

Full Length Research Paper

Characterization and analysis of farming system of Cheliya and Ilu Gelan districts of West Shewa Zone, Ethiopia

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The study characterizes and analyzes the existing farming system and identifies the production and marketing constraints of Cheliya and Ilu Gelan districts with cross-sectional data of 105 sample households. The farming system of the study areas is characterized as mixed farming systems with 59.1 and 27.44% contribution of crop and livestock, respectively for livelihood activities. From the survey results, disease (96.19%), shortage of grazing land (73.33%), feed shortage (48.57%), shortage of veterinary medicine (20.95%), shortage of water (18.10%) and lack of improved breeds (14.29%) were identified as major important constraints in livestock production. High transaction cost (71.43%), lack of capital (35.24%), lack of market information (23.81%), price and demand fluctuation (21.90%), lack of market linkage (14.29%) and unorganized marketing system (12.38%) 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 needs attention. Additionally, improving crop productivity through Integrated Pest Management (IPM), improved varieties, minimizing transaction cost, focusing on high value crop, expanding soil and water conservation, strengthening market information and linkage needs urgent concentration for interventions.

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

INTRODUCTION

Agriculture is the most important sector in Ethiopia and contributes significantly to the livelihoods of the study areas with fastest growing economic (Paul et al., 2016).

Agriculture of the country areas has been characterized by low productivity due to land degradation, low technological inputs, low soil fertility, weak institution

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linkage, lack of appropriate and effective agricultural policies and strategies (Aklilu, 2015; Abush et al., 2011). Smallholder farmers in the study areas are not focused on market oriented productions rather than substance production in dynamics of farming system. These challenges call for characterization and analysis of farming system of the study areas to enhance production and productivity of crop, livestock and natural resources.

A farming system is a unique and reasonably stable arrangement of farming enterprises that a household manages according to well defined practices in response to the physical, biological and socio-economic environment and in accordance with the household goals preferences and resources (Garnett et al., 2013). The Ethiopian agriculture is dominated by about 11.7 million smallholders responsible for about 95% of the national agricultural production while large farms contribute only 5% 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 comprise complex production units involving a diversity of mixed crops and livestock in order to meet the multiple objectives of the household (Dennis et al., 2012) which is similar to the study areas. 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 (FAO, 2016). 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.

Therefore, 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.

Specific objectives

- (1) To characterize and analyze the existing farming system of major agro-ecology of the study areas;
- (2) To identify the production constraints and opportunities of the farming system for interventions.

RESEARCH METHODOLOGY

Sampling techniques

A multi-stage technique was employed to select sample households

from the population. In the first stage, West Shewa Zone was stratified into two agro-ecologies which are high land and mid land that are more homogenous than the total population. In the second stage, from each stratum one district was selected purposively based on agro-ecology, crop potential, livestock and natural resources. Accordingly, Cheliya district was selected from highland and Ilu Gelan district was selected from midland agro-ecology. In the third stage, two kebeles were selected purposively from each district based on agro-ecology, crop potential, livestock, natural resources and accessibility. Finally, 105 sample households were selected randomly using probability proportional to size.

Data type and data collection analysis

The study was based on both primary and secondary data. Primary data were collected from the sample households using a semi-structural schedule by trained enumerators. In order to capture better information of the study areas, qualitative data collection such as focus group discussion was conducted using checklist schedule. Each group consisted of at least 20 considering gender and wealth status based on formal survey. Secondary data were also collected from published and unpublished materials from the respective West Shewa zone and districts for a comprehensive report and rational conclusion.

Data analysis methods

Descriptive statistics such as mean, standard deviation, frequency and percentage were used to analyze quantitative data gathered from sampled households. The constraints were analyzed using pair wise ranking to prioritize the constraints.

RESULTS AND DISCUSSION

Sample household characteristics

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 followers. According to key informants interview model the farmers adopted new technologies early than followers. Only 12.40% of sample households were rich in wealth status (Table 1). The average household size across the surveyed households was 7.39 whereas the average number of adults was 5.91 using conversion factors which consider age and sex of the member.

Land holding and acquisition methods

Land is the most important asset of sample household in Ethiopia and the availability of land permits the production of more crops (Bekele et al., 2017). The study indicated land tenure and how land under the farmers control was utilized. The survey result revealed that, the average of 2.04 ha per farmer was owned by sample households and 1.56 ha per farmer was cultivated. The average grazing land, forest land and residential land is summarized in Table 2. About 0.42, 0.18 and 0.07 ha per

Table 1. Sample households' characteristics.

Variable		Cheliya (49)		Ilu Gelan (56)		Total (105)	
		Frequency	%	Frequency	%	Frequency	%
Sex of household head	Male	44	89.80	56	100	100	95.2
	Female	5	10.20			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

Source: Survey Results (2017).

