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Value Chain Analysis of Head Cabbage: The Case of Kofele and Kore Districts in West Arsi Zone, Oromia National Regional State, Ethiopia

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Abstract

Head cabbage value chain study was conducted in Kofale and Kore districts with the objective of analyzing its entire value chain. Data were collected from both primary and secondary sources. The primary data were generated by household survey using a pre-tested structured questionnaire and key informant interview using checklists. The data were collected from 120 farmers, 50 traders and 50 consumers and analyzed using STATA software. The result of the study shows that farmers in the study area used three market outlets to sell their cabbage product in the study area. These are collectors, wholesalers and consumers and also five market channels were identified. From the identified market channels, the highest total gross margins were 79.28% in channel II. The highest gross marketing margin of producers markets channels are 85.56% in channel IV. From total quantity of head cabbage produced only 33.48% supplied to the market in the study area. The Ordinary least square regression model results showed that seven variables such as education, head cabbage farming experience, land allocated for head cabbage, market price, livestock holding, market information access, and participation in off/non-farm income activities significantly affects the volume of head cabbage supplied to the market. The multinomial probit model results also indicated that the probability to choose the collector outlet was significantly affected by district dummy, education level, family size, quantity of head cabbage produced and distance from nearest market center. Similarly, the probability of choosing wholesaler and retailer marketing outlet was affected by head cabbage farming experience, quantity of head cabbage produced and access to credit. Policy implications drawn from the findings include the need to improve farmers' knowledge and experience on head cabbage production and marketing, encouraging adult education through extension service, improving land allocated for head cabbage, improving productivity and volume sales of head cabbage, improving market information access, expanding accessibility of market infrastructure and strengthening supportive institutions like credit access are recommended. In addition to this the study suggests that it shall be better to improve the farmers' market margins from collectors and wholesalers by strengthening farmers-traders linkage through reducing brokers' exploitation and solving related production and marketing problems in the study area.

Key words: *Value chain analysis, head cabbage, marketing margin, market performance, Kofele and Kore districts.*

Introduction

In Ethiopia, vegetable production is becoming an increasingly important activity in the agricultural sector mainly due to increased emphasis of the government on the commercialization of smallholder farmers (Hailegiorgis and Hagos, 2016). Integrating vegetable production into a farming system has contributes substantially to the Ethiopia's economy in terms of food and nutrition security as the vegetables complement stable foods for a balanced diet by providing vitamins and minerals (Bezabih *et al*., 2015).

Head cabbage is one of economically important vegetables in the country which grows best under cool conditions. According to CSA (2014), annual head cabbage production (in quintal) and area under production (in hectare) has increased by about 16 and 30 percent, respectively, from 2012/13 to 2013/14 in Ethiopia. Similarly, head cabbage is widely produced in Kofele and Kore districts of West Arsi Zone due to its suitable environmental condition. It is also one of the cash crop vegetable produced and marketed by farmers in the area. Agriculture and Natural Resource offices of Kofele and Kore districts (DOANR, 2013) shows that head cabbage is widely produced and marketed in West Arsi Zone. The significantly increasing head cabbage indicates that smallholders may have better surplus for market. However, market incentive gained from head cabbage products supply to market is very low due to poor market performance, in adequate market facilities, perish ability of the product, and poor performance of market chain (that is if market performance is not efficient, sufficient and price signal arising at consumers level are not adequately transformed to farmers) places farmers at a disadvantage.

Despite the production potentials and importance of head cabbage crop for the country as well as the study area, there has been limited performance of farmers in head cabbage marketing. The factors governing head cabbage producers supply to the market are not well studied and appropriate policy options need to get location-specific information to solve inherent problems. This study tries to fill the gap by providing location-specific and timely information on smallholder farmers' head cabbage supply to the markets. Even though some related studies were carried out in different regions of the country, such study that provides empirical evidence for improving the production and marketing of head cabbage has not been undertaken in the study area. Therefore, there is a strong need to make value chain analysis to identify head cabbage value chain and examine the performance of actors in the chain, to identify the determinants of quantity of head cabbage supplied to the market in the study areas and to identify the determinants of market outlets choice decisions of head cabbage producers.

Methodology

Description of the study area

This study was carried out in Kofale and Kore districts of West Arsi Zone, Oromia Regional State. West Arsi Zone is one of the 18 administrative zones under Oromia Regional State (the region accounting for about 34 percent of the country's total area) and it is divided into 12 districts. Out of 12 districts, Kofale and Kore districts cover for about 5.3 (663 square kilometers) and 4.2 percent (533 square kilometer), respectively, of the zone's total area. According to CSA (2013) population projection of the country, total population of these districts, respectively, is estimated to be 216,159 and 124,556 in 2014 with most population residing in rural areas.

According to the traditional classification system of climatic zones of Ethiopia cited in Deressa *et al.* (2010), agro-ecology of the study areas is dominantly highlands with altitude ranges from 2550 to 3150 masl. The annual rainfall ranges between 1800 and 2700 mm with bi-modal rainfall distribution. The main rainy season, *Ganna* extends from June to September/October and short rainy season, *Arfasa*, covers the time between March/April and May. The average daily minimum and maximum temperatures of both districts are 17 - 19^{0}C and 22 - 23^{0}C, respectively. The study districts are characterized by crop-livestock mixed farming system dominated by smallholders who integrate rain-fed crop cultivation and low input-output livestock production. Baseline information from Offices of Agriculture and Natural Resources (DoANR, 2013) indicates that agriculture, both crop and livestock production, is the major source of livelihood for most households (65 and 77 percent, respectively, in Kofale and Kore) followed by non-farm and off-farm activities. Crops including barley, wheat, maize, faba bean, pea and linseed are grown in these districts. Potato and head cabbage are also vegetables grown in the study areas for household consumption and income generation.

Sampling procedures

A multi-stage sampling procedure was used to identify sample households for data collection. In the first stage, head cabbage producer *Kebeles* were purposively identified in collaboration with concerned experts from district office of agriculture and development agents based on the intensity of head cabbage production and markets. The second stage involved random selection of three head cabbage producing *Kebeles* from a list of the head cabbage producer *Kebeles* in the districts namely, Shire kombolcha, Bole Hilensaa and Doda Dayu from Kore district and Wamagn Alkaso, Koma Bitacha and Germama from Kofale District. In the third stage, 120 head cabbage producers were randomly selected from the total head cabbage producers in the districts using Yamane (1967) sample size determination as follows:

$$n = \frac{N}{1+N(e)^2}$$

Where**,** n = is the sample size of head cabbage producer households, N= total number of households producing head cabbage in the districts, e= level of precision considered 9%.

Table 1. Sample distribution of head cabbage producers in study area

No	Kebeles	Total number of head cabbage producers (N=10,000 both districts)	Number of sampled households
1	Shire Kombolcha	1667	20
2	Bolo Hinlensa	1667	20
3	Doda Dayu	1667	20
4	Wamagn Alkaso	1667	20
5	Koma Bitacha	1582	19
6	Germama	1750	21
	Total	**10,000**	**120**

The sites for the trader surveys were market town in which a good of sample of head cabbage existed. On the basis of flow of head cabbage, four markets (Kofele, Kore, Shashemene and Hawassa) were selected as, the main head cabbage marketing sites for the study areas. Hence a purposive sampling method was used to select wholesalers, collectors and retailers from specified markets. As a result, 50 head cabbage traders and 50 consumers were selected randomly to obtain information related to traders and consumers.

Sources of data and method of collection

Both primary and secondary data were collected and used for this study. Secondary data sources include Kofele and Kore districts irrigation and development authority, Districts Agriculture and Natural Resource Offices, District Trade and Market Development Office and Central Statistical Authority (CSA), published and unpublished reports, bulletins, and websites. Both qualitative and quantitative data were collected and used for the study.

Primary data were collected from farmers, wholesalers, collectors, retailers and consumers using informal and formal surveys and key informants interviews. For informal survey Rapid Market Appraisal (RMA) technique like focus group discussion and key informant interview was used with checklists. The formal survey was undertaken through formal interviews with randomly selected farmers and purposively selected traders and consumers using a pre-tested structured questionnaire for each group. Before data collection, the questionnaire was pre-tested on four 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.

Methods of data analysis

Descriptive analysis (frequency, mean, standard deviation and percentage)and inferential statistics (t-test and chi-square test) were employed to describe the socio-demographic characteristics of sampled farm households, traders and consumers. Value chain analysis was also used to analysis value chain of head cabbage which includes value chain map, actors and their roles, value chain governance, challenges and opportunities along value chain, marketing channels, marketing costs and margins, and benefit shares of actors in the value chain. Econometric analysis (multiple linear regression and multivariate probit models) was employed to identify determinants of head cabbage market supply and the determinants of outlet choice of head cabbage producers.

Results and discussion

Demographic, socio-economic and institutional characteristics of the producers

The average age of the sample respondents was found to be 37.33 years having head cabbage farming experience of 5.78 years. This range of households' ages implies most of them were within their productive age bracket. About 12.5% of households in the sample are female headed. The average household size is about 8.67, with family labour supply of 4.4 persons per household, figures which are which is larger than the national average 4.6 persons per household (CSA, 2014). Livestock owned 7.25 TLU. A household on average operates about 2.56 ha land of which 0.42ha is allocated for head cabbage production, perhaps due to the availability of more arable farmland in the area. Almost 82.5% of household heads are literate, a figure which has shown significant rise in recent years. The extension services reached out 68.3% of the farm households, while the credit service extended only credit about

30%. Though all the respondents in this survey are primarily engaged in crop production and livestock rearing, 56% of them are also participated in off/non-farm activities to generate additional income. Off/non-farm activities refers both to self-employments in non-farm sectors such as petty trade, craft work/carpentry, blacksmith, and off-farm employment such as cash/food for work (safety net), daily labor, and guard.

The average years of farming experience related to head cabbage production was 6.88 and 4.68 years in Kofele and Kore districts, respectively. There was significant difference in head cabbage production experience in the two districts at 1% significant level. Market factors are external factors that affected the demand for or the price of a good or service (Sigei *et al*., 2014). It includes distance from market, access to road, market information, and price of outputs. The respondents are travelled on average about 2 and 2 and half hours per trip to reach the main commercial town i.e. Kofele and kore town respectively but in the study area are on average about 1.55 km away from nearest market center for both districts. This study result showed that 68.33% of the sampled households have access to market information when they want to supply head cabbage to the market. Neighbor farmers (46.3%), brokers (42.3%), and friends (39.8%) are the major sources of market information that market participants received about market in study area.

Table 2. Demographic, socio-economic and institutional characteristics of households

Variables	Kofele (n=60)	Kore (n=60)	Total sample (n=120)	t-test
	mean ± SD	mean ± SD	Mean+SD	
Age	36.92± 9.27	37.75± 11.75	37.33±10.55	0.431
Family size	8.93±2.97	9.73±10.92	9.33± 9.34	-0.873
Farming experience	6.88±4.38	4.68±2.84	5.78± 3.84	-3.263***
Farm size	2.402±1.66	2.73±1.30	2.56± 1.49	1.189
Land allocated for head cabbage	0.565±0.36	0.28±0.17	0.42± 0.32	-5.576***
Distance from nearest market center	1.58±1.32	1.52±1.36	1.55± 1.34	0.543

Source: Survey result data, 2014; ***, **,*, statistically significant at 1, 5 and 10% level.

Table 3. Socio-economic and institutional characteristics of households for dummy variable

Variables		Kofele (n=60)	Kore (n=60)	Total sample (n=120)	χ2-test
		Frequency	Frequency	Frequency	
Participation in non/off-farm	Yes	34	33	67	0.054
	No	26	27	53	
Sex	Male	53	52	105	0.076
	Female	7	8	15	
Education	Literate	51	48	99	7.149
	Illiterate	9	12	21	
Credit services	Yes	17	19	36	0.159
	No	43	41	84	
Extension services	Yes	40	42	82	0.154
	No	20	18	38	
Market information	Yes	40	42	82	0.256
	No	20	18	38	

Demographic and institutional characteristics of traders and consumers

The proportion of male among interviewed sampled were 60% and 26% from traders, and consumers respectively (Table 4). The average experience of traders was 5 years in head cabbage selling (Table 4). The traders, and consumers' average age were found to be 29 and 27 year respectively. This study also revealed that the majority the traders and consumers are literate in the study areas.

Table 4. Demographic and socioeconomic characteristics of sample traders and consumers

Variables	Traders (n=50)				Consumers (n=50)			
(Continues)	Mean	Std. Dev.	Min	Max	Mean	Std. Dev.	Min	Max
Age	28.72	9.54	15	60	26.82	8.45	15	50
Experience	4.57	5.35	0.5	20				
Distance	48.375	88.27	0.25	270				

Variables	Traders (n=50)			Consumers (n=50)	
(Dummy)	Category	Frequency	Percentage	Frequency	Percentage
Sex	Male		60	13	26
	Female		40	37	74
Education status	Illiterate		14	7	14
	Literate		86	43	86

Production of head cabbage in the study area

As the study result revealed that from total quantity of the head cabbage produced only 33.48% proportion supplied to the market indicating low level of commercialization in the study area. This means the mean percentage of head cabbage harvested which was taken to the market for sale by the respondents in rural area was 33.48%. Of their total land holdings, respondents in the study areas had been allocated 0.42 ha of land for head cabbage production. On average land area covered by head cabbage was 0.564 ha per household in Kofele district and whereas 0.276 ha per household in Kore district. There was a significant difference in land allocation to head cabbage at 1% significant level due to high population density, land size is small in Kore district compared to the land allocated for head cabbage in Kofele district and hence the area allocated to head cabbage production is small compared to Kofele district.

The head cabbage productivity is 62.35 qt/ha. The average head cabbage productivity in Kofele district is higher than Kore district. In Kofele district the mean productivity of head cabbage was 76.93 and in Kore district the mean productivity of head cabbage was 47.78 qt/ha (Table 5). In both districts the average yield is lower than the national average which is 91 qt/ha (CSA, 2012). According to farmers response this is related to lack of good quality seed, pests attack, diseases, and inadequate input supply such as fertilizer and chemical. Two sample t-test indicates there was a significant difference in head cabbage productivity between the districts at 1% significance level (Table 6).Shortage of quality seed, high cost of inputs, poor seed germination, limited knowledge on recommended agronomic practice, diseases and pest attacks, lack of storage and high perishability nature of product are the main production constraints of head cabbage whereas, suitable climatic conditions & fertile land and enabling policy environment &

support from public organization & NGOs are the main opportunity for head cabbage production in the study area.

Table 5.Production and productivity of head cabbage in the study area

Head cabbage	Kofele(N=60)		Kore (N=60)		Total (N=120)		t-test
	Mean	SD	Mean	SD	Mean	SD	
Land allocated to head cabbage/ha	0.564	0.361	0.276	0. 173	0.420	0.317	-5.576***
Productivity of head cabbage	76.93	47.98	47.78	19.58	62.35	39.32	-4.357***

Source: Survey result of 2014; *** Statistical significant at 1% level.

Market supply and marketing of head cabbage in the study area

In the study area, farmers set head cabbage sell price before marketing the products based on the received market information and also expected better incentives from the supplied head cabbage products. However, the majority (90%) of sample respondents were sold head cabbage less than the price they set due to head cabbage market price fluctuation and brokers interferences. Farmers sold one kilo of head cabbage by the mean price of ETB 2 in 2013/14 by directly negotiating with buyers and also through brokers. According to the information obtained from the farmers the average selling price of cabbage per kg dropped from 2.5 birr at the beginning of the cabbage production in January to 1.5 birr in March 2013 (the survey time). This was because of the quality reduction of the produce due to heavy rain and increased farmers' cabbage production. The average price per kilo of cabbage at the wholesaling area was found to be 3.0 birr and at the retailer's level, it was 6.0 birr. However, this price varies from time to time depending on the supply and quality of the produce. Cabbage is a highly seasonal crop with an oversupply during the dry seasons (winter and spring seasons) which are production peaks and undersupply during lean season (summer season) resulting in highly fluctuating prices. During the summer season, farmers have power to decide on the price, whereas during the dry season, price fluctuation is mostly on the hand of wholesalers and intermediaries. Market information is playing an important role in supplying agricultural commodities for market through informing the farmers about market condition (Jari and Fraser, 2009; Adenegan *et al.,* 2012).

Head cabbage producer were sold different amount of head cabbages depending on different demographic and socioeconomic characteristics of the household. The producers were supply on average 50.19 quintals (that is 80%) of head cabbage to market in 2014 production season. Two sample t-test shows that there was significant difference in market supply between the Kofele and Kore districts at 1% significant level (Table 6). The reason was due to the difference in head cabbage production between the districts. Price setting problem, product quality problem, broker interferences, low price for the products, high perishability of the product, limited function of cooperative and shortage of transportation are the main market problem of head cabbage product in the study area. Farm gate head cabbage selling was dominated (71.03%) and the rest head cabbage selling was undertaken at village (6.54%), district (17.76%) and out of district (4.67%) respectively. However, due to brokers' interferences, shortage buyers, and low product quality farmers' market incentive obtained from head cabbage sell was very low.

Table 6. Average head cabbage market supply in the study area

	Kofele (N=60)		Kore (N=60)		Total (N=120)		t-test
Amount of head cabbage	Mean	SD	Mean	SD	Mean	SD	
Supplied to market	62.42	39.25	37.97	18.64	50.19	32.97	4.35***

Source: Survey result of 2014; *** Statistical significant at 1% level.

Head cabbage is highly perishable product and due to limited on-farm storage facilities farmers immediately sell their product after harvest. There are various participants in the head cabbage market chain namely: farmers, rural collector/brokers, wholesalers, retailers, processor (restaurants/hotel) and consumers as illustrated in Figure 2. Farmers form the first link in the head cabbage marketing supply chain. Some farmers sell their head cabbages to the consumers in the weekly village markets. However, the main channel through which farmers sell majority of their produce is through the rural collectors/brokers. Farmers also sell head cabbage directly to wholesalers. Rural collectors/brokers sell head cabbages directly to wholesalers mainly from Kofele, Kore and Shashemene towns. Brokers also play a facilitation role to link other market participants to each other especially to farmers. Wholesalers purchase head cabbages from farmers and rural collectors/brokers and then transport and sell to retailers, restaurants/hotels, and consumers at Kofele, Kore and Shashemene towns. Consumers are the final link in the head cabbage market chain. They obtain raw head cabbage from farmers, wholesalers, and retailers.

Farmers and traders of head cabbage faced various challenges in head cabbage selling in the study areas (Table 7). Brokers' interference was most serious constraint followed by the perishability of the products and shortage of transportation that hinders farmers and traders at the time of sale. The problem of brokers could be due to the nature of the supply chain where middlemen determine the price the trader pays and other chain actors receive.

Table 7. Head cabbage marketing constraints in the study

Nº.	Constraints	Farmers (%)	Constraints	Traders (%)
1.	Brokers interferences	36.67	Brokers set price	52.08
2.	Perishability of products	25.83	Lack of processing technology	6.25
3.	Shortage of transportation	20.83	lack of storage	4.17
4.	Shortage of buyers	9.17	Perishability of products	12.50
5.	Diseases, pests and insects problem	7.50	Shortage of transportation	10.42
			Financial Problem	8.33

Value chain analysis

Value chain activities were identified by the respondents analyzed qualitatively to establish which factors influence the value chain activities in the organization. The analysis of the value chain is divided into the primary activities, support activities and factors that influence the value chain activities. A tangible head cabbage volume is moved from its production field to markets and consumed by final beneficiaries. It is essential to know at first what the current situation is and what strategy needs to be adopted in order to overcome the bottlenecks.

Head cabbage value chain actors and major functions

Value chain is a sequence of related business activities (functions), from the provision of specific inputs for a particular product to primary production, processing, sales and distribution, to final consumption. It is clear that along with the farmers, a number of actors participated in the marketing of head cabbage from the production point to the consumer point. From an institutional perspective, a value chain can be defined as the organizational arrangements linking and coordinating the producers, processors, traders, and distributors who perform these functions (Joshi and Gurung, 2009). The main actor involved in the head cabbage value chain, their roles and inter relationships are discussed below.

Inputs suppliers

Agriculture value chain analysis begins at the input supply level. Inputs such as seeds, fertilizer, and chemicals are supplied by Union, Cooperative, District Office of Agriculture and Natural resource, NGOs, traders at market and farmers to farmers exchange mechanism. Most (97%) of the farmers were purchase seeds (Euro and Holland) from market for head cabbage production. Source of fertilizers were cooperatives (67.26%), strict Office of Agriculture and Natural resource, (22.12%) and market (9.73%).The major suppliers of chemicals are private traders (63.77%) from market, Union (26.09%), strict Office of Agriculture and Natural resource, (7.25%) and cooperative (2.90%).

Producers

Farmers are the primary and most valued actor in the head cabbage value chain. Producers decide, what input to use, when to seed and harvest, how much to consume, and how much to sell, considering the available resource. They perform most of the value chain functions right from farm inputs preparation on their farms to post harvest handling and marketing. The major value chain functions that head cabbages producers perform include land preparation, growing/planting/, fertilization, protecting from weed, pest/disease, harvesting and post-harvest handling and marketing.

Rural collectors

Rural collectors are independent operators at primary markets who assemble and transport head cabbage from farmers, using pack animals and small trucks for sale to larger markets. The local traders play the key role as in the head cabbage value chain in area; their trading activities include buying and assembling, repacking, sorting, and selling to wholesalers typically transport on donkeys or cart to nearest town. Their major sales outlets are relatively rural collector. And most of these outlets own or rent storage but usually do not store for more than two or three days. These local traders collect head cabbage for wholesalers and wholesalers purchase from rural collectors by covering all cost and also additional fee for their services.

Brokers/middle men

Brokers in the districts have regular and temporary customers from major towns and cities across the country. Brokers facilitate transaction by convincing farmers to sale his head cabbage and facilitating the process of searching good quality and quantity head cabbage to wholesalers. The share of profit that goes to brokers varies from farmer to farmer and from trader to trader. The brokers sometimes go beyond facilitation of transaction and tend to set prices and make extra benefits from the process. A few wholesalers go straight to farmers' fields without using brokers to purchase the head cabbage products from the farmers where they negotiate prices. Brokers do not follow proper business conduct and as a result they constrain the marketing system more than they facilitate. In case the producer is not sold through broker, they forced to sell at the lower price because of perishability of the product. The broker travel to the rural areas and contact producers, they inspect the product quality, estimate output, set price and come back to communicating with wholesalers to purchase and transport. The farmers have no idea of the price paid by the wholesalers and only receive what has been bargained with the broker.

Wholesalers

Wholesalers are traders that buy head cabbage from rural collectors and also directly from farmers, usually those in surplus areas for resale in deficit, to larger market centers and retailers with better financial and information capacity. Wholesalers are the second major buyers of head cabbage as they buy at least a truck load of head cabbage at a time from farmers. They mostly purchase from farmers and local collectors. Wholesalers are traders that buy head cabbages from rural collectors and also directly from producer farmers of Kofele & Kore districts and sell to retailers and consumers at Kofele, Kore, Shashemene and Hawassa markets.Wholesalers buy head cabbage from producers through brokers who represent them in head cabbage buying activities. They have better storage, transport and communication access than other traders.

Retailers

Retailers are key actors in head cabbage value chain within and outside the study area. These are known for their limited capacity of purchasing and handling products and low financial and information capacity. They are the last link between producers and consumers. There are two types of retailers in the study area districts retailers and central retailers. Districts retailers are buying head cabbage either from farmers or wholesale traders. While central (urban) retailers in major cities mostly they buy from wholesalers and sell to urban consumers. The supermarket and shops are mainly in the major cities and commonly buy head cabbage from wholesalers. During the market visit, it was observed that retailers keep small amount of head cabbage. Consumers usually buy the product from retailers as they offer according to requirement and purchasing power of the buyers.

Consumers

Consumers are final purchasers of head cabbage products mostly from retailers for consumption purpose. Head cabbage consumers are individual households (rural and urban dwellers) hotels and institutions. The majority of sampled consumers preferred undamaged and clean head cabbage. Consumers think that if the chain becomes shorter and shorter the price of head cabbage will be reduced.

Enablers and facilitators

In the value chain, enablers include all chain-specific actors providing regular support services or representing the common interest of the value chain actors. The supporting function players for the head cabbage value chain are those who are not directly related to the head cabbage value chain but provide different supports to the value chain actors. The support functions include different services (e.g. credit), research and development, infrastructure, and information. Support service providers are essential for value chain development 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 head cabbage value chain in one way or another. The most common support providers are District office of Agriculture and natural resource, District Trade and Market Development Office, Cooperatives, Oromia Micro Finance Institutions, and Private transporters. Some service providers extend services beyond one function and others are limited to a specific function.

Value chain map of head cabbage in the study area

Mapping a value chain facilitates a clear understanding of the sequence of activities and the key actors and relationships involved in the value chain. Mapping of value chain functions is considered to show the relationships and integrations of the processes and activities performed along the value chain. Major functions include input supply, production, trading, processing and consumption. Figure 2 displays the head cabbage value chain map.

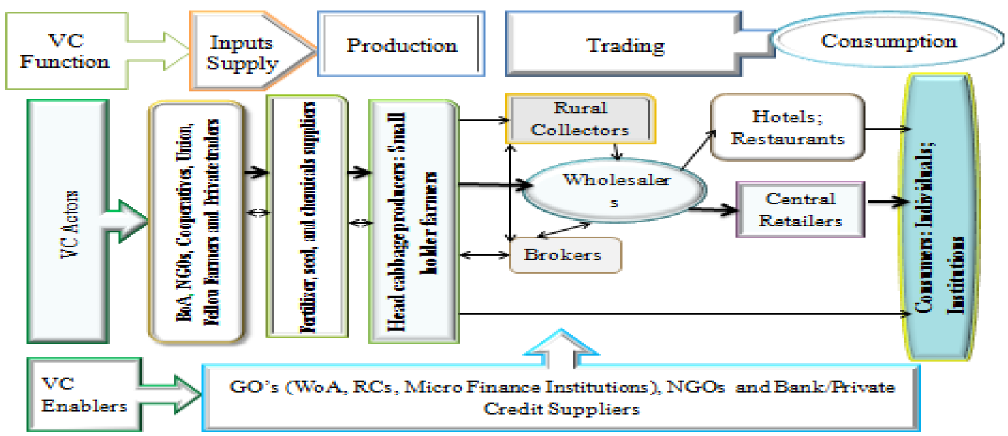

Figure 2: Value chain map of head cabbage in the study area
Source: Sketch from survey result, 2014.

Value chain governance

The value chain governance structure gives information about the position of the farmers in the chain and the relations between smallholders and purchasers. The producers' position in price negotiation is not good in the study area. Due to lack of valuable market information and not well organized producers heavily depend on traders. Hence, they are price takers and hardly negotiate the price due to fear of post-harvest loss, in case the product is not sold. From focus group discussion producers reported that co-ordination among the value chain actors was low and also there were the complexity of information and knowledge sharing among the chain. The study indicates that the rural collectors and brokers were the main head cabbage value chain governors. In general, the governance structure in the study area was characterized by low coordination among the value chain actors in information exchange and knowledge transfer and low involvement in changing the rules and regulations that was exercised in the study area. Therefore, care should be taken in order to create a co-ordination mechanism among the value chain actors and encouraged all actors in changing the rules and regulations that was exercised in the areas.

Challenges and opportunities faced by actors along head cabbage value chain

One of the merits of value chain analysis is that it helps to clearly identify bottlenecks to the development of the chain right from input supply up until the consumption level in intense way. Accordingly, a number of constraints and opportunities are explained by different actors through focus group discussion and questionnaire. The major head cabbage production constraints were poor seed germination, limited knowledge on recommended agronomic practice, diseases and pest attacks, lack of storage and high perishability of product whereas, marketing constraints are price setting problem, product quality problem, brokers interferences, low price for the products, limited function of cooperatives and shortage of transportation.

Table 8. Challenges & opportunities of actors along head cabbage value chain

Value chain stage	Constraints	Opportunities
Inputs supply	▪ Shortage of quality seed and ▪ High cost of inputs	• High demand for quality seed
Production	▪ Poor seed germination ▪ Limited knowledge on recommended agronomic practice ▪ Diseases and pest attacks ▪ Lack of storage ▪ High perishability of product	• Suitable climatic conditions & fertile land for production • Enabling policy environment & support from public organization & NGOs
Marketing	▪ Price setting problem ▪ Product quality problem ▪ Brokers interferences ▪ Low price for the products ▪ High perishability of the product ▪ Limited function of cooperatives and ▪ Shortage of transportation	• Government investment on infrastructure development • Good market demand of the product • Establishments of credit providers • Government encourage research
Consumers	▪ Income shortage and ▪ Lack of consumers cooperatives	• High consumption preference

Marketing channels and marketing margin of head cabbage

Head cabbage marketing channel

Head cabbage market performance was evaluated based on the level of marketing margins obtained and considering associated marketing costs for each key market channels. Accordingly, during the study time costs and purchase prices of the main chain actors', margins at farmers', collectors, wholesalers, urban retailers and consumers' level were analyzed. Of total respondents farmers 65% sold head cabbage to wholesalers, 31.67% to retailers and 3.33% to collectors. Marketing channel and marketing margins were used in the analysis of supply chain performance. Four parameters are necessary to measure the efficiency of a channel. These are quantity handled, producers share, total marketing margin, and rate of return. Out of these volumes handled, producers share and marketing margin were considered for all the head cabbage in this study. Consequently effectiveness is defined as the ability of the marketing channels to result to (or offer) proper service outputs or the right services in relation to consumer preferences. In essence therefore, identification of the marketing chain precedes its analysis. Marketing channels are defined as alternative routes of product flows from producers to consumers, (Kohls and Uhl, 1990). According to Adugna (2009), a marketing channel involves a series of intermediaries through which vegetables pass from producers to consumers. Five marketing channels of head cabbage are exhibited in the study areas. It was estimated that 6023 quintals of head cabbage were supplied to market by sampled farmers. Rural collectors and Wholesalers were the main receivers of head cabbage with percentage shares of 67.13% and 26.56%, respectively (Figure 2).

The market channels identified during the survey were:
Channel I:Producer--->Consumer
Channel II:Producer--->Rural collector--->Wholesaler--->Central retailer--->Consumer
Channel III:Producer--->Wholesaler--->Consumer
Channel IV:Producer--->Wholesaler--->Central retailer--->Consumer
Channel V**:** Producer--->Wholesaler--->Processor--->Consumer

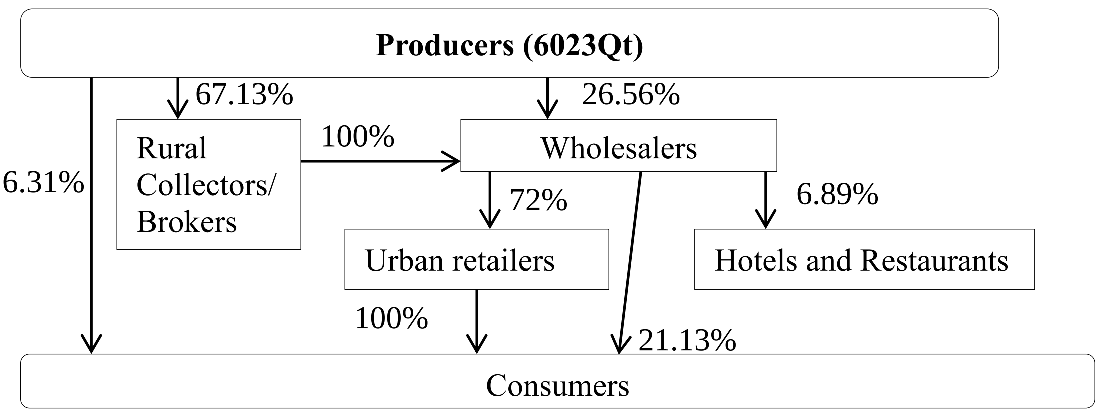

Figure 2.Head cabbage marketing chain in Kofele and Kore districts
Source: Survey Data (2014).

Marketing margins of head cabbage

Margin determination surveys should be conducted parallel to channel surveys based on price (payment) received or selling price to calculate the margin. A systematically recording of prices at different levels of marketing chain during a two to three week period is sufficient to calculate quite accurately the relevant marketing margins (Pomeroy and Trinidad, 1995).Total gross marketing margin (TGMM) across complete distribution channel was 23.02% in both Kofele and Kore districts.

Tables 9 and 10 depicted that buying and selling prices and marketing margins of different actors of head cabbage in each district. In Kofele, average purchase price (P_1) was ETB [1]981/quintal while the average selling price (P_2) was EBT 1356/quintal. In Kofele, head cabbage supplier farmers obtained the highest marketing margins by selling directly to consumers while the lowest is obtained from wholesalers (Table 9).The same is true for Kore district where head cabbage supplier farmers' obtained the highest marketing margins by direct sell to consumers (Table 9). These differences in margins indicate that head cabbage market suitability varies across the districts. These variations mainly occur due to marketing channels through which head cabbage passes and price differences across the district.

Head cabbage suppliers received the highest margins by selling head cabbage to consumers in both Kofele and Kore districts given the prevailing market prices. However, the volume of head cabbage supplied to rural collectors was high compare to wholesalers and consumers. The reason was due to shortage of transportation and high perishable nature of the products which needs immediate market. Head cabbage supplier farmer's shares low marketing margins (9.79%) from wholesalers while high marketing margins (33.55%) from consumers' in Kofele district. In Kore, the highest and lowest farmer's margin shares were from consumers and wholesalers respectively. In both districts, the higher volume of head cabbage sold to rural collectors and wholesalers brought lower margin while the lower volume of head cabbages sold to consumers received higher margin. This implies that head cabbage supplier farmers had received higher marketing shares (margins) when they supply their products to consumers and as the channel increases farmers share is reduced in the study area. This result may point to the need for improving farmer's supply of their products to consumers through strengthening their linkage and delivering timely and adequate market information in the study areas. Outsourcing bulk consumers may also provide the opportunity to uptake bulk production with reasonable price.

Table 9. Head cabbage marketing margins for producers in Kofele district

Actor	Q_1	P_1	P_2	Q_2	V_1	V_2	V_2-V_1	GMM (%)
Rural collectors	2179	1630	2236	1839.59	3551770	4113323	561553	13.65
Wholesalers	1483	1083	1422	1252	1606089	1780350	174261	9.79
Consumers	63	230	410	53.19	14490	21806.7	7316.65	33.55
Average prices		981	1356					
Percentage loss	0.16							

Table 10. Head cabbage marketing margins for producers in Kore district

Actor	Q_1	P_1	P_2	Q_2	V_1	V_2	V_2-V_1	GMM (%)
Rural collectors	1281	1114	1435	1099.82	1427034	1578242	151208	9.58
Wholesalers	434	416	530	372.62	180544	197487	16942.7	8.58
Consumers	563	485	630	483.37	273055	304523.70	31468.70	10.33
Average prices		671.67	865.00					
Percentage loss =	0.14							

Results of the econometric model

Determinants of quantity of head cabbage supplied to the market

Analysis of determinants affecting farm level volume supply of head cabbage was found to be important to identify factors constraining head cabbage supply to market. Prior to fitting multiple linear regressions, the hypothesized explanatory variables were checked for existence of multicollinearity, heteroscedasticity and endogeniety problems. The result of the tests indicated that there were no serious problems of multicollinearity, heteroscedasticity and endogeniety in the data. Also, the model specification was carried out using the Ramsey-reset test, and the results revealed that there were no omitted variables in the model. Therefore, OLS method was used to identify factors affecting the volume of head cabbage sold to the market (farm level marketed surplus of head cabbage) by head cabbage farmers in the study area since all assumption was fulfilled. As depicted in Table 11, the model was statistically significant at 1% probability level indicating the goodness of fit of the model to explain the relationships of the hypothesized variables. Coefficient of multiple determinations (R^2) was used to check goodness of fit for the regression model. Hence, R^2 indicates that 78 percent of the variation in the quantity of head cabbage supplied to market was explained by the variables included in the model. The explanation on the effect of the significant explanatory variables is discussed below.

The result shows that land allocated for head cabbage has significant effect on volume of head cabbage supplied to the market at 1% significant level with expected positive sign (Table 11). The positive sign of the coefficient implies that the larger the land size allocated for head cabbage production the larger the quantity produce and thereby increasing the quantity of produce available for sale. Thus, the per unit production costs will be lower due to the economics of scale. Increase in the size of one hectare of land allocated for head cabbage increases volume of sales of head cabbage by 73.65 quintal, keeping other factors constant. In support of the finding here, Wubshet (2010), Alemnew (2011), and Toyiba *et al*. (2014) indicated that the area of land allocated for coffee, red pepper and papaya production affected farm level marketed supply of each commodity significantly and positively. Households with larger land size are relatively better off because it allows the household to have a surplus production above subsistence needs and enable them to sell products for market. An increase in farm size naturally implies an increase in output which leads to increase marketed surplus.

Education has showed positive effect on head cabbage quantity supplied to market with significance level at 10 % (Table 11). The survey results revealed that, if head cabbage producer gets educated, the amount of head cabbage supplied to the market increases by 0.35 quintal, keeping other factors constant. This may be because majority of the farmers in the study area have minimum education requirements to make them market oriented and thus enable them to have better skills and better access to information to supply more head cabbage to market. This is also in line with previous studies conducted by Astewel (2010) and Ayelech (2011), who found that if paddy and avocado producer gets educated, the amount of paddy and avocado supplied to the market increases, respectively. Amare (2013) also reported that education level of farmers exhibited a significant and positive effect on the marketed surplus of pepper.

Head cabbage farming experience of households has significant effect at 5% significant level for head cabbage quantity sold with expected positive sign. Thus, the result implied that, as farmers experience increase by one year, the head cabbage supplied to market increased by 0.243 quintal, keeping others factors constant. This means that the farmers with more experience in head cabbage production and marketing have higher ability to sell more head cabbage produces in the market than less experience because they have more marketing network and information. This is in line with finding of Ayelech (2011), and Ele *et al*. (2013) who illustrated as farmers experience increased the volume of tomato, avocado and crops supplied to the market has increased, respectively. Market price of head cabbage influenced the volume of sale positively at 1% level of statistical significance with expected positive sign. This result shows that one ETB increase in head cabbage price increase the volume of head cabbage supplied to the market by 11.087 quintal, keeping other factors constant. This suggested that farmers are more response to higher prices because they get higher incomes from their produce. This result is in line with the findings of (Sebatta *et al.*, 2014; Sigei *et al*., 2014).

Owning more number of livestock had a positive influence on the level of head cabbage sale at 5% level of statistical significance. This implies that an additional of livestock in TLU would increase the extent of head cabbage sells by 6.84 quintals, keeping other factors constant. Households with higher livestock possession would lead to higher probability of getting excess livestock for selling to purchase inputs for production, particularly the owner of more oxen have an ability of ploughing more land on time, thereby achieving crop yields which increase the marketable surpluses. Some livestock (donkey and horse) also used for transporting head cabbage products to market which reduces transportation costs. This result is in line with the findings of (Solomon *et al.*, 2010; Aman *et al.,* 2013).

Access to market information had a positive impact on the extent of head cabbage sells at 1% significance level. This indicated that the more households' access to market information the extent of head cabbage offered for sells would increase by 0.604 quintals, *ceterus peribus*. This result implies that market information availability motivated households to sell more head cabbage produces since it informs the farmers about market. This result is in line with the findings of (Jari and Fraser, 2009; Gani and Adeoti, 2011). Participation in off/non-farm activities had a negative impact on the volume of head cabbage supplied to the market at 5% level of statistical significance. This implies that the respondents' involvement in off/non-farm activities would decrease the extent of head cabbage sells by about 0.146 quintals, keeping other factors constant. The probable reason was that the respondents' engagement in off/non-farm activities share more labor and time allocated for growing head cabbage which results in low head cabbage production and possibly leads to smaller quantities of head cabbage sold. This result is in line with the finding of Sebatta *et al.,* 2014.

Table 11.Determinants of volume of head cabbage supplied to the market (OLS estimates)

Variable	**Coef.**	**Std. Err.**	**P>t**
Constant	1.404*	0.790	0.079
Age	0.002	0.007	0.774
Sex	0.219	0.226	0.335
Education	0.350*	0.200	0.083
Head cabbage farm experience	0.243**	0.101	0.017
Family size	0.026	0.023	0.257
Land allocated for head cabbage	73.65***	5.836	0.000
Head cabbage market Price	11.087***	2.102	0.000
Livestock holdings [a]	6.840**	3.592	0.050
Market information	0.604**	0.261	0.021
Distance to the nearest market	-0.017	0.033	0.614
Access to extension service	0.206	0.146	0.180
Access to credit service	0.104	0.153	0.498
Participation in off-farm income activities	-0.146**	0.073	0.045
Number of Observation		120	
F(13, 106)		32.23	
Prob>F		0.0000***	
R-Squared		0.780	

Note: Dependent variable is quantity of head cabbage supplied to market in quintal in 2013.

***, ** and * are Significant at 1%, 5% and 10% level of probability, respectively.

Determinants of head cabbage producers market outlet choice

The result of multivariate probit model as depicted in Table 12 shows that the Wald test was significant at the 1% level, which indicates that the subset of coefficients of the model is jointly significant and that the explanatory power of the factors included in the model is satisfactory. Furthermore, results of likelihood ratio test in the model (LR χ^2 (3) = 20.567, $LR\chi^2(3) = 8.039,\ p > \chi^2 = 0.0452$ is statistically significant at 5% level, indicating that the independence of the disturbance terms (independence of market outlets choice) is rejected. The likelihood ratio test of the null hypothesis of independence between the market outlets decision ($\rho_{21} = \rho_{31} = \rho_{32} = 0$) is significant at 5%. Therefore, the null hypothesis that all the ρ (Rho) values are jointly equal to 0 is rejected, indicating the goodness-of-fit of the model. Hence, there are differences in market outlet selection behavior among farmers, which are reflected in the likelihood ratio statistics. Separately considered, the ρ values (ρ_{ij}) indicate the degree of correlation between each pair of dependent variables. The ρ_{32} (correlation between the choice for retailer and wholesaler outlet) are negatively interdependent and significant at the 1% probability level indicating a competitive relationship of retailer outlet with wholesaler outlet. The simulation results also indicate that the probability that producers choose collector, wholesaler and retailer outlet were 38%, 90% and 18%, respectively. The likelihood of households' success to jointly choose the three market outlets were 4.28% compared to their failure to jointly choose the three market outlets of them were 3.38%.

The model result indicated that woreda dummy was positively and significantly related with collector outlet at 1% significance level. As the Woreda becomes Kofele, the probability of choosing retail outlet increased by 42% (Table 12). This shows that the interference of intermediate traders was low in Kofele Woreda compared to Kore Woreda. The reason may be is the most dominantly produced vegetable in Kofele Woreda is head cabbage and traders are not participated in head cabbage market compared to other vegetables. This forced head cabbage producers to sell to retailers in the market.

The finding reveals that, quantity of head cabbage supply to market was positively and negatively influenced the likelihood of choosing wholesaler and rural collector and retailers market outlet at 1%, 1%, 1% significance level, respectively. This implies that the larger head cabbage quantity sold the more a farmer was likely to sell to wholesaler and less likely to sell to rural collector and retailer outlet. The positive coefficient further implies that households tend to increase association with wholesaler when the amount they sold increase because wholesaler has capacity to purchase large volume of head cabbage. This may be because farmers producing small quantities have little opportunity to sell through wholesaler outlet and more likely to sell to rural collector and retailer outlet. This is a line with Bezabih *et al*. (2015) reported that the likelihood of choosing collector and retailer only market outlet was negatively and significantly affected by potato quantity sold. Family size is positively and significantly associated with selling head cabbage to collectors at 1% significance level. This result shows that those households with large family size are more likely to choose collectors outlet than other market outlets. This may imply large household size is an indicator of labour availability which enables farmers to produce more head cabbage and sell to collectors' outlets.

Education level of households has negative and significant effect at less than 5% probability level on choosing of collector outlet. The more educated a farmer is the less likely to sell head cabbage through collector because more educated farmers are less time spend on doing marketing activities (Table 12). The negative relationship between education level and selling to collector outlet can be explained by the fact that being educated enhances the capability of farmers in making informed decisions with regard to the choice of marketing outlets to sell their farm produce based on the marketing margin and marketing cost. A study by Nyaupane and Gillespie (2010) on factors influencing producers‟ marketing decisions in the Louisiana Crawfish Industry found that farmers with college degrees are more likely to sell their product via wholesalers and less likely to market via processors.

The result shows that, distance from nearest market is negatively associated with likelihood of farmers selling to collector at 10% level of significance (Table 12). It reflects the difficulty of remote households in delivering head cabbage to collector due to lack of market information and poor road facility to sell their product in collector market outlet and sold to available outlet in local market. The finding of Chalwe (2011) showed that distance to nearest market was significantly and negatively related to best channel choice decision. The author reason out that most beans farmers are poor in resource endowment and lack transport resources, transportation costs associated with moving the produce to the market therefore discourage farmers to participate in markets far from their premises.

The likelihood of choosing wholesaler and retailer outlet were positively and negatively affected by farming experience at 10% levels of significance for each market outlet. This result indicated that more experienced households in head cabbage production were more likely to deliver head cabbage to wholesaler outlet and less likely to sell to retailer outlet. The many years engaged in head cabbage production and marketing gives the farmers desire to adjust their market links; trying alternative marketing outlets to increase sales volume or better prices all this to maximize profits. The relationship also implies that experienced farmers had better knowledge of cost and benefits associated with various head cabbage marketing outlets; consequently they are likely to increase the quantities supplied through the wholesalers to benefit from economies of scale. Riziki *et al*. (2015) found that households with more experience in agro-pastoralists are assumed to be more exposed and venture into commercial activities like African indigenous vegetables marketing because they aware marketing and differences in profitability in the different marketing outlets.

Table 12. Determinates of head cabbage producers market outlets choice (Multivariate probit)

Variables	Collectors			Wholesalers			Retailers		
	Coef.	Robust SE.	P>z	Coef.	Robust SE.	P>z	Coef.	Robust SE.	P>z
WOREDA	4.155***	1.340	0.002	-0.985	0.652	0.131	0.985	0.652	0.131
AGE	-0.099	0.046	0.290	-0.008	0.030	0.790	0.008	0.030	0.790
SEX	1.600	1.202	0.183	-0.331	0.719	0.645	0.331	0.718	0.645
EDU	-2.283**	0.922	0.013	-0.120	0.785	0.879	0.120	0.785	0.879
Farm experience	-0.410	0.621	0.509	0.709*	0.406	0.081	-0.709*	0 .406	0.081
Family Size	0.369 ***	0.125	0.003	-0.048	0.088	0.585	0.048	0.087	0.585
TA	-0.898	2.465	0.716	-2.082	1.526	0.172	2.082	1.526	0.172
lnPRod	-5.545***	0.997	0.000	2.505***	0.621	0.000	-2.505***	0.621	0.000
Market Price	0.173	0.604	0.775	0.120	0.411	0.770	-0.120	0.411	0.770
MKTINFO	0.359	1.447	0.804	1.239	1.003	0.217	-1.239	1.003	0.217
DISTANCE	-0.421*	0.225	0.061	-0.057	0.124	0.650	0.057	0.124	0.650

EXTENSION	1.615	0.974	0.970	-0.084	0.562	0.882	0.084	0.562	0.882
CREDIT	1.244	0.823	0.130	-1.465**	0.702	0.037	1.465**	0.702	0.037
Constant	17.607***	4.687	0.000	-10.425***	3.904	0.008	10.425***	3.904	0.008

Predicted probability	0.3803	0.9040	0.1854
Joint Probability(Success)		0.043	
Joint Probability (Failure)		0.034	
Number Of Draws (#)		5	
Observations		120	
Log Likelihood		-37.503	
Wald(χ2(13)		3299.71	
Prob >χ2		0.0000***	

Estimated correlation matrix

	ρ_1	ρ_2	ρ_3
ρ_1	1.0000		
ρ_2	0.0644	1.0000	
ρ_3	-0.3533	-0.3551***	1.0000

Likelihood Ratio Test of: $\rho_{21} = \rho_{31} = \rho_{32} = 0$

$\chi^2(3) = 8.039$

Prob >χ^2 = 0.0452**

Note: *, ** and *** indicate statistical significance at 10, 5 and 1%, respectively. RSE is robust standard error, Y1=Collector, Y2=Wholesaler and Y3=retailer

Conclusions and Recommendations

This study was conducted to analysis value chain of head cabbage in Kofele and Kore districts of Arsi Zone. The specific objectives of the study were identifying head cabbage value chain actors, their respective roles and to draw up value chain map, analyze head cabbage market performance, analyzing the determinants of quantity of head cabbage supply and market outlet choice decisions of head cabbage producers. To address the objectives of the study, both quantitative and qualitative methodologies were used. The data were generated from both primary and secondary sources. The primary data were collected through personal interviews form a total of 220 respondents (120 producers, 50 traders and, 50 consumers) using structured and semi-structured questionnaires. Qualitative data were also collected through focus group discussions, key informants interviews and observations. Descriptive statistics, gross margin and econometric models were used to analyze the data collected using (STATA Software Package). Ordinary least square regression (OLS) model was adopted to understand the determinants of head cabbage supply to market and multivariate probit model (MVP) to analyze factors affecting market outlet choice of farmers. The findings of this study are summarized as follows.

Head cabbage is a widely produced vegetable in Kofale and Kore district. Majority of head cabbage producer farmers were market oriented. Head cabbage productivity in both districts is lower than the national average. The major factors affecting head cabbage production in the study area are inadequate seed quality, pest and disease attack and lack of adequate input supply on time. Furthermore, broker interferences, lack of transportation and perishability of the products are the major bottlenecks. The market margins output shows that head cabbage producer farmers share more market margin when they sell directly to consumers compare to collectors and wholesalers in both districts.

Head cabbage producers in the study areas supply their produce through different market outlets. The result of the study shows that farmers used three market outlets to sell their product. The farmers were classified into three categories according to their outlet choice decision: those who have supplied most of their produce to collectors (67.13%); wholesalers (26.56%); and retailers (6.31%). However, they earn low/little market margins from the large volume of head cabbage they sold to collectors and wholesaler compare to consumers. This is due to brokers who have the power to determine prices paid by the traders and thus extract huge marketing margins. The chain is governed mainly by rural collector with the assistance of brokers. Five major market channels of head cabbage were also identified in the study area.
Econometric result of the linear regression model also indicated that education, head cabbage farming experience, land area allocated for head cabbage, head cabbage market price, livestock holding, market information access and participation in off/non-farm income activities are significantly determining the quantity of head cabbage supplied to the market. Therefore, these variables require special attention if farmers quantity of head cabbage supplied to the market is to be increased. In addition, , multinomial probit model was used to identify factors determining farmers' market outlet choice decision. The model results indicated that the probability to choose the collector outlet was significantly affected by woreda dummy, education, family size, quantity produced and distance to the nearest market center. Similarly the probability of choosing both wholesaler and retailer marketing outlet were affected by farm experience, quantity produced and by access to credit. Therefore, these variables require special attention if farmers margin from head cabbage production is to be increased.

From the finding of this study enabled us to make the following recommendations for policy makers, developments actors and researchers who have strong interest in promoting head cabbage production and marketing for equal benefits among value chain actors. Interventions in the form of establishing new farmers cooperatives/groups and improves the existing farmers cooperatives/groups to collect head cabbage products and link farmers cooperatives/groups with output markets are required to reduce broker interferences and transportation costs and also sustain farmers benefits from their products..

The econometric analyses of multivariate probit findings indicated that farmers have been influenced by different factors to choose appropriate marketing outlets to sell their head cabbage product. The results of this study suggest several ways in which smallholder farmers can actively market their produce. The findings suggest that an adjustment in each one of the significant variables can significantly influence the probability of choice market outlets. Initially, expanding equal accessibility of infrastructures such as road and transportation facilities needs government intervention to promote the effective marketing of head cabbage through all outlets. Strengthening the linkage between producer farmers and consumers is better recommended to improve farmers' incentive. Intervention targets to improve farmers marketing margins through creating better head cabbage market channel for farmers by reducing brokers' market interferences is a good option required for the study areas. This intervention may encourage farmers to supply their products to market. Working with farmer's organization and frequent quarantine may solve input supply and seed related quality problems.

The findings point to the need for increasing the quantity of head cabbage sold for choice of appropriate market outlets by improving productivity of head cabbage. Policy makers should focus more on enhancing producers' marketed surplus of head cabbage which could be attained through providing the marketing infrastructure, technical and organizational assistance, and access to markets and support to improve the farmers bargaining power by establishment of farmers' organizations. Distance from the farm to the nearest market significantly affect market outlets choice decision, government should ensure developing markets for head cabbage within reach this will motivate a lot of farmers to participate in head cabbage supply their by increase their income and choice of appropriate outlets. Collector outlet choice is negatively and significantly also affected by education, quantity produced and distances from the nearest market center.

Therefore, these factors must be promoted by upgrading the knowledge of the households through education and trainings, increase quantity of head cabbage produced and developing road infrastructures. Farm experience and quantity of head cabbage produced significantly and positively affected wholesaler outlet choice. Therefore improving farmers' farm experience through arranging experience sharing from older farmers is essential to make head cabbage market efficient in addition to increasing quantity of head cabbage produced. Retailer outlet choice is significantly and positively affected by access to credit service. Therefore, improving farmer's access to credit service is essential to make head cabbage market efficient. Retail outlet choice also negatively and significantly affected by farm experience of the household head and quantity of head cabbage produced. Therefore, these factors must be considered in future intervention.

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Soya bean Value Chain Analysis in Chewaka District, Buno Bedele Zone of Oromia

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Abstract

Soybean is among the important pulse crops grown in different parts of Ethiopia as stable food and income generation source. Market continues to be seen as the means for ensuring that smallholder farmers of agricultural products are effectively integrated into the mainstream of national economies. The study was conducted in Chewaka district of Buno Bedele zone. A three-stage sampling technique was employed to select appropriate sample household heads. Descriptive statistics and costs and margins analysis methods along the value chains were employed for the study. The core functions in Soya bean value chain of the study area include: input supply, production, marketing, processing and consumption where cor. Under this core functions, actors are broadly classified into three, namely inputs suppliers, direct market actors and chain supporters. The study result indicated that there is fair producers' share of final price among all major marketing channels and market actors obtained fair selling price of net margin in five major marketing channels, but traders obtained low net marketing margin. Major constraints that influence the development of Soya bean value chain in the study area were identified and prioritized. Access market information, linkage, farmers-cooperatives contractual and others issues need attention.

Key words: *Soya bean, chewaka, actors, marketing margin and value chain*

Introduction

Soya bean is among the important pulse crops grown in different parts of Ethiopia as stable food and income generation source. The country has immense potentials for Soya bean production and popularized in different parts of the country with multiple food and economic advantages for small-scale farmers. It is used as food for home consumption, raw materials for local factories and feed (both hulm and husk) for animal dairy or fattening farms (Abebe, 2017; Sisay, 2017). The crop has relatively high protein content (about 40%) with a good balance of the essential amino acids, unsaturated and non-cholesterol fatty acid (approximately 20%) and contains vitamins such as thiamine, niacin, riboflavin, choline, vitamins E and K, which are necessary for normal body growth and development (Tinsley, 2009; Adelodun, 2011).

Many efforts have been done in improved Soya bean varieties development and/or adaptation with different agronomic and other management options since 1950 in Ethiopian agricultural production systems (Addisu *et al.*, 2016). Bako agricultural research center also made great effort to generate, promote and disseminated this technology in potential production areas of western Oromia for more than ten years. Chewaka district is among the areas where this technology was introduced and disseminated to improve food security and income of smallholder farmers. In the district smallholder farmers who are currently producing the Soya bean are preparing different recipes with different types of cereal and vegetable crops use as parts of their stable foods. In this area Soya bean is widely produced by the majority of farmers and playing a crucial and diverse role in the diets of community, cash generation and enhancing soil fertility.

Markets continue to be seen as the means for ensuring that smallholder farmers of agricultural products are effectively integrated into the mainstream of national economies, especially in developing countries and its provide the opportunity for farm production to contribute in poverty reduction through the cash income realized from sales of farm produce. In turn, markets drive production as farmers struggle to meet the demands of consumers and end-users in terms of quantity and quality (Tewodros, 2014). Locking markets for smallholder farmers is therefore considered a crucial developmental necessity. Research and case studies conducted in various parts of the country point to the importance of the market access to smallholders (Chilot *et al*., 2010).

Therefore, assessment of better processing and food preparation, market and value chain development in the study area is the major ones. Cognizant to the importance of value chain approach to stimulate both supply and demand side equation, attention was given to study the marketing practice and value chain of Soya bean with the following objectives: (1) to identify different marketing channels and actors in Soya bean value chain (2) to determine the extent of value addition in terms of marketing cost and margins in successive stages of Soya bean movement and (3) to assess major constrains and opportunities in Soya bean value chain in the study area.

Research Methodology

Description of study area

Chewaka district is found in Buno Bedele zone of western Oromia. It is located about 390 kilometers distance from Finfinne, the capital city of Ethiopia to the west direction. The District is found between Debana and Dhidhesa drivers' catchmentat about 900-1400m asl and it has 28 rural and 2 urban kebeles. Chewaka district has 13,063 households head on 57,300 hectares of land. The major crops grown in the study area are maize, sorghum, rice, Soya bean and sesame crop for home consumption and income generation source.

Sources and Data Collection Methods

Both primary and secondary data were collected from sample households, traders, Chewaka district offices and other sources. Primary data like land allocation with productivity, inputs used for Soya bean, price of Soya bean inputs and outputs, market outlets, constraints and opportunities were collected from sample households and traders. The secondary data which are relevant to this research topic were used as additional information to strengthen the primary information for rational conclusion. These data were collected from both published and unpublished documents like Journals, local administration offices, Research Centers, and Central Statistical Agency.

For this data collection, different methods and instruments were employed. Focus Group Discussion (FGD) for both sample households and traders were conducted and based on FGD result, interview of Soybean producers and traders were conducted using semi-structured schedule. Field enumerators were involved in data collection with the close supervision of the researcher.

Sampling Techniques

A three stage of sampling technique was employed to select appropriate sample households. Chewaka district was selected purposively because of Soya bean technologies were widely popularized and extent of production. In the second stage, three kebeles were selected randomly from Soya bean produced kebeles. Finally, about 121 sample households were selected randomly based on probability proportional to size. About 10 traders, 3 primary cooperatives and one union were selected from sample frame of trade and industry office of the district.

Data Analysis

To address the objectives of the study, descriptive statistics and market performance along the value chains of data analysis were employed. Descriptive statistics such as mean, standard deviation, and percentages were used to have a clear picture of the characteristics of sample units.

The term marketing margin is the percentage of final weighted average selling price taken by each stage of the marketing margin. Total gross marketing margin is the difference between producer and consumer prices of an equivalent quantity and quality of commodity (Tomek and Robinson, 1990; Sexton *et al*., Jema, 2008). In other word it is the difference between retail price and farm price (Cramer and Jensen, 1982). However, it may also describe price of differences between other points in marketing chains. Marketing margins of Soybean producers and traders were estimated using margin analysis as;

$$\mathrm{TGMM} = \frac{\text{Consume Price} - \text{Farm gate Price}}{\text{Consumer Price}} \mathrm{x100}$$

$$\mathrm{GMM_p} = \frac{\text{Consume Price} - \text{Gross Marketing Margin}}{\text{Consume Price}} \mathrm{x100}$$

$$\mathrm{NMM} = 100\% - \mathrm{TGMM} \text{ or } \mathrm{NMM} = \mathrm{TGMM} - \mathrm{TMC}$$

Where: TGMM is total gross marketing margin; GMM_P is producers gross marketing margin, TMC is total marketing costs and NMM is the net marketing margin.

Results and Discussion

Household Characteristics of Soya bean Producers

The average age of sample households was about 39.02 years with standard deviation of 11.34 and the average family size of sample households was 6.33 persons per household with standard deviation of 2.15. The average educational level expressed in years of schooling of the sample households was about 3.03. With regards of sex and marital status out of the total sample households about 95% and 97.5% were male headed and married, respectively (Table 1).

Table 13. Sample household characteristics of Soya bean producers

Household Description (N=121)		Mean	Std. Deviation
Age of Household		39.02	11.34
Education level of respondents		3.03	2.65
Total family size		6.33	2.15
Participated in agriculture		2.50	1.00
Household head		Frequency	Percent
Sex	Male	115	95
	Female	6	5
Marital status	Married	118	97.50
	Single	1	0.80
	Widowed	2	1.70

Land Holding for Major Grown Crops with their Productivity

In the study area, maize, Soybean, sorghum and rice are the major crop grown by sample households. On average 0.51 and 0.56 hectares of cultivated land were allocated for Soya bean during 2014/15 and 2015/16 cropping season, respectively. The productivity of this crop was 1.86 and 1.95 tons during 2014/15 and 2015/16 cropping season, respectively (Table 2). This implies that Soybean is an important crop grown by farmers in the study area. Land allocated for maize, sorghum and rice were summarized with their productivity during 2014/15 and 2015/16 cropping season.

Table 14. Land allocated for major crops with their productivity by sample households

Major crops Grown	2014/15				2015/16			
	Land allocated (ha)		Productivity (ton)		Land allocated (ha)		Productivity (ton)	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Maize	0.28	0.23	3.81	1.47	0.36	0.51	3.83	1.56
Soya bean	0.51	0.23	1.79	0.72	0.55	0.26	1.86	0.83
Sorghum	0.40	0.25	2.58	1.51	0.34	0.24	2.52	1.18
Rice	0.16	0.18	3.04	1.53	0.18	0.19	3.00	1.39

Trends of Soya bean for Past Five Years

In the study area, farmers produce Soya bean for dual (home consumption and income source) purpose. According to the study findings both supply and demand sides were increased for the past five years (Table 3). Majority of the respondents confirm that both supply and demand are increasing from time to time. The demand for Soya bean bulk products at national level is very high. Different lead-firms like Guts Agro-industry, Alema Koudjis Feed Factory, FAFa Food Share Company and others were widely used Soybean grain product for the production of blended soya-maize flour, and poultry feeds. Therefore, different NGOs and private companies were popularized Soybean technologies for producers. This indicates that the demand of soybean grain bulk at the national level is very high while the linkage among local producers and the final grain buyers is very weak**.**

Table 15. Trends of Soybean supply and demand of 2011/12-2015/16 production years

Trends	Supply		Demand	
	Frequency	Percent	Frequency	Percent
Increase	100	82.6	104	86
Decrease	10	8.3	4	3.3
The same	11	9.1	13	10.7

Soybean Value Chain Analysis

Core Functions and Major Actors

The core functions in Soybean value chain of the study area include: input supply, production, marketing, processing and consumption. Under these core functions, actors are broadly classified into three, namely inputs suppliers, direct market actors and chain supporters (Figure 1).

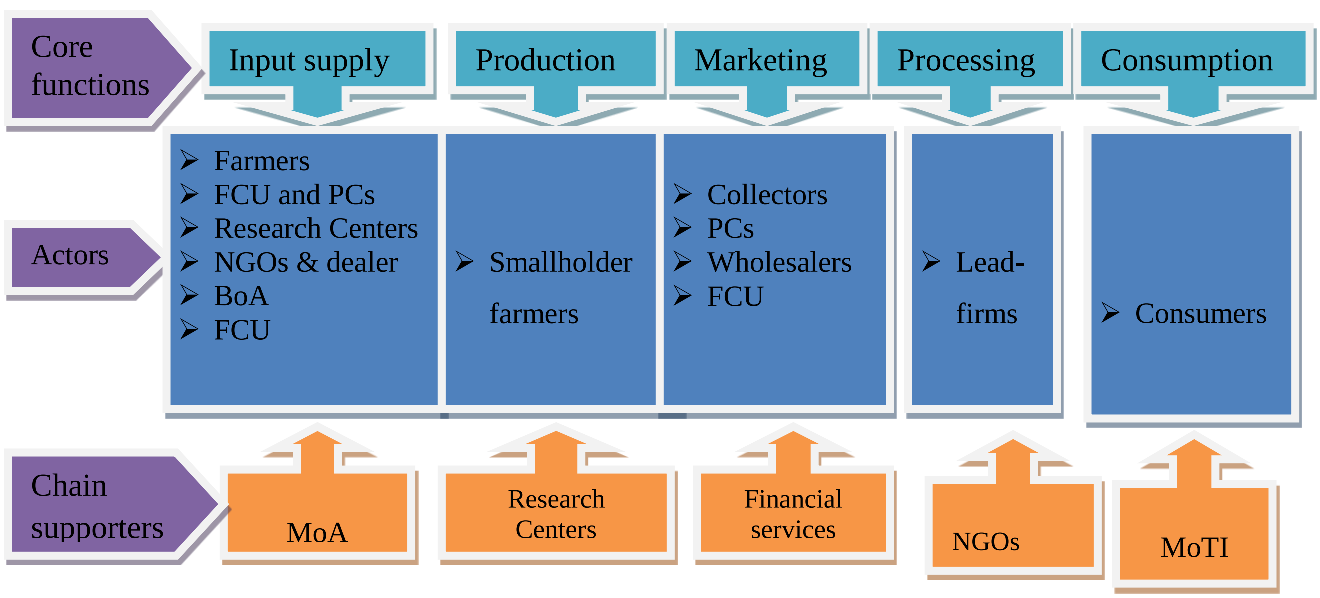

Figure 1. Core functions and actors of soya bean value chain

Where: PCs is primary cooperatives, FCU is farmers' cooperative union, LFs is lead-firms, SM is supermarket and WS is wholesalers

Major actors who involved in input supply functions were farmers, private dealers, NGOs, agricultural research centers, cooperative union, primary cooperatives, woreda office of agriculture. They are mainly delivered inputs like fertilizers, inoculants, seed and others (such as credit, insecticide, etc). The direct market actors were those involved in Soybean trade who order the flow of Soybean in time and space. These include producers, local collectors, primary cooperatives, cooperative union, wholesalers, lead-firms and consumers. The chain supporters are involved in technical advice, service provision and policy formulation and implementation of chain. Technical advices like extension services and marketing information along Soybean chain provided by DAs, BoA, Research Center and NGOs. According to survey report about 69%, 19% and 4% obtained information by government experts, research center and NGOs, respectively. The market information shares and buyers were only traders and cooperatives in the study area. Accordingly, about 92% and 8% buyers were traders and cooperative, respectively. Financial is another most important chain support specially, in Soybean production and marketing functions.

Marketing Channels

Marketing channel is an organized network of different agencies and institutions which in combination perform all the activities required to link producers with consumers to accomplish the marketing tasks. Only a small portion of goods and services is consumed at the point of production and only a small fraction of any output is purchased by the ultimate consumers directly from the final producers (Jaleta, 2011). Marketing of Soybean starts from production areas moving on to the end users. Based on the direction of flow and volume of Soybean transacted, five marketing channels were identified (Figure 2).

According to household and traders survey about 4,500qts of Soybean were transacted by sample traders end buyers. The percentage of Soybean transacted by each channel was summarized by figure 3.

The identified channels were:

Channel 1: Producer → PCs → FCU → Farmers (157qts)

Channel 2: Producer → PCs → FCU → LFs → Consumers (1,418qts)

Channel 3: Producer → Collectors → LFs → Consumers (124qts)

Channel 4: Producer → Collectors → WS → LFs → Consumers (2,351qts)

Channel 5: Producer → WS → LFs → Consumers (450qts)

Channel 1 starts from producers and ends with farmers for the purpose of seed. In this channel about 157qts (3.5%) volume of Soybean was supplied. Channel 2 and 4 were dominants as the accounted about 1,418qts (31.5%) and 2,351qts (52.2%) volume of the Soybean were supplied to lead-firms, respectively. Channel 5 supply about 450qts (10%) volume of Soybean and channel 3 only about 124qts (2.8%) volume of the total Soybean was supplied to lead-firms (Figure 3).

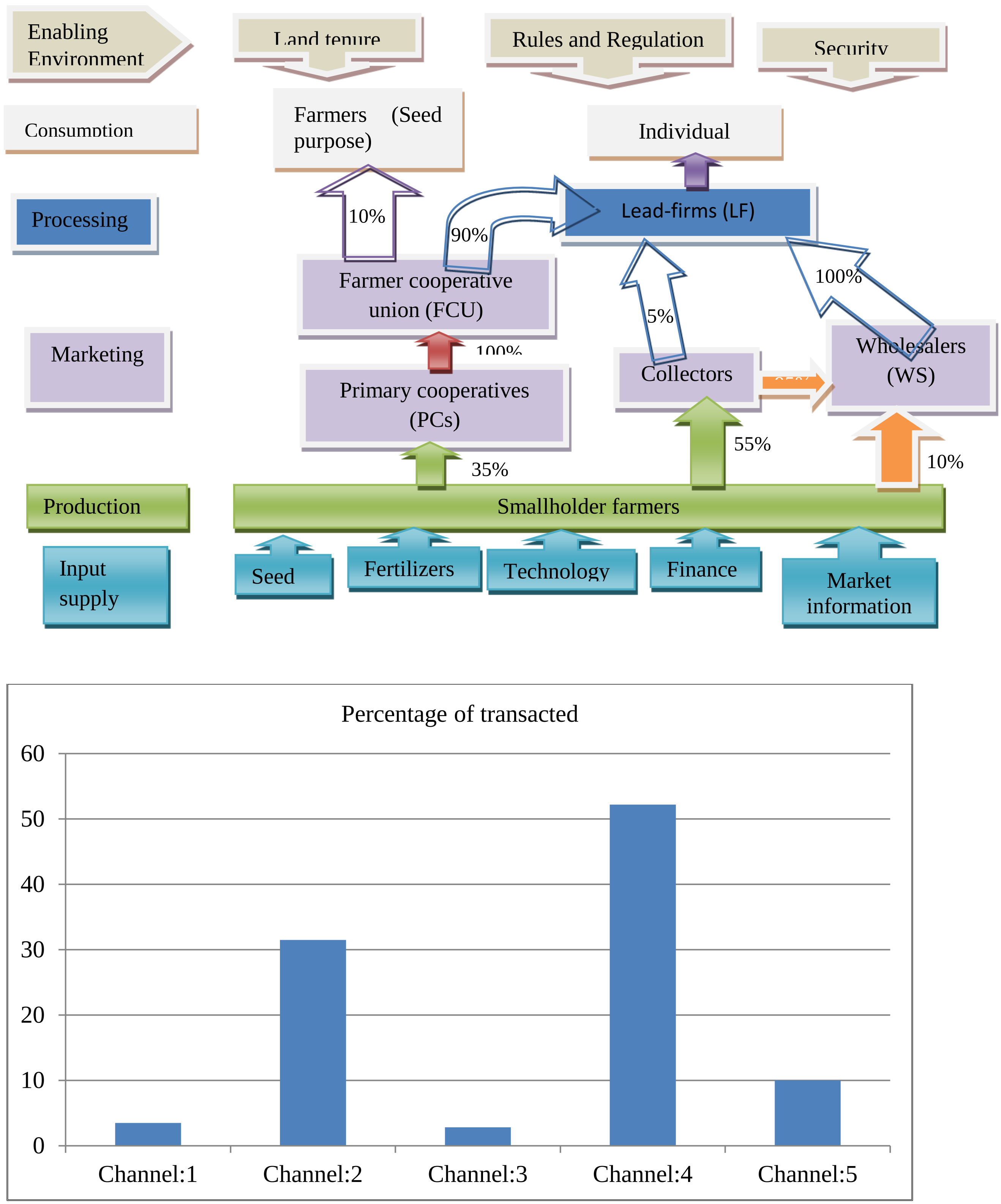

Figure 3. Soybean marketing channels and percentage of Soybean transacted

Costs and Margin Analysis

In order to indicate the distribution of marketing costs and margins, the major marketing channels were identified based on the direction of flow and volume of production supplied to market. The flow of benefits among actors in the value chain was another aspect of the value chain. In this study market channel, it is the one that lead Soybean to farmers for the purpose of seed. This channel involves producers, primary cooperatives, farmers' cooperatives union and farmers. Soybean producers obtain about 81% of the final price of the processed Soybean sold farmers' cooperative union. Both Union and PCs gets only about 3% of their selling price as a net margin.

Table 16. Soybean marketing costs and margins of major channels

Marketing Descriptions	Channel-I			Channel-II			Channel-III		Channel-IV			Channel-V	
	Producers	PCs	FCU	Producers	PCs	FCU	Producers	Collator	Producers	Collectors	WS	Producers	WS
Selling price	710.50	780	880	700	760	850	715	850	705.65	765.45	855	720	855
Total marketing cost		50	78		50	78		45		41	63		103
Marketing margin		69.5	100		60	90		135		59.8	89.55		135
Net margin		19.50	22		10	12		90		18.8	26.55		32
Producers' share of final price			81			82		84			83		84
Percentage of selling price													
Marketing cost		6	9		7	9		5		5	7		12
Gross margin		9	11		8	11		16		8	11		16
Net margin		3	3		1	2		11		3	4		4

Market channel II is the channel that supplies Soybean to lead-firms. This channel involves producers, primary cooperatives, farmers' cooperative union, lead-firms and consumers. Soybean producers obtain about 82% of the final price of the processed Soybean sold union. Primary cooperatives and union also gets about 1% and 2% of their selling price as a net margin, respectively. Market channel III is less leading that supply Soybean to lead-firms. This channel involves only producers, collectors, lead-firms and consumers. Soybean producers obtain about 84% of the final price of the processed Soybean sold wholesalers. A collector also gets about 11% of their selling price as a net margin.

Market channel IV is the dominant that supply Soybean to lead-firms. This channel involves producers, collectors, wholesalers, lead-firms and consumers. Soybean producers obtain about 83% of the final price of the processed Soybean sold wholesalers. Wholesalers and collectors also gets about 4% and 3% of their selling price as a net margin, respectively. Market channel V is also supply Soybean to the lead-firms. This channel involves producers, wholesalers, lead-firms and consumers. Soybean producers obtain about 84% of the final price of the processed Soybean sold farmers' cooperative union. Wholesalers also get only about 4% of their selling price as a net margin (Table 4). In this study, for all channels producer's share of final price is high as compared to chickpea which is 54.2% (Tewodros, 2014). This implies that there is fair producers' share of final price among the major marketing channels and traders were obtained fair selling price of net margin in five major marketing channels.

Major Constraints and Opportunities in Soybean Value Chain

Major Constraints

There are different constraints that influence the development of Soybean value chain in the study area. Some of the major constraints that influence the value chain actors are described as follows.

Input supply constraints: According to the respondents, the availability of Soybean rust resistance variety and inoculants are the major important constraints. There are no local market supply inoculants to the farmers in the study area.

Table 17. Pair wise ranking of major constraints of Soybean value chain during survey period

Input supply constraints	Score	Rank
Shortage of inoculants	1	1
Shortage of capital	0	3
Lack of rust resistance variety	2	1
Production constraints		
Disease (yellow rust)	5	1
Weed problem	4	2
Low price	1	5
Low productivity	2	3
Shortage of information (price, inoculants and rust)	2	3
Poor soil fertility	1	5

Marketing constraints		
Low supply	2	2
Poor infrastructure (poor market linkage and road)	3	1
Shortage of credit	1	3
Low capital	0	4
Processing constraints		
Low supply	1	2
Poor quality	2	1
Poor market linkage	0	3

Production constraints: The major production constraints reported by respondents were disease (yellow rust), weed control problem, low price of grain, low productivity, Shortage of information and poor soil fertility. In the study area recently, Soybean yellow rust and weed control problem are the bottle neck to boost Soybean production and productivity.

Marketing constraints: Regarding marketing (traders and lead-firms) were low supply, poor infrastructure (poor market linkage and road), shortage of credit and low capital are reported as major constraints by respondents. Poor infrastructure, shortage of credit and low supply were the series problems in Soybean marketing in the study area.

Processing constraints: It was reported that poor quality and low supply were the major constraints in processing Soybean. Due to weak of vertical linkage there is information gap between lead-firms and producers on grain quality amount supply in a year. Even though there is supply increase in the past five years; it's not full fill demand interest (with both quality and quantity of lead-firms).

Major Opportunities

Hunde Chewaka union and different NGOs work on Soya bean: Due to increasing trend of demand hunde chewaka union and other NGOs like 2SCALE, AGRA, N2-Africa work on inputs supply and collect the grain through primary cooperatives. In the study area there is few local collectors and no input suppliers. Currently hunde chewaka union installed their capacity supporting by different NGOs to competitiveness input supply to farmers and grain supply to lead-firms.

There are strong community seed producers in the study area: In the study area there is formal community seed producers to produce and supply seeds to others farmers. Therefore, smallholder producers can access improved and certified seed easily with minimum resources to other producers.

Government commitment to support legume production: Chewaka district is one of the maize and sorghum mono-cropping dominants areas. In this area to break this mono-cropping system Soya bean and common bean production is the only solution to break these maize and sorghum mono-cropping system. Therefore, different research centers, universities, NGOs and others interested in order to provide necessary support for Soya bean production.

Many local soya factories established in the country: There is a huge demand for Soya bean bulk products in the country. For instance, Gut-Agro Industry needs more than 5000 metric tons per annum of legume including soybean grain product for the production of blended soya-maize flour (Wolde-meskel, 2017) and the government of Ethiopia has made an agreement to produce corn-soybean blend (CDB) to produce up to 39000 metric tons with eight different local manufacturers (Francom and Counselor, 2016). This indicates that the demand of soybean grain bulk at the national level is very high while the linkage among local producers and the final grain buyers is very weak.

Conclusion and Recommendations

Conclusion

Soybean is among the important pulse crops grown in different parts of Ethiopia as stable food and income generation source, particularly in the study area. Many efforts have been done in improved soybean varieties development and/or adaptation with different agronomic and other management options. Besides, locking market for smallholder farmers is therefore considered a crucial developmental necessity.

The study was conducted in Chewaka district which found in Buno Bedele zone west direction of the country. Both primary and secondary data were collected and used for this study from sample households, traders and Chewaka district offices and other sources using different survey instruments and data collection methods. A three stage of sampling technique was employed to select appropriate sample household heads. Descriptive statistics and costs and margins analysis methods along the value chains were employed for this study.

In this study five core functions with major value chain actors were identified. Actors in this study were broadly classified into input suppliers, direct market actors and chain supporters. The actors who delivered inputs were farmers, private dealers, NGOs, cooperatives and woreda BoA. The direct market actors were involved in Soybean flow which includes producers, collectors' cooperatives, wholesalers and consumers. The chain supporters are involved in technical advice, service provision and policy formulation and implementation of chain.

About five major Soybean marketing channels in the study area were identified and analyzed. The total amount of Soybean that was transacted through these marketing channels was 4,500qts to end users. The study result indicated that there is fair producers' share of final price among five major marketing channels and market actors obtained fair selling price of net margin in five major marketing channels. In five major channels traders were obtained low net marketing margin.

Major constraints that influence the development of Soybean value chain in the study area were identified and prioritized. Accordingly, lack of rust resistance variety and availability of inoculants are the major constraints in input supply. The major production constraints were disease, weed control problem, low productivity, low price and poor soil fertility where as low supply, shortage of credit poor infrastructure and low capital reported as major constraints traders. Besides, low supply and poor quality of grain also reported as major lead-firms constraints. To enhance production and productivity of Soybean different opportunities were identified and summarized.

Recommendations

- Access to market information and credit enables farmers to participate in market options which secure them in higher price for their Soybean products are crucial. This network undoubtedly provide useful information on price, quality, quantity needed by lead-firms and accessibility of credit by local traders. This means producers remain price takers not price makers.

- A set of enabling constraints will deepen the impact of Soybean production along value chain actors very loose of production. This may require expanding the existing extension systems on agronomic practices, high yielder with disease resistance varieties, and appropriate chemical for weed control and grain quality parameters to increase productivity of Soybean need attention.

- Many efforts should be needed to sustainably make strengthening market linkage among the producers and the final grain buyers. This may require formalizing the quality grain needed by lead-firms and providing information to producers on how price related to quality of grain.

- Better farmers-cooperatives/unions are instrumental in cultivating trust and establishing the missing link between the farming and business firms. This may need appropriate institutional and legal frameworks to stimulate the development of more out-growers.

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Determinant and Intensity of Willingness to Pay for Soil Conservation Practices in Gobu Seyo District, Eastern Wollega Zone, OromiaNational Regional State of Ethiopia

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Abstract

This study was conducted to explore the household's willingness to pay for soil conservation practices in Gobu Seyo district Oromia National Regional State of Ethiopia. In this study, multi-stage sampling procedure was used to select 3 sample KAs and 238 specific sample farm households. *Data collection was conducted from September to October 2015. The objectives were to explore the determinant and intensity of households (HHs) willing to pay for soil conservation practices. Tobit model to examine factors affecting maximum willingness to pay as well as intensity of payment, showed that HHs heads of education level, social position, distance to development centers and access to credit were significantly affects willingness to pay for soil conservation practices. As policy implications, an effort would be needed to strengthen literacy, increase farmers' awareness about the importance of conservation practices and credit facilities, increase numbers of extension office to minimize the time of farmers to contact extension workers.*

Key words*: Gobu Seyo District; households; soil conservation practices; Tobit, and Willingness to Pay*

Introduction

Soil is the second most important factor for life after water. Abundant growth of life is found in areas with good soils. From the record of past achievements, history has unveiled that civilization and fertility of soils are closely interlinked. However, throughout the world today, depletion of natural resources is among the major problems facing human beings. Worldwide inappropriate agricultural practices on the degraded soils are causing great threat to food security. Today soil erosion is almost universally recognized as a serious threat to human wellbeing especially in developing countries (Bai *et al*., 2008).

Ethiopia, being among developing countries, has heavily relied on its agriculturally based economy. However, agriculture in Ethiopia is characterized by limited use of external inputs and continuous deterioration of the resources (Daniel 2002). Ethiopia has a total surface area of 112 million hectares of which 60 million (53.57 percent) hectares is estimated to be agriculturally productive. Out of the estimated agriculturally productive lands, about 27 million (24 percent) hectares are significantly eroded, 14 million hectares are seriously eroded and 2 million hectares have reached the point of no return, with an estimated total loss of 2 billion m3 of top soil per year (Assefa, 2009).The amount of yield reduction as a result of loss of topsoil each year is increasing substantially, which has made it difficult to attain food self-sufficiency at national level. This makes the issue of soil conservation not only necessary but also a vital concern if the country wants to achieve sustainable development of its agricultural (Eleni, 2008).

In Ethiopia, efforts towards soil conservation were started since the 1970s and 1980s. Since then, a huge amount of money has been invested in an attempt to introduce soil and water conservation measures particularly in the areas where the problem of soil erosion is threatening and food deficit is widespread. The conservation measures were in most cases physical measures and undertaken through campaign using Food-for-Work or Cash-for-Work as an instrument to motivate farmers to putting up the conservation structures both on community land as well as on their own plots. However, success to date has been limited and its production and productivity is highly influenced by soil erosion (Derajew*et al*., 2013).

Especially the western oromia where this study has been undertaken, scaling up of different conservation measures were implemented with-out consideration of farmers' willingness to pay (WTP). But now soil erosion is explained by a decline in productivity, formation of small gullies in both farming and grazing lands through time. Given this state of conditions, analysis of the issue of what specifically determines the decision taken by farmers and intensity of WTP to invest in soil conservation practices was very important and relevant to formulate policy options and support systems that could accelerate use of soil conservation measures.

Research Methodology

Description of the Study Area

Gobu Sayo district is situated in East Wollega Zone of Oromia National regional state which is 265 km West of Addis Ababa and 65 km from Zonal Town Nekemte. Its altitude is in the range of 1556- 2580 meter above sea level. The district consists of 8 rural Peasant Association (PAs). The total land area of the district is estimated to be about 33,753 ha of which 21640(64%) hectares are cultivable, 1132(3.3%) hectares are covered by forest, 6907(20.5%) hectares are pasture land, 4073(12.2%) hectares are barren (degraded) and unutilized land. The total population of the district was 46806 (49.44% male, 50.56 % female) in which 6442 were headed by male and 832 were headed by female households. The Agro climatic conditions of the district are 80% weyena dega and 20% kola. The annual rainfall of the area ranges from maximum 1658 mm to minimum 830 mm. The annual maximum and minimum temperature ranges from 27^0c to 13^0c.The common crops produced by farm households in the area include maize, Finger millet, *Teff* and sorghum.

Data source and data collection method

A multi stage sampling techniques was used to select representative sample households. In the first stage, Gobu Seyo district was purposively selected from the Eastern Wollega Zone taking in to account the accessibility to conducting survey and severity of erosion problem. In the second stage, three Peasant Associations (Ongobo Bekanisa, Ago Laften and Tibe Hara) were randomly selected. In the final stage, total of 238 households were selected from the 3 PAs in probability proportional to number of households in the PAs using systematic random sampling techniques. For this study, primary data was collected from sample respondents through a structured questionnaire, via face to face interview. Secondary data were obtained from year of 2015 annual reports of Gobu Seyo district agriculture office.

Theoretical model

In Logit and Probit model the concern was with estimating the probability of willingness to pay as the function of socio economic variables, but the advantage of Tobit model is in finding out the amount of a man day family's spends on a soil conservation practice in relation to socio economic variables (Gujarati, 2004). The model is used to identify factors that determine farmers' maximum willingness to pay in soil conservation. Hence, the form of the Tobit model following Verbeek (2004) is;

$$y_i^* = X_i^{'} \beta + \varepsilon_i \quad \text{--} \quad (1)$$

$y_i = 0$ if $y^* \leq 0$, $y_i = y_i^*$ if $y^* > 0$ and $\varepsilon_i \sim n\ d\ (0, \delta^2)$

Where y_i^* is the latent variables and y_i is the observed variables, X_i are explanatory variables used in the modeling of WTP distribution, β represent a vector of unknown parameters of the model and ε_i represent the error term.

Assume that $\varepsilon_i$is continuous random variable with mean 0 and variance δ^2,

The value ofβ_0, β_1 and δ that maximize the likelihood function with the log(L), have been determined using the following formula (Verbeek, 2004)

$$\ln L = \sum_{y_i>0} \frac{-1}{2}\left[\log(2\Pi) + \ln\delta^2 + \left(\frac{y_i - X_i^{'}\beta}{\delta^2}\right)^2\right] + \sum_{y_i=0} \ln\left[1-\phi\left(\frac{X_i^{'}\beta}{\delta}\right)\right] \qquad (2)$$

Where φ(.) is the probability density function

The estimated parameters β_j measure the effects of X_j on y^*. The marginal effect determines the effects of X_j on the actual y.
The marginal effect on the actual variable was estimated by using the following formula (Verbeek, 2004)

$$\frac{\partial E(y\ / X)}{\partial X_K} = \beta_K \Phi\left(\frac{X\beta}{\delta}\right) \quad \text{- - ---- - - -- - - - -- -- -- - - - - -- - - -- - - - -- - - - - -- - - -- - - - -(3)}$$

Marginal effect on positive observation was estimated by using the following formula;

$$\frac{\partial E(y\ / X, y>0)}{\partial X_K} = \beta_k 1 - \lambda(c)[c+\lambda(c)]\} < \beta_k \quad \text{--- - -- - - -- - - -- --- ---- -- - - -- - ---- (4)}$$

Where $\lambda(c)$ is inverse mills ratio.

$$\lambda(c) = \frac{\phi(c)}{\Phi(c)} = \frac{\phi\left(\frac{X\beta}{\delta}\right)}{\Phi\left(\frac{X\beta}{\delta}\right)} \quad \text{--- - -- -- - -- - -- - - - -- -- - - - -- - - - -- - - -- -- -- - - ------ - (5)}$$

Where φ (.) is the probability distribution function and Φ (.) is cumulative normal distribution. $\lambda(c)$ Captures the change in the population.

Marginal effect on the probability that an observation is uncensored was computed using the following formula;

$$\frac{\partial pr(y>0/X)}{\partial X_K} = \phi\left(\frac{X\beta}{\delta}\right)\frac{\beta K}{\delta} \quad \text{-- -- - - -- - - -- - - - - -- - - - -- - - - --- - -- - - - - - -- - - (6)}$$

Results and discussion

Descriptive Analysis

Socio-economic and demographic characteristics of sample households

Table 118: Households' characteristics of marital status, Religion, Source of income and Status of land shared or rented

Socio economic Characteristics	Categories of HHs	Frequency	%
Sex	Male headed	233	98.0
	Female headed	5	2.0
Marital status	Single	1	0.4
	Married	234	98.3
	Divorced	3	1.3

Religion	Orthodox Christian	118	49.4
	Protestant Christian	106	45.0
	Muslim	14	5.6
Educational status	Illiterate	71	30.0
	Literate	167	70.0
	Grade 1-8	116	69.4
	Grade 9-12	51	30.6
Primary source of Income	Crop production	203	89.4
	Live stock raising	21	7.1
	Others	14	3.5
Sharing and Rented of land	Yes	178	79
	No	60	21

Source: Own Survey (2015)

The socio economic characteristics of sample households are given in Table 1, the majority of respondents 233(98 percent) were males. Out the households surveyed, about 98.3% were in marriage, and 0.4% has never been married while divorced persons were account for about 1.3% of the respondents. With regard to religious affiliation, 49.4% were Orthodox Christians,45% Protestant Christians and 5.6% of the respondents were Muslims. The education figures revealed that 167 (70%) had received formal education with average years of schooling 4.54 while 71 (30 percent) were illiterate. Out of the total literate household heads, 116 (69.4%) received primary education (from grades 1-8). However, 51 (30.6%) had received secondary education (grades 9-12).

The 89.4% respondents indicated that crop production was the main source of their income,7.1% earned major income from the sale of livestock and the other 3.5% of respondents' primary source of income was selling Eucalyptus trees and renting out animal cart. Out of the total sample respondent, there were only 60(21 percent) farmers who did not either rented in or rented out the land. However, 79% of the sample households practiced rented in or rented out or share cropping (Table 1).

Table 2, reveals that more than 87% of the farmers used their cash obtained through credit from Oromia Credit and Saving Share Company to purchase agricultural inputs. The table also shows for 71% of the respondents' crop produced on their farm was sufficient to meet family consumption requirement for the year, whereas 29% were required to purchase additional food grain from market at least for more than one month during the year. Thus, the type of farming in the study area is subsistence in nature.

Table 219: Household's food self-sufficiency, sources and purpose of credit borrowed

	Farmer response	Frequency	Percentage
A	Food shortage in certain month of the year.		
	Yes	66	29
	No	176	71
B	Formal sources of credit		
	Yes	145	62.8
	No	86	37.2
C	The main Purpose of credit		
	i. Purchase of agricultural inputs	118	86.8
	ii. Purchase of oxen	13	9.6
	iii. Others	5	3.7

Source: Own Survey (2015)

As indicated in FAO (1994) views on impact of land degradation on poverty remains inconclusive. One school of thought posits the vicious cycle of poverty–land degradation, which states that poverty leads to land degradation and that land degradation leads to poverty, poor land users lack the capital required to invest in land improvement. Neither labor nor capital resources are available to invest in land conservation measures. Because farmers cannot afford inputs such as fertilizer, pesticide, or irrigation equipment, as a result the productivity of the land declines. Another school of thought maintains that the poor, who heavily depend on the land, have a strong incentive to invest their limited capital into preventing or mitigating land degradation if market conditions allow them to allocate their resources efficiently. The former theory is similar with the problem around the study area, because there is no implication of investment on long term advantages especially for soil conservation practices. For instance, 86.8% and 9.6% of the respondents use the credit borrowed for purchase of agricultural inputs and oxen respectively (Table 2)

Farmer's perception of decline in agricultural productivity

Soil conservation, from an economic perspective, implies saving soils for future use, i.e., redistribution of soil use rate into the future. Farmers are more likely to have short planning horizons, but long-term effects of erosion on productivity will have less influence on land use decisions. However, agricultural productivity decrease year after year mainly because of the deterioration of soil fertility (Tessema, 2011). And this problem was subsidized by application of inorganic fertilizer and introduction of many high yielding crop varieties for many years. But now problem of decline in agricultural productivity is becoming beyond of application of fertilizer and high yielding varieties. For instance, despite the continued development of new and improved modern varieties and greater use of chemical fertilizers, yield growth began to slow in the latter part of the 20th century (Brevik, 2009).

Majority (75%) of sample farmers reported that there was decline in the crop yield year after year on their farm. Out of these farmers, 26%,31%, 29% and 14% of respondents rated their perception for decline in crop productivity due to application of fertilizer below the recommended rate, wild animal attack, soil erosion problem, and other problem (lack of improved Variety of seed, faulty management of farm land and problem of pest and plant disease) respectively.

The problem of wild animal's attack ranked as a primary problem in reducing agricultural production in the study area. There is a proclamation any wild animals are not killed unless permission is given by government organization. The number of wild life eating agricultural product increase from time to time because there is no any carnivorous animals eating them to balance the nature. Hence, it is becoming inconclusive unless some measures are taken up on those from they take much labor from production to keep them from the attack of crop as well as domestic animals. In addition, the farmers clear and devastate the forest around their farm land to make far away from agricultural production.

Current soil conservation practices in the area

Various measures of soil conservation practices have been introduced by the agriculture department to the farmers in the study area for more than two decades (GSDAO,2015).As indicated inTable3, different households undertake different conservation practices on their land. Among these, crop rotation, Contour plowing-cultivating crops, soil bund, water way and cut of drain are the major conservation methods practiced in the study area. Crop Rotation- is widespread biological conservation type and it has an advantage in increasing soil fertility. More than 50% of respondents implement crop rotation on their farm land.

Soil (stone) bund is an embankment or ridge built across a slope along the contour. Out of the 238 sample HHs, on which soil bund constructed on their own farm land were 147(62%). Out of these, 39%, 48% and 12.97%respondents, the soil conservation practices was done by campaign, family and Sustainable Land Management project respectively. As indicated in this table only 59% of HHs maintains the already established soil bund on their farm plot while 41% did not do any maintenance especially these structures done in campaign work

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Table 20: Soil conservation practices and its maintenance in the study area

Type of conservation practices	Number of adopter farmers	Percent of the total HHs
Crop rotation	131	55
Grass strip	34	14
Tree planting	36	15
Soil bund	147	62
Soil bund has undertaken by		
In campaign	57	39.0
Family	70	48.0
Both (In campaign and family)	4	0.03
Sustainable Land Management project	16	12.97
Total	147	100
Maintain the physical structure Worked		
Yes	86	59
No	61	41
Total	147	100

Source: Own Survey(2015)

According to secondary data obtained from agricultural office, physical conservation like soil bund, cut of drain and water way were mainly under taken by the campaign work on the continuous basis covering of each farmers plot. However, it has a drawback as it lacks sustainability by which the farm land silt caused by erosion fills the embankment if it lacks maintenance in every year until it stabilized. Because the maintenance always have to be under taken by individual farmers who not have enough labor to maintain those structure already done by campaign work on his total farm land.

Around the study area(in the most of the Eastern part of Oromia)where high intensity of rain fall and silt formation is very high, the embankments was filled with silt when there is no maintenance, keep the farm land out of any conservation practices in short period of time.

Vetivar grass is the most known grass strip demonstrated to the farmer starting before two decades in the study area and most farmers adopted the practice. Even it served as source of income through its sale to different organization, especially for stabilizing road construction. Thirty four percent of sample households used vetivar grass as grass strip practices for soil conservation. Minimum tillage has been observed as one of conservation practices, undertaken. In the study area land preparation for *teff* need 3-5 times of tillage and for maize with minimum of 2-3 times of tillage. But now most of the farmers adopt this practice for its reducing number of tillage and labor too. According to data obtained from agricultural office, 3377 hectares (10% of total area of the district) of crops were planted with minimum tillage in year 2015.As revealed in FAO (2000) the advantage of this practice compared to conventional soil preparation were reduction of soil losses by 5%, increase or maintenance of soil organic matter, reduction in labor requirements up to 70% on animal traction systems and reduction in cost of production between 5 to 15%.

Concerning tree plantation, according to secondary data from agricultural office, the total numbers (area) of tree planted and survived for five years (2011-2015) were 64.3 million(6325 hectares) and 43.26 million (5766 hectares) respectively. When the survived planted trees hectares were divided into total area coverage 33,753 ha of the district, it is 17%.But by transect walk during survey time such practices could not be seen in the field so much. This may be either because of the exaggerations of the number of planted trees or the low survival rate of newly planted seedlings due to moisture stress, livestock interference and the associated poor soil fertility.

Even though, the advantage of *Cordia Africana* which was indigenous usually used as agro forestry, important tree for soil conservation practices and common cash generating tree, *Eucalyptus* account for the majority of plantation forests in the study area. This is may be due to the fact that harvesting and transporting of woods from some indigenous trees, including high-value indigenous timber tree species such as *Cordia africana*, are prohibited, according to forest proclamation of Oromia proc.No. 72/2003 (OFP, 2003) cut and utilize the tree without permission penalized with 5-15 years imprisonment. Because of this problem, use of this indigenous tree species is impossible without pay their precious time for getting permission from Agricultural or Rural Land Administration and Environmental Protection Office. Which may be one factor the farmers did not encouraged for nursing this important tree. Similar to this finding, as indicated by Mulugeta and Habtemariam(2014)prohibition aggravate deforestation of natural forests and such policies discourage farmers from growing native timber species on their farm lands, and force them to continue planting mainly exotic species, which contradict policies of natural forests mainly conservation-oriented.

Tobit Model Results and Discussion

As noted in Greene (2002) a dependent variable that has a zero value for a significant fraction of the observations requires a censored regression model (Tobit model) because standard OLS regression fails to account for the qualitative difference between limit (zero) and non-limit (continuous) observations.

As presented in Table 4, the determinant and intensity of willingness to pay for conservation practice was estimated by Tobit model. Since the P-Value (Prob> chi2) is equal to 0.0000, implied that the model was overall significant. Interpretation of the Tobit coefficients depends on whether one is concerned with the marginal effect of the independent variables on the latent variable or on general change of WTP, observed dependent variable or for intensity of change and the probability of being uncensored dependent variable. Out of the 15 explanatory variables hypothesized to determine the willingness of farmers' to participate in soil conservation practices in the study area, 4 were found to be significant and influenced the probability of willingness to pay among the farm households at less than or equal to 5% probability level of significance. These were the education level, distance of household residence to agricultural office; the respondents social position in KAs and access to credit.

Table 21: Results based on Tobit Model estimation of willingness to pay

Explanatory variables	Total WTP			Marginal effect		
	Coef.	Std.Err	P >/z/	General change of WTP	Intensity of change	Probability of change
AGE	-.296570	.3015843	0.327	-.29358	-.277671	-.0005859
AGESQ	.0034515	.0032802	0.294	.003416	.0032315	6.82e-06
EDUC	3.659518***	.390615	0.000	3.622628	3.426307	.0072299
SOCP	16.37675***	3.407956	0.000	15.85557	14.2263	.0817223
DISDC	-1.3335**	.5496264	0.016	-1.32006	-1.24852	-.0026346
OWNL	-.019004	.5327482	0.972	-.018813	-.017793	-.0000375
FAMS	.981099	.7742432	0.207	-.971209	.918576	.0019383
FARMI	.000339	.0003229	0.294	.000336	.000318	6.7100
LOGIN	3.628412	5.008456	0.470	3.591836	3.397184	.0071685
PROD	3.474681	2.772673	0.212	3.432132	3.220761	.0081081
LIVES	-.129474	.3335835	0.698	-.128169	-.121223	-.0002558
PERER	1.47185	2.797358	0.599	1.45771	1.381378	.0027875
EXV	.0885819	.0731148	0.227	.087689	.0829368	.000175
LANDT	3.133802	3.299748	0.344	3.093738	2.897353	.0075945
CRED	12.2146***	2.575452	0.000	12.0717	11.39187	.0266568
Const	-3.47526	18.3367	0.850			

LR chi2(15) = 206.38, Prob> chi2= 0.0000, Log likelihood = -653.26258,Pseudo R2 = 0.2364
Obs. summary: 29 left-censored observations, 182 uncensored

** and *** show significant at 5%, and 1% probability level of significance respectively

Source: Own Survey (2015)

The perusal of Tobit Model result as presented above in table 4,revealed that household education level(EDUC)positively and significantly affected households' maximum willingness to pay for conservation practices at 1% probability level of significance. Ceteris paribus, when education level of household's head increased by 1 class of schooling, the probability of maximum WTP of household increased by 0.72%, while the amount of labor he/she could pay for soil conservation practices increased by 3.62 among the total population. However, the amount of respondent's willingness to pay with explanatory variable of education level among individual who were WTP was 3.42.

With regard to the relationship between social position of household head (SOCP) and WTP of labor contribution, a positive and significant relationship was observed. Holding other effects constant, when household participated in either of social position in KAs the probability of maximum WTP of household increased more than those not participated in any social position by 0.82%, the amount of labor he/she could pay for soil conservation practices increased more than these not participated by 15.86 among the total population, however the amount of respondents willingness to pay with explanatory variable of social position among individual who were WTP, increased the labor contribution more than these not participated by 14.23.

Resource availability was generally expected to positively influence farmers' land management practices. Hence, access to credit(CRED) was expected to have positive relationship with farmers' willingness to adopt conservation practices. Farmers with access to credit services were found to be statistically different from farmers with no access to credit in their practice of soil conservation and the relationship was highly statistically significant ($p<0.01$). Holding other explanatory variables constant, HHs who had access to credit were willing to pay more than those without access to credit by 2.67%. The amount of labor he/she could pay among the total population and the amount of labor he/she could pay among individual who were WTP increased labor contribution more than these not access to credit by 12.07 and, 11.39 respectively.

Conclusion and policy recommendations

This study examined Households' Willingness to pay for soil conservation practices in Gobu Seyo district, Eastern Wollega Zone,Oromia National Regional State, Ethiopia.The main objective of this study was to identify *the determinant and intensity of HH's willing to pay for soil conservation practices.* The data used for this study were both from primary and secondary sources. The primary data were collected using semi structured questionnaire and the secondary data were obtained from Gobu Seyo District Agriculture office. Both descriptive and econometric analyses were made by using STATA software.

Results of the descriptive analysis showed the average total sample age of respondents was 41.92 years. The average family size was 7 people. The average size of cultivated land owned by the sample respondents was about 3.14 ha. In this study 41% of farmers did not perform any maintenance work on the soil bund constructed on their farm land especially those structures done in campaign work. In addition, damage to crops by wild animals was also a serious problem in the study area. Indirectly they were observed to play role in devastating the forest of the area.

Tobit model was used instead of simple linear regression to identify the major factors affecting households' WTP. Households head education level, social position of household head, access to credit and HHs residential distance to agricultural office were significantly affected households' WTP for adopting improved soil conservation practices. Therefore, it was concluded that adequate attention about of these variables may greatly contribute to increase willingness to pay and the sustainable use of soil conservation practices in the study area. Conservation practices of natural resources would be most effective when understood in the context of individual farmer's WTP. To implement desirable land management method in a more sustainable way, it is essential to generate viable changes in the attitude of farmers as initial step. It may serve as a corner stone for initiating appropriate planning and program implementation.

Based on the results of the study, the following recommendations were made to accelerate the adoption of soil conservation practices in the study area as follows.

- Actions are needed to increase farmers' awareness about the importance of conservation practices through extension demonstration and training. This should be an integral part of soil conservation initiatives which may help to fostering positive perception and attitudes of framers towards soil conservation efforts.
- Programs for training to farmers regarding implementation of soil conservation practices in successful manner need to be imparted along with emphasis to increase literacy.
- Linking farmers with credit facilities to induce sufficient investment on their land .The combined effort is needed to design policy interventions for not only increasing agricultural input used for short term but also increasing conservation practices for increasing productivities in sustainable manner.
- More emphasis should be laid down on biological conservation practices rather than labour intensive conservation practices, such as building and maintaining physical structures.
- Measures should be taken to protect the crop through damages caused by wild animals. Further study on the problem should be conducted in the study areas.
- Farmers should be motivated to grow indigenous species of tree which enable them to use the products freely. For instance, prohibiting use of *Cordia africana* without permission may discourage them to grow on their farm land.

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Assessment of Rural Energy Sources and Energy Consumption Pattern in West Oromia, Ethiopia

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Abstract

The study was conducted in West shewa and East wellega zones, Oromia Regional State with objectives of identifying the major rural source of energy and consumption pattern and identifying constraint and potential of energy use in the study areas. Simple random sampling technique was used to select a total of 180 respondents and interviewed using structured questionnaire. Descriptive statistics with Statistical Package for Social Science (SPSS) software were used for analyzing the collected data. .The result of the finding indicated that the majority of the respondents in the study *areas used firewood as the main energy sources About 91.1% and 16.9% of the respondents were used agricultural residue for the purpose of baking Enjera. In addition, about 57.2% and 22.8% of the respondents were used firewood charcoal for the purpose of heating respectively. Moreover, about 55% and 20% the respondents were used kerosene and small size solar for the purpose of lighting in the study areas. Accessibility and use of electricity, battery cell and biogas were limited in the study areas was the lowest level energy sources of study area. In study area, limited households have access to electric service and use for the purpose of lighting in study area. , but they did not use for the purpose of* cooking *and heating Biogas, modern charcoal stove, stove and small size solar energy were promoted in the study areas as alternative energy technologies. But limited farmers were accessed and used these technologies in the areas. As a result, firewood and agricultural residue were the potential energy sources for farmers in study area The result of the finding further revealed that lack of research intervention on rural energy sources, lacks of effective rural energy technologies, socio-economic problem to accept available rural energy sources, lack of information and how alternatives rural energy technologies accessed were identified as major constraints of rural energy sources in study areas. To fill these gaps research centers, Zone and district water, mine and energy offices and other development partners should be planned to introduce natural energy sources and disseminate the available alternative technologies for rural households of the study areas.*

Key words: *Agricultural residue, alternative energy sources, biomass, firewood, rural energy sources*

Introduction

Energy is very crucial for daily life to meet human beings basic need such as cooking, boiling water, lighting and heating (WHO, 2006). Household energy is a key issue of Ethiopian energy sector. Efficient energy consumption is a basic input for socio-economic growth and development at national and as well as global levels. There is a strong linkage between energy and the millennium development goals. According to World Bank (2009), energy service delivery, especially to the rural communities, contributes to achieve the millennium development goals. Hence, without efficient and accessible modern energy economies cannot grow and develop and also poverty could not be eradicated. Since energy is vital input to all sectors of the economy, mainly such as industry, agriculture, and social services.

However, the majority of the developing countries face a lack of sufficient power supply that is obstacle for their economy growth. Moreover, most of the household in developing countries continue to be dependent on traditional use of solid fuels (biomass) for cooking and heating, due to lack of access to electricity and modern energy sources. The consumption of traditional fuels has negative impact on environmental, economic and health. That is, increased use of fire wood and charcoal leads to deforestation, leading to ecological imbalance and increased use of agricultural residues and animal dung depriving the land off essential nutrients that are necessary for soil fertility. The inefficient way people use energy is factor accreting deforestation. The main causes of deforestation in Africa are fuel wood collection, logging, agricultural expansion, and population pressure (Nebiyu, 2009). Nonetheless, almost 2 billion people are dependent on biomass fuel in low income countries (Anderson, 1996).

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Biomass sources (fuel wood, animal dung, crop residues and charcoal) constitute over 94 percent of the country's energy supply. The industrialized (developed) countries depend, primarily on modern energy while the developing countries rely on traditional fuel (Araya, 2002). There is strong cultural preference in Ethiopia in general and in Oromia in particular to use fire wood and charcoal for cooking (World Bank, 1994). To solve the shortage rural energy sources the federal and regional governments made an efforts to enhance the availability of alternative energy sources by distributing of different level of solar energy, mirt enjera stove and improved stove for rural areas in Agricultural Growth Programme I(GTP I).

In Western oromia, rural communities used various energy sources for different purpose. Shortage of energy aggravated the shortage of rain, drought, deforestation, hot temperature and termite infection. Those problems were decrease production and productivity, decrease income, and loss saving poverty was developed at household level and decrease access of water availability (East Wolega Zone Disaster Prevention and preparedness office, 2014). Again Agricultural Engineering Research center it should be contribute in reducing energy problem for selected zones. So survey was needed and pin point relation with Energy sources of rural areas in selected zones. So It need a careful identification of rural households energy and constraints and potentials energy use selected zones, no systematic studies have been undertaken regarding the rural energy consumption behavior of households. Hence, this study was designed to identify the major source of energy consumption and identify constraint and potential of energy use in the study areas.

Methodology

Description of study areas

The study was conducted in West shewa and East wellega zones, western part of Oromia Regional State. It has 18 and 17 districts respectively and located about 114km and 331km from Addis Abebe respectively. The West shewa zone has a total land of about 1,434,929 Ha; from this, farming 61.34%, grazing 17.39%, forest 7.3% and other 13.9% and it contains about 3.8% of oromia land. Its agro-ecology 27% dega, 56%Weina dega and 17% kola with minimum and maximum temperature 10^{o}c and 25^{o}c respectively, gain 812-1699mm rain fall in the year. According to the information collected from Zone Agriculture and Natural Resource Office (2008), West Shewa zone has a total rural population of 2,109,637 of which male and female are 1,047,711 and 1,061,926, respectively. Accordingly, East Wellega Zone has a total land of about 1,384,973 ha; from this, farming 63.3%, grazing 10.5%, forest 11.5% and other 14.7% and it contains about 3.7% of oromia regional land. Its agro-ecology 7.2% *dega* , 51.1%*Weina dega* and 41.7% kola with minimum and maximum temperature 23^{o}c and36^{o}c respectively, gain 800-2260 mm rain fall in the year. According to the information from Zone Agriculture and Natural Resource Office (2008, East Wollega Zone has a total rural population of 1,199,444 of which male and female are 617,753 and 581,871, respectively.

Sampling procedures

Multistage sampling procedures were used to select the study areas and sample respondents. In the first stage, East Wolega and West Shewa Zones were selected randomly from Western Oromia. In the second stage, six districts (Sibu Sire, Diga and Jima Arjo from East Wolega Zone and Ilu Galan,Dandi and Dire Incini districts’ from West Shewa Zone)were selected purposively based on ’households’ sources of energy. At the third stage two *Kebeles* were randomly selected from each district and a total of six *Kebeles* were selected for the intended purpose. Finally a total of 180 farm households were randomly selected based on Probability Proportional to Size (PPSS).

Source and methods of data collection

Both primary and secondary data were collected and used for assessing energy sources and consumption pattern in the study areas. The secondary data were collected from Zonal and districts water, mineral and energy offices, and other published and unpublished documents from different sources. The primary data were collected through household survey using structured questionnaire.

Methods of data analysis

Descriptive statistics such as, percentage, mean, standard deviation were used to analyze the collected data using Statistical Package for Social Science (SPSS) of Version 20 software.

Results and discussions

Demographic and socio-economic characteristics of households

As shown in Table 1 from the total number of farm households surveyed 141 (78.3%) were male and 39 (21.7 %) were female farm house households. ,about 97.3% were married farm households involved in the survey., Regarding education, the results show that 66% of the household heads had formal education from grade one up to college diploma while 32.22% the farmers were illiterate (Table 1), In this study, educated household heads are assumed to be more aware of the environmental and health effects of biomass fuels (firewood, dung, agricultural residues), and able to use alternative sources of energy.

Table 22. Demographic characteristics of households in the study area

Characteristics	Frequency (n=180)	Percentage (%)
Sex		78.3
Male	141	21.7
Female	39	
Education		
Illiterate	58.0	32.22
Read and write	3.0	1.67
Grade 1-4	30.0	16.67
Grade 5-8	60.0	33.33
Grade 9-10	16.0	8.89
Grade 11-12	11.0	6.11
Dioloma	2.0	1.11
Marital status		
Single	1	0.6
Married	175	97.2
Divorced	3	1.7
widowed	1	0.6

Source, Survey result, 2017

The mean age of household heads was 40 with the minimum and maximum 18 and 75 years respectively. The average family size was 6 with a minimum of 2 persons and a maximum of 13 persons and the mean cultivated land size was 3.35 hectares (Table 2).

Table 23. Socioeconomic characteristics of households

Characteristics	**Minimum**	**Maximum**	**Mean**	**SD**
Age (year)	18	75	40	11.5
Family size (person)	2	13	6	2.1
Cultivated land in hectare(ha)	0.25	8	1.5	1.28
Grazing land (in hactare)	0.1	2	0.5	0.39
Forest land ()	0.13	2	0.39	0.45

Source, Survey result, 2017, SD =Standard deviation

Sources of rural energy

The results of the study revealed that firewood, crop residue and kerosene are the major source of energy for the farmers in the study areas. All of households (100% households were reported that firewood as a major source of energy in the areas and they used it commonly for cooking and heating. The result also shows that out of the total households, about 62.8% and 61.7% of the households were reported that crop residue and kerosene as a major source of energy in the study areas, respectively (Table 3). In addition to these, some households used other source of energy such as charcoal, animal dung, solar, biogas, electricity, and, battery cell and used for different purposes. Similar result was also reported by Mekonnen and Kohlin (2008) in Ethiopia, woody biomass, dung and kerosene are the main sources of energy for rural households.. However electricity, and liquefied petroleum gas are possible alternative energy sources, and they are hardly used at all in the rural areas due to its high prices and lack of accessibility.

Table 24. Household's major energy source in the study area

Energy sources	Frequency(number)	Percentage (%)
Firewood	180	100
Crop Residue	112	62.8
Animal dung	36	20
Charcoal	36	20
Kerosene	111	61.7
Electricity	33	18.3
Small size solar	36	20
Battery cell	8	4.4
Biogas	3	1.66

Source, Survey result 2017

As shown from Table 4, about 48.3% households were used the firewood as a source of energy in both dry and wet seasons in the study areas. About 35% and 16.7% of households were used the firewood in wet and dry seasons, respectively. On the other hand, about 91.2% of respondents were used crop residue as sources of energy during dry season in the study areas.

Table 25. Season of energy consumption by households in the study areas

Energy sources	Season of energy consumption					
	Dry season		Wet season		Both season	
	N	%	N	%	N	%
Fire wood	30	16.7	63	35	87	48.3
Crop residue	103	91.2	5	4.4	5	4.4
Animal dung cakes	15	8.3	3	1.7	18	10

Source, Survey result 2017

In the study areas, farm households used different energy sources for cooking, heating and lightning. The result of the study revealed that, about 91.1.% and 57.2% of the households were used firewood for cooking and heating respectively and also about 22.8% of the households were mostly used charcoal for heating purpose.. In addition, out of the survey, about 55% of the respondents reported that they use kerosene for lighting. Table 5 also shows that limited farm households were also used solar, electricity, battery cell and biogas for the purpose of lighting in the areas.

Table 26. Energy sources and consumption pattern of households in the study area

Energy sources	Energy consumption of household					
	Enjera Baking		Heating		Lighting	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Firewood	164	91.1	103	57.1	0	0
Crop residue	16	8.9	29	16.1	0	0
Firewood with dung cake	0	0	5	2.8	0	0
Charcoal	0	0	41	28.9	0	0
Kerosene	0	0	0	0	99	55
Small size solar	0	0	0	0	36	20
Battery cell	0	0	0	0	8	4.4
Electricity	0	0	0	0	33	18.3
Biogas	0	0	3	1.5	1	0.6

Source, Survey result 2017

The collection of firewood was done by women and girls in the study areas. The survey result indicated that about 51.8% respondents reported that the collection of firewood was performed by women and girls and followed by women (Table 6). Moreover, the result indicated that about 62.7%, 25.3% and 12% of respondent collects were collected the firewood from their own farm lands, community forest and free space, respectively in the study areas, and used for cooking and heating.

Table 27. Gender roles in firewood collection in the study areas

Participants	Frequency(N=166)	Percentage (%)
Women	58	34.9
Girls	11	6.6
Women and girls	86	51.6
Boys	3	1.8
Men	2	1.2
Boys and Men	6	3.6

In the study, finding shown that (Table 7) on average households were traveled 0.5hr, with minimum and maximum 0.1hr and 2 hr to collect firewood and they collected firewood 2 to 3 times in a week. The fire wood collection frequency depends on the family size and also on distance from the source. Large families require more wood to fulfill their domestic energy needs, so they collect 2 to 3 times in a week. Their fire wood demand doubles in winter season as compared to the summer season because they require more fuel wood for heating purposes. On average the respondents were collected 3 times per week with minimum and maximum 1 times and 7 times per week and on average it takes 1.3 hrs with minimum and maximum of 0.2 hours and 6hrs to collect fire wood for one trip.

Table 28. Distance traveled, frequency per week and time spent for firewood

Variables	Minimum	maximum	Mean	SD
Time traveled (Hrs)	0.1	2	0.5	0.36
Frequency collected per week	1	7	3	2.07
Time taken to collect for one trip (Hrs)	0.2	6	1.3	1.06

Source, survey result 2017, SD=standard Divetion

Constraints of biomass energy consumption

As shown in Table 8 the main limitations of using biomass energy sources was to smoky and causes eye disease and cough (61.1%), increased burden on women (21.1%), facilitate soil erosion on the farm (11.7%), deforestation (6.1%) were the major constraints biomass energy source.

Table 29 Distribution of households reply problems of using biomass (N=180)

limitation of biomass energy consumption	Frequency	Percentage (%)
Too smoky when they uses and causes eye tiers disease and cough	110	61.1
Increased burden on women	38	21.1
Facilitate soil erosion	21	11.7
Deforestation	11	6.1

Source, survey result 2017 N=Number HH reply

Alternative rural energy sources

In the study areas various alternative energy sources were distributed through office of water, mineral and energy offices. As shown in the table 11, the collected data collected from shown that a total of 42998 improved charcoal stoves, 87853mirt stoves, 19630 solar energy and 163 biogas were distributed to the farm households in the study areas.

Table 30. Alternative rural energy sources distributed in the study area

Selected Zone and districts	Unit	Biogas	Modern charcoal stove	Mirt stove	Solar Energy	Carbon izer
East Wolega Zone	Number	209	121,923	174,393	2,550	NA
Sibu Sire	Number	32	20,000	11,00	7,889	NA
Digga	Number	0	300	500	1,120	NA
J/Arjo	Number	17	81	4,627	2,460	NA
West shewa	Number	77	16,068	70,011	6,910	NA
Ilu Galan	Number	0	5,648	6,049	0	NA
Dandi	Number	16	89	6038	200	NA
Dire Incini	Number	21	812	628	1051	NA

Sources, Zonal and Districts WME office, 2016 NA= Non –available data

Regarding to accessibility and use of alternative energies, the result of the study shows that about 111(61.7%) households have no access alternative energy sources like biogas, solar energy and improved charcoal stove, mirt enjera stove, electricity but about 69 (38.3%) have such like alternative energy. For respondent who have no alternative Energy sources, the possible reason why they have no alternative energy sources are, lack of cost, lack accessibility, lack of awareness on availability of alternative energy source and lack of interest on to get alternative energy source**.** The table 10 shows that about 43.5% of the households were used small size solar energy in the study area.

Table 31. Households use alternative energy sources in study area

Alternative energy source	Frequency	Percentage (%)
Biogas technology	4	5.8
Small size solar energy	30	43.5
Mirt enjera stove	6	8.3
Improved charcoal stove	5	7.2
Electricity	20	29
Mirt enjera stove and electricity	3	4.3
Biogas , Mirt Enjera stove and Electricity	1	1.4

Source, survey result 2017 N=Number HH reply

As shown in table 11, about 87%, 90% and 88% of respondents reported that they didn't have access to training on biogas technologies, solar energy and improved charcoal stove and mirt enjera stove respectively. From this could conclude that biomass energy sources is the dominant fuel sources by both households with no and with access to alternative energy sources in the study area implying that burden on biomass (wood, dung and Agricultural residue) energy sources which leads to environmental problem and subsequent reduction in agricultural productivity.

Table 32. Households training on alternative energy sources

Alternative Source of Energy	HH With Technology (N=69)				HH without technology (N=111)				Total (N=180)			
	yes		No		yes		No		Yes		No	
	N	%	N	%	N	%	N	%	N	%	N	%
Biogas technology	17	24.6	52	74.6	7	6.3	104	93.7	24	10	156	87
Solar Energy	11	15.9	58	84.1	7	6.3	104	93.7	18	10	162	90
Improved charcoal	10	13.2	59	86.8	11	9.9	100	90.1	21	12	159	88

Source, survey result 2017

Comparison of households with no and with Access to alternative rural energy

The socio-demographic characteristics of households defined in terms of sex, marital status, education level, age and family size. The Distributions of household's socio-demographic characteristics have indicated (below in table 12). The result of this study reveals that mean age of the household is 38 and 42 years of old for households with no and with access to alternative rural energy source respectively. the mean comparison of households with no and with access to alternative rural energy technology in terms of age was significant (t-value= 2.113, sig. 0.036). As the results shows in table 12 the average of family size in the study area was 6 and 7 for households with no and with access to alternative source of rural energy respectively. Similarly, the sex of the households with no access and with access alternative energy source was about 78%. These imply that the mean difference observed in terms of sex statistically not significant (t-value=0.019, sig. 0.985). Table 16 indicates the educational level of head of the households; about 61% of the households with no access to alternative rural energy are literate household head while households with access to alternative rural energy account 78% household heads are literate. This difference is statically significant at 5%. This implies that literate headed households are consumed more alternative rural energy source than illiterate headed households.

As shown in able 1 that households with no access to alternative rural energy source about kitchen service is 71%, 3.6% and 25% prepared food in separate kitchen, open space and in living room respectively while households with access to alternative rural energy source prepared the food is 85% and 4% in separate kitchen and open space respectively while the remaining 11% households with access to alternative rural energy source prepared the food in their living room. The Kitchen service of household heads has significant effect on decisions to consumed alternative rural energy source at 5% level of significance. Furthermore, the average time in hour from the household's home to the Farmers training center for households with no and with access to alternative rural energy sources 0.56Hr (34 min) and 50hr(30 min.) respectively; this mean difference is statistically insignificant at 5% (t-value=-0.665 sig-value = 0.50). Similar way, the mean time in hour from the households' home to health extension center for households with no access to alternative rural energy source is about 0.47hr (28min), the mean distance traveled to health extension center by households with access to alternative rural energy sources 0.43hr **(**26min). This difference is also statistically insignificant at 5 %(t-value= -0.859 Sig -value= 0.392)

Table 33. Comparison of households with no and with Access to alternative energy sources

Socio-demographic character	Mean			
	With no access	With access	t-value	Sig-value
Age	38	42	2.11	0.036*
Family size	6	7	1.32	0.189
Time taken to travel farmers training center(FTC)	0.56hr	0.5hr	-0.665	0.5
Time taken to travel health extension center	0.47hr	0.43hr	-0.859	0.392
Education			2.9	0.004*
Sex			0.19	0.985
Place of cooking			0.295	0.004*

Source, survey result 2017

Constraints of rural energy sources in study area

In study areas, the constraints of rural energy sources were identified and prioritized in order to importance by farmers in study area. Table 13 indicate that about 40% of respondent reported that reply lack of manufacturer on alternative rural energy source, lack of effective alternative rural energy sources(33.8%) socio-economic problems to accept available rural energy technology(12.7%), lack of information where and how to get alternative energy sources (7.5%), unlike, Agricultural input, lack of research on alternative energy sources (6%), were identified as a the major constraints in accessing alternative energy sources.

Table 34. Constraints of alternative rural energy sources in the study area

Constraints	N	Percent	Rank
Lack of manufacturer on alternative rural energy source	72	40	1st
Lack of effective alternative rural energy source	61	33.8	2nd
Socio-economic problems to accept available rural energy technology	23	12.7	3rd
Lack of information where and how to get alternative rural energy source	13	7.5	4th
Unlike, Agricultural input, lack of research on alternative energy sources	11	6	5th

Source, survey result 2017

Conclusions and recommendations

The study was conducted in West Shewa and East Wollega zones, in Oromia Regional State with objective of to identify the major source of energy consumption in the study area and identify constraint and potential of energy use in the study area to select sample study areas and households, multistage sampling procedure was used to select the survey areas. A total of 180 households were randomly selected and interviewed using structured questioner. The characteristic of household energy source utilization, the majority of respondent uses firewood about 91.1% and about 16.9% the respondent uses crop residue for the purpose of cooking. Firewood is the first widely used energy source, about 57.2% of the respondents were firewood and about 22.8% of the respondents were used charcoal for the purpose of heating mostly. About 55% the respondents ware used kerosene. The respondents use small size solar only about 20% for purpose of lighting. Electricity, battery cell, biogas was the lowest level energy sources of study area. In study area even if some rural households with access to electric service , they did not use for the purpose of cooking as well as heating , only use for the purpose of lighting in study area. The main reasons for preference of biomass energy consumption in the study area is ease of access (31.7%), cultural preference (30%) and cheap prices (21.1%) source of energy furthermore the least reasons for choice of rural households energy consumption is convenience when they used and no alternative energy source of 8.3% and 8.9% respectively. Among the various fuels considered fire wood and crop residue turned out to be the prominent energy sources of households in the study area.

The finding revels that on average households traveled 0.5 hr, with minimum and maximum 0.1hr and 2hr to collect firewood. They collect wood 2 to 3 times in a week. The firewood collection frequency depends on the family size and also on distance from the source. Large families require more wood to fulfill their needs, so they collect 2 to 3 times in a week. Their firewood demand doubles in winter season as compared to the summer season because they require more fuel wood for heating purposes. On average the respondents collect 3 times per week and on average it takes 1.3 hrs with minimum and maximum of 0.2 hrs and 6hrs to collect fire wood for one trip. The main activities affected by firewood collection was, educational activities of the female, and Agricultural activities was the mostly affected activity. The main problems using firewood was to smoky and causes eye disease and cough, increased burden on women, facilitate erosion and deforestation respectively.

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About 111(61.7%) of households have no alternative energy sources like biogas, solar energy and improved charcoal stove, mirt Enjera stove, electricity but about 69(38.3%) have such like alternative energy sources. The possible reason for households without alternative energy source why they have not were lack of cost, lack accessibility, lack of awareness on alternative energy source and lack of interest on to get alternative energy source**.** According to rank to correlation analysis between two zones show that the relation of the causes of 80% and this can be similarity reasons of not have alternative energy sources. Firewood and crop residue is dominant energy sources and energy potentials for enjera baking and heating in the study area. In same the way kerosene and small size solar system was energy potentials for lighting.

The constraints of rural energy sources were identified and prioritized in order to importance by farmers in study area. About 40% of respondent reply lack of manufacture on alternative rural energy source, Lack of effective alternative rural energy sources(33.8%),socio-economic problems to accept available rural energy technology(12.7%), lack of information where and how to get alternative rural energy source (7.5%) unlike, Agricultural input, lack of research on alternative energy sources (6%), are the major constraints identified. The heavy dependence and inefficient utilization of biomass resources of energy have resulted in high exhaustion of firewood, crop residue, dung and charcoal in the area. So, should be promoted of improved stove that contribute to reducing burden on biomass. Almost all a household do not have access to training on alternative rural energy sources like biogas, solar heating and Improved charcoal stove and stove to fill this gap should train rural household on alternative rural energy source and disseminate the available rural energy sources, the government and development partners should be planned to introduce efficient energy sources rural communities to reduce burden on biomass energy sources in the study areas.

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Analysis of Productivity and the Profitability of Smallholder Potato Growers in Bore District, Guji Zone, Oromia Regional State, Ethiopia

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Abstract

Agricultural production of the Ethiopia is mostly dominated by smallholders. The development of agricultural production is mostly known when smallholder farmers have obtained high productivity and high returns from their farm. But due to various chronic constraints the productivity and profitability of smallholders are low. The general aim of this study was to analyze productivity and profitability of smallholder potato growers in Bore district. Seven kebeles were randomly selected. Based on proportion to the number of potato producers in the selected kebeles, 192 sample size was used. Questionnaire and Focus Group Discussion were employed to collect primary data while secondary data were collected from different sources including reports and internet. The collected data were analyzed by frequency, percentage, mean and standard deviation. The mean of productivity, total costs and gross margin of potato was 109.95 qt/ha, 10938.38 *birr/ha and* 10930.97 *birr/ha* *respectively. The mean of net farm income from potato was 10090.45 Birr/ha. The result of Kendall's concordance coefficient showed that the most prevalent constraints of the smallholder potato growers in Bore district were diseases, lack of good market price, lack of improved seed, low yield. Despite the constraints smallholder potato growers were profitable. The results of Ordinary Least Square showed that sex, improved variety, fertilizer, experience, access to extension, harvesting time, nature of access to land, access to irrigation schemes affect both profitability and productivity of smallholder potato growers. To improve the productivity of smallholder potato growers provision of improved seed, use of fertilizers and chemicals as recommendation should be used by the smallholders. In addition, the smallholders should conserve their soil and harvest potato as soon as it matured. Furthermore, legal rules that sustain agreement on share and contract land use, developing market access by agricultural cooperatives and mobilizing smallholders to form groups should be encouraged to bring reliable market access for smallholders' product.*

***Key words**: Potato, smallholder, productivity, profitability, OLS.*

Introduction

In Ethiopia, agriculture plays an important role as the primary source of food and income for the poorer sections of the population (Tassew, 2014). In Ethiopia, agriculture is the most important sector which accounts 46% of GDP, 80% of export value and about 73% of employment (Aklilu, 2015). In addition, agriculture of the country supports 98% of the total calorie supply and 70% of industrial raw material supplies (Assefa, 2014). The sector still remains largely dominated by rain-fed subsistence farming by smallholders (Aklilu, 2015).

Potato (*Solanum tuberosum* L.) is the fourth most important food crop in production after maize, wheat and rice (Ayalew, 2014). It produces considerably more energy and protein than cereals (Haverkort *et al*., 2012). Potato is also the fastest growing staple food crop and source of cash income for smallholder farmers in Ethiopia (Beliyu and Tederose, 2014; Berhanu and Getachew, 2014). Potato is regarded as a high potential food security crop because of its ability to provide a high yield of high-quality product per unit input with a shorter crop cycle (mostly less than 120 days) than major cereal crops (Ephrem, 2015).

Despite the importance of potato for household food security and income generation in Ethiopia, the crop has less productivity beyond the country's potential due to use of poor quality seed potatoes varieties by most potato growers, sole dependency on local variety, poor research-extension and farmers' linkage, decline in soil fertility, poor application of fertilizers and diseases (Gildemacher *et al*., 2009; Hirpa *et al*., 2010, Mesfin *et al.*, 2014, Ephrem, 2015). In the study area, Bore district, the yield potential of potato lower and unsatisfactory. The average yield of potato in Bore district is 137 qt/ha (BOARC, 2013) while the average potato yield of smallholder's field in Ethiopia and Guji zone is about 137 qt/ha and 141 qt/ha respectively in 2014/15 (CSA, 2015). In addition to the productivity gap, there are also related to profitability of smallholder potato growers.

Thus this study was intended to analyze the factors affecting productivity and profitability of smallholder potato growers in Bore district, Guji Zone, Ethiopia.

General Objective

The general objective of the study was to analyze the factors affecting productivity and profitability of smallholder potato growers.

Specific Objectives

1. To assess profitability of potato production in the study area.
2. To identify the factors affecting productivity and profitability of smallholder potato growers.
3. To identify the potato production constraints faced by smallholders in potato production.

Methodology

Description of Study Area

Bore is one of the 180 disricts of the Oromia Regional State and found in Guji Zone. Bore is 385 km from Addis Ababa. The district is bordered by Hula district of SNNPR in the North, Ana Sora district in the South, Bona district of SNNPR in the East and Dama district in the West. Bore is divided into 33 rural kebeles and 3 town kebeles (BoARDO, 2015). The total population of the district is 158359. About 92% of population lives in rural area. The proportion of male and female population in rural area is 50.3% and 49.7% respectively while the proportion of male and female in town area is almost similar (ibid).

The major agro-ecology of the district is highland (90%) and midland (10%). Annual average of temperature of the district is 16.05 ^{0}C. The mean annual rainfall is 1300 mm while its altitude ranges from 1400 up to 2910 masl allowing a favorable opportunity for wider crop production and better livestock rearing. From the total land area (64395 ha) of Bore district, 37375 ha was allocated for annual crops where 57.7% covered by cereals, 21.5% pulses, 10.3% root crops, 8.7% vegetables and 1.8% covered by cash crop namely coffee (ibid). The major soils of Bore district are Nitosols and Orthic Acrosols which are suitable for maize, wheat, barley, potato, linseed, faba bean, field bean, cabbage and *enset*. Farm size per household varies from less than 0.10 to over 10.00 hectares in the district. The average landholding of the district varies among the agro-ecologies and slightly higher in highland kebeles (1.5 ha) than midlands (1ha) (Zonal Survey, 2003/4). Table 1 explains the current land use pattern of the district.

The two types of rainy production seasons in Bore district are *belg* and *meher* seasons. The *belg* starts from February to May and the other is *meher* starts from June to January. Root crops such as carrot and onion and vegetable crop like cabbage could be grown throughout the year but majority of farmers/smallholders commonly produce these crops during *belg* season. Potato is also one of the root crop mostly grown in the study area. Most of smallholder potato growers also produce potato during *belg* season. Crops grown during *belg* season serves smallholder farmer as cash crop in the study area. Wheat, barley, field bean, faba bean, *teff*, haricot bean and others were produced during *meher* season.
At Bore district, cattle, horses, sheep and bee keeping are the dominant livestock. Selling of milk is one of income generating activity for rural women. Bore is also well known by its 'white honey' which is produced from different vegetation distributions found in the district. Most rural youth and male farmers of Bore district migrate to extract minerals namely gold in order to maintain their income

during off season. Institutionally, there are 59 farmers' service cooperatives in the district providing agricultural inputs, credit, saving, potable water, modern crops storage services and facilities for the members (Zonal Survey, 2003/4). There are also few community based seed producers. Potato is mainly multiplied by research center and local based seed producers.

Table 1. Land use pattern of Bore district, 2015

Land use	Area Coverage in ha	% coverage
Land planted with annual crops	37375	58%
Grazing Land	14468	22.48%
Un productive land	1205	1.9%
Forest land	8898	13.82%
Area covered with water	1849	2.87%
Others	600	0.93%
Total	64395	100

Source: BoARDO (2015).

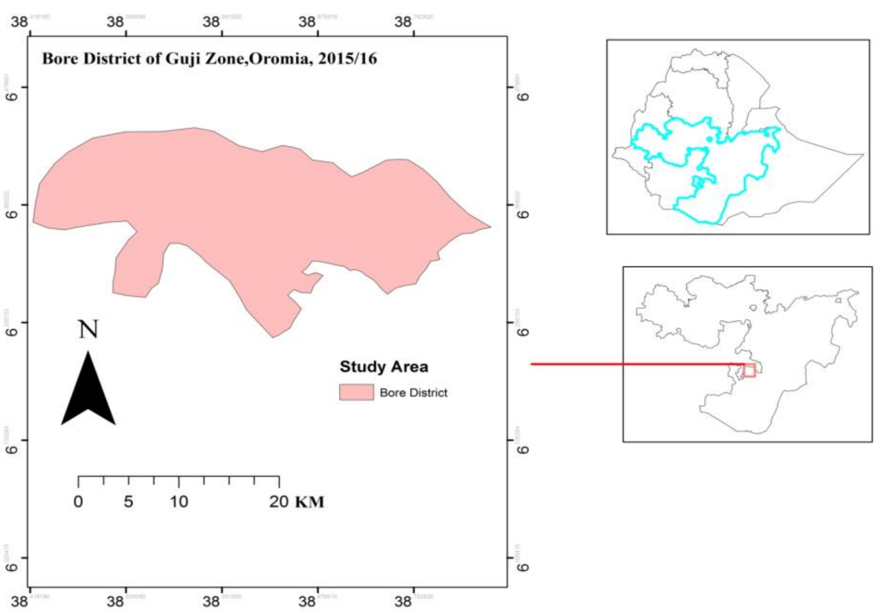

Figure 2. Map of the study area

Source: Own computation, 2015

Sampling Technique and Sample Size

Bore district was purposively selected as the district has potential for potato production. The district has 33 *kebeles* out of which 14 *kebeles* are major growers of potato. In the first stage, seven *kebeles* were selected randomly from 14 *kebeles* of major growers of potato and the number of respondents was determined by using probability proportional to size. Simple random sampling technique was employed to select the size of the sample smallholders from each kebele. From 3428 household heads producing potato in the district a total of 192 household heads were selected by simple random sampling method. To determine the required sample size, this study employed a simplified formula developed by Yamane (1967:886) at 93% confidence level and 10% non-response rate as provided below:

$$n = \frac{N}{1+N(e)^2} = \frac{3428}{1+3428(0.07)^2} = \frac{3428}{17.7972} = 192.$$

Where, n= sample size for the study, N= total number of household head producing potato

e= margin of errors at 7% and 10% non-response rate.

Data Collection

Both primary and secondary data were collected and used in this study. The nature of primary data such us socio-economic profiles of respondents, varieties, yield of potato and constraints related to potato production was collected from smallholder potato growers. For this study, primary data was collected by using structured and non-structured questionnaire interview. The questionnaire was reviewed by Development Agents and different researchers for a sake of relevancy of questionnaire to respondents' characteristics like their languages. After translation to local language (Afaan Oromo), questionnaires were pretested on ten (10) farmers outside the sample size and the final questionnaire was prepared using responses obtained from the pre testers. This is done in order to ensure the content validity of questionnaires. Primary data was collected by trained enumerators and collected from smallholders who were growing potato in 2015 *belg* season.

Three Focus Group Discussions (3FGDs) having 5-8 members were conducted in order to generate information and elaborate factors affecting profitability and productivity of potato and constraints of potato production. From the seven *kebeles* selected, three *kebeles* were considered and 1FGDs from each kebele was conducted based experience of farming, gender and locally known persons. On each FGD, 2-3 women were participated. Topics of discussions were listed by researcher and members were aimed to discuss. Secondary data such as literature review, district report on potato work, number of smallholders participating on potato farming, constraints of smallholders was collected from internet, published and unpublished journals and reports of the district.

Data Analysis

The study used both descriptive statistics and econometric model in analyzing primary data. Descriptive statistics like means, percentages, standard deviation and frequencies were used in analyzing socio-economic characteristic of respondents. Profitability determined as gross margin (GM) is defined as total revenue less total variable cost per hectare (Olujenyo, 2008). But Gross margin alone does not indicate profitability unless fixed costs would be included and deducted from total revenue in the analysis. Following Sadiq *et al.* (2013) and Ogisi *et al.* (2013), Net Farm Income (NFI) was used for this study to determine profitability of smallholder potato growers. Profit calculation model was as follows:

GM=YxP– TVC………………………………………………………………………1

GM= TR – TVC……………………………………………………………………….2

NFI (Л) = GM – TFC…………………………………………………………………………….3

Where, Y=yield in quintals/hectares of potato, P=price of yield in units of birr/quintals; TVC=Total Variable Costs which are the cost of seeds, fertilizers, agrichemicals, labour and cost of management practices for potato in units of money/unit of land. TFC= Total Fixed Cost is the cost of land rent for potato production. NFI = Net Farm Income, Л = profitability. Total cost is the summation of variable and fixed costs. YxP is called Total Revenue (TR).

Statistical Package for social sciences (SPSS) version 20 and stata version 13 were used to analyze data. A multiple regression model (specially OLS) was employed to analyse factors affecting productivity and profitability. Prior to operating the model, all the hypothesized independent variables was tartan for the assumptions of OLS. When fitting a linear regression model one assumes that there is a linear relationship between the dependent variable and each of the independent variables. However, in many situations there may instead be a non-linear relationship between the variables. This can sometimes remedied by applying a suitable transformation to some (all) of the variables, such as power transformations or logarithms. In addition, transformations can be used to correct violations of model assumptions such as constant error variance and normality.

There are various functional forms for expressing production relationships such as: Polynomial, Linear, Cobb-Douglas, quadratic, semi log and square roots. In this study ordinary least square (OLS) was used to analyze factors affecting productivity and profitability because the OLS estimator is known as best, linear, unbiased estimator (BLUE) under the validity of a particular set of assumptions. The underlying OLS assumptions are as follows: (1) the variance of independent variables is the same all over the ranges; (2) the variance of error term value is approximately the same over all ranges of independent variables; (3) the expected value of each disturbance (error term) is equal to zero. However, when these assumptions are violated, this would weaken the validity of the results obtained from the regression (Fred *et al.*, 2012).

Following Obasi *et al*. (2013) and Osondu and Ijioma (2014), four (4) functional forms of production namely linear, semi-log, double-log and exponential were fitted to data on both productivity and profitability using OLS technique under the assumption that data fulfilled the assumptions of the multiple regression models. The lead equation was chosen based on a prior theoretical expectations, magnitude of the coefficient of multiple determinations (R^2) and statistical significance of the coefficient. The explicit forms of productivity analysis model were as follows:-

Y= β0+ β1X1 + 2βX2 + β3X3 + β4X4 + ……………. + β16X16 + et (Linear) ……….....4

lnY= β0 + β1lnX1 + β2lnX2 + β3lnX3 + β4lnX4 + …+ β16X16+et (Double-Log)………..5

Y= β0 + β1lnX1 + β2lnX2 + β3lnX3 + β4lnX4 + ….. + β16X16+ et (Semi-Log)………….6

lnY = β0 + β1X1 + β2X2 + β3X3 + β4X4 + ………...+ β16X16+ et (Exponential)……….7

Where, Y= represents the yield per hectare of potato produced, β0 = constant, βi = estimated coefficients of the explanatory variables, $X_{1\text{-}16}$ = independent variables: age of household head, sex of household head, education level of household head, potato farming experience of farming household head, household size, seed variety, fertilizer, farm size, soil conservation, harvesting time, access to extension, credit, market, irrigation, nature of access to land and seed cost, et = error term.

The same independent variables included in the production model were also fitted in the profitability analysis except for purchasing price of potato seed and output price for productivity and profitability respectively. Four functions were also regressed on Net Farm Income (NFI) in order to analyze factors affecting profitability of smallholder potato growers. The explicit forms of factors affecting profitability model were as follows:-

$NFI = \beta0+ \beta1X1 + 2\beta X2 + \beta3X3 + \beta4X4 + \ldots + \beta16X16+ et$ (Linear) ………......8

$\ln NFI = \beta0 + \beta1\ln X1 + \beta2\ln X2 + \beta3\ln X3 + \beta4\ln X4 + \ldots + \beta16X16+et$ (Double-Log)… ..9

$NFI = \beta0 + \beta1\ln X1 + \beta2\ln X2 + \beta3\ln X3 + \beta4\ln X4 + .. + \beta16X16+ et$ (Semi-Log)……......10

$\ln NFI = \beta0 + \beta1X1 + \beta2X2 + \beta3X3 + \beta4X4 + \ldots + \beta16X16+ et$ (Exponential)……......11

Where, NFI = Net Farm Income, ln = natural logarithm, β0 = constant, βi = estimated coefficients of the explanatory variables, X_i = independent variables, et = error term.

The Kendall's Coefficient of Concordance test is used to identify a given set of constraints from the most influential to the least influential as well as measure the degree of agreement or concordance among the respondents (Anang *et al*., 2013). The Kendall's Coefficient of Concordance test was used to identify and rank the constraints to potato production in the study area. In this study, constraints of potato were ranked from the most influential to the least influential using numerals 1, 2, 3 ... n in that order (where n is a positive integer). The total rank score for each constraint was computed and the constraint with the least score was ranked as the most pressing constraint, while the constraint with the highest score was ranked as the least constraint. The total rank score computed was used to calculate the Kendall's Coefficient of Concordance (W), which measures the degree of agreement between respondents in the ranking. The Kendall's coefficient of concordance was computed as:

$$W = 12\,\frac{[\Sigma T^2 - (\Sigma T)^2/n]}{m^2 n(n^2-1)} \quad \ldots\ldots 12$$

Where, W = Kendall's Coefficient of Concordance, T = Sum of ranks for constraints being ranked, m = Total number of respondents, n = Total number of constraints being ranked and Σ= summation symbol (Anang *et al.*, 2011). The Coefficient of Concordance (W) was tested for significance in terms of the F-distribution. From Edwards (1964), the numerator and denominator degrees of freedom is calculated as (n-1)-(2/m) and m-1[(n-1)-2/m] respectively. The F-ratio is given by:

$F = [(m\text{-}1)W/(1\text{-}W)]$ ……………………………………………………………...13

Ho: Respondents do not agree on the ranking of the constraints to potato production in the area.

Results and discussions

This chapter deals with the findings of field study. It covers descriptive statistics and econometric models on smallholder potato production. It also deals with the analysis of profit and productivity of potato. The chapter also examines access to support services such as extension, credit, market and irrigation in production of potato relevant to smallholder potato growers during *belg* season in Bore district. Factors affecting productivity and profitability of smallholder potato growers were also described by using OLS model. The chapter ends by describing ranks of major constraints that smallholder farmers face in production of potato.

Socio-Economic Factors

Demographic Characteristics of Sampled Smallholders

Demographic variables include the sex of household head and educational level of respondents. In the study area, the household head is mostly responsible for the coordination of the household activities. Due to this, it important to relate some variables such as sex and education level of household in analysing productivity and profitability of smallholder potato growers. Out of 192 sampled respondents, 79% were male headed and 21% was female headed household.

Another attribute of importance is the level of education attained by the heads of the household, normally, they are the decision makers. Education also enables the person with skills and knowledge to do farm business purpose. In addition, more educated persons have good and confident relationship with DAs as a result they can maximize their yield of potato. Educational level analysis revealed that 23% of potato smallholder farmers had no formal education and 25% were primary school (grade 1-4) attendant.

Table 3. Demographic characteristics of sampled respondents

Demographic Characteristics		Frequency	Percent
Sex of household head	Male	152	79
	Female	40	21
	Total	192	100
Educational level of household head	Non formal	44	23
	Primary education /grade one -four/	49	25
	Primary education /grade five-eight/	39	20
	Secondary education /grade nine-twelve	28	15
	Beyond secondary	32	17
	Total	192	100

Source: Own Data, 2015.

Household and Farm Characteristics of Selected Respondents

The mean age of smallholder farmers was 39 years indicating that most of the households were in the active age group engaged on potato farm. The study area seems highly populated since the mean household size was approximately 9 persons per household and the maximum house size was 18 persons were living together in the house. Culturally, in the study area, it is common that the male households were married to many women resulting high household size. This high household size could influence productivity since greater family labour being available to the household for the timely operation of farm activities could increase yield but consume more resulted low profitability. The mean family and hired labour used for one hectare of potato were 103 and 18 workers respectively. This indicated that smallholder farmers depend mostly on family labour in their potato farming activities to make it productive and profitable.

One important factor for production of potato was experience of household head as experienced smallholder accumulated technical experiences over years. The mean of experience was four years. Land size is key resource for production of potato. In most rural areas majority of land was categorized for crop and livestock production. This implies that respondents allocate their farm land for different crops which are more important for household livelihood and for livestock forage. Most smallholder have small amount of land though they have ability to produce more. This could restricts the smallholder farmers either to grow more potato other than others crops or divided the land equally as each crop, and this has influence on smallholder livelihood. In the study area, the average land holding for household was 2.1 hectare while 1.44 hectare and 0.69 hectare was allocated for crop and livestock rearing. The average farm size allocated for potato land per holding was 0.38 hectare.

Table 4. Household and farm characteristics of selected respondents

Characteristics	Mean	Std. Dev
Age of household head in years	38.83	8.352
Household size in numbers	8.46	3.042
Experience of household head	3.56	1.832
Family labour used for potato production	103.36	31.074
Hired labour for potato production	18.45	14.690
Total farm size	2.1	1.078
Farm size allocate for crop production	1.44	0.712
Farm size allocate for livestock rearing	0.69	0.578
Farm size allocate for potato per crop	0.38	0.189

Source: Own Data, 2015/16.

Crop and Livestock Production in the Study Area

Livestock production is one of the components of farming system in the study area. Ownership of livestock helps the smallholder in the production of crops. Major animals owned by the sampled smallholder are cows, oxen, horse, sheep and bee keeping. Oxen are the main source of farm power for plowing while horses are used for haulage and threshing. On average of 5 cows, five sheep, three hives, two horses, two oxen and other animals were owned by sampled respondents. This could imply that livestock ownership has impact on potato production, for instant, oxen used for ploughing while horses used as transporting potato to the market.

From the total sampled respondents (192 households), who were interviewed from seven administrative *kebeles* all of them were producers of potato during *belg* cropping season. The major reasons behind for growing of potatoes are as follows: Since potato is early mature than other crops, it serves as home consumption of households during shortage of crops in the study area. Potato also serves as a cash crop to increase the income of the producers. In terms of land allocation, Table 5 shows that, on average, 0.38 hectares of land per household is allocated for potato farming as compared to 0.42 and 0.34 hectares for wheat and maize, respectively. Potato has higher productivity (109.95 qt/ha) than other crops produced in the study area but less than the country's average which 137 qt/ha (CSA, 2015). Out of 192 respondents, nearly all the respondents (189) cultivated *enset* on a mean average of 0.28 hectare. In study area, *enset* was used for household consumption though it is very difficult to know its productivity due to its measurement was in unstandard bags and intermittently extracted when it was needed by smallholder.

Table 5. Livestock ownership and crop production of respondents during survey period

Farm characteristics		N	Mean	Std. Dev.
Number of animals owned	Cows	192	5.60	5.063
	Oxen	192	2.29	2.368
	Sheep	192	5.27	3.603
	Horses	192	2.14	1.717
	Goats	192	0.19	0.752
	Beehives	192	2.90	6.041
	Hens	192	6.66	4.296
	Others	192	0.18	0.446
The farm size of major crop produced in the study area	Potato	192	0.38	0.189
	Wheat	151	0.42	0.508
	Barley	158	0.31	0.122
	Maize	129	0.34	0.317
	Enset	189	0.28	0.183
Productivity of major crop during survey period	Potato	192	109.95	19.20
	Wheat	151	22.60	3.838
	Barley	158	13.62	3.170
	Maize	129	20.71	4.853
	Enset	189	-------	--------

Source: Own Data, 2015/16

In addition to potato production, the sample smallholders cultivate other crops like wheat barley, maize, faba bean, field, onion, cabbage and carrot. Especially the cabbage and onion including potato were sold to Adola and Shakisso merchants. The mean productivity and profitability of smallholder potato producers were 109.95 qt/ha and 10090.45 birr/ha. The average productivity and profitability was higher in Abay Kuture (116.67qt/ha and 10673.52 birr/ ha) than the rest of *kebeles*. The one way ANOVA analysis shows that there is a significant difference in potato production among seven kebeles at 5% level of significant (F-value is 2.217 and P=0.046). This could implies that there is difference between *kebeles* based on either the nature of agro-ecological, the volume of extension services given or others make production difference in the study area.

In the study area potato is consumed either when cooked alone or with *wot.* There is no simple machine that can process potato like *kishkish* in the study area. But there is one certified local seed producer and research center. Their main objectives were to deliver quality of potato to the end users. Despite delivering potato advanced (processed) utilization of potato in the study area is not observed.

Table 6. Productivity and profitability of potato by the sampled households 2015

Sampled kebele producing potato		N	Mean	Std. Dev.	F-value
Productivity	Litu Ghoda	25	100.08	14.9	2.217**
	Enshido Aleyehu	35	108.00	23.7	
	Abay Kuture	27	116.67	21.2	
	Ano Kerensa	31	109.94	18.4	
	Gutu Reji	29	107.86	22.2	
	Jarota Wolena	21	114.00	14.1	
	Songho Baricha	24	114.54	11.8	
	Total	192	109.95	19.3	
Profitability	Litu Ghoda	25	9560.28	1714.8	
	Enshido Aleyehu	35	10284.26	1939.5	
	Abay Kuture	27	10673.52	1610.4	
	Ano Kerensa	31	10329.29	1305.0	
	Gutu Reji	29	9923.66	1295.6	
	Jarota Wolena	21	9669.57	1231.7	
	Songho Baricha	24	9965.46	1266.6	
	Total	192	10090.45	1544.1	

Source: Own Data, 2015. ** shows significant at 5% level.

Technological and Management Related Factors

This section describes the types of input mostly seed variety, fertilizer, compost, manure and pesticides that smallholder used in production of potato. Methods of potato production such land preparation, rotation of land, row planting and earthing up of potato. Harvesting time, method of potato storage and soil conservation during potato production was included.

Most rural communities use their own (local) seed from year to year. Seed varieties could affect the productivity and profitability of smallholders. This would influence the production as seed degenerate its status over years. But in the study area, most smallholder were using the improved seed (77.6%) purchasing from agricultural office (43.2%) and Community Based Organizations of potato producers (28.5%). They also used their own seed and purchased from market and other sources for their production.

The two commonly used fertilizers in the study area were: DAP and UREA. The use of above and below the recommended amount of fertilizer can influence the production and profitability. The recommended DAP and Urea for potato in the study area is 100kg and 165kg respectively (BoARC, 2013). However, the amount of fertilizer used by respondents was below the recommended. About 43% of respondents were not applying fertilizer as recommended due the major reason as likely explaining that their land was fertile/no need of fertilizer (17.2%) following no potential income to purchase fertilizer (14.6%).

The methods of production could determine the outcome of the production and profitability of smallholder farmers. In the absence of in organic fertilizers such as DAP and UREA, the respondents prefer to use compost and manure for potato production though the amount can have an extra influence. Majority of the respondents (89%) were using the manure and 60.9% of the respondents were not using compost in producing potato. About 71% of the respondents were not using pesticide in case of Late Blight disease. Rather they prefer to use the traditional mechanism like removing the infected tubers and adding ash to minimize late blight severity. Despite of these local methods prevention by the respondents, late blight has been highly affecting the production of potato in Bore district.

Most smallholder have small piece of land and hence use the land year to year the same crop which declines the fertility of land that in turn declines production of crop. But in the study area, about 95% of respondents were used crop rotation for potato production. That mean potato land is not repeatedly used for production rather changing the crop to the land enhancing soil fertility. Most of respondents (93.2%) were applying earthing up. After applying UREA, earthing up is needed for potato production because earthing up could increases temperature for the potato tuber thereby increasing in yield. Potato harvesting is carried out in the area by axe and oxen. The potato harvested by axe is used for home consumption while for seed and market purpose digging by oxen is crucial. Soil conservation play a great important role in production of the crop. Out of 192, 96% of the respondents were conserving their soil land. There are different soil conservation mechanism that could increase soil fertility resulting increase of productivity and profitability of potato by respondents. These mechanisms were fallowing (12.5%), application of man fertilizer (24%) and shifting cultivation (57.8%). Since the majority of the smallholder hold small amount of land they prefer more shifting cultivation than fallowing their land.

Table 7. Technological and management practiced used by respondents

Technologies		Frequency	Percent
Access to seed variety	Improved variety	149	77.6
	Local variety	43	22.4
Name of improved seed used by smallholders	Gudane	103	53.3
	Jalene	18	9.4
	Belete	28	14.6
Name of local seeds used	Locals	18	9.4
	Qey dinich	25	13
Most sources of seeds	Own (saved) production	28	14.6
	Market	22	11.5
	CBOs	55	28.6
	Agricultural office	83	43.2
Amount of seed used per hectare		Mean 12.67	St. Dev. 3.39
Amount of fertilizer applied per hectare		Mean 93.70	St. Dev.37.57
Reasons not using fertilizer as recommendation	Reasons	Frequency	Percent
	No need/fertile land	33	17.2
	Fertilizer was not available on time	5	2.6
	No potential to purchase	28	14.6

	Recommendations rate of fertilizer is not profitable	11	5.7
	Others	6	3.1
	Total	83	43.2
Methods of potato production	Methods used	Yes (%)	No (%)
	Use compost	75 (39.1%)	117 (60.9%)
	Manure	171 (89.1)%	21 (10.9%)
	Pesticides	55 (28.6%)	137 (71.4%)
	Crop rotation	183 (95.3%)	9 (4.7%)
	Use of oxen for ploughing	192 (100%)	0
	Row planting	174 (90.6%)	18 (9.4%)
	Use oxen for harvesting	192 (100)	0
	Earthing up of potato	179 (93.2%)	13 (6.8%)
	Use of axe for harvesting potato	62 (32.3%)	130 (67.7%)
Soil conservation by respondents	Yes	184	95.8%
	No	8	4.2%
Mechanisms of soil conservation	Fallowing	24	12.5%
	Applying man made	46	24%
	Shifting cultivation	111	57.8%
	Others	3	1.6%

Source: Own Data, 2015.

Potato could stay under the ground without harvesting at its maturity time. This could help poor smallholders who have no storage facilities. But being in the ground, potatoes are susceptible for insects, animals or even they may sprought under the ground which affects the production and profitability of potato. In the study area, 102 (53.1%) of the respondents harvest their potato as soon as it matured and 90 (46.9%) delayed harvesting time of potato. As explained in Table 8, the most reason to harvest as soon as potato matured was to produce other crops which maintain income of respondents by producing twice in a year on the same land. Out of 90 respondents, 58 (32.2%) were postponed harvesting time to get high price for their yield.

Potato is a perishable crop that needs special treatment. Unless effective potato storage facilities are constructed, potato could not last until the price escalates. Most smallholder vendor their outputs during harvesting time when less market gate prices persists. Those who have storage would wait until the price increase especially when potato sprought and high demand is at the peak planting resulting in high profit. Thus to gain high profit, storage of potato seed is crucial. In the study area, however, majority of the respondents (57.3%) were not storing their potato seed for the next season mainly due to lack of storage facilities (45.8%). Out of 192, 82(42.7%) of the respondents stored their potato by using different methods. The common storage methods of potato in the study area was traditional (under the ground, on the ground). About 46 (24%) used the tradition method of storage and 36 (18.8%) used the Diffused Light Storage (DLS) which is mostly constructed from locally available materials.

Table 8. Postharvest management practices of respondents

Postharvest issues		Frequency	Percent
Harvesting time	As soon as potato matured	102	53.1%
	Postponed harvesting	90	46.9%
	Total	192	100
Reasons for as soon as maturing harvest	To produce other crops	89	46.4%
	To consume	4	2.1%
	To escape from thief	7	3.6%
	To escape from rainfall	2	1%
	Total	102	53.1%
Reasons for postponed harvesting	To get high price	58	32.2%
	Lack of storage facilities	19	9.9%
	Lack of man power during maturity	8	4.2%
	Others	5	2.6%
	Total	90	46.9
Did you store potato?	Yes	82	42.7%
	No	82	57.3%
Reasons why not storing	Lack of storage facilities	88	45.83%
	Produced for local consumption	7	3.65%
	To escape from thief	7	3.65%
	Other reasons	4	4.17%
	Total	82	45.83%
If you store potato, how do store?	Tradition	46	24%
	Modern	36	18.7%
	Total	82	42.7%

Source: Own Data, 2015.

Potato Selection by the Sampled Respondents

Crop breeders develop varieties often using yield as the sole criterion although sometimes they look at other factors such as response to fertilizer, resistance to pests and diseases and maturity time. However, smallholder farmers have own criteria for crop variety choice such as good yield, which is reliable and stable and at times they prefer a mixture of varieties to minimize risks. The behaviour of smallholder farmers making use of more production criteria than profit criteria in variety selections is not uncommon. For example, other studies such as Bekele *et al*. (2011) and Hemachandra and Kodithuwakku (2010) generally indicate that farmers had greater inclination towards production orientation than profit orientation. This leads to conclude that farmers are not irrational, they have their own important criteria for the production decisions they make. Basically, the choices of crop varieties differ upon the concerns of the farmers attributes in terms of a range of attributes, such as income returned from crop, yield, input requirements and intensity of managements required. Table 9 shows that the preference of potato by smallholder. Respondents were asked to evaluate potato with other crops they produced.

As shown in Table 9, majority of respondents (66%) explained that there was high market demand of compared to other crops produced. As explained during FGDs, there was tuber shortage during planting time resulted in high demand. The price on sale of potato compared to other crops was medium (47.9%) while the price of the inputs required for potato production relative to other crops was high (59.4%). This in balance of cost of potato production shows that there was no satisfactory market demand of potato throughout the seasons. During harvesting there was surplus production in the area resulted to low demand. Even though potato is mature (3-4 months), its resistivity to late blight was low (50%). Potato maturity time was short hence labor required for land preparation, planting, weeding, harvesting, etc. was low (70.8%) compared to other crops which needs frequent management practices. This showed that potato production in the study area requires less labor and hence small household male and female could produce potato. Despite low resistivity to Late Blight disease potato is higher profitable (55.3%) than other crop produced in the study area.

Table 9. Potato preference by the sampled respondents

Preferences		Frequency	Percent
Market demand of potato compared to other crops	Low	3	1.6%
	Medium	60	31.3%
	High	127	66.1%
	Very high	2	1%
	Total	192	100
Price on sale of potato compared to other crops	Very low	3	1.6%
	Low	78	40.65%
	Medium	92	47.9%
	High	19	9.9%
	Total	192	100
Price of potato inputs compared to others	Very low	2	1%
	Low	6	3.1%
	Medium	36	18.8%
	High	114	59.4%
	Very high	34	17.7%
	Total	192	100
Resistance to diseases	Very low	41	21.4%
	Low	96	50%
	High	43	22.4%
	Total	192	100
Maturity date of potato compared to others	Very short	138	71.9%
	Short	52	27.1%
	Medium	2	1%
	Total	192	100
Intensity of labor requirement in terms of production	Very low	20	10.4%
	Low	136	70.8%
	Medium	27	14.1%
	High	9	4.7%
	Total	192	100
Profit of potato per hectare compared to other crops	Low	7	3.6%
	Medium	68	35.4%
	High	106	55.3%
	Very high	11	5.7%
	Total	192	100

Source: Own Data, 2015

Institutional Related Factors

In this section, access to institutional services such as nature of access to land, extension, credit, market and irrigation were analyzed. Accessibility of parts of these services could not bring impact on agricultural production unless it is institutionalized and functional within the system.

A visible concern of many smallholders is land insecurity with impacted for low yield of the crop. But in the study area, majority of the respondents produce potato on their own land (77.6%). In the case small of land, the respondent were contracted the land for potato (13%). Other form of land acquisition in production of potato was share (9.4%) in which land user contribute all costs, inputs and provide necessary managements while land owner provide land and share potato yields at harvesting time based on their agreements.

Extension services are services rendered to farmers through educational procedures so as to improve farming methods and techniques which could result to high yield and income. The agricultural extension service is provided with the objectives of increasing production and productivity of small-scale farmers through research generated information and technologies. Wider dissemination of improved farm technologies, management practices and know-how to the smallholder farmers have been the major activities of the extension program (Asfaw *et al.,* 2012). There are many agricultural extension services conducted in Ethiopia but major extension services given at farm level are expert advice, training, exchange visit and field days. For this study, respondents assessed these services obtained during potato production seasons. Out of 192 respondents, majority of households (111) have access to extension services like expert advice, training and field days and the most source of extension services was Farmer Training Center FTC (38%).

Access to credit is important for smallholder since loan derived from credit institution would help smallholder to purchase inputs for farm production. In the study area, out of 192 respondents 119 (62%) have access credit during potato production. The only type of credit used by respondents was cash. Source of credit used by 81 sampled respondents were micro finance institutions (42.2%). Other respondents (29) did not have access to credit due to the requirements by the credit source is complex and are unable to meet criteria such collateral and lack of a person who could signed for credit user with loan providers. High interest rate (9.9%) and lack of know how (8.9%) was another constraints to credit access by the sampled non-credit users.

Most rural smallholders were characterized by the absence of market for their produce. But in the study area, 53% had access to market information. This could be due the fact that now a day there is a dissemination mobile phone through which smallholders and farmers access and share market information. But during harvesting time, market price would spectacularly fail which tell us smallholder have no access to the market throughout their production seasons. Most buyers at harvesting time were local traders who were more benefited than producers who did not have access to market (47%). The mean road distance between the plots of smallholder to the market place was 7.07 KM while the minimum and maximum road distance were 1 KM and 17 KM where there is a great road distance variation to the market place.

Since producers or smallholder farmers were scattered with no formal farmer associations, they practically had no say on prices. Quite often they have remained price takers. On the other hand poor price has negative consequences to farmers because it results into low or non-use of inputs and poor crop management practices. The low input use and the poor management of crop result into poor yields. Being question that quality of information obtained from different sources, smallholder mainly get price information on potato from other farmers (89.6%) and other farmers also share where inputs provisions and market outlet information were get (43.8%). This is true that farmers themselves share price information and the supply of inputs among each other. Development Agents (DAs) were also played in providing input provision for potato growers (41.1%).

In most of the potato farming zones of Ethiopia two rainy seasons can be identified, the main (*Meher*) season and a short rainy season (*Belg*). Rain fed potato farming during the *Belg* season is practiced at high altitude, where evapotranspiration is low and rainfall higher than average in the country. However, in most areas the *Belg* season is short and unreliable and supplementary irrigation is imperative (Gildemacher *et al.*, 2009). Irrigation could increase production per season. But in the study area, majority of the potato growers had no access to irrigation (78.1%) due to enough rain fall in the area (35.7%), irrigation methods were not available (30.7%) and materials of irrigation schemes are not affordable (10.9%). Few respondents (21.9%) had access to irrigation by a means of surface irrigation in which watering seedling potato when there is no sufficient rainfall especially after fertilizer was applied. Potato seedling would dry out unless they watered after fertilizer application.

Table 10. Descriptive results of institutional variables explained by respondents

Institutional variables		Freq.	%
Nature of access to land	Own	149	77.6%
	Contract	25	13%
	Share	18	9.4%
	Total	192	100
Access to extension services	Access	111	57.8%
	No access	81	42.2%
	Total	192	100
Access to credit	Access	119	62%
	No access	73	38%
Sources of credit	Neighbors /relatives	15	7.8%
	Farmers' union/ cooperatives	5	2.6%
	Micro finance institutes	81	42.2%
	NGO	11	5.7%
	Local money lenders	7	3.5%
	Total	192	100
Why not access to credit	I do not have collateral	7	3.6%
	High interest rate	19	9.9%
	Requirement by the source is complex and unable to meet	29	15.1%
	I do not have know-how	17	8.9%
	Other constraints	1	0.5%
	Total	73	38%
Access to market	Access	102	53.1%
	No access	90	46.9%
	Total	192	100
Price information	Other smallholder farmers	172	89.6%

	DAs	8	4.2%
	Mass media	9	4.7%
	Others	3	1.6%
Institutional variables		Freq	%
Source of input provision and market outlet information	Other farmers	84	43.8%
	DAs	79	41.1%
	Unions	25	13.0%
	Traders	4	2.1%
Access to irrigation schemes	Access	42	21.9%
	No access	150	78.1%
	Total	192	100
Type of irrigation used	Surface irrigation	42	21.9%
Reasons not access to irrigation schemes	Materials not affordable	21	10.9%
	There is enough rainfall in the area	70	35.7%
	Irrigation method is not available	59	30.7%
	Total	192	100

Source: Own Data, 2015

Profitability of Potato

Cost and return analysis of potato production in Bore district

Profitability refers to the capacity of an enterprise to generate more revenue through the sale of its products than its costs to produce those products. Profitability can be enhanced by increasing production, obtaining a higher price for products, or by reducing costs.

Table 11 shows that the average costs and returns of potato production in Bore district. Revenue of potato was considered as the average potato harvested from the land including consumed and tuber seed used for planting purposes. From smallholder farmers the yield data was collected from one fourth (1/4 of hectare) of the land but for productivity and productivity analysis the data was analyzed by based one hectare. The average amount of potato produced by smallholder and the farm gate price of potato was 109.95 qt/ha and 191.22 birr/qt respectively. The productivity of potato during study season seems to low compared to productivity in 2013 which was 137 qt/ha (BoARC, 2013). This low productivity potato was due to influence of diseases during study period. The mean total cost of potato production was 10938.38 birr. The Table 11 also showed that the gross margin and net farm income from potato production in the study area was 10930.97 birr and 10090.45 birr respectively.

The major costs of potato production were considered in calculating profitability of the crop. The result revealed that fixed cost and variable cost accounted for 7.68% and 92.32% respectively of the total cost of producing potato. The cost of management practices include cost of planting, weeding, top dressing, earthing up, grading and harvesting. Among the variable costs the cost of seed accounted for the largest proportion (42.59%) and 39.32% (4300.53/10938.38) of the total cost production was covered by seed cost. Cost of seed followed by cost of family labour which accounted for 19.17% of total variable costs and 17.69% of total costs of potato production. This clearly shows that large amount of money is spent by potato smallholder growers in the study area on purchase of seeds and family labour wage. This also indicated that smallholder farmers depended heavily on family labour in their potato farming activities to make it productive and profitable.

Storage cost, cost of sacks and transportation cost to store and market were considered as marketing costs which accounted 1164.94 birr. A positive NFI shows that an enterprise is a profitable one and it is worth continuing with while a negative NFI signifies a loss and a business not worthy. The result of NFI analysis as a measure of profitability smallholder potato growers had the positive values of NFI (10090.45 birr) obtained by smallholder potato growers confirmed to the fact that smallholder potato growers were able to cover their operating expenses with a significance level of NFI obtained from the study area. Thus, potato production is profitable for smallholders in Bore district.

Table 11. Cost and return analysis of potato production in Bore district

Elements of costs and returns	Mean	Std. Dev.	% share
1.Potato yield obtained per hectare in quintals **(Q)**	109.95	19.28	
2. Price of potato sold per quintals in birr **(P)**	191.22	17.33	
3. Total Revenue (TR) = Q.P	21024.64	4023.06	
4. Variable costs			
4.1. Seed cost per quintals in birr	4300.52	1448.51	42.59
4.2. Family labour costs[1] of management practices in birr	1935.36	593.77.	19.17
4.3. Labor cost other than family[1] (hired labour) in birr	556.67	443.43	
4.4. Cost of oxen during land preparation and during harvesting in birr	879.08	431.86	
4.5. Fertilizer cost for potato production in birr	1233.54	743.23	
4.6. Pesticides cost in birr	28.07	60.24	
4.7. Marketing costs (costs of transportation, store and sack)	1164.94	458.29	
4.8. Total Variable Costs (TVC)	10098.22	2994.75	92.32
5. Fixed Cost (FC)			
5.1. Land rented in birr	840.16	154.86	
5.2. Total Fixed Cost (TFC)	840.16	154.86	7.68
6. TC= TVC+TFC	10938.38	2992.63	
7. GM = TR-TVC	10930.97	1568.99	
8. NFI= GM-FC	10090.45	1544.15	

Source: Own Data,2015. [1] shows costs of major management practices such as planting, weeding, harvesting, UREA application, earthing up, grading and sorting.

Testing Procedures in analysis of profitability and productivity

Some data transformation was carried out. Before running the OLS models, the multicollinearity test was carried out. The effect of the continuous variables were checked for multicollinearity using Variance Inflation Factors (VIF) while Contingency Coefficients (CC) was used to detect the degree of association among the discrete and categorical explanatory variables (See Appendices Table 1 and 2). According to the results no serious problems of multicollinearity and very high degree of association were not observed. Thus, all the selected independent variables were safely used to estimate the models. Robust standard error was used to control for heteroskedasticity problem. Shapiro-Wilk W test also used to test normal distribution of error terms (residuals). As shown in Appendix Table 3, the residuals were normally distributed implying that both dependent variables (profitability and productivity) have normal distribution.

Linktest command performs a model specification link test for single-equation models. Linktest is based on the idea that if a regression is properly specified, one should not be able to find any additional independent variables that are significant except by chance. Linktest creates two new variables, the variable of prediction, **_hat**, and the variable of squared prediction, **_hatsq**. The model is then refit using these two variables as predictors. **_hat** should be significant since it is the predicted value. On the other hand, **_hatsq** should not, because if the model is specified correctly, the squared predictions should not have much explanatory power. If the predicted value actually predicts the true value well, the slope on the predicted value would be near one (1). The null hypothesis of this study was there is no specification error. Since the p-value of _hatsq is not significant then one could fail to reject the null and conclude that the model was correctly specified for both dependent variables (See Appendix Table 4).

The assumption of the error term has an expected value of zero can be understood by linktest. Given any values of the independent variables, the error term must have an expected value of zero. This assumption could be weaken by (1) reverse causation: if y influence x's, then error term is associated with the x's. (2) measurement error in the x: x includes not only x but also something else (additional variables). This something else would get into error term. But the test of link test showed that there is no error in the model. In this case, all independent variables are exogenous. Otherwise, at least one independent variable suffers from an endogeneity problem.

The OLS results of the variables that are expected to affect profitability potato are presented in Table 12. Linear function was chosen based on theoretical, prior hypothesis, number of significant of independent variables. The R^2 of the model was 68.72 and. The R^2 (68.72%) indicates that variables entered into the model are explained NFI by the selected independent variables with the remaining 31.28% due to random error in the model. The test of significance of the R^2 produced an f-value of 35.01 which was significant at 1%, implying that the linear function gave a good fit to the data. The linear function was therefore chosen as the lead equation and used for discussion.

Out of 16 variables, 12 were found to significantly influence the profitability of smallholder potato growers at different level of significance. Accordingly, sex, age, education level, seed variety, farm size, experience, fertilizer, harvesting time, access to extension services, nature of access to land, irrigation and output price affect profitability of smallholder potato growers in Bore district.

Socio-economic related factors

1. Sex of household head. It was hypothesized that gender of household head affect profitability of potato positively. However, the opposite has been observed in the result. Gender of household head was significantly and negatively affected profitability similar to the studies of Henri-Ukoha *et al*. (2015) and Berihun *et al*. (2014) also studied that net farm income was influenced by gender of household. Other factors being constant, an increase of male household head on potato production decreases the profitability of male headed household by 250.12 birr. Female headed households were more profitable than male headed households in the study area. This could be due to in the study area most male headed household were migrant but female households stay at home and could well manage their farm than male headed households. When male headed household migrate their potato management could be declined resulted to lower profit.

2. Age of household head (age). Age of household head affect profitability of smallholder positively and significant at less than 1%.The result of this study was against the study of Masuku and Xaba (2013) and Henri-Ukoha *et al*. (2015). All else equal, 1 year increase of age household head led to increase in the profitability by 29.52 birr. The implication is that older respondents could have more resources that help them to maximize their profit than youngsters.

3. Educational level of household head (educ). Educated farmers are more likely to apply modern technologies and information that can raise the farm value addition process which can result in higher profitability. However, educational level of household head was statistically significantly at 1% negatively opposing prior hypothesis like study of Sakurai (2015). The study of Masuku and Xaba (2013) and Mugula (2013) also stated that educational level affect profitability of vegetables and rice respectively. Other factors being constant increase in attaining educational level led to decrease the profitability of smallholders by 174.75 birr. Thapa (2010) reported that more educated people prefer working on off-farm activities, probably due to the low wages and returns from the agricultural sector. Further reasons could be the fact that more educated were participated on social affairs such as kebele administrations where most of their time was overlap with that of agricultural activities which needs intensive managements. Despite educated people have knowledge and skills on farm activities they were mostly busy by different activities and have no enough time for managing potato farm that led to poor management practices which in turn led to lower return from their farm.

4. Farm size (farmsize). Like prior hypothesis, farm size affect profit of smallholder potato growers. Though smallholder are generally considered as own shortage of land resulted to low profit the result of this study revealed that farm size affect profitability of smallholder in the study area. The result in consonance with Singh (2016) who found that farm size affect productivity and profitability of potato. Other studies of Berihun *et al*. (2014) and Henri-Ukoha *et al*. (2015) also revealed that farm size affect profitability. The coefficient farm size was significant at 10%. When other variables are held constant, an increase of 1 hectare of farm size increase profitability of smallholders by 1021.38 birr.

5. Experience (experie). Potato farming experience was expected to affect the profitability of potato. The result also confirmed that experience directly affect the profitability of potato at less 1% of level of significance. The result of this study is also similar to the recent studies of Chinwuba and Otunaruke (2015), Henri-Ukoha *et al*. (2015) and oppose the study of Masuka and Xaba (2013) and Lighton *et al*.(2014) who stated experience has little impact on profitability. As the number of years of potato production increases by 1 year, the profitability of smallholders increase by 251.49 birr, being all the other factors constant.

Technological and management related factors

6. Seed variety. As prior hypothesis, potato varieties used by smallholder affect profitability. This study is similar to Berihun *et al.* (2014) and against the study of Almaz, *et al*., (2014) and Mugula (2013). Other variables are held constant, improved seed varieties yield more and resulted high profit. At 5% the coefficient of seed variety used was significant. An increase in the use of improved seed led to increase the profitability of smallholder potato growers by 82.92 birr.

7. Fertilizer. The amount of fertilize used by smallholder was expected to affect profitability of potato. The result of analysis also validated as fertilizer strongly affect profitability of smallholder potato growers at 1%. This study also supported by Onoja and Herbert (2012) as fertilizer applied affect profitability of rice and oppose Lighton *et al.*(2014).When other variables are held constant, 1Kg of fertilizer increase profitability by 10.5 birr. Even though smallholder use fertilizers beyond the recommended, amount of fertilizer had a direct relationship with profitability of potato in the study area.

8. Harvesting time (harvtime). Like other vegetables, potato is a seasonal crop could be harvested at different time. To get high price or for other reasons, smallholder harvest potato at certain time. Harvesting time affect profitability of potato at 5% of level of significance. Other variables are held constant, harvesting as soon as mature increase profitability of potato by 317.26 birr. The implication is that smallholder harvest their produce as soon as it matured and use their land for other cropping purposes to maximize their farm returns.

Institutional related factors

Institutional factors that could affect profitability in the context of this study include the support provided by various institutions and organizations to enhance the profitability of smallholder potato growers. Services examined includes access to extension, credit, market, nature of access to land, irrigation and output prices.

9. Access to extension services (extension). The aim of the extension service is to introduce smallholder farmers to new and improved agricultural inputs in order to improve production and productivity in turn increase marketable supply which has a positive effect on profitability. Extension services affect profitability of potato at 10% level of significance and the study confirmed with that of Lighton *et al.* (2014) and contradict with Masuku and Xaba (2013); Mugula (2013) and Olawale and Noelle (2015). Being other variables were held constant, an increase of access to extension services on potato increase profitability of potato by 67.25 birr. This implies access to extension influences farmers' profitability as farmers become equipped with agricultural information from extension agents.

10. Nature of access to land (Ltenure). The result of the study showed that nature of access to land influence the profitability of smallholders potato growers at 5%. This result is also agree with Lighton *et al.*(2014) who stated contract farming affect profitability of smallholder out growers tea and disagree the study of Otsuka *et al.* (2015) who reported as contract farming has smaller impact on total household income and Berihun *et al*. (2014) who stated land ownership could not influence farm income. Smallholder farmers use different land arrangement like own, contract and share to maximize their profit.

11. Access to irrigation (irrig). It was hypothesized that access to irrigation schemes influence the profitability of smallholder potato growers. This result agree the study of Onoja and Herbert (2012) and Singh (2016) who studied irrigation has impact on profitability farm. irrigation scheme affect profitability of potato at 10% level of significance. However, the magnitude of coefficient of access to irrigation was negative indicating reverse relationship between irrigation and profitability. That mean further increase of access to irrigation scheme decrease profitability of potato by 90.26 birr, other factors being constant. One reason could the amount water applied to the crop is above the crop requirement and the cost of irrigation schemes could minimize the profit. Further reason could be since the study area is highland and obtained enough rainfall additional use of irrigation lead to over loss of product. This implies use of inputs beyond and above optimum level affects the profitability of smallholder farmers.

12. Output price (selprice). One determinant of profit analysis was output price of commodity. Commodity prices vary within and across seasons. Some intra-seasonal variation is expected, given the seasonality of local supply and the cost of storage. In this study output price of potato was hypothesized as determinant of profit and the result also indicated that selling price of potato influence profitability at 10% level of significance. This result is supported by Nwaru *et al*. (2011) and Almaz *et al*. (2014) who found that a selling price affect profitability of vegetables. But Olawale and Noelle (2015) studied that seed price are negatively affected profitability. According to them, the estimated profit function is convex in input prices and as costs increase they lower the profit made by the rice farmers. Other variables being constant,1birr increase of output price per quintal increases profitability of smallholder potato growers by 6.65 birr.

Table 12. The OLS result of determinants of the Net Farm Income (NFI) of smallholder potato growers

Functional forms												
Independent Variables	Linear (L)			Double log			Semi log			Exponential		
	B	Robust Std.err	t	B	Std. Err	t	B	Std.err	t	B	Std.err	t
Sex	-250.12***	45.21	-5.53	-0.06***	0.01	-5.84	-645.85***	120.01	-5.38	-0.023***	0.004	-5.51
Age	29.52***	8.79	3.36	0.1***	0.03	3.14	1122.84***	360.31	3.12	0.003***	0.001	3.24
HHsize	-22.78	22.52	-1.01	-0.01	0.01	-0.98	-267.07	168.94	-1.58	-0.0006	0.002	-0.29
Education	-174.75***	47.75	-3.66	-0.03***	0.01	-3.2	-299**	117.8	-2.54	-0.019***	0.004	-4.58
Seedvarity	82.92**	41.38	2	0.02**	0.01	2.43	211.07*	113.51	1.86	0.01**	0.004	2.45
Farmsize	1021.38*	531.2	1.92	0.05***	0.02	3.07	598.48***	176.08	3.4	0.08**	0.035	2.26
Experience	251.49***	52.43	4.8	0.06***	0.01	4.42	745.76***	161.05	4.63	0.02***	0.004	4.89
Fertilizer	10.5***	2.82	3.73	0.09***	0.02	4.95	990.54***	199.47	4.97	0.001***	0.001	4.3
Conservation	124.73	119.88	1.04	0.03	0.02	1.45	346.42	217.52	1.59	0.01	0.008	1.38
Harvetime	317.26**	150.88	2.1	0.05***	0.02	2.62	558.1**	222.85	2.5	0.3**	0.013	2.17
Extension	67.25*	34.71	1.94	0.01*	0.01	1.86	189.46**	88.81	2.13	0.01*	0.003	1.7
Credit	15.91	34.63	0.46	0.006	0.01	0.76	80.37	87.08	0.92	0.001	0.003	0.34
Mrkt	-10	33.49	-0.3	-0.0004	0.01	-0.05	-9.82	87.39	-0.11	-0.001	0.003	-0.25
Nattureland	156.03**	68.76	2.27	0.005	0.01	0.46	377.02***	135.93	2.77	0.002	0.006	0.32
Irrigation	-90.26*	52.55	-1.72	-0.02*	0.01	-1.81	-264.27**	112.5	-2.35	-0.01	0.004	-1.4
Outputprice	6.65*	3.64	1.83	0.14**	0.07	2.01	1233.82	759.68	1.62	0.001**	0.001	2.13
_cons	5735.56***	956.56	6	7.85***	0.38	20.71	-4274.32	4273	-1	8.87***	0.08	107.09
R^2 = 68.72, F=35.01***				R^2 =67.21, F =22.42***			R^2 =68.25, F= 23.51***			R^2= 68.68, F=23.99***		
				Adjusted R^2 = 64.21			Adjusted R^2 = 65.34			Adjusted R^2 =65.82		

Source: Own Data, 2015. L= shows Lead equation. Symbol ***, ** and * shows the significant level at 1%, 5% and 10% respectively

The OLS results of the variables that are expected to affect productivity of potato are presented in Table 13. Even though the R^2 of linear function of productivity measurement was lower than double log function but higher than the other functions, it was chosen based on theoretical, prior hypothesis and fulfilling assumption of OLS model. The R^2 of the model was 85.72%. The R^2 (85.72%) denotes that 85.72% of the total variation of the dependent variable (productivity) is explained by the independent variables included in the multiple regressions. The remaining 14.28% is due to random error in the model. The test of significance of the R^2 produced an F-value of 73.65 which was significant at 1%, implying linear function gave a good fit to the data and the joint effects of all the independent variables on the productivity variation of smallholder potato growers was significantly above zero. The critical F-value has an n and n-k-1 degrees of freedom, where n is the number of respondents and k is the number of independent variables inter into the model. The standard error of regression coefficients is the measure of error about the regression coefficients. The linear function was therefore chosen as the lead equation and used for discussion.

Out of 16 variables, 12 were found to significantly influence the productivity of smallholder potato growers at different level of significances. Accordingly, sex of household head, education level of household head, seed variety, farm experience of household head, fertilizer, harvesting time, soil conservation, access to extension services, access to market, nature of access to land, access to irrigation scheme and seed cost affect productivity of smallholder potato growers in Bore district.

Socio-economic related factors

1. Sex of household head. It was hypothesized that sex of household head influence the productivity of smallholder potato growers. As earlier hypothesis, the result of the study also confirmed that sex of household head affect productivity of potato at 1% level of significance. This result also similar to the one reported by Okoli *et al*. (2015). However, the magnitude of coefficient of sex of household head was negative indicating reverse relationship with productivity. Other variables constant, increase of male household head in production of potato decrease productivity of potato by 2.37 qt/ha in the study area. Female households were higher productivity than male household head in the study area. The implication could be male households head most of the time migrate during off season which is also potato's farming calendar in the study area. While women were stayed at home and could provide on right management practices for their farm thus could obtained higher yield than male household heads.

2. Educational level of household head (Educ). The educational level of household head was hypothesized as it could affect positively the productivity of smallholders. Education affects the productivity of smallholder potato growers at 1% level of significance. Despite the importance of education in increasing farm productivity (Okoli *et al.,* 2015), surprisingly, its effect was negatively significant in this study. More educated smallholder obtain less yield than non educated in the study area like the study of Nahusenay *et al*. (2015) and contradict studies of Aklilu *et al.* (2015) who stated that more educated get higher yield than non educate of onion producers. All else variables constant, an increase in educational level of smallholders decrease the productivity of potato by 1.77 qt/ha. The higher education they reach the more they move away from agricultural activities to non agricultural enterprises including salaried work and therefore produce only small amount for home consumption and had other enterprises which reduced their time for potato management practices which could influence crop productivity.

3. Experience (experie). Experience of potato production was highly affecting the productivity of potato at 1% of level of significance and similar to studies of Okoli *et al*. (2015) and Lawal *et al*. (2013). There is positive relationship between experience and productivity since more experienced could learn production of potato gradually from their practices than their counterparts. Other factors constant, one year increase in the farming of potato led to increase productivity smallholders by 3.36 qt/ha. This implies that the more experience a smallholder farmer gains in potato farming the more productive the farmer becomes.

Technological and management related factors

4. Seed variety. The result of this study showed that seed variety affect the productivity of smallholder potato growers. This result is also similar to study of Asres *et al.* (2013) and contrast to the study of Mugula (2013).The use of improved varieties lead to increase productivity of smallholder. Wondwesen *et al.* (2015) also stated that dissemination of improved variety to the farmer is vital to increase the productivity of Irish potato. Access to seed led improved productivity (Gemechis *et al.* 2012; Anang *et al*. 2013). An increae in using improved seed by smallholders increases their productivity by 1 qt/ha. This showed that in order to maximize smallholder production improved seed variety is crucial.

5. Fertilizer. Amount of fertilizer applied by smallholder was expected to influence productivity of smallholder potato growers. The variable was highly significant and affect positively the productivity of smallholders. The study is similar to the findings of Aklilu *et al.* (2015) and Okoli *et al*. (2015) and contrast with Ogisi *et al*.(2013). Where other variables held constant, additional increase of fertilizer by 1kg led to increase the productivity of smallholder potato growers by 0.17 quintals per hectare. Thus, applying amount of fertilizer based on the recommended in the study area had impact on productivity.

6. Soil conservation (soilconse). Soil conservation methods while producing potato was expected to affect the productivity of smallholder potato growers. Consequently, the independent variable was affect the productivity positively. The coefficient is significant at 10%. Crop rotation is widely recognized as a useful tool for soil health and nutrient management and the positive effects of varying crop sequences on crop yields are well documented (Campbell *et al.,* 2011; Davis *et al.,* 2012) and fertility of the land influence agricultural production (Okoli *et al.,* 2015). Soil conservation methods can positively determine the productivity of smallholder. Other factors being constant, increase in soil conservation by smallholders increases potato productivity by 1.54 qt/ha. Thus, conserving soil could increase fertility of soil which could increase productivity of crop.

7. Harvesting time (harvtime). Potato yield is a bulky nature. Some smallholder harvest as soon as it matured to use their land for other purpose while others postponed the harvesting time for different reasons as explained in descriptive analysis. Harvesting time affect the productivity of potato in the study area. Harvesting during the rainy season causes rotting resulted to loss of potato. Traders also force farmers to harvest potato early in order to purchase at lower price reducing production of farmers (Kaguongo *et al*., 2015). The coefficient of harvesting time was (3.84) significant at 1% level of significance. Harvesting potato as soon as it matures date increases the productivity. This could be due to no yield loss by insects and by others in the ground. Reuse of the land of potato for the other crops also could increase the productivity of smallholders.

Institutional related factors

8. Access to extension services (extension). The major role of extension service in agriculture is dissemination of technologies such as agricultural inputs, management practices and advising services to increase productivity of smallholder farmers. The result of this study also confirmed that access to extension services positively affect the productivity of smallholder potato producers. This result also similar to the finding of Lawal *et al*. (2013) and oppose Ali *et al*. (2012) who reported that extension contacts made no difference in the achievement of farmers regarding their productivity. The coefficient of extension service was significant at 1% level of significance. Additional increase of access to extension services on potato increases productivity of smallholder by 20.9 quintals per hectare. This suggests that access to extension services has a great role in increasing productivity of smallholder.

9. Access to market (mrkt). Market access is determined by factors such as, product availability, attributes, prices, costs of these processes and market information (Anim and Mukwevho, 2014). The result of this study showed that access to the market is also another factor, which positively affects productivity of smallholder at 1% significance level. Market access is a critical determinant of farmers' production habits: those who live close to better roads and have more frequent and direct contacts with the market appeared more willing to produce more systematically for the market, while those with poor market access have little incentive to produce crops other than those required for domestic consumption (Onoja *et al*., 2012b). Having market access increases the productivity of smallholders by 0.86 quintals per hectare. The implication is that obtaining and verifying information helps to produce more.

10. Nature of access to land (Nausela). The nature of access to land was expect to influence the productivity of smallholders potato growers. The result of the study also showed that nature of access to land affect productivity of smallholders. This study support study of Asres *et al*. (2013). Contract farm has positive impact on productivity of farming but has smaller impact on total household income (Otsuka *et al.,* 2015). However, Key (2013) argues that contract farm enhance the expansion farm of size especially for small-scale farmers resulted in improvement of productivity from scale effects. Idoma and Isma'il (2014) also indicated that there is relationship between land tenure mode and farmers' level of agricultural output. According to authors, farmers who rent land had higher output of agricultural production than freeholders and communal land owners by justifying renters of the lands who usually have small parcel of land go on intensive agricultural resulting into higher yield. Smallholders produce potato based on different arrangement of land use like own, contract and share in order to increase their productivity.

11. Access to irrigation (irrig). The result of the study confirmed that irrigation scheme affect productivity of potato at 5% level of significance. This result also similar to the study of Aklilu *et al*. (2015) who reported number of irrigation applied affect yield of onion and Nahusenay *et al*. (2015) studied that small-scale irrigation schemes could improved agricultural production and utilization of irrigation technologies increased a agricultural productivity of farmers**.** However, in this study the magnitude of coefficient of access to irrigation was negative indicating reverse relationship between irrigation and potato productivity similar to the study of Singh (2016) on potato productivity. That mean additional increase of access to irrigation scheme decrease productivity of potato by 0.85 quintals per hectare in the study area. This could be due to the amount of water applied to the crop is above the crop's requirement. After tubers were planted some potato tubers have long dormancy period while others early germinate. Frequent usage of irrigation schemes on dormant and late seedling affect the growth of crop Thus usage of irrigation request the knowledge of when to apply and what amount of water to apply.

12. Seed Cost (seedcost). One determinant of productivity of smallholder was seed cost of potato tubers. The result of this study showed that seed cost of potato influence productivity at 1% level of significance. This result is supported by Masuku and Xaba (2013). Seed cost vary across seasons. At harvesting time seed cost is low since there is a surplus production. But at planting time seed cost is high since tubers are highly demanded for planting purpose. Most smallholder farmers expect more yield when they purchased the seed at high cost. This high cost push the smallholder farmers to do necessary management practices that bring high productivity so as to regain the cost they incurred for seed.

Table 13. The OLS result of determinants of the productivity of smallholder potato growers

Functional forms												
	Linear (L)			Double log			Semi log			Exponential		
Independent Variables	B	Robust Std.err	t	B	Robust Std. err.	T	B	Std.err	t	B	Std.err	t
Sex	-2.37***	0.41	-5.72	0.02	0.02	1.07	-6.12***	1.14	-5.37	-0.02***	0.004	-6.06
Age	0.001	0.07	0.01	0.01	0.06	0.24	0.77	3.34	0.23	-0.001	0.0007	-0.19
HHsize	-0.05	0.19	-0.27	0.05**	0.03	1.97	-1.53	1.6	-0.99	0.001	0.002	0.11
Educ	-1.77***	0.43	-4.09	0.01	0.02	0.66	-2.4**	1.08	-2.22	-0.021***	0.004	-5.54
Seedvarity	1.03***	0.36	2.87	-0.02**	0.02	-1.15	2.6**	1.04	2.51	0.01***	0.004	2.92
Farmsize	5.91	3.71	1.59	0.83***	0.03	28.84	3.45**	1.64	2.11	0.04	0.032	1.25
Experience	3.36***	0.52	6.48	0.01	0.03	0.51	10.34***	1.53	6.78	0.03***	0.004	7.2
Fertilizer	0.17***	0.03	6.88	-0.05	0.03	-1.62	13.42***	1.88	7.13	0.006***	0.001	7.49
Conservsoil	1.54*	0.84	1.84	-0.05	0.04	-1.51	4.22**	2	2.11	0.013*	0.007	1.84
Harvestime	3.84***	1.19	3.24	0.01	0.04	0.33	6.89***	2.06	3.35	0.037***	0.012	3
Accesextser	20.9***	0.31	2.93	0.01	0.01	0.67	2.6***	0.81	3.19	0.008***	0.003	2.69
Accesscredit	0.13	0.29	0.43	0.001	0.01	0.1	0.1	0.8	1.12	0.001	0.003	0.39
Accessmrkt	0.86***	0.3	2.93	-0.01	0.01	-0.89	2.33***	0.79	2.93	0.007***	0.003	2.58
Nausela	1.18**	0.48	2.46	-0.004	0.02	-0.18	2.6**	1.25	2.07	0.012**	0.005	2.24
Accessirrig	-0.85**	0.38	-2.25	-0.003	0.02	-0.17	-3.05***	1.03	-2.95	-0.008**	0.004	-2.06
Seedcost	0.003***	6.1E-04	5.35	0.09	0.04	2.16	16.16***	2.38	6.8	3.14E-05***	4.75E-06	6.61
_cons	62.36***	5.72	10.9	-0.87**	0.42	-2.08	-92.01	23.9	-3.85	4.3***	0.05	89.95
	R^2 = 85.72, F= 73.65***			R^2 = 86.50, F =70.10***			R^2 = 82.88, F= 52.95***			R^2 =85.06, F= 62.27***		
				Adj. R^2 = 85.27			Adj. R^2 = 81.32			Adj. R^2 = 83.69		

Source: Own Data, 2015. L= Lead equation, symbol ***, ** and * shows significant level at 1%, 5% and 10% respectively.

Constraints of Potato Production in the Bore district

There are a number of factors that affect agricultural productivity in general and potato production in particular in Bore district. Low management practices, poor farming technology and limited inputs are among critical ones. Smallholder farmers are faced with many constraints, some of these include low uptake of improved farm inputs, weak links to markets, high transportation costs, small and weak farmer organizations, lack of information on markets and prices, lack of storage facilities and household and climate related factors limit productivity and income earning capability of producers.

The results of the Kendall's coefficient of concordance are presented in Table 28. The results are statistically significant at less than 1% level. The null hypothesis (Ho) that there was no agreement among the respondents over them ranking the constraints to potato production was rejected at the 0.001% significance level because the calculated F-value (162.7) was greater than the critical F-value (3.14). Hence there was agreement among the respondents on the ranking of the constraints. The Kendall's Coefficient of Concordance (W) analysis showed that 46% of the smallholders were in agreement with each other on the ranking of the constraints to potato production. The main constraints of smallholder potato production were explained as follows.

Disease (*Late Blight*) was found to be the most important constraint to potato production in Bore district. Despite smallholders use traditional methods like using ash and removing infected potato tubers smallholders' production are lowered than the potentiality of the area to produce more. Lack of control of this disease may therefore have negative consequences on potato production improvements.

Low farm gate price, lack of improved seed and low yield was the second, third and fourth most important constraint respectively faced by smallholder potato growers in Bore district. As different studies explained, low farm gate price affect smallholders motivation to highly produce potato for the market. Potato has fair price for smallholder only at planting time where as though production is there at harvesting time the its price was lower led to poor satisfaction from the produce. In the study area, seed production is mostly by research center and few community based potato producers who could not provide enough potato tubers to all potato producers. Hence, there is lack of improved potato seed to smallholders. Lack of improved yield could led to low yield. By disease or lack of improved seeds or by others reasons, low yield of potato constraint is the fourth constraint of smallholders in the study area.

Difficulty in accessibility of herbicide was the fifth constraint of smallholder potato growers. In the study area there are no formal agents who can provide herbicides and chemicals to control late blight and other problems. These inputs were not easily accessed by smallholders. Unless these chemical reach smallholder on right with that of potato tubers and fertilizer it seriously affect potato production because one reason is that potato is early mature crop and finish its life in a short period of time and needs frequent follow and treatments and secondly Late Blight could destroy the tubers in a short time unless it is treated on time.

Fertility of land could determine the production of potato. Potato selects fertile land. Lack of fertile land was one constraints of smallholders. Though respondents have moderate land size compared to the country and small potato farm size (0.38ha) was affecting the production of potato. This implies that not all land owned by smallholders are potential yield producer.

Lack of know how in production and use was another constraint identified and ranked on seventh. Within short time of potato production, it needs aptitude extension approach in addressing practices needed for potato production like land selection, land preparation, planting according to crop calendar and with agronomic recommendations. The discussion during FGDs reaveled that trainings and some field days on potato were not addressing all potato producers and only benefit few selected smallholder farmers. This implies there is extension service gap in addressing all kebeles producing potato.

Lack of storage facilities was ranked next to lack of knowhow and use. Like other vegetables potato is a perishable and need special storage facilities to store for a certain time. Even though storage facilities like Diffused Light Storage (DLS) could easily constructed from locally available materials, smallholder are facing lack of storage facilities and enforced to sell their produce during harvesting time at less price. Most smallholders store potato on the flour and sometimes in bags of quintals which are rudimentary and susceptible to insect attack. Poor storage facilities, which result in high post-harvest losses, are a disincentive to potato production in the district. When there is no post-harvest managements like storage facilities, potato could easily affected by diseases and lose its color attribute to the market. Lack of capital, inadequate labor and climate adverse were slightly ranked as lowest constraints of potato production in the Bore district. The detailed is explained in Table 14.

Table 14. Rank of constraints of potato production in Bore district**.**

Constraints of potato productions	Rank	TWS	Rank scores of constraints										
			1	2	3	4	5	6	7	8	9	10	11
Diseases	1	679	64	39	30	25	19	11	4	6	3	5	3
Low farm gate price	2	924	32	16	24	19	30	18	10	12	9	13	7
Lack of improved seed	3	985	19	31	19	23	25	21	8	8	12	10	16
Low yield	4	1227	17	28	23	10	3	3	26	1	15	39	27
Difficulty in accessible to herbicides	5	1293	11	8	21	28	17	8	11	4	20	35	29
Lack of land	6	1590	4	11	3	10	0	0	27	41	20	18	58
Lack of know how in production and use	7	1652	0	0	3	4	12	27	19	12	21	43	51
Lack of storage facilities	8	1697	1	0	8	6	7	8	9	16	46	41	50
Lack of capital	9	1762	4	2	2	6	9	13	6	6	18	37	89
Inadequate labour	10	1911	1	3	0	0	0	0	4	8	30	64	82
Adverse climate condition	11	1977	0	0	0	1	0	1	2	4	11	81	92
		∑TWS								15697			
		$\sum TWS^2$								24264527			
		$\sum (TWS)^2$								246395809			
W = 0.46, Fcal = 162.7, Ftab = 3.14 (α=0.001level). TWS =Total Weight Score													

Source: Own Data, 2015

Conclusions and Recommendations

Chapter 5 provides summary and conclusions obtained and strategic policy recommendations drawn from the study. The Ethiopian economy is characterized by the persistence of low technology intensive, poor management practices and other interrelated problems resulted into low yield. The major agricultural production is dominated by smallholder farm households with less productivity and less return. Better agricultural productivity and profitability of smallholder potato producers can be achieved through improvement of household situations and improvement of technological and management related factors. Moreover, the availability of institutional and organization services and their well-functioning accordingly are the most important in improvement of smallholders production system.

Summary and Conclusions

The analysis of productivity and profitability of smallholder potato growers was conducted in Bore district, Guji Zone, Oromia Regional State, Ethiopia. In the district, potato is a currently crop used for both cash and household consumption. The requirement of labour for the potato crop production compared to other crop in the area was less and can be managed as a sole crop because potato farm calendar is different from other crops so that there is no over load of other activities of farms of smallholder households. This study also used potato to analysis of smallholder productivity and profitability.

Seven kebeles were randomly selected from the district. The sample size of respondents selected from kebele was based on the proportion of potato producers in their kebele. Simple random sampling technique was employed to select respondents from seven kebeles. A total of 192 sample size was used for analysing the data. Both primary and secondary data sources were used to obtain relevant information according to the objective of the study. Questionnaire and FGDs was employed to generate primary data from the potato producers. Data collected were analyzed by the help of descriptive statistics and econometric Ordinary Least Square (OLS) model to analyze productivity and profitability while Kendal Concordance of Coefficient was used in analyzing constraints of potato.

Socio-economic characteristics of the smallholders were described as follow. The mean age of the overall household heads was 39 years, and they have average household size of 8. About 89% of respondents had adequate family labour for potato production and only 11% face labour shortage in the production of potato. This implies that almost all smallholders were depending mainly on their family labour in producing potato. From total sample of 192, 79% of sample smallholders were male headed household where as 21% female household head. By the educational level of household, majority (23%) of the respondents had non-formal education.

Potato is the second crop next to wheat according to crop per land allocation on major crops production during study period. Smallholders used different types of potato varieties in their farming. About 78% respondents were used improved seed while 22% used local ones. But currently the productivity some varieties like Jalane variety is declining due to less resistance to disease though early mature than other varieties. Local seed were planted from year to year commonly for household consumption while improved seed were used for both tuber seed for next season and household consumption. Despite the importance of fertilizer in increasing the productivity of potato, smallholder were not to less applied the recommended amount of fertilizer due to the major reasons of no need of fertilizer (17.2%) and unable to purchase (14.6%). Further study on perception on fertilizer usage would be needed to explore more sophisticated reasons why they were not applying amount recommended to the area.

In Bore district, potato could be harvested any time. Smallholder farmers also have their own reasons of harvesting potato. About 53% respondents were harvesting potato as soon as it matured in order to re-use the land for other crop production and improve production in general (46%). But others (47%) of respondents postponed harvesting time mostly to get high price (32.2%). One of post-harvest management of potato is storage. But most of respondents (57%) were not storing potato for the next season of production due to lack of storage facilities (46%).

One of institutional services examined in this study was nature of access to land. In the study area, potato is mainly produced on own land (78%) and contract (13%) while the remaining portion used by share farming. Majority of respondents (58%) had access to extension services mostly from Farmer Training Center (FTC). Most of respondents (62%) had access to credit from micro finance institutes (42%) and from relatives (8%). The most common constraints regarding access to credit were the complexity of requirements asked by credit sources and difficulty to meet the requirements (15%) and high interest rate (10%). The most source of information of both for market (90%) and inputs provision sources (44%) were smallholder farmers themselves. Only 22% of respondents had access to surface irrigation. Majority of respondents were had no access to irrigation, the most two reasons were enough rainfall in the area (36%) and irrigation material were not available (30%).

Potato was preferred by smallholders in the study area as the crop has very short maturity date (72%), and low intensity of labor requirement in production (71%), high market demand compared to other crops (66%) with medium on price sell (48%) and high price on purchase of inputs (59%). In the study area, resistivity of potato against disease was low (50%), very low (21%), medium (23%) and high (6%). Profitability of potato compared to other crops was high (56%) and medium (35%) in the study area.

The result of Kendall's concordance coefficient showed that the most constraint of smallholder potato growers in Bore district were diseases, lack of good market price, lack of improved seed, low yield and difficulty in accessibility of herbicides. In addition, lack of land fertile land for potato production, lack of know how in production and use also constraints to potato production in the study area. Moreover, lack of storage facilities, lack of capital, inadequate labor and adverse climate conditions were also ranked as constraint to potato production in the study area. Smallholder agricultural growth will not be achieved without access to support services. Increasing agricultural productivity requires addressing all problems simultaneously.

The mean productivity of potato per hectare was 109.95 qt/ha while the mean of output price by smallholder were 191.22 birr/qt. The mean of gross margin of potato production was 10930.97 Birr/ha while the mean of NFI from potato was 10090.45 Birr/ha. Despite the most constraints of potato such as disease, lack of good farm gate price, lack of improved seed and low yields in the study area potato is still profitable crop for smallholder since the measure of profitability of Net Farm Income of potato is positive.

The results of Ordinary Least Square (OLS) of linear function of profit analysis showed that gender, age and educational level of household heads affect the profitability of smallholder potato growers in Bore district. Age of household head had positive relation with profitability. Despite numerous challenges of women in rural kebeles, in this study, female headed households were more profitable than male headed due to male household were migrant so less profitable from potato farm than female household heads who stay and manage their farm. Farm size, seed variety used, experience on potato farm, amount fertilizer applied and harvesting time also affect profitability of smallholder potato growers at different significant level. An increase on each unit of these variables led to increase profitability of smallholder potato growers in the study area. Moreover, the profitability of smallholder potato growers were influenced by institutional services such as access to extension services, nature of access to land access to irrigation scheme and output price. Extension has a great impact on profitability of smallholders. Different access to land effect on profitability and productivity in different ways, for instance, in share arrangement there could problem of not working together. in contract arrangement there could be issues of over exploitation. Like economic theory of profit as a function of quantity and price, in this study output price of potato affect profitability of smallholder potato growers.

The result OLS model on productivity analysis showed that sex and educational level of household head affect the productivity of smallholder potato growers. Female households were more productive than male in the study area mainly due to female farmers well manage potato than their males. More educated earn less productivity in this study. This might be due to more educated were shifted to other business than potato farm. Others variables like seed variety used, amount fertilizer applied, experience of potato farming, soil conservation and harvesting time also affect the productivity of smallholder potato growers in the study area. An increase on each units of these variables led increase of potato productivity of smallholders. Moreover, institutional related independent variables such as nature of access to land, access to extension services, access to market, access to irrigation schemes and seed cost of potato tubers also significantly affect the productivity of smallholder potato growers in Bore district. Except for access to irrigation schemes, an increase on each unit of institutional variables increases productivity of smallholder potato growers in Bore district.

Recommendations

Small scale potato producers in Bore district face many production constraints which limit their ability to increase production and make profit. The most pressing constraints identified and ranked by respondents were disease, low farm gate price, lack of improved and low yield. These and other constraints hinder improvement of potato productivity in the study area. Potato production in the area however become interesting due to the crop is used for cash and household consumption, early mature crop and hence serving households during shortage of other food crops and potential to be produced twice in a year to increase production and returns. For this to happen, there is the need for practical government policies which could create incentive and enable environment for the improvement of smallholder potato production.

Based on the outcome of the study, the following recommendations were made:

- Lack of improved seed could be solved by establishing and strengthen community based potato growers and capacitate these seed producers by inputs and technical backstopping as they can produce more potato for majority of the smallholders. Clear and improved seed have to be multiplied by the seed producers including research center.

- Extension services (training and field visit) have to widely reach the smallholders to increase the capacity of smallholders in usage of fertilizers and other recommended packages of potato productions. Since potato is early mature it also needs quick managements and follow ups for better productivity.

- Since *Late Blight* is the most constraint of potato production in the area, chemicals that can control this and other diseases should be applied by smallholders and should be available on right time. Smallholder farmers also should use chemicals, improved seed and the recommended amount of fertilizer to increase their potato productivity and profitability.

- Since the productivity and profitability is influenced by soil conservation, soil conservation should be encouraged by smallholder farmers.
- Smallholder should harvest their potato as it matured. Postponed harvesting led to loss of yield.

- Extension services also needed in post-harvest management of potato. Storage facilities should be constructed by smallholders to store their produce for next production based on the quality of their seeds and sold at high price to earn more returns.

- Smallholders should develop legal rules that can sustain their responsibilities on share and contract arrangement of land use on their potato production.

- Amount of water and the time of use of irrigation should be known by smallholders since over use of resource (water) lead to loss of productivity and profitability. Because amount of rain fall with combination of irrigation could be above crop requirement leading to loss of yield and returns.

- Market access could be developed by establishing agricultural cooperatives that help smallholders jointly negotiate better prices for seeds, fertilizer, transport and storage. Smallholders growing potato should be mobilized to form groups so that together they could form their own produce markets and collectively establish organized market networks which enable them to access reliable markets.

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Value Chain Analysis of Groundnut: The Case of Babile, Gursum and Fadis Districts of Eastern Hararghe Zone of Oromia Region, Ethiopia

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Abstract

The groundnut crop has the ability to survive in areas of low rainfall; it increases soil fertility by fixing nitrogen. Groundnut is one of the cash crops in lowland area of Ethiopia. This study was undertaken in Babile, Fadis and Gursum districts of eastern Hararghe zone, with the tile of groundnut value chain analysis during 2015/16 production year. Total of 245 farm household and 8 whaleselers,4 cooperatives, 6 retailers and 8 local assembler were interviewed. To analysis the data, percent, mean, standard devotion and gross margin used. Producers prepare the land in February-March and plant it in April-May then harvest during October-November. On average, farmers allocated 0.46 ha of land to groundnut in Gursum whereas in Fadis and Babile woreda is 0.57 and 0.56 ha per household respectively. Average yield of groundnut was found to be 17.57qtl, 15.5 and 13.49qtl in Babile, Fadis and Gursum area respectively. The largest proportion especially in Fadis 82.15% was sold while 80.39 % of product sold in Babile woreda. In the area purchasing price of groundnut was 35-36Birr/Kg at Wholesalers. Producers created 10.50Birr/kg as value, local assembler 8 Birr, wholesaler added 5.6Birr/kg while retailers added 10.1Birr/kg as value added. Lack of decorticator, market information, storage, low price, lack of transports, , Brokers problem and Price fluctuation were found as main marketing constraint. The major traders' constraints are limited power of pricing, poor linkage among actors and supply shortage, lack of storage, low product quality, price fluctuation and lack of support and unlimited government taxation.

Key words: *Groundnut, Value Chain, Mapping and Marketing Margin*

Introduction

Groundnut (*Arachishypogaea*L.) is an important monoecious annual legume used for oilseed, food and animal feed all over the world (Pande*et al*., 2003; Upadhyaya *et al.,* 2006). It is the main source of food in various forms and used as a component of crop rotation in many countries (Gbèhounou and Adengo, 2003). Groundnut is grown on 26.4 million ha worldwide with a total production of 38.2 million metric tons (FAOSTAT, 2010). Developing countries account for 97% of the world's groundnut area and 94% of the total production.

The agricultural sector plays an important role in the economy of sub-Saharan countries by providing employment, food, and income for the majority of the work force. On average, 71% of the people in sub-Saharan Africa live in rural areas where agriculture is the main economic activity. In countries such as Ethiopia, Uganda, Tanzania, Malawi, Rwanda, Burundi, Ghana, and Nigeria, agriculture generates at least one-third of the GDP and employs at least 57% of the workforce (FAO, 2009; World Bank Indicator, 2010).

The groundnut plant has the ability to survive in areas of low rainfall (arid and semi-arid regions) and, because it is a legume, it increases soil fertility by fixing nitrogen in the soil. It requires fewer inputs than many other crops, giving a high return per unit of land, and hence is appropriate for small-scale farmers, including women, (Okello, 2010; Mutegi, 2010). The literature reveals that in African countries, groundnuts were originally cultivated by women to supplement their families' diet with protein. However, groundnut production can also be a way for women to earn income and participate in the cash economy. Women account for 70–80% of household food production in sub-Saharan Africa, growing crops to sell in the market, as well as preparing it for their families (ICRISAT, 2001; Lastarria-Cornhiel, 2008). Thus, any improvements in technical efficiency and productivity will improve the welfare of African farm women and their families.

Groundnut (*Arachishypogaea*L.) is an important food and feed crop, which also serve as component of crop rotation in many countries (Pande et al., 2003; Upadhyaya et al., 2006). Groundnuts are also significant source of cash in developing countries that contribute significantly to food security and alleviate poverty (Smart et al., 1990). Developing countries account for 97% of the world's groundnut area and 94% of the total production (FAOSTAT, 2010). However, groundnut yield in this part of the world and particularly in Africa is lower than the world average due to prevailing abiotic, biotic and socio-economic factors (Pande et al., 2003; Upadhyaya et al., 2006; Caliskan et al., 2008).

The Eastern lowland areas of Ethiopia have considerable potential for increased oil crop production including groundnut. Particularly areas such as Babile, Darolabu and Gursum are the major producers of groundnuts for local and commercial consumption (Getnet and Nugussie, 1991; Chala et al., 2012). Nevertheless, the area may also be very conducive for toxigenic fungi like *Aspergillus* spp. owing to its warm and dry climate. Moreover, farmers' practices of production and handling of groundnut at pre-harvest and pos-harvest stages may provide favorable conditions for outbreaks of fungi and their mycotoxins. As Chala et al. (2012) reported, groundnut from East Ethio-pia is heavily contaminated by aflatoxins at levels much more than international standards, and this might be associated with infection of the crop with *Apsergillus*spp., mainly *A. falvus*and *A. parasiticus*that are known producers of aflatoxins. However, up to date information on the prevalence of fungi, and studies on environmental factors and farmers' practices that promote fungal contamination, which could be basis for the reduction of mycotoxins are limited under Ethiopian conditions.

Research result showed that groundnut farmers can produce groundnut yields of 2000 kg/ha or more but the national average yield produced by the farmers in Ethiopia is considerably low, 1200kg/ha *al*., 1992). Similarly, Central Statistics agency Ethiopia (2009) survey report revealed that 1123 kg/ha average yield of groundnut per early and leafs spot are the commonly existing diseases in Eastern party of Ethiopia and their effect can contribute to yield loss up to 65% (Riley, 1985).

FAOSTAT (2010) reveals that, groundnut yield in Africa is lower (980 kg/ ha) than the average world groundnut yields .The lowland areas of Ethiopia have considerable potential for increased oil crop production including groundnut. The estimated production area and yield of groundnut in Ethiopia in 2010/2011 cropping season were 49,603 hectares and 716,068 quintals, respectively, and the largest groundnut production areas are found in Oromiya (32967.8 ha), Benshangul-Gumuz (9968.73 ha), SNNPR (635.04 ha) and in Amhara (344.57 ha) regional states (CSA, 2011). Somalia and Gambela regional states also produce a considerable amount of groundnuts. The national average yield of groundnut is 11.23 qt/ ha, however, there are 16 improved varieties released by Melkawerer Agricultural Research Center, which give 12-35 and 32-80 qt/ha under rain fed and irrigation conditions, respectively. The survey report (Berhanu, *et al*., 2011 not published) indicated the significant yield gap between the farmers' fields and the research centers, which is due to the improved groundnut varieties not reaching the farmers.

Methodology

Description of the study area

The study was conducted in Oromia National Regional State, East Harerghe Zone. Eastern Hararghe zone is one of the 17 zones of the Oromia National Regional State. It is located in the eastern part of the country. It divided into 19 districts and Harar is the capital town of the zone and is located at the distance of 525 kms from Addis Ababa. The agro climatic range of Zone includes lowland (*kolla*, 30-40%), midland (*weynadega*, 35-45%) and highland areas (*dega*, 15-20%), with lowest elevations at around 1,000 m a.s.l, culminating at 3,405 m, at the top of GaraMuleta mountain. There are two rainy seasons, the small *belg* and the main *meher*. *Belg* production is limited within the *dega*zone and part of the wetter *weynadega*, but *belg* rains are widely used for land preparation and seeding of long cycle *meher* crops (sorghum & maize). Annual rainfall averages range from below 700 mm for the lower *kolla* to nearly 1,200 mm for the higher elevations of *weynadega*&*dega* zones. 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), this 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. Within the area of 17,935.40 square kilometers, it has a population density of 151.87, while 216,943 or 8.27% are urban inhabitants, a further 30,215 or 1.11% are pastoralists. A total of 580,735 households were counted in this Zone. The main socio-economic activities in the districts are mixed farming (crop production and animal husbandry) non/off-farming. Moreover, the main crops grown in the area include maize, sorghum, groundnut, *khat*, coffee, haricot bean, sweet potatoes and pepper. Livestock husbandry includes cattle, sheep, goats, chicken camel and donkey. Groundnut production in the area accounts to 43.14% of total national output and it supports the livelihoods of estimated 78,450 households (CSA, 2009).

Sample size and sampling technique

To gather information, three districts of eastern Hararghe zone (Babile, Gursum and Fadis) were purposively selected for availability of potential groundnut production. Total kebele in each district were listed. From the two districts three kebeles were selected while four kebele's were selected from Babile district using simple random sampling technique. Total often kebele were interviewed three districts. Total of 245 sample household and 36 respondents from traders (8 wholesalers, 4 cooperatives, 6 retailers and 8 local assemblers) were selected and interviewed randomly. Total of 281 respondents were interviewed for this study.

Types of data and method of data collection

Both primarily and secondary data sources were used for this groundnut value chain analysis. The data required for this study was collected from sample respondents using Focus Group Discussion (FGD) and questionnaire. The enumerators for the data collection were researcher from agricultural research center and their ability to work with local language. Short term tutorial was made on questionnaire about method of data collection and the contents of the questionnaire. Pilot testing was conducted and modification was made based on the feedback from the pre-test and normal data collection was started as scheduled. Secondary data that could supplement the primary data was collected from published and unpublished documents obtained from Eastern Hararghe zone.

Method of data analysis

Costs, Margins and Price Spread

Market functionaries or institutions move the commodities from the producers to consumers. The intermediaries or middlemen make some profit to remain in the trade after meeting the cost of the function performed. In the marketing of agricultural commodities, the difference between the price paid by consumer and the price received by the producer for an equivalent quantity of farm produce is often known as farm-retail spread or price spread. Sometimes, this is termed as marketing margin. The total margin includes: (i) The cost involved in moving the product from the point of production to the point of consumption, i.e., the cost of performing the various marketing functions and of operating various agencies; and (ii) Profits of the various market functionaries involved in moving the produce from the initial point of production till it reaches the ultimate consumer. The absolute value of the marketing margin varies from channel to channel, market to market and time to time.

Margins represent the price charged for one or a collection of marketing services. In this circumstance, the market margins are the difference between prices at two market levels. Marketing margin is defined as the difference between the price paid by consumers and that obtained by producers. It is also called the 'Farm-Retail Price Spread''. Margins can be calculated all along the market chain and each margin reflects the value added at that level of the market chain. The aim of the marketing margin analysis is to show the relative importance of the marketing costs in order to reveal real differences between and among markets (inter-market variations) to allow further market integration. The target remains the producers' share that revolves. Price Spread is the difference between the retail price and the farm value of a product. Thus, the spread represents the payment of all costs involved after the product has left the farm plus the profit margins.

Marketing margins on the other hand, represent the difference between the sales of a given product and the costs of the product sold. In this case the margin is typically the profit made under a given market condition. The farmer receives what the consumer pays after the various costs of marketing have been deducted. This residual, expressed as a percentage of the price paid by the consumer (retail price), is the farmer's share. The farmer's share in the amount of the consumer's outlay at the retail level is not static and undergoes change with the change in market conditions. An increase in the share is taken as an evidence of increase in the efficiency of the marketing system in favor of the farmer, while a decrease in the farmer's share is taken as evidence of the fact that middlemen retain a larger share. This is the net price received by the farmer at the time of first sale. This is equal to the wholesale price at the *primary assembling*centre, minus the charges incurred by the farmer in selling his produce.

FS= (RP-MC/RP) X 100

Where FS= farmer's share in consumer's price expressed as a percentage

RP= retail price

MC= marketing costs, including margins

PF= price received by farmer, i.e from Wholesalers

But, RP-MC=PF

Therefore, FS= (PF/RP) X100.

Similarly, Farmers share (%) = Farm gate price/Retail price*100 if no marketing cost

Results and Discussion

Groundnut seed system

Groundnut seed system in the area is not formally developed. All respondents mentioned that they grow almost local varieties using their own saved seeds or bought from the market. However, some farmers were using 'Roba' variety which is introduced in the area in recent years. This variety is somewhat improved variety that is released in recent years. Some farmers say this variety resists drought in the case of shortage of rain in the area. The other local varieties are 'Sartu' and 'Ol-Dhale' variety which are common in the eastern Hararghe.

Groundnut production and utilization

The activity calendar and storage time of groundnut production in Babile, Fadis and Gursum woredas is given in Tables 1 and 2 respectively. The majorities of the producers prepare the land in February to March, and plant it in April-May and harvest it during October-November. Thus, October is the peak groundnut production and marketing seasons which also characterized by low price.

Production season: In the study area the land for groundnut production is cultivated 1-2 times with oxen when the rain season has started in March and in the first two weeks of April. Then groundnut planting is done in the last two weeks of April and May. Regarding fertilizer application, 89.4% of the respondents use fertilizer but 10.4% of the respondents did not apply any fertilizer for groundnut production. On average sample respondents have used 28.26kilograms of fertilizer for their groundnut production. Many farmers do hoe-cultivation twice to control weeds and loosen the soil, the first cultivation is done to enhance growth and the second cultivation is at early flowering stage to loosen the soil for easing entrance of the moisture into the soil where the pods are developed. Groundnut planted in April is matured after five months that is in September-October, and harvested in October with a spade when the leaves' color changed to yellow and started shedding. The uprooted plants are left in the field for some days facing the root with the pods upside to the sun for proper drying, and the pods are collected from the plants by hand. If the pods are not dried enough at the field, they are further dried by spreading groundnut with pods on the floor around the homestead.

Table 35. Groundnut production activities calendars in the study area

Main activities	Sep	Oct	Nov	Dec	Janu	Feb	Mar	April	May	Jun	July	Aug
Land preparation						■	■					
planting								■	■			
Weeding										■	■	■
Harvesting		■	■									
Marketing			■	■	■	■	■	■	■			

Source: Survey results

The producers' farmers stored groundnut in sacks for some months even up to planting time or until the market price of dried groundnut increases. On average 90.5 percents of respondents said that they store groundnut for market and seed (Table 2). On the other hand, some of respondents said that they do not store groundnut and sold their product on the field. The respondents mentioned that if the pods are not dried as required the color of the seeds is blackened, has a bad smell and bitter taste. The haulm of groundnut is used for animal feed, and some of the respondents use the hull/shell as fire wood.

Table 2. Percentage respondents storing groundnut in respective month

Duration of groundnut storing in Months	Location groundnut production			**Total**
	Babile HH(N=120)in %	**Fadis** HH(N=80) in%	**Gursum** HH(N=45)in %	
1-4	34.6	12.6	6.5	53.7
5-7	9.3	2.8	5.7	17.8
8-9	17	0.8	1.2	19
Total	**60.9**	**16.2**	**13.4**	**90.5**

Source: Own survey results

Productivity: On average, in the study area the respondents' farmers allocate 0.54ha for groundnut production. In the Gursum district, the landholding size is small as compared to the land holding in Fadis and Babile District area. Hence, the area located to groundnut production is small as compared to Fadis and Babile. During 2015, farmers in Gursum woreda, on average, allocated 0.46 ha to groundnut production whereas the area allocated to groundnut in Fadis and Babile woreda is 0.57 and 0.56 ha per household respectively. Moreover, average groundnut yield is highest in Fadis area that is 11.50 than Babile (11.12Qt/ha) and Gursum (11.16Qt/ha) area. In both cases (Babile and Gursum), the average yield of groundnut production is lower than that of reported in literature. The lower level of groundnut productivities may be attributed to the types of groundnut varieties farmers growing which is usually local or old improved variety, poor seed quality, disease and poor management practice.

Table 36. Average yield of groundnut shelled groundnut production (in Qtl/ha)

Location	N	Mean	Minimum	Maximum	Std. deviation
Babile	120	11.12	7	14	1.59
Fadis	80	11.50	8	13	1.34
Gursum	45	11.16	8	13	1.46
Total	**245**	**11.25**	**7**	**14**	**1.49**

Source: Own survey results

Groundnut production and utilization

The survey result shows that the average yield of groundnut production found to be 17.57 Quintal, 15.5 and 13.49 Quintal in Babile, Fadis and Gursum area respectively. The largest proportion products especially in Fadis (82.15%) was sold while 80.39 % of product sold in Babile woreda. The average quantity of groundnut produced and consumed was 1.79 Quintal, 1.76 and 1.13 quintal in Fadis, Babile and Gursum woredas, respectively. As own product is the major source for seed source about 10.7%, 9.7% and 6.75% of groundnut product was saved as seed in Gursum, Babile and Fadis woredas respectively. This quantity of groundnut product is amount of product that used for in the next cropping year.

Table 37. Groundnut production and utilization per household in study area

Woreda	Production(Qtl)	Utilization (Qtl)			Utilization (%)		
		Sold	Consumed	Seed	Sold	Consumed	Seed
Babile	17.6	14.13	1.76	1.7	80.39	10.02	9.67
Fadis	15.5	12.78	1.79	1.1	82.15	11.49	6.75
Gursum	13.5	10.67	1.13	1.4	79.1	8.5	10.71

Source: Own survey results

Groundnut Value Chain Actor and Functions

Value chain actors are classified as those individuals who take ownership of a product, through the exchange of money or equivalent goods or services, during the transaction process of moving the product from conception to the end user. Those individuals or firms providing a service without taking ownership of the product are classified as service providers**.**

The primary actors in a groundnut value chain in three waredas are seed and other input suppliers; farmers; Local collectors; brokers; wholesalers; retailers (processors) and consumers. Each of these actors adds value in the process of changing product title. The main processes of groundnut value chain include input supply, technical support (extension service), production, trading, processing, and consumption. The description of the value chain functions and actors is given in the subsequent sub-sections.

Input suppliers

Groundnut producers in the study areas, get seed from different sources. In Babile, Fadis and Gursum woredas, the majority of the sample producers (84%, 90%and 78%) respectively, used their own seed. The remaining proportion of respondents gets seed from Market and relatives. Regarding fertilizers, some farmers used only organic fertilizer (manure and compost) while some farmers used both inorganic and organic fertilizers depending on the land size allocated to groundnut production and the soil fertility status as perceived by the farmers. Groundnut growers obtained fertilizer from either cooperatives or private traders. Farmers use small amount of fertilizer for groundnut while most of them do not apply any amount of fertilizer.

Table.38. Amount of fertilizer used for groundnut production (in Kilogram)

Waredas	N	Mean	Minimum	Maximum	Std. Deviation
Babile	120	26.53	0	65	19.09
Fadis	80	32.73	0	75	17.38
Gursum	45	25.62	7	100	18.76
Total	245	28.38	0	100	18.66

Source: Own survey results

Groundnut producers

The next major groundnut value chain actors following input suppliers are groundnut producers. They are generally smallholder farmers having different land size. The descriptive statistics of land allocated to groundnut in Babile, Fadis and Gursum woredas during 2015/16 production year is given in Table 6. Groundnut production in these three woreda was based on rain fed. Larger land size was allocated to groundnut production in Babile woreda (0.6 ha) as followed by Fadis wareda (0.5ha) and in Gursum wareda (0.4ha).

Table 6. Descriptive statistics of land allocated for groundnut production in the study area

Waredas	N	Mean	Minimum	Maximum	Std. Deviation
Babile	120	0.6	0.2	1.2	0.27
Fadis	80	0.5	0.1	1.4	0.33
Gursum	45	0.4	0.3	1.1	0.17

Source: Own survey results

Groundnut producers are the major actors who perform most of the value chain functions right from farm inputs preparation on their farms or procurement of the inputs from other sourcesto post harvest handling and marketing. The major value chain functions that ground nut producers perform include ploughing, planting; fertilization, weeding, diseasecontrol, harvesting (digging and pod collection) and post-harvest handling. The most difficult function according to thefarmers is digging or uprooting groundnut from their farm since it requires labor intensive. This activity is labor intensive and tedious work followed by pod removal.

Cropping system: groundnut sole cropping is the most popularly practiced production system in three waredas. More than 68% of groundnut producers reported that they practice sole cropping (Table 7). Out of sole cropping more than 56% of respondents reported in Babile wareda followed by Gursum woreda (23.2%).Farmers also practice intercropping groundnut with other crops like sorghum and Chat in the study areas. Proportion of respondents that practice intercropping groundnut with other crop like chat and sorghum ware reported in Babile, Fadis and Gursum is 20.8%, 57.5% and 13.3% respectively. In cases of intercropping groundnut with other crop farmers responses uses as risk minimizing strategy and increase land productivity.

Table 7. Groundnut production cropping method (% respondents)

Groundnut Cropping System		Location of Groundnut Production			Total
		Babile	Fadis	Gursum	
Sole Cropping	Count	95	34	39	168
	% within cropping System	56.5	20.2	23.2	100
	%within location	79.17	42.5	86.7	68.6
Intercropping with other Crop	Count	25	46	6	77
	%within location	20.8	57.5	13.3	31.4
Total	Count	120	80	45	245
	%within location	100	100	100	100

Source: Own survey results

Post-harvest handling: Post harvest handling, which includes different activities like sorting, packing, storing, transportation, loading and unloading, is done by the farmers themselves or local collectors. If Groundnut is sold at the farm gate which is the case in Gursum and Fadis Districts' kebeles, some parts of these activities are performed by the buyer (Local collectors). After harvesting, groundnuts are collected in sacks of various sizes ranging from 50 kg to 100 kg, a common measurement unit which is used within the study area. Most of the farmers use sacks as a groundnut store. In most of the groundnut producing areas, producers transport their groundnut to the nearby markets, be it rural or urban centers. Means of transportation varies among locations but predominately on pack animals (donkey) to home and to nearby market. In other cases, farmers and local collector transports products to the market using car and Bajaj depending distances of the residence.

Local Assemblers/ collectors

Local assemblers procure groundnuts from farmers at farms. They act in one of two ways. They either use their own finance to buy the produce from farmers to sale to the next level or they could work on a commission bases so that they collect groundnuts from farmers on behalf of wholesalers or they are paid their commission. Since groundnut production in Ethiopia is dominated by small scale farmers who cultivate on fragmented plots of land, collection of produce from large number of small farmers widespread in different areas is a challenge. The village collectors play an important role in bridging the gap between producers and the next level of actors in the groundnut marketing. Most of the collection from farmers is made via the village collectors. They collect groundnuts from producers, assemble them in one place and then sell it to wholesalers or transport it to other towns. These local assemblers collect groundnut for wholesalers and wholesalers pay small fee for their service. However, every cost is covered by the wholesalers themselves.

Some local collectors also act as trader that can purchase groundnut by themselves and store them for some time, negotiate the price with wholesalers and sale it when necessary. These traders also involved in value addition activities. They buy unshed sacks of groundnut negotiating on with producers in the market and shell groundnut then sale it to wholesalers and retailers. These traders are selling their shelled groundnut in kilogram to wholesalers. Other local measurement in groundnut trading is 'Tasa' or Tin. This shows that they are highly dependent on the willingness of wholesalers to sale the collected groundnut if they do not agree on the price in advance. Similarly, producers themselves have to bring the shelled and unshelled groundnut to the wholesalers' store houses purchase place.

Table 8. Proportion of producers who sold groundnut for different chain actors

Chain Actors		Location of Groundnut Production			Total
		Babile	Fadis	Gursum	
Retailers	Count	23	3	1	27
	% within chain Actors	85.2	11.1	3.7	100
Wholesalers	Count	31	22	5	58
	% within chain Actors	53.4	37.9	8.6	100
	%within location	25.8	27.5	11.1	23.7
Local Assemblers	Count	52	14	7	73
	% within chain Actors	71.2	19.2	9.6	100
	%within location	43.3	17.5	15.6	29.8
Cooperatives	Count	14	41	32	87
	% within chain Actors	16.1	47.1	36.8	100
	%within location	11.7	51.2	71.1	35.5
Total	Count	120	80	45	245
	% within chain Actors	49. 0	32.7	18.4	100
	%within location	100	100	100	100

$Chi^2 = 73.32$,p-value = 0.000, DF=6
Source: Own survey results

Wholesalers

There are very few wholesalers around 12 persons who have the license to do wholesale in the Babile town. But the majority of wholesalers are located outside the districts mainly in Harar. Wholesalers in the local market are closely working with local traders/collectors to buy the groundnut collected in bulky and sell it to other wholesalers Harar. They started collecting groundnut from local traders or order them to collect only when they got call from brokers. Brokers play crucial role in groundnut marketing system by facilitating groundnut transaction by linking local wholesalers with regional wholesalers. They do not follow proper business conduct and as a result they constrain the marketing system more than they facilitate. Wholesalers mostly purchase in bulk from other districts' wholesaler, transport and sell the produce in the different major towns like Jijiga, Ciro, Hirna, Badesa, Adama and Adis Ababa. Wholesalers that found in Babile and Harar buy both shelled and unshelled groundnut from farmers, local traders and other wholesalers.

Processers/Retailers

Large scale groundnut processing is non-existent in Ethiopia in general and in the study areas in particular. Groundnut is commonly consumed in the form of dry roasted and shelled groundnut in different markets, shop and on streets. Similarly, unshelled wet and roasted groundnut also consumed in the early time before harvesting. In urban areas it is also usually consumed as '*Halawa*' produced in Dire Dawa. Most commonly, street vendors prepare roasted and unroasted shelled groundnut using both kilogram and 'Tasa[2]' or tin then supply to consumers in the market. What is limiting groundnut consumption in the study area is that very little is known to make different form of butter and Oil. Retailers are key actors in groundnut value chain within and outside the study area. They are the last link between producers and consumers. They mostly buy from wholesalers and local traders then sell to urban consumers. Sometimes they could also directly buy from the producers. Other retailers also sell groundnut in the market on market days using local measurements called 'Tasa' or Tin. Consumers usually buy the product from retailers as they offer according to requirement and purchasing power of the buyers. However, in towns local retailers/vendors buy groundnut from producers and wholesalers and sell to consumers that use groundnut with 'khat' in open market. Most consumer, consume groundnut with 'khat'. Roasted groundnut is 30 birr large white tin (shimiriri) while small tin (shimiriri is 25Birr/Tin. Retailer said two of one and half xasa become one Kilogram.

Table 9. Quantity of groundnut sold to market chain actors

Chain actors	Mean	Percent
Retailers	14.185	11.98
Wholesaler	13.676	24.97
Local assemblers	13.068	29.84
Cooperatives	12.207	33.21
Total	**13.051**	100

Source: Own survey results

Consumers

Groundnut consumers are individual [rural and urban dwellers] in different form. Groundnut is largely consumed locally and outside the study area. Consumers usually buy the product from retailers as they offer according to requirement and purchasing power of the buyers. However, in towns local retailers/vendors buy groundnut from producers and wholesalers and sell to consumers that use groundnut with 'Chat' in open market. Most consumer, consume groundnut with 'Chat'. They never chew chat without groundnut.

Cooperatives

In a similar fashion, cooperatives in the major groundnut producing regions supply inputs to groundnut small scale farmers and collect their produce and supply to the market mainly to wholesalers and processors. However, the role of cooperatives in this regard is limited.

Service providers

Agricultural development office provides agricultural extension services to farmers through development agents. The office provides advisory service, facilitate access to different agricultural inputs and provide technical support in crop protection. One should note that, there is no specialized extension services for

[2]Five Tasa =Three kg?

groundnut growers except that groundnut are considered as just one of the cash crops. The interview results show that the producers get extension service on general agriculture though not sufficient to improve the technical skill of the farmer's specific knowledge and skill in production and management of groundnut. However, shortage of technical expert exists though farmers know about groundnut thorough experience they almost start agriculture by producing groundnut production.

Production cost and price distribution of groundnut

In calculating cost of producing groundnut, respondents were asked regarding each activity that was under taken from land preparation to transportation fee to the market. Unit cost of each operation is measured. In calculating these costs, market price for purchased goods and services were considered. For imputed value of family labor and owned oxen which the households use in groundnut production without paying direct cost, opportunity costs of the commodities were used. One of the important aspects of agricultural marketing of a country is the behavior of prices of the agricultural produces. The prices of agricultural commodities are lowered generally during the harvesting period. The price of groundnut varies from time to time. At harvesting time, the price of groundnut ranges between 500-650ETB. Then it becomes between750-800ETB then 900-1300EB per quintal of unshelled groundnut. Twenty-kilogram unshelled groundnuts contain fifteen kilograms of shelled groundnut.

Table 10. Cost and benefit of groundnut production

Cost and benefit	Babile, N=120	Fadis, N=80	Gursum, N= 45
	(Birr/Qtl)	(Birr/Qtl)	(Birr/Qtl)
Average cost of producing one quintal of groundnut	453 or 12.49Birr/kg	470.23	574.73
Average producers selling price	816.50 or21.60/kg	823.12	954.89
Net benefit of producers	363.03	353.00	380.24

Source: Own survey results

Value chain constraints

Production constraints

Diseases and pests, insects, groundnut weeds, draught, lack of improved varieties and lack of capital and credit availability were found as main groundnut production constraint in the area. Sample respondents identified diseases for groundnuts were ***goggogso*** (root-rot) and Aflatoxin that decay the groundnut shrubs and nut in pod respectively.

Table 11. Groundnut production constraints in the study area

Production constraints		Location of Groundnut Production			Total
		Babile	Fadis	Gursum	
Oxen shortage	Count	11	5	5	21
	% within location	9.2%	6.2%	11.1%	8.6%
Labor shortage	Count	14	2	3	19
	% within location	11.7%	2.5%	6.7%	7.8%
Disease	Count	57	11	18	86
	% within location	47.5%	13.8%	40.0%	35.1%
Drought	Count	18	35	3	56
	% within location	15.0%	43.8%	6.7%	22.9%
Weed	Count	9	14	7	30
	% within location	7.5%	17.5%	15.6%	12.2%
Improved seed shortage	Count	6	8	5	19
	% within location	5.0%	10.0%	11.1%	7.8%
lack of pesticide	Count	0	3	2	5
	% within location	0.0%	3.8%	4.4%	2.0%
lack of storage	Count	3	0	1	4
	% within location	2.5%	0.0%	2.2%	1.6%
Other	Count	2	2	1	5
	% within location	1.7%	2.5%	2.2%	2.0%
Total	Count	120	80	45	245
	% within constraints	49.0%	32.7%	18.4%	100.0%
	% within location	100.0%	100.0%	100.0%	100.0%

Source: Own survey results

Diseases and pests: Disease is the primary problem of the famers in the study area. Out of total producers in Babile 47.5% of them replied groundnut disease as constraint, 13.8% of Fadis and 40% of the farmers also respond facing with problem of diseases as production constraints in the study area. According to the sample respondents, the identified Diseases for groundnut were gogogso and Aflatoxin type. This disease is reducing the quality of the product. Unavailability of pesticide and herbicides mainly create these problems in addition to the problem of accessing to improve and diseases resistance seeds. This shows most farmers are using poor quality seeds, as high-quality seeds are often not available at planting time and it also caused by shortage of water or draught. The other reason for this problem is the problem of management skill. Inadequate farmer skills and knowledge on production and farm management creates such problems. This is mainly related with poor extension service in the area.

Insects: Insects also reduce the ability of the plant roots to absorb water or nutrient when they eat parts of the roots. Sometimes, insects inject toxic substances when they feed on the plants or create holes through which disease-causing bacteria or fungi may enter the plant and parts of the plants. Insects such as groundnut borer at storage and on field, stem weevil and many others readily migrate to nearby or distant fields. This is mainly due to lack of pesticide for insects in the study area. 3.8% of farmers in Fadis and 4.4% of them in Gursum district respond that lack of pesticide or insects as production constraint.

Groundnut weeds: Weeds: many broad leaved and annual grass weeds infest groundnut in the areas. Especially, nowadays the rapid expansion of aggressive weeds such as *striga*and *partinium* are becoming the critical problems of agricultural production in general and sorghum production in Babile area. Even if the groundnut is resists the striga weeds which series problem for maize and sorghum production, it can cause loss in groundnut production. Weeds compete directly with the groundnut plant for light, water and nutrients. Dense weed infestations restrict growth resulting in smaller leaves, lower dry matter content, lower quantity of product and poor quality. In addition, the weeds restrict air flow through the canopy, which increases the potential for disease development, provide alternate hosts for diseases and insects, and interfere with the harvesting operation. The results also revealed that, 7.5% of groundnut producers in Babile 17.5% farmers in Fadis and 15.6 % of farmers in Gursum districts were replied weed as groundnut production constraint in the area.

Draught: Drought is the one of the major groundnut and other agricultural production constraints of the farmer in the study area. About 15% of producers in Babile district, 43.8% of producers in Fadis district and 6.7 % of groundnut producers in Gursum district have replied problem of drought as groundnut production constraints. This problem also cause disease called “gogogso” which can reduce or destroy the production of groundnut.

Lack of improved varieties: As indicated in table, lack of improved varieties was responded by 5 percent of the farmers in Babile district, 10 percent of groundnut producers in Fadis district and 11.1 percent of producers in Gursum district were replied lack of improved verity of groundnut as production constraint. Almost all farmers in the area cultivate local variety which is poor in disease resistance and low productivity.

Marketing constraints

Producers’ market constraint

Almost all groundnut producer farmers responded that there were market problems in their area. The major groundnut marketing constraints are related with low price of product, lack of storage, and low quality product that cannot meet consumers demand. Brokers also cause a problem to farmers by hiding price information before them entering the market. Because broker most of the time buy the groundnut from the farmers in the village, on the road and remote place to hide information.

Table 12. Groundnut Market constraints in the study area

Groundnut marketing constraints		Location of Groundnut Production			Total
		Babile	Fadis	Gursum	
low price of products	Count	26	5	7	38
	% within location	21.7%	6.2%	15.6%	15.5%
lack of storage	Count	6	1	6	13
	% within location	5.0%	1.2%	13.3%	5.3%
lack of transports	Count	1	9	6	16
	% within location	0.8%	11.2%	13.3%	6.5%
lack of market information	Count	9	14	2	25
	% within location	7.5%	17.5%	4.4%	10.2%

Brokers hinders fair price	Count	57	28	13	98
	% within location	47.5%	35.0%	28.9%	40%
lack of decorticator	Count	16	11	10	37
	% within location	13.3%	13.8%	22.2%	15.1%
groundnut Price fluctuation	Count	5	12	1	18
	% within location	4.2%	15%	2.2%	7.3%
Total	Count	120	80	45	245
	% within Market constraints	49%	32.7%	18.4%	100%
	% within location	100%	100%	100%	100%

$Chi^2 = 19.92$, p-value = 0.001, DF=5

Source: Own survey results

Traders and Local Assemblers constraints

The major problem of wholesalers is capital shortage, high payment for tax and competition with unlicensed traders. Again, all traders engage in groundnut value chain confirmed that there are marketing problems in groundnut value chain. The major groundnut marketing constraints mentioned by traders are related with the limited power of price setting, poor linkage with value chain actors and problem of supply shortage, limited credit access, lack of storage facility, problem in information flow, low product quality, price fluctuation, high market distance and lack of support from concerned bodies and unlimited government taxation.

Other Constraints

Lack of in adequate technology: Problems of machine to shell the unshelled groundnut. This problem has an effect on the time of the producer and it cost labor. Farmers sell groundnut without adding value of their product because there is no perfect machine, there is a machine but it breaks the groundnut it does not protect the quality of the groundnut for marketing and other related purpose.

Lack of capital and credit availability: Farmers have an urgent need for money immediately after harvest. Even if the price of paddy is always at lowest during that period, farmers badly needed cash during this period in order to pay their rent and debts as well as to buy certain necessities.

Opportunities

Some of the potentials to mention are the following. These Woredas are very suitable to produce not only groundnut products but also other market oriented commodities of cereal, pulses and/or animal production. Of the potential crops, and cereals like sorghum, maize, and improved local animals for milk and meat production are some of the available potentials. On top of this, relatