting, weeding, and etc for majority of the crop have been conducted by traditional method. Man power and oxen power was the main source of labor for land plowing and other farm activities in all study districts. For major activities the crop calendar is an important aspect of crop production in studies districts. The majority of producers in three districts sow/plant their crops by row and broadcasting. Crop technologies have started to be used in the last decade in most of the studies districts. For instance, application of commercial fertilizer, use of improved varieties, herbicide and manure application have increased over the last ten years. However, from crops produced in three districts producers access improved varieties for only maize, sorghum, teff and coffee crops for others crops there was no improved varieties available which implies there is high need to generate, adapt and popularize improved varieties for farmers in the zone for improving production and productivity of major crops.

Table 6: Crop calendar and method of planting of major crops produced in Kellem Wollega Zone

S/N	Type of crops	Land preparation	Planting (sowing)	Weeding	Harvesting	Method of planting/sowing	Improved varieties available
1	Maize	March-April	April- early June	June-July	October-December	Row planting	Shone, Limu.BH-661,BH-660,BH-540
2	Sorghum	March-April	March-June	June-July	November-January	Row and broad casting	Chemeda, Gemedi and Lalo
3	Teff	May-July	June-August	August-September	November-January	Row and broadcasting	Kuncho
4	Wheat	May-July	July-August	August-September	November-December		
4	Barely	March-April	April-May (1st season) and Aug-Sept (2nd season)	May-July and September-October	August-September (1st) and November-December (2nd)	Both row and broadcasting	Not available
5	Finger millet	May-July	June-July	August-Sept.	December-February	Broadcasting	Boneya
6	Haricot bean	March-May	April-May(1st) and July-August(2nd)	May-June(1st) and July-September (2nd)	July-August(1st) and September-December (2nd)	Row and broadcasting	Nassir and ICAP-0056
7	Fababean	April-June	June-August	July-September	November – December	Row and broadcasting	Not available
8	Sesame	May-June	June-August	July-August	November-December	Broad casting	Not available
9	Pepper	March-April	May-July	June-September	November –January	Row and broadcasting	Not available
10	Sweet potato	March-April	June-July	July-August	November-December	Row planting	Balo
11	Potato	March-April	March-May	June-August	July-September	Row planting	Not available
12	Cabbage	April-May	May-July	June-September	July-October	Row planting	Not available
13	Anchote	March-April	April-July	June-July	September –January	Row and broadcasting	Not available
13	Coffee	May-June	May-July	August-September	November-January	Row planting	Jimma-742

Source: Own survey results, 2016.

Inputs utilizations and sources of major inputs in selected districts

The use of improved agricultural technologies was very crucial to increase agricultural production and productivity. The use of these improved technologies such as chemicals, fertilizers, improved seeds and agricultural mechanizations, etc is very low in the study area. The use of improved seeds still remains very low in the study area compared to the other areas. Moreover, farmers respond that the supply of agriculture mechanizations are not available in study area. Farmers' access improved seed for maize and sorghum only; this indicates there are a lot of gaps in supply of improved seeds. Chemicals and fertilizers utilizations also low in Kellem Wollega Zones. Recently farmers practiced using of the natural fertilizers such as the farm yard manure, compost, etc and also they used chemical type fertilizers like DAP, UREA and NPS. Farmers applied 100 kg/ha (NPS/DAP and Urea each) to land for producing maize in the study area. The rate of fertilizers applied for lands for production of sorghum were 73.5kg/ha of DAP and 70.18kg/ha of urea in the study area Table 7.

According to survey results 54.55% of sampled households obtained improved seeds from seed producers cooperatives followed by unions (32.73%) while about 95.58% of sampled households obtained fertilizers from unions in the study area. The source of agro-chemicals was traders/markets (100%). As indicated in Table 8, the accessibility of agricultural inputs medium and low. About 48.21% of producers reported that the quality of improved seeds was medium and about 13.39% users reported that the quality of improved seed was poor/low. According to survey results about 41.23 and 46.32 of sampled households reported that the quality of fertilizers and chemicals were medium/average, respectively (Table 8). Moreover, farmers respond that the prices of agriculture inputs was high/expensive.

Table 7: Types of inputs used and available improved verities of major crops produced in selected districts

S/N	Type of crops	Mean Seed quantity used (kg/ha)		Available Improved crops varieties	Mean Fertilizers quantity used (kg/ha)		Mean Manures (qt/ha)	Chemicals used (lt/ha)
		Improved	Local		DAP	Urea		
1	Maize	25	25.94	Shone, Limu, BH-661,BH-660,BH-540, Agar and Hidase	100	100	11.03	
2	Sorghum		14.13	Chemeda, Gemedi and Laaloo	73.5	70.18	8.545	1.20
3	Teff		24.08	Kuncho	80.68	54.62		1.46
4	Wheat	139.4	126.615		90	96.15		1.45
4	Barely	140		Not available				1.25
5	Finger millet		21.82	Boneya			10.5	1.33
6	Haricot bean		29.97	Nassir and ICAP-0056				
7	Faba bean		56.071	Not available	100			
8	Sesame		5.33	Not available				
9	Pepper		13.428	Not available	33.4	52.70		
10	Sweet potato			Balo				
11	Potato		147.5	Not available	25			
12	Coffee			Jimma-742				

Table 8: source and quality of agricultural inputs and quality of in the study areas

No.	Inputs	Items	Improved seed		Fertilizers		Chemicals	
			Freq.	%	Freq.	%	Freq	%
1	Sources	Agricultural offices	7	6.36	3	2.65		
		Seed producers cooperatives	60	54.55	-	-		
		Union/cooperatives	36	32.73	108	95.58		
		Others farmers	4	3.64	1	0.88		
		Traders/Markets	3	2.73	1	0.88	95	100
2	Quality of inputs	Good	43	38.39	55	48.25	42	44.21
		Medium/average	54	48.21	47	41.23	44	46.32
		Low/bad	15	13.39	12	10.53	9	9.47
3	Accessibility	Good	55	49.11	71	62.28	47	48.96
		Medium/average	48	42.86	35	30.70	23	23.96
		Low/bad	9	8.04	8	7.02	26	27.08
4	Price of inputs	High	103	92.79	110	97.35	74	77.08
		Fair	3	2.70	1	0.88	16	16.67
		Low	5	4.50	2	1.77	6	6.25

Source: Own survey results, 2016.

Major Crops Produced Under Irrigation in Selected Districts

Both traditional and modern irrigation were practiced in the Kellem Wollega Zone. Irrigation enables to increase the frequency of crop production and alleviate the water shortage caused by poor rain or dry season. Thus, the central role of irrigation agriculture with the context of poverty reduction must be well understood in the eyes of peoples. According to survey results, only 10.94% of sampled households produced crops using irrigation and about 89.04% of sampled households have no access of irrigation (Table.9).

Table 9: Number of farmers produced crops using irrigation and bone

No.	Types		Frequency	Percent
1	Number of Farmers produced crops using irrigation	Yes	14	10.94
		No	114	89.06
2	Number of Farmers produced crops using bone	Yes	9	22.5
		No	31	77.50
3	Respondents preference in type of crops produced	High value crops/cash crops	3	21.43
		Both cash and food crops	11	78.57

Source: Own survey results, 2016.

In Kellem Wollega Producers preferred to produce high values crops (21.43%) and also produced food crops using irrigation methods. This indicate majority of farmers not aware the importance of irrigation practiced and concerned bodies should popularize irrigation activities in the zone. The major crops produced in selected districts under irrigation were maize, onion, potato, cabbage, carrot, hot pepper, tomato, coffee, sugar cane (Table 10).

Table 10: The major crops produced under irrigation and bone in selected districts

Districts	Cereal crops	Pulse and oil crops	Horticulture crops	Spice and industrial crops
Dale Sadi	Maize	Haricot bean	potato, carrot, cabbage, garlic, pepper and tomato	Coffee and sugarcane
Seyo	Maize	Haricot bean	Potato, carrot, garlic, tomato, onion and pepper	Coffee and sugar cane
Yemalogi Welel	Maize	Haricot bean	Potato, pepper, onion, tomato, cabbage, and carrot	Coffee and sugar cane

Source: Focus group discussion, 2016.

As indicated in Table,11 the major constraints of crop production by using irrigation were wild animal attack, lack of irrigation facilities, traditional irrigation practices, shortage of improved seed and fertilizers, high disease and pest occurrences and lack of extension services.

Table 11: The major constraints of crops production using irrigations and bone in selected districts

No.	Constraints	Dale Sadi	Seyo	Yemalogi Welel	Total
1	Lack of irrigation facilities	2	2	2	2
2	Poor/traditional irrigation practiced	4	4	5	4
3	Shortage of improved seed and fertilizers	5	5	3	4
4	High diseases and pest occurrences	3	3	3	3
5	Lack of extension services providers	6	6	6	6
6	Wild animals problems	1	1	1	1

Source: Own survey results, 2016.

2.5. Major Disease and insect pest of general crops in Kellem Wollega Zone

Kellem Wollega Zone in general and studies districts specifically is known by its high rainfall, relative humidity, and temperature which give favorable conditions for disease development and make the region a hot spot for most crop diseases. In these districts, cereals, pulse, fruits and horticultural are widely grown. The productivity of these crops is very low as compared to the national average. This is partly due to disease, insect pests and weed damages. Insect pests like stalk borers, termite, cut worm, and armyworm on maize affect growth and production of crop in these districts. Stalk borers and Shoot fly on sorghum are also important field problems in the districts. Storage insect pests like weevil, on maize, wheat, and sorghum are causing huge losses to the production. Termites are also difficult to control, they cause significant crop loss, damaging the crop from its early germination stage to the time of harvest and the termites may even go on affecting the crops in storage. To manage the termites, farmers have been using traditional method and chemicals applications. Wild animals' damage is also the major problem of maize and sorghum related to yield reduction.

The major diseases of maize were turcicum leaf blight, gray leaf spot, common smut diseases, head smut, gray leaf spot, Ear rot and maize streak virus (Table 12). The major diseases of sorghum were head smut, rust and anthracnose. Bird damage was also the major problem of sorghum related to yield reduction. The major diseases of wheat were root rot, stem rust and yellow rust, and the major disease of finger were leaf blight, head smut, head fusarium and head blight. The major disease of teff were blight disease, rust and fusarium wilt while common bacterial blight, leaf rust and leaf blight were major faba bean and field pea disease. Haricot bean angular leaf spot, chocolate spot, common bacterial blight, eye spot and Ascochyta blight were the major disease reduced production and productivity of haricot bean in Kellem Wollega Zone. Fusarium wilt, leaf blight, pod rot, root wilt, and late blight disease were raised as an important disease that hampered hot pepper production and leaf blight and root rot the major disease of ginger in the districts. The major diseases of potato were late blight, early blight, root rot and leaf blight while the major disease of coffee were Coffee Berry Disease(CBD), Coffee Wilt Disease (CWD), Coffee Cherry disease (CCD) and coffee rusts (Table 12).

Table 12: The major types of disease and insect pests and management option of major crops in study districts

No.	Major crops	Major diseases	Major insect pests	Control option of disease and insect	Major weeds types	Control option of weeds
1	Maize	Turcicum Leaf Blight, Gray Leaf Spot, Common Smut Diseases, Head Smut, ear rot and Maize Streak Virus	Stalk Borers, Termite, Cut Worm, Armyworm and Weevils	Early planting, using improved seed chemical methods	Setaria viridis Snowdenia polystarcya, Bidens spp.	Hand weeding Hoeing Frequently plowing Plowing between wow
2	Sorghum	Head Smut, rust and Anthracnose	Stalk borers, Shoot fly, birds, weevils and termite	Crop rotation Bell/ring for bird attack	Cynodon dactylon Snowdenia polystachya	Hand weeding Frequently plowing
3	Teff	blight disease , rust and Fusarium Wilt	Termites	Crop rotation	No specific weed	Hand weeding chemical application (2-4D, pallas)
3	Finger millet	Leaf blight, head smut, head fusarium and head blight	Termites	Early planting and crop rotation	No specific weed	Hand weeding and Frequently plowing
4	Wheat	Root rot, stem rust and yellow rust	Termites	No control option	No specific weed	Hand weeding. Frequently plowing 2-4D
5	Haricot bean	Angular leaf spot, chocolate spot, common bacterial blight, eye spot and Ascochyta blight	Termites	Early planting and Crop rotation Mound hollow out and applying chemical for termite management	No specific weed	Hand weeding Frequently plowing
6	Faba bean	Common Bacterial Blight and Leaf Blight	Termites and weevils	No control option	No specific weed	Hand weeding and Frequently plowing
7	Hot pepper	Fusarium wilt, leaf blight, pod rot, root wilt, and late blight	Termites and ants	No control option	No specific weed	Hand weeding Frequently plowing
8	Potato	late blight, early blight, root rot and leaf blight	Termites	Applying chemical	No specific weed	Hand weeding and Frequently plowing

9	Avocao	Fruit spot		No control option	No specific weed	
10	Orange	Root spot and leaf spot		No control option	No specific weed	
11	Ginger	leaf blight and root rot	Termites	No control option	No specific weed	Hand weeding
12	Coffee	Coffee Berry Disease (CBD), Coffee Wilt Disease (CWD), Coffee Cherry disease (CCD),and Coffee Leaf Rust (CLR).	Termites	Cutting affected coffee and remove out	No specific weed	Hand weeding Hoeing

Source: Own survey results, 2016

2.6. The major Constraints of crops production in selected districts of Kellem Wollega Zone

The major problems of crop production in selected districts were shortage of improved seed, disease and insect-pest problem, low soil fertility, termite problem, high inputs costs, and heavy rain/weather fluctuation. As shown in Table 13, the extent or rank of the problems shortage of improved seed and Disease and insect pest problem ranked as first and second major problem, respectively three districts

Table 13: Crop production problems and their rank in selected districts.

Major crop Constraints	**Dalle Sadi**	**Seyo**	**Yemalogi Welel**	**Total**
	Rank	**Rank**	**Rank**	**Rank**
Disease and insect-pest problem	2	2	2	2
Infertility of soil	4	4	5	5
Termite problem	3	5	4	4
Shortage of improved varieties	1	1	1	1
High inputs costs	5	3	3	3
Weather fluctuation/heavy rainfall	6	6	6	6

Source: Focus group discussions, 2016.

Crop marketing systems and major marketing challenges

Crop production in the Kellem Wollega Zone is dominated by smallholder farmers. Most farmers in the zone are growing crop both for self-consumption to meet food security and for market to meet cash need requirements. Majority of the farmers sell their crops immediately after harvest mainly due to the lack of warehouse and cash shortage for the payment of taxes and other requirements. In all three districts major cash crops farmers stated as cash crops were coffee, hot pepper, noug, teff, sesame, maize, haricot bean, faba bean, field pea, banana, onion, potato, avocado, carrot and mango. Coffee, hot pepper, noug and sesame share the major proportion for fulfill farmers cash needs in the study area. These crops are traded both in rural and urban markets. Majority of farmers sold their crops from January to May. According to survey results from December to March the price of the crops was low due to oversupply of the products during these months. However, from July to October the price of crops was high due to shortage of products supply to markets at that time in the study area.

The crops marketing actor involves in Kellem Wollega Zone were producers, product collectors/assemblers at farm level, local traders, brokers/agents, and wholesalers in the transitory or terminal markets such as districts markets (Dambi Dollo, Alem Teferi and Tejo), Gimbi, and ECX. Crop producers are largely smallholder private farmers. Crops products are supplied to local markets from local supply. Producers sell cereals, pulses, oil seeds, vegetables and coffee to local traders, village collectors, wholesalers, cooperatives/unions, and consumers. Brokers specialize in bringing the buyers and sellers together. They sell the products of producers to wholesalers or that of wholesalers to other wholesalers, processors or retailers. They also disseminate price and other market information and play a leading role in influencing crops products trade and price formation in towns. Wholesalers purchase the product in bulk from farmers and local collectors and sells to national or regional or ECX markets. Nowadays, cooperatives and cooperative unions serve also play the role of wholesalers when they collect and sell in bulk and act as retailers when they distribute traders in smaller quantities to consumers. But, cooperatives in the study area is not fully functioning as expected from them and government should give attentions for strengthen the cooperatives by providing sufficient budget and re-organizing them. ECX creates opportunities for farmers and traders in the study areas to bring integrity, security, and efficiency to the market especially on coffee market. ECX has established in Gimbi towns and represents both Kellem and West Wollega Zones allied to coffee market. Producers in the study area obtained market/price information from traders, DAs, fellow farmers, union/cooperatives and media (radio and television).

According to survey results and focus group discussions the major challenges of crops marketing in the study area were low price of crops products, high involvements of unlicensed traders, road and transportations problems, fluctuation of crops price, weak linkages with nationals markets, trade barriers, oversupply of crops product during harvest, high involvement of brokers/middleman, unfair/cheat weighing of crops products (Table 14).

Table 14: The major challenges of crops marketing and their ranks in selected districts

No	**Constraints**		**Districts**					
			Dale Sadi		**Seyo**		**Yemalogi Welel**	
			Freq.	**%**	**Freq**	**%**	**Freq.**	**%**
1	Road and transportation problem	Yes	12	33.33	8	20	18	56.25
		No	24	66.67	32	80	14	43.75
2	Fluctuation of product price	Yes	12	33.33	20	50	10	31.25
		No	24	66.67	20	50	22	68.75
3	Oversupply of product during harvest	Yes	2	5.56	5	12.5	0	0
		No	34	94.44	35	87.5	32	100
4	Low price of product	Yes	24	66.67	31	77.5	27	84.38
		No	12	33.33	9	22.5	5	15.63
5	High involvement of brokers/middleman	Yes	13	36.11	14	35	4	12.50
		No	23	63.89	26	65	28	87.50
6	Unfair/cheat weighing of crops products	Yes	5	13.89	4	10	9	28.13
		No	31	86.11	36	90	23	78.13

7	Weak linkage with national markets	Yes	6	16.67	4	10	7	21.88
		No	30	83.33	36	90	25	78.13
8	High involvement of Unlicensed traders	Yes	5	14.29	4	10	5	15.63
		No	30	85.71	36	90	27	84.38

Source: Focus Group Discussions and key informants interviews, 2016

Livestock production

Livestock plays significant role in the economy of the zone in general and household particular. In general they provide food (milk, meat, egg, and hides) as power for cultivation, serve as means of transportation, manure production for soil fertility management and as saving. They are also kept for prestige as indicator of social status and wealth in society. They are the drivers of crop production mainly as sources of draught power and provision of manure for soil fertility restoration. Every household keeps livestock such as cattle, sheep, goats, horse, donkey and poultry. The mean numbers of various species owned by household and purpose of rearing livestock in the study areas shown in Table 14. Local cows are dominant species followed by local oxen for all selected districts.

Cattle

Cattle rearing are one of the sources of livelihood of farmers in the three districts. Cattle are kept for food, cash, draught power and manure production. Local dairy cows in the area provide the households with milk and manure. As indicated in Table 15, on average about 1.64, 1.47 and 1.91 local oxen were holds by sampled households in Dalle Sadi, Seyo and Yemalogi Welel districts, respectively. According to survey results, crossbreeds cows almost not available in Seyo and Yemalogi Welel districts.

Small ruminants

Goats and sheep are used as a means of cash income whenever the farmers are in need of money and source of meat for home consumption. Small ruminants are kept because they reproduce themselves within a short period of time. Sheep and goats are the main source of meat during religious festivals and on occasions when some respectable guests are called.

Equines

Donkeys, horses and mules play an important role in transportation of both people and goods in selected districts. Mules are used as in burial or funeral ceremonies particularly on the occasion of the wedding and used as carts for transportation of production from fields to production storage.

Poultry

Chicken are kept mainly for production of eggs and reproduction of themselves as a means of cash income and source of meat. Local poultry is the most commonly available in number compared to other livestock species in the zone but they are mostly susceptible to disease particularly to Newcastle disease.

Beekeeping

Bee-keeping is also an important activity in the study area which is mainly used as a source of income by selling honey and home consumption. In Kellem Wollega Zone, honey bees were being the most potential area of livestock production, but nowadays the productivity is decreasing from time to time because declining of bee flora and agro-chemicals application. Most of the farmers use traditional beehive, which limit the productivity of honey. On average sampled households hold 10, 16.5 and 9.17 number of traditional bee hives in Dale Sadi, Seyo and Yemalogi Welel districts respectively (Table 16). Besides, farmers' holds on average 3 and 2 number of transitional hives in Dale Sadi and Seyo districts, respectively. Farmers harvest honey yield on average 2.75, 6 and 4.14 kg/hives in Dale Sadi, Seyo and Yemalogi Welel districts respectively.

Table 15: Livestock population and purpose of rearing in selected districts

No	**Livestock type**	**Dale Sadi**	**Seyo**	**Yemalogi Welel**	**Purpose of rearing**
		Mean	Mean	Mean	
1	Local cow	1.65	1.35	1.86	For milk, meat, market and for manure
2	Cross breed cow	1	0	0	For milk, meat, for market and manure
3	Local oxen	1.64	1.47	1.91	For milk, meat, draft power, for market and manure
4	Local heifers	1.31	1.44	1.5	For meat, market and for manure
5	Local calves	1.52	1.43	1.5	For meat, market and for manure
6	Local Bull	1.83	1.5	1.6	For draft, reproduction, meat, market and for manure
7	Goat	3.83	1.5	3.15	For meat and marketing
8	Sheep	1.89	2.76	3.1	For meat and marketing
9	Local poultry	4.28	4	4.67	For egg production, meat and for market
10	Improved poultry	5.33	4.77	2.5	For egg production, breed source, meat and market
11	Donkey	1.2	1.35	1	Transportation
12	Mule		1	1.14	Transportation
13	Horse			3	Transportation

Source: Own survey results, 2016.

Table 16: Hives types and average numbers of hives per households in three district

No	Types of Hives	Dale Sadi	Seyo	Yemalogi Welel	purpose
		Mean	mean	Mean	
1	Traditional hive	10	16.5	9.714	Honey production for home and market
2	Transitional hive	3	2		Honey production for home and market
3	Modern hive	0	1		Honey production for home and market
4	Honey yield from traditional hive (kg/hive)	2.75	6	4.14	
5	Honey yield from transitional hive (kg/hive)	6	10		
6	Honey yield from modern hive (kg/hive)		10		

Source: Own survey results, 2016.

3.1. Breed type and Breeding system

During the focus group discussion and survey farmers reported that open natural mating with available local bulls is the common mating system for livestock in the study districts. Crossbreds are available only for cows, oxen and poultry in all districts which are insignificant in numbers. According to focus group discussion Jersey, Borena and Holstein fression are some of improved breeds available. The respondents expressed their interest towards having improved breeds; however they doubt their adaptability to the environmental conditions especially in relation to disease prevalence and availability of feeds. Artificial insemination (AI) service for cattle breeding is also appeared to be weak and poor with success rates. The reason might be due to shortage of technical well trained inseminator's technicians and lack of AI related technologies. The low milk yield is mainly associated with low genetic potential of local breeds and poor management of the dairy animal i.e. poor feeding, housing and other management practices.

Livestock management and feed resources

Livestock management practices in all the districts are based on the traditional knowledge of the farmers and it was noted that the farmers lack adequate knowledge and skills in improved livestock management practices. Watering of livestock in the study area is by moving their animals to rivers and hand hole (ponds). Open communal grazing land is the commonly practiced system of grazing in all the three districts. Feed shortage is also commonly experienced among most farmers particularly from December onwards. The feed resources in the selected districts are primarily natural pasture (communal and own grazing), cultivated forages, crop residues and purchased supplementary feed. As indicated in Table 17, about 34.17% of respondents' responds communal grazing lands and crop residues are the major sources of livestock feeds. The study further revealed that second most important contributor to livestock feed supply is communal open grazing land (24.17%) followed by combinations of own grazing lands and crop residues (Table 17).

Crop residues usage is not common in selected districts but during animals feed scarcity farmers feed their animals crops residues. Substantial amounts of crop residues are wasted due to improper use or burned in study area. Ever more land is allocated for cropping, thus shrinking land for fodder production. Thus the excess forage available during the rainy season is often wasted by being trampled upon by animals and burning during the dry season. Thus it is important to raise awareness of the farmers for proper management of crop residues and available forage to enhance their utilization as animal feeds in the face of declining availability of natural pastures and lack of other alternatives sources of feed supply in the study area. The contribution of improved forages and local beverage by products were minimal. Recently farmers in the study area cultivated Elephant grass, Rhodus grass, dinsho grass, vetiver grass and oats as the most important improved forage. Supplementary feed farmers used for their animals during shortage of animals feed are powder of crops, amole salt, molasses and local beverage by product (Atella).

Table 17: Source of livestock feeds and improved forage produced in the selected districts

No	Source of feeds		Frequency	Percent
1	Communal grazing land		29	24.17
2	Own grazing land		13	10.83
3	Crop residues		6	5.00
4	Own grazing land and crop residues		21	17.50
5	Communal grazing land and crop residues		41	34.17
6	Own grazing land, crop residues and supplementary feed		2	1.67
7	Communal grazing lands and supplementary feed		4	3.33
8	Communal grazing lands and supplementary feed		2	1.67
9	Own grazing land and supplementary feed		2	1.67
	Number of farmers produced improved forage	Yes	35	27.34
		No	93	72.66
		Total	128	100
	Type of improved forage produced by farmers			
1	Elephant grass and Rhodus		8	22.86
2	Rhodus only		2	5.71
3	Dinsho and Vetiver grass		2	5.71
4	Elephant grass, Rhodus and Dinsho		1	2.86

5	Elephant grass and Dinsho	1	2.86
6	Oats and Vetiver grass	2	5.71
7	Elephant grass only	17	48.57
8	Dinsho grass only	2	5.71

Source: Own survey results, 2016.

3.2. Feed seasonality

Livestock feed is seasonal. Grazing of natural pasture constitutes the main source of animal feed throughout the year in the study area. Accordingly, as indicated in Table 18 about 45.58%of sampled households respond that during the dry season (January to May) livestock's faced feeds shortages in the study areas. Moreover, about 29.41, 19.12% and 5.89% of the respondents reported that during March-May, June-September and February-April, respectively, shortage of livestock feeds faced. As depicted in Table 18, about 56.00% of sampled farmers' reports that the coping mechanisms during shortage of livestock feed was feeding crops residues like straw, hay, some leaf of trees, Mujja. Besides, about 40% of respondents farmers reported that they feed their livestock by combining crop residues and supplementary feed (Atela, powder of grains, etc) during feed shortages (Table 18).

Table 18: Seasons of livestock feed shortages and coping mechanisms

Months	Districts						Overall	
	Dalle Sadi		Seyo		Yemalogi Welel			
	N	%	N	%	N	%	N	%
January-May	11	47.8	8	42.1	12	46.2	31	45.58
June-September	5	21.8	4	21.1	4	15.4	13	19.12
February –April	0	0	0	0	4	15.4	4	5.89
March-May	7	30.4	7	36.8	6	23.1	20	29.41
Total	23	100	19	100	26	100	68	100
Coping mechanisms								
Feeding crops residues (Straw, hay, Mujja, some leaf trees, etc)	10	66.67	5	33.33	15	71.43	28	56.00
Feeding crops residues and supplementary feed (Atela, Powder of grains)	5	33.33	8	53.33	6	28.57	20	40.00
Supplementary feeds	0	0	2	13.33	0	0	2	4.00
Total	15	100	15	100	21	100	50	100

Source: Own survey results, 2016.

Livestock production problems

The major problems and their rank according to farmers are presented in Table 19. In all three districts seemed to have similar ranking of their problems and the major problems are disease and parasite, shortage of animal feed and improved forage, lack of improved breed, shortage of veterinary service and AI services, wild animals and lack of grazing land. Diseases are an important cause of reduced productivity of meat and milk as well as draft animal power, hide and dung fuel. The major livestock's diseases identified during focus group discussions the major animal health problems listed in table 19.

Table 19: The major livestock disease and parasites and affected livestock species

No	Type of livestock	Major diseases and parasites	Traditional disease Management
1	Cattle	➢ Anthrax, Tryipanomiasis, Pastoryolosis, Black leg, Bloating, Blue tongue, Lump skin disease, Foot and mouth disease, Gubaa", Citaa",Contagious bovine pleuropneumonia (CBPP) and TB ❖ Tick, Crap lice, Faciolla and other external and internal parasites	❖ Vaccination and ❖ Skin burning for anthrax
2	Sheep and goat	➢ Brucellosis, Foot rot, Diarrhea, Contagious Etyma, Ovine Pasteurolosis, Black leg,Septicemia and Sheep pox ➢ Internal and external parasites	➢ Vaccination
3	Mule and donkey	➢ Tryipanomiasis, Lymph skin disease ➢ Tick and Internal and external parasites	➢ Vaccination
4	Horse	✓ Tryipanomiasis, African horse sickness and Lymph skin disease ✓ Tick and Internal and external parasites	✓ Vaccination & skin burning
5	Poultry	New castle disease (NCD), fowl,Typhoid, Pastoryolosis, coccidiosis Flea, Sissio'oo"	Vaccination
6	Apiculture	➢ Bacterial brood diseases ➢ Ants, monkey, wax moth (*Galleria mellonella*), spider	➢ smoking the cattle dung, ash, and spraying DDT

Source: Focus Group Discussion and Bureau of Agricultural Offices, 2016.

As depicted in Table 20, about 37.84%, 36.59% and 47.22% of sampled households in Dale Sadi, Sayo and Yemalogi welel, respectively, identified diseases as the major problem of cattle. Shortage of animal feed and improved forage was also indicated as the second most important constraint for cattle production in all three districts. The study revealed that lack of improved breed and AI services are others problems that hinders farmers to improved livestock production. Thus, the study suggests that there is a need to focus on improve veterinary services provision to reduce animal health problem, supply of improved forage to reduce shortage of feed and introduce artificial insemination service to increase the genetic merit of the cattle and small ruminants production to improve milk and meat production in the study area. Concerning production of poultry farming shortage of improved breed and disease and parasites are the major constraints of households faced in the three districts (Table 20).

The smallholder farmers in the three districts also practices beekeeping which play a significant role and one of the possible options to sustain their livelihood. The majority of farming community was used traditional bee hives for honey production. Even though honey production is practiced by smallholders, the sub-sector has not been fully exploited to its potential due to several constraints. Based on focus group discussions data obtain rank of the major constraints faced by beekeepers in the study area were shortage of bee forage, agro-chemical application, pest and predators, lack of awareness and training on beekeeping, absconding and lack of beekeeping equipment and theft.

Table 20: The major problem of livestock production in Kellem Wollega Zone

No	Constraints	Dale Sadi		Seyo		Yemalogi Welel		Total	Rank
		Freq.	%	Freq.	%	Freq.	%		
The major constraints of cattle									
1	Shortage of animal feed	9	25	12	29.27	5	13.51	26	3rd
2	Disease	17	47.22	15	36.59	14	37.84	46	1st
3	Shortage of grazing land	7	19.44	12	29.27	17	45.95	36	2nd
4	Shortage of animal health service	0	0	1	2.44	1	2.7	2	4
5	Lack of crossbreed	2	5.5	0	0	0	0	2	4
6	Shortage of drinking water	1	2.77	1	2.44	0	0	2	4
Total		36	100	41	100	37	100	114	
The major constraints of small ruminants									
1	Disease and parasites	11	73.33	10	71.43	20	76.93	41	1st
2	Shortage of animal health service	1	6.67	0	0	2	7.69	3	4th
3	Shortage of grazing land	1	6.67	2	14.29	1	3.85	4	2nd
4	Shortage of animal feed	0	0	2	14.29	2	7.69	4	2nd
5	Lack of cross breeds	2	13.33	0	0	0	3.85	2	5th
Total		15	100	14	100	25	100		
The major constraints of equine									
1	Disease	7	87.5	11	100	12	100	30	1st
2	Shortage of animal health service	1	12.5	0	0	0	0	1	2nd
	Total	8	100	11	100	12	100	31	
The major constraints of poultry									

1	Disease and parasites	0	0	5	14.28	0	0	5	2nd
2	Shortage of improved breed	19	95.00	29	82.68	21	95.45	69	1st
3	Shortage of feed	1	5.00	1	2.86	1	4.55	3	3rd
Total		20	100	35	100	22	100		
The major constraints of honey bee		Freq.	Rank	Freq.	Rank	Freq.	No.		
1	Shortage of bee forage	7	1st	4	2nd	5	2nd	75.00	1st
2	Pest and predator problem	7	1st	4	2nd	2	4th	12.50	2nd
3	Agro-chemical application	6	3rd	5	1st	6	1st	12.50	
4	migration of bee colony	6	3rd	3	4th	4	3rd	0	
	Lack of bee equipments	0		1	6th	2	4th		
	Theft problem	0		2	5th	0			
	Total	8		7		7		100	

Source: Own survey results, 2016.

Marketing problems of livestock

Livestock marketing and market related things are a crucial problem. Farmers of the three districts reported that there access market in districts town but the main problem are high involvements of brokers or middle men in marketing of livestock, low price of livestock, fluctuation of market price of livestock and livestock product, no linkages with national markets, lack of market information and lack of cooperatives. According to Focus group discussion farmers stated that no transparency between seller and buyer due to middle men or brokers. Although farmers had produced locally such as milk, honey and eggs to local markets not produced for regional or national markets. Farmers have been selling livestock products as a source of income for the household to fulfill others needs. Furthers, farmers responds that price/demand fluctuation and poor transportation facilities were mentioned as a major challenges facing marketing of livestock and livestock products. Lack of market information and lack of cooperatives were also the major challenges which force farmers to sold their livestock and livestock products with low price at local markets to fulfill immediate cash needs to purchase materials for foods and others inputs. The major livestock market problems and their priority ranking according to farmers are presented in Table 21.

As depicted in Table 21, farmers stated that low price of livestock and livestock product (64.2%), high involvement of middlemen (59.1%), lack of fair livestock market (30.7%) and poor road facilities and shortage of transportation (12.4%) were the major marketing problems of agricultural production (crops and livestock’s) in the study area.

Table 21:-Markets Problems of livestock production in the three districts

No	Constraints	Districts						Total		Rank
		Dale Sadi(		Seyo		Yemalogi Welel				
		Freq. (%)		Freq. (%)		Freq. (%)		Freq. (%)		
		Yes	No	Yes	No	Yes	No	Yes	No	
1	Poor road facilities and lack of transportation	2 (5)	38 (95)	9 (19.2)	38 (80.8)	6 (14.6)	35 (85.4)	17 (12.4)	120 (87.6)	4th
2	Low price of livestock and livestock products	25 (62.5)	15 (37.5)	33 (70.2)	14 (29.8)	30 (73.2)	11 (26.8)	88 (64.2)	49 (35.8)	1st
3	High involvement of middle men (brokers)	21 (52.5)	19 (47.5)	33 (70.2)	14 (29.8)	27 (65.8)	14 (34.2)	81 (59.1)	56 (40.9)	2nd
4	Small traders monopolize livestock marketing and block others traders from others area	5 (12.5)	35 (87.5)	5 (10.6)	42 (89.4)	6 (14.6)	35 (85.4)	16 (11.68)	121 (88.32)	5th
5	Lack of market information	2 (5)	38 (95)	1 (2.1)	46 (97.9)	1(2.4)	40(97 .6)	4(2.9)	133(97. 1)	6th
6	Lack of fair livestock market	9 (22.5)	31 (77.5)	19 (40.4)	28 (59.6)	14 (34.1)	27 (65.9)	42 (30.7)	95 (69.3)	3rd

Source: Own survey results, 2016.

Natural resources and management

Forestry and Agro-forestry

According to the reports from key informants, the forest and woodland resources of kellem wollega zone can be categorized into four major types of vegetation. These include natural forests, plantation forests agro-forestry and shrubs and bush lands. The first one is natural forest of vegetation which is mainly found in coffee plantation areas and uncultivated land areas (kola/Bereha area) of the three selected districts. All of the farmers and key informants responds that the forest cover in their respective districts have been diminished in the last 20 years due to increments of population density and resettlements in the study area. There are different types of indigenous naturally growing trees in the kellem Wollega Zone. These native species are found in the natural forest found scattered on coffee lands, farmlands, grazing areas, farm boundaries around the fences etc. *Eucalyptus saligina* is the common permanent tree found in the area which farmers use it as source of income, fire wood, construction of house and fence. *Syzgium guineense* (Badessaa) and *Cordia africana* (Waddessa) are also common trees found in the area which are used for coffee shade, timber, beekeeping and climatic condition (Table 15).

Plantations forests is the second type of vegetation types in the three districts which include the trees planted by government or individual farmers in different tree growing niches for different purposes. *Eucalyptus saligina* is the dominant tree species that has been planted as a plantation tree in the three districts. There are also many exotic tree species planted by individuals' farmers and governments in the three districts. Species such as *Syzgium guineense*, *Cuppressus lustanica*, *Cordia Africana* and others are some plantations forests. Agro-forestry is the third vegetation types which is a collective name for a range of land use practices in which trees or shrubs are grown in association with herbaceous plants (crops or pastures), in a spatial arrangement or a time sequence, and in which there are both ecological and economic interactions between the tree and non-tree components of the system. The economic interaction is the production of fuel wood or fruit for cash or income. The ecological interaction is the biogeochemical cycle in the system. Trees in homesteads and scattered trees in farm lands are the dominant practices. The fourth vegetation type is bush lands and shrub lands in the study area, which are largely restricted to grazing lands and degraded hill sides. The summaries of major trees and shrubs species identified in the three districts are indicated in Table 22.

Table 22: Major indigenous tree and shrubs species commonly found in the selected districts

Local name	Scientific name	Habit	Major use/purpose
Bargamoo	*Eucalyptus saligina*	Tree	Construction, wood, bee floral
Badessaa	*Syzgium guineense*	Tree	Construction, wood, bee forage, coffee shade and fence
Wadessaa	*Cordia africana*	Tree	Coffee shade, beekeeping, wood, timber and fence
Bakkanisaa	*Croton marcrostachyus*	Tree	Coffee shade, beekeeping, wood and termite resistant
Eebicha	*Vernonia amaygdalina*	Tree	coffee shade, bee feed and fence
Laaftoo	*Accaia abyssinica*	Tree	Charcoal, bee feed, coffee shade, soil fertility improvement and fence
Gatiraa	*Cuppressus lustanica*	Tree	Timber and wood
Abbayii	*Masea Lanceolata*	Tree	Weevil control,Coffee shade and fence
Yaangoo		Tree	Timber and construction
Kararoo	*Aningeria Altissima*	Tree	Construction, wood and bee forage
Muka arbaa	*Albizia gummifera*	Tree	Coffee shade, fence &charcoal
Qilxuu	*Ficus vasta*	Tree	Coffee shade, agro-forestry, live fence & hive

		constructions
Reejjii	*Myrica salicifolia*	

Source: key informants and Focus group discussions, 2016.

As indicated in Table 23, out of 128 respondents, 22 respondents have their own nursery site. About 44 sampled households have access for government nursery site. From chi-square results it is possible to generalize that there is no a significant difference in between districts with owns of nursery site and access of government nursery site.

Table 23: Number of HH access for nursery site

Variable	Dalle Sadi		Sayo		Yemalogi welel		Total		Chi-square (χ^2)
	Freq.		Freq.		Freq.				
	Yes	No.	Yes	No	Yes	No	Yes	No	
1. No. respondents who have own nursery site	9	31	7	31	6	35	22	106	0.561
2. No. of respondents access for government nursery site	17	23	15	32	12	29	44	84	0.413

Source: Own survey result, 2016.

Soil characteristics and soil related problem

The major causes of soil erosion and type of erosion in selected districts of west wollega zone

According to survey results and secondary data different soil types in terms of physical and chemical properties were identified in the area. They usually base the local classification on soil color, workability, texture, productivity and response to fertilizer applications. Accordingly, they are identified four soil types which are red soil, black soil, loam and sandy soil. As depicted in Table 24, about 70 respondents reported that the color of their soil are red and 37 respondents respond the color of their soil are black color. Sheet erosion, rill erosion and gully erosion were the common erosion types observed in Dalle Sadi, Seyo and Yemalogi Welel districts. As indicated in Table 24, 53.84%, 47.82% and 35.90% of respondents said sheet erosion is the major type of soil erosion in the case of Dalle Sadi, Sayo and Yemalogi Welel, respectively. The major causes of soil erosion identified by the Focus Group Discussions conducted in three districts were; slope steepness of land, over cultivation or absence of fallowing, deforestation, high intensity of rain fall and overgrazing. The major soil related problems that reduce productivity of crops in the area were soil erosion, reduction of soil fertility and termite problem.

Table 24: Color of soil and the major causes of soil erosion in selected districts

Variable		Dalle Sadi		Sayo		Yemalogi Welel		Total	Chi-square (χ^2)
		Freq.	%	Freq.	%	Freq.	%		
1	Color of soil								
	Black soil	12	30%	19	40.43%	6	14.63 %	37	0.012
	Reddish (Red soil)	27	67.5%	20	42.26%	23	56.00%	70	
	Dark-black	1	2.5%	8	17.02%	12	29.27%	21	
2	Type of soil erosion								
	Sheet erosion	21	53.84%	22	47.82%	14	35.90%	57	0.658
	Gully erosion	3	7.69%	7	15.22%	5	12.82%	15	
	Rill erosion	15	38.46%	17	36.96%	20	51.28%	52	
3	Major soil related problem								
	Soil erosion	38	95%	44	100%	38	95%	120	0.321
	Reduction of soil fertility	40	100%	42	95.45	38	95%	120	0.371
	Termite	35	87.5%	21	47.73%	27	(67.5%)	83	0.001***

Source: Own survey result, 2016

Soil fertility and soil management practice

According to survey results about 70%, 91.305 and 87.80% of respondents reported that soil fertility of their land was declining. As indicated in Table 25, farmers identified that the main cause for reduction of soil fertility was soil erosion, overgrazing, over cultivation, absence of fallowing, lack of soil and water conservation and deforestation. To minimize this problem farmers practice soil fertility improvements such as soil conservation (soil bunds, terrace, grass strips, stone bund and dams), mulching and intercropping, fertilizer and compost application, crop rotation and fallowing.

Table 25: The main cause of soil fertility reduction and farmers management practice

No.	Variable	Dalle Sadi	Sayo	Yemalogi Welel		Chi-square (χ^2)
		Freq. (%)	Freq.(%)	Freq.(%)	Total	
1	Perception of respondents on the status of fertility of their land					
	Improving	4(10%)	2(4.35%)	2(4.88%)	8	0.097*
	Decline	28(70%)	42(91.30%)	36(87.80%)	105	
	The same	8(2)%)	2(4.35%)	3(7.32%)	13	
2	Causes of reduction of soil fertility					
	Soil erosion	22(78.57%)	31(73.81%)	25(71.43%)	78	0.809
	Overgrazing	4(14.29%)	7(16.67%)	3(8.57%)	14	0.573
	Over cultivation	13(46.43%)	21(50%)	14(40%)	48	0.678
	Absence of fallowing	5(17.86%)	6(14.29%)	7(20%)	18	0.797

	Lack of soil and water conservation	2(7.14%)	5(11.90%)	1(2.86%)	8	0.327
	Deforestation	2(7.41%)	1(2.38%)	1(2.86%)	4	0.532
3	Farmers practices for soil fertility improvements					
	Soil Conservation(Soil bunds, terrace and Dams)	17(85%)	24(75%)	15(71.43%)	56	0.563
	Mulching and intercropping	0	1(3.13%)	3(14.29%)	4	0.098*
	Applying fertilizer and compost	3(15%)	13(40%)	3(14.29%)	19	0.043*
	Fallowing	2(10%)	14(43.75%)	1(4.76%)	3	0.206
	Crop rotation	6(30%)	14(43.75%)	10(47.62%)	30	0.477
4	Soil and water conservation practiced					
	Soil/stone bund	23(57.50%)	24(52.17%)	23(65.71%)	70(57.85%0	0.258
	Cut-off drains	4(10.00%)	0	2(5.71%)	6(4.96%)	
	Fanyajuu	1(2.50)	3(6.52%)	0	4(3.31%)	
	Waterways	0	1(2.17%)	1(2.86%)	2(1.655)	
	Check dams	0	3(6.52%)	2(5.71%)	5(4.13%)	
	Terraces	12(30.00%)	15(32.61%)	7(20.00%)	34(28.10%)	

Source: Own survey results, 2016.

Soil and water conservation practices

As indicated in Table 25, farmers practiced different physical, biological and chemical soil fertility management practices methods in the study area. Soil/stone bund and terraces were the most common structures used for soil and water conservation in the selected districts which most farmers construct on their farm lands during the off season, i.e., before planting. The major physical soil and water conservation method they practiced in the three districts are soil bunds, check dams, terraces, stone bunds, grass strips and waterways and biological soil conservation practiced like crop rotation, intercropping, crop residues/manure application and flowing frequency practiced in the study area. Fertilizers like NPS, DAP and Urea application were also chemical method of improving soil fertility practiced by farmers

Natural resource management constraints in selected districts of Kellem Wollega Zone

According to Focus Group discussion the major causes of natural resource degradation are deforestation, overgrazing, increments of human population and reduction of intensity of water in the study area. Deforestation was increase from time to time in all three districts due to expansion of cultivated land to fulfill food need of high human population. Farmers reported that deforestation intensity are high in resettled area and resettlements of farmers are the main cause of deforestation in the Kellem Wollega Zone. Overgrazing is also the major problem of natural resource degradation in the study area.

As indicated in Table 26, about 48.48%, 37.88%, 30.30%, 28.79% and 27.17% of respondents report that lack of sustainable bund managements, lack of training on soil and water conservation practices, over cultivation and overgrazing, lack of multipurpose tree seedling and high population pressure, respectively, the major constraints of natural resource managements. Soil nutrient depletion has become a common feature in the Kellem Wollega zone although the degree varies from district to districts. Furthermore, soil erosion mainly caused by intensive rain water, deforestation, over grazing, cultivation of the same land year after year and fertility depletion are the major constraints related to natural resources in all three districts.

Table 26: The major constraints of natural resource managements in selected districts

No	Constraints	Districts							
		Dalle Sadi		Sayo		Yemalogi Welel		Total	
		Freq	%	Freq	%	Freq.	%	Freq	%
1	Termite problem	6	33.33	5	20.00	3	13.04	14	21.21
2	Lack of nursery site	2	11.11	7	28.00	4	17.39	13	19.70
3	Soil erosion	5	27.78	5	20.00	5	21.74	15	22.73
4	Lack of multipurpose tree seedling	5	27.78	6	24.00	8	34.78	19	28.79
5	Lack of sustainable bund managements	8	44.44	13	53.00	11	47.83	32	48.48
6	High Population pressure	4	22.22	8	32.00	8	34.78	20	30.30
7	Over cultivation and overgrazing	6	33.33	6	24.00	6	26.09	18	27.17
8	Lack of training on SWC practices	9	50.00	10	40.00	6	26.09	25	37.88

Source: Own survey results, 2016.

5. Enablers and Supportive Institutions of Agricultural Development in the study area

Institutions play a significant role in promoting people's participation in the supply of services and resources for human development, improving resource allocation and for ensuring effective public service delivery. The supporting function institutions are those who are not directly related to agricultural productions but provide different supports to the farmers. The support functions include different services (e.g. credit), research and development, infrastructure, and information. Support service providers are essential for agricultural developments and include sector specific input and equipment providers, financial services, extension service, and market information access and dissemination, technology suppliers, advisory service, etc. In the study areas, there are many institutions supporting the agricultural sectors in one way or another. The most common support providers are Woredas Agriculture and Natural Resource Management Office(WANRMO), Livestock and Fisher Resources Development Offices(LFRDO), Woredas Irrigation and Development Authority(WIDAO), District Trade and Market Development Office (DTMDO), Cooperatives, Oromia Micro Finance Institutions and Agricultural Research Center.

Extension services

As depicted in Table 27, about 95.31% of the farmers reported that they had access to extension service in 2016 production season. Only 4.69% of the farmers reported that they had no access to extension service. The extension services providers were Agricultural research center, office of Agriculture and Natural resource management experts, Livestock and Fishers Resource Development experts, District Irrigation and Development Authority, DAs and NGOs. District Irrigation and Development Authority and Agricultural Development Office provide agricultural extension services to producers through experts and development agents. Agricultural and Natural Resource Managements Offices, Livestock and Fishers Resources Development Offices and District Irrigation and Development Authority offices are engaged mainly in technology transfer and dissemination, provides advisory service, facilitate access to inputs and provide technical support in agricultural productions in their own mandate areas. Development Agents (DAs) constantly train and advise farmers who are using the minimum package. Three extension agents are assigned at each kebele. One of them specializes in the field of crop science, the other on animal science and the last one on natural resources conservation. One Farmers Training Center (FTC) is established in each kebele of the study areas. Moreover, it was found that NGOs are operating in providing technical services to the farmers in the study area. The extension services provided were extension advices, training and visits (Table 27).

Table 27: Households access to extension services and services providers

No.	Items		Frequency	Percent
1	Access to extension services	Yes	122	95.31
		No	6	4.69
		Total	128	100
2	Extension services providers	DAs at FTCs	85	69.67
		Research	3	2.46
		DAs and BoA	22	18.03
		DAs at FTCs and NGOs	6	4.92
		DAs FTC and Research	6	4.92
			122	100
		Total	100	100
3	Type of extension services provided for farmers	Extensions advices	15	12.61
		Training and visits	12	10.08
		Only Training	7	5.88
		Extensions advices, training and visits	77	64.71
		Extension advice and training	8	6.72
		Total	119	100

Access to credit services

Finance is the crucial element starting from land preparation up to the marketing of the product and also for livestock production. Farmers mainly require credit to purchase agricultural inputs, i.e., improved varieties, fertilizers, chemicals, agricultural mechanization, oxen, to practice crop production, fattening and rearing of animals and also for off and non-farm activities. The main institutions that provide credit for farmers are cooperatives and Oromia Credits and Saving Share company (OCSSCO). As depicted in Table 28, only 43.75% of sampled producers had access to credit services in from total sampled households. The main objectives households take of the credit were to purchase fertilizer, to purchase improved seeds/seedling and for family consumptions. The providers of credit services were micro finance institutions (94.64%), traditional institution (Ikub and Idir) (3.58%) and NGOs (2.63%). The major problems farmers reported related to credit services were Farmers fear of inability to pay back(41.67%), lack of service providers(6.95%) and high loan interest rates and unequal handlings of farmers by credit providers in providing loans (19.45%) (Table 28).

Table 28: Access to credit service and problems of credits services of sampled households

No	Items		Frequency	Percent
1	Access to credit services	Yes	56	43.75
		No	72	56.25
		Total	128	100
2	Source of credits	Microfinance Institutions	53	94.64
		Traditional association (Idir and Ikub)	2	3.58
		NGOs	1	2.63
		Total	38	100
3	Problems related to credit services	Farmers fear of inability to pay back	30	41.67
		Lack of service providers	5	6.95
		High loan interest rate and discriminations in giving credit service	14	19.45
		Lack of collateral	1	1.39
		Lack of interest to take credit due to no shortage of money	22	30.56
		Total	38	100

Source: Own survey results, 2016.

Conclusion and Recommendations

Conclusions

Farming system characterization survey was undertaken in kellem Wollega Zone of Oromia National Regional State. From total of 12 districts of the zone, the three districts namely Dalle Sadi,Sayo and Yemalog Welel were selected for this study based on variation altitude and agricultural resource. From three districts six kebeles and about 128 samples of household heads was randomly selected and interviewed. Data collection tools such as individual interviews, Focus Group Discussions (FGD), key informants interviews, field observations and document analyses were used by developing questionnaires and checklists. The farming systems in the Kellem Wollega Zone was characterized as mixed farming systems.

A crops production takes place using rainfed and irrigations in the study areas. For all crop types produced in three districts average productivity per hectare are above and below national average productivity by using rainfed and irrigations. The major cropping systems in the study area are mono cropping, intercropping, double cropping and crop rotations systems. The major problems of crop production in selected districts include disease and insect pest problem, land shortage and soil fertility problems, termite problem, shortage of improved varieties , lack of agricultural mechanization and weather fluctuation. The major challenges of crops marketing in the study area were fluctuation of crops price, oversupply of crops product during harvest, high involvement of brokers/middleman, low price of product, low quality of product unfair/cheat weighing of crops products, transportation problem, poor linkages with national markets and high involvement of unlicensed traders on coffee marketing

Livestock production is an important source of income and means of livelihood in kellem Wollega Zone. Livestock management practices in all the districts are based on the traditional knowledge of the farmers. The feed resources in the selected districts were primarily natural pasture (communal and own grazing), cultivated forages, crop residues and purchased feed. The major problems of livestock rearing were disease and parasite, shortage of animal feed and improved forage, lack of improved breed, shortage of veterinary service and AI services, wild animals and lack of grazing land. The major livestock marketing problem are involvements of brokers or middle men, low price of livestock and livestock product, fluctuation of market price of livestock and livestock product, no linkages with national markets, lack of market information and lack of cooperatives.

A large number of tree and shrub species were observed in natural forest found scattered on coffee lands, farmlands, grazing areas, farm boundaries around the fences in the study area. In the study area four soil types namely red soil, black soil, loam and sandy soil are identified. The major physical soil and water conservation method they practiced in the three districts are soil bunds, check dams, terraces, stone bunds, grass strips and waterways and biological soil conservation practiced like crop rotation, intercropping, crop residues/manure application and flowing frequency practiced in the study area. The major constraints of natural resource which accountable for productivity decreasing in the study area are; soil erosion, termite attack, soil acidity, deforestation, heavy rain, overgrazing and lack of sustainable bunds managements.

Recommendations

Crop production

Based on the findings of the study generated from Individual interview, KIIs, FGDs and available secondary data, the following recommendations are given:

Agricultural Research Center

- ✓ Ensure the continued supply of improved seeds for major crops like maize, sorghum, finger millet and pulse crops.

- ✓ Ensure the provision and supply, distribution of crops technologies and improved agronomics practices for the study area.
- ✓ Trains farmers and developments agents on improved crops technologies packages
- ✓ Strengthen agricultural research on crops disease and termite control and use crop agriculture research findings for similar agro-ecologies
- ✓ Capacitates farmers' indigenous knowledge on disease and insect-pest managements and should be supported scientifically for better control of crop pests
- ✓ Increase production and productivity of the major crops by proper agricultural land utilizations and improved technologies

Government

- ✓ Ensures an adequate supply of fertilizes and agro-chemicals and promote farmers' effective demand for fertilizers and agro-chemicals usages.
- ✓ Disease, insect and weed control technologies should be developed as the zone is highly prone to crop diseases, insect pests and weed
- ✓ Capacitates farmers on integrated pest managements (IPM) and rely, as much as possible on no-chemical measures to keep pest populations.
- ✓ Expand small-scale irrigated agriculture through efficient irrigation water use
- ✓ Transfers smallholders from subsistent farming to commercialization by strengthen specialization on high value/cash crops and diversification of field crops
- ✓ Promote market and demand oriented crop production systems

Livestock Productions

Agricultural Research Center

- ✓ Promote animal feed production and forage seed developments in the study area
- ✓ Improve farmers awareness to feed for their animals crop residues and improve quality of crops residues
- ✓ Enhance improved forage seed production and pasture developments
- ✓ Develop and expands honey productions through introduce and popularize apiculture technologies for the zone.

Government

- ✓ Enhance livestock productivity and production through breed improvements
- ✓ Control of infectious diseases and parasites by improving veterinary services and vaccine quality control
- ✓ Improve and expand animal health services by rehabilitations of existing clinics and animals health posts
- ✓ Capacitates indigenous knowledge of farmers on animals disease control and increase technical assistance for farmers
- ✓ Strengthen the artificial inseminations (AI) services by supplying AI equipment and facilities

- ✓ Expands and increase small ruminants and poultry production for fulfill populated meat needs
- ✓ Improve marketing systems of livestock through controlling illegal traders and brokers
- ✓ Expands and promote livestock productions and livestock products for domestic markets and exports.

Natural Resources Managements

Depending on the survey and FGDs result of the findings the recommendations below has been given for future natural resource improvement and the sector development in the study areas.

Agricultural Research Center

- ➢ Developing and popularizing well adapted multipurpose trees species to the suitable agro-ecologies should give attentions by woredas concerned bodies and forestry research program
- ➢ Research should expands forest developments technologies and encourages indigenous farmers tree plantations activities practiced through trainings and capacity buildings
- ➢ Expand awareness for farmers to use physical and biological soil conservation for rehabilitation of degraded lands and replenishment of the declined soil fertility in the study area
- ➢ Expanding soil and water conservation practice by farmers and must be supported by research to minimize soil erosions and termite attacks in the study area
- ➢ Soil fertility management researches based on soil test recommendations must be soon launched with the integration of organic and inorganic soil fertility improvement strategies.

Government

- ➢ Strengthen and developing nursery site for multiplying of different multipurpose trees species and for developments of agro-forestry practices in the study areas.
- ➢ Afforestation and tree planting are quite significant to save natural vegetation lose in the study area
- ➢ Governments should give attentions to protects forest from threats

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Determinants of Adoption of Improved Beekeeping Technologies in West Shewa and Oromia Special Zone Surrounding Finfine, Oromia Regional State, Ethiopia

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Abstract

Improved technologies in beekeeping have brought and advanced over decades in the country. However, it has been observed that improving the rural household income by adopting modern beekeeping technologies is still a challenge despite these technological advances. This is due to the relative slow adaption rates of the new technologies. Therefore this study was, designed to find out the determinant factors of adoption of improved technologies in beekeeping and identifying the major constraints of beekeeping production in the study area. A total of 120 *farmer households were purposively and randomly selected from two zones. Semi structured questionnaires used for gathering primary data. The data gathered was analyzed using SPSS version 22. The study result showed that from the total sampled households, 56.7% of the households are adopted improved Beekeeping technologies and the remaining 43.3% of the households were did not adopt. A logit model result revealed that adoption is positively affected by extension services, awareness, and livestock holding whereas absconding is negatively affected the adoption of improved beekeeping practices. So, Farmers alertness on beekeeping technologies and extension advice should be strengthened. In addition, having some financial sources like livestock holding is also support the adoption. So, encouraging reacting in any other supplement income generating activity beside of beekeeping is also better, this make easy for input purchase. In general, efforts should be put into empowering the farmers with knowledge and skills, ensuring availability of modern technologies and increasing the beekeepers awareness on the technologies. The main challenges being hindering the bee product were: Agro chemical application, pests and disease, and lack of improved beekeeping materials among other challenges. So, special attention on solution for anti bee chemical application, bee pests and predators, and other causes of colony deterioration should get in thoughtfulness.*

Key words: *Adoption, Beekeeping, Determinants, Improved technologies*

Introduction

One of the means by which farm level productivity can be increased is through the introduction and dissemination of improved agricultural technologies to farmers. This is possible if and only if, information on the adoption and risk taking behavior of farmers is known in advance. In order to promote diversification in agriculture and reduce poverty in Ethiopia, beekeeping offers a great potential for income generation and poverty alleviation (FAO, 2012; Sisay, 2015). Unlike other agricultural projects such as crop and livestock, beekeeping is a relatively low investment enterprise and can be undertaken by most people irrespective of age, sex, disabled. However, Beekeeping has not received sufficient attention in the past as it does presently in developing country (Matanmi, 2008). Despite the potentiality of beekeeping in Ethiopia, little research and development in beekeeping has been conducted. Agricultural research has not given due emphasis to assessment and understanding of modern methods of bee farming especially in the country where the scholars and policy makers have not been able to adequately demonstrate the importance of these modern methods to livelihoods. Adopting improved technologies and improved management practices would greatly improve the yields and quality of honey (Wilson 2006). Even though considerable attention is given in reports and documents to the significance of beekeeping in Ethiopia, little research and development in beekeeping has been conducted. Efforts to increase production would require proper assessment of the factors affecting the adoption of beekeeping and associated technologies (like improved hive and other accessories, bees and product management technologies). It is the research gap initiates this study to identity factors influencing adoption of improved beekeeping technologies and their major constraints in beekeeping production in the study area.

Research Methodology

Area description

The study was conducted in west shewa zone and Oromia special zone surrounding finfine in oromia region. The West Shewa Zone is one of the administrative zones of the Oromia Regional State. The zone has located between 8°51'16"N to 9°14'53"N 38°15'2"E to 38°28'45"E and about 120 km West of Finfine and consisting of 13 districts(ZAO, 2017). The zone has 13 districts from which two districts (Dandi and Ejere) were conducted for the study. Dandi district is one of the thirteen districts in West Shewa zone of Oromia a regional state located about 90 kilometer away from Addis Ababa west side at an altitude ranging from 2140-2800 m above sea level with mean annual rainfall of 1140 mm and average daily temperature of 16.3°C (Belay and Azage , 2012). The capital of the district is known as Ginchi. Ejere district is located in western Shewa Zone of Oromia regional state located 44 km west of Addis Ababa at altitude of 2060-3085masl and, 38° -22' E longitude and 9°2'N latitude.

The area receives an average annual rain fall of 1075 mm (Sisay *et al.*, 2017). Special Zone of Surrounding Finfine (S/Z/O/S/F) is the zone from which Walmara and Sebeta hawas were selected for the study. It is located in the central highlands of Ethiopia, in Oromia Regional state surrounding the capital city, Finfine. Geographically, the zone lies between 8^0 34' – 9^0 32' North latitude and 380 25' – 390 08' East longitude. Walmara is one of the woredas in the Oromia region part of the Oromia Special Zone Surrounding Finfine; it is bordered on the south by the Sebeta Hawas, on the west by west Shewa Zone, on the north by Mulo, on the northeast by the Sululta, and on the east by the city of Addis Ababa. Sebeta hawas is one of the districts in the oromia region part of the Oromia Special Zone Surrounding Finfine; Sebeta hawas is on the southwest by southwest Shewa Zone, on the northwest by Walmara, on the north by Burayu, on the northeast by the city of Addis Ababa, and on the east by the Akaki. The Awash River defines this district's boundary with southwest Shewa Zone. The altitude of district ranges from 1700 to about 3385masl. The highest point in this district is Mount Wechacha (3191 meters), located in the southern part of the district. The Menagesha National Forest covers the southern and western slopes of this mountain; it is 2500 hectares in size (Bradt, 2002). Other notable peaks include Mount Menagesha between 2800 and 2900 meters (https://unjobs.org).

Sampling method

For this study, Oromia region was purposively selected because the region is one of the most beekeeping production potentialities in the Country. Again two zones from the region also selected purposively where the technology was addressed. Then stratified and simple random sampling method had been conducted to select Districts and PAs (Peasant Associations). Finally, the number of households to be drawn from each farmers association was determined by using probability proportional to size (PPS). Table 1 below illustrates the sample size determination that has been employed.

Table 1 Household Sample Size across Adoption Status for the Study

No	Zone	Districts	Non Adopter	Adopter	Total
1	West shewa	Ejere	19	22	41
		Dandi	12	19	31
		Total	**31**	**41**	**72**
2	OSZSF(oromia special zone surrounding Finfine)	Walmara	17	15	32
		Sebeta hawas	4	12	16
		Total	**21**	**27**	**48**
	Over all Total		52	68	120

Type of data

In the study, primary data was collected on all variables hypothesized to influence beekeeping technologies adoption. The samples respondents had been interviewed with the help of semi-structured (close & open ended questions) schedule and secondary data from zonal and district Agricultural office, would be applied for crosschecking the gathered data.

Data analysis

The collected data were analyzed using descriptive statistics and econometric models. Descriptive statistics (mean, frequency, percentage, standard deviation, *t*-test, and x^2 - test) were used to present and describe socio economic characteristics. A binary logit model also used to identify the determinants of improved beekeeping adoption in the study. Following Gujarati (1995) the model is specified as: $\text{Ln}\,[P/(1-P)] = \beta_0 + \beta_1 X_1 + \ldots \beta_n X_n + e$…………… (1).

The model was estimated using the maximum likelihood method. Adoption category (whether adopted or not adopted the improved beekeeping technologies) was considered as dependent variable which is dummy. The technology is full package of improved beekeeping technology recommended in the study area includes: use of improved bee hive, bee forage planting, feeding of bee colony, seasonal colony management, inspection, colony transferring, colony splitting, queen raring, use of protective cloth, harvesting, product quality management and use of recommended container for storage. The variables presented in table 2 were used in the model.

Table 2 Dependent and Independent variables with expected sign

Variables	Type	Measurement	Expected Sign
Dependent variable	Dummy	Adopter = 1 non-adopter = 0	
Independent variables			
Age	Continuous	Number of years	- ve
Literacy Status	Categorical:	1=Illiterate; 2= Read & Write; 3= Grade 1 -4; 4= Grade 5-8; 5= High School; 6= Higher Education	+ve
Sex	Dummy	0 = Female, 1 = Male	+ve
Training On Beekeeping	Dummy	1 = Yes 0 = No	+ve
Household Land Size	Continues	Measured in hectares	-ve
Family Size	Continuous	Number members	+ve
Experience In Beekeeping	Continuous	Number of years	+ve
Livestock Holding	Continuous	TLU	+ve
Market For The Products:	Dummy	1 = Available; 0 Otherwise	+ve
Extension Contact:	Dummy	1= advised ;0= Otherwise	+ve
Credit Use	Dummy	1 = User 0 Otherwise	+ve
Absconding of Honeybees	Dummy	1= Absconding; 0 Otherwise	-ve
Field day visit	Dummy	1 = visited; 0 other wise	+ve
Traditional hive owned	Continues	Numbers of colony	+ve

Results and Discussions

Demographic features

This section deals with results obtained using statistical measures and comparison for demographic features is based on the corresponding continuous and dummy/categorical variables. The household head mean age was 40.3 years while the mean age for adopters and non-adopters were 40.41 and 39.54 respectively (Table 3). No significance difference was observed across adoption category based on age. The sampled farm households' average family size was 5.27 and 6.07 persons for non adopters and adopters respectively. Experience on beekeeping is one of the variables that were considered but it was found to be insignificant in affecting the adoption of the technology under consideration but with slight difference between mean of the adopters 9.04 and non-adopters 9.93 (Table, 3). This may imply farmers of the study area go with traditional practice for long time as usual of the country's feature of production. Total mean farm size of sample respondents was about 1.5 and it was 0.98 and 2.38 hectare of land for adopters and non-adopters respectively with significant mean difference at 1 % probability level (Table 3). The result shows that the beekeepers in the study areas having more land divert their business to land product rather depending on off-farming activities like beekeeping. So if development agents focus on land less household and youth to implement off-farm activities for those promptly adopts new technology, landless farmers and jobless youth may be benefited.

Number of livestock is an important proxy for income generating activity in terms of dairy, poultry, ruminant, and cattle sale in the study area. Farmers with high number of livestock have an opportunity to bear the risk that may occur. It is possible to understand that the mean livestock owned by the adopter is 2.56 and 1.35 by non adopters, respectively. The *t*- test result indicated that there is significance difference between adopters and non-adopters of improved beekeeping technologies at 1% significance level (Table, 3). This is due to the income generated from the sale of livestock and their products may support purchase of the technologies input and brings farmers for adopt. Number of livestock was measured in Tropical Livestock Unit (TLU).

Variables	**Adoption category**	**Group Statistics**					
		N	**Mean**	**Std**	**Mean**	**Std**	**t- test**
Age	NAD	52	39.54	11.43	-0.873	2.089	-0.42
	AD	68	40.41	11.27			
Family size	NAD	52	5.27	2.96	-0.804	0.516	-1.56
	AD	68	6.07	2.67			
Land holding	NAD	52	2.377	1.67	1.39531	0.2334	5.98***
	AD	68	0.98	0.84			
Experience	NAD	44	9.93	7.44	0.888	1.307	0.68
	AD	68	9.04	6.28			
TLU	NAD	52	1.35	0.97	1.2	0.3	-3.95***
	AD	67	2.56	2.02			
Traditional hive Owned	NAD	52	4.23	3.94	-4.196	0.98	-4.28***
	AD	68	8.43	6.18			

****** Significant at P<0.01, ** Significant at P<0.05; NAD = Non Adopter; AD = Adopter***
Source: own survey result, 2016

The mean traditional honeybee colony holding was 8.43 and 4.23 honeybee colonies for adopters and non-adopters, respectively. Owing more or less number of colonies affect the use of improved beekeeping, as farming households decided to use the technology if they have knowhow about the product (Workneh,2011). Traditional beehives the beekeepers possessed were positively influence the probability of adoption decision of modern beehive (Asmiro, 2017). The study also agree with previously research done, illustrates the significant difference among the group at $p<0.01$ probability level (Table, 3).

Most of the farmers had no education which range from illiterate to higher education. From the sampled households, 24.2% did not pass through formal schooling (Table, 4). Based on adoption category, more of them were from who did not accept the technologies. About 36.5% of non adopters were illiterate while 14.7% were from adopters. Comparison was done between adopters and non-adopters in relation to their educational level. It has statistically significant mean difference at $P<0.05$. This explains that the education level of adopters of improved beekeeping technologies is higher than non-adopters of the technology, implying the influence of the variable in making adoption decisions. Similar result was achieved by Bunde and Kibet (2015) done on Socio-Economic Factors Influencing Adoption of Modern Bee Keeping Technologies in Baringo County, Kenya.

Awareness about the technologies and its benefit helps the beekeeper to learn more about the technologies and alerts them. It also motivates the beekeepers to-wards adopting the technology. Among the respondents, 94.1 % and 32.7 % of adopters and non-adopters, respectively, had got an opportunity to aware/hear about the technology (Table 4). It is statistically significantly different at $P<0.01$. This shows that the beekeepers that got a chance of having information on the technologies, adopt more. Among the respondents, 95.6% and 23.1 % of adopters and non-adopters respectively, had got an opportunity to contact with extension. It is significantly different at $P<0.01$, showing that farmer those advised and supported by extension workers on beekeeping activity, adopt more. Similarly, study identified that, farmers' characteristics such as participation in field days and visiting different demonstrations on apiary sites enhance adoption of farm technology. In other explanation the more participated on field day are from adopter category which is supported by $\chi 2 = 71.59$ indicates significant difference (Table, 4).

Regarding to credit, it makes possible, farmers to acquire inputs for technology adoption. It is more essential for poor beekeepers having necessary equipments, which the farmers perceive the technology to be costly to engage in the activity. The study confirms the idea found that the adopters have more used the credit, with significantly different among the group at $P<0.01$(Table, 4). So, if promotion of the technology is accompanied by credit, as the fact the beekeepers who decide to adopt the technology can get credit. As shown in Table 4, 100 % of the adopters supplied their product to the available market and they had responded that the availability of market, while lesser (68%) of the respondent positively respond concerning market availability from non adopters. This assists the beekeepers to know more about the market and motivated to produce more, which in turn help them to adopt the technology to produce more products and supply more. The difference is statistically significant at P<0.01. Beekeeping training develops the beekeepers' self-confidence in the use of the technology. As summarized in Table 4, it is significantly different at P<0.01, which implies developing the skill of bee-keeper through beekeeping training especially, practical participation improved adoption of improved beekeeping technologies.

Table 4 Demographic and Socio-Economic Characteristics for categorical variables

Variables	Category	Adopters N (%)	Non-adopters N (%)	Total (%)	χ2
Sex	Female	2(2.9)	1(1.9)	3(2.7)	0.125
	Male	66(97.1)	51(98.1)	117(97.5)	
Marital status	Single	5(7.4)	6(11.5)	11(9.2)	3.669
	Married	62(91.2)	42(80.8)	104(86.7)	
	Divorced	1(1.5)	4(7.7)	5(4.2)	
Education status	Illiterate	10(14.7)	19(36.5)	29(24.2)	14.349**
	Read and write	5(7.4)	8(15.4)	13(10.8)	
	Grade 1-4	12(17.6)	8(15.4)	20(16.7)	
	Grade 5 - 8	17(25.0)	8(15.4)	25(20.8)	
	Junior Secondary School	15(22.1)	8(15.4)	23(19.2)	
	High school	6(8.8)	1(1.9)	7(5.8)	
	Higher education	3(4.4)	0(0)	3(2.5)	
Awareness	no	4(4.4)	35(67.3)	39(31.7)	54.046***
	yes	64(94.1)	17(32.7)	81(68.3)	
Extension Contact	no	1(4.4)	40(76.9)	41(34.2)	74.58***
	yes	67(95.6)	12(23.1)	79(65.8)	
Field day	no	10(14.7)	48(92.3)	58(48.3)	71.59***
	yes	58(85.3)	4(7.7)	62(51.7)	
Use credit	no	10(14.7	35(68.6)	45(37.8)	36.04***
	yes	58(85.3)	16(31.4)	74(62.2)	
Market available	no	0(0)	16(31.4)	16(13.4)	24.65***
	yes	68(100)	35(68.6)	103(86.6)	
Training	no	8(11.8)	46(88.5)	54(45)	70.03***
	yes	60(88.2)	6(11.5)	66(55)	

**** Significant at P<0.01, ** Significant at P<0.05*

Sources: Own survey result, 2016

Logistic Regression for Factors Influencing Adoption

The variables subjected to econometric logit model and the results are as shown in table 5. From the study result, the total variation for the adoption of improved beekeeping technologies that explained by binary logit model was about 92.2 %. The model properly predicted sample size of 96.8 % for adopters, and 85% for non-adopters. The variables that were incorporated in the logistic and significantly affect adoption of improved beekeeping technologies were discussed here. Education increases the access to information and thereby possible knowledge of beekeepers regarding improved beekeeping technologies. It also increases the understanding of the technologies and facilitates its application. As hypothesized, education affects adoption of improved beekeeping technologies positively and significantly at $P<0.1$. The result is also supported by earlier studies of Workneh (2011) that dealt with factors associated with the adoption of improved bee hive. Bunde and Kibet (2016) had reported, education level of the household head was found to have positive and significant relationship with the intensity of adoption of modern bee keeping technologies**.**

So, farmer who are educated were likely to adopt modern bee keeping. The coefficient of the variable representing farmers' contact with extension agents was statistically significant with a positive sign. The positive and highly significant coefficient of the extension contact, this means that farmers who had an opportunity to contact with extension agent are strongly motivated to adopt the technologies. The extension contact helps the smallholders to raise their awareness about the characterization and attributes of the technology and use. The result is concurred with research done by Assefa and Gezahegn (2009) on Adoption of Improved Technology in Ethiopia. Improved beekeeping technology requires awareness on the benefits and practical aspects. The odds in favor of adopting improved beekeeping technologies increased by a factor of 94.391 for beekeepers who acquired information on improved beekeeping practices. The finding is concurred with the study of Renaud *et al.* (2018). Their findings suggest that to increase the uptake of beekeeping the following should be considered: increasing awareness and knowledge in allocations but particularly in the low traditional beekeeping areas. Livestock holding as measured Tropical Livestock Unit (TLU) had a positive and significant influence on the technologies adoption. As expected, the more farmers have other financial supplement sources the more likely for the farmer to diversify income sources. Unlike other agricultural activities beekeeping does not compete on resources, like land, feed, labor and other required inputs with other income generating activities. This is that having livestock to beekeepers to widen the financial basis of poor beekeepers. This may reduce beekeepers can suffer in the use of loan to buy modern beekeeping materials, such as access to modern beehives equipment and accessories like the honey extractor, wax stumper, queen excluder, smokers, brush, gloves, bee veil, and others. Absconding is the total movement of honeybee colony by leaving the hive. Absconding can happen due to different reasons. Lack of feed, honey bee pests and drought are the main problems that may cause absconding. As hypothesized, absconding influences adoption of improved beekeeping negatively and significantly at $P<0.1$, the odds in favor of adopting improved beekeeping increased by a factor of 0.029 for beekeepers who had suffered by absconding (Table,5).

Table 5 Logistic regression factors influencing adoption the technologies

Variables	B	S.E.	Wald	Sig.	Exp(B)
Sex	-19.46	40192.95	0.000	1.000	0.000
Age	-0.042	0.088	0.224	0.636	0.959
Family size	0.154	0.278	0.309	0.578	1.167
Education	0.607	0.338	3.225	0.073*	1.835
Land size (ha)	-0.334	0.527	0.402	0.526	0.716
Experience	-0.034	0.115	0.086	0.769	0.967
Traditional hive possessed	0.190	0.127	2.256	0.133	1.210
Awareness	4.547	1.617	7.907	0.005***	94.391
Absconding	-3.541	1.868	3.594	0.058*	0.029
Extension contact	4.157	1.375	9.145	0.002***	63.874
Training	0.986	1.021	0.934	0.334	2.681
Market	17.165	12234.4	0.000	0.999	28474377.7
Use of Credit	0.081	1.090	0.006	0.941	1.085
TLU	0.267	0.162	2.725	0.099*	1.306
Constant	-4.106	42013.73	.000	1.000	0.016

-2 Log likelihood = 34.869[a]
$\chi 2$ = 102.739***
Predicted adopter = 96.8%;
Predicted Non adopter = 85% ;
Overall = 92.2%

*, *** significant at p<0.1, and p<0.01, respectively

Constraints

In order to utilize the beekeeping sub sector, identifying the existing constraints and searching for solutions are of paramount importance. Accordingly, the respondents identified nine major constraints. All problems cannot be solved at once because of time and capital shortage. As a result, prioritization of the problems was made to identify the most important constraints that hinder the development of beekeeping sub sector in the study area. The constraints can also hinder adoption of improved beekeeping technologies. As indicated in Table 6, agro chemical application is the primary constraint in beekeeping sub sector in the study area. It affects their feed sources (bee forage) and leads death of colonies. As a consequence, the honeybee colony declined and discontinued of production in the areas. The existence of honeybees' disease and pests affect the honeybees' life which, in turn, also leads them to absconding. The remaining constraints prioritized above affect the hive products of the study area, though their degree of influence is different.

Table 6, Ranking of beekeeping constraints in the study area

Constraints	Frequency	Percent
Agro chemicals	35	31.3
Diseases, pest and predators	29	25.9
lack of bee keeping material	20	17.9
Absconding	10	8.9
Lack of skill	7	6.3
High cost of improved bee keeping material	5	4.5
Declining of Bee colony	4	3.6
Shortage of bee forage	1	0.9
Lack of extension support	1	0.9
Total	112	100.0
Missing System	8	
Total	120	

Conclusions &Recommendations

The study was conducted in two zone of oromia region based on potentiality of beekeeping practice and early addressed of the technologies. Descriptive statistics and econometric model were employed for analysis. From descriptive result, demographic/institutional factors like education, awareness/information, extension contact, field day, use credit, training, and market available are the variables viewed significant difference among the groups on adoption of improved beekeeping technologies. In addition total mean farm size, number of livestock owned (TLU), and number of bee colony are considerable factor in making for adoption of the technologies. The binary logit model also clearly shows that educational level, extension contact, number of livestock owned, Awareness and absconding are the main determinants factors of probability of adoption in the study area. Even though the government of Ethiopia gives great attention to the beekeeping sub-sector to promote modern beekeeping technologies, but the probability of adoption the technologies is found to be minimal and affected by different factors. Agro chemical application is ranked as a first; Diseases, Pests and predators are ranked as the second major constraints of beekeepers. Bee equipment and accessories, and high costs of the material are the succeeding rank respectively. Based on the conclusions the following recommendations are drawn:

- ✓ Education is an important factor for any new hi-tech adoption. So, future researchers can explore how to promote beekeeping among educated farmers. This is because presently, it is mainly done by uneducated farmers.
- ✓ Lack of extension support was found to be the major factor influence to modern bee keeping practices in the area. So, Agricultural extension services have to be provided for

farm households including those farmers who are far from development agent offices and should take the lead in creating necessary linkages and activating such off-farm activities.

- ✓ Having other supplement income is also important to purchase the required beekeeping improved inputs. This may reduce beekeepers can suffer in the use of loan to buy modern beehives and access to modern beehives equipment and accessories. So running other agricultural activities beside beekeeping is recommended since the activity is never competing any doings.
- ✓ In order to support beekeeping adoption, efforts should be focused on continuing and intensifying initiatives that increase awareness and knowledge, particularly in improved beekeeping activities. Early awareness may be effective in raising motivation and reducing inequalities or negative perceptions and feelings based on false information. So, adequate information have to be provided for farm households about the technologies, benefits, usages, as well as system have to be formed by giving attention to the wise way of using different chemicals specifically herbicides to minimize the death of honey bees.
- ✓ Appropriate interventions in disease, pest and predator control should be strengthened to reduce colony disturbance and improve overall productivity.
- ✓ Beekeeping equipment and accessories have to be supplied /accessible/ to the farmers at affordable price and great attention have to be given which can increase productivity and take appropriate management practices.

Variables test

Table 7 Results of multicollinearity test: Contingency coefficient for dummy variables

	aware	abscond	extension	Field day	training	market	credit	sex	Education
Aware	1								
Abscond	0.1058	1							
Extension	0.4027	0.0715	1						
Field day	0.5219	0.0630	0.7120	1					
Training	0.4950	0.0038	0.6206	0.6668	1				
Market	0.4632	0.0503	0.4158	0.388	0.3912				
Credit	0.1321	-0.0737	0.2439	0.2432	0.2329	0.0699	1		
Sex	-0.057	-0.0358	-0.0627	-0.088	-0.076	-0.034	-0.067	1	
Education	0.2172	0.0495	0.2586	0.3373	0.2964	0.1150	0.0544	0.1305	1

Table 8 Results of multicollinearity test: Variance inflation factor for the continuous explanatory variables

	Tolerance	**VIF**
Family size	0.786	1.273
Hectare of land	0.846	1.183
Traditional honey bee colony owned	0.974	1.027
TLU	0.790	1.266
age of household head	0.729	1.371

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Characterization and Analysis of Farming System in Central Oromia,Ethiopia

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Abstract

Designing agricultural transformation strategies that modernize small-scale farming in Ethiopia require actions built upon solid, holistic baselines, and affordable technical intervention. A study was conducted to identify and prioritize the production systems and major production constraints of farming in the study areas. The Study was conducted in West shewa, South west shewa, North shewa and Oromia special zone surrounding Finfine. The selection of the zones and districts was done purposively based on the agro ecology. The main methods used to gather the data were survey, key informant interviews, group discussions, observations and reviewing of secondary data from different sources. A total of 200 Sample households were randomly selected for primary data collection. Descriptive ways of analysis method were applied using SPSS version 22. The study was focused on major characteristics of crop production, livestock production, and natural resources management. The study revealed that mixed crop-livestock production system was found as the dominant farming system with the average landholding is *less than 2 ha per family size of five. The dominant crop was cereal and pulse crop followed with vegetable. Mixed crop-livestock production, peri-urban, and urban dairy farming system were the identified livestock production system in the study area. Livestock production is subsistence-oriented and is an important component of the mixed farming system that integrated with crop production. The study indicated that major constraints of agricultural production in the area are farm land shrinkage, crop disease, insect-pests, inadequate livestock feed, lack of improved seed and input, less farming mechanization, less attention on irrigation production, no legal limitation between upper and lower stream among irrigation product, water pollution from urban for irrigated products, and less attention given to the livestock sector by government. So, concerned body will invited to intervene through lessening the main constraints mentioned.*

Keywords: *Farming system characterization, opportunities, constraints, central Oromia*

Introduction

Farming system is set of agricultural activities organized while preserving land productivity, environmental quality and maintaining desirable level of biological diversity and ecological stability. The emphasis is more on a system rather than on gross output. Farming system consist of several enterprises like cropping system, dairying, poultry, fishery, bee keeping etc. these enterprises are interrelated. Farming characterizing research is considered a powerful tool for natural and human resource management in least developed countries such as Ethiopia. Ethiopia is an ecologically diverse country with an agricultural sector. Yet, the largest share of the GDP of the country still comes from agriculture (Diao *et al.,* 2010). The country's economy is predominantly rural and agricultural, and the declining trend in size of land holding poses a serious challenge to the sustainability and profitability of farming. Under the gradual shrinking of land holding, it is necessary to integrate land based enterprises within the bio-physical and socio-economic environment of the farmers to make farming more profitable (Behera *et al*., 2004). No single farm enterprise is likely to be able to sustain the small and marginal farmers without resorting to integrated farming systems for the generation of adequate income and gainful employment year round. The present critical situation in the countries food supplies, especially in food insecure areas demands that all available agricultural resources be utilized to full maximize food production through improved agronomy, efficient use of resources, effective use of improved crop varieties, and improved livestock husbandry practices. To implement the above mentioned agricultural technology involvement, farming system study is very crucial and hence, improves and direct agricultural research and development interventions in the area.

Research objectives

- To assess and identify the agricultural production systems of the study area and;
- To identify and prioritize major constraints agricultural production in the study area

Methodology

The study was conducted in four zones from which fifteen districts contacted were: South West Shewa zone (wenchi, waliso, Becho, Ameya) districts; O/S/Z/S/Finfine (Walmara, Sululta, Sebeta hawas, Berek) districts; North Shewa (Wichale, Abote, Degem, Wara jarso) district; West Shewa (Chaliya, Toke kutaye, and Dire inchinni) districts. Some districts of the study area like Walmara, Sululta & Berek, and Sebeta hawas are geographically located under west shewa, North Shewa, and south west shewa zone of the Oromia Regional State respectively; but they have been administratively placed under the Oromia Special Zone Surrounding Finfine since 2008 (https://en.wikipedia.org).

The study location

West shewa: The Zone is known for its mixed crop-livestock farming systems. Geographically, West Shewa bordered on the south by the Southwest Shewa Zone and the Southern Nation Nationality and People (SNNP), on the southwest by Jimma, on the West by East Wellega, on the Northwest by Horro Gudru Wellega, on the North by the Amhara Region, on the Northeast by North Shewa, and on the East by Oromia Special Zone Surrounding Finfine(figure 1). The zone has located between 8°51'16"N to 9°14'53"N 38°15'2"E to 38°28'45"E and about 120 km West of Finfine (ZAO, 2017).

North shewa: It is surrounded by Amhara National Regional State and three Oromia zones, which is North shewa of Amhara National Regional State in the North and East direction, in the Western, West Shewa zone of Oromia regional state, Oromia Special Zone Surrounding Finfine in the South, and in the South East Shewa. Astronomically, the Zone lies between 8^0 55’N and 10^0 23’N latitude and 37^0 56’E and 39^0 32’E longitude (ZAO, 2017). This Zone features crop-livestock farming systems.

Southwest Shewa: The Zone is known for its mixed crop-livestock farming systems. Geographically, is bordered by by Oromia Special Zone Surrounding Finfine on east, North by West Shewa zone, on the Northwest and South West by SNNP. It is located at 8°16-9°56´N latitude and 37°05´-38°46´E longitude.

Special Zone of Surrounding Finfine (S/Z/O/S/F): is located in the central highlands of Ethiopia, in Oromia Regional state surrounding the capital city, Finfine. Geographically, the zone lies between 8^0 34’ – 9^0 32’ North latitude and 380 25’ – 390 08’ East longitude

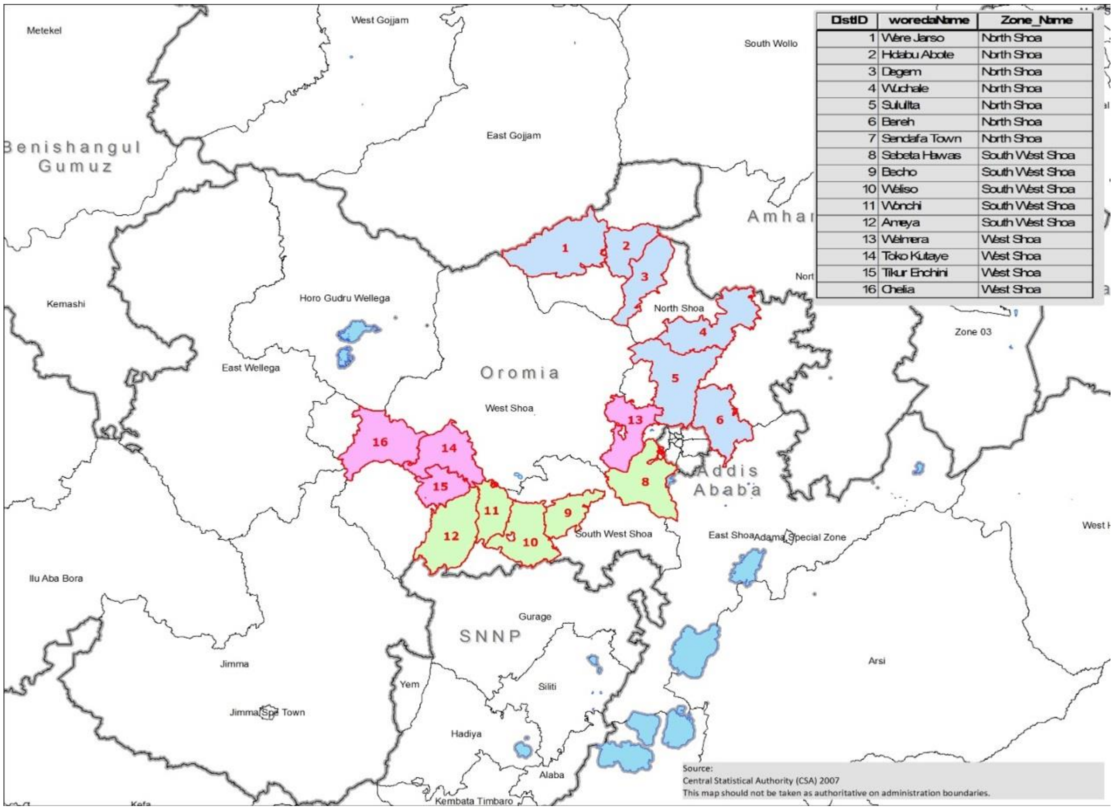

Figure 1 Map of the study area

jere is located between 8°51'16"N to 9°14'53"N and

38°15'2"E to 38°28'45"E and about 40 km west of Addis

Ababa

Topography and Soil Type

This study area has four major physiographic divisions: Plane, Mountain, Valley, and Hill based on topography; and highland, midland and low land based on agro ecology. From table 1, zones conducted for the study, topography of the area is plane in large proportion except data unavailable for Oromia Special Zone Surrounding Finfine (O/S/Z/S/F). However study from (http://shodhganga.inflibnet) indicates the low plateaus and the associated low lands are constituted about 50 per cent of the total area of the Zone lies within the range of 1500-2500 meters. This indicates that half of this special zone lies in the low plateau (mid land) area.

In the study area plane (flat surface), mountains, valley and hills are characterized by black, reddish, and reddish brown in color; clay and heavy clay soil in texture. Categorically: Vertisols, Leptosoils and Cambisols soil types are prevailed predominantly. Vertisols is developed on the flat highland of the study area and suitable for cultivation of cereals and pulses and is a heavily textured soil dominating the study area. Because of the high content of shrink-swell clay in these soils, cultivation is difficult when they are dry and water logging is a problem when they are wet. Leptosoils is low in agricultural potentials, and Cambisols which is well drained and has relatively good organic content. These soils are mainly pulverized acid soils. The main problem is high acidity and low soil organic matter. The study visited with poor or no soil conservation practices in the study area however, the fertility status of the soil of the zone is good and conducive for crop production (OWWDSE, 2011). Detail Topography, ecology and scientific soil type of the study areas were observed from table 1.

Rainfall and temperature

Report from farmer community of group discussion portrays that, there are two main seasons: *Ganna* is a main rainy season which extends from June to early September, and *Arfasa* the period that extends from March to May. The *Ganna* rains are used for planting both long and short cycle crops. Maize, the long cycle crop, is grown from May to December. Teff and wheat, short cycle crops are grown from July to November. Chickpea, another short cycle crop is grown from September to December. The harvesting period for teff and wheat is the month of October and November. Chickpea is harvested in December. Vegetation coverage consists of scattered bushes and scrubs. Detail rain fall amount and temperature of the study area presented in Table1.

Definition of some topographical category

Plain (*Lafa diriiraa/Dirree*): *plane* is a land formation refers to a flat, treeless area of land. In local language is called ***Lafa diriiraa/Dirree.***

Hill (*Tabba*): Hills are most commonly formed by erosion of land. Portion of the earth's surface elevated above its surroundings (https://dpipwe.tas.gov) and is called ***Tabba*** in local language.

Mountain *(Tulluu/gaara*): is a large landform that rises above the surrounding land in a limited area, usually in the form of a peak. A mountain is generally steeper than a hill (hh://en.wikipedia.org/wiki/Mountain), and is known as ***Tulluu/gaara*** locally.

Valley (Lafa dhooqa/bo'oo): Markedly elongated depression in the earth's surface, often containing a watercourse and locally is called as ***Lafa dhooqa/bo'oo.***

Table 1 Topography, ecology and soil type of the study areas

Variables	**N/Shewa**	**W/Shewa**	**O/S/ZS//F**	**S/W/Shewa**
1. Topography				
Plain	43.8%	47.7%	nd	33.5%
Mountain	19.8%	16.8%	nd	25%
Valley	7.4%	46%	nd	26.7%
Hill	28.9%	25.7%	nd	14.7%
2. Main soil type	Vertisol,	Vertisol,	Chromic and	Vertis soil,

		Lepto soil,	Luvisols, Leptosols, Nitisols	Pellic Vertisols	Luvisols
3.	Total farm land (ha)	433020	621132.7	203270	232491
4.	Lowland	23%	33%	nd	0%
5.	Midland	34.82%	40%	50%	70.9%
6.	Highland	42%	27%	nd	29.1%
7.	Rain fall (mm)	800 - 1600	812 - 1699	nd	900 - 1900
8.	Temperature(^{0}c)	16 – 32	20 - 25	16 - 26	10 -30
9.	Elevation (m.a.s.l)	1080 - 3541	1050 - 3500	1500 - 3440	1600 - 3576

***Sources**: ZAO (Zonal Agricultural Office, 2017)*

Note: nd = No Data

Sampling procedure

For this study, the zones were purposively selected from oromia regional state based on agro ecology and mandate area of the research axis. From the selected zones, again districts were selected purposively based on the ecology (Low, mid, and high land agro ecology) then PAs (Peasant Associations) and farmers were selected randomly based on PSS

Data collection and analysis

Blends of tools and techniques were adopted to collect the required information and dataset that address the objectives of the study. The standard data collection techniques and approaches employed in this study included desk reviews, quantitative and qualitative survey techniques. Qualitative survey methods including participatory approaches to collect primary information from the key informant of farming community and staffs of zone and district level Agriculture Offices. Quantitative survey was from randomly selected farm household respondents of 200 in size. Data analysis was done as per the data collected using SPSS software 22.

Results and discussions

The results discussed in this paper will focus mainly on farming systems characterized in the low, mid and highland areas of central oromia. Main farming system is mixed (crop - livestock) and main crop production system is sole cropping systems.

Demographic characteristics

Demographic characteristics may include: Category of farmers (wealthy category), Farmer ethnicity, HH Education status, and HH Religion, HH Sex, HH Marital Status, and Family size.

During discussions with the zones and district offices of agriculture staff and the community, ranges of socio-economic issues were assessed. Accordingly, farmers of the study area are categorized under different farming group based on resources they owned and farm. In the context of highland agro-ecologies, relatively well-to-do (wealthy) households are those who own more than 10 cattle with a pair or more of oxen for farm operations. Result is similar with the study conducted by Agajie *et al.,* (2018) on the same area. The farmers perceive that large livestock ownership ensures high production of grain and livestock products such as milk and butter. The implication is that such households can also afford to purchase inputs including new agricultural technologies and they are often risk takers in trying new technologies.

Even though there could be variability from location to location, such households, however, account for a very small proportion in the community; the result point out 34.5% however is far above 10% have been reported by Agajie *et al.,* (2018). Similarly in the context of lowland agro-ecologies, wealthy farmers are those who can produce and cover food demands but not in full months of in year. They adopt various practices to achieve this level of food security, such as the use of short maturing varieties, and others. Medium wealth categories in the context of highland agro-ecologies often own a pair of oxen. Apart from agricultural produce, they also strive to generate supplementary incomes through off-farm activities. Despite not as much as well-to-do households, they make all the efforts to afford purchases of inputs, send their children to school, and produce food for their family. They are not, however, food secured and economically strong as the rich wealth category.

They have to strive further and enhance their economic capacity through technology use and other options of income sources. According to survey' estimates, this wealth category accounts for about 83.5 % of the farmers are middle farmers from four zones of central oromia. While the least portion about 17% is resources poor relatively (table 2). Households categorized as poor farmers in the context of lowland agro-ecology can produce and cover food demands only for five months. This means, they have to run food insecure for seven months in a year and find a living through various options, such as looking for government supported, and engagement in daily labor, migration to towns, and others. To cross check the idea raised from farm community based on wealthy category, the wealthy indicators for farm households of the study area Livestock and land were taken as the factors since all dependency of rural economy is on these things. Figure 2 indicates land resources in ha for crop production and livestock holding in TLU. The results of the present study revealed that larger proportion of land owned and allocated for crop production is an indicator of wealth status. In addition Livestock and livestock products serve as routine sources of income to smallholder farmers in the study areas. The data collected also provide supported result obtained from qualitative data generated through key informant group discussion. Accordingly, the model farmers are better-off in terms of farm land and livestock holding (figure 2).

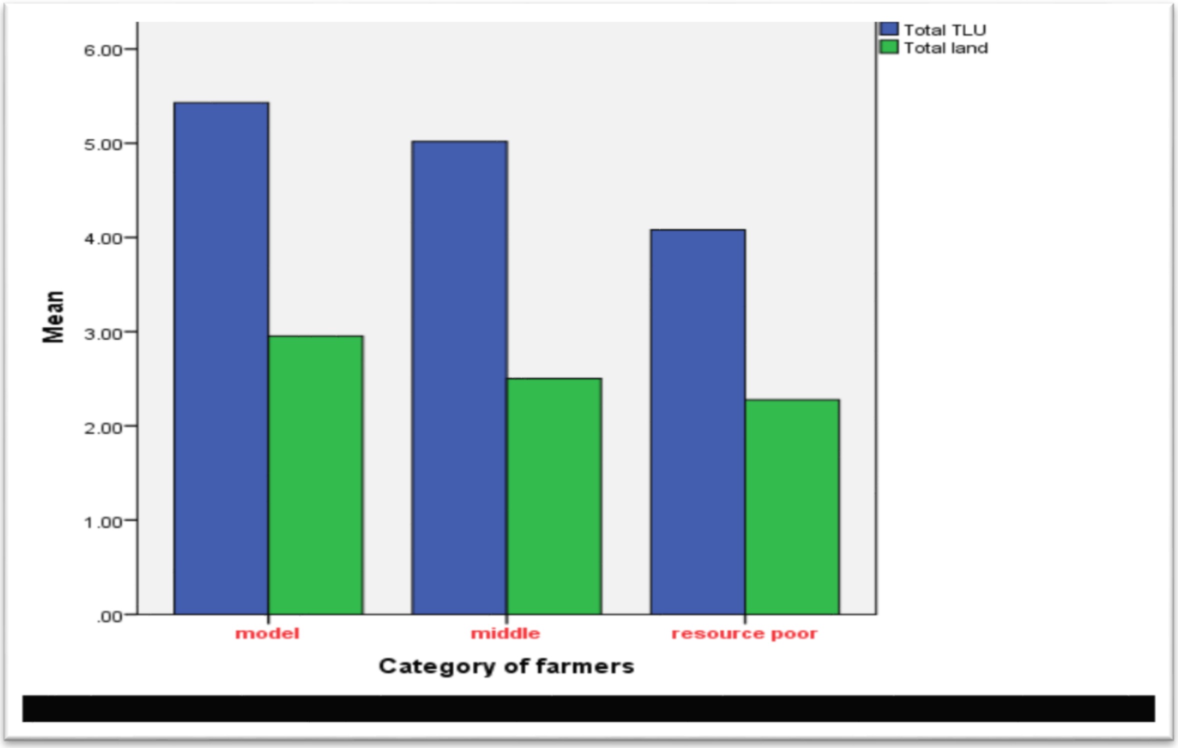

Figure 2 Category of farmers based on farm land and TLU owned

The ethnicity groups from the study area are almost all are Oromo with a few number Gurage ethnic group. The household religions of the sampled are Orthodox Christianity in large proportion (62%) following with protestant. The education status of household head is on good status since the nearness of the study areas to the center. About 47.5% have elementary school and 25% have high school. While only 2.5% of them have higher education (Table 2).

Table 2. Demographic characteristics of farmers

Variables	**parameters**	**N**	**%**
Category of farmers	Model	69	34.5
	Middle	97	83.5
	Resource poor	34	17.0
	Total	200	100.0
Farmer ethnicity	Oromo	199	99.5
	Gurage	1	0.5
	Total	200	100.0
HH Education status	No educated	34	17.0
	Read and write	16	8.0
	Elementary school	95	47.5
	High school	50	25.0
	Higher education	5	2.5
	Total	200	100.0

HH Religion	Muslim	4	2.0
	Orthodox	124	62.0
	Protestant	72	36.0
	Total	200	100.0
HH Sex	Male	197	98.5
	Female	3	1.5
	Total	200	100.0
HH Marital Status	Single	13	6.5
	Married	184	92.0
	Divorced	1	0.5
	Widowers	2	1.0
	Total	200	100.0
Family size	Min = 1	Max = 12	Mean = 5 (Sd.D = 2.27)

Sources: Own computational survey, 2017

Crop Production Systems

The general agricultural feature of the study area is mainly characterized as traditional and subsistence type of mixed crop-livestock production system. The production was nearly all rain fed dependent and produced for consumption and local market, whilst little amount of vegetables produced by irrigation for marketing purpose mainly.

Grain: Farmers practice a cereal dominated cropping system with teff as the most important crop in low and medium altitudes, followed by maize, chick pea, lentil, and rough pea/grass pea. In the high altitude, wheat is the most important crop followed by faba bean, barely, field pea for all the study sites. On specific at high altitude, the settler from the Gurage area introduced enset and is adapted by many farmers in south west shewa zone. The average farm size in the central highland cereal- pulse mixed farming system is about 0.25 – 9 ha under rain fall. Under irrigation, *Guaya* from pulse crop and almost all vegetables are produced allocating an area of 0.13 – 3 ha. In the zones, the average landholding is less than 2 ha per family size of five. The system is characterized by low management intensity, a medium level of market linkages and narrow crop commercialization.

Vegetables and fruits: The consumption and marketing of vegetables and fruits is relatively limited, largely because of their low productivity; high perish ability, long time maturity and high production cost. Horticultural crops (vegetables & fruits) such as Potato, tomato, onion, cabbage, beet root, sweet Potato, Carrot, Pepper (green and red), banana, garlic, orange, avocado, mango, apple, enset, lemon, Papaya and Shallot are the major ones that grow in the study site. Even though the zones are suitable to grow any types of horticultural crops, most farmers grows the mentioned one in table 3 on average.

Oilseeds: The main oilseeds are neug (also known as noug or Niger seed; Guizotia abyssinica), and linseed (also known as flax; Linum usitatissimum) with a little share of land. The cultivation of noug is found mostly in the northern and central highlands at elevations between 1800 and 2500 meters. Linseed is cultivated in the same areas as Niger seed. Generally, production of oil crop is not principal in the area. Linseed and Noug are represented the oil crop, and they share little amount of land size.

Table 3. Dominant crop and livestock

Zone	Dominant crop	Dominant vegetables	Dominant fruits and roots	Dominant livestock
N/Shewa	1. Teff 2. Chick pea 3. Wheat 4. Barley 5. H/bean	1. Potato 2. Onion 3. Garlic 4. Cabbage 5. Carrot	1. Mango 2. Banana 3. Orange	1. Dairy 2. Small ruminants 3. Equines
W/Shewa	1. Teff 2. Chick pea 3. Wheat 4. Pea	1. Peppers 2. Cabbage 3. Potato 4. Tomato	1. Mango 2. Koki	1. Power cattle 2. Dairy 3. Beekeeping 4. Poultry 5. Equines 6. Ruminants
O/S/Z/S/F infine	1. Wheat 2. Teff 3. Chickpea 4. Lintel	1. Potato 2. Tomato 3. Cabbage 4. Carrot 3. Onion 4. Lettuce	1. Koki	2. Dairy 3. Equines (horses)
S/W/Shewa	1. Teff 2. Wheat 3. Chickpea	1. Potato 2. Tomato 3. Onions 4. Cabbage 5. Carrot 6. cucumber	1. Enset 2. Mango 3. Banana 4. Avocado	1. Power cattle 2. Ruminant 3. Dairy

Sources: Key informant and community group discussion, 2017

Results from table 4 indicates, that majority of the farmers produce Tef as the first, and land allocation is also goes to Teff in large amount. Table 4 clarified that the mean land allocation for Teff is about 1 ha with ranging 0.13 to 5 ha which shares above half of the land owned, and the next largest land area is goes to wheat on average 0.72 ha and ranging from 0.13 – 10 ha. Land allocated for Barley production per year was about 0.68 ha with maximum 3 ha. From cereal crop, less size of land is allocated for maize and sorghum as data from sampled households. This because of large portion of agro ecology of the study area is highland and mid to highland which is less suitable for maize and sorghum. From pulse crop chickpea, lentil, pea, bean are also share large areas of farm land, and on specific chickpea particularly in all zones shares about 0.60 ha of land ranging from 0.13 – 2 ha. Generally, in the study area Tef, chick pea, Wheat, Lentil, Potato are the main production crop and they have been consider as food and cash crop. Maize and wheat is the most productive crop per hectare followed by Teff (table, 4). Potato is the most dominant vegetable crop in terms of production, consumption and marketing.

Table 4. Land allocated for each crop and productivity in the study area @ 2017

Land allocated (ha)					Productivity (Qt/ha)			
crop	Min	Max	Mean	Std. D	Min	Max	mean	Std. D
Teff	0.13	5.0	0.94	0.817	1	25	6.4	4.77
Wheat	0.13	10.0	0.72	0.962	1	30	7.7	5.35
Chickpea	0.13	2.00	0.60	0.430	1	8	3.8	1.91
Bean	0.13	5.0	0.60	0.887	1	10	3.8	2.41
Maize	0.10	2.0	0.33	0.328	2	30	12.5	10.04
Barley	0.13	3.0	0.68	0.620	0.25	40	9.1	8.99
Guayas	0.13	5.0	0.54	0.988	1.5	10	4.2	2.75
Sorghum	0.13	2.0	0.42	0.644	3	30	12	15.59
Enset	0.10	5.00	0.735	1.505	-	-	-	-
Potato	0.13	1.00	0.268	0.188	1	150	27	35.34
Lin seed	0.10	0.50	0.267	0.129	1	4	1.7	1.211
Noug	0.25	0.25	0.250	.	1	4	1.7	1.211
Oath	0.13	0.13	0.125	.	1	1	1	.
Pea	0.20	2.00	0.738	0.852	6	6	6	.
lentil	0.50	1.25	0.750	0.433	3	22	9.5	8.58

Sources: Own computational survey, 2017

Cropping techniques calendars: In general cereals require finer seedbed preparation than pulses and hence more cultivation is carried out before sowing. As specified earlier, seedbed preparation for planting begins normally with the *belg* rain in March/April. Cultivation generally continues up to May depending on the soil moisture, and resumes in late June when the main rain commences. But sowing of each crop is occurred in different time. Traditionally, farmers without adequate number of draught animals take advantage of the long ploughing period to share them with others.

Farm clustering based crop production: Crop is the main stable food, income generating and export commodity in the country. The study area is the core for production of crop those are explained in table 5. Generally, over all the study area is categorized under *Tef* cluster. The *Tef* cluster in Oromia encompasses West Shewa, East Shewa, South West Shewa and Special Zones covering 200,192 hectares over 15 woredas. Approximately 72% of farmers in this area are engaged in *Tef* production. Slightly more than half (52%) of Tef grown is marketed, primarily through traders, but also through six major unions to a smaller degree (ATA, 2018).

Livestock production system

Mixed crop-livestock production, peri-urban, and urban dairy farming system were the identified livestock production system in the study area. Livestock production is subsistence-oriented and is an important component of the mixed farming system and is well integrated with crop production. Livestock species kept by the farmers comprise cattle, sheep, goats, equines and chicken. Cattle are the dominant species, mainly used for draught power, followed by milk and meat production, income and manure for fuel than for maintaining soil fertility. Livestock also have an important socio-cultural role in the study area. The livestock owned had been converted to TLU for each species. Accordingly the largest total livestock was found in west shewa having top in cattle and least in ruminants (Figure 3). Oromia special zone surrounding finfine (O/S/Z/S/F) stands second in all types of livestock units and first in ruminants. Peri-urban and urban production systems are developed in areas where the population density is high and agricultural land is shrinking due to urbanization around big cities like Addis Ababa and other zonal towns. In this system crossbred animals are kept in small sized farms.

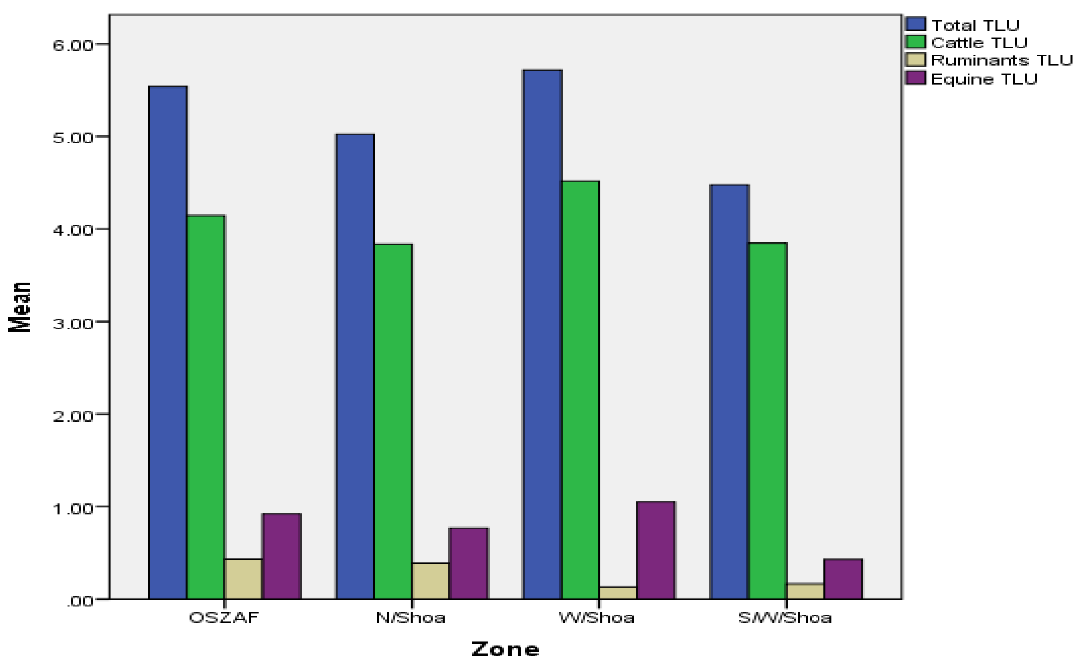

Figure 3 Livestock in TLU found in each zone

Dairy Production Systems: Two major dairy production systems, namely urban (Urban and peri-urban milk production) and rural or mixed crop/livestock production systems were identified. From figure 4 one can observe the milk yield from both breed cows is better in O/S/Z/S/Finfine On average, about 7.5 and 1.4 liters of milk were produced daily per cross breed and respectively. This may be because of better management with small herd size. From cross bred, the primary of the production system is to sale milk as a means of additional cash income because of high milk yield relatively. So, provision of better milk yielding animals with management practice to rural farmers may lessen food insecure problem. From the left zone even if dominance of cattle is observed in west shewa zone, the milk yield performance is the lowest as observed from figure 4. Due to low milk productivity of cows, animals are milked to provide the family with fresh milk butter and cheese. Surpluses are sold, usually by women, who use the regular cash income to buy household necessities or to save for festival.

Peri-urban and urban dairy production systems also found in the outskirts of the capital city and zonal cities and mostly concentrated with in below 100 km distance around Addis Ababa which includes dairy farms ranging from smallholder to commercial farmers. The system comprises small sized dairy farms that own crossbreed dairy cows. The primary objective of milk production in this system is generating additional income to the household. Husbandry practices such as feeding, watering, housing, breeding, milking, calf rearing, waste management, and record keeping were different in the two production systems.

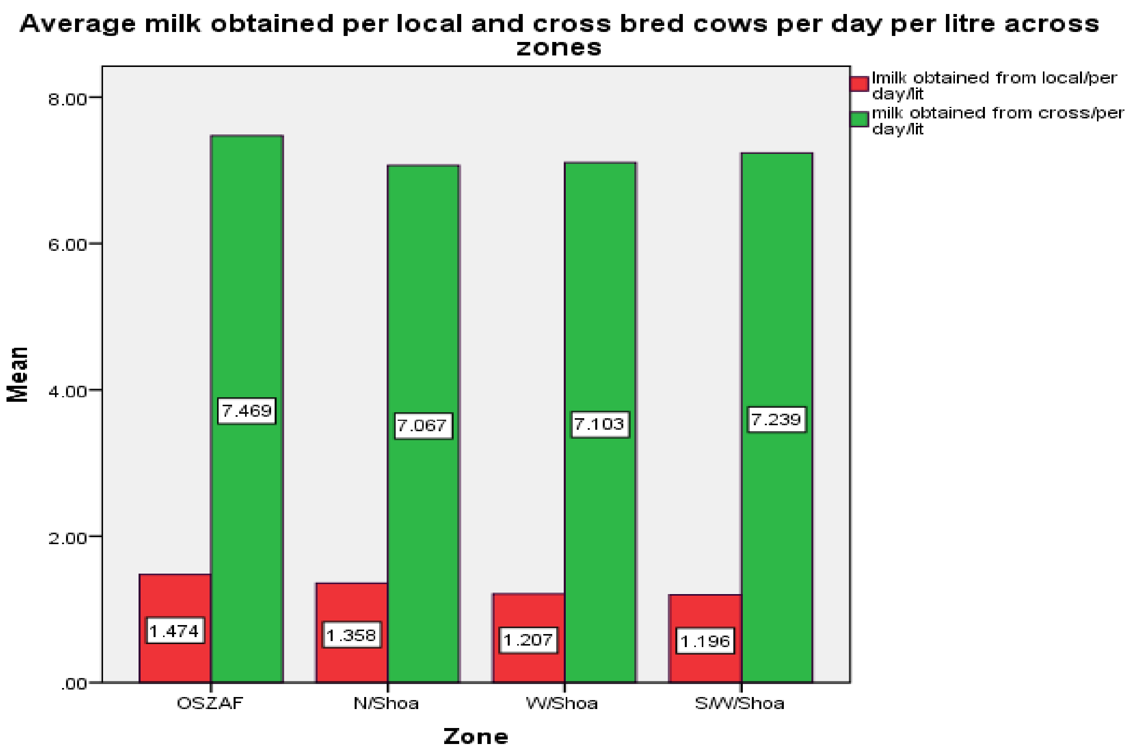

Figure 4 Milk yield per cows /L/Day

Feeding system: The feed resource base for livestock producers in the mid and highlands includes feeds produced on-farm and those obtained from off-farm sources. While roughage feeds are mainly produced on-farm by the farmers, concentrate feed ingredients are produced as by-products of agro-industries located in different parts of the country and being channeled to the smallholder farmers through various chains. Accordingly type of feed supplied to dairy cattle is explained in table 5, based on locations. Mostly, urban dairy cattle feed with by-products of agro-industries and little amount of cereal by product while the rural one from farm by product. The daily feed supply to animals was not measured by any of the dairy farmers rather feed was provided roughly based on the availability of feed and daily milk yield. Shortage of feed supply and poor nutritional quality of available feed resources are the major constraints affecting livestock productivity in study area. It is thus important to tackle the feed shortage issue to ensure economically viable and environmental friendly livestock production.

Beekeeping production system: Ethiopian farmers have a very long tradition in bee keeping. Many smallholder farmers keep bees for their honey and beeswax, and bee colonies are a good source of income. These products have a high demand and the prices stay high throughout the year. Moreover, they are not perishable. This contributes significantly to the household's food security; especially areas with moisture stress and degraded farming areas. Report from farmers of the study area said recently beekeeping is facing serious problems: one is that the bee colonies are escaping from their hives. This is because the bee forage is drying up faster than before and as well as there is insufficient water supply, the other foraging problem is chemical application that farmers use pesticides for the control of weeds, diseases, and insects and bees are foraging that. Poor knowledge in using of modern technology, and over confidence of using the unwisely constructed material like hives constructed out of recommended design. Sometimes the beehives sold in the market are not made from selected and suitable wood (Flailu *et al.,* 2012). This also causes the absconding of bees and deriving the low productivity of the sector. There are two basic types of beehives in farmers' hands. These are the traditional and modern types.

Traditional beehive: There are different designs of traditional beehives that are cheap and easy to produce or buy. One type looks like a large log, circular in cross-section, is made from wood, even a hollow branch, or sticks tied together and plastered with cow dung and/or mud. Farmers use this design of beehive to put their bee colonies up in the branches of trees when they are flowering and in trees next to their flowering crops. They also hang them up in trees to catch escaping bee colonies.

Modern beehives: Farmers are interested to have modern beehives as they have different compartments inside and they have higher yields, but it is expensive. However, they do not sit and wait for a solution to be given to them. To improve their incomes, many farmers are creative in improving beekeeping. However some Farmers started their innovations by combining components of the traditional and modern hives, and said that improved endogenous beehive is far cheaper and easy to make, easy to understand, it is better insulated against both heat and cold, and brings higher net return than the modern beehives in some areas. However this reversely cause for absconding, leads zero production. So, affordable hive price may be the solution to follow the modern one for the farmers. Currently farmers of the study area were found with large number of traditional bee hives in all selected zones (table 6).

Table 5 Bee hives (colony) owned by beekeepers of the study area (2009 E.C)

Zone	Traditional hive (#)	Transitional hive (#)	Modern hive (#)
West shewa	159300	36251	6410
O/S/Z/S/F	18780	10857	4968
South west shewa	55618	15017	5002
North shewa	158948	14422	6481

Sources: Zonal Livestock and fishery development office, 2017

Potential area of beekeeping: From table 7, districts of having potentiality in beekeeping were displayed from the study area. Accordingly, Dannoo, Noonnoo Chaliya Gindabarat**,** Ada'a berga ,Bako Tibe, Ejersa lafto and Jaldu districts are from West shewa zone where as Wonchi, Amaya and Waliso districts from S/W/Shewa has potential for beekeeping activities because relatively the area is coved with high natural resource and thus in the district's apiculture resource is immense. In addition North shewa and Oromia Special Zone Surrounding Finfine Zones have also some potential districts like Dera, Wara jarso, Yaya Gulalle, Walmara, and Sebeta as listed in Table 7, categorically. In this area the constraint of beekeeping potentiality is chemical of the flowering project and limited diversified forest since the place is central to the capital city of the country, most land is going for urban development.

In general, even though, the district has huge number of bee colonies, farmers cannot get the benefit they should get from beekeeping sub-sector because of more than 90% beekeepers follow the traditional method of beekeeping.

Table 6. Districts of Potential areas for bee keeping under each zone in the study area

West shewa	**S/W/Shewa**	**North shewa**	**O/S/Z/S/Finfine**
• Dannoo • Noonnoo • Chaliya	• Wonchi • Amaya • Waliso	• Dera • Wara jarso • Yaya Gulalle	• Walmara • Sebeta
• Gindabarat • Jaldu • Abbona • Ambo	• Taji • Goro • Bacho		

- Ejersa lafto
- Ada'a berga
- Bako Tibe

Sources: Zonal Livestock and Fishery development office, 2017

Farm resources

Landholding and Land Use Pattern: The average land holding per household varied among land types of the study area. Result from the sampled household indicates major portion 47 % and 21.7% of the land was allocated for crop production produced both under rain and irrigation respectively. However, since, some portion of crop land under rain feed is used again under irrigation in unrainy season; no valid amount is known separately. Hay and pastureland occupied 9.12 % of the total land of the study area (figure 5). The overall average landholding per household in the study area was 2.6 hectare including productive and unproductive land. The average landholding reported in this study is comparable with 2.5ha per household for Debre Zeit, central Oromia. Beyene (1984) reported that about 90% of the landholdings in the central highlands of Ethiopia are below 5ha and 65% are less than 1.5ha. The results are consistent with the land holdings of smallholder farmers in Jaldu district of West Shewa, Zone of Oromia Regional State, (Andnet *et al.*, 2014). Such small land holdings are typical of the densely populated areas of the Ethiopian highlands. None of the respondents from each kebeles was landless.

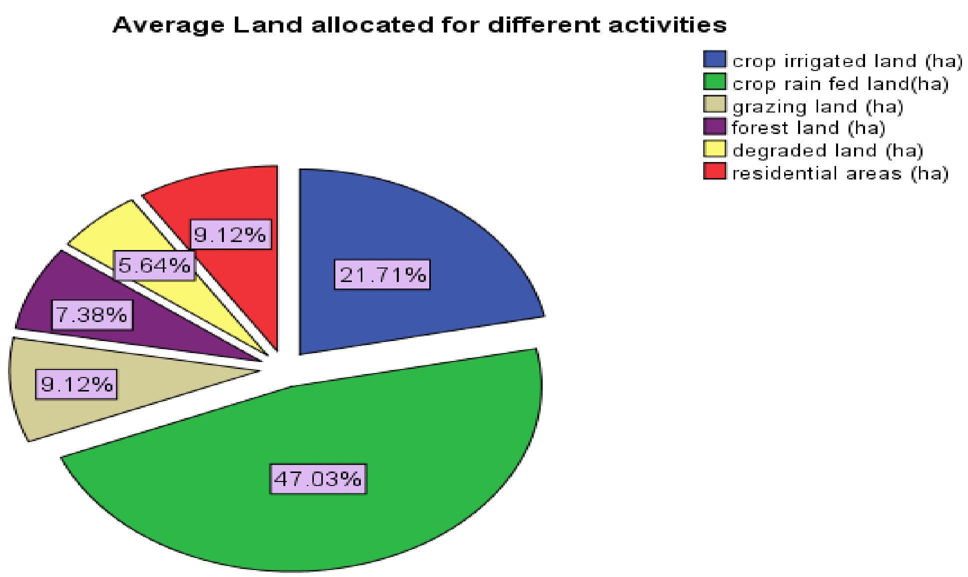

Figure 5 Average land allocated under different activities

Labor availability: The second resource in agriculture is labor. Farmers in the area use human and animal labor to support their agriculture. Availability of labor in the area is not a major problem. Farmers need labor throughout the year for various agricultural activities such as planting (especially for farmers using oxen to plough their farm land), weeding, harvesting, threshing and crop residue collection from the farm in rare case. The average family size is 5, with the minimum and maximum being 1 and 12, respectively. Farmers primarily use family labor in their agricultural activities. When family labor is not enough, farmers hire in labor. Thus, the requirement for daily laborers is not a critical problem for the majority of the farmers. However, labor is required during planting and harvesting by and large.

Gender Division of Labor: Men are mostly engaged in productive (agricultural activity) and also in other socio - political responsibilities also. Women on the contrary play triple roles and responsibilities. Women are mainly responsible for productive, reproductive and also social activities. Women play significant role in agricultural production in the study area. Many labor-intensive agricultural activities such as land preparation, weeding, harvesting and transporting require active involvement of women and men. The gender division of labor in different farm tasks has revealed that women across the study sites take part in almost all farming activities. The only exception is ploughing, which is exclusively done by men. Taking care of the cattle is done equally by men and women, while managing dairy products is more often done by women.

Capital and Technology: There is no question that small farmers characterized by high labor /capital ratios, account for the major portion of agricultural production in Ethiopia. However almost all of the farmers are using some common technologies like, in organic fertilizers, crop varieties, herbicides, pesticides, and row planting, however some agronomical problem was observed due to costs and knowledge gap on input usage. In the area none of mechanized agriculture is observed like using tractor for plowing, harvesting, and threshing due to costly and awareness problem on how to use, cost – benefit analysis and confessing the users (farmers) is important in spite land suitability of the area. Table 8, presents technology used in the study area.

Table 7. Type of technology used in the study area

Type of technology	**Name of the variety used**	**Most preferred and demanded variety**	Zone
Fertilizer	DAP &UREA	Both	All
Row planting	Maize, wheat, Tef	Maize, wheat	All
Improved Tef	Kuncho,D2-01-354, Kaacha, Gaajoo, Magna, Ada’e	Kuncho, Kora, D2-01-354	All
Improved Wheat	Danda’a, Digalu, Qaqaba, Huluka, Quubsa, Hidase	Digalu, Danda’a, Kakaba	All
Improved Barley	Cocobe, Beera		All

Improved Maize	BH 660, BH 661, , Limu, Shone	Shone, BH660, BH661, Limu	All
	Boset	-	North shewa,
Improved Sorghum	Abshir, Gubiye	-	North & west shewa
Improved Bean	Rare	-	All
Improved Chick pea	Dubbe	-	All
Improved Potato	Jalanne, Balaxa, Gudane	Jalanne	All
Improved Lentil	Alamaya	Alamaya	North shewa & O/S/Z/S/F

Sources: Group discussion, 2017

Natural resource context

Ethiopia is a largely agricultural country whose economy is based on renewable resources in rural areas. Given the low level of economic development in the country, the pressure exerted on the environment by growing human and livestock populations has exacerbated the rapid depletion of the natural resource base (Feoli *et al.,* 2002). Endowment of natural resources (favorable land, water resources, vegetation and climate) makes Oromia the leading region in contributing to agricultural growth and economic development of the country. However the climax vegetation of the study area has been extensively cleared to give way for agricultural activities and establishment of human settlements. Thus, only some patches of natural vegetation and scattered trees are remained, and now the main natural resources existed are forest, water body, communal grazing land, and mountain. Utilization of the resource is on infant stage due to facility service problem, pollution, land escape and less attention by any concerned body in the region and the study area particularly. For instance Akaki water has a potential for irrigation, fishery and recreation but due to pollution from urban settlements and industries the impact leads to negative for the users instead of benefiting. Similarly there are natural tourist attraction sites in the study area (Table, 9). Among others Wenchi creator lake, panoramic view of wenchi Woreda landscape in wenchi Wereda and panoramic view of Tulu Maja (Abbo Mountain) in Waliso Woreda of south West Showa zone and Huluka water fall, book-tulle and Boku-chitu ritual sites are the main tourist attraction identified in Ambo Wereda of West Showa zone. So it is deemed that the intervention of important facility and attention will have significant contribution for effective utilization of the specified attraction and to explore the non-identified sites.

Table 8. Natural resources locations and name in the study area

Zones	**Forest name** [a]	**Water body**[b]	**Mountain and others**	**Purpose**
West shewa	Chilimo , Jibat Gedo Wos-washa	Huluka water, Guder river, Alaltu river	Book-tulle Boku-chitu ritual sites Sankale stone	[a](Bee keeping, charcoal & construction) [b](recreation) ***c***(tourist attraction)
South west shewa		Wanchi lake Kulit,Awash, Wudocha, Wealcha,Bibin	Tulu Maja	[b](tourist & irrigation)
O/S/Z/S/Finfine	Menagesha Entoto forest	Akaki river		[a]*(*Beekeeping &tourist) [b](Irrigation and fishery)
North shewa	Hagenia forest	Aba Jama river		-

Sources: Key informant Group discussion, 2017

Natural resources conservation: Type of Land Management Practice like Soil bund construction, Stone bund construction, leaving crop residues on farm land, Compost & manure and Fencing the farmland are the common practice. In this regard, diversifying as well as increasing the quantity of tree planting and construction of other terracing structures is crucial in order for the land management undertaking to be robust enough.

Problems and Opportunities

Opportunities

- Diversified agro ecology (Low, mid, high) of the study area
- Topography of the areas' land makes suitability for farm mechanization
- Excellency of the area in stable food production (Tef, wheat, potato)
- Nearness of the area to central market and attractive for any investors
- Having of the area in dairy and beekeeping potentiality

Problems

Table 10 Crop related problem: Many interrelated challenges for crop production were identified and prioritized

Problems	*Intervention needed*	*Zone*
1. Land shortage (land shrinkage)		
There is an increasing and of course, unregulated competition for land (for home stead, business, industries) which affects the sustainable use of land resource in the study site	Effective land use planning	O/S/Z/S/F
2. Pollution: Environmental pollution is another major threat to the sustainability development of crop production. As information from Livestock and fishery development office, Farmers of the area seriously affected due to that the rivers. For instance Akaki River in Finfine area simply used as a receptacle of all kinds of wastes released in the city. There is a high amount of waste disposal in the river and riverbanks from municipal source (municipal solid and liquid wastes), liquid wastes from toilet, open urination and defecation.	Low cost pollution control and waste water treatment	O/S/Z/S/F
3. No farm mechanization Traditional farming like less farming mechanization, less attention on irrigation production is main problem for all.	Dissemination of the technologies	All
4. Inefficiency of supply and delivery of inputs Lack of seed of improved varieties was a major concern with most farmers who are presently using own, exchanged or market purchased grain	Strength Agricultural extensions	All
5. Un known Enset diseases and Pests: Disease and pest is another problem of crop production in study area for all zones, but un known Enset diseases as specific is the serious concern	Research on pathology	S/West shewa
6. Water logging In the North and southwest Shewa Zone, there is a problem of water logging, especially along with poor soil fertility while in lowland areas where sorghum is the main stay of the population, the problem of moisture stress is seriously affecting crop production.	Research and dev't for soil content and treatment	North & S/West shewa
7. Irrigation Conflict Other problem on crop production of the study area was conflict on irrigation among upper and lower streams of farmer. The impact of conflict on irrigated agriculture and consequently summer crop production within conflict-affected agricultural lands was observed in some parts the study area .Farmers and development agents (experts of irrigation) complaining no rule and regulation in the use of irrigation	Set Rule of use	S/West shewa
8. Marketing *Vegetable marketing*: Fluctuations in volume of supply and demand, fluctuation in price, problems with storage, (lack of post-harvest handling), lack of market place (shade), Lack of awareness for nutritional issues, reluctance to consume indigenous vegetables were major problem raised	Sustainable production for balancing DD/SS,& strength extension follow-up	All

Source: ZAO, 2017

Table 11 Livestock problem

Problems	Intervention needed	Zone
Shortage of livestock feed	Livestock development programs in the area should address the chronic feed shortage of the study areas through integration of forage production into crop farming system, sustainable conservation, proper storage, processing and proper utilization of available fee resources	West and S/west shewa
Costly of livestock feed	If provide at affordable price	All
Dependency of indigenous dairy cows and un availability of crossbreed	If availed un addressed area with management practice	West and S/west shewa
Less attention paid for livestock sector as zonal and district level	If paid attention by any related stake holders	All
Little attention given to livestock based business like beekeeping, poultry, dairy, fattening	If awareness/training provision with financial and market support	All
Destruction of bee colony due to chemical application and deforestation	More attention should be paid to specific anti bee chemical that may result in synergistic toxicity to bees.	All
Costly of farm inputs and unavailability of credit facilities with easy bureaucracy for the farmers to participate livestock based activities (fattening, beekeeping, poultry)	Strengthening credit facility to provide with credit service With easy bureaucracy	All
Un known poultry diseases	Agricultural Research for identifying	West shewa
Less and unwise utilization of natural resources (forest, water, grazing land)	The eradication of invasive noxious plants that is invading grass land needs due attention	All

Source: ZAO, 2017

Conclusions and recommendations

Farming systems in oromia are highly dynamic and this needs to be well understood in order to formulate interventions that can bring positive change. Farmers are highly to mixed (crop-livestock) farming systems and slowly commercialized crop production under irrigation. They therefore need kills and knowledge to manage these production systems in a sustainable way. Low productivity levels of these regions were attributed to: water logging, land shortage, and pollution problem for crop irrigated which is tested and said has heavy metal, less mechanization farming, crop disease and pests. To optimize the crop performance in these areas, it is important to introduce soil management practices, modern storage practices and appropriate diseases and pest control mechanisms at required time, mechanization based faming.

From livestock sector dairy farming and beekeeping constitutes an important part and potential activities which plays a crucial role for economic development of the country as a source of feed and income. It has many opportunities for dairy and honeybee development; more or less stable market price for the products, good infrastructure, healthy dairy cattle and honeybee colonies, and good accesses to beehives are amongst the others. On the contrary, the major constraints hindering for dairy development in the study area includes shortage of feed, little number of improved cattle in spite of its milk yield is superior while the most constraints for beekeeping includes pests and predators, shortage of bee forage, and high cost of improved inputs for beekeeping. Improved beekeeping technologies have been introduced to oromia regional state in general and the study sites in particular. However, most of the introduced modern ways of beekeeping are not in use to the desired extent. So, affordable input price and appropriate credit system to be developed to solve financial problem. Since adequate, quality and affordable credit system could contribute a lot towards improving the performance of beekeeping business.

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Characterization of the Farming Systems of Jimma and Ilubabor Zones, Oromia Regional State

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Abstract

The study was carried out in six selected districts (Limmu Kossa, Nono Benja and Dedo) of the Jimma zone and (Metu, Bure and Gechi) of Ilubabor zone) south western Ethiopia, with the objectives was to classify, characterizing and map the farming systems, identify and prioritize the major constraints and opportunities of characterizing of farming systems in the area. A total of 321 household heads were selected for the detail study using a systematic random sampling method. Data were collected through semi-structured questionnaire and focus group discussion. The major constraints were identified like feed shortage, poor access to improved extension services, lack of improved cattle breeds livestock are disease, parasite and distance to marketing points and poor administrative mechanisms to restore range ecosystem. The major problems of the cropping production in the study areas are land shortage, pest problem, soil fertility decline and high input cost. Major cropping system in the study areas practices perennial crops and mono cropping. On other hand under mechanization technologies there is lack of improved farm implements (mound board, cultivator, and seed and fertilizer applicator and planters), lack of irrigation technologies and lack of post-harvest technologies. Additionally improving coffee production practices, honey production, poultry and lack of joblessness for youth need typical interventions to improve access to farmers' income of the household. Policy implementations drawn from the finding suggested to improve mechanization technologies, improve quality of seed variety, distribution of mechanization technologies and expanding of awareness for farmers in soil and water conservation at different landscape and strengthening farmers by using scaling and demonstration system.

Key words: *farming characterize, production, natural resource, coffee*

Itroduction

Ethiopia is one of the fastest growing economy countries in Africa. The country is heavily reliant on agriculture as a main source of employment, income and food security for a vast majority of its population Agriculture generates 40% of gross domestic products (GDP) and accounts for 85 and 90% of total employment and exports, respectively.

Farming system typologies are dictated by climate, production goals and culture with a farming system being described as a unit consisting of a human group (usually a household) and the resources it manages in its environment, involving the direct production of plant and/or animal products (Scherr, 1997b, 1999; FAO, 1990). Around 60% of the Arid and Semi-Arid Land ASAL inhabitants live below the poverty line (ALRMP, 2007), (subsisting on < one dollar a day) higher than the 50% of the country average and are adversely affected by land degradation, desertification and drought.

The farming system describes what is currently being done by a group of farmers operating under certain common conditions. The system focuses on farm-household and rural community systems and their interactions with physical, socio-cultural and political environments forming the backbone of these farming systems. Farming Systems in Ethiopia can be categorized broadly following the Agro-Ecological Zones (AEZ). These describe the climate, soil characteristics, vegetation, land suitability and water resources. In describing the climate of the area, temperature, rainfall, soil, topography and humidity have a direct relation to the farmer's situation. Temperature will affect the cropping pattern and type of livestock kept. Rainfall amount, distribution, reliability and intensity will determine the crops grown, livestock kept and soil treatment needed. Soil fertility and structure influences the cropping pattern and soil management practices.

Most agricultural production in Ethiopia comes from the peasant sector whose production technologies are primary traditional (CSA, 2014). Production and productivity under such traditional system, however have been considerably low, due mainly to the inherently low productivity of technology used, declines soil fertility and effects of different factors (Firdu and Tsedeke, 2007).

Ethiopian economy is principally rural and agricultural, and the declining trend in size of land holding attitudes a serious challenge to the sustainability and profitability of farming. The crop and cropping system based perspective of research needs to make way for farming systems based research conducted in a holistic manner for the sound management of available resources by small farmers (Jha, 2003). Under the gradual shrinking of land holding, it is necessary to integrate land based enterprises like fishery, poultry, ducker, apiary, field and horticultural crops, etc. within the bio-physical and socio-economic environment of the farmers to make farming more profitable and dependable (Behera et al., 2004). No single farm enterprise is likely to be able to sustain the small and marginal farmers without resorting to integrated farming systems

(IFS) for the generation of adequate income and gainful employment year round (Mahapatra, 1992; 1994).

A farming system is the result of complex interactions among a number of inter-dependent components, where an individual farmer allocates certain quantities and qualities of four factors of production, namely land, labor, capital and management to which he has access (Mahapatra, 1994). “The household, its resources and the resource flows and interactions at the individual farm levels are together referred to as a farm system” (FAO, 2001). Farming systems research is considered a powerful tool for natural and human resource management in least developed countries such as Ethiopia. This is a multidisciplinary whole-farm approach and very effective in solving the problems of small and marginal farmers. The approach aims at increasing income and employment from small-holdings by integrating various farm enterprises and recycling crop residues and by-products within the farm itself (Behera and Mahapatra, 1999; Singh et al., 2006).

Topography attributes such as altitude, slope and soil conservation measures affect the cropping pattern the farmer will adopt while humidity will determine the pests, diseases and storage methods that the farmer will adopt. The present critical situation in the countries food supplies, especially in drought prone and food insecure areas demands that all available agricultural resources be utilized to the full to maximize food production through improved agronomy, better soil management and crop husbandry, the use of improved seeds and fertilizers, efficient use of water, effective weed control, effective crop protection and improved livestock husbandry practices.

More specifically, this paper discusses the farm-household criteria based on resource base, resource utilization, production constraints and opportunities for improvement. To implement the above mentioned agricultural technology interventions, farming system study is very crucial and hence, improves agricultural technology interventions in the area. Past experiences show that most of the time technologies distributed to the farmers did not bring the required change on the livelihood of the farming community. This is mainly due to lack of detail farming system analysis of the environment in which the technology are disseminated. Moreover, farmers` perspectives have been not adequately considered in the development and dissemination of technology to alleviate their problems. Therefore, conducting farming system study is very important to develop and disseminate appropriate agricultural technologies that fit to the environment, which is also important for further agricultural research and development intervention in the area.

Objectives of the study

- To classify and map farming systems of the study areas
- To characterize the identified farming systems of the study areas
- To identify and prioritize farming system constraints and opportunities

- To identify future intervention areas

Methodology

Description of the study area

The research was carried out in Dedo, Limmu Kossa and Nonno benja districts of Jimma zone, and Bure, Metu and Gechi districts of Ilubabor zone Oromia National Regional State, Ethiopia. Jimma and Iubabor zones are among the 22 administrative zones of Oromia National Regional State and located in south-western Ethiopia.

Jimma zone

Jimma zone is located in the south-western zone (about 350km south-western of Addis Ababa). Jimma zone has 20 rural and two town districts, out of which seven districts are suitable for high coffee production. The other rural districts are production agro- pastoralists. A total population of Jimma Zone over 2.2 million. The Zone covers total areas of 19,300 Km^2 that receive reliably good rains ranging from 1,200–2,800 mm per annum.

From the total land of the zone, coffee land covers 274,423 hectare among this 94,597 hectares are currently on production (Jimma Zone Agricultural Bureau report, 2016). The zone has large areas of potentially cultivable and irrigable lands. In 2013/14 about 45% of the total zonal area was arable (of which 30% was under cultivation); 14% grazing and 27% forest land (including coffee forest). The zone is classified in to three agro-climatic zones: kolla (14.9% - highland); woina dega (64.6% - mid highland); dega (20.5% - lowland). High forest, woodland, riverine, shrub and bush, and man-made forests are all found in the zone .Subsistence farming is the dominant form of livelihood in the area where only 15% of the population is in non-farm related jobs. The area has suitable agro-ecological potential with the lowest drought risk rating in the country. Cereals (maize, teff, sorghum and barley), pulses (beans and peas), cash crops (coffee and khat), and root crops (false banana and potato) are the major crops produced in the area. Different fruits and vegetables are also commonly grown where home-gardening by small holder families was observed to increase household income and food security. Enset is a strategic crop substantially contributing to the food security of the zone and is especially important in highlands.

The three largest ethnic groups reported in Jimma were the Oromo (87.6%), the Amhara (4.05%) and the Yem (3.12%); all other ethnic groups made up 5.23% of the population. Oromiffa was spoken as a first language by 90.43% and 5.33% spoke Amharic; the remaining 4.24% spoke all other primary languages. The majority of the inhabitants were Muslim, with 85.65% of the population having reported they practiced that belief, while 11.18% of the population practiced Ethiopian Orthodox Christianity and 2.97% professed Protestantism (Mengistu, 2014).

Ilubabor zone

Illubabor (or Illu Ababora, Illu Aba Bora) is one of the zones of the Oromia Region of Ethiopia which is located in the South-western zone (600km South-western of Addis Ababa).A zone has

13 rural and three town districts, out of which eleven districts are suitable for high coffee production. The other rural districts are production agro- pastoralists.

The Zone has a total population of 1,271,609 of whom 636,986 are men and 634,623 women; with an area of 15,135.33 square kilometers, Illubabor has a population density of 84.02. While 124,428 or 12.16% are urban inhabitants, a further 68 persons are pastoralists. A total of 272,555 households were counted in this Zone, which results in an average of 4.67 persons to a household, and 263,731 housing units. The two largest ethnic groups reported in Illubabor were the Oromo (89.67%) and the Amhara (7.37%); all other ethnic groups made up 2.96% of the population. Oromiffa was spoken as a first language by 90.68% and 7.08% spoke Amharic; the remaining 2.24% spoke all other primary languages stated. The majority of the inhabitants were Muslim, with 50.6% of the population having reported they practiced that belief, while 26.51% of the population practiced Ethiopian Orthodox Christianity and 22.51% professed Protestantism (Mengistu, 2014).

The major crops grown are: maize, teff, sorghum, barley, wheat, pulses and coffee. Maize production constitutes 65% of the total food crops production in the zone. The main season *kiremt/ganna* rains usually commence at the end of March and last until October.

Honey production is one of the more important sources of local earnings to both zones. Jimma and Illubabor zones share many similarities in their agro-ecological conditions, cropping systems, vegetation types and climatic conditions. Both zones were and are among the more prosperous zones in the country, contributing significantly to national food security and the economy. Nevertheless, the degradation of natural resources has accelerated in recent years without commensurate measures being taken to protect the resource base and conserve the environment.

Sampling Procedures

a multi-disciplinary team from Jimma Agricultural Engineering Research Center staff conducted the survey using structured questionnaires with individual household interview and focal group discussion methods. Multi-stage sampling techniques were employed for data collection. Specifically the study was conducted in six districts of two zones which were selected randomly at the first stage among 31 districts in Jimma and Ilubabor zones. In the second stage PA were listed for all selected districts randomly three PA for each according to their typology. The number of the respondents involved in the study from each PA was determined in accordance population.

Table 1. Distribution of sample households

Zone	Woreda	Number of respondent	Percent
Jimma	Dedo	36	11.2
	Limmu kossa	40	12.5
	Nono benja	68	21.2
Ilubabor	Bure	67	20.9
	Gechi	56	17.4
	Metu	54	16.8
Total	321		100.00

Source: own survey result 2016/17

Types of data and method of data collection

For this study both primary and secondary data collection were used. Secondary data collections were collected from different research output materials and other report document. Primary data were collected through separate questionnaires and checklist were prepared and engaged to collect from individual farmers. To collect data, data collection tools such as individual interviews, focal group discussion, key informant interview and field observations were employed. Official survey was under taken through formal interviews using structured questionnaires. The questionnaires were pre-tested on some amount of individual farmers to evaluate the appropriateness the design and the significance of the questionnaire and to estimate time required for an interview.

Method of data analysis

Descriptive statistics such as mean, percentage, frequency and standard deviation were used to analysis to socio economic characteristics of sample household. Qualitative data collected through focal group discussion and key informant interview were analyzed qualitatively using narration method.

Results and discussions

Socio-economic characteristics

In the survey areas, the age of household heads varied from 22 to 90 and the duration of their farming experience is varied 6 to 70 years. The overall means of age, farming experience and years lived in the area were 37, 20 and 31 years respectively for Jimma zone districts and 45, 24 and 38 years respectively for Ilubabor districts. The mean age of respondents in Dedo (27.98), Limu kossa (30.89), and Nono Benja (52.51) for jimma zone districts and Metu (41.69), Bure (51.74) and Gechi (43.24) for ilubabor zone districts (Table 2).

In respect to age, a t-test showed the absence of statistically significant the difference between the respondents in both three districts of each zone. Though there is a statistically significant difference at the 5% probability level between the three districts of each zone with regard to years lived in the area the respondents and another at the 1% probability level between their farming experiences.

Table 2 Respondent's Socio-economic characteristics variables / Jimma zone

Statistics	age of household heads			farming experience			Years lived in the area		
	Dedo	L/kossa	N/benja	Dedo	L/kossa	N/benja	Dedo	L/kossa	N/benja
N	36	40	68	36	40	68	36	40	68
Mean	27.98	30.89	52.51	14.92	16.58	28.19	23.31	25.9	44.03
Std. Dev	7.22	7.97	13.56	7.19	7.99	13.58	8.47	9.41	16.00
t-value	-1.346 NS				-2.162**		-2.004		
p- value	0.137				0.018		0.005		

Source: own survey data 2016/17, Ns- non significant, **significant at less than 5% level of significance, *** significant at less than 1% level of significance

Table 3. Respondent's Socio-economic characteristics variables/ilubabor zone

Statistics	age of household heads			farming experience			Years lived in the area		
	Metu	Bure	Gechi	Metu	Bure	Gechi	Metu	Bure	Gechi
N	67	56	54	67	56	54	67	56	54
Mean	41.69	51.74	43.24	27.77	23.21	22.38	43.38	36.26	34.97
Std. Dev	10.76	13.36	11.16	13.39	11.19	10.79	15.76	13.17	12.71
t-value	-1.032NS				-1.152**		-2.606***		
p- value	0.421				0.017		0.007		

Source: own survey data, Ns- non significant, **significant at less than 5% level of significance, *** significant at less than 1% level of significance

The results show that there were four main production systems and each system has unique, significant issues that need to be addressed in order optimize agricultural production in these fragile and resource-limited environments. The identified production systems were: (1) irrigated agriculture for the production of crops for local markets, (2) rain fed and integrated livestock-arable farming with various crops mainly for domestic consumption, (3) Mixed systems: rain fed and in places irrigated mainly under subsistence farming (4) coffee as a main cash crop.

Table 4 Summary of household characteristics per district of jimma zone

Characteristic		District mean (±SE)			
		N/benja	L/kossa	Dedo	p
Age of respondent		43.62 ± 1.32^{ab}	45.88 ± 1.04^{a}	41.00 ± 1.25^{b}	*
Number of children		6.43±2.98	6.58±3.64	6.39±3.40	ns
House hold size		8.79 ± 3.01^{b}	9.45 ± 3.17^{a}	9.63 ± 3.11^{b}	***
	District % (frequency)				
Marital status of the HH head	Single	0%	3.33%	3.33%	ns
Educational status of the HH head	Married	100%	96.67%	96.67%	
	Literate	9.84%	26.67%	30%	*
	Illiterate	90.16%	73.33%	70%	

Means in the same row for each parameter with different superscripts are significantly different ($p < 0.05$); *p<0.05;***p<0.001; ns: non-significant difference ($p > 0.05$); SE: standard error of means

Household Characteristics: household characteristics per district are summarized in Table 4. The statistical analysis revealed that in N/benja, L/kossa and Dedo districts, most respondents were middle aged (43.6, 45.9 and 41) respectively ($p < 0.05$). There were relatively larger numbers of children per household in all the three districts, however statistically significant difference was not observed between districts ($p > 0.05$). Having many children is thought as an asset for supply of labor for farming activities and big large in number in social prestige showing the strength of that family. The average household size of each district was 8.80, 9.50, and 9.63 respectively ($p < 0.001$). The highest values in household size could be due to practices of polygamous marriage as well as meager family planning activity in the districts.

Table 5. Summary of household characteristics per district of ilubabor zone

Characteristic		District mean (±SE)			
		Metu	Bure	Gechi	p
Age of respondent		33.62 ± 1.33^{ab}	40.78 ± 1.04^{a}	31.00 ± 1.35^{b}	*
Number of children		3.43±2.98	2.58±3.64	5.39±3.30	ns
House hold size		4.79 ± 2.01^{b}	8.45 ± 3.17^{a}	6.63 ± 3.11^{b}	***
	District % (frequency)				
Marital status of the HH head	Single	0%	2.33%	3.25%	ns
Educational status of the HH head	Married	100%	86.17%	76.68%	
	Literate	7.84%	26.67%	30%	*
	Illiterate	80.16%	76.33%	74%	

Means in the same row for each parameter with different superscripts are significantly different (p <0.05); *p<0.05;***p<0.001; ns: non-significant difference (p>0.05); SE: standard error of means

Household characteristics per district are summarized in Table 5. The statistical analysis revealed that in Metu, Bure and Gechi districts, most respondents were middle aged (33.62, 40.78 and 31) respectively ($p < 0.05$). There were relatively larger numbers of children per household in all the three districts, however statistically significant difference was not observed between districts ($p > 0.05$). The average household size of each district was 3.43, 2.58, and 5. 39 respectively ($p < 0.001$), The small values in household size could be due to unpracticed of polygamous marriage as well as sufficient family planning activity in the districts

Table 6. Mean landholding (ha) (±SE), use patterns by household per district and percentage of respondent farmers perceived a decrease in landholding status.

District mean (±SE)				
Characteristic	N/benja	L/kossa	Dedo	p
Grazing land	$0.27{\pm}0.05^{ab}$	$0.46{\pm}0.08^{a}$	$0.21{\pm}0.03^{b}$	*
Coffee /forest	$2.01{\pm}0.76^{a}$	$1.85{\pm}1.12^{b}$	$1.75{\pm}0.10^{b}$	*
Crop land	$0.18{\pm}0.03^{a}$	$0.08{\pm}0.03^{ab}$	$0.02{\pm}0.0.02^{b}$	*
Total land	$2.39{\pm}0.17^{a}$	$2.38{\pm}0.15^{ab}$	$1.98{\pm}0.11^{b}$	*
Decreasing trend in landholding,%	71.56^{c}	82.53^{b}	87.56^{a}	**

Different superscripts in a row indicate statistically significant difference between the districts (p<0.05); *P<0.05; **P<0.01; SE, standard error of means

Land Holdings: Respondents explained about the land .use patterns mainly for three purposes: crop production, grazing (livestock) and coffee/forest (Table 4). Mean landholdings between the districts showed significant variation (p<0.05). Mean landholding values in the studied districts are categorized between small and medium land size as compare to Ethiopian national average, 1.3 (ha) which call for intensification of livestock production in the area. According to the 91.70 % of respondents, the total land holding per household over the last 30 years had decreased; yet 10.63% of respondents agreed that size of land holdings for crop, grazing and coffee/forest had increased overtime (p<0.05). Therefore, it is clearly shown that there is decline of landholding by household over the past 30 years. This can be attributed to the population increase over the three decades.

Table 5 mean land ownership, rent out, rent in, shared out and shared in the 2016/17 cropping season

Land tenure	Mean(ha)	Cultivated land(ha)	Coffee/forest (ha)	Rented out (ha)	Shared out (ha)
Own	1.256 (98.2)	1.33 (93.3)	1.88 (69)	0.422 (8.3)	0.528
Rented in	0.90 (40)	0.55 (42)	1.17 (7.3)		
Shared in	2.65 (21.2)	0.40 (20.1)	0.64 (2.6)		

Farmers in the study areas own land for farming, even though they also accessed land through renting and sharing with the farmers in addition to their own when there is periodic shortage. Older and resource poor farmers rent out land to youth and wealthier farmers. More than 98% of respondent farmers owned 1.256 (ha) on average, varying from and about 93% and 69% of respondents allocate 1.33 and 1.88 ha of their own land for cultivation and coffee respectively. In case of land shortage based on their capability (finance to cover input cost like fertilizer, seed and pesticides) farmers in the study areas accessed land through renting in and sharing in. in contract to this due to financial problem and lack of oxen for ploughing some farmers rent out 0.422 ha and shared out 0. 528 (ha) some of their land

Table 6: Mean (±SE) livestock composition and ownership by house hold across the district

District mean (± SE)			
Types of LS	N/benja	L/kossa	Dedo
Cattle	3.36±0.11*	5.25±0.17	4.46±0.13*
Sheep	3.72±0.14*	4.83±0.58	2.77±0.13*
Goat	2.22±0.03**	2.42±0.20	1.22±0.08**
Poultry	1.30±0.11	1.02±0.20	1.30±0.13
horse	0.30±0.12	0.15±0.05	0.30±0.13
Donkey	1.43±0.13	0.37±0.05	0.43±0.15

SE, standard error of means; means with different superscripts in a row indicate statistically significant difference between the districts ($p<0.05$); *$p<0.001$; **$p<0.01$, non-significant difference ($p>0.05$)

Livestock Composition and Ownership: Relatively large average holding of cattle and sheep was recorded in average holding of cattle and sheep was recorded in L immu kossa (Table 6). In all the districts, cattle were ranked first in population followed by sheep, goats and poultry. Cattle were the main livestock species in the smallholder agricultural sector because of their multiple uses. Cattle are the major source of draught power, beef and milk for geometrically growing human population. The relative population of equines is found to be low as compared to other provinces of Oromia zones. This might be attributed to climatic influences and cash crop areas. The former provinces of Limmu Kossa (Jimma zone) and bure districts (Ilubabor zone) shared the lowest levels of all provinces in the study area suggesting environmental conditions maybe a significant factors

Table 7: Mean (±SE) livestock composition and ownership by house hold across the district

District mean (± SE)			
Types of LS	Metu	Bure	Gechi
Cattle	4.38±0.10*	1.37±0.22*	3.40±0.13
Sheep	2.90±0.18*	1.52±0.14*	2.70±0.13
Goat	2.52±0.16	3.22±0.03**	1.22±0.08**
Poultry	1.52±0.16	1.30±0.11	2.30±0.13*
horse	0.18±0.08	0.10±0.12	0.30±0.13
Donkey	0.45±0.09	1.43±0.13	0.43±0.15
Mule	0.20±0.10	0.12±0.06	0.46±0.10

SE, standard error of means; means with different superscripts in a row indicate statistically significant difference between the districts ($p<0.05$); *$p<0.00$; **$p<0.01$, non-significant difference ($p>0.05$)

Livestock constraints

Under livestock enterprise farmers and experts (SMS) responses during FGD and KII were placed into one of these categories to gain insights into where the main weaknesses were perceived to exist. Clearly, some of these categories overlap. Furthermore, a clear-cut classification of the problem in some cases does not exist. No explicit recording of the frequencies of mentions of particular problems/issues was made. The comments made in the discussion in regard to the number of times a particular issue was raised are therefore subjective discussed below.

Restricted market access and low and unstable prices (low profits due to payment of high commissions to too many middlemen), Minimum availability of extension services and facilities, Lack of suitable animals with an adequate genetic potential, Shortage of feed resources at affordable prices, Effects of disease both on mortality and productivity, A low level of technology, Feed supply, specifically limited dry season green growth, and much forage has low nutritional value, Limited technical support and insufficient proven practical livestock extension, There is a general lack of technical knowledge on application of newer more intensive animal production technologies.

Natural resource management

Agroforestry Practices and Purposes

According to the reports from key informant interview agroforestry and its practices of Jimma and Ilubabor zones, The collected information revealed that almost all of the farming activities of the area involve deliberately perennial woody species, in three distinct types of niches, i.e., homestead, coffee plot, and farmland, which locally identified as guwaro, lafa bunna, and lafa qonna, respectively. By adopting the classification scheme of Nair the locally recognized farming practices were identified as home garden, multistorey-coffee-system, and multipurpose-trees-on-farmland. A home garden is a complex multispecies production system practiced around the homestead, locally named guwaro. Multistorey-coffee-system is locally named lafa bunna, literally translated as coffee land.

Although coffee cultivation is present in most land-use systems, multistorey-coffee- system is distinguished by involving naturally grown and/or planted coffee with mostly native shade trees, resembling a multi-strata forest. The third type, multipurpose tree farmland, locally known as lafa qonna, literally farmland, refers to lands designated for the production of annual crops that deliberately integrate perennial woody species to increase or optimize plot output.

About 80% of the respondents involve in all three practices Multistorey-coffee-system alone is practiced by 97% of the households, home garden by 91%, and multipurpose-tree farmland by 85%.home garden covers the smallest area (average 0.08 ha), and Multistorey-coffee-system the largest (2.6 ha). Concerning the primary purpose, Multistorey-coffee-system is used entirely for income generation, 66% of multipurpose-tree farmland and is devoted to food production, in some cases also to wood and cash crop cultivation, and home garden focuses on food (41%) and cash crop production (41%). Regarding the number of specific purposes/benefits per practice (annual crop production, fruit production, cash crop production, vegetable production, etc.), the highest was in home garden (max. eight) per household, and in more than 89% of the households at least three specific outputs were generated. In contrast, the lowest value was found in multipurpose-tree farmland per household.

Water resources and managements practices

The main sources of water recognized in the present study areas were pond, holes, spring water and rivers. The majority (42.4%) of households in mixed crop livestock system obtained water from river while 20% from pipe water and the remaining gets from different sources.

Soil erosion as a form of land degradation

The major physical agents in environmental degradation in the settled highlands of Jimma and Ilubabor zones are soil erosion. Topography, rainfall, wind, lack of vegetation cover, soil properties, and land use and management practices are the immediate causes of soil erosion.

There are also underlying or distant causes, such as population pressure, poverty, high cost and inaccessibility of inputs, insecure land tenure, lack of appropriate production and conservation technologies and many of these are further influenced by various government policies or lack of them.

Topography affecting erosion

In Jimma and Ilubabor topography consists of high altitudes and rugged landscapes, as described earlier. The rugged topography and steep slopes affect soil erosion rate through its morphological characteristics. Two of these, namely gradient and slope length, are essential components in quantitative relationships for estimating soil loss. On sloping lands, more than one-half of the soil particles that are dislodged by raindrops during rainfall are carried downhill. Erosion increases dramatically because the increased angle facilitates water flow and soil movement. It is not surprising, therefore, that areas like the Dedo highlands in Jimma, Bure areas in Ilubabor, etc. suffer some of the districts highest erosion rates

On the other hand, forests those found in, Jimma and Illubabor areas are dominantly mixed broad leaves, consisting of aningeria adolfi friederici, edebergia, albizia, bosqueca, fagaropsis, pegeum, syzygium, croton, celtis, polyscias and schefflera spp. These areas are homes to coffee arabica, which accounts for about 66% of the country's foreign exchange earnings. The coffee-growing area increased from thousand hectares. This expansion has been taking place by removing forest cover including wild coffee plants, thereby posing a threat to biodiversity in coffee. In some areas such as Limmu Kossa, coffee and other crop-growing areas are being converted to chat plantations because of its quicker cash generation potential and because of the high incidence of coffee berry disease. The area growing chat increased hectare. It is becoming an important source of cash income for farmers and foreign currency for the country. It is claimed that growing chat contributes to reducing erosion as fields are prepared and trees are planted so moisture is retained and runoff is reduced

Livelihood activities

Various prior studies adopted asset based approach to cluster households on the basis of livelihood strategies and use the resulting strategy specific income distribution to test differences in welfare among identified livelihood strategies (C. B. Barrett, Reardon, & Webb, 2001; Stifle, 2010). Income, however, is unstable indicator of livelihood strategy. For instance, rural households who have lost its production may have zero or negative income, but still they are agrarian. Livelihood is beyond income generation; it involves social process of making living. This study followed clustering livelihood activities based on sectors. Accordingly, sample households were grouped into agrarian only, those who make living from non-farm and those who pursue both agricultural and non-agricultural livelihood strategies.

The majority of sample households were confined to agricultural livelihood activities. Households pursuing only agricultural livelihood constitute 92.4 percent of the sample. These groups of households are those who make their livelihood from crop cultivation and livestock rearing. The non-farm livelihood category consists of households whose main living is based on activities outside agriculture. These include daily labor in others farm, self-employment in own business, trade of grains, petty trading, trade of livestock, remittance, charcoal selling and traditional brewing. Labor employment activities include contract weeding, hay cutting and gathering, crop harvesting, contract farming and keeping livestock of others, among others. These activities are undertaken by 2 percent of the respondents. About one percent of households live only on non-farm livelihood activities.

Livelihood Assets

Natural capital: land

Access to land is an important asset for the majority of household who, one way or the other, depend on agricultural production for their income and subsistence. From the sample, 85.6 percent had access to land. Of 85.6 percent of households having access to land, 2.7 percent pursue purely non-farm livelihood. These respondents rented out their land on long-term basis (more than five years) and work as wage laborers or self-employed. Similarly some rural households of both zones are landless and depend entirely on non-agricultural sources of food and income. Land access is not a sufficient condition for household's decision to choose between alternative livelihoods activities. The minimum landholding size was 0.25 hectare; 10 (4.7) households had land size of 0.25 hectare. The average land holding of respondents was 1.8 hectares and maximum holding was 7 hectares. The average size of land holing was 2.3, 0.8, and 1.4 hectares for households pursuing agricultural, non-farm and a combination of agricultural and non-farm livelihood clusters respectively. Hence, relatively, large holding more characterizes households working in agricultural livelihood than those engaged in non-farm livelihood portfolios.

Table 8. Size of landholding

Size of Land holdings					
Land holding	Agricultural activities only (X =2.3 hect.)	Non-farm livelihood activities only (X =0.79 hect.)	Both agricultural and non-farm activities (*X* =1.4 hect)	Total (N=321)	χ2
0-0.5	10(5.4)	2(1.1)	17(9.2)	29(15.8)	
0.51-1.5	42(12.0)	51(1.6)	57(19.0)	150(32.6)	
1.6-2.5	35(19.0)	26(1.5)	16(8.7)	77(27.7)	
2.6-3.5	14(9.2)	0(0.0)	10(3.8)	24(13.0)	189*
3.6-4.5	12(6.5)	0(0.0)	1(0.5)	13(7.1)	
4.6-5.5	14(2.2)	0(0.0)	1(0.4)	15(2.2)	
5.6+	11(1.1)	0(0.0)	2(0.5)	13(1.6)	

Farm implements

Major traditional farm implements used in study areas include axe, Saw, hoe, pole (*gajera*), there is no availability of improved farm implements/farm mechanization. Farmers mainly get these farm implements from local and markets by unfair price.

Farming system

Crop production

Jimma and Ilubabor crop agriculture is complex, involving substantial variation in crops grown across the districts different kebeles and agro ecologies. Smallholders account for 96 percent of total area cultivated and generate the key share of total production for the main crops. The core crop season is the Meher season, with harvests between September and February. Five major cereals (maize, teff, sorghum, wheat, and barley) and cash crop (coffee and ckat) is the core of two zones.

Maize and teff are dominated food crops produced and utilized by a large number of farmers for consumption and sale. Farmers use crops produced mainly for both family consumption and marketing. For different crops the amount sold and consumed varies across household depend on family size, quantity produced, crop type and market demand.

Agricultural crop area and production

Smallholder farms (5.2ha) and large coffee farms (>25.2ha). The majority of farmers in study are smallholder farms, producing mostly for own consumption and generating only a small marketed surplus. Only 40 percent of the smallholders cultivate more than 0.5ha and these 'medium-sized farms' account for three-quarters of total area cultivated. Large farms (averaging 25 hectares per farm only for coffee) are not widely spread in study area and the contribution of these farms to total agricultural output is limited. Smallholder farms generated 95 percent of total production for the main crops (cereals, pulses, oilseeds, vegetables, root crops, pepper, fruits, and cash crops). In contrast, large farms contributed to only 5 percent of total production of these main crops and to only 2.6 percent of cereal production in particular.

Major Crops Cultivated and Cropping System in Jimma and Ilubabor

Cropping system

Most farmers in the study districts practices continue cropping. Both Jimma and Ilubabor zone has one season of production in a year. In all districts of the study area only few farmers use crop rotation when there is suitable rain fall in the areas double cropping especially where irrigation is available.

The major crops grown in the selected districts include maize, sorghum, finger millet, common bean, Enset, , Irish potato, Taro, Coffee, Pepper, pigeon pea, ground nut, Mango, Avocado and Banana. The study area has one cropping seasons' summer. Common cropping systems practiced in districts are sole cropping and intercropping. Farmers grow crops for home consumption, seeds and income generation. As there are diverse farming systems in Ilubabor zone, the production problems are also diverse.

Farmers listed series of problems that affects the productivity of the existing crop varieties as army worm and stalk borer on maize and sorghum, head smut on sorghum and maize, ear rot on maize, leaf blight on common bean bacterial wilt on Enset and Banana, anthracnose on mango and avocado, bird attack on sorghum, erratic rainfall, mole rat attack on Enset. Weevils and rats are storage pest on different crops. In general the key informants strongly emphasized that the major crop production constraint, Storage pest and opening nature maize variety they are using are major production constraints.

Crop management

Fertilizer, inorganic fertilizer application is common in crop production of both districts. NPS is applied at sowing where urea is applied in fragmented for maize but use of fertilizer for other crops in very low as compared to maize due to high prices of fertilizer and its availability.

Agronomic Practices

Land preparation

All farmers use oxen plowing for land preparation. The land is tilled 2-4 times until it gets ready for seed sowing depending on crop types and nature of land. Major constraints of land preparation and planting as mentioned by the key informants are livestock diseases, erratic nature of rainfall, shortage of farm implements and labor. According to interviewed farmers using FGD, the common cropping systems practiced in the study area mono cropping but previously they use intercropping. Both broadcasting and row planting are practiced in the PA. Sorghum and Finger millet are broadcasted whereas maize and common bean are planted in row. Common bean is planted being mixed with maize.

Cropping pattern

Agricultural production patterns vary markedly across study according to agro climatic conditions, in particular, widely varying rainfall and elevation.

Food security status of the household

Discussion on categorical variables: educational status of the household heads among food insecure and food secure households were found to be categorical variable that have association with status of household food security. The data obtained from the sample respondents revealed that 68% food insecure and 32% of food secure households were found to be illiterate (who can't read and write in Amharic and Oromiffa languages). On the other hand 77% of foods secure and 32% of food insecure households were literate (who can read and write in Amharic and Afaan Oromiffa). The chi-square value for this variable shows that there significant association (at $p<0.01$) between educational level of the household head and food security status at household level. This finding coincides with various literatures.

Use of fertilizer was one of important variable assumed to have association with household food security status. Data recorded from sample respondents revealed that there is significant difference between users and non-users (at $p< 0.01$). The data obtained from households revealed that 25% and 95% of food insecure and secure households, respectively were found to be users of chemical fertilizer where as 69% of food insecure and 15% of food secure households are non-users of chemical fertilizer.

Improved seed was one of important agricultural input used by the farmers of the study area. It was one of the variables that are assumed to have association with the level of household food security. Accordingly it was found that 17% of food insecure and 39% of food secure households use improved seed to increase production and productivity. The chi-square test for this variable shows that there is significant difference (At $p< 0.05$)in the level of food security by using or not using improved seed for the major crops.

Using improved technology limited resources like mechanization technology improved production and productivity. This variable was considered as important variable that have association with the attainment of household food security. It was found that 43% of food insecure and 84% of food secure households using improving technology on their farm land.

Table 9. Descriptive statistics of Categorical variables

		Food security status		
Description of variables	Categories	Insecure (%)	Secure (%)	Chi square
SEXHHH	Male	84	91	1.96(NS)
	Female	70	40	
EDUHHH	Illiterate	68	23	34.32***
	literate	32	77	
USEFSEERT	Users	25	95	52.48***
	Non users	69	15	
IMPROVSEED	Users	17	39	3.89**
	Non users	83	60	
PESTPROB	Yes	48	47	0.01(NS)
	No	62	63	
ACCESSMART	Yes	76	88	3.75(NS)
	No	35	13	

CREDITACCESS	Yes	26	37	1.67(NS)
	No	74	65	
USEIMTECH	Yes	43	84	29.079***
	No	57	16	

Source: own data

Cropping calendar

The Crop Calendar is a tool that provides timely information about seeds to promote local crop production. It contains information on planting, sowing and harvesting periods of locally adapted crops in specific agro-ecological zones. It also provides information on the sowing rates of seed and planting material and the main agricultural practices. The cropping calendars are almost similar across study areas where majority of respondents (95%) the seedling from May to July and starts harvesting after 5-7 years after planting. however the intensity of these practices depends on the expectation of the rain fall.

Table 10 Farm operation calendar of some crops in Ilubabor zone selected districts

Crop	Land preparation	owing/planting	Harvesting
Maize	February	March – April	October-December
Sorghum	February	March – April	November -December
Teff	June	July	October
Hot pepper	May	June	November -December
Bean	May- June	June – July	November -December
Wheat	May	June	November -December

Table11 Farm operation calendar of some crops in Jimma zone selected districts

Crop	Land preparation	owing/planting	Harvesting
Maize	February	March – April	October-December
Sorghum	February	March – April	November -December
Teff	June	July	October
Ground nut	May	June	November -December
Bean	May- June	June – July	November -December
Wheat	May	June	November -December

Land Use System

In the entire study districts, the land-use system operated under traditional mixed crop-livestock farming system. The land-use system of farm households could be broadly classified into crop production, livestock production, and coffee plantation. On average, crop production occupied the largest proportion of the land, followed by coffee plantation and livestock production. Fertile and good-quality land was allocated for crop production, while very small plots and marginal lands were reserved for grazing. It was also noted that small patches of woodland, having regulated as well as non-regulated use, were irregularly distributed over all selected districts.

Farmers were found to have planted trees primarily for construction and fuel-wood purposes, as boundary plants on crop land or woodlots on small plots of land, and often as homestead plantations. Establishment of homestead plantations with pure eucalyptus stands was common place.

Farm Implements /Mechanization

Various traditional implements are used in both zones for different activities. Almost all farming tools in study are traditional and made from different wood materials. This tool includes sickle, pick axe, plough shaft, ploughshare, plow, yoke and animal force as machines. These implements are conventional, less effective, time consuming and laborious. The sources of farm implements are local markets.

Weed Control practices of study area

Weed is among the crop problems faced by the farmers in crop production in the two zones which hampered production and productivity of agricultural production. Because crops are not normally planted in rows, weeding is a time-consuming task. Farmers in Ethiopia use various strategies to reduce or avoid weed infestation in their fields. Current weed control practices are discussed below.

Hand weeding

It is the most common weed control method used by small-scale farmers. It usually requires no capital outlay. This is a major advantage when cash is not readily available and labour is provided from the farmer’s immediate family or through non-cash exchange. It may be the only feasible method for weeding broadcast crops when herbicides are not available. Hand weeding is intensive and slow compared to other methods, and may damage crop roots.

Increasing the frequency of plowing

Making three to six passes with a traditional plow before planting is a common practice aimed at preventing or reducing weed emergence.

Late planting

Maize and sorghum are normally planted before the rains. Dry planting allows crop seeds and weeds to germinate simultaneously, so weeds and crop seedlings compete for moisture and nutrients. However, planting after rainfall allows crop seeds to germinate before weeds, so that crop seedlings dominate the weeds

Crop rotation

Crop rotation is an important means of weed control adopted by some farmers. For example, sorghum, a weed-suppressing crop, can reduce weed levels in the following season

A traditional animal-drawn weeding system

A practice known as Shilshalo involves ox cultivation in either broadcast or row-planted maize at different spacing. A traditional animal-drawn plow is used for inter-row cultivation. This breaks the soil crust, reduces run-off and increases the soil infiltration rate, in addition to controlling weeds and thinning plants to appropriate levels. However, as most farmers do not practice Shilshalo at the correct stage of crop development, substantial plant damage (stem breakage and uprooting) is common, leading to low yields**.**

Alternative weeding methods

Mechanical weeding implements

Efforts have been made to design and develop convenient and practical mechanical weed-control methods using simple implements and tools. Mechanical equipment can be time-saving during peak operation, resulting in higher output per worker and reductions in the cost of weeding. Such mechanical equipment may be manual or animal-drawn.

Manual weeders

Manual weeders commonly used include chopping hoes (pull-and-push type weeders) comprising a steel blade (the soil-working component) fitted to a long wooden handle.
These weeders are most useful when weeds are small and the soil is not too hard.

Chemicals

A few farmers have started using herbicides to control weeds, all study areas. However, herbicides have been found to be less effective than hand-weeding, as they require specific conditions which may be more limiting than other control methods. For example, the correct herbicide must be selected for the particular crop and weed spectrum present. It must be applied at a specific rate, at the correct time and only under specific environmental conditions (soil fertility, soil moisture, rainfall, temperature, humidity and air movement).

Fertilizer and compost utilization

Fertilizer and compost are the most public inputs used by the farmers to increase crops productivity in the study area. Fertilizer type available to the area is NPS. Farmers use/apply DAP during planting while UREA applied at ploughing between row during cultivation period. Major crops receiving fertilizer in order of importance as suggested by farmers were maize, sorghum, wheat and barley respectively. Problems encountered by farmers in using fertilizer are high fertilizer price, rainfall shortage and inadequacy, lack of awareness of some farmers and unavailability at the right time and place. Compost collection, preparation /storing and application are also commonly practiced in the area. Compost is collected during dry season and applied mainly to; pepper, wheat, sorghum and maize. Problems related to compost preparation are low number of livestock ownership especially in high and mid lands and lack of means of transporting from source to the field.

Agricultural production constraints of Ilubabor zone

Table 12: Major problems identified by farmers in the Bure district

Major problems	Rank
Land shortage	1
Lack of improved technologies	2
Diseases and pests	3
High price of fertilizer	4
Shortage of draught power	5
Feed shortage	6
Drought	7
Low price of agricultural products	8
Land degradation	9
Fluctuation of RF	10
Scarcity of grazing land	11
Lack of infrastructure	12
Pepper marketing problem	13

Source: own survey data (FGD)

Table 13: Major problems identified by farmers in the Metu district

Major problems	Rank
Lack of improved technologies	1
Land shortage	2
High price of fertilizer	3
Scarcity of grazing land	4
Feed shortage	5
Shortage of draught power	6
Diseases and pests	7
Low price of agricultural products	8
Land degradation	9
Fluctuation of RF	10
Lack of infrastructure	11
Lack of mechanized technology	12
Drought	13

Source: own survey data (FGD)

Table 14: Major problems identified by farmers in the Gechi district

Major problems	Rank
Lack of improved technologies	1
High price of fertilizer	2
Low price of agricultural products	3
Diseases and pests	4

Land degradation	5
Lack of mechanized technology	6
Lack of irrigation technology	7
Fluctuation of RF	8
Land shortage	9

Source: own survey data (FGD)

Agricultural production constraints of Jimma zone

Table 15: Major problems identified by farmers in the Dedo district

Major problems	Rank
Soil fertility problem	1
High price of fertilizer	2
Diseases and pests	3
Lack of enset processing technology	4
Land degradation	5
Lack of mechanized technology	6
Lack of improved technologies/variety	7
Lack of irrigation technology	8
Low price of agricultural products	9
Land shortage	10
Land slide problem	11

Source: own survey data (FGD)

Table 16: Major problems identified by farmers in the Limmu Kossa district

Major problems	Rank
Low price of agricultural products/coffee	1
Shortage of agricultural land / occupied by investors	2
Lack of mechanized technology	3
High price of fertilizer	4
Soil fertility problem	5
Diseases and pests	6
Lack of improved technologies/variety	7
Lack of irrigation technology	8
Shortage of pesticides supply	9

Source: own survey data (FGD)

Table 17: Major problems identified by farmers in the Nono Benja district

Major problems	Rank
Soil fertility problem	1
High price of fertilizer	2
Lack of mechanized technology	3
Water shortage	4
Lack of improved technologies/variety	5
Diseases and pests	6

Source: own survey data (FGD)

Storage, Processing and Marketing

Majority of farmers in both in Jimma and Ilubabor zones store their crop products mainly in granary made of wood /bamboo which leads to entrance of storage pest (weevil and rats). Rats and weevils are the common storage pests in the locality. With regard to marketing, the farmers revealed that the districts potential for diverse crop production they have surplus production for sale.

Hot pepper (Bure), groundnut (Limmu Kossa) and maize (all district) are sold in large quantity for merchants in local as well as in urban. Maize is sold in large quantity to earn money to cover input price. The farmers in the area utilize perennial and tuber crops in to pay fertilizer cost and land taxes. Maize is susceptible to weevil and usually sold immediately after harvesting as result the farmers are forced to sell it in cheap price. Traditional way of harvesting leads to injury of the fruit such as Mango and as a result the price of the product decreases.

Constraints in production of vegetables

Responses regarding various problems in production were recorded and analyzed during the field study. The respondents were asked to identify, choose and prioritize the various categories of problems they had been facing on vegetable cultivation. Despite the immense merits of vegetable to farmers, their production has been constrained by a myriad of biotic and abiotic factors as well as institutional. The majority of the sample producers indicate disease and pests attack, weeds, shortage of quality seed, lack of pesticide and lack of irrigation water/pump for irrigation as major constraints of vegetable production in the area. Similarly, a survey in low land (major pepper growing area) confirmed that pests and diseases, coupled with a low level of improved agricultural technology, recurrent droughts, and decreases in soil fertility levels are some of the major contributors to the low and unstable crop yields in the study area.

Production Constraints of fruits in the study area

The major production problems that need intervention according to farmer’s response are:

- Vegetative growth: Most of the farmers reported that their avocado trees show only vegetative growth rather than giving yield at their fruit bearing stage
- Falling down of fruits before they are matured
- Pest problem**:** The pest looks like a fly, white in color and attacks the stem. This problem is largely observed in Metu and Limmu Kossa districts.
- There are no improved agronomic practices introduced in the area
- Disease (drying at the tip and branches) of avocado and mango. this is largely observed in three district (Bure, Metu and Limmu Kossa)
- There are no extension activities undertaken on fruit in the surveyed areas

Constraints of Beekeeping in Bure and Metu Wereda areas

As depicted in Table 18**,** the major constraints of beekeeping in the areas include Insufficient visit and bee management skills (22.4%), Bee enemies in the area (14.3%), Drought and Wild burning (13.1%), Absconding and Migration of bee colony (%), Poison plant in the area (4.9%) and Poison chemical spraying (4.3%).

Table 18: the major constraints of beekeeping in the areas

Apiculture Constraints	% Respondents
Insufficient bee management skills	22.4
Problem of Inspection & apiary cleaning	24.3
Low level of technology used	10.1
Bee enemies in the area	12.3
Lack of training & extension service	43.0
Drought and Wild burning	13.1
Absconding and migration of bee colony	12.3
Poison plant in the area	4.9
Poison chemical spraying	4.3
Total	100

Constraints faced in accessing markets

The constraints faced by individual household when accessing markets were similar across all districts of the study area with transport problems and low prices consistently ranking highly. Transport problems included the high cost and unreliability of transport, and the absence of a means to get their goods to market (their only option being to carry them). Lack of information on prices and potential buyers were also consistently cited as challenges for individual farmers.

Conclusions and Recommendations

The research was carried out in Dedo, Limmu Kossa and Nonno benja districts of Jimma zone, and Bure, Metu and Gechi districts of Ilubabor zone Oromia National Regional State .From this study result it could be concluded that farming system in Jimma and Ilubabor classified in to three broad groups as crop- LS mixed farming system, coffee cash and sub- clustered in cereal crop farming system. In general each sub- cluster has its particular production potentials and constraints.

Major production constraints in study areas are:

- ✓ Constraints faced in accessing markets
- ✓ Constraints of Beekeeping in Bure and Metu Wereda areas
- ✓ Production Constraints of fruits in the study area

The major production problems that need intervention according to farmer's response are:

- Most of the farmers reported that their avocado trees show only vegetative growth rather than giving yield at their fruit bearing stage, falling down of fruits before they are matured and the pest looks like a fly, white in color and attacks the stem. This problem is largely observed in Metu and Limmu Kossa districts. There are no improved agronomic practices introduced in the area
- Low land (major pepper growing area) confirmed that pests and diseases, coupled with a low level of improved agricultural technology, recurrent droughts, and decreases in soil fertility levels are some of the major contributors to the low and unstable crop yields in so that it needs research intervention. All study area were non- mechanized because of nature of topography, so it needs small scale farm implements/ seed & fertilizers applicators, cultivators, chemical sprayer, harvesting technologies especially for fruits.

Recommendations

Crop Production

- ❖ Improving facilitates and institutional facilities such as market information and transportation were also found to be vital to motivate pepper producers and increase pepper production and productivity /Bure.

- ❖ Most of coffee farm management system and agronomic practices of farmers of the study area were traditional. Therefore, emphasis should be given in enhancing extension services to improve their skill and knowledge on coffee production system. Input provision such as intensification of farm land, irrigation access, improved seeds, fertilizers, and pesticides should also be adequately scheduled to meet the cropping calendar.
- ❖ The farming system with crops and livestock turns out to be remunerative across all categories of farmers. In order to sustain and improve the income levels of farmers, linkage of production system with marketing/honey, fruit and vegetables agro-processing and value added activities are crucial.

- ❖ Thus, agricultural extension programme need to be developed with market extension towards system efficiency. Diversification of farming systems also need greater emphasis on livestock, as they are land saving and stabilize the income and increase the employment opportunities on the one side, and reduce the risk of lower returns on the other.

Livestock

- ❖ Strengthening the artificial assimilations services by supplying its equipment and facilities and recovers and expands animal health services by recuperations of existing animals' health posts.
- ❖ Encourage animal feed production and forage seed expansion and capacities of an indigenous knowledge of farmers on an animal's disease control and increase technical support of farmers.
- ❖ Improve and expands honey production through announce and promote apiculture technologies for the zone and improving marketing system of livestock through controlling illegal traders and dealers with expand and promote livestock production and livestock products for domestic markets and disseminates.

Natural resource management

- ❖ Soil fertility management based on soil test must be thrown with the integration of organic and inorganic soil fertility improvement approaches and expand awareness for farmers to use soil and water conservation of degraded lands and replacement of the deteriorated soil fertility
- ❖ Administration should be give kindness to protect forest from threats and strengthening and developing nursery site for multiplying of different multipurpose tree species and for increases of agro-forestry practices in the study area.

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Factors Affecting Adoption of Improved Haricot Bean Technology in West Hararghe Zone: The case of Habro and Darolebu Districts

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Abstract

Adoption of improved technologies is one of the most promising ways to reduce food insecurity in Ethiopia. However, the adoption and dissemination of these technologies is constrained by various factors. The aim of this study was to determine intensity of adoption of improved haricot bean technology and identify factors affecting its adoption in the study area. The study was based on cross sectional data collected from 148 randomly selected improved haricot bean producing farmers. Descriptive and econometric analyses were used to analyze data. The descriptive result shows that about 62.2% and 37.84% were adopters and non-adopters of the crop, respectively. Tobit model results showed that livestock size, membership in social organizations and extension contact affected the intensity and probability of adoption of improved haricot bean technology positively and significantly while age of the household head affects intensity and probability of adoption negatively and significantly. Generally, this study recommended that government, policy makers, researchers and so on have to design and implement appropriate policies and strategies against those significant variables to increase the adoption of smallholder farmers in improved haricot bean technology in the study area.

Key words: adoption, agronomic practices, haricot bean, tobit

Introduction

Ethiopia's economy is largely based on agriculture, which provides 80-85 percent of employment for the population as well as contributing about 43.5% of GDP and 61% of the total export (NABC, 2015). Agriculture remains Ethiopia's most promising resource potential for self-sufficiency and export development. Many other economic activities depend on agriculture, including marketing, processing, and export of agricultural products. The agricultural sector plays a central role in the economic and social life of the nation and is a cornerstone of the country.

Beans (Phaseolus Vulgaris L) known as haricot bean in Ethiopia are increasingly becoming an important crop to the Ethiopian national economy (commodity and employment) and to farmers as food and as cash income generating crop. Ethiopian farmers grow beans for two major consumption uses namely: canning and cooking types. The white navy beans are grown for export canning industry and others are mainly for households' food for national and regional markets. Each of this market has been growing at a higher rate (Rubyogo *et al*., 2011). Virtually all bean production is carried out by small-holder farmers, which are estimated to be about 3.1

million in 2012 (CSA, 2012). Due to high demand in international and domestic market, Ethiopian haricot bean has increased more than two-fold from 138 to 463 thousand tones between 2005 and 2012/13. Haricot bean export account for about 41% of pulse production and exports from 2005 to 2012and its share of total pulse production grew from 11% to 16.3% in the same period. Its contribution to national export earning was 95.3 million USD in 2012 (FAO, 2015).

Adoption is degree of use of new technology in long run equilibrium when the farmer has full information about new technology and its potential (Feder *et al*., 1985). They further divided adoption into individual (farm level) adoption and aggregate adoption. Final adoption at the individual farmer's level can be defined as the degree of use of new technology in long run equilibrium when the farmer has full information about new technology and its potential. Aggregate adoption is a process of spread of new technology within a region. Aggregate adoptions are measured by aggregate level of use of specific new technology within a given geographical area or within a given population. The rate of adoption is defined as the percentage of farmers who have adopted a given technology and intensity of adoption is the number of hectares planted with improved seed or the amount of input applied per hectare (Feder *et al*., 1985).

Between 2005 and 2012 area cultivated with haricot bean has been increased from 169 to 359 hectares, on the other hand, the average national yield per hectare was low over the same period, with an average of 1.2 tons per hectare (CSA, 2012). The situation can be explained by supply side constraints, including low adoption of improved seeds, limited knowledge of small-holders on production practices and benefit of diversification, and by market-led constraints, particularly, price instability in 2008 that led to diminished trust in the pulse sector for small producers after declining market returns. Additionally, there is insufficient seed in the country owing to an increasing demand from export markets, and therefore particular problems in accessing new white bean varieties (Alemu *et al*., 2010).

However, the government has increased extension efforts and price have risen steadily since 2009 (FAO, 2015). Haricot bean technology package consisting of improved seed (Awash-Melka and Awash-1), seeding rate, fertilizer rate and spacing were introduced and scaled up in West Hararghe Zone by Mechara Agricultural Research Center since 2011. Different stakeholders (Goal, World Vision, Chercher and Oda Bultum Union, and Bureau of Agriculture of the Zone)also have beenscaling upthe technology in the study area.

But, small scale farmers' decision to adopt or reject agricultural technologies depends on their objectives, constraints, cost and benefit occurring to it. Farmers will adopt technologies that only suit their need and no attempt has been made to study intensity and factors affecting adoption of improved haricot bean technology in the study area.

Therefore, the study was attempted to identify factors affecting the adoption of the introduced technology and to determine the intensity of adoption of the technology.

Objective of the study

The general objective of this study was to study adoption of improved haricot bean technology in the study area.

Specific Objectives

- To determine intensity of adoption of improved haricot bean technology in the study area.
- To identify factors affecting adoption of improved haricot bean production technology.

Research Methodology

Description of the study Area

The study was conducted in Habro and Darolebu districts of West Hararghe Zone which have potential in production of Haricot bean.

Description of Habro district

Habro district is one of the fifteen districts of West Hararghe administrative zone of the Oromia National Regional State.It is located404 km to East of Addis Ababa, which is capital city of Ethiopia and 75 km to South of Chiro. The district is boarded by Guba Koricha district in West, Boke district in East, Daro Lebu in South and Oda Bultum in North. Gelamso town is the administrative seat of the district. According to CSA (2013), the population of the district is estimated to be 244,444 of which women account for 118,268(48.4%) and men account for 126,176(51.6%)of the population. The altitude of the district ranges from 1600 to 2400 masl.The annual average rainfall the district is 1010 mm & the mean temperature ranges between 16 and 32℃. There are two cropping seasons in the area, Belg (short rainy season) from March to June and Meher (main rainy season) from June to September. Belg rains are mainly used for land preparation and planting long cycle crops such as maize. The Meher rains are used for planting of cereal crops like barley, teff, wheat and vegetable crops. Meher rains are also the major source of moisture for the growth and development of perennial crops such as mango, coffee and chat. Haricot bean is grown in both of the cropping seasons.

Description of Darolebu district

Daro Lebu is one of the districts found under West Hararghe Zone. The capital town of the district, Mechara is found at about 434 km South East of Addis Ababa. Longitudinally the district is found at 08°35'589" North and 40°19'114" East. It has 42 kebeles of which, 37 are rural kebeles and 5 are urban kebeles. It is bordered by Boke in East, Arsi Zone in West, Habro District in North, and Hawi Gudina District in South. Agro-ecology of the district is 44% midland and 56% lowland. The district is characterized mostly by flat and undulating land features with altitude ranging from 1350 to 2450 masl. Ambient temperature of the district ranges from 14 to 26°C, and receives minimum and maximum annual rainfall of 900 mm and 1300 mm, respectively. The pattern of rain fall is bimodal and its distribution is mostly uneven. Generally, there are two rainy seasons: the short rainy season 'Belg' lasts from mid-February to April whereas the long rainy season 'kiremt' is from June to September. The most commonly available soil type is sandy loam clay which is reddish in colour. The rainfall is erratic; onset is unpredictable, its distribution and amount are also quite irregular (Asfaw *et al*., 2016).

Sampling procedure

In this study a multi-stage sampling technique was employed. Firstly, two districts were selected from the zone purposively based on their potential of using the technology. Secondly, two kebeles from each district were selected purposively based on their potential of using the improved haricot bean technology. Finally, in collaboration with Development Agents (DAs) a total of 148 representative households were selected randomly by considering probability proportional to population size. The simplified formula provided by Yamane, (1967) was employed to determine the required sample size with degree of variability = 0.5 and level of precision (e) = 8%.

$$n = \frac{N}{1 + N(e^2)} \qquad \ldots\ldots\ldots\ldots\ldots\ldots \ (1)$$

Where n is the sample size, N is the population size and e is the level of precision.

Table 1: Total number of sample households

Districts	Kebeles	Number of sample households
Darolebu	Sekina	38
	Kurfa-wachu	27
Habro	Haro-chercer	55
	Wachu-bedada	28
Total		**148**

Data Source and Method of Data Collection

Both primary and secondary data sources were employed. Secondary data source was collected from formal and informal documents of district Agricultural Office to support the primary data. The primary data was collected from the selected sample representative households through FGD and direct interview. Both qualitative and quantitative primary data was collected by using interview schedule. Prior to the administration of the questionnaire, enumerators were trained about the objectives study.

Method of Data Analysis

Data was analyzed with STATA 13 and SPSS software version 20. SPSS version 20 was used for descriptive analysis and STATA 13 was used for econometric analysis. Both descriptive statistics (such as mean, standard deviation, frequency and percentage) and econometric model (Tobit model) was employed to meet the specific objectives of the study. Adoption index formula was also used to know the adoption level of farm households.

Analytical Model

Estimation of the Adoption index

Before analyzing the determinants of adoption, it is important to assess the level of the adoption for each farm household. Accordingly, farmers who were not growing improved variety of haricot bean were considered as non-adopters, while farmers who were growing improved variety with some of the recommended agronomic practices of haricot bean production for at least one (1) year cropping season were considered as adopters. Among improved agronomic practices only three practices (improved variety, seed rate, and fertilizer application rate), are currently practiced by haricot bean producer in the study area. The rest two practices (spacing in cm and chemical application) were excluded because of absence and difficulty in getting reliable information on them. Adoption index score was calculated by adding up the adoption quotient of each practice and dividing it by number of adopted practices of each respondent. The adoption quotient of each practice was also calculated by taking the ratio of actual rate applied to the recommended rate. In this study, adoption index was used to measures the extent of adoption at the time of the survey for multiple practices (package), which shows to what extent the respondent farmer has adopted the most set of package. The index for each respondent farmer was estimated as:

$$AIi = \frac{\sum\left(\frac{AHi}{ATi} + \frac{SRAi}{SRRi} + \frac{FAi}{FRi}\right)}{NP} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where,

AI_i= Adoption index

AH_i= Area under improved variety of haricot bean of the ith farmer.

AT_i= Total area allocated for haricot bean production (improved variety+ local, if any) of the ith farmer.

SRA_i = Seeding rate applied per unit of area in the production of improved haricot bean of ith farmer,

SRR_i = Seeding rate recommended per unit of area,

FA_i= Amount of fertilizer applied per unit ofarea in the cultivation of improved variety of Haricot bean by ith farmer,

FR_i= Amount of fertilizer recommended for application per unit of area in the

cultivation of improved variety of Haricot bean,
NP= Number of practices

Thus, the adoption index is a continuous dependent variable calculated using the formula presented above with a value ranging from zero to one. Zero (0) indicates no adoption and one (1) indicates full adoption.

Improved haricot bean production involves use of different package practices. These include use of improved variety, seeding rate, fertilizer rate, spacing and so on. Significant improvement in production and productivity depends on the extent to which a household has practiced the recommended improved agronomic practices. The level of adoption of improved haricot bean production practices by farmers may vary depending on demographic and socioeconomic variables, although institutional and environmental factors in which the household operates also influence level of adoption. The actual adoption index score ranges from 0 to 1. The sample households' index scores were categorized into four adopter groups' namely non-adopter, low, medium and high adopter. Adoption index score of zero point implies non-adoption of the overall improved haricot bean technology and greater than zero (>0 and ≤1) implies adopters with three category; namely low adopters, medium adopters and high adopters.

Tobit model

In this study tobit model was used to examine factors affecting adoption and intensity of adoption. Most adoption research has viewed the adoption decision in dichotomous terms (adoption and non adoption). But for many types of innovations, the interesting question may be related to the intensity of use of e.g., how much fertilizer is used per hectare or how much land is planted to improved varieties (Feder *et al*., 1985). The farmer may adopt only some part of the recommended package and may also do this on 1% or 100% of his/her farm (Alamitu, 2011). So, tobit model, which has both discrete and continuous part, is appropriate because it handles both the probability and intensity of adoption at the same time.

- As cited in Alene *et al*., (2000) the tobit model used for this study is specified as;

$$AI = \beta_0 + \beta_1 X_1 + + \beta_2 X_2 + \beta_3 X_3 + \ldots\ldots\ldots\ldots\ldots + \beta_9 X_9 + U_i$$
$$AI = AI^* \text{ if } AI^* > 0, AI = 0 \text{ if } AI^* < 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

Where;
AI = is adoption index of the sample households
AI* = is the latent variable
β = vector of unknown parameters to be estimated
U_i = is error term which is normally distributed with mean 0 and constant variance.
X_1= Age of the household head in years
X_2 =Sex of the household head showing 1 if the household head is female; 0 otherwise
X_3 = Experience of the household head in improved haricot bean production in years

X_4= Land holding size in hectares
X_5 = Livestock owned in numbers
X_6= Dummy variable showing access to training=1, otherwise zero (0)
X_7 = Membership of the household head in social organizations
X_8 =Dummy variable showing access to credit=1, otherwise zero (0)
X_9 = Extension contact (1 if yes; 0 otherwise)
The value of AI_i for all non-users equals 0.

- following tobin (1958) the adoption and intensity of adoption of improved haricot bean technology will be estimated by;

$$E(AIi) = X\beta F(z) + \alpha f(z) \quad \text{.......} (4)$$

Where;
F (z) - is cumulative normal distribution function
f (z) - is the value of derivative of normal curve at the given point
z - represents z-score for the area under normal curve
α- is the standard error of the error term
β- is a vector of tobit maximum likelihood estimates

- The marginal effect of explanatory variable on the expected value of the dependent variable is;

$$\frac{\partial E(AI_i)}{\partial X_i} = F(z)\beta_i \quad \text{.......}(5)$$

Change in explanatory variables (X_i) has two effects;
1. It affects the conditional mean of AI_i^* in the positive part of the distribution
2. Probability that the observation will fall in that part of distribution

- The change in probability of adopting improved haricot bean technology as explanatory variables changes will be estimated by;

$$\frac{\partial F(z)}{\partial Xi} = \frac{f(z)\beta i}{\sigma} \quad \text{.......}(6)$$

- similarly, the change in the intensity of adoption with respect to change in an explanatory variables among adopters will be estimated by;

$$\frac{\partial E(AI_i/AI_i^*) > 0}{\partial X_i} = \beta\left[1 - z\frac{f(z)}{F(z)} - \frac{(f(z))^2}{F(z)}\right] \quad \text{.......}(7)$$

Definition of Explanatory Variables used for Analysis

The explanatory variables in this study are those variables, which are thought to have influence on intensity of adoption of improved haricot bean production package. These include household's personal and demographic variables, economic variables, and institutional variables.

The explanatory variables are defined as follows:

Age

It is measured in number of years from birth. It is believed that the youth are more energetic and are able to perform more strenuous work and older age farmers are usually more conservative than the youngest one to adopt new technology. On the other hand, it is usually considered in the adoption studies that, older people have more farming experience that helps them to adopt new technology. But,for this study it was expected that the farmer's age and adoption of haricot bean technology are inversely correlated.

Sex

Gender difference is one of the factors influencing new technologies. Due to many socio-cultural values and norms, males have freedom of mobility and participation in different extension programs and access to information. Therefore, it is expected that male farmers are more likely to adopt new technologies.

Farming Experience

Farmers with higher experience in haricot production are supposed to have better knowledge and advantages of the technology and therefore, it is expected that it affects adoption positively.

Land Holding Size

Farmers with larger land can afford the expenses on new agricultural technologies and can bear the risk in case of failure of crop. Therefore, it is expected to influence adoption positively.

Livestock Ownership

This is measured in terms of tropical livestock unit. Households with large livestock size can have good access for more draft and can purchase other critical inputs. Therefore, it is hypothesized that number of livestock owned affects adoption of haricot bean positively.

Membership in Social Organization

Being members of an association or cooperatives can influence decision of farmers to adopt new agricultural technologies. Farmers who bear responsibility to execute and organize on the behalf of the community get the chance to acquire timely and vital information from government officials and change-agents. Social participation influences adoption of improved technology positively (Negash, 2007; Ernest, 2015)

Access to Credit

If farmers get credit they can buy improved varieties of haricot bean. Access to capital in the form of either accumulated savings or capital markets is necessary in financing adoption of new agricultural technologies (Feder *et al.*, 1985). Thus, it is expected that access to credit can increase probability of adopting improved haricot bean technology.

Extension Contact

When there is contact with extension agent, the greater is the possibilities of farmers being influenced to adopt agricultural innovations. New agricultural technologies are usually introduced to farmers through extension agent. Therefore, farmers who have contact with extension agent have more probability of adopting new improved haricot bean technology.

Training

Training is an important input that improves farmers' performance and equips farmers with new knowledge and skills. Farmers who have skill and know-how about the technology have high probability of adoption. Thus, it is expected to positively influence adoption of improved haricot bean technology.

Results and Discussion

Age, land holding size and experience of the respondents

The mean age of sample households was 36.51 years with standard deviation of 9.904. The maximum age for the sample farmers was 60 years while the minimum was 17 years. On average, the sampled respondents have 12.04 years of experience in haricot bean cultivation.

Table 2: Age, land holding size and experience of the respondents

Variable	Minimum	Maximum	Mean	St.dev
Age	17	60	36.51	9.404
Experience in haricot bean production	1	32	12.04	7.599
Land holding size	.25	4	1.20	0.763

Sex of the respondent

About 119 (80.4%) of the sample farmers' households are headed by male while 29 (19.6%) were headed by female. The percent of male headed households of seed producers were higher than that of female-headed households. This is attributed to various reasons including the problem of economic position of female-headed households like shortage of labor, limited access to information and required inputs.

Table 3: Sex of the respondent

Category	Sex of the respondents		Grand total
	Female	Male	
Adopters	15	77	
Non adopters	14	42	
Sub-total	**29**	**119**	**148**

Adoption status of sample households

Survey result showed that out of the total sample households 92 (62.2 %) of them were users (adopters) of improved haricot bean technology, while the rest 56 (37.8 %) were non- users (non-adopters).

Table 4: Frequency and percentage of adoption status

Adoption index value	Adoption category					F	p-value
	Non-adopters	Adopters			Sub-total		
		Low	Medium	High			
0.00	56	0	0	0	56		
0.10-0.33	0	3	0	0	3		
0.34-0.66	0	0	68	0	68		
0.67-1.00	0	0	0	21	21		
Sub-total	56	3	68	21	148	1351.101	0.000

Source: Own computation

One way analysis of variance revealed that there is significant mean difference (F=1351.101, P=.000) among the adoption index score of the four adoption categories at 1% significance level which indicates variation in level of adoption among sample farmers.

Crop and livestock production in the study area

Annual crops

In the study area both annual crops and perennial crops are produced simultaneously. The major annual crops grown in the area include maize, sorghum, teff, and haricot bean among major cereal crops; chickpea and groundnut from pulse and oil crops; tomato, cabbage and hot pepper among major horticultural crops. Mostly these cereal crops are used for food consumption and rarely for market purpose while the pulses and horticultural crops are produced completely for market purpose.

Table 5: Area coverage and yield per hectare of major annual crops in the year 2015

Crop type	**N**	**Area coverage (hectare)**			**Average yield (qt/ha)**
		Minimum	Maximum	Mean	
Maize	136	.06	2.00	.42	23.5
Haricotbean	127	.06	2.00	.35	28.4
Sorghum	89	.06	2.50	.56	11.1
Teff	56	.06	.63	.28	6.5
Chickpea	50	.13	.50	.29	10.3
Groundnut	20	.06	1.00	.28	42.8
Tomato	17	.13	.50	.19	-
Cabbage	10	.06	.38	.15	-
Hotpepper	5	.06	.31	.18	-

Source: Survey data

Perennial crops

The major perennial crops produced in the area include chat, coffee and mango. These perennial crops are often used for market sale. As a result they are known as cash crops. On average, coffee is grown by 43.4% of sample households on about 0.60 hectare of land. Chat is cultivated on area of 0.34 hectare of land by 19.6% of sample households on average.

Table 6. Area coverage and yield per hectare of major perennial crops in the year 2015

Crop type	**N**	**Percentage**	**Area coverage (hectare)**		
			Minimum	Maximum	Mean
Chat	64	43.4	.06	2	.34
Coffee	29	19.6	.13	2	.60

Source: Survey data

Livestock production

Along with crops, livestock production is also practiced in the area. Livestock have an important role in rural economy as a source of draught power, food, and cash income, animal dung for organic fertilizer and fuel and means of transport. The types of livestock found in the study area are cattle, equine, sheep, goat and poultry. The survey result showed that on average adopter farmers owned 2.43 TLU while non adopter farmers have 1.88 TLU. The t-test result computed to see the mean differences between adopter and non-adopter farmers in livestock ownership indicate there was a significance difference at 10% significance level. The result of this study is in conformity with earlier adoption studies such as Degnet *et al.*, (2001) and Habtemariam (2004), who in their studies reported that livestock holding has a positive significant influence on adoption of agricultural technologies.

Table 7: Number of livestock owned by sample farmers in the area

Livestock type	**N**	**Minimum**	**Maximum**	**Mean**
Oxen	75	1	4	1.54
Cow	91	1	4	1.32
Heifers	43	1	3	1.12
Donkey	42	1	3	1.26
Goats	39	1	20	3.28
Sheep	13	1	5	2.23
Bull	14	1	4	1.28
Calves	46	1	3	1.41
Poultry	24	1	15	4.83
Beehives	1	6	6	6.00

Source: Own computation

Table 8: Livestock ownership (TLU) by adoption categories

Category	N	TLU		F	p-value
		Mean	Std. dev		
Adopter	92	2.43	1.748		
Non-adopter	56	1.88	1.803	7.779***	0.000

Source: Own computation

The results of one way ANOVA (F=7.799 and P=0.000) reveals statistically significant mean difference between adoption categories in relation to livestock ownership (TLU) at 1% probability level.

Cropping systems in the study area

As observed from the study main cropping systems practiced in the area are sole cropping and intercropping. Intercropping has an immense importance for small-scale resource poor farmers' who experience food shortage (Tolera *et al.*, 2005). The cereal/legume intercropping could benefit smallholders through generating sustainable income, minimizing risk of crop failure and providing a source of protein diet (Chemeda, 1997). In the study area, 112 (75.6 %) sample farmers used mono-cropping method of production, 16 (10.8 %) employ intercropping and while 20 (13.5 %) of them used both mono-cropping and intercropping in one production season in the same or different plots of land, simultaneously. During group discussion some respondents mentioned that due to farm land shortage and to minimize the risk of crop failure they employ intercropping. In the study area, haricot bean is mainly intercropped with the major crops such as; maize, sorghum, chat and coffee.

Table 9: Cropping systems practiced in the area.

Cropping systems	N	Percentage
Sole cropping	112	75.6
Intercropping	16	10.8
Both	20	13.5

Source: Survey data

Agronomic practices of haricot bean production in the area

Seed rate

Farmers in the study area were found to use both improved and local haricot bean varieties. There is a variation among the sample households in the amount of seed rate per unit area used. On average, the farmer used 10.3 kilogram per hectare of improved haricot bean variety with a minimum and maximum of 1 and 35 kilograms, respectively. Similarly, the mean seed rate of local variety used was 8.8 kilograms per hectare of which the minimum was 2 kg, while the maximum was 20 kg. The result of one-way ANOVA indicated the presence of significant mean difference in seeding rate applied between seed adoption categories (F= 2102.603, P=.000) at 1% significance level (Table11).

Fertilizer application

Fertilizer application is one of the most important practices that need to be adopted by haricot bean growers. Farmers in the study area used fertilizer for haricot bean production. The mean fertilizer rate applied for haricot bean production by sample producer households during the 2015 production year was 17.1 kilograms which ranges between 5 and 50 kilograms. Analysis of mean variance indicated that there was significant mean difference between adoption categories (F= 3946.251, P= 0.000) in relation to fertilizer application rate at 1 % probability level.

Table 10: Agronomic practices in the area

Agronomic practices	**N**	**Min**	**Max**	**Mean**	**F**	**p-value**
Seed rate of improved variety (kg/ha)	92	1	35	29.4	2102.603	0.000
Seed rate of local variety (kg/ha)	66	2	20	25.8		
Fertilizer applied (kg/ha)	92	5	50	48.8	3946.251	0.000

Source: Own computation

Improved varieties

A lot of efforts have been made by different organizations in developing, adapting and disseminating different types of improved varieties with appropriate agronomic practices to improve production and productivity of haricot bean. Among the released haricot bean varieties Awash-1 and Awash-melka were introduced to the farmers in the study area through a different stakeholders such as Mechara Agricultural Research Center, District Office of Agriculture, Melkassa Agricultural Research Center, Haramaya University and Chercher Oda-bultum Union. For the computation of adoption index (AI), area under improved variety of haricot bean to the total land under both improved and local haricot bean varieties was used.

Table 11: Improved Haricot bean varieties grown, number of production years and their source

Crop type	Variety	N	No of production years			Source of improved varieties
			Min	Max	Mean	
Haricot bean	Awash-1	70	1	15	4.08	Research centers, NGOs, neighboring farmers, District Office of Agriculture, Haramaya university, traders, CASCAPE, farmers cooperatives
	Awash-melka	22	1	10	3.23	

Source: Survey data

Institutional services in the study area

Agricultural extension is of paramount importance to introduce better agricultural practices and improved technologies to smallholder farmers ina country like Ethiopia where the traditional practices are dominating.

Extension visits will help to reinforce the message and enhance the accuracy of implementation of the technology packages (Gezahegn, 2008). More frequent DA visits, using different extension teaching methods like attending demonstrations and field day can help the farmers to adopt a new technology. If the farmers get better extension services, they are expected to adopt seed production technologies than others. Mechara Agricultural Research center along with other stakeholders has been carrying out different researches that increase the production and productivity of farmers in the study area.

The survey result showed that 63 (68.4%) of adopter farmers and 21 (37.5%) of non-adopter farmers have extension contact while 29 (31.5%) and 35 (62.5%) of adopter and non-adopter farmers have no extension contact during the cropping season, respectively. The study also revealed that 41 (44.6%) of adopter farmers and 7 (12.5%) of non-adopter farmers were trained regarding improved haricot bean varieties and its agronomic practices, while 51 (55.4%) of adopters and 49 (87.5%) of non-adopter farmers were not given any training during the cropping year. In general, out of the sample households only 32.4% of them were taken training related to improved haricot bean technology and about 67.6% of sample farmers have not received training.

Table 12: Frequency of institutional services by adoption category

Variable	Category	Type of institutional services					
		Extension contact		Training		Credit service	
		Yes	No	Yes	No	Yes	No
Adoption	Adopter	63	29	41	51	25	67
	Non-adopter	21	35	7	49	12	44
	$\chi 2$ test	30.879		21.878		16.721	
	p-value	0.000		0.513		0.830	

Source: Survey data

The chi-square result ($\chi 2$=30.879 and P=0.000) shows statistically significant difference between adoption categories with respect to farmers contact with extension agent. Lelisa, (2002.) and Mulugeta *et al.,* (2001) also reported similar result. The chi-square test result also shown that there is no significant difference among adopters and non-adopters with regard to training and access to credit (table 12).

Table 13: Summary of statistics of independent variables used in the model

Variables	Unit of measurement	Mean	N		Percentage	
			dummy=1	dummy=0	dummy=1	dummy=0
AGE	Years	36.51	-	-	-	-
EXPHBP	Years	12.04	-	-	-	-
TOTLH	Hectare	1.20	-	-	-	-
TLU	tropical livestock unit	2.22	-	-	-	-
SEX	Dummy	-	29	119	19.6	80.4
ECTNCON	Dummy	-	84	64	56.8	43.2
TRNNG	dummy	-	48	100	32.4	67.6
MSHIPSO	Dummy	-	120	28	81.1	18.9
CREDIT	dummy	-	37	111	25	75

Source: Survey data

Econometric Model Analysis Results

Factors affecting adoption of improved haricot bean technology

Before running the model analyses multicollinearity test was undertaken by using Variance Inflation Factor technique if multicollinearity exists among independent variables. The variance inflation factor (VIF) value for all variables entered in to the model shows that there was no severe multicollinearity problem. In addition, a Breusch-Pagan/Cook-Weisberg test was also undertaken for heteroskedasticity and the test result indicated that there was no problem of hetroskedasticity in the models.

The independent variables considered in this specific study were: age, sex, experience in improved haricot bean production, land holding size, livestock owned, membership in social organizations, credit, extension contact and training. From these 9 explanatory variables hypothesized to influence adoption of improved haricot bean technology, four(4) variables were found to significantly influence intensity of adoption of improved haricot bean production technology.

Table 14: Factors affecting adoption of improved haricot bean technology

Variables	**Coefficient**	**Std. error**	**t**	**p-value**
Constant	1.205863***	0.387492	3.11***	0.000
AGE	-0.0104**	0.005229	-1.99**	0.049
SEX	0.022124	0.107702	0.21	0.838
EXPHBP	-0.00434	0.006409	-0.68	0.500
TOTLH	0.053765	0.05504	0.98	0.330
TLU	0.033348*	0.022811	1.46*	0.100
MSHIPSO	0.35417***	0.121971	2.9***	0.001
CREDIT	-0.02631	0.088597	-0.3	0.767
EXTCON	0.19104**	0.09277	2.06**	0.041
TRNNG	-0.04396	0.107527	-0.41	0.683
Sigma (σ).4020053	.0333523			
Number of obs =148	Prob > chi^2 =0.000		Pseudo R^2 =0.1653	
LR chi^2 =36.47	Log likelihood = -92.061694			

Note: ***, ** and * implies significant at 0.01, 0.05, 0.1 level, respectively.

Source: Model output

Detailed discussion of some significant variables is stated as follows:

Age (AGE)

The finding of the study shows that age affected adoption of improved haricot bean technology of the smallholder farmers negatively and significantly at 5% significance level. This implies that younger farmers were more likely to adopt new technology than the older ones. This was probably because of their risk averting nature; older age farmers are more conservative than the younger ones' to adopt new improved agricultural technologies. In addition, Gezahegn (2008) said that, as farmer's age increases probability of adoption is expected to decrease. This result is in line with the findings of Hailu (2008) and Techane (2006).

Livestock (TLU)

It was hypothesized that livestock size is positively related to the adoption of agricultural technologies because it serves as proxy for wealth status. The result shows that livestock size has a significant and positive impact on adoption at 10% level of significance. This was probably that households with large livestock holding can have good access for more draft and can purchase improved agricultural inputs by selling their livestock. This result is in line with the findings of Chilot *et al* (1996), Asfaw *et al* (1997) and Habtemariam (2004).

Membership in social organizations (MSHIPSO)

The result of the study also shows membership in social organizations is one among the explanatory variables which affected adoption positively and it is significant at 1% level. This indicates that those farmers who actively participated in some social organizations as member or leader are more likely to adopt improved haricot bean technology. Additionally, being member of an association or cooperatives can influence decision of farmers to adopt new agricultural technologies. This was because, the membership and leadership in community organization assumes that farmers who have some position in rural kebeles and different cooperatives are more likely to be aware of new practices as they are easily exposed to information. This result agreed with the findings of Habtemariam (2004), Negash (2007) and Ernest (2015).

Extension contact (EXTNCON)

Result of the finding indicated that extension contact was positively and significantly related to adoption of improved haricot bean technology at 5% significance level. This was probably that contact with extension agent is the crucial means through which farmers get information about improved haricot bean technology and it agronomic practices. In this study, contact of farmers with extension agents was hypothesized to have positive relationship with adoption of haricotbean technology. The result of this study agreed with the findings of Tesfaye *et al*. (2001) and Yishak (2005).

Effect of change in significant explanatory variables on adoption: Marginal effect analysis

Table 15: Effects of change in significant explanatory variables

Variables	**Change in probability of adoption (dy/dx)**	**Change in intensity of adoption (dy/dx)**
AGE	-0.0080121	-0.0104001
TLU	0.0207555	0.033348
MSHIPSO	0.2723155	0.3541682
EXTNCON	0.1425215	0.1910426
Constant	0.6181346	1.205863

Source: Model output

The marginal effect analysis result illustrate that an increase in the age of a sample farmer by 1 year decreases the probability and intensity of adoption of improved haricot bean technology by 0.8 and 1.04 %, respectively. This implies that younger farmers were more likely to adopt new technology than the older ones. Therefore, promoting improved haricot bean technologies to younger farmers is good to speed up its adoption.

As the analysis of marginal effect indicates an increase in livestock ownership increases probability of adoption improved haricot bean grower farmers by 2.1 % and intensity of adoption of improved haricot bean technology by 3.3 %.

The marginal effect analysis also shows that the estimated increase in the probability and intensity of adoption of improved haricot bean technology resulting from actively participating in social organizations; such as *'ikub', 'idir'*, primary agricultural cooperatives, etc, is 27.2 % and 35.4 %, respectively. This is because farmers which are members of social organizations such as; primary agricultural cooperatives, *'idir', 'ikub'* easily get information and credit access to buy improved technology.

An increase in extension contact increases probability and intensity of adoption of improved haricot bean technology package by 14.2% and 19.1%, respectively. This indicates that strengthening extension supports is important to improve adoption of improved haricot bean technology.

Conclusion and Recommendations

This study was conducted in order to identify factors influencing adoption and intensity of use of haricot bean production technology package by farmers in the area. The study tried to investigate the status of adoption and factors influencing farmers' adoption behavior. Improved haricot bean production package considered to calculate adoption index in this study includes use of improved variety, seeding rate and fertilizer rate. Adoption of these improved technology packages is very important to improve production and productivity of haricot bean.

Adoption index values for the sample households in this study ranges from 0 to 1, zero (0) showing non adoption and one (1) showing full adoption of improved haricot bean technology. Out of the total sample households the share of non-adopters, low adopters, medium adopters and high adopters were 56 (37.8%), 3 (2%), 68 (45.9%), 21 (14.2%), respectively. As observed from the survey result there was variation among the improved haricot bean grower households in their level of adoption.

Tobit model results showed that livestock owned, extension contact, social participation andage of the household head are significant determinants of probability and intensity of adoption of improved haricot bean technology. Furthermore, the results revealed that age of the household head influence adoption of improved haricot bean technology significantly and negatively in the study area. On the other hand, the result also showed that extension contact, membership in social organizations and livestock ownership are important factors that significantly and positively affect adoption of improved haricot bean technology of the smallholder farmers in the area.

The study puts the following recommendations:

- The study indicated that younger farmers were more likely to adopt new technology than the older ones in the study area. Older farmers are somehow resistant as compared to younger ones to adopt improved technology because of their risk aversive nature. Therefore, attention has to be given to younger household heads to increase their access to improved haricot bean technology, and improve their knowledge and capacity in improved haricot bean production activities by delivering training and agricultural inputs to enhance the adoption of improved haricot bean varieties in study area.

- Non-adoption and variation in level of adoption among households was found to be influenced among other things by livestock ownership of household head. A household with large livestock holding can obtain more cash income from the sales of animal products. This income in turn helps smallholder farmers to purchase farm inputs. Strengthening the existing livestock production system through providing improved health services, better livestock feed (forage), targeted credit and adopting agro-ecologically based high-yielding breeds and disseminating artificial insemination in the areas improve intensity of adoption of improved haricot bean varieties.

- The study indicates that those farmers who actively participated in some social organizations as member or leader are more likely to adopt improved haricot bean technology. Additionally, being member of an association or cooperatives can influence decision of farmers to adopt new agricultural technologies. Therefore, farmer's participation should have to be improved through intensive awareness creation regarding the benefits of rural social associations; such as primary agricultural cooperatives, ikub and idir.

- Improved haricot bean production involves the use of different practices which require knowledge and skill of application and management. Extension service on improved haricot bean production was found to have a strong relation with adoption of improved haricot bean production package as it enhances ability to acquire and use information required for production. Emphasis has to be given towards strengthening farmers' knowledge on improved haricot bean production by arranging training on agronomic practices (such as fertilizer application, land preparation, sowing, spacing, weeding, and postharvest handling), field visit and demonstration. Therefore, extension service provision has to be strengthened so as to improve farmers' access to information and extension contact.

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Assessment of the Role of Agricultural Cooperatives in Input Output Market in Boke, Anchar and Darolebu Districts of West Hararghe Zone, Oromia Region, Ethiopia

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Abstract
The study was conducted in three districts where agricultural cooperatives have been well promoted in West Hararghe zone to identify role of primary agricultural Cooperatives and factors affecting its role in the study area. Structured interview schedule were used to collect data from 180 cooperative members and non-members selected randomly from six agricultural cooperatives and its surrounding. Focus group discussions were also conducted to collect qualitative data from respondents. In this study, the statistical tools like descriptive statistics such as mean, frequency distribution and percentage, SWOT analysis and an index score was used to rank major constraints. Out of interviewed respondents, 66.7% were member of cooperative while 33.3% were non-members of the cooperatives. Most primary cooperative mainly focuses on the activities like provision of fertilizer (DAP, UREA and NPS), consumable food items (sugar and cooking oil) and rarely involved in improved seed distributions. Lack market interest, climate change, lack of market information, insufficient capital and low price of the marketable commodity were major constraints found in agricultural commodities in study area. Strengthening training, improve their capital, services and transparency, increasing members participation, sharing dividend to the members and annual auditing their status were major recommendation delivered for responsible bodies by the study.

Key words: agricultural cooperative, role, inputs, outputs

Introduction

The cooperative movement began in Europe in the nineteenth century, primarily in England and France. The industrial revolution and the increasing mechanization of the economy transformed society and threatened the livelihoods of many workers (SOEMCO, 2016). According to ILO (2007), over 100 million jobs have been generated by cooperative societies around the world.

Today the co-operative principles are successfully applied throughout the world to a vast array of co-operative enterprises, farming co-operatives, fishing co-operatives, credit unions, retail cooperatives, manufacturing co-operatives, even co-operatives providing internet access services (SOEMCO, 2016).In developing countries like Ethiopia, cooperatives have been devoted an important role as tool of economic and social transformation. (Kanagaraj and Mosisa, 2015).

Traditional forms of cooperation involved community members voluntarily pooling financial resources through iqub, idir and Jigie -Wonfel are among others(Bezabih, 2009). Debo, Jigge, Wonfel, Edir, Ekube, Senbete etc. are some of the cultural Cooperatives which were the bases of Ethiopian modern types of Cooperatives (Bedru, 2017). However, the formation of modern cooperative societies was started soon after the Italian invasion in 1960s that a cooperative legally enacted. During the reign of Haile Selassie, the cooperative legislation No241/1966 has proclaimed and about 154 different types of cooperatives were organized. During the Derg regime, cooperatives that organized earlier deliberated unnecessary and discarded. The newly organized cooperatives under the regime have purposefully made instruments of political power. Their organizational procedures not based on internationally accepted cooperative principles. New era in cooperative development was then started in 1998 when new co-operative legislation No 147/1998 was enacted (FCA, 2009).

Establishment and current status of primary cooperativePurpose at establishment and its achievement

According to Ethiopian Proclamation NO 147/1998, cooperative society to be established in objectives of to improve the living standards of members by reducing production and service costs by providing input or service at a minimum cost or by finding a better price to their products or services. But, the study result on figure 3 revealed that currently most of primary cooperative mainly focuses on activities like providing fertilizers (DAP, UREA and NPS) and consumable food items (sugar and cooking oil). Some of the primary cooperatives were supplying improved seed of maize, *teff*, haricot bean and hot pepper crops in rare case and non-continuous way. As Ngwamba (2016),membership participation, availability of inputs such as capital, land and skilled labor and less stiffened state policy and regulative frameworks can contribute to the success or failures in cooperative operations. Again as Mahazril *et. al* (2012) participation from members' are importance for the cooperative movement.

According to 2nd Growth and Transformation Plan (GTP-II), cooperatives are playing their role in economic growth by supplying and providing input, credit and services to its members, by accessing market for its products as well as supplying consumable commodities to stabilize the current unfair market. Moreover, it creates job opportunities for those jobless citizens through value addition.

According to Cooperative Societies Proclamation No. 147/1998 of Ethiopia, establishing cooperative societies which are formed by individuals on voluntary basis and who have similar needs for creating savings and mutual assistance among themselves by pooling their resources, knowledge and property to actively participate in the free market economic system. According to

FCA (2015) annual report indicates, there are 56,355 primary and secondary cooperatives, both agricultural and non-agricultural sector, of which, 56,044 are primary and 311 secondary cooperatives. Throughout the country, the total member of primary cooperative reached to 9,393,201 of which, 7,177,525 are male and 2,215,678 are female members and holding a total capital of 11.3 billion birr.

A large number of cooperatives in Ethiopia participate in the marketing of agricultural inputs and produce (Bernard et.al, 2007 cited in Bantyergu, 2015).About 90,000 people in the agricultural sector of Ethiopia are estimated to generate their livelihood from their cooperatives (Adeyemo and Bamire, 2005).The existence of cooperatives in the agricultural sector is induced by a number of biologically related conditions that imply greater uncertainty. Driven by this economic force for survival, by joining together farmers tend to achieve a greater bargaining strength (Chloupková, 2002).Therefore, to regulate the inflation and price fluctuation market problems, establishment of cooperative is an indispensable tool(Kanagaraj and Mosisa, 2015).

As a result, several agricultural cooperatives promotion office/bureaus have been established across the country as an integral part of farming communities not only to benefit members, but also benefit rural communities. Furthermore, in Oromia regional state, there are 18,431 primary and 120 secondary cooperatives found (FCA, 2014). And in the study area, Daro Lebu, Boke and Anchar districts which is found in west Hararghe zone of Oromia region, there are 113 cooperatives and out of these, 84 are multipurpose agricultural cooperatives, 22 are saving and credit cooperatives and7 are consumers cooperatives(WHZCPO,2015).

West Hararghe zonehas a numbers of agricultural cooperatives that hoped to benefit their community in respect of fair prices, high quality products and in reliable services. Besides these, in West Hararghe zone agricultural cooperatives were used as a place of agricultural products marketing for farmers. This study was conducted with the objectives of assessing the role of cooperatives in agricultural input-output marketing, analyzing members' participation and identifying the constraints of cooperatives.

Methodology

Description of Study Area

This study was carried out for one year in Daro Lebu, Boke and Ancar districts of west Hararghe zone of Oromia national regional state.

Daro Lebu is one of the districts found under West Hararghe Zone in which cooperatives are well established and serve functionally the farmers. The capital town of the district Mechara is found at about 434 km South East of Addis Ababa. The district is situated between 7°52'10" and 8°42'30" N and 4°023'57" and 41°9'14" E at 08°35'589" North and 40°19'114" East (Abduselam, 2011). The district is characterized mostly by flat and undulating land features with altitude ranging from 1350 to 2450 m.a.s.l. Ambient temperature of the district ranges from 14 to 26°C, with average of 16°C and average annual rainfall of 963 mm/year. The pattern of rain fall is bimodal and its distribution is mostly uneven. Generally, there are two rainy seasons: the short rainy season 'Belg' lasts from midFebruary to April whereas the long rainy season *'kiremt'* is from June to September. The rainfall is erratic; onset is unpredictable, its distribution and amount are also quite irregular (Asfaw et al., 2016). Consequently, most kebeles frequently face shortage of rain; hence moisture stress is one of major production constraints in the district (DLWADO, 2016).

Boke district is anotherdistrictin which cooperatives well established thanother districts in West Hararghe zone of Oromia National Regional State. Itfound at distance of 70 KMto the South West direction of the zone town.It bordered by district of Oda Bultum in North East, Daro Lebu in South West, Habro in North and Burka Dimtu in Southhaving an area of 123,188.06 hectares. Boke Tiko town is its administrative seat. The district has a total population of134,687 of whom 66,671 were males and 68,016 were females among 23,914 are households whereas 18,134 are males and 5,780 are females' households. The topography of the district is mainly midland (80%) while the rest is lowland(20%) zones. The districtreceive annual rain fall minimum of 600mm and maximum of 800mm per year having bimodal rainfall in Summer during mid of June to mid of September and in *Belg*February up to April. Its altitude stretches between 1100 and 1980 m.a.s.al. The major economic activity of the district was depends on agricultural activity among production of Maize, Sorghum and *Teff* for food; Coffee and Chat for cash crops.There was 21 multipurpose Cooperatives which targeted on marketing of exportable crops specially coffee through buying from farmers and supply for Chercher Oda Bultum Unionto increase farmers productivity and profitability(BANRDO, 2016).

Anchardistrict is one major district in West Hararghe zone, in which cooperatives are well established and serve functionally the farmers. It found at distance of 131KM to west direction from Chiro, zone capital town.It bordered by district of Habro & Guba koricha in East, Mieso in North East, Daro Lebu in South east, Fentale in west, Aseko & Guba Gololcha in South and and Afar regionin North having total population of 113,763 of whom 58,881 were males and 54,882 were females.Celelaqa town is its administrative seat.The topography of the district is and mainly lowland (63%) while the rest is highland (13% and midland (24%).The district receive annual rain fall minimum of 700and maximum of 1200mm per year having bimodal rainfall in Belgi during January to march and Summer during June to August.Its altitude stretches between 900 and 3065 metre above sea leveland situated between$8^0$44'1.221" Nlatitude and $40^0$12'8.204"E longitude. The major economic activity of the district depends on mixed farming (Agriculture & trade) activity among the crops produced haricot bean, sorghum & maize are major.There was 24 multipurpose Cooperatives which targeted on marketing of exportable crops specially haricot bean through buying from farmers and supply for Chercher Oda Bultum Union to increase farmers productivity and profitability(AANRDO, 2016).

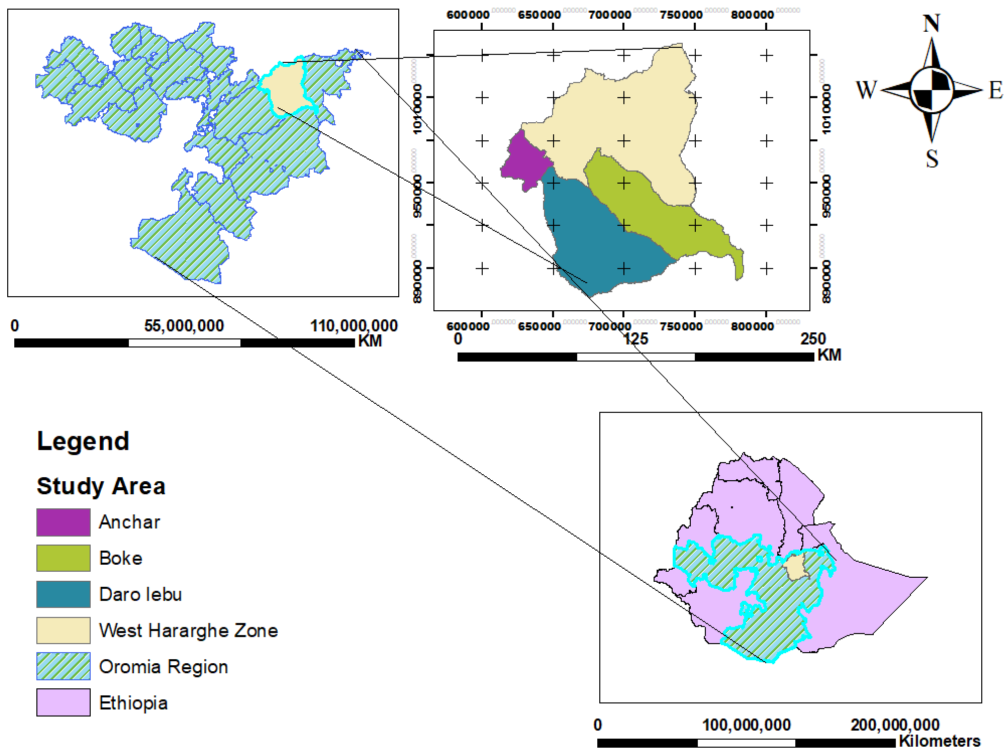

Figure 2: Political map of the study area.
Source: Own computation from GIS data, 2018

Sampling Technique

The study employed multistage sampling techniques in selecting representative households. In first stage, districts were selected purposively in collaboration with zonal Cooperative office based on the availability of large number of cooperatives, long year of establishment and model in cooperative. Accordingly, Daro Lebu, Boke and Anchar districts were selected out of 15 districts of West Hararghe Zone. In second stage, two kebeles from each district (Miceta and Kurfa Wachu from Daro Lebu district; Meyu and Mildab kebeles from Boke district; Xixiya Daro and Lefto Goba kebeles from Anchar district) were selected randomly. From those six (6) kebeles, 6 primary agricultural cooperatives were selected based on their long (age) year of establishment, having large number of members and model cooperative in the respective districts. Finally, a total of 180 sample households were selected using simple random sampling method by considering probability proportional to population size. The simplified formula provided by Yamane, (1967) was employed to determine the required sample size with degree of variability = 0.5 and level of precision (e) = 8%.

$$n = \frac{N}{1 + N(e^2)} \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

Where *n* is the sample size, N is the population size and e is the level of precision.

Table 1. Cooperatives sampled and sample size taken.

District	Kebeles	Name cooperatives	Sample size kebeles	Sample size per district
Daro Lebu	Miceta	Mara Gudis	34	65
	Kurfa Wacu	Birbirsa	31	
Boke	Meyu	Jirenya umata	30	60
	Mildab	Hunde Gudina	30	
Anchar	Xixiya Daro	Daro Gora	31	55
	Lefto Goba	Milkessa lafto	24	
Total				**180**

Types of data and Method of data collection

In this study, both primary and secondary data were used. Primary data was collected from the selected sample representative households of members and non-members of cooperatives through direct interview schedule by using semi-structured questionnaire. Besides, focus group discussions were conducted to collect qualitative data at each kebeles. The secondary data also collected from published and unpublished documents of zonal and district cooperatives promotion offices to support the primary data. A total of five enumerators were involved to conduct the survey. These enumerators were trained regarding the objectives of the study and particularly on the detailed contents of the questionnaire.

Method of Data Analysis

In this study SPSS software was employed to manage data and analyze primary collected data, respectively. Descriptive statistics such as mean, frequency distribution and percentage were used to describe the basic features of households. An index score is a way of compiling score of major constraints from sampled cooperative and provide summaries responses for multiple rank-ordered on a certain belief, attitude, or experience. So, it was calculated and used to provide overall ranking of major constraints of multipurpose cooperative in input output marketing in the study area. In addition, the SWOT analysis was conducted to identify major strengths, weakness, opportunities and threat found in multipurpose cooperatives in the study area.

Results and discussions

Socio-Economic Characteristics of Households

The socio-demographic characteristics entail the fundamental background of households. Education is a good opportunity for the cooperatives to inculcate and train the members to produce better leaders for betterment of its marketing role (Tewodros, 2017).From the sample households, 45 (25%) of the respondents were illiterate, 25 (13.9%) of them could read and write, 110 (61.1%) attended formal education (Table 1). This indicates the majority of the respondent could attain formal education. This is also important as household members' education may contribute in different ways on the decision to enter other income generating activities.

The study also indicates that respondents were categorized on the basis of marital status into four categories namely, single, married, divorced and widowed. From the sample respondents, 92.8 % of them were married; While 1.1, 5.6 and 0.6% were single, divorced and widowed respectively (table 1). This indicates that majority of the respondents were married and they could be more stable.

Table 2 .Descriptive analysis of the respondents

Characteristics	**Variable**	**N**	**%**
Sex of the respondent	Female	21	11.7
	Male	159	88.3
	Total	180	100
Educational level of respondent	Illiterate	45	25
	Read and write	25	13.9
	Formal education	110	61.1
	Total	180	100
Marital status of the respondent	Single	2	1.1
	Married	167	92.8
	Divorced	1	0.6
	Widowed	10	5.6
	Total	180	100

Source: Survey result

The majority of the respondents were male 159 (88.3%), while 21 (11.7%) were female. This may be due to male and female membership number disparity in cooperatives. Numbers of male are greater than number of female in all selected agricultural cooperatives (Tewodros, 2017). The gender disparity is caused by the active participation of female in collective action than men as a result of social protection (Mubirigi, 2016).

Resource Endowment

The age distribution of the sampled respondents ranges from 20 to 87 with the average of 38.48 years. It indicates that the majority of respondents were in the range of economically productive age (Jima *et. al*, 2016).

Survey result showed total family size of the respondents was 6.68. The average land owned in hectares of the respondents during the study was 1.09 hectares (Table 3). With standard deviation of 0.82 and with the minimum and maximum values of 0.13ha and 6 ha, respectively; while average cultivated land in hectares is 1.17. Of this cultivated land, they allocated 0.24 hectares for Khat production on average.

Table 3. Family size and land holding

Characteristics	**N**	**Minimum**	**Maximum**	**Mean**	**Std. Deviation**
Age	180	20	87	38.48	10.50
Total family size	180	1	16	6.68	2.94
Total land owned in hectares	170	0.13	6	1.09	0.82
Total cultivated land in hectares	177	0.06	10	1.17	0.99
Land allocated for Khat in hectares	100	0.03	1	0.24	0.19

Source: Survey result

Participation in different income activities

Table 4. Participants of off/nonfarm activities of respondents

Participants and nonparticipant of off/nonfarm activities		**N**	**%**
Participants of off/nonfarm activities	Petty trade	37	20.6
	Daily laborer	3	1.7
	Hand craft	7	3.9
	Others	17	9.5
Non participants of off/nonfarm activities		116	64.4

Source: Survey result

The major livelihood income sources of sample respondents are the farm activity (crop production) and off/non-farm activities. Accordingly, about 64.4% of sample respondents were not participate in off/nonfarm activities; while 35.6% engaged in off/nonfarm activities. Out of participants' in the off/non-farm activities, 20.6% in petty trading, 3.9% in hand craft, 1.7% daily laborers and other the rest for additional income generation (Table 4.).

Table 5.Distance of respondents from market places

Characteristics	N	Minimum	Maximum	Mean	Std. Deviation
Time taken to cooperative from Home (Hour)	175	0.02	2	0.33	0.29
Time taken to village market from home (Hours)	149	0.02	2	0.46	0.42
Time taken to district market from home taken in hours	175	0.02	8	1.48	1.67

Source: Survey result

Distance from the cooperative and age of the cooperative were among factors that determine the trust and commitment to the cooperative (Getaw, 2015).

Agricultural Cooperative Membership

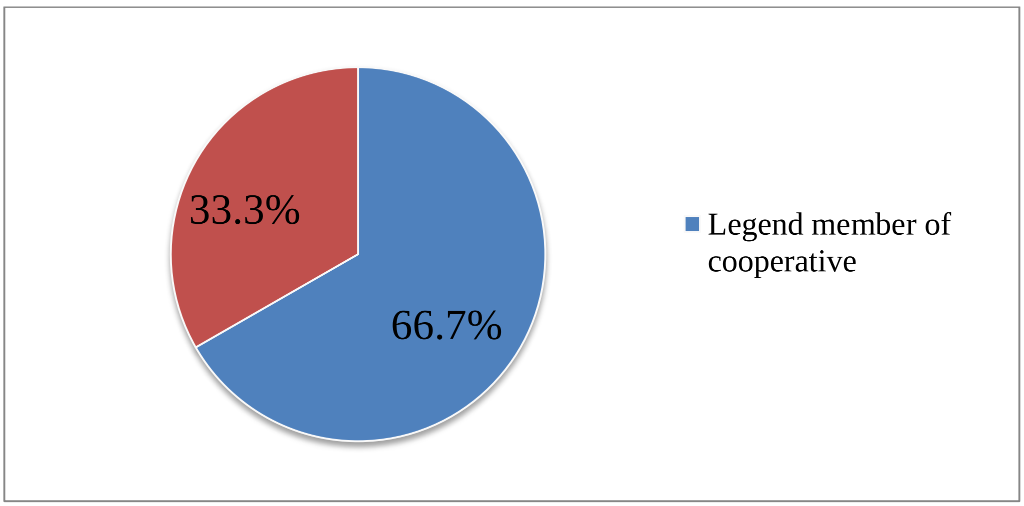

Figure 3.Membership of respondents for cooperative

Among respondents interviewed, 66.7% were members of cooperative while 33.3% were non-member in the study area. The membership of the respondents ranges from one year to eleven years with an in average of 4.07 years. According to the International Cooperative Alliance (2009), membership for cooperative is open and voluntary where openness of cooperative for membership makes increment of cooperative members.

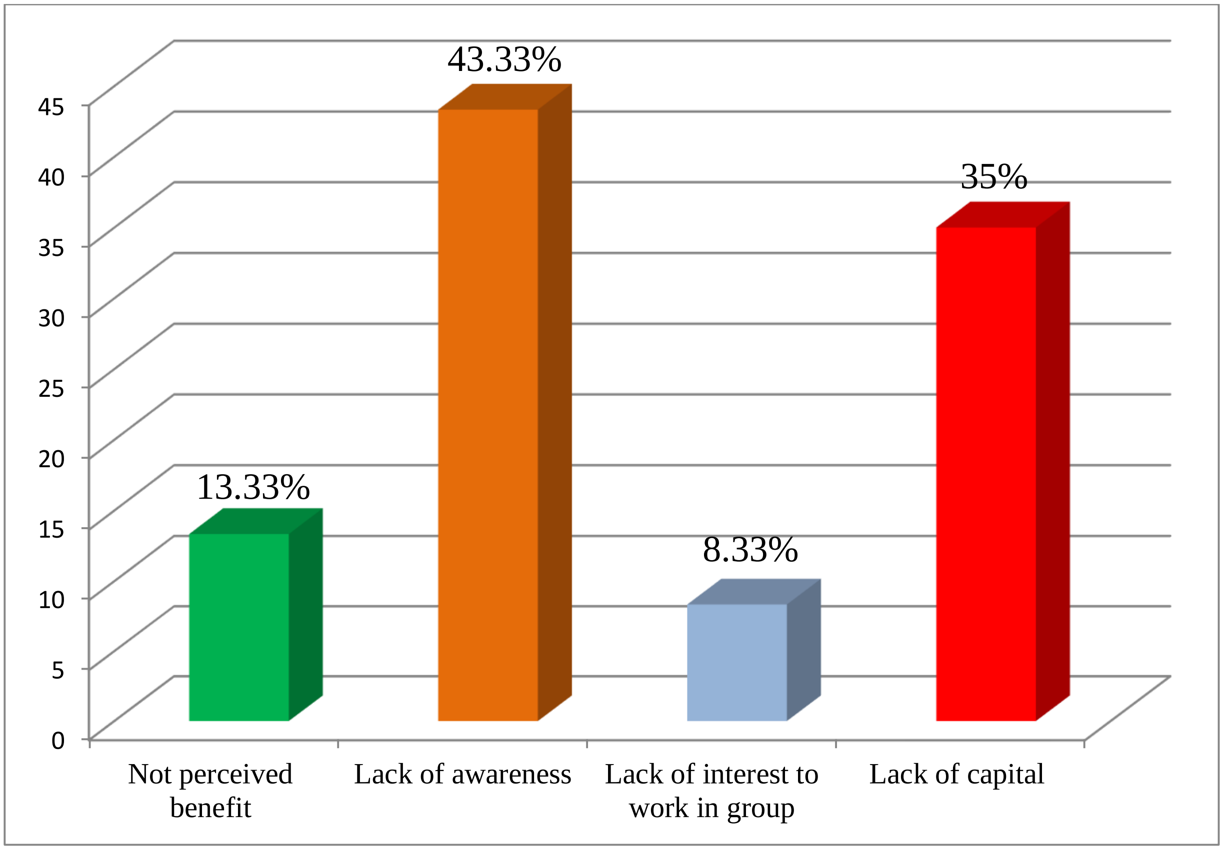

Figure 4. Reason for non-membership for cooperative

The reasons behind for non-membership of cooperatives were lack of enough information on importance of cooperative (43.33%), lack of capital to buy initial share (35%) and believed as cooperative not perceived benefit and lack of interest to join a cooperative (13.33%).According to Banishree and Kumar (2006) and Mahazril *et. al.* (2012) that people are not well informed about the objectives of the movement to join the cooperatives.

Table 6. Current status of cooperative in the study area

Name cooperatives	**Establishment year (E.C)**	**Initial capital (birr)**	**Current capital in 2008E.C year (birr)**	**Initial Members**			**Current members**		
				M	F	T	M	F	T
Mara Gudis	1997	5,700	407,675	54	3	57	108	19	127
Birbirsa	2006	110,000	1,345,000	32	1	33	58	28	86
Jirenya umata	2005	92,000	180,000	32	4	37	163	13	176
Hunde Gudina	1997	7,000	163,000	40	4	44	268	8	276
Daro Gora	1997	1,200	1,509,479.89	12	0	12	116	57	173
Milkessa lafto	2006	21,000	42,905	66	7	73	119	16	135

The field data indicates that the number of members in Milkesa Lafto primary cooperative has increased from 73 to 135 within 3 years; Jiregna Umeta from 36 to 176 within 4 years; Birbirsa from 33 to 86 from within 3 years; Mara Gudis from 57 to 127 within 11 years; Hunde Gudina from 44 to 276 within 11 years and Daro Gora from 12 to 173 in 11 years (Figure 1). As Ethiopian Cooperative Societies Proclamation No. 147/1998, any individual may become a member of a society where he has attained the age of 14, able to pay the share capital and willing to implement his obligation and observe the objectives and by-laws of the society. Willingness and openness of cooperative membership can ensure that every decision taken by the cooperative in relation to the operations communicated efficiently yielding awareness in all cooperative members (DTI, 2012).

The study confirms that the capital of all cooperatives has been increasing since their establishment. From the survey result, Daro Gora primary cooperative was established by 1200 birr currently reach 1,509,479.89 birr within 11 years; Hunde Gudina cooperative increased their capital from 7,000 birr to 163,000 birr within 3 years. Similarly, Mara Gudis cooperative also improve their capital from 5,700 birr to 407,675 birr within 3 years; Birbirsa cooperative improve their capital from 110,000 birr to 1,345,000 birr within 11 years. And also, Jiregna Umeta cooperative increases their capital from 92,000 birr to 180,000 birr within 3 years and Milkesa Lafto cooperative improve their capital from 21,000 birr to 42,905 birr within 3 years in line with study of Mahazril *et al*. (2012), cooperatives‟ strategic planning and participation from their members are the identified factors that contribute to their overall achievement and performance of cooperatives. According to Wanyama *et al*. (2008), cooperatives have advantages of identifying economic opportunities for the poor, empowering the disadvantaged to defend their interests and providing security to the poor by allowing them to convert individual risks into collective risks.

Output marketing

Table 7. Commodity purchased by cooperative

	Variable	**N**	**%age**
Selling status to the cooperatives	Sold	98	54.4
	Not- sold	82	45.6
Types of product sold	Coffee	61	62.25
	Haricot bean	35	35.71
	Other crops	1	1.02
	Oxen	1	1.02
Other distination of their product	Village traders	38	79.17
	Consumers	2	4.17
	District market	8	16.66

Selling outputs to cooperative offers better price than other market participant agents (Getaw, 2015). In the area, the majority of respondents were sold their products to cooperatives due to cooperatives are relative higher price, due to proximity, no price cheating and as a fevor to strengthening cooperatives (Figure 4).

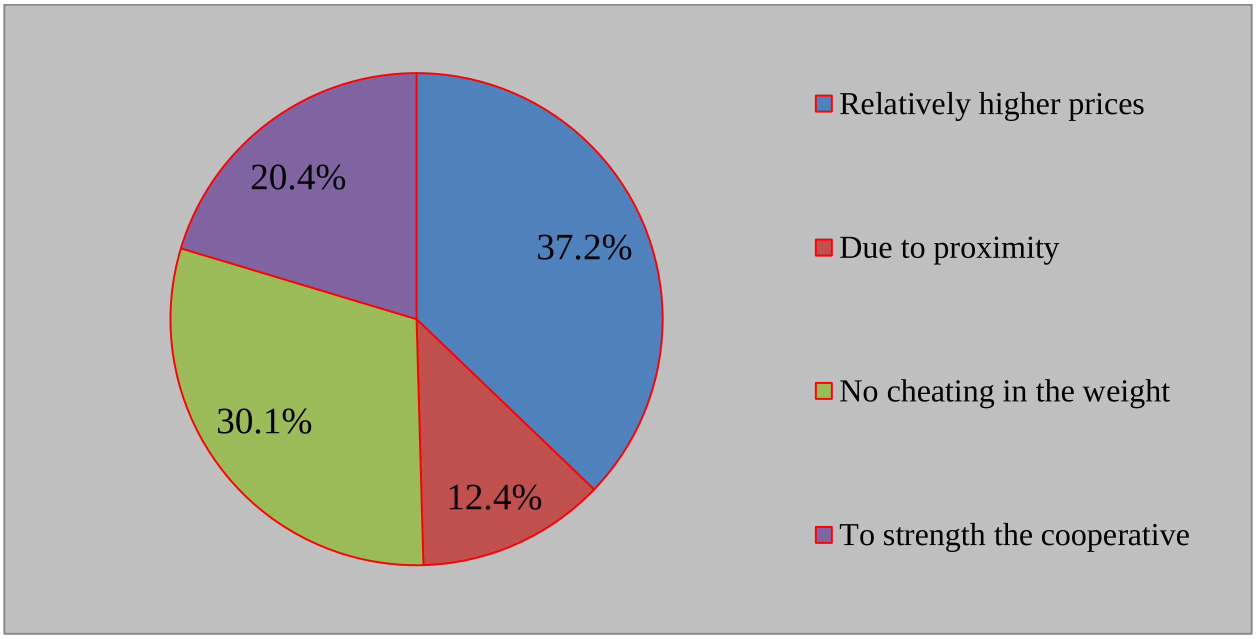

Figure 4. Reason of households sold their products to cooperative in the area.

The remaining respondents were not sold to cooperative but selling to other body like village traders, consumers and district market. These are due to the following reason as indicated figure below (Figure 5).

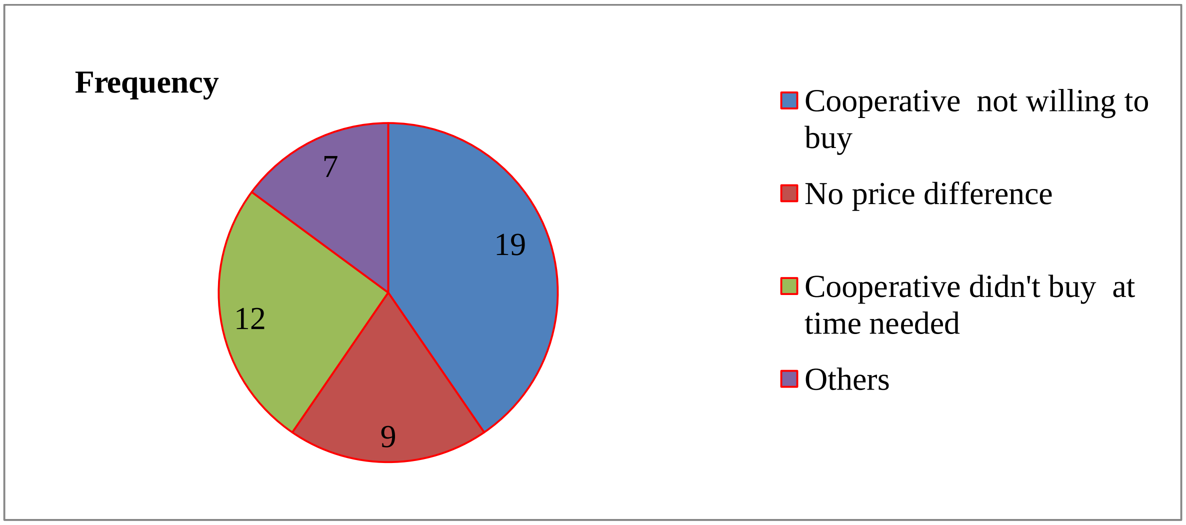

Figure 5. Reasons of Households those sold to other market agents rather than cooperatives.

Institutional services of the cooperatives

In the study area, training was mainly given by the district cooperative promotion office on uses of cooperative, cooperatives management and etc. However, only 32.40% had received training among the sampled respondents. In contrast, 67.60% had not received training due to training provider mostly focused cooperatives committees and some members. In addition, cooperative management committee, Haramaya University and NGOs were also providing training to some extent for the farmers on the uses and management of cooperative and quality of product especially on quality of coffee production. However, training was not sufficient for the member to increase their confidence on their cooperative and to increase the number of members. Other study indicated that educating members and public about the use of cooperatives were insufficiently articulated (Mesganaw, 2015).

Table 8. Training given on the uses of cooperative

	Variable	**N**	**%**
Access to training	Trained	58	32.40
	Non- trained	121	67.60
Training providers	Cooperative management committee	25	43.10
	District cooperative office	29	50.00
	NGOs	1	1.72
	Haramaya university and others	2	3.45
Issues of training	Uses of cooperative	52	91.23
	Cooperative management	1	1.75
	Coffee quality	4	7.02

Source: Survey result

Credit services

The majority (75%) of the interviewed households were access to credit services whereas only 25% of the respondents were access credit. The amount of credit in the form of cash ranges from 100 to 10,000 birr whereas other access to credit in the form of fertilizer, maize, wheat and seed from local traders and relatives.

Table 9. Access to credit service

	Variable	**N**	**%**
Access to credit service	Yes	45	25
	No	135	75
Forms of credit	In cash	19	42
	In kind	26	58
Sources of credit service	WALQO	21	46.7
	Local traders and relatives	24	53.3

Source: Survey result

SWOT Analysis

The government cooperative promotion structure had crucial role in success of primary cooperatives through technical supports and regulates the activities of those cooperatives (auditing, inspection and giving legal service). During the FGD, the key-informants were identified the strengths, weakness, opportunity and threats of the cooperatives in their area.

Table 10. SWOT analysis of primary multipurpose cooperative in the study area.

Strength	**Weakness**
Existence of strong linkage with union	Lack of sharing of dividend for the members
Payments of higher fair price	Poor awareness creation
Supplying of basic utility such as food oil and sugar	Lack of auditing all primary cooperative annually
Commitment of the members	Poor commitments of some committees
Increment of members participation	poor discussion with members of the cooperatives
Strong unity among the farmers	Poor access to market information
Ownership of better conflict resolution mechanisms	Poor gender inequality in the cooperatives
Existence of monitoring and evaluation practices	Only focusing on specific crop i.e. maize/coffee/haricot bean
Opportunity	Inability to repay loan
Attention of the government is good on the cooperatives	Lack of market access and educated man power
Increment of number of member and community participation in cooperative(by selling output)	**Threat**
Increment of the communities positive attitude toward importance of cooperative(Opportunity to increase members)	Climate change
Linkage being created between primary cooperative with business owners	Frequent fluctuation of market price
Road accessibility	Traders interference through lowering commodity prices (maize)
Promise of the government to employ cooperative expert for each cooperative	Increment of some commodity price like haricot bean
	Unsustainable supply of commodity (food oil)

Source: Survey result

Major constraints of cooperatives in agricultural input output

In the study area, the constraints in agricultural input output were identified and prioritized by farmers in order of their importance. The survey result revealed that lack of market access is the major constraint of cooperatives followed by climate change on agriculture, lack of market information and insufficiency of budget/capital with an index value of 0.1240, 0.1055, and 0.1029, respectively (Table 11).

Table 11.Rank of major constraints of cooperatives in agricultural input output marketing in the study area.

No	Constraints	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5	Rank 6	Rank 7	Rank 8	Rank 9	Rank 10	Rank 11	Index score	Rank
1	Lack of market access	33.33	16.67	16.67	*	*	*	16.67	16.67	*	*	*	0.1319	1
2	Climate change	16.67	*	16.67	33.33	16.67	*	*	16.67	*	*	*	0.1240	2
3	Lack of market information	16.67	*	*	*	16.67	50	*	16.67	*	*	*	0.1055	3
4	Insufficiency of budget/capital	*	16.67	16.67	*	16.67	16.67	16.67	*	*	16.67	*	0.1029	4
5	Low price of commodity	*	*	33.33	16.67	*	*	16.67	16.67	16.67	*	*	0.1003	5
6	Lack of transport	*	33.33	*	*	16.67	*	*	16.67	16.67	*	*	0.0897	6
7	Lack of storage	*	16.67	16.67	16.67	*	*	16.67	*	*	*	*	0.0844	7
8	Lack of educated member	16.67	16.67	*	*	*	16.67	16.67	*	*	*	*	0.0844	7
9	Packing problem	*	*	*	*	33.33	16.67	16.67	*	*	33.33	*	0.0765	9
10	Lack of office	16.67	*	*	16.67	*	*	*	*	16.67	*	16.67	0.0607	10

11	Lack of transparency and accountability	*	*	*	16.67	*	*	*	16.67	16.67	*	*	0.0396	11

Source: survey result

Notice: *Index score for particular constraints = sum of [11for Rank1+ 10for Rank2+ 9 for Rank3+ 8 for Rank4 + 7 for Rank5+ 6 for Rank6 +5 for Rank7+ 4 for Rank8+ 3 for Rank9+ 2 for Rank10 + 1 for Rank11] divided by sum of [11for Rank1+ 10for Rank2+9 for Rank3 + 8 for Rank4+ 7 for Rank5+ 6 for Rank45+ 5 for Rank7 + 4 for Rank8+ 3 for Rank9 + 2 for Rank10 + 1 for Rank11] for all for all constraints*.

However, low price of commodity, lack of transport, lack of storage, lack of educated member, packing problem, lack of office and lack of transparency and accountability are among listed constraints of agricultural cooperative in the study area.

Conclusion and recommendatiions

Conclusions

This study was conducted with the objectives of analyzing the functions of cooperatives in agricultural input output marketing through evaluating their performances, analyzing members' participation and identifying the constraints of cooperatives in west Hararghe zone, Oromia, Ethiopia. The study used primary and secondary data generated through scheduled interview and focus group discussion. The study provided a clear framework about the operations of agricultural cooperatives with the study area. Agricultural cooperatives participants are involved in farming businesses due to access to affordable and quality supplies such as food items and fertilizers.

However, currently most primary of the cooperatives were mainly focused on provision of fertilizer, sugar and cooking oil. However, they lag behind to collect members' products during harvesting season with fair price. However, lack of market access, climate change, and lack of market information and insufficiency of budget/capital were the major factors affecting the performance of the cooperatives.

Recommendations

Depending on the results of the finding, the following recommendation has been given to improve multipurpose agricultural cooperative and thereby performance of cooperative in the study area.

- Strengthening the skill of managements and members of the cooperatives through training and employment of skilled man-power. Training should be given for the cooperative member to improve members' participation and decision-making abilities on cooperative issues, its management, and their responsibility.

- Most of primary cooperatives face shortage of capital to become competent with local traders in markets.
- Majority of primary cooperatives were lack of transparency between members and committees. Cooperative committees should enhance transparency with the members through reporting from time to time for the members. In addition, auditing on time should be carrying out to identify the progress direction of the cooperative and dividend should share for the members to enhance transparency and increase members' participation.

- Mostly services of cooperatives were limited to only the supplying of some commodities (fertilizers, food oil and sugar). Cooperatives should go further than this through distributing improved seeds, buying farmers' crops products (outputs) from farmers, creating job opportunities for youth and delivering credit services for the farmers in the area.

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Milk Value chain Analysis in Borana Zone, Southern Oromia, Ethiopia

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Abstract

The pastoral communities of the Borana lowlands are predominantly based there live on livestock and livestock products where dairy product share a tiger portion as a dairy cash source. This study was undertaken to evaluate market performance, problems and opportunities in milk value chain in Borana zone. To address the target, the primary data was collected from 125 and 20 sample of households and traders were selected randomly along the milk value chain. The study found that more than 50% of the gross marketing margin is shared among other marketing actors whereas less than <50% gross marketing margin goes to the producers. However, the larger cost of marketing is high at production level and become decrease as the market moves to the point of retailers. Though the producers are expected to harvest the tiger share of the net marketing margin, the study found that other actors' harvests more margin than producers do. On the other hand, the milk value chain is dominated by informal traditional business actors which reduces the efficiency of milk value chain performance. This study thus recommends that integrated interventions is an important to enhance the milk value chain from the current traditional practices.

Key words: milk, pastoralists, trader, traditional, *Value* chain

Introduction

The livestock resource forms an integral part in the agricultural system and basis of livelihood for entire rural and semi-urban population in Ethiopia. In pastoral areas, however, beyond the economic advantage as a source of income, it matters social prestige and status in the community (Coppock D. , 1994). According to the estimates made by the CSA, the country has the largest livestock population in Africa with 58 million cattle, 57 million sheep and goat, 1.23 million camels and an assortment of equines and poultry(CSA, 2015). In the economy of the country, livestock sector contributes about 7.1% of national GDP and about 19.48% of value added in agricultural sector (EEA, 2017). However, it contributes to livelihoods of 60-70% of the population (Aklilu , Almekinders, Udo, & Van der Zijpp, 2007)(Ayele , Assegid , Jabbar , Ahmed , & Belachew , 2003). From these contribution, dairy output accounted for about half of the livestock output (Getachew & Gashaw , 2001).

Likewise, the pastoral communities of the Borana lowlands are predominantly based their livelihood on livestock and livestock products. Particularly, dairy products are an important commodity that can be used as a source of food and income. It is known to contribute significantly to the household food and income, especially for poor female headed pastoralists and in meeting the urban demands for milk products (Little, 1994)(Adongo , Ng'a , Younan , & Recke , 2005). Moreover, dairy products have social (customary and ritual obligatory) values to the pastoral communities of Borana.

However, though various studies were undertaken in the past, it is difficult to address the challenges of dairy value chain when the pastoral livelihood is in concern. Thus, demands, understanding of the current dairy marketing system, value chain and supply problems. On the other hand, Borana pastoralists were not economically benefited to the extent it ought to be due poor access to the marketing system. Likewise, both the productivity and price variability are higher in pastoral areas due to unpredictable rains and other natural hazards.

Therefore, supporting the pastoralists to generate a reasonable income from their milk production may have a significant role in building their resilience against the shock they are facing. Good understanding of the entire value chain of milk productions are very crucial for both research and development intervention to enhance and diversify the income of the pastoral households in Borana zone.

Objectives

1. To evaluate milk value chain in Borana zone
2. To estimate performance of milk value chain
3. To identify problems and opportunities along milk value chain

Expected outputs

1. Relationship of market chain actors will be identified
2. The performances of milk market will be evaluated
3. Problems and opportunities along milk value chain will be identified

Methodology

Description of the study area

Borana is found in the southern part of Oromia regional state which characterized by 10%, 20% and 70% highland, mid-highland and lowland agroecology respectively. The economic basis of its community in lowland is based on livestock production whereas the population in mid-highland and the high land are based on both livestock and crop production.

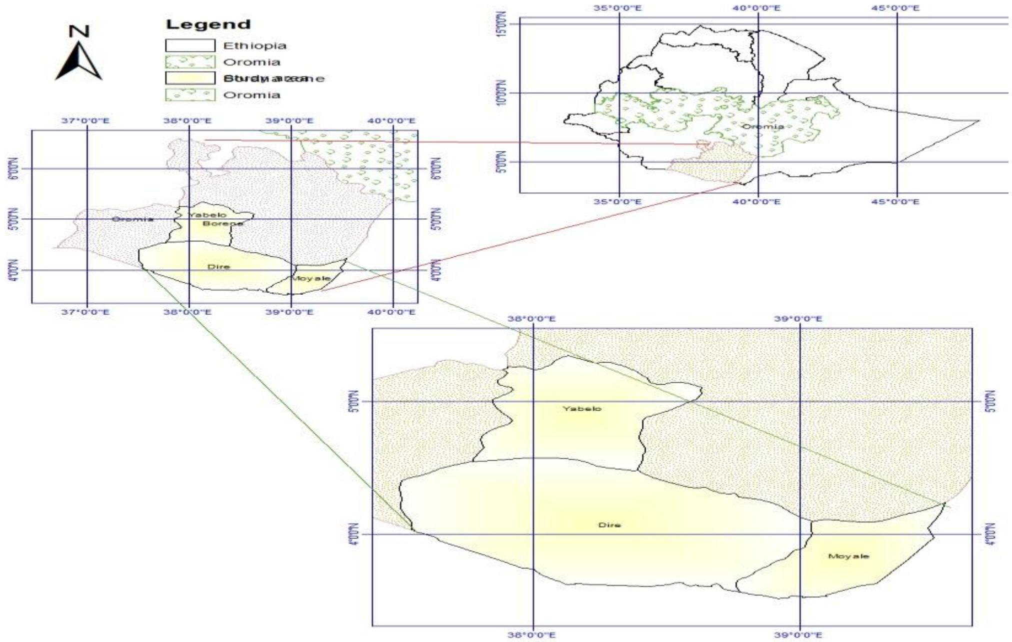


Figure 1. Study area

Method of data collection and source of data

In this study, both secondary and primary information were collected from different data sources. Secondary information was collected from different sectors of Pastoral Development Office (PDO), which have direct and indirect stake on milk productions in the area. Moreover, relevant literatures and documents was consulted to provide technical background and to develop a basic understanding of how milk productions and marketing system operates in the study areas. Focused Group Discussions (FGD), key informants’ interview and visual observations was also undertaken to collect primary data.

In data collection, different set of checklists was used for different group of actors to guide group discussions and key informant’s interviews. In driving respondent households, the study stratified Borana zone according to its agro-ecologies (high land, mid-highland and low land) and social arrangements as pure pastoralists, agro-pastoralists and farmers. Then, two peasant associations selected from each agro-ecologies based on purposive manner on milk productions potential. Finally, the study applied simple random sampling to draw 123 respondent households from the total kebele selected on proportional basis. At the same time, the study addressed 20 traders and other marketing actors like processors (2) and consumers in demands for triangulation information.

Method of data analysis

Though there are various methods of data analysis, the study employed both descriptive statistics and econometric model. For further explicit analysis, the study employed SPSS software particularly for quantitative analysis. Similarly, qualitative data was analysed using content analysis and categorization of the information under the main themes beside descriptive parameters such as mean, standard deviation and x^2-tests.

Additionally, the study applied marginal analysis tools to evaluate the market performance of dairy market in the study area *along the dairy market chain such as marketing margin*. A marketing margin is the percentage of the final weighted average selling price taken by each stage of the marketing chain. The total marketing margin is the difference between what the consumer pays and what the producer receives for his product. In other words, it is the difference between retail price and farm price (Cramer & Jensen, 1982). Computing the total gross marketing margin (TGMM) is always related to the final price paid by the end buyer and is expressed as percentage (Scott, 1995).

$$TGMM = \frac{P_C - P_P}{P_C} \times 100 ------------------------------ (1)$$

Where, TGMM=Total gross marketing margin;

P_C=Consumer price (end buyer price); and

P_p=Producer price (or first seller price)

It is useful to introduce the idea of 'producers' portion or producers 'gross margin' (GM_P), which is the portion of the price paid by the consumer that goes to the producer and the producer's margin, is calculated as:

$$GM_P = \frac{P_C - TGMM}{P_C} \times 100 ---------------------------- (2)$$

Similarly, within the participants/market intermediate MM is the ratio of difference of selling and buying to the final consumer price

$$MM = \frac{SP - BP}{FCP} \times 100 ------------------------------ (3)$$

Where: MM= Marketing Margin (%)

SP= Selling Price at each level

BP= Buying Price

FCP=Final Consumer Price

The net marketing margin (NMM) is the percentage of the final price earned by the intermediaries as their net income after their marketing costs are deducted. Transport cost, container cost, harvesting cost and storage costs are some of the agricultural marketing cost components. The percentage of net income that can be classified as pure profit depends on the extension to such factors as middlemen's own (working capital) cost. If marketing costs (MC) is estimated without significant biases, the net marketing margin (NMM) will be estimated as:

$$NMM_P = \frac{TGMM_C - MC}{P_C} \times 100 --------------------------- (4)$$

Results and Discussions

Demographic characteristics of the sample households

Household size and age composition

Human capital is an important key resource that can capable to organize other resources for efficient allocation. With this regard, family size is an import key resource for individual households that can be a blessing or swear based on the management of the household head. The proportion of male and female in the household is on average constitute a one-to-one (3:4) ratio with the mean of seven family size on average (Table 1). The average male and female constitute proportional with a minimum of one for both and a maximum of 10 and 14 for male and female respectively with a total minimum of 2 family size. The total family size ranges from 2-20 family members particularly for polygamous households. About 99% of the respondents have at least two children with a maximum of 10 females and 14 males.

The age of sample households ranges between 18-76 years with the mean of 42 years (Table 1). On average, more than 75% of the sample households were aged less than 52 years and more than 90% were aged less than 60 years. Interestingly, about 90% of the respondents were ranges from 18-64 years' old which indicates that larger parts of the respondents are within the working age that clarify that they have ample experience and knowledge about the matter of study.

Table 21. Age and family size

Variable		N	Mean	Std. Dev	Min	Max
Age		121	46.43	13.75	18	76
Family size	Male	123	3.75	1.98	1	14
	Female	122	3.38	1.87	1	10
	Total	122	7.20	3.30	2	20

Source: Own survey, 2016

Sex Composition and Education Status of Households

Most of the sample households were male-headed households, which constitute about 87% of the sample households, and only 13% of the sample households were female-headed (Table 2). From all sample households, only about 33.3% were able read and write in which some of the sample households have accessed through youth education provided by government during night and/or weekend (Table 2). From the sample households with the ability to read and write, the survey result indicates that about 75% of the sample households were below a maximum of grade 8 and about 50% of the sample households were access the ability to read and write through informal education system, i.e. zero education level without formal schooling. From the chi-square result, though there is no significance difference in access to education between sexes of household head, there is high significance difference in the choice of livelihood option, land ownership and crop production. This hints that male is more relatively able to participate on various livelihood option, crop production and ownership of land.

Table 22. Sex composition of sample households

Descriptive variable		Descriptive across sex		Total	χ^2
		Male	Female		
Education status	Literate	58	26	84	0.04
	Illiterate	22	9	21	
Livelihood option	Pastoralists	23	22	45	12***
	Agro-pastoralist	55	13	68	
	Trade	1	0	1	
	Labor work	1	0	1	
Land ownership	Own	72	26	98	4.8**
	Not own	8	9	17	
Produces crop	Producing	17	2	19	4.3**
	Not producing	62	33	95	

Source: Own survey, 2016 *, **, *** is significant at <10%, <5% and <1% respectively

Access to infrastructure

Infrastructure is key determinants in the livelihood resilience of a given country. Particularly, the distance to infrastructure limits the access to basic need of a society. Particularly, the effect of distance to infrastructure, principally road, is highly affects the livelihood of poor society due their day-to-day livelihood income was derived from market. In our case, the distance from infrastructure affects the access to buyers, milk supply into market, quality and quality milk supplied and time of milk supply to the market in general. From the survey result, about 50% of the respondent households travel 6-20 km per day to arrive at the nearby market for selling milk, which can take about 1-4 hour on foot travelling.

Though town is the major milk-selling destination, the selling center, is a bit far from producers, which ranges from 7-40 for about 50% of the respondents (Table 3). Due to poor infrastructure, larger milk is transported on foot which can take 1.5-8 hours to sell milk which indicates that it is hardly common to supply after a travel of eight hours.

Table 23. Distance from major infrastructure

Distance from	**N**	**Mean**	**Min**	**Max**
Milk market	122	8.67	0.001	40
Livestock market	123	9.08	0.04	40
Town	123	6.96	0.04	20
Public Veterinary post	123	6.07	0.01	25
Water source	4	5.62	1	10
Primary veterinary post	107	6.69	0.01	30
Pharmacy	103	6.62	0.01	30

Livelihood basis

Borana rangeland is known for its livestock production, which is the main source of food and financial requirements. It plays a great role as sources of food in the forms of milk and meat and main sources of financial requirement. Additionally, it is considered as a measure of wealth, which provides a cultural recognition in social position of Borana pastoralists.

However, in recent times due to climate change the livelihood based on only livestock production was weakened. Due to this, the households in the study area were practicing small scale crop farming to fulfill the food requirement of their family. From field survey, the key informants described that most of the community willing to practices farming even though it is an ad hoc gambling game with climate condition.

Table 24. Livelihood system of sample households

Sex of Respondent	Livelihood activities				Total
	Pastoralists	Agro-pastoralism	Traders	Labor work	
Male	25	57	1	3	88 (71%)
Female	23	13	0	0	36 (29%)
Total	48 (38.7%)	70 (56.45%)	1(0.81%)	3(2.42%)	124

Source: Own survey, 2016 *** is significant at p <5%
Pearsonchi2 (4) = 14.4806 Pr = 0.006

The result proves that about 56% of the sample households are agro-pastoralists followed by pastoralism (Table 4). From those agro-pastoralists, about 81% and 19% of households are male-headed and female-headed households respectively. However, farming is a serious gambling with rain failure where risk of crop failure is common and high.

Compostion of dairy animals

Cow is the dominat source of milk followed by goat and camel respectiviely based on number of household owning the animal. From the survey result, more than 90% of respondent owned cow whereas 59% and 32% of respondets were owned goat and camel respectively (Table 5). In this case, about 50% of the respondent own both cattle and goat together. Simlalry, about 27% of the respondets own camel and goat together whereas about 24% of the respondets have cow and camel together.

Table 25. Proportion of dairy animal composition matrix

		Goat		Camel	
		Own	No	Own	No
Cow	Own	62	47	30	79
	No	8	7	8	6
Camel	Own	37	13		
	No	50	35		

This hints that the livestock composition is on the ground. Explicitly, the respondents' households have on average 16 TLU with a per-capita livestock of 3.4 TLU holding. Though cattle are the most susceptible to drought from pastoral experience, still cattle dominate, 63%, the livestock population of the household (table 6). Though the total livestock holding is 16TLU on average, 50% of respondents own less than 1.76 and about 75% have own 1.87 and about 90% of the respondents own less than 4.78. From the study, only 10 percent of the respondents have more than 8.9 TLU.

Table 26. Livestock size owned

Livestock types	N	Mean	Std. Dev	Min	Max
Cattle	125	10.01	26.75	0	210
Goat	124	1.76	4.89	0	50
Camel	125	2.88	7.49	0	60
Sheep	125	0.63	0.96	0	6
Poultry	125	0.02	0.03	0	0.2
Donkey	125	0.58	1.51	0	15
Mule	125	0.017	0.14	0	1.4

Source: Own survey

Dairy Animal management and selection

The output from any production needs sufficient input besides the required quality. In pastoral area, the production of milk is an important dairy product. However, the production of milk is commonly undertaken in traditional approach. From the survey result, about 66% of the respondent households where practices selection of dairy animal with larger milk yield by considering size, age, color, calf survival, growth, maturity, milk yield and breed type as some major criteria for selecting animal for milk production. However, the main aim of milk yield focus is not market oriented but related to the breed types that deep-rooted in pastoral history to improve their livestock production.

Table 27. Dairy animal selection

Variable	Top one criteria		Top two criteria		Top third criteria	
	N	%	N	%	N	%
Size	41	34.5	22	18.5	9	7.6
Age	0	0	12	10.1	19	16.0
Color	18	15.1	22	18.5	23	19.3
Calf survival	1	0.8	3	2.5	3	2.5

Growth	0	0	1	0.8	1	.8
Maturity	1	.8	3	2.5	2	1.7
Milk yield	7	5.9	9	7.6	7	5.9
Breed type	14	11.8	10	8.4	14	11.8
Total	**82**	**68.9**	**82**	**68.9**	**78**	**65.6**

As a matter of facts, to increase the milk production the pastoralists were doing a little from their experiences. From the survey result, only 10% of the respondents were separating dairy animal from their total herd in their experience. However, 70% of the respondents were provides hay either frequently or occasional to their dairy animal (Table 6). However, a few respondents were providing crop residues for their dairy animal from their production.

Generally, the efforts to increase the milk production was limited in pastoral area though the marketing of dairy product become increasing. On the other hand, the supply of milk to the market was not to get more benefit as a causal cash sources for daily home expense. From their experiences, there was unsatisfactory interventions to enhance the production and marketing of dairy product particularly milk. As a result, the pastoralists supply milk to the market that left over from their home consumption, which indicates that their production system is not market oriented. These demands, intensive efforts to enhance the market-oriented milk production system by improving its marketing structure.

Table 28. Dairy Animal management

Activities	Response	Sex of respondent		Chi square
		Male	Female	
Select breed	Yes	62	22	26.8***
	No	16	10	
Separate dairy cattle herding	Yes	13	1	24.4***
	No	64	30	
Feed Hay/Standing dairy animals	Yes	61	26	29.7***
	No	14	7	
feed crop residues dairy animals	Yes	16	8	0.49
	No	50	24	

Other livelihood activities

Destitute households in particular, are increasingly involved in the sale of firewood and charcoal. Because, the poorest households have a few options available to them especially during climate extremes, typically during drought. The petty trade activities include the sale of vegetables grown around the homestead and the sale of essential items brought in to the villages from larger market centers or nearby town in a rural area. However, during this survey fewer percent, 18%, of the respondents were generally participating in the NFNP livelihood activities. The major reason behind this low level of NFNP income source is that larger percent, 95%, of the respondents were a recipient of aid services in different form. Most dominantly, the respondents receive aid in cash, food, oil and livestock feed (Table 9). The survey result indicates that 65%, 89% and 30% of the respondents received aid in the form of cash, food and oil respectively.

Table 29. Participation in non-farm-non-pastoral activities

NFNP income source	Number of responds		Chi sq.
	Male	Female	
NFNP activity involvement	13	9	60.4***
Aid	77	33	0.23
• Cash aid	41	24	36.90***
• Food aid	75	31	46.6***
• Oil aid	28	8	16.4***
• Feed aid	55	21	46.9***
• Small ruminant	3	-	27***
• Water	7	6	27.2***

Source: Own survey, 2017 *** is significant at $p < 0.001$

Dairy value chain analysis

Value chain selection

In value chain analysis, it is important to select potential value chain, which could create a potential impact on the livelihood of the target society or industry. This demands, analysis of value chain, which have a practical implementation in the development intervention from different perspectives. The selection of potential value chain could be considered from market potential, economic and social value and enabling environment. The market potential is proving the competitiveness of the intervening business from the perspectives of growth potential into industry, existences of unmet demand, potential for value adding, involvement of number of peoples, comparative advantage, and presence of leading firms and sustainability of the market.

Similarly, the economic and social perspective represents the target of an intervention into a designed business. The target indicates whether the interventions is to the priority challenges of a society to enhance their livelihood. From the target perspective, potential for employment generation, potential for income generation, potential for poverty reduction, potential to scale up, potential for outreach (cover larger area) and low risk from the major. The enabling environment is the existing favorable condition that supports the implementation of the interventions. These includes government/and donor involvement, favorable business environment, institutional mandates, environmental suitability, government strategies and social acceptances (Valuable) form the major.

In Borana zone, milk, butter, cheese, buttermilk and fermented milk are the major dairy product currently on the market. However, this study was unable to address the value chain of all dairy products due to limitation of resource, security issues, availability of coordinating industry, and length of the market channel and abundancy of the product. Based on these concerns, milk value chain was selected for this analysis as part of dairy value chain, which have a deep rooted and long market chain in Borana zona (Table 10).

Table 30. Value chain ranking

Major criteria	Major Value (sum=100%)	**-1-** Specific Criteria	**-2-** Specific Weight	**-3-** *Rank across specific criteria (1-4)*				
				Milk	Butter	Cheese	Butter milk	Fermented milk (*Itittu*)
Market criteria	*38.5%*	Growth potential into industry	6.5%	0.34	0.29	0.18	0.28	0.24
		Unmet demand	5.8%	0.21	0.19	0.14	0.08	0.14
		Potential for value adding	6.3%	0.26	0.20	0.13	0.21	0.22
		Involvement of number of peoples	4.5%	0.21	0.13	0.07	0.06	0.18
		Comparative advantage	5.8%	0.22	0.20	0.16	0.08	0.16
		Presence of lead firms	3.8%	0.18	0.19	0.17	0.07	0.11
		Sustainability of the market	6.0%	0.23	0.12	0.10	0.13	0.14
Social and economic Criteria	*30.25*	Potential for employment generation	6.0%	0.37	0.26	0.18	0.12	0.24
		Potential for income generation	8.0%	0.35	0.29	0.22	0.15	0.31
		Potential for poverty reduction	5.5%	0.26	0.23	0.09	0.10	0.19
		Potential to scale up	4.0%	0.23	0.22	0.10	0.12	0.23
		Potential for outreach (cover larger area)	3.5%	0.19	0.16	0.10	0.09	0.18
		Low risk	2.8%	0.07	0.16	0.12	0.07	0.12
Enabling environment criteria	*31.25*	Government/and donor involvement	5.8%	0.24	0.14	0.10	0.14	0.09
		Favorable business environment	5.3%	0.34	0.30	0.10	0.16	0.30
		Institutional mandates	3.8%	0.13	0.11	0.03	0.06	0.08
		Environmental suitability	5.8%	0.15	0.17	0.11	0.16	0.12
		Government strategies	5.0%	0.17	0.10	0.10	0.05	0.15
		Social acceptances (Valuable)	6.3%	0.16	0.12	0.05	0.12	0.19
Total	**100%**		**100%**	4.27	3.56	2.22	2.24	3.38
Rank				**1st**	**2nd**	**5th**	**4th**	**3rd**

Source: Key informant FGD result, 2017

Dairy value chain map

Milk is the dominant dairy product in pastoral area though there are whey, butter and sometimes cheese in peri-urban area. Milk value chain is extending from input supply to consumption point in which different actors involved at different point of value chain or along the whole value chain.

Core function

The milk value chain passes through 6 key processing function to reach the final consumer in general. However, these key functions are not mandatorily undertaken at a point of time and node but at different time. Moreover, the whole milk supplied to the final consumers is not mandatory passes through these functions. Particularly, the processing function is less likely viable in most case due to raw milk consumption dominancy.

Figure 2. Core function of milk value chain

Input supply: The most common input used in pastoral area to enhance the milk production are traditional minerals, veterinary drugs, livestock feed and water. However, still the supply of water and feed is a critical challenge during drought season due to no common suppliers of these resource beyond the seasonal involvements of different actors from individual to government organization. On the other hand, the supply of improved breed and AI is not available in pastoral area of Borana to enhance the production and productivity of milk. The worrisome is the pastoralists are hardly worry about the input for dairy animal due to poor marketing system of the dairy product. Generally, the input supply system is an infant business in the study area.

Milk Production: The productivity milk is very low in pastoral area though it has higher livestock population. On average, the productivity of cow, camel and goat was estimated to be 1.3, 1.74 and 0.34 liter per day per milking animal. As compared to the harsh resource requirements, the productivity of livestock is relatively very low. Though higher numbers of livestock population, the profitability of milk production is doubting. Generally, the economies of scale limit the profitability and supply of milk production.

Collection: The milk collection system in the area is highly infant which need urgent interventions. In the Borana pastoral area, the collection of milk remains to informal and unregistered trader pastoralists with no or poor collection center. Furthermore, besides the collection center there is no specific distribution center beyond road side, public marketing center and home to home distribution. In general, the issues related collection and distribution is immoral in concern with human health and quality management.

Transportation: The transportation of milk from a point of production to the point of consumption were materialized by public transportation, donkey and human power with jerry-cane, plastic containers and traditional equipment. However, these issues are also related to the quality and time of milk deliverance. Moreover, the transportation milk is also related to human health which need further interventions.

Milk Marketing: The milk marketing system is characterized by poor marketing system due to lack of coordinating business. The major marketing actors in Borana pastoral area are dominated by small traders, small producers and pastoral retailers. Most dominantly, the marketing actors at the level of collection and distribution is unregistered trader. This can suggest challenges related to ill price determination and greedy income-oriented milk dilution.

Process: Milk processing remains to the traditional production system with a traditional production material. However, the practice of traditional milk processing is very low due to raw milk consumption regardless of its time of supply. Milk processing to butter, butter milk, fermented milk, rarely cheese and whey. Due to the higher raw milk consumption, the processing to other products owned to time, volume and cultural purposes.

Consumption: Raw milk consumption is the dominant form of consumption mode in pastoral area. Moreover, the consumption of butter milk and fermented milk is also common in pastoral area. However, the consumption practices at the consumption center is hardily satisfactory. At the consumption center, most dominantly single unit of consumption and measurement is in use. This could rise a question related to orally transmitted disease and disease related to poor hygiene.

Value chain actors

Main actors

Market actors are an important ingredient, which makes the movements of the commodity along the value chain to be realized. Pastoralist largely dominates from production to consumption along the dairy value chain. Beside pastoralists, retailers, wholesalers, government, NGOs and cooperatives are the major actors of the dairy marketing system in the study area.

Input supplier: along the natural vegetation, pastoralists are providing additional input for their livestock such as feed, minerals, veterinary drugs and water. However, the Borana pastoralists were receiving various input via aid services, in most case, the households were purchasing livestock feed and veterinary drugs to enhance the production of their livestock. One should notice that the main motives of input supply in the pastoral household is hardly related to enhance milk production but to maintain the health of animal particularly in case of feed shortage. In the study area, about 61% (Table 9) of the households were received feed aid in the past 12 months due the feed shortage. On average, the pastoral households ‘costs about 8,161.14 ETB for livestock feed, crop residues, mineral, pods, commercial and hay for the livestock feed in which about 75% of the cost is incurred to commercial feed and hay (Table 11). Only about 8% goes to mineral supply such as veterinary drug and conventional salt such as ***Dilloo, Boqee, Soodda and Magaadoo*** at different season.

Table 31. Cost of livestock feed

Cost of feed	N	Minimum	Maximum	Mean	Std. error
Crop residues	19	0	15,000	1,878.42	851.06
Mineral	70	2	5,520	929.86	126.61
Pods	5	0	1,600	320.00	320.00
Commercial	69	0	25,000	4,169.93	564.89
Hay	64	30	75,000	4,974.75	1,366.87
Average cost of feed	87	0	100,600	8,161.14	1,399.94

Source: Own survey, 2017

Pastoralists: in dairy value pastoralists, the primary producers; are the dominant actors in the value chain. However, due to the dominancy of their role pastoralists are dominantly working on the production of dairy product. In pastoral area, the pastoralists are the dominant suppliers of the milk due to the production characteristics in the area.

Wholesalers: Wholesalers are those individuals that participants in collecting milk from producers and send the whole jerry can to the retailers in the other area. In the study area, surupha is the main sources of milk and Moyale is the main receivers of milk from Surupha.

Processors: There is no formal processing unit in Borana zone except traditional practices of making butter. However, conventionally the pastoral households are processing milk into various dairy product dominantly butter and whey. In fact, these products were remaining within the local market, in which the producers are most dominantly supplied to the consumers.

Retailers: the retailers of dairy product are those individual distributing to any individual consumers including services center such as hotels and restaurants. In pastoral area, however, retailers are either informal traders that purchase milk from both producers and wholesalers for retailing milk at the market center or home to home or roadside sellers. In all case, retailers were commonly working within their vicinity.

Consumers: Dominantly consumers are pastoralists in restaurant, roadside and in the market. However, the flow of milk to the final consumer is via hotel and restaurants, retailers, wholesalers and pastoralists, which knowingly or unknowingly acts as a medium of milk flow.

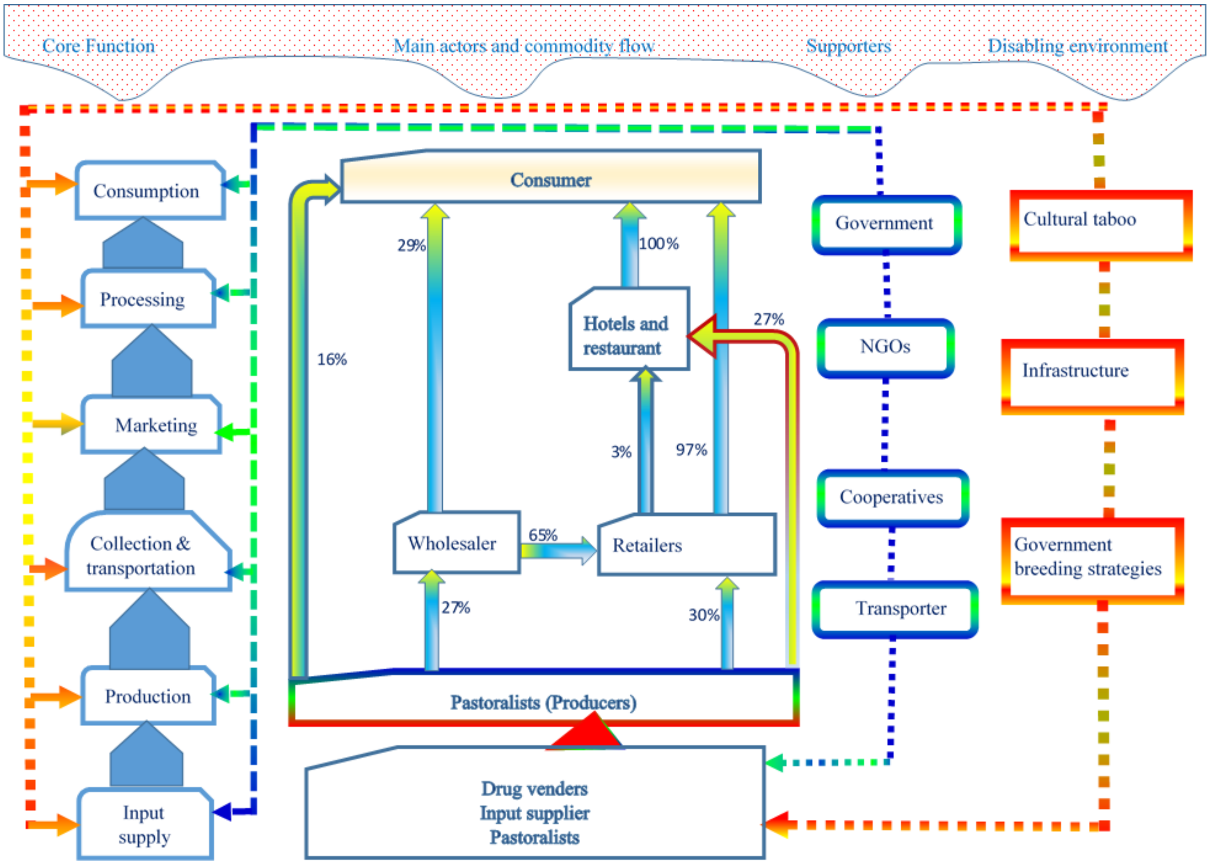


Figure 3. Milk value chain in Borana zone

Other actors (Supporters)

NGOs: the interventions from different NGOs has been undertaken in the past by organizing various business groups and/or providing capacity building in pastoral area. Particularly, NGO's intervention was focused on capacity building for different expert and pastoralists of their intervention area. In the study area, care Ethiopia, Mercy Corps and SOS Sahel has been done a lot. However, the problem with interventions of NGOs is not sustainable across time quoted from history.

Government: It is the key actors in the dairy value chain that has been created supportive opportunities and restricting environment. As part of pastoral development, the local government has been undertaken various intervention such as training, awareness creation and providing some important inputs. However, the interventions of government were poorly measurable due to inconsistent and infrequent interventions.

Table 32. Value chain actors and their role

Process	Actors	Main role	Supporters	Dis/enables
Input supply	- Pastoralists	- Breeding cattle - Milk production	- Government	- Taboo
	- Private feed suppliers	- Supply of commercial feed	- NGOs and private feed supplier	- Infrastructure
Production	- Pastoralists	- Breeding - Feed and watering - Milking - Health care and livestock management	- Government - NGOs	- Government breeding strategies - Infrastructure
Milk collection	- Pastoralists	- Supplying milk to collectors	- Government	- Infrastructure
	- Retailers	- Collecting milk and supplying to others	- NGOs	
	- Collectors (Wholesaler)	- Collecting milk and processing	- Informal Coops	-
Retailing	- Pastoralists	- Supplying milk to collectors	- Government	-
	- Retailers	- Retailing of milk	- NGOs	-
	- Collectors	- Collecting milk and processing	-	- Infrastructure
Milk processing	- Pastoralists	- Milk supply and home processing	-	- Government
	- Cooperatives and milk processing	- Milk collection and processing	-	- NGOs
Consumption	- All users (Consumers)	- Buying	-	- Taboo

Dairy Marketing Channel

The dairy product is flowing via seven directions from producers to the consumers. The longest marketing channel is relatively the flow from producers to

Pastoralists ➔Collectors ➔Wholesaler➔ Retailers➔Processors ➔Consumer

Whereas the shortest marketing channel is

Pastoralists ➔Consumer

However, the thumb rule detects that the shortest marketing channel is more advantageous for consumers though it is immaterial to the producers. The longest marketing channel is an indicative for the higher marginal addition whereas the shortest marketing channel is an indicative for low price margin due to low number of intermediaries. From the survey result, the price of milk is 18ETB at surupha for cow and 12 ETB for camel per liter. However, when it tracked to Moyale, the price of cow milk is tending to rise to 30 ETB and 24 ETB for camel per liter. On the other hand, the retailers harvest larger margin for the milk supplied from the nearby town due to low marketing cost.

However, the flow of information related to the product is poorly addressed due to conventionally deep rooted from their experiences. Particularly, the feedback from the major actors in the area remains very low due to poor linkage among the actors beyond the purchase-selling system of the commodity. This drives an indication for poor information flow to improve the product quality, differentiate the product and processing and poor intention for value chain upgrading. On the other hand, the interventions to improve the value chain system is very low regardless of the milk potential in the area.

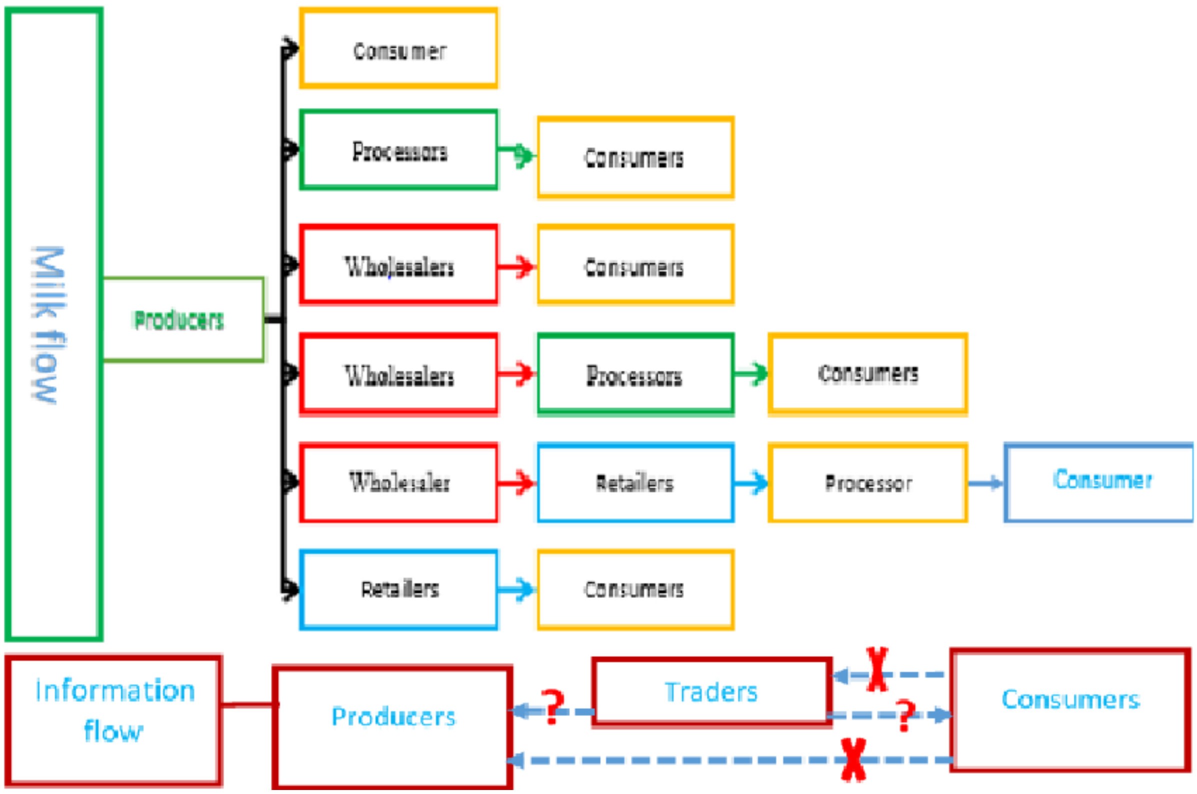


Figure 4. Mmilk marketing channel

Dairy market performance Analysis

In this study, own labor force was not taken into account due to many reasons such as budget limitation, security issues, time frame and climate risks. However,

Table 33. Price variation of milk

Actors	Price of cow milk (ETB)		Price of camel milk (ETB)		Transportation cost per liter
	Buying price	Selling price	Buying price	Selling price	
Producers	0	15	-	12	2
Wholesalers	15	18	12	15	1.25
Retailers	18	24	15	18	-
Distributer	24	30	18	21	-
Consumers	30	-	21	-	-

In during study, camel milk and cow milk is the dominant types of milk in the study area though milk from goat and sheep are common for home consumption. From the analysis, on average the total gross margin is 50% for cow milk and 43% for camel milk. Though camel milk is highly distributed than cow milk in terms of volume, cow milk has higher preference in all area. As a result, the marginal gain from cow milk distribution (marketing) is higher than camel milk. From the analysis, though larger share received by producers, other actors have higher net marginal benefit. Generally, producers are the major looser from the dairy marketing analysis though existences of dairy marketing are very critical.

Table 34. Cow milk marginal Analysis

Variables	Producers	Wholesaler	Retailers	Distributer
MM	-	10%	20%	20%
SP	15`	18	24	30
BP	0	15	18	24
FCP	30	30	30	30
MC	0.88	0.42	-	-
GMp	50%			
TGMM	50%			
NMMp	-1%			

Table 35. Camel milk marginal Analysis

Variables	Producers	Wholesaler	Retailers	Distributer
MM	-	14%	14%	14%
SP	12	15	18	21
BP	0	12	15	18
FCP	21	21	21	21
MC	0.82	0.42	-	-
GMp	57%			
TGMM	43%			
NMMp	-2%			

Challenges and opportunities along milk value chain

In pastoral area, milk marketing is characterized by multifaceted challenges though opportunities are at the door. The traditional dominancy of milk marketing system adds a numerous burden to the milk value chain in Borana zone. With this regard, the households survey plus the SMS (subject matter specialist) forum was undertaken to identify challenges and opportunities of milk value chain in the study area as follows.

Table 36. Challenges and opportunities along milk value chain

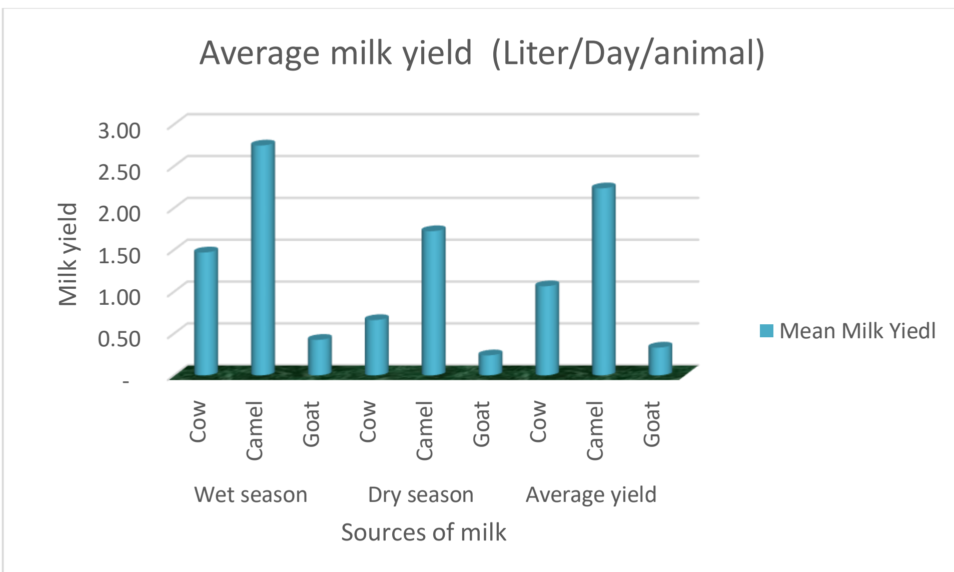
Process	**Activities**	**Constraints**	**Opportunities**
Input supply			
Capital, breed, feed, land, water, drug and labor	- Feed supply - Water supply - Vet. Drug supply - Capital supply	-Shortage of feed -Genetic dilution of local breed -Poor access to vet. drug	✓The practice of feed conservation ✓The use of commercial feed ✓Availability of crop residues ✓Availability of vet post
Production			
	- Feeding, watering, breeding, milking, health care	- Low milk yield -Poor milk management -Drought	-Expansion of community ranch for breed improvement -The existence of research on DVC
Milk collection			
Place, Material, Storage, fridge, transport	- Transportation - Storing - Collecting - Delivering	- Poor rural road - No cooling facility - Poor transportation - No quality test	- Expansion of rural road - Existence of milk cooling equipment - IK of milk conservation
Retailing	-	-	-
	- Milk selling - Milk retailing	- Lack of market linkage - Seasonal variability - No market center	- Existences of informal linkage - Expansion of community ranch
Milk processing			-
	- Milk collection - Milk treatment - Milk processing - Selling	- Lack of processing equipment - Poor milk quality - Shortage of milk - Low skill of processing	- Introducing milk processing equipment - Availability of credit - Improving milk processing practices - Improving milk production and supply
Consumption		-	-
	- Buying milk	- Adulteration of milk - Low quality of milk	- Expansion of milk marketing - Awareness milk selling - IK of milk hygiene management

Borana zone is one of the potential areas of dairy product, particularly, production in the dairy market due to the livestock dominancy livelihood system in the area. Unfortunately, due to the area is a drought prone zone, the production of dairy product is full of challenges beside the inflated impact of climate change. As a result, the production, marketing and consumption of dairy product is owned to the favor for climate change due to natural vegetation dependency of the livestock.

In general, the dairy production has been tempted by different natural and climate calamities that exacerbated by erratic rainfall, recurrent drought and changing in the biological properties of the Borana rangeland. Value chain is blogged by different factors from input supply to the point of consumption. However, the factors can be disaggregated in to the value chain nodes as follow.

Input Supply

Livestock production is a deep rooted and extremely socially linked practical experience in Borana zone. This attached with the highly feverish of livestock product utilization dominantly dairy product. The improved dairy livestock are not common in the area due to different factors related to breed dilution and climate change. The productivity of the current livestock on hand is, however, still declining from time to time.



Input is the key determinant of output owned to the quality, quantity and types of input though optimal application is another question. To improve the production of dairy product, particularly milk, availability of best breed, feed and water is very important. However, in the study area though the local breed, principally Qorti, is the best breed both for milk and meat, now days the available breed in the area was already diluted with other low yield breed. As a result, the milk yield is remains about 1.1, 2.3 and 0.33 Liter per cow, camel and goat per day respectively on average.

On the other hand, the availability of feed resources is another critical input in the production of dairy products. In the study area, the availability feed is among the top challenges of livestock production, which has a direct correlation with milk production. Feed is a critical pastoral resource that induces the migration from place to place overtime. Furthermore, other input such as veterinary drug and extension services are limited and owned to pastoral indigenous experience.

Declining of livestock productivity

Climate change that exacerbates the decline in the rangeland productivity was resulted in the deterioration of pastoral economy. Particularly, the practices of conventional climate variability strategies have on the other hand costs the original breed to diluted livestock breed. Today, the original Borana breed was diluted to the level that it is difficult to access the original Boran cattle is hardly assessable. Moreover, unlike earlier eras the potential of Borana rangeland was captivated by bush encroachment, land degradation, expansion of farmland and unstructured settlement besides other contingent factors.

On the other hand, the seasonal variability of the conventional common was also disturbed beyond the conventional coping and adaptation strategies of the pastoralists. As a result, climate shock created by a seasonal variability creates a multiplied effect shock in the pastoral production system. These factors summed to justify the decline in the livestock productivities in Borana pastoral area. As a result, the decline in the livestock productivity and genetic dilution contributed to the decline in the milk yield per livestock, particularly cattle.

Infrastructure

The dairy product is characterized by the conventional production system, which demands for further detail value chain development. Particularly, the marketing system of dairy product is poorly developed in the study area due to lack of different infrastructure and facilities. Rural smallholder is the solo dominant supplier of the dairy product in the Borana pastoral area. However, poor access to dairy specific transportation facilities due to lack of the conducive road access. As a result, the supply of dairy product to consumer dominant nearby urban area remains a blockage for the development dairy value chain development in the Borana pastoral area. Access to all season road, transportation facilities and formalized value chain limits the production and supply of dairy product.

Besides lack of macro physical infrastructure, lack of facilities in the marketing system presses the dairy product to remains to the level of conventional practices. Particularly, lack of cooling facilities, collection center, modern processing facilities, and poor and inconsistent milk supply create a blocking syndrome in the dairy value chain.

Hygiene

The dairy production, marketing and consumption are all dominated by traditional practice due to poor dairy value chain. Starting from container, all practices and management is dominated by conventional acts. Pastoralists from the production to consumption core process mostly dominate the dairy value chain, which limits the experience from exposure. Most dominantly, poor milk management, poor milk quality and adulteration of milk.

Natural calamity

Drought is a key natural calamity that recurrently diminishes the population and productivity of milk production. Though water and feed are the key important natural resources, drought is key factors that periodically culling the livestock population particularly female cattle. As a result, the milk production remaining low, inconsistent and characterized by different factors.

Marketing system

Unlike past, the practices of milk selling become expanding in Borana zone as a daily income source. Particularly, argue to get daily cash income as an alternative income sources to livestock selling and NFNP income sources. However, the supply of milk is characterized by fragmented and disordered marketing system from its supply to consumption. The dairy market system was poorly organized where larger market actors are dominantly unregistered and informal actors which directed by their own motivations.

However, the situation detects that there is an informal agreement among the milk traders the control the milk prices though it is well organized. The linkage among market actors, particularly traders, seems a collusion form to delimit the price gained by producers. As a result, once a time a producer is sellers, collectors, consumers, and traders without any legal restriction. As a result, the informal traders are exploiting the consumers to the level of doubling without any value addition.

Opportunities

Input supply

The availability of natural input critical milk production in the study area is water and feed though various input are equally important if sustainability is a question. The supply of veterinary drugs, commercial feed resources and the expansion of ranch-based livestock production practices are among the critical opportunity in Borana zone. Particularly, the practices to supply of *qorti* breed type bulls from the research center and local ranch is a critical opportunity to improve milk production though the exotic breed is waiting for its time.

Natural resources

Borana rangeland is a potential resource in Ethiopia, which provided an inclination opportunity to attract potential resources for conservation. The availability of potential rangeland resources combined with the ability of Borana cattle to withstand the harsh environment is a double blessing for Borana pastoralists. However, these potential resources are being depleted due to manmade and natural phenomenon.

This opportunity provides another option for pastoralists to develop feed resources to withstand a recurrent drought what create intense feed shortage recurrently. Unlike its coverage, the availability of feed is very low in pastoral area. This bears the depletion of the original Borana cattle that was basis for the improved breed of the world.

On the other hand, the expansion of farmland provides another option for pastoral households to expand an option for feed shortage. The problem is; however, the expansion of farmland is ad hoc planning with a limited controlling system. The fear is that the expansion of the farmland would erodes the potential rangelands. However, a serious of strategic planning would help to balance the expansion of farmland and rangeland management.

Other opportunities

There are number of opportunities that were available to overcome challenges of milk value chain in Borana zone. The good start of improved local cattle regeneration (Rebreeding) is another opportunity to improve the value chain due to the expectation of improved milk production and productivity. Moreover, the expansion of bush clearing and water development efforts are another opportunity that helps to increase the milk production by reducing the far migration of the dairy livestock.

Similarly, the developments of infrastructure such as road, which could have an implication on access to transportation, is another effort that have implication milk supply. The introducing milk cooling equipment was started in the area even though it was privately owned by different consumer center such restaurants and bars. Moreover, the pastoralists have a deep-rooted traditional milk conservation skill to transform milk into different dairy product such as cream, whey, yoghurt, buttermilk and fermented milk. Therefore, amalgamate of this traditional and modern practice helps to transform milk value chain into modern marketing system.

Though livestock feed is a critical challenge in pastoral area, strategic planning and networking of the available supply of feed supply to sustain the birth cycle and milk production is important. The supply of feed during dry season was not a new recommendation but already started. Finally, the existing of conventional marketing linkage has great opportunities to enhance the strong value chain system by linking actors and supports along producers-consumer value chain. However, this demands for organizing business entity that facilitates the sustainable marketing system.

Conclusions and Recommendations

Livestock production is still dependent on mobility basis, which reduces access to milk market on one hand and reduce the sustainability of milk supply on the other hand. Though ranch-based livestock productions are an infant intervention, it become the critical option in pastoral area. Particularly, the efforts related to restoration of original Boran cattle, which is naturally a drought resistant with fair milk production, need critical interventions. Furthermore, evaluation of simultaneous community based and other methods of breed restoration is highly important to improve the milk productivity of current Boran cattle.

Along all value chain, it is dominated by traditional milk marketing and consumption system. The milk production was remains very low though the maintenance of dairy animal needs integrated interventions to enhance milk supply. Additionally, sustainable milk supply is a critical challenge for poorly organized dairy cooperatives. Besides low milk production, fragmented marketing system discouraged the milk production due to the dominancy of VC by unlicensed traders, lack of marketing center, lack of improved milk management facility remains the critical challenges of milk marketing Thus,

- Licensing of youth based dairy or milk cooperative business and encouraging rural milk supplying members
- Enhances modern milk processing, preservation, and redistribution scheme
- Enhancing dairy cooperative based network in the rural area

The effort to enhance the milk productivity is very low due to lack of encouraging milk marketing system and economy of scale. As a result, the migration of dairy animal to the remote area for searching feed and water remains a habitual act. However, integrated watershed-based feed development needs further interventions beyond the current government supported traditional practices. Feed searching mobility with dairy animal is common in pastoral area that has a very critical impact on milk supply. On the other hand, land degradation and bush encroachment has been the critical challenges. Thus, integrated rangeland restoration with,

- Encompasses carrying capacity development
- Enhancing rangeland productivity
- Improved rangeland management could enhance the suitability of milk supply

Generally, water and feed resource have a strong link with rangeland in pastoral area which demands strict link of water development with a rangeland development. On the other hand, dry season and recurrent drought remains a critical challenge in the sustainable milk supply.

Dairy potential was not aligned with the formal employment opportunities. Formally, organized graduated youth based dairy business in the form of cooperatives, unions and IMX is a critical issue suggested by this study though a critical analysis the past challenges of existing broken dairy cooperatives remains a hot issue to be addressed.

On the other hand, the financial management of the informal cooperatives is characterized by infant operating system though the customary honest was richly developed in pastoral area though lack of business and financial management skill development need critical and urgent interventions. Thus, encouraging the existing informal traders to organized into formal dairy business and linking with existing financial market adds the flavors to the dairy value chain development.

Finally, value chain upgrading is an important issue beyond the milk value chain when the wellbeing is in question. The main purpose of value chain upgrading is to improve the performance of the value chain and then to contribute to the wellbeing of all the participating actors. With this regard, it needs an integrated stakeholder's interventions due to different stages of value chain upgrading.

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Identification and characterization of farming system in West Arsi and East Shewa Zones, Oromia national regional state, Ethiopia

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Abstract

Targeted agricultural extension service for heterogeneous farming systems is a challenge in developing countries. Farming system is a complex combination of inputs which is influenced by environmental, economical, institutional, political and social factors. Farm type identification and characterization based on agro-ecology, production system and different farm components help identify area specific problems and give proper technological intervention to address the problems. Therefore, farming system characterization is a vital activity for agricultural technologies generation, development practitioners and policy makers. Therefore, this study was done to identify and characterize the farming system in West Arsi and East Shewa Zones with the objectives of identifying and characterizing the existing farming systems, identify and prioritize constraints of the farming system for identifying potential research interventions. To accomplish the study both Primary and secondary data sources were used. Secondary data was collected from both Zones and eight selected districts in the Zone using checklists. In addition to this published and unpublished materials were used as the secondary data sources. Multi-stage sampling technique was employed to select sampled districts, kebeles and household farmers. Primary data was collected by conducting focus group discussion (FGD), key informant interview and household's interview by using semi-structured questionnaires. One FGD which contains 8-10 farmers was undertaken per selected district to collect data. Key informants interview was made with concerned experts and Development agents at districts and Kebeles levels. A total of 448 sample households were selected from West Arsi and East Shewa Zones to collect primary data through direct interview. Descriptive statistics was used to analyze the collected data using STATA version 14. The study finds out that West Arsi Zone was dominated by mixed crop-livestock farming system whereas East Shewa Zone practices pastoral/ agro-pastoral and mixed crop-livestock farming systems. Mixed farming system of West Arsi Zone was classified into potato-haricot bean based farming system and cereal based farming system which classified into wheat-teff based, food-malt barley based and maize based farming systems. Mixed farming system of East Shewa Zone was classified into irrigation based farming system that dominated by onion-tomato based farming system and rain-fed based farming system which classified into maize-teff based and haricot bean-chickpea based farming systems. Major agricultural production constraints within the farming systems across Zones are identified and the possible policy implications are suggested to solve the identified problems.

Keywords: Farming system, identification and characterization, Classification, Constraints, FGD, West Arsi and East Shewa Zones.

Introduction

Agriculture remains the best opportunity for the estimated 1.5 to 2 billion people living in smallholder households to escape poverty. Studies show that income growth generated by agriculture is up to four times more effective in reducing poverty than growth in other sectors (Growth Commission, 2008). Agriculture contributes 36.2 percent of the Ethiopian gross domestic product (GDP) and 72.7 percent of employment and 70 percent of export earnings (Getachew, *et al*., 2018). The economy of the Ethiopian country is heavily dependent on agriculture, with over 85% of the rural population deriving their livelihoods directly from agriculture.

Farming system is a complex combination of inputs, managed by farming families, influenced by environmental, economical, institutional, political and social factors. Basically, it is a set of interacting activities (NRl.org, 2004). Research and extension institutions are increasingly aware that a holistic approach, drawing on both local and external knowledge, is necessary if they are to be effective in addressing poverty and sustainability. The systems approach basically consists of accepting the irreducible complexity of the system under study, of striving to understand the overall operation of the system and not only the mechanisms which are brought into play within it.

According to FAO (2007), a farming system is defined as a population of individual farm systems that have broadly similar resource bases, enterprise patterns, household livelihoods and constraints, and for which similar development strategies and interventions would be appropriate. The classification of the farming systems of developing regions has been based on the following criteria: available natural resource base, including water, land, grazing areas and forest; climate, of which altitude is one important determinant; landscape, including slope; farm size, tenure and organization; and dominant pattern of farm activities and household livelihoods, including field crops, livestock, trees, aquaculture, hunting and gathering, processing and off-farm activities; and taking into account the main technologies used, which determine the intensity of production and integration of crops, livestock and other activities.

Farming systems research is an approach for generating appropriate technologies for the existing farming systems and involving the technology users - usually the small farmers in the planning and evaluation process. Thus, study of farm typology is of practical interest for precise and effective technological interventions. Farm typology study recognizes that farmers are not a monolithic group and face differential constraints in their farming decisions depending on the resources available to them and their lifestyle (Soule 2001). Ellis (1993) observes that small farmers are always and everywhere typified by internal variations along many lines. Although every farm and farmer is unique in nature, they can be clustered into roughly homogeneous groups. Developing a typology constitutes an essential step in any realistic evaluation of constraints and opportunities that farmers face and helps forwarding appropriate technological solutions, policy interventions (Ganpat 2001, and Vanclay 2005) and comprehensive environmental assessment (Andersen, *et al.* 2009).

According to FAO (1980), the approach is justified on the basis of three vital considerations. Firstly, the farmer and his family are rational in their decision-making. Given their available resource base, circumstances, opportunities and knowledge, they typically manage a combination of crops, animals, and other on-farm and off-farm activities to satisfy basic physical, financial and social needs. Secondly, the production systems of small farmers embody an integrated set of husbandry practices that have developed over centuries so that these systems are stable, complex and very sensitive to the ecological, biological and socio-economic. Thirdly, a farming system belongs to the goal-setting and purposeful category of systems and its direction is determined by the farmer and his family.

Farming System Characterization involves an understanding of the structural and functional relationships of current farming systems in specific geographical areas and an identification of the constraints to achieving farmers' goals. **Analysis Farming System** involves understanding how a system works implies knowing the parts (crop, livestock, and trees interactions) and how they relate to each other and to the environment (Dillon, Plucknet and Vallaeys, 1978). Farming systems are changing rapidly; the prices and availability of agricultural inputs vary, the cost and availability of labour fluctuates, marketing opportunities change, and the incidence of pests and disease may sometimes preclude the production of certain crops. Farming systems have changed substantially in recent decades. Their evolution is directly influenced by internal factors – notably the availability of resources and population growth – as well as by external factors such as markets, new technologies, support services, policies and information.

The bottleneck was the missing knowledge on the existing farming systems and their proportion in the total population of the provinces. Thus, farmers are forced to change their farming system or management practices when the environmental, economic, technical or social conditions change, particularly soil organic matters depletions, soil erosion, changing pattern in land use and socio-economic factors that pose a great threat in meeting the food requirement. Hence, it is required to prioritize agricultural production constraints and developing local solutions to ensure the long term productivity and sustainability of the systems. This signifies the optimization of various agricultural activities and their integration for multi-enterprise farming systems, development of sustainable farm practices to enhance resource use efficiencies under diverse farming situations and farm categories will be of paramount importance.

The decision to introduce changes or adopt any innovation depends entirely on how the household assesses the relative advantages and disadvantages in terms of its own perceptions and priorities. Because of these considerations, FSR is an interdisciplinary, integrative, problem-oriented and farmer-centered approach. In order to improve the productivity, profitability, and sustainability of smallholder farming system of area, Oromia Agricultural Research Institute has gone a long way to establish different research centers at different location. Because improving the productivity, profitability and sustainability of farming system is the main pathway out of poverty in using agriculture for development. Possible future events and emerging situations have not been systematically explored to the same extent Farming systems in holistic manner with special reference to small and marginal farmers. Site specific system based resource management practices for sustained productivity and profitability.

Hence, it is very important to characterize, analyze the farming system of the area in the arena of multi-stakeholders' perspectives. Thus, this activity intends to identify the potential, constraints and opportunities of the farming system of the area.

General objectives

The general objective of this study is to characterize and analyze the smallholders` existing farming systems of the area.

The specific objectives

- To identify and characterize the existing farming systems of the West Arsi and East showa Zone
- To identify and prioritize constraints of the farming system of the area,
- To identify and prioritize potential research intervention areas to harness the existing opportunities of the farming system in the study areas

Research Methodology

Description of the Study Areas

The research was conducted in West Arsi and East Shewa Zones. West Arsi Zone is found in the south part whereas East Shewa Zone is found in central part of the Oromia National Regional State. West Arsi Zone lies between 6^0 00' N to 7^0 35'N and 38^0 00'E to 40^0 00'E and demarcated by Bale Zone in west direction, Arsi Zone in East direction, Southern Nation Nationality and People Regional State in South direction, and East Shewa Zone in north direction. The Zone has 12 districts. Shashemene is the capital city of West Arsi Zone and located at 250 km from Addis Ababa/Finfinnee towards South direction on Addis Ababa/Finfinnee-Hawassa main asphalt road.

West Arsi Zone encompasses different agro-ecologies namely high land, midland and lowland. In the Zone the high land agro-ecology (47.92%) took more coverage followed by midland

(42.50%) and lowland (9.82%) agro-ecologies. The Zone lies within altitude of 1500-3800 meter above sea level (ZoARD, 2016).

The total population in the Zone was 2,290,280 of which 45.50% are male and 50.50% are female. The Zone receives 600mm-2700mm annual rain fall and has a bimodal pattern of rain fall. It also receives 12^{o}C-27^{o}C annual temperature per year. The Zone has a total of 1,286,277.50 hectare of land. From the total land, 0.36% is arable land, 29.27% cultivated land, 19.50% forest land, 17.05% grazing land, 4.58% used for construction and 29.26% used for other purposes (ZoARD, 2016).

East Shewa Zone lies between 60 00' N to 70 35'N and 380 00'E to 400 00'E. This zone is bordered on the South by the West Arsi Zone, on the Southwest by the Southern Nations, Nationalities and Peoples Region, on the West by South west Shewa Zone, on the Northwest by North Shewa, and on the Southeast by Arsi Zone. Adama city is the capital city of East Shewa Zone and located at 100 km from Addis Ababa/Finfinnee towards South–East direction.

East Shewa Zone has different agro-ecologies which categorized as highland, midland and lowland agro-ecologies. In the Zone, 18.70% of the agro-ecology is high land, 27.50% is midland and 53.80% is lowland. The total population in the Zone was 1,275,645 of which 53.26% are male and 46.74% are female. It receives 350mm-1150 mm annual rain fall and has uni-modal nature of rain fall pattern. This Zone also receives 12^{o}C-39^{o}C annual temperature per year (ZoARD, 2016).

The Zone has a total of 971,159.21 hectare of land. From the total land, 12.57% is arable land, 47.31% is cultivated land, 4.18% forest land, 14.58% grazing land, 4.89% is used for construction and 12.82% is used for other purposes (ZoARD, 2016).

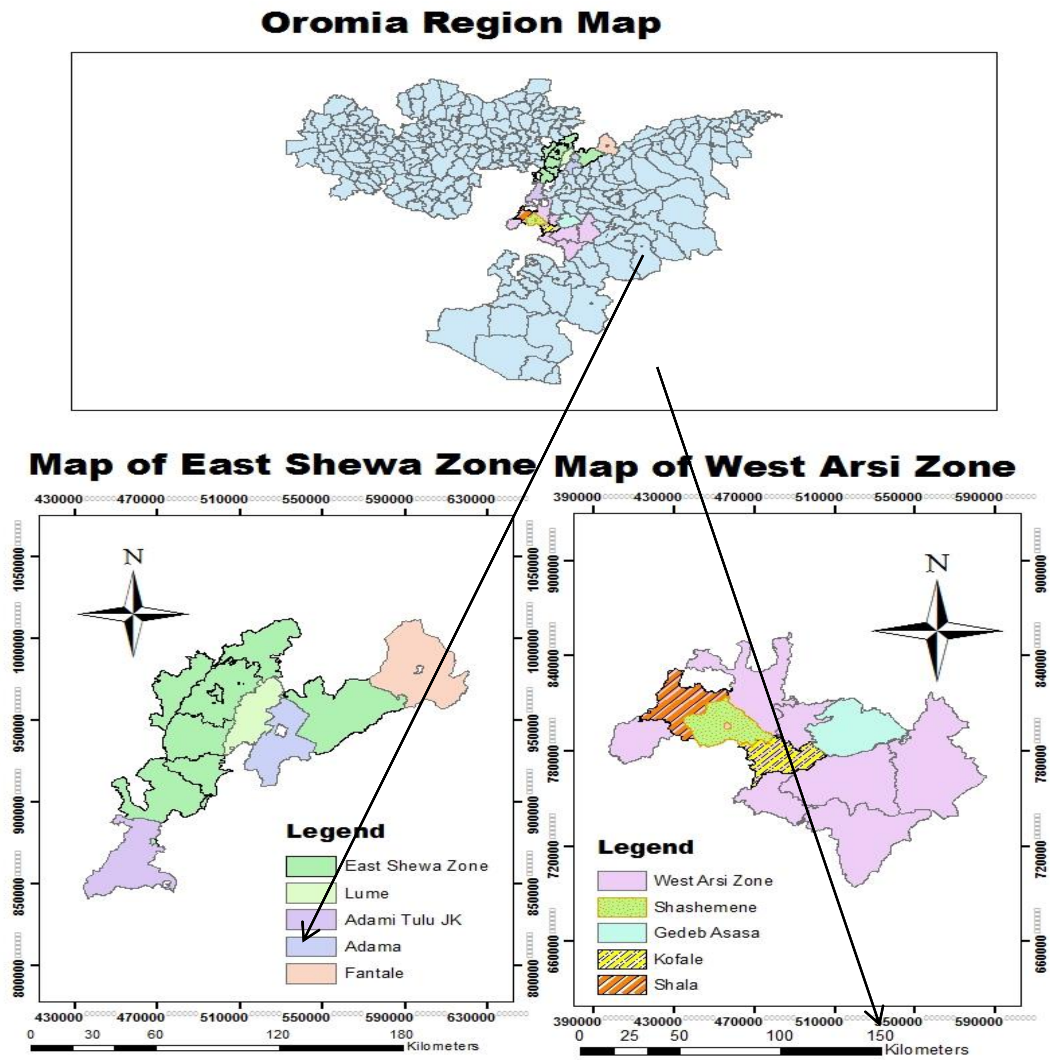

Figure 5. Map of the study areas

Sampling Procedures

Multi-stage sampling procedure was applied to select representative districts, kebeles and sample households in West Arsi and East Shewa Zones. On the basis of agro-ecology diversity, representative districts, Kebeles and sample household was selected using systematic sampling technique. From the selected Kebeles, sample households were randomly selected for data collection. Probability Proportional to size was used for selecting the sample households. The sampling method took the following components into consideration; the age–sex composition, educational status, roles and responsibilities in the community. A multi-disciplinary team was established to conduct the survey using different PRA tools. Different PRA tools like direct interview, focus group discussions and personal observations were employed to collect data on different aspects of existing farming systems of the study area. The focus group discussion and key informant interview were undertaken before conducting survey. Focus group discussion and key informant interview with farmers, Development agents, and community leaders were employed to get an insight about the existing farming system, prevailing opportunities and constraints in the study areas.

West Arsi and East Shewa Zones farming systems were stratified based agro-ecology and production characteristics depending on consultation workshop result that were made with different experts at Zone levels and secondary data. West Arsi Zone farming system is clustered as highland barley belt, highland wheat belt, midland potato belt, and low land maize belt and East Shewa Zone farming system is clustered as midland haricot bean belt, midland chickpea belt, lowland maize belt, and lowland onion-tomato belt farming system. From each cluster one sample district and from each district four sample Kebeles were selected by using systematic random sampling method in each Zone. One FGD was undertaken per each selected district to collect data. A total of 8-10 farmers were selected based on their elder in the community, farming experience, gender, and educational background to conduct FGD and discussion was also made with concerned experts and Development agents at each selected Kebeles to conduct key informants interview. Finally, 264 and 184 sample households were selected for primary data collection from West Arsi and East Shewa Zones.

Types of Data, Sources and Method of Data Collection

Both primary and secondary data was collected from different sources at different levels. Primary data was collected through focus group discussions, key informant interview and households interview using checklist and semi-structured questionnaire.

Secondary data were collected from different agricultural and natural resource development offices, livestock agency, trade and market development office, irrigation offices at different levels (Zones, districts, and Kebeles), different NGOs and stakeholders working in the areas, CSA reports, and different un published reports

Methods of Data Analysis

The collected data was analyzed using STATA version 14 software. The quantitative and qualitative data was analyzed using descriptive statistics like mean, standard deviations, frequency, chi square test and t-test to describe data and see the relationship between variables. The qualitative data collected through FGD and KII was also analyzed by narrating methods.

Results and Discussions

Socioeconomic Characteristics and Resource Ownership of Households

In the farming system analysis socioeconomics factor and household resource endowments play an important role in identifying and characterizing the farming system of a given area. The socioeconomics characteristics included age of household, marital status, education background, total family size, labor availability, and participation in non-farm and off-farm activities under this study. In this study, 58.93% sample households are taken from West Arsi Zone whereas 41.07% sample households are taken from East Shewa Zone (Table, 1).

Table 37**.** Number of sample households in the Zones

Name of Zones	Frequency	Percentage
West Arsi	264	58.93
East Shewa	184	41.07
Total	448	100

Sources: household survey result, 2016.

The study result indicated that the majority (72%) of the sampled households are Muslims followers followed by Orthodox (17.45%) and Protestant (8.95%) in the study areas. Around 92% and 80% of the sample households were male headed households in West Arsi and East Shewa Zones (Table, 2).

Table 38. Description of categorical variables of sample households

			West Arsi Zone		East Shewa Zone	
No	**Variables**	**Category**	**Frequency**	**Percent**	**Frequency**	**Percent**
1	Sex	Male	243	92.05	148	80.43
		Female	21	7.95	36	19.57
2	Education	Illiterate	58	21.97	73	39.67
		Read and write	3	1.14	18	9.78
		Formal education	198	75	88	47.83
		College/University	5	1.89	5	2.72
3	Marital status	Single	11	4.17	16	8.70
		Married	247	93.56	162	88.04
		Widowed	3	1.14	5	2.72
		Divorced	3	1.14	1	0.54
4	Religion	Muslim	236	89.39	86	46.99
		Orthodox	6	2.27	72	39.34
		Catholic	1	0.38	1	0.55
		Protestant	21	7.95	19	10.38
		Wakefata			5	2.73
5	Farmers category	Model	31	11.74	12	6.52
		Middle	180	68.18	135	73.37
		Resource poor	53	20.08	37	20.11

Sources: Household survey result, 2016.

The majority (64%) of the sample households are attended formal education in followed by illiterate (29%) in both Zones (Table, 2). In the study areas, farmers were categorized as model, middle, and resource poor based on their wealth status. The majority of the farmers were categorized under middle farmers in both West Arsi and East Shewa Zones.

The mean age of the sampled households was 40 years in West Arsi Zone and 41 years in East Shewa Zone. The mean family members per household in West Arsi and East Shewa Zones were 8 and 7 respectively (Table, 3). The mean landholding of the farm households is 2.06 hectares and 2.24 hectare in West Arsi Zone and East Shewa Zone respectively.

Table 39. Description of continues variables of sample households

		West Arsi Zone		East Shewa Zone	
No.	**Variables**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
1	Age	39.90	12.75	41.39	14.63
2	Total Family size	8.23	3.61	7.04	3.61
3	House number	1.83	1.16	1.32	0.72
5	Total land holding (ha)	2.06	1.44	2.24	1.92
6	Total cultivated land (ha)	1.60	1.10	1.51	1.05

Sources: Household survey result, 2016.

Type of Houses Owned by Households

Shelter is one of the basic things that required in human life. There are different types of houses that owned by households in the study areas. Table 4 below indicated that about 49% of the households in West Arsi Zone owned grass roof houses and the remaining farmers owned both grass roof and iron corrugated sheet houses. In East Shewa Zone sampled households owned iron corrugated sheet houses (39%) followed by grass roof houses type (29%). This result implies that the iron corrugated sheet house type is more in East Shewa zone compared to West Arsi Zone.

Table 40. Type of houses owned by the households in the study areas

House types	West Arsi Zone		East Shewa Zone	
	Frequency	**Percent**	**Frequency**	**Percent**
Grass roof	129	48.86	53	28.80
Iron corrugated	30	11.36	72	39.13
Grass roof and Corrugated iron	103	39.02	29	15.76
Mud house			7	3.80
Iron corrugated sheet and mud house	2	0.74	23	12.50

Sources: Household survey result, 2016.

The Land Use Patterns

Land is one of an important input in agricultural production. The study result revealed that the sampled households allocated more lands for cultivation purpose (table, 5). In addition to this, they also allocated their lands for forest and grazing lands. The land degradation was also occurred due to miss-use of the land in the study areas. From focus group discussion and household level survey, there is no communal grazing land except in pastoral/agro-pastoral areas like Fentale district. A significant proportion of crop production was harvest by using rain fed agriculture whereas a small amount of crop production was harvested from irrigation based production. This is due to unavailability of irrigation water in both West Arsi and East Shewa Zones.

Table 41. The households land use system

Variables	**West Arsi Zone**		**East Shewa Zone**	
	Mean	**Std.Dev.**	**Mean**	**Std. Dev.**
Land cultivated by rain fed	1.46	1.03	1.30	0.96
Land cultivated by irrigation	0.004	0.04	0.02	0.10
Land for grazing	0.25	0.33	0.10	0.21
Erosion affected land	0.05	0.13	0.01	0.06
Forest land	0.02	0.08	0.01	0.07
Homestead land	0.24	0.16	0.29	0.39

Sources: Household survey result, 2016.

Households' Participation in Off/Non-Farm Activities and Food Security Status

The farmers in the study areas engaged in farm (crop and livestock) and off/non-farm activities to diversify and improve their livelihoods. The Household's participated in off/non-farm activities in West Arsi and East Shewa Zones to generate income. The off/non-farm activities that households engaged to generate additional incomes are work as labor (causal) on other's farm activity, trade, salaried worker as guard, petty trade and driving carts. The households participated more in trades (crop and livestock) to generate additional income in the study areas (Table, 6).

Table 42. The type of off/non-farm activities performed in the study areas

Off/non-farm activities	**West Arsi Zone**		**East Shewa Zone**	
	Frequency	**Percent**	**Frequency**	**Percent**
Casual farm labor	4	5.71	3	14.29
Salaried worker as guard	12	17.14	7	33.33
Traders (crop and livestock)	46	65.71	8	38.10
Petty trade	4	5.72	1	4.76
Driving carts	4	5.71	1	4.76

Food security status of the household was also assessed during this study whether the households are food secured throughout the year or not. The study result indicated, 59% and 55% of the sampled households were food unsecured in West Arsi and East Shewa Zones respectively. The households cover up food shortage period through purchasing food from the market and getting aid from government food aid programs in the areas.

Institutional Facilities for Agricultural Production in West Arsi and East Shewa Zones

The institutional factors play a crucial role to increase agricultural production. These institutional facilities are extension services, credit facilities and market services

Credit service is an important factor that increases agricultural production. The majority (77%) of the sample respondents did not get credit services in the two years period around. The reasons why households did get credit services are high interest rate, lack of collateral and religious influences. However, few respondents (33%) had access to credit services and used credit for purchasing agricultural inputs (fertilizers, improved seeds, and chemicals), purchasing animals for fattening/breeding and for purchasing food for home consumption. The chi square test indicated that there is a significance difference between West Arsi Zone and East Shewa Zone in getting credit service at 1% significance level. This result showed that West Arsi Zone has better access to credit service relative to East Shewa Zone (Table, 7). The possible reason was the credit service providers was prevalent more and benefited the users in West Arsi Zone than East Shewa Zone. The major credit providers in the study areas were saving and credit association (40.40%), microfinance institutions (30%) and Non-governmental organizations (17.17%) respectively.

Table 43. Institutional facilities in the study Zones

Facilities		West Arsi Zone		East Shewa Zone		
	Responses	Frequency	Percent	Frequency	Percent	χ^2 value
Credit services	No	178	67.43	164	91.11	34.89***
	Yes	86	32.58	16	8.89	
Extension services	No	28	10.61	25	13.59	0.92
	Yes	236	89.39	159	86.41	
Market information	No	65	24.62	103	58.86	52.21***
	Yes	199	75.38	72	41.14	

****: indicated statistical significance at 1% level*

Extension service is another institutional factor that affects agricultural production in the areas. Table 8 above indicated that the majority (88%) of the respondents get extension services on agricultural production. Most of the farmers got extension advices from development agents (93.42%), development agents and research center (4.18%), and development agents and NGOs

(1.77%) in the study areas. The respondents got advice on fertilizer application, row planting, how to use improve seeds, weed management, and post-harvest handling.

In the study areas, the majority (75%) the households received market information in West Arsi Zone but it is inversed in East Shewa Zone that means the majority (59%) of the households do not received market information. The chi square test indicated that there is a significance difference between West Arsi Zone and East Shewa Zone in getting market information at 1% significance level. This result showed that West Arsi Zone has better access to get market information compare to East Shewa Zone (Table, 9). The major sources of market information in West Arsi and East Shewa Zones were traders (28.46%), traders and neighboring farmers (18.29%), and neighboring farmers (16.26%) followed by union (1.22%) and cooperatives (1.22%). This result revealed the Union and Cooperatives are lees delivering market information for the farmers in the study areas.

Households Livelihood Diversification

The households in the study areas diversified their livelihood to different activities. The household livelihood diversification could be enterprise diversification or participation in off/non-farm activities. The sampled households' livelihoods were majorly (74%) depend on mixed crop-livestock farming (crops production, crops and livestock production, only livestock rearing) activities followed by the combination of farming and off/non-farming (24.17%), and off/non-farming (2.02%) activities.

Even though there is high diversity in important enterprises, the major livelihoods in all farming systems were crop production, cattle, small ruminants (sheep for mid and highland areas and goats for lowland pastoral/agro-pastoral, poultry and off-farm activities. But in each sub-farming system there is a kind of specialization on different enterprises and off-farm activities especially where there was shortage of land both for livestock keeping and crop production.

The small ruminant production/ rearing (sheep and goat) activities were dominant in lowland agro-ecologies of East Shewa and West Arsi Zone with the mean of 9.66 and 4.2 respectively. Therefore, attention should be provided to small ruminant to improve the development of each sub-sector. In all agro-ecologies, however, cattle and poultry were taken as the crucial enterprises so due attention need to be given for those enterprises to improve the production and enhance the livelihood of the farmers.

Households' Farm Labor Availability

Many of the subsistence farming used family labor for agricultural production. The majority of the farmers in the study areas used family labor for agricultural production. The sample t-test indicated that there is a significance difference between West Arsi and East Shewa Zones by labor availability at 10% significance level. This result implies that West Arsi Zone has better labor availability for agricultural production compare to East Shewa Zone (Table, 8). The farmers in the study areas used labor exchange, employing casual labor, and hired labor during labor shortage and busy working time.

Table 44. Labor availability in West Arsi and East Shewa Zones

	West Arsi Zone		East Shewa Zone			
Variable	**Mean**	**Std.Dev**	**Mean**	**Std.Dev**	**t-test value**	**Sign**
Labor equivalent	5.45	2.61	4.98	2.69	t = 1.86	0.06

Sources: Household survey result, 2016.

The Farming System of West Arsi Zone

The farming system of West Arsi Zone is totally mixed crop-livestock farming system. These mixed crop-livestock farming system is dominant in all agro ecologies (Highland, midland and low land) of the Zones. The crop-livestock mixed farming is clustered into two sub-farming clusters as potato-haricot bean based and cereal based farming. The cereal sub-cluster is also further clustered into food barley-malt barley belt, wheat-teff belt and maize belt farming system. There is also further clustering based on number of cropping per a year as double cropping and single cropping. All of cereal sub-cluster are double cropping because they have two rain fed cropping seasons except maize based. Potato-haricot bean based farming is also double cropping, even potato belt area produce triple without any irrigation access.

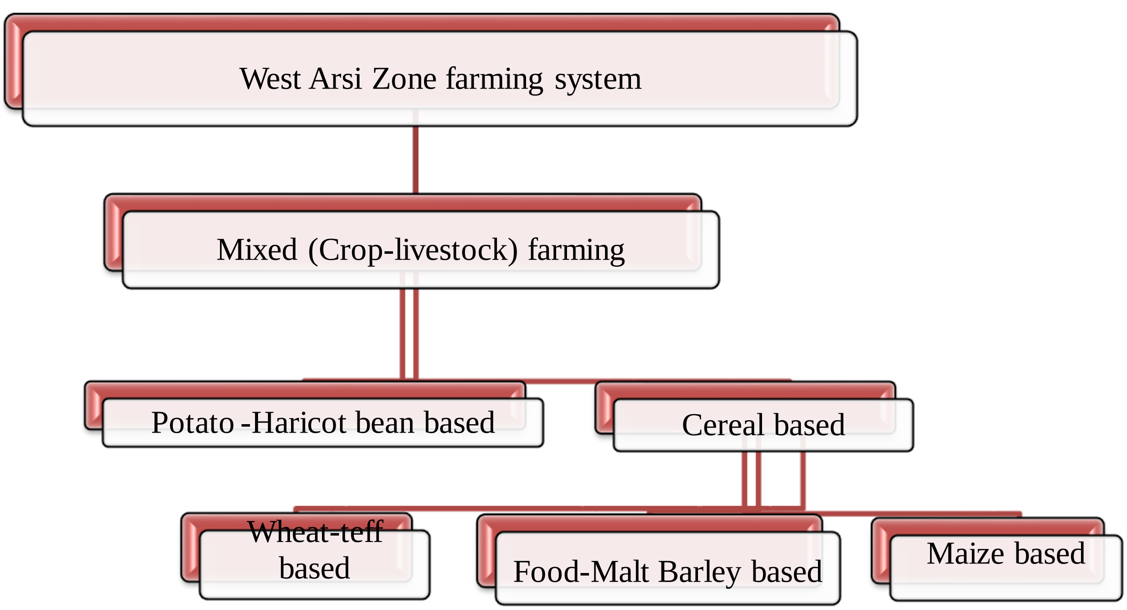

Figure 6. Classification of farming system in West Arsi Zone

Characteristics of sub- clusters farming system

Under this sub chapter, Potato-Haricot bean based, maize-wheat based, food-malt barley based and maize farming systems with their respective constraints are discussed in detail.

Potato-Haricot bean based farming system

This farming system is found in highland and midlands of Shashemane, Kofale, Shalla and Siraro districts of West Arsi Zone. The major crops produced in this sub-cluster are potato, haricot bean, wheat, teff, maize, millet, finger millet and other vegetables. Potato was used as rotational crops for cereal crops to maintain the fertility of soil especially with wheat and teff whereas; haricot-bean used as intercropping crops with maize. Potato is the first leading cash crop produced in large amount in this sub-cluster farming system whereas haricot bean is the second major cash crop produced next to potato. Both potato and haricot bean are cash crops and produced and supplied to the market. In the meantime both of them are used for household home consumption.

Potato is the most favorable sub-enterprise in this sub-cluster and it accounts for about 40% of total land allocation (0.64ha for potato production from 1.60ha of total cultivated land) of the total farm land followed by haricot bean which accounts about 17% of total land. Pulse crops like faba bean, lentils, and field peas were also grown on considerable size of farmland cultivated land. Mean productivity of potato was 103 quintals per hectare while Haricot bean was 10.23 quintals her hectare. Livestock production especially cattle breeding, sheep, dairy production and beekeeping were also the most important enterprises in this sub-cluster farming system.

Potato is produced for the purpose of consumption and sale in this farming cluster. From total sample respondents, 42.86% of them perceived that trends of potato production in the past five years were increasing. In this sub-cluster farming system majorities of potato producers produce potato by rain-fed and only 4.17% use irrigation. Both local and improved varieties were used for potato production in this farming cluster. Currently, improved potato varieties being grown in the areas are Gudane, Jalane and Kulumsa whereas, the major local varieties grown are *Agazer*, Bule, Nech ababa, Dima, '*Key ababa'*, '*China'* and '*Durame'*. From local varieties grown, '*Bule'* is the most commonly known for home consumption whereas '*Agazer'* is commonly known for market. Farmers look for specific traits and characteristics which suit their production and marketing situations when choosing varieties for production.

Major production opportunities and constraints of the sub-cluster

Index ranking was employed to prioritize the major production constraints of the sub-sector during focus group discussion (FGD) with farmers and discussion with agricultural experts at district level. The result further attests that the major opportunities of production in this farming system are good weather condition, good infrastructure and good market availability while, the major constraints of production are unavailability of quality seed at the right time, lack of cash and credit, lack of irrigation, poor input supply such as chemicals and fertilizers, lack of modern storage, disease and insect incidence, market problem and climate change (drought).

According to the sample respondents, 79.19% of respondents used traditional storage mechanism (dark space in the house, ground bin (*Gotera*), spread outside the house and covers it with crop residues, *inset* leaf and others) whereas, 15.83% of the sample respondents practiced postponed storage mechanism (farmers store seed potato by leaving the tubers in the soil un-harvested/ delay harvesting) in this sub-cluster farming system.

The major reasons for discontinuing use of improved potato varieties are unavailability of quality seeds at the right time, high seed price and hence unaffordable to most subsistence potato producers, unavailability of credit access (in kind), low yield, diseases and pest problem. In general, fear of market risks, unavailability of quality seeds at the right time (supply shortage) and financial constraints were some of the reasons for discontinuing use of improved potato varieties. As a result, most sample farmers planted improved potato varieties in combination with local potato varieties.

Specifically, about eight production constraints of this sub-cluster were identified by farmers and they were ranked according to their importance. In root-crop production the major constraint was mentioned to be storage and market related. The perish ability nature of the crop and lack of storage or processing technologies lead the producers to sell their produce at unreasonably lower price during peak production seasons and huge postharvest losses (Table, 9).

Table 45. Major crop production constraints in potato-haricot bean based farming system

No	Major Constraints	1st		2nd		3rd		4th		Index Rank
		Freq	%	Freq.	%	Freq.	%	Freq.	%	
1	Unavailability of quality seed at the right time	63	23.86	44	16.92	28	11.76	20	10.69	1
2	Disease and insect incidence	58	21.97	38	14.62	56	23.53	11	5.88	2
3	Poor complementary input supply (chemicals and fertilizers)	42	15.91	56	21.54	32	13.45	12	6.42	3
4	Lack of credit and cash	36	13.64	46	17.69	34	14.29	40	21.39	4
5	Climate change (drought)	32	12.12	26	10.00	29	12.18	22	11.76	5
6	Lack of irrigation	10	3.79	23	8.85	11	4.62	12	6.42	6
7	Market problem	3	1.14	12	4.62	18	7.56	18	9.63	7
8	Lack of modern storage	12	4.55	6	2.31	8	3.36	7	3.74	8

Wheat-teff based sub-cluster of farming system

This farming system is found in mid highlands of the Zone and mostly known by growing wheat, teff, barley, oilseeds, line seed, faba beans, peas, chickpea and spices crops. Wheat is dominantly produced cereal crops in this sub-cluster. On average household allocate 1.19 hectare for wheat production which accounts 54% while households allocate 0.425ha for teff which accounts about 19%. The reason for high production of this crop is; it is used both for human and animal consumption which accounts 48.44% for additional animal feed. Teff is mainly produced for food consumption while wheat is produced and supplied to the market. In West Arsi Zone this sub-cluster is almost highly mechanized farming system. Almost all of the households were using tractor and combine harvesting constantly each year. Wheat and teff productivity were medium in this sub-sector which was 24 and 7.48 quintals per hectare on average. In these mechanized areas, wheat was predominantly grown year after year on the same farm and mono-cropping was one of the serious problem of this sub-cluster which was a cause for many other problems like soil fertility decrease, wheat crop disease (rust), and grass weed.

Major production constraints of wheat-teff based sub-cluster

Specifically, about six production constraints of this sub-cluster were identified by farmers and they were ranked according to their importance. In wheat-teff production the major constraint was mentioned to be mono-cropping and soil fertility problem related. Complementary input related such as supply gap and high price of chemicals and fertilizers compared to output price and land productivity, crop diseases (Wheat rust, and wilt), soil fertility decline problem which result in low productivity, mono-cropping which leads to soil fertility decline, and high grass weed problem (Table, 10).

Table 46. Major production constraints in wheat-teff based farming system

		1st		**2nd**		**3rd**		**4th**		
No	**Major Constraints**	Freq	%	Freq.	%	Freq.	%	Freq.	%	**Index Rank**
1	Crop diseases	63	23.86	44	16.92	28	11.76	20	10.69	1
2	Complementary input supply gap and high price such as chemicals and fertilizers	58	21.97	38	14.62	56	23.53	11	5.88	2
3	Climate change (drought)	42	15.91	56	21.54	32	13.45	12	6.42	3
4	Grass weed problem	36	13.64	46	17.69	34	14.29	40	21.39	4
5	Mono-cropping	32	12.12	26	10.00	29	12.18	22	11.76	5
6	Soil fertility problem	10	3.79	23	8.85	11	4.62	12	6.42	6

Source: Household survey result and FGD report, 2016.

Food barley-malt barley based sub-cluster farming system

This farming system is found in highlands of the West Arsi Zone in Gedab Hasasa and Kofale. Malt barley is dominantly produced in Kofale district whereas food barley is dominantly produced in Gedab Hasasa. Food barley was majorly produced for food consumption whereas malt barley produced for market purposes. Therefore, barley dominantly produced cereals crops in this sub-cluster farming system because it's used for home consumption and market sold as cash crop. In addition, barley straw was also used for animal feed. The major crop type in this sub-clusters were barley, wheat and rain fed based root crops like potato, carrot, beetroot garlic etc and *khat* trees. Large varieties of other crops especially pulses like faba bean, field pea, lentils, and rapeseeds are also grown in this farming system. These crops were used as rotational crops for cereal crops to maintain the fertility of soil.

Malt and food barley is the most favorable sub-enterprise in this sub-cluster and it accounts for about 30% of total land allocation of the total farm land. Pulse crops like faba bean, lentils and field peas were also grown on considerable size of farmland of total cultivated. Mean productivity of malt barley was 21.53 quintal per hectare and for food barley was 14.17 which shown that there is high potential for malt barley production in this area. Livestock production especially cattle breeding, sheep, dairy production, horse and a little beekeeping were also the most important enterprises in this sub-cluster farming system.

Major production constraints of the sub-cluster

The farmers faced different challenges in barley production in West Arsi Zone. The major barley production constraints were shortage of high yielding and disease resistance varieties, shortage of improved seed supply, disease (rust and wilt), lack of mechanization technologies (chemical sprayers), drainage problem, climate change (erratic and unevenly distributed rainfall), infertile soil and invasive grass weed, high input price (fertilizer, herbicides and other pesticides) and lack of storage facilities (Table, 11). This problem resulted into other problems like increase in production cost, low productivity and crop complete devastation (failure) in most cases.

Table 47. Major crop production constraints in malt-food barley based farming system

		1st		2nd		3rd		4th		Index Rank
No	**Major Constraints**	**Freq**	**%**	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**	
1	Crop diseases	63	23.86	44	16.92	28	11.76	20	10.69	1
2	Shortage of improved seed	58	21.97	38	14.62	56	23.53	11	5.88	2
3	Erratic rainfall	42	15.91	56	21.54	32	13.45	12	6.42	3
4	Drainage problem	36	13.64	46	17.69	34	14.29	40	21.39	4
5	Lack of mechanization	32	12.12	26	10.00	29	12.18	22	11.76	5

	technologies									
6	Soil infertility and weed problem	10	3.79	23	8.85	11	4.62	12	6.42	6
7	High input price (fertilizer and herbicides)	3	1.14	12	4.62	18	7.56	18	9.63	7
8	Shortage of storage	12	4.55	6	2.31	8	3.36	7	3.74	8

Sources: Household survey result and FGD report, 2016.

Maize based sub-cluster of farming system

This farming system was practiced in moderately hot sub-cluster of the West Arsi Zone like Shalla, Siraro, and Wondo genet districts. The major crops produced in this farming system next to maize are teff, haricot bean, finger millet and *khat* trees around Wondo district. The mean landholding of this sub-cluster was 1.39 hectare. Maize is the most favorable enterprise in this sub-cluster and it accounts for about 57.69% of total land allocation of the total farm land. Maize is the first leading food crop produced in large amount in this sub-cluster farming system. The reason for high production of this crop is; it is used both for human and animal consumption (stalk and leaf), for home fuel consumption and construction purpose, adaptable to weather condition of the area. Maize Stover was also used for animal feed and fire. On average the productivity of maize in this sub-cluster farming system was 25.24qt per hectare.

Major production constraints of maize based sub-cluster farming system

The farmers faced different production constraints in maize based farming system. The major constraints that farmers faced in this farming system are Shortage of mechanization agricultural technologies, crop disease (smut) and pests (stock borer), climate change (drought and erratic rain fall), draught power shortage, poor inputs (chemicals, fertilizer, and seed) supply system due to illegal traders control over the market, soil infertility and expansion striga weed (severe in Shalla and Siraro districts), high input price (fertilizer, herbicide and pesticides) and land degradation (Table 12). The index ranking was used to prioritize the production constraints for economically important crop enterprises. Therefore, there is a need for development of technologies for efficient use of water and improvement in soil moisture conserving technologies in the future and demonstration of at hand pre-harvest and harvest technologies like ARDU plows, small powered tractors, BBM and harvesting technologies like thresher is most important activities to be planned.

Table 48**.** Major crop production constraints in maize based farming system

		1st		**2nd**		**3rd**		**4th**		Index
No	Major Constraints	Freq	%	Freq.	%	Freq.	%	Freq.	%	Rank
1	Shortage of mechanization technologies	63	23.86	44	16.92	28	11.76	20	10.69	1
2	Crop pests	58	21.97	38	14.62	56	23.53	11	5.88	2
3	Climate change	42	15.91	56	21.54	32	13.45	12	6.42	3
4	Draught power shortage	36	13.64	46	17.69	34	14.29	40	21.39	4
5	Poor Inputs (chemicals, fertilizer, and seed) supply system	32	12.12	26	10.00	29	12.18	22	11.76	5
6	Soil infertility and weed	10	3.79	23	8.85	11	4.62	12	6.42	6
7	high input price (fertilizer, herbicide and pesticides)	3	1.14	12	4.62	18	7.56	18	9.63	7
8	Land degradation	12	4.55	6	2.31	8	3.36	7	3.74	8

Sources: Zone and Districts Office of Agriculture and survey result, 2016.

The Farming System of East Shewa Zone

East Shewa Zone practiced both mixed crop-livestock farming system and pastoral/agro-pastoral farming system. The mixed crop-livestock farming system is dominantly practiced compare to pastoral/agro-pastoral farming system. The mixed crop-livestock farming system is classified into irrigation based farming system and rain fed based farming system. The mixed crop-livestock farming system was widely practiced in midland agro-ecologies of East Shewa Zone whereas the pastoral/agro-pastoral farming system was practiced in lowland agro-ecologies of East Shewa Zone like Fentale district. The mixed crop-livestock farming system is classified into three sub-cluster farming system. These sub-cluster farming system are Onion-Tomato based farming system, Maize-teff based farming system and Haricot bean-Chickpea based farming system. The onion-tomato based farming system is widely practiced in irrigation available areas whereas Maize-teff based farming system and Haricot bean-Chickpea based farming system are practiced under rainfall. There is also further clustering based on number of cropping per a year as double cropping and single cropping. Almost all mixed crop-livestock farming system practiced single cropping while irrigation based farming practiced double cropping and even triple cropping by using irrigation.

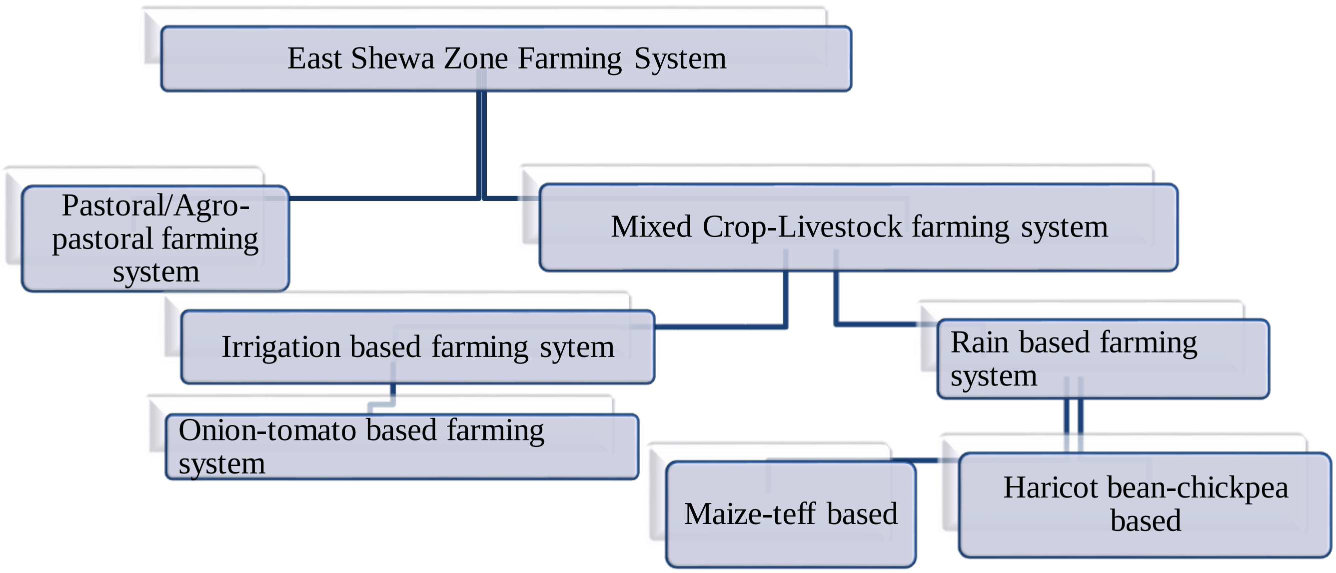

Figure 7. Classification of farming system in East Shewa Zone

Characteristics of Sub- Clusters Farming System in East Shewa Zone

Under this farming system onion-tomato based farming system, maize-teff based farming system, and haricot Bean-Chickpea based farming system with their respective constraints are discussed in detail.

Onion-tomato based farming system

This farming system was widely practiced in lowlands of Adami Tulu, Dugda, Bora and Fentale districts where irrigation is available. The major crops produced in this sub-cluster in addition to onion and tomatoes are hot pepper, cabbage (*Ethiopian Kale*), snap bean (*Fosolia*) and haricot bean. Maize production was also undertaken in small amount in this cluster. The majority irrigation user farmers used traditional irrigation system like flooding. Onion is the first leading cash crop produced in large amount in this sub-cluster farming system whereas tomato is the second major cash crop produced next to onion.

From the total cultivation land (1.51ha), about 30% of the land allocated for onion production. The tomato production was also shares about 28% of total land. The mean onion production was 80 quintals per hectare while tomato was 42.32 quintals per hectare. Livestock production especially cattle breeding, sheep, Goat, and beekeeping were also the important enterprises in this sub-cluster farming system. Donkeys are also important for transport purpose in this sub farming system.

The households produced onions and tomatoes majorly for marketing and for home consumption. From total sample households, 57.14% of the respondents perceived that the trends of onion production in the past five years is increasing and about 42.86% of the respondents perceived that the trends of tomato production in the past five years is decreasing. The probable reason for the decline of tomato production was the outbreak of pests (*Tuta Absoluta*), shortage of disease resistance varieties and high input costs.

Major production constraints Onion-tomato crops based farming system

The onion-tomato based farming system was challenged by different factors like other farming system. The major constraints in the onion-tomato based farming system are lack of credit and cash, shortage of improved seed, market problems (lack of market information and high price of inputs), untimely supply of agricultural technologies (fertilizers and chemicals), disease, climate change (drought and erratic rain fall), lack of storage and low soil fertility (Table, 13). Index ranking was employed to prioritize the major production constraints of this farming system.

Table 49. Major production constraints in onion-tomato based farming system

No.	Constraints	**1st**		**2nd**		**3rd**		**4th**		**Index rank**
		Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**	**Freq.**	**%**	
1	Lack of credit and cash	15	18.07	15	18.29	18	23.38	15	25.42	1
2	Shortage of improved seed	20	24.10	13	15.85	7	9.09	10	16.95	2
3	Market problems	9	10.84	14	17.07	15	19.48	5	8.47	3
4	Lack of supply of agricultural technology on time	13	15.66	13	15.85	10	12.99	6	10.17	4
5	Disease	17	20.48	8	9.76	7	9.09	3	5.08	5
6	Climate change	3	3.61	8	9.76	7	9.09	9	15.25	6
7	Lack of storage	2	2.41	4	4.88	6	7.79	4	6.78	7
8	Low soil fertility	1	1.20	3	3.66	2	2.60	2	3.39	8

Sources: Household survey result, and FGD result, 2016.

Maize-teff based farming system

The highland, midland and lowland areas of East Shewa Zone are known by maize and teff production (ZoARD, 2016). The Maize-teff based farming system was widely practiced in Lume, Adea, Adama, and Adami Tulu Jidokombolcha districts of East Shewa Zone. The major crops produced in this sub-cluster farming system in addition to teff and maize production are wheat, barley and haricot bean based on the proportion of land allocation. The mean land allocated for Teff was 0.98 hectare that shares 65% of the total cultivated land and 0.875 hectare for maize production which shares 58% of the total cultivated land in the area. Livestock production was also undertaken in this sub-cluster farming system to diversify the livelihood of the households.

Major production constraints in Maize-Teff based farming system

This sub-cluster of farming system was widely practiced in highland and midlands of East Shewa Zone. In this farming system, eight production constraints were identified and ranked according to their severities. In Maize-Teff base farming system the major constraints were lack of credit and cash, lack of market information, untimely of agricultural technologies (fertilizers and chemicals), shortage of improved seed, disease, shortage and unevenly distributed of rain fall, low soil fertility, and lack of mechanized agriculture (Table, 14). The majority of the households are challenged by lack of credit and cash, lack of market information, and untimely supply of agricultural technologies (fertilizers and chemicals) in crop production. This implies that an intervention required on these problems to increase crop production in the study areas.

Table 50. Major crop production constraints in maize-teff based farming system

Constraints	1st		2nd		3rd		4th		Index rank
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	
Lack of credit and cash	47	26.55	36	23.53	28	22.05	26	27.37	1
Market problems	16	9.04	33	21.57	22	17.32	18	18.95	2
Shortage of improved seeds	33	18.64	26	16.99	16	12.60	10	10.53	3
Untimely of supply of agricultural technology	31	17.51	21	13.73	20	15.75	11	11.58	4
Disease	32	18.08	17	11.11	19	14.96	4	4.21	5
Climate change	14	7.91	12	7.84	17	13.39	14	14.74	6
Low soil fertility	4	2.26	6	3.92	2	1.57	5	5.26	7
Lack mechanized agriculture		0.00	2	1.31	3	2.36	7	7.37	8

Source: household survey result and secondary data report, 2016.

Haricot Bean-Chickpea based farming system

Chickpea and haricot bean are widely produced in East Shewa Zone (ZoARD, 2016). The haricot Bean-Chick pea based farming system was widely practiced in midland of Adea, libean cukala, Gimbichu and Lume districts of East Shewa Zone. The mean land allocated for chickpea and haricot bean production was 0.5 hectare and 0.48 hectare respectively. The major crops produced in this sub-cluster farming system next to chickpea and haricot bean production are lentils, wheat, barley, maize, teff and linseed. From the total cultivated land (1.5ha), 35% allocated for lentils, wheat, barley, maize, teff and linseed production. Livestock production was also undertaken in this farming system for diversifying the livelihood of the farmers.

Major production constraints of Haricot Bean-Chick pea based farming system

The major constraints in this sub-cluster of farming system were identified and ranked based on their appearance in the study areas (Table, 15). These constraints are lack of credit and cash, market problems (market information, high input prices and low market price of outputs), untimely supply of agricultural technologies (fertilizers and chemicals), shortage of improved seed and disease resistance varieties, disease, climate change (erratic rain fall and drought), and lack of mechanized agriculture. According to the respondents the crop disease occurred due to shortage of chemicals, untimely supply of chemicals according to the requests and lack disease resistance varieties.

Table 51. Major production constraints in haricot bean-chickpea based farming system

		1st		2nd		3rd		4th		Index rank
No.	Constraints	Freq.	%	Freq.	%	Freq.	%	Freq.	%	
1	Lack of credit and cash	32	32.00	25	25.25	16	18.82	16	25.40	1
2	Market problems	7	7.00	20	20.20	12	14.12	13	20.63	2
3	Untimely supply of agricultural inputs	18	18.00	12	12.12	13	15.29	7	11.11	3
4	Shortage of improved seed	13	13.00	19	19.19	12	14.12	4	6.35	4
5	Disease	15	15.00	12	12.12	14	16.47	3	4.76	5
6	Climate change	11	11.00	6	6.06	10	11.76	7	11.11	6
7	Lack of mechanized agriculture		0.00	2	2.02	5	5.88	5	7.94	7

Source: Household survey result, and secondary data report, 2016.

Farmers' perception towards change in farming systems in West Arsi and East Shewa Zones

Land is an important input factor in agricultural production. However, the farmers faced shortage of land in both West Arsi and East Shewa Zones. The main causes of land shortage were an alarming rate of population growth and expansion of cultivation land. The sampled households mean land holding in West Arsi Zone and East Shewa Zone are 2.08 hectare and 2.31 hectare respectively. Population growth and expansion of cultivation land leads to shortage of grazing and deforestation which result in ozone depletion that causes global warming. Therefore, an intervention is required especially on intensification farming and awareness creation on forest conservation in the zones.

Land shortage limited households to operate on small farms which may cause low crop production. Low crop production leads to shortage of food supply and income. Hence, intensifying farming system and engaging in off/non-farm activities are a good option for reducing food shortage and income problems. There are different measures taken by the farmers to offset the land shortage and increase production under conditions of land shortage. Those measures are use of fertilizers and improved seeds, compost and manure, crop rotation, share cropping, land renting which accounts around 44 and 37% respectively in West Arsi and East Shewa Zones, livestock rearing and accomplishing other off/non-farm activities like daily laborer, petty trade and the like as additional source of income.

More than 94.70 percent and 75.69 percent of the respondents in West Arsi and East Shewa Zones perceived that the grazing land becomes reduced due to expansion of cultivation land and population pressure. In West Arsi Zone, 43.25%, 29.66% and 23.95% of the households perceived that trend of crop production is increasing, decreasing and fluctuating respectively since five years. In East Shewa Zone, 20.65%, 62.50%, and 16.85% of the households perceived that trend of crop production is increasing, decreasing and fluctuating respectively since five years. This indicated that the nature of farming system changes from time to time due to different factors. The cause for increasing in agricultural production was training and advices obtained from development agents and other bodies on production inputs (fertilizer, improved seeds and livestock breeds, and pesticides), agronomic practices (land preparation, row planting, and weed management) and few mechanization technologies in cop and livestock production. However, the reduction in agricultural production was due to mono cropping, unavailability of inputs at required time and required amount, shortage of quality and diseases resistance varieties, and climate change (drought and erratic rain fall) in West Arsi and East Shewa Zones.

The dynamism in farming system in West Arsi and East Shewa Zones occurred due to change in climate, shifting from one enterprise (livestock to crop) to another due to awareness created and production goal (from household consumption to market oriented production) and shift in enterprise due to continuous disease and pest occurrence. Most farmers change their whole dependence on agriculture and shift to off/non-farm activities like petty trade because of frequent crop failure, farmland shortage and search for better living standards in urban areas.

Cropping system in West Arsi and East Shewa Zones

The production system in West Arsi Zone is dominated by rain fed while East Shewa Zone had both rain fed and irrigation. As indicated in table18, the major cropping systems practiced in West Arsi Zone are intercropping, relay cropping, mixed cropping, solo/mono cropping, and crop rotation systems. Maize relayed with teff, haricot bean, chickpea, and linseed, while intercropped with cash crops such as haricot bean and sometimes sorghum. Sole cropping is dominantly practiced in West Arsi and East Shewa Zones (Table, 16). This practice brought soil infertility problem which leads to low crop production. The other cropping system like intercropping, mixed cropping, and crop rotation are also practiced in both Zones (Table, 18). Maize relayed with teff, haricot bean, and chickpea and it intercropped with haricot bean and with sorghum sometimes.

Table 52. The type of cropping system practiced in West Arsi and East Shewa Zones

Cropping system	West Arsi Zone (%)	East Shewa Zone (%)
Intercropping	2.02	0.76
Relay cropping	1.61	0
Mixed cropping	4.44	0.76
Solo (Mono cropping)	79.84	88.64
Crop Rotation	10.89	9.85

Source: Household survey result, 2016.

Livestock Production System in West Arsi Zone

Livestock is the most important farm activity in crop-livestock mixed farming system. However, there is a difference in owning livestock among households based on climate and intensity of crop farming across districts. The major livestock type owned was cattle with overall mean of 9.15 followed by poultry and sheep having a mean of 8.47 and 4.2 respectively (Table, 17). Overall, West Arsi Zone have an average of 10.74 total livestock unit (TLU) that indicated there is still livestock production even though, its trends decreasing since last five years as 87.40% farmers perceived.

As the study result revealed that, in addition to free grazing, 93.56% of sample respondent farmers use crop residues such as wheat and barley bran for their livestock feeding. Moreover, the above feeding system (utilization of crop residue) is due to shrinkage of grazing land as 94.70% sample respondent perceived evidenced.

Table 53. Livestock production in West Arsi Zone

No	Livestock type	Amount	Conversion factor	Converted in tlu	Remark
1	Local Cows	2.49	1.0	2.49	
2	Cross breed cows	0.803	1.0	0.803	
3	Local Oxen	1.81	1.0	1.81	
4	Heifers	1.61	0.75	1.21	
5	Calf	1.60	0.25	0.40	
6	Bulls	0.84	0.75	0.63	
7	Goat	2.88	0.13	0.37	
8	Sheep	4.2	0.13	0.546	
9	Local chicken	5	0.013	0.065	
10	Exotic chicken	3.47	0.013	0.045	
11	Donkey	1.49	0.70	1.043	
12	Horse	1.21	1.10	1.331	
13	Camel	0	1.10	0	
	Total			**10.74**	

West Arsi Zone has only about 2.35 percent of crossed breed compared to local breeds (table, 16). Even though there is high livestock potential, activity done so far to improve livestock breed in West Arsi Zone very less.

To classify livestock in terms of their keeping purpose, cattle especially the male ones were majorly kept for draught forces, and followed by other social values (prestige) and beef while female cattle were kept for breeding purposes, followed by milk production and social values.

The mean milk production per household in West Arsi Zone was around 1.99 liters per a household per day during shortage of feeding. The milk productivity obtained from local cow and cross breed cow was 1.10 liter/day/cow and 2.88 liter/day/cow during feed shortage. But the productivity of both local and crossed breed increased during sufficient availability of feed with the mean value, 2.27 liter/day/cow and 5.40 liters/day/cow respectively for local and cross breed cows. Therefore, working on all aspects of the dairy cows like feed and health can improve the production and productivity. Furthermore, livestock in West Arsi Zone were also important sources of household cooking energy (animal dung) especially in highland and mid highland areas.

Pack animals (donkey, horses and mules) were all most important means of transportation in farm and non-farm activities (petty trading); productive and reproductive activities and both for human and agricultural products. In all cluster of farming system these animals were ranked next to cattle (which are main sources of draught power) in terms of their economic importance.

Small ruminants were kept for immediate/emergency cash obligations, unplanned emergency issues, educating children, to purchase agricultural inputs like fertilizer, seed and chemicals. While poultry birds were mostly owned by children and female spouses and used for household consumption and selling to markets to purchase the households' consumables which were non-agricultural products.

Major livestock production constraints in West Arsi Zone

As the index rank result indicates, the major livestock production constraints were identified as lack of improved breed, lack of improved agricultural technologies/mechanization especially for poultry production, shortage of feed, disease, and climate change. Lack of credit, lack of market information, labor force shortage and poor access to extension service were also another major livestock production constraint in West Arsi Zone (table, 18).

Table 54. Major livestock production constraints in West Arsi Zone

No	Major Constraints	1st		2nd		3rd		4th		Index Rank
		Freq.	%	Freq.	%	Freq.	%	Freq.	%	
1	Lack of credit	29	11.03	72	28.57	47	22.38	27	27.27	1
2	Lack of improved breed	54	20.53	56	22.22	34	16.19	10	10.10	2
3	Shortage of feed	41	53.61	37	14.68	23	10.95	11	11.11	3
4	Poor access to extension service	13	4.94	28	11.11	39	18.57	20	20.20	4
5	Lack of market information	8	3.04	14	5.56	27	12.86	18	18.18	5
6	Lack of improved agri. technologies/mechanization	3	1.14	16	6.35	12	5.71	3	3.03	6
7	Climate change	4	1.52	12	4.76	11	5.24	4	4.04	7
8	Disease	8	3.04	10	3.97	11	5.24	1	1.01	8

Source: household survey and FGD results, 2016.

Livestock production system in East Shewa Zone

Livestock is an important enterprise that reared by farmers in both agro-pastoral and crop-livestock mixed farming system. Agro-pastoral farming system was dominant in Fentale district in which small ruminants took lion share for their livelihood activities. Mixed crop-livestock farming system was dominant in remaining districts of East Shewa Zone. However, there is difference in livestock type owned by the farmers across districts due to climatic condition and intensity of crop farming. The major livestock type owned was small ruminants with overall mean of 9.66 followed by cattle and poultry having means of 6.99 and 6.94 respectively. Overall, average livestock owned in East Shewa Zone was 9.37 TLU even though livestock production trend is decreasing since last five years as 91.80% farmers' perceived (table, 19).

In East Shewa Zone, majority (88.04%) of the farmers used free grazing land for livestock feeding. In addition to this, the sample farmers used crop residue for their livestock feeding due to shrinkage of grazing land as 75.69% sample respondent perceived. In pastoral/agro-pastoral farming system (like Fentale district) the farmers migrates from one area to another area like Adami Tulu Jido Kombolcha (ATJK), Arsi Nagelle and Shashemane districts for searching livestock feed especially for cattle and camel.

Table 55. Livestock production in East Shewa Zone

No	Livestock type	Amount	Conversion factor	Converted in TLU
1	Local Cows	1.99	1.0	1.99
2	Cross breed cows	0.082	1.0	0.082
3	Local Oxen	2.101	1.0	2.101
4	Heifers	1.16	0.75	0.87
5	Calf	1.152	0.25	0.288

6	Bulls	0.51	0.75	0.383
7	Goat	5.36	0.13	0.697
8	Sheep	4.3	0.13	0.559
9	Local chicken	5	0.013	0.065
10	Exotic chicken	1.94	0.013	0.025
11	Donkey	0.79	0.70	0.55
12	Horse	1.19	1.10	1.31
13	Camel	0.41	1.10	0.45
	Total			**9.37**

Source: Household survey result, 2016.

To classify livestock in terms of their keeping purpose, cattle especially the oxen and bull are kept for draught power, social values (prestige, and gift during weeding ceremony) and beef while female cattle are kept for breeding purposes, milk production and social values. The mean milk production per household in East Shewa Zone was around 1.33 liters per day during feed shortage. The milk productivity of local cow and cross breed cow was 0.75 liter/day/cow and 1.90 liter/day/cow during feed shortage. But, the productivity of milk for local and cross breed increased during sufficient availability of feed with the mean value of 1.88 liter/day/cow and 7.33 liter/day/cow respectively for local and cross breed. Therefore, working on all aspects of the dairy cows through supplying improved feed can increase the production and productivity. Furthermore, livestock in East Shewa Zone were also important sources of household cooking energy (animal dung) especially in highland and midland areas.

Pack animals (donkey, horses and mules) were important means of transportation in farm and non-farm activities (petty trading), generate income by serving as cart and selling, and sources of household cooking energy (dung). In all cluster of farming system these animals were ranked next to cattle (which are main sources of draught power) in terms of their economic importance.

Small ruminants are kept for immediate/emergency cash obligations, unplanned emergency issues, paying education fee of children, purchase agricultural inputs like fertilizer, seed and chemicals. The poultry are kept by households for household consumption and selling to purchase the households' consumables goods.

Major livestock production constraints in East Shewa Zone

As the index rank result indicates the major livestock production constraints were lack of improved breed, lack of improved agricultural technologies/mechanization especially for poultry production, shortage of feed, disease, and climate change (table, 20). Lack of credit, lack of market information, labor force shortage and poor access to extension service are also the major livestock production in East Shewa Zone.

Table 56. Major livestock production constraints in East Shewa Zone

No	Major Constraints	1st		2nd		3rd		4th		Index Ranking
		Freq.	%	Freq.	%	Freq.	%	Freq.	%	
1	Shortage of feed	94	51.37	34	18.89	13	8.50	11	11.11	1.00
2	Lack of credit and cash	30	16.39	50	27.78	37	24.18	27	27.27	2.00
3	Lack of improved breed	34	18.58	49	27.22	25	16.34	10	10.10	3.00
4	Market problems	7	3.83	16	8.89	41	26.80	18	18.18	4.00
5	Poor extension service	5	2.73	18	10.00	23	15.03	20	20.20	5.00
6	Climate change	7	3.83	6	3.33	3	1.96	4	4.04	6.00
7	Lack of agri.technologies	2	1.09	3	1.67	7	4.58	3	3.03	7.00
8	Disease	3	1.64	3	1.67			1	1.01	8.00

Source: household survey and FGD results, 2016.

Beekeeping and Production Constraints in West Arsi and East Shewa *Zones*

The study result showed that only 15.53 percent of the households practiced beekeeping and around 84 percent of the households do not practiced beekeeping in West Arsi Zone. Only 2.17 percent of the households practiced beekeeping and around 98 percent of the households do not practiced beekeeping because of different reasons in East Shewa Zone. The probable reason was lack of awareness and climate change in both Zones.

The sampled households have on average two traditional beehives under production in West Arsi Zone whereas in East Shewa Zone the households have on average four traditional beehives under production. However, the households who have transitional and modern beehives were very few in both Zones. In West Arsi Zone the household harvested on average about 9 kg/hives of honey from traditional hive at one harvesting time. In East Shewa Zone the household on average harvested 8kg/hive from traditional hive twice per annual. The average selling price of honey was 133.18birr/kg in West Arsi Zonal market whereas 170birr/kg in East Shewa Zonal market. The most important reason that was ranked first was because of own ignorance.

The major constraints of beekeeping in West Arsi and East Shewa Zones are chemicals applied to different crops, bee forage and water shortage, predators, high price and supply shortage of modern beehives, labor and land shortage.

Agricultural Technologies Use in West Arsi and East Shewa Zones

The Absence or supply shortage of agricultural mechanization technologies were the major production constraints in all farming system of West Arsi and East Shewa Zone. In wheat, barley and teff growing areas, even though farmers understood the importance of row planting, absence of row planter technologies were the major bottleneck problems during sowing in both Zones. The existing chemical sprayer equipment (knapsack) which was carried on human's back is unsafe for the operator and tiresome. This leads to misapplication of chemicals which may affect crop production. Therefore, provide training for farmers on chemical application and safety, and modernizing/further mechanizing the technology was important solution to reduce misapplication of chemicals in the study areas.

In areas where crop productions were high but mechanized agricultural technologies were unavailable, supplying technologies like harvesting and threshing/shelling based on the capacity and demands of the producers.

The table 21 below indicated that the farmers are using agricultural technologies in crop production. The majority of the households used different types of improved seed, row planting & inorganic fertilizer in crop production. The few farmers used BBM to plough the land and sowing the crops. Very few numbers of farmers were also use large mechanized technologies like tractor and combiner for ploughing their lands and harvesting the crops.

Table 57. The types of Agricultural technologies used in West Arsi and East Shewa Zone

Agricultural technologies	West Arsi Zone (%)	East Shewa Zone (%)
Improved Seed	18.85	6.72
Inorganic fertilizer utilization	16.54	12.69
BBM	0.38	0.75
Improved seed, row planting & inorganic fertilizer	29.62	22.39
Improved seed and inorganic fertilizer	29.62	51.49
Inorganic fertilizer and row planting	5.00	5.97
Total	**100**	**100**

Source: Household survey result, 2016.

Soil and Water Conservation and Soil Fertility Improvement Practices

There are two major types of soil water conservation practices in West Arsi and East Shewa Zones. In West Arsi Zone, most (90%) of farmers practiced physical soil and water conservation practices whereas 8.87% practicing physical and biological soil and water conservation and about 2% practicing biological soil and water conservation on their own farm lands (table, 22).

Soil bund and cutting check-dam were the widely used physical soil and water conservation while planting multi-purpose trees and grasses were among the biological types of soil and water conservation. The farmers planted grasses like elephant grass, Desho grass and Rhodes on their land in West Arsi Zone to protect soil erosion.

The physical soil and water conservation practice was widely practiced by farmers in the East Shewa Zone. Around 85 percent farmers used physical soil and water conservation whereas 13.12% practicing biological soil and water conservation and 1.64% practicing both physical and biological soil and water conservation on their own farm lands (table, 22). Soil bund, terraces and cutting check-dam were widely used in physical conservation while planting multi-purpose trees and grasses were among the biological types of soil and water conservation. The farmers planted grasses like elephant grass and Rhodes on their land in East Shewa Zone to protect soil erosion.

Table 58. Soil and water conservation practices in West Arsi and East Shewa Zones

SWC Practices	**West Arsi Zone (%)**	**East Shewa Zone (%)**
Biological	1.61	13.115
Physical	89.52	85.25
Both	8.87	1.64
Total	**100**	**100**

Source: Household survey result, 2016.

The farmers practice different soil fertility improvement activities in West Arsi and East Shewa Zones. Animal manure, composts, crop residues and crop rotation were widely used in West Arsi Zone to improve soil fertility. The majority of the households applied animal manure followed by compost for soil fertility improvement in both Zones (Table, 23).

Table 59. Soil fertility improvement practices in West Arsi and East Shewa Zones

SFI Practices	**West Arsi (%)**	**East Shewa (%)**
Use animal manure (dung)	79.88	85.19
Use compost	13.61	8.15
Use crop residue	2.96	0
Use all animal manure, compost and crop residue	3.55	6.66
Total	**100**	**100**

Source: Household survey result, 2016.

Conclusions and recommendations

This chapter explains the summarized findings of the study and gives important policy recommendations on the identified gap of the study.

Conclusions

The conclusion of the study is made based on the findings of the farming system study. The study was conducted in West Arsi and East Shewa Zones to identify and characterize the farming systems. The assessment was undertaken through conducting survey at household levels which addresses 264 households in West Arsi Zone and 184 households in East Shewa Zone. The farmers are categorized into model farmers, middle farmers, and poor farmers based on their resource endowments (wealth status). So, this study finds out that 68% and 73% of the farmers categorized under middle farmers in West Arsi Zone and East Shewa Zone.

From the study result it can be concluded that mixed crop-livestock farming system is fully practiced in West Arsi Zone. Mixed farming system in West Arsi Zone was classified into potato-haricot bean based farming system and cereal based farming system. The cereal based farming system was also classified into wheat-teff based farming system; Food-Malt barley farming system and maize based farming system. In East Shewa Zone farming system was classified into pastoral/agro-pastoral farming system and mixed crop-livestock farming system. Mixed farming system was classified into irrigation based farming system that contains onion-tomato based farming system and rain-fed based farming system that clustered into maize-teff farming system and haricot bean-chickpea based in farming system.

This study identified and ranked the major constraints that farmers encountered in agricultural production in West Arsi and East Shewa Zones. The major constraints that farmers faced in crop production and livestock rearing are Shortage of improved seed, disease incidence (rust), unavailability of agricultural technologies (fertilizers and chemicals) on time with the required amount, lack of credit and cash, market problems (market information and high input price), climate change (drought and erratic rain fall), shortage of improved breed, shortage of feed, poor access to extension service(AI and health) and absence of mechanized agricultural technologies.

Recommendations

- The study recommendation was made based the identified gaps of the farming system study in West Arsi and East Shewa Zones.

- Upgrading the farmers' skills on agricultural technologies (fertilizer and chemical applications) through trainings have better improvement on agricultural production;
- An intervention is required on improving the livestock production through providing improved health services and breeds, improved feeds and feeding system;
- It is better to work on demonstrating the existing agricultural technologies and promote the demanded technologies to improve agricultural production;
- The traditional agriculture is widely practiced in West Arsi Zone and East Shewa Zone. This leads to low agricultural production. Therefore, any intervention that shifts traditional agricultural production to modern agriculture like irrigation based production is encouraged to increase production and solve the problem of food insecurity

- Shortage of credit delivery service is one of the major constraints that affect farmer's production. Therefore, an intervention that improves credit delivery services is recommended to enhance farmers' production in areas.
- Low soil fertility is one of the major constraints that affect crop production in the study areas. Therefore, any interventions that improve soil fertility are required in the areas to enhance crop production and productivity in the areas;
- Deliver proper & adequate market information through strengthening market information delivery network and also link farmers' cooperatives/groups with proper sources of market information;
- Strengthening farmers' linkage by linking them to input suppliers and delivering proper & adequate market information through market information delivery network;
- Agro metrology based agricultural production should be identified by research to develop mitigation and coping up mechanism to adapt climate change and reduce its impact on agricultural production.

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