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

Land category	Cheliya (49)			Ilu Gelan (56)			Total (105)		
	%	Mean	Std. Dev.	%	Mean	Std. Dev.	%	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).

farmer were allocated for grazing land, forest and residential land, respectively. In the survey sites, fallow land was not a common practice due to shortage of land. There was minimum activity on land renting and more than half apply crop sharing system during the survey period (Table 2).

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 farmers. Households own ox-plough, hoe and other (Spade, axe, etc.) farm equipment which are the most important in farming activities. 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 which are used as technology information disseminated to farmers in the study areas (Table 3).

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 production, livestock rearing and off/non-farming. As indicated in Table 4, about 100 and 98.10% of sample households' livelihood depend 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, and wood craft were additional income and food sources of households. The result indicates that about 53.33% of sample households participated in off/non-farming activities which contributed 13.46% to annual income generation.

Table 3. Ownership of farm equipment and information communication technology.

Asset	Cheliya (49)		Ilu Gelan (56)		Total (105)	
	%	Mean	%	Mean	%	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

*² = only two farmers have hydro/line electricity and numbers in parentheses are standard deviations.
Source: Survey Results (2017).

Table 4. Livelihood activities of sample households.

Activity	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

Table 5 presents 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 owned horses, donkey and mule for means of transportation service and income generation source.

Analysis of the herd size shows 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 than shoats and equines with only 6.70% households keeping improved poultry.

The average milk per day was 1.48 and 1.30 L at Cheliya and Ilu Gelan districts, respectively. Majority of sample households reported milk productivity decreased from time to time over last five years due to feed shortage and disease.

Livestock ownership is generally regarded as key to rural livelihoods which are sources of power and fertilizer for crop production, supply human food, transportation, income generation sources and wealth communication (Behnke and Fitaweke, 2011; Amede et al., 2011). Moreover, the role of oxen availability played in the timely adequate cropland preparation could contribute to increase food-feed crop production.

Livestock production and marketing constraints

Livestock producers were asked to give their perspectives on most important constraints affecting their livestock farm operations and their responses are summarized in Table 6. The three most frequently reported production constraints were disease like trypanosomiasis, black leg, anthrax, pastevrellosis and mastitis (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 the 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 (pastevrellosis, lichen, leg and foot and mouth and dermatophytosis) and shortage of grazing land were the most important production constraints of shoats and equines. There are about 52.38 and 49.52% of disease

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

Livestock type	Cheliya (49)		Ilu Gelan (56)		Total (105)	
	% h. holds	Mean (TLU)	% h. holds	Mean (TLU)	% h. holds	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)

*Percentage of crossbred poultries and numbers in parentheses are standard deviations.
Source: Survey Results (2017).

Table 6. Major livestock production and market constraints of sample households.

Production constraints (n=105)	Percentage of households reported as constraints and their rank							
	Cattle	Rank	Shoats	Rank	Equines	Rank	Poultry	Rank
Shortage of grazing land	73.33	2	49.52	3	30.48	2	-	-
Disease	96.19	1	52.38	1	31.43	1	66.67	1
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	4	5.71	-	-	-	16.19	5
Water shortage	18.1	-	6.67	-	-	-	-	-
Market price/demand fluctuation	21.90	-	14.29	-	6.67	-	16.19	5
Lack of capital	35.24	5	16.19	-	-	-	10.48	-
Lack of information	23.81	-	33.33	4	9.52	4	18.10	4
Lack of market linkage	14.29	-	28.57	5	8.57	5	19.05	3
Unorganized marketing system	12.38	-	8.57	-	7.62	-	10.48	-
High transaction cost	71.43	3	52.38	1	14.29	3	23.81	2

Source: Survey Results (2017).

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

The main marketing problems 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 summarized in Table 6. 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 the marketing of cattle. The result indicates that about 23.81 and 21.90% of sample households reported to 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 6, high transaction cost (52.38%), lack of market information (33.33%) and lack of market linkage (28.57%) were the main constraints

Table 7. Livestock feed sources and feeding system of sample households

Common feed source	Cheliya n=(49)		Ilu Gelan (n=56)		Total (n=105)	
	N	%	N	%	N	%
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

Source: Survey Results (2017).

Table 8. 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).

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 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.

Livestock feeding system

Types of livestock feeding systems were summarized in

Table 7. Livestock producers practiced three grazing systems and their combinations. Straw (teff, barley, wheat, bean, pea) and stover of maize and sorghum 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 the survey period. Supplementary feeds like fagullo and salt were used by few farmers during the survey period.

Beekeeping practices

Beekeeping practice is a common practice of rural livelihoods as income generation source and home consumption. Table 8 presents beekeeping practice and major constraint in terms of number and production

Table 9. 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
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)

Numbers in parentheses are standard deviations.

Source: Survey Results (2017).

honey. Result shows that a few percentage of the sample households in the survey areas own traditional types of beehives (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%), ants 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 the survey period.

Crop pattern and productivity

Cropping patterns adopted by farmers in the study areas depend 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 9). The result shows that

99.05% of the sample households 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 ha of land, respectively.

Analysis of crop yields was done separately at the district level and overall expressed in quintal per hectare as summarized in Table 9. The yield of sample households during the 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 practice was reported though in medium usage (Table 9). About 75.24% of sample households reported their soil status to be good depending on

their perception. Some of the soil fertility enhancing practices identified includes conservation tillage, crop residue retention, maize-legume intercropping and cereal-legume rotation, especially in Ilu Gelan district. Soil fertility management has been shown to improve yields more than using of chemical fertilizers (Tchale and Sauer, 2007). Therefore, it implies that improved soil fertility increases crop yield than using of appropriate improved inputs.

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 10 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

Table 10. 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 (%)		Time planting
								Row	Broadcasting	
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

4*=four sachets inoculants were recommended per hectare.
Source: Survey Results (2017).

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 plant 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 10). In addition to low inputs, using unsuitable planting methods may

decrease 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 range from March to end May. In general, there is a knowledge gap using inputs appropriate rate and time of application.

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 spp (*hadaa/tufoo*), bromuss (*Keelloo*) and snowdenia polystarcya (*Mujjaa*). Besides, Oxallis (teff), avena fatua (wheat and barley), commelina benghalesis (maize), raphatum (field pea) and cuscuta compestris (nug) were reported as important weeds in the study districts during the survey period.

Weed management options exercised by sample

households was typically hand weeding and herbicide like 2-4-D. Hand weeding was conducted throughout the crop stage ranging from 1 to 3 times depending on crop types and weed infestation. After 2-4-D herbicide application at least one-time hand weeding was common in the study areas.

Cropping system

Cropping system of the study areas is summarized in Table 11. The term cropping system is crop sequences and the management techniques used in a particular field over a period of year.

The result shows that mono cropping, crop rotations and double cropping systems were common cropping systems practiced in the study areas. Mono cropping system 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

Table 11. Cropping system and improved crop technologies used by sample households

Cropping system	Percent used technology (%)			Current used technology
	Cheliya (n=49)	Ilu Gelan (n=56)	Total (n=105)	
Mono-cropping	34.69	60.71	48.57	-
Crop rotation	65.31	39.29	50.48	-
Double cropping	40.82	3.57	20.95	-
Crops	Varieties			
Maize	Improved varieties	36.70	96.40	68.60
Teff	Improved varieties	6.10	5.40	5.70
Wheat	Improved varieties	22.40	5.40	13.30
Potato	Improved varieties	24.50		11.40
Soybean	Improved varieties	-	7.14	3.81

Source: Survey Results (2017).

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 other within a year. According to the survey result about 50.48 and 20.95% of sample households 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 of cropping system.

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 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.

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 majority of sample households use manure organic fertilizer. This implies that manure organic fertilizer was the most known by sample households.

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 presented in Table 15.

Results presented in Table 12 show 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. Other constraints such as high cost of inputs (53.33%), weed infestation (47.62%), shortage of 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 constraints in potato, nug and field pea were pests and low yield as presented in Table 12. 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 12, 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

Table 12. Major crops production and marketing constraints of sample households.

Major crops constraints (n=105)	Percentage of households reported as constraints									
	Maize	Teff	Soybean	Wheat	Potato	Field pea	Faba bean	Sorghum	Barley	Nug
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	-
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).

Table 13. Forestry and rainfall pattern for last five years of sample households.

Forest type	Cheliya (n=49)		Ilu Gelan (n=56)		Total (n=105)	
	Frequency	%	Frequency	%	Frequency	%
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
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).

was necessary for fulfillment of short term needs like quantities, prices and market infrastructure (Denning et al., 2009).

Forestry and agro-forestry

According to 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.

Over the last five years the status of plantation increased (41.90%) and the same (33.30%) sample households reported, respectively (Table 13). This implies that different natural rehabilitation practices of the last five years may increase 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

Table 14. Soil and water conservation type and major constraints of sample households.

Practices		Cheliya (n=49)		Ilu Gelan (n=56)		Total (n=105)	
		Frequency	%	Frequency	%	Frequency	%
Type of SWC	Terraces	4	8.20	6	10.70	10	9.50
	Check dam	31	63.30	33	58.90	64	61
Plantation 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
Major constraints of SWC	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).

of income generation following gravilia. Majority of the sample households grow plantation around their home (garden), along the farming land and marginal land for plantation. Though, the result indicates that strategic plan for plantation needs attention.

Agriculture in the study areas was dominant in rain fed and it is highly dependent on rainfall on set and offset. According to the survey result, about 84.80% sample households were reported as late on set and early offset rainfall. Only about 15.20% of sample households reported early on set and off set rainfall (Table 13). 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, maintenance and consumption of common pool resources like forest, soil and water. Soil and water conservation received attention from government to sustainable uses of natural resource.

According to the survey result, about 61 and 9.50% of sample households practiced on their land check dam and terraces soil and water conservation, respectively for soil erosion decrease and improved soil fertility. Few farmers grow gravilia, getra and elephant grass on their soil and practice water conservation (Table 14).

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 reported soil erosion and soil fertility decline as main important constraints, respectively. About 43.81 and 33.33% of sample households reported water logging

and soil acidity as important constraints, respectively. Only 12.38% of sample households reported termite as constraint in the study areas.

Agricultural extension services

Technology adoption is highly dependent on information access (Berhanu et al., 2006). 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 obtained information/advice services from DAs and BoANR, respectively. Only about 2.86% of sample households gained extension service from research centers. The extension services are focused on crop production (97.14%), livestock rearing (64.76%) and natural resource (58.10%) managements through training and/advice services (Table 15). 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 visited demonstration of FTC and model farmers. Regarding adopted technologies visited, about 47.60% adopted who they visited demonstration (Table 15). This implies that field day is better than training and advising services in terms

Table 15. Agricultural Information sources of sample households.

Extension service sources		Cheliya (n=49)		Ilu Gelan (n=56)		Total (n=105)	
		Frequency	%	Frequency	%	Frequency	%
Sources of extension services	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
Extension services specified	Crop production	48	97.96	54	96.43	102	97.14
	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).

Table 16. Credit utilization and constraints of sample households.

Credit		Cheliya (n=49)		Ilu Gelan (n=56)		Total (n=105)	
		Frequency	%	Frequency	%	Frequency	%
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).

of technology adoption.

Credit utilization

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 16, about 43.81% of sample households utilized credit for purchasing inputs (fertilizer, seed and chemical). Fattening and petty trade were important activities attached to credit. Results show that about 36.19 and 21.90% of sample households were used for fattening and petty trade activities, respectively (Table 16). 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 needed credit to buy input following fattening activity. The source of this credit was microfinance like Oromia saving and credit, Eshet and Wasasa share companies. The majority of sample households reported collateral (42.86%) and high interest rate (9.52%) as important constraints (Table 16).

Market and mode of transportation

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 (Denning et al., 2009).

Table 17. Market and mode transportation of sample households

Variable	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 (minutes)	118.95	34.67	89.02	47.68	113.43	37.12
Main mode of transport	N	%	N	%	N	%
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

Source: Survey Results (2017).

Table 18. Market information of the sample households.

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	DA	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

Source: Survey Results (2017).

Results from analysis of the market situation were summarized in Table 18. Farmer on average access market place 1.25 with average walks of 113.48 min. The main mode of transport is also analyzed in Table 17. 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 used cart for transportation service.

Marketing information

Information flow reduces market imperfections with choices for the type of market of farmers to sell their product. Regarding market information access, about 81.90% of sample households 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 obtained information from neighbor farmers and traders, respectively. About 23.81 and 16.19% sample households gained information from DAs and cooperatives, respectively (Table 18). Among these sources, neighbor farmers, traders and cooperatives were more preferable by sample households with information reality. There are significant opportunities for

sustainable agriculture-led growth in this system, through market access and input supply chains (Kindu et al., 2014).

CONCLUSION AND RECOMMENDATIONS

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 are 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 practice in the study areas by sample households during the survey period. Few farmers practiced traditional beekeeping with herbicides, shortage of bee forage, ants 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 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 used vaccination and drug for controlling disease with poor quality and knowledge. To improve livestock production and productivity access improved breed, improved forage, control disease infection and improving marketing linkage are crucial.

In all crop types produced in the districts, average productivity per hectare is below national average productivity due to different constraints. 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. To enhance production and productivity of crops supply improved inputs capacitates farmers' awareness on integrated pest managements (IPM) to control pests and strengthen marketing linkage.

A large number of tree species were observed in natural forest found scattered on farmlands, garden areas as live fences and marginal land as a source of income generation, control soil erosion and soil fertility improvement. The major constraints of natural resources which account for productivity 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. However, expanding natural resource conservation and more awareness about the use of physical and biological soil conservation are more critical for soil improvement and increased productivity.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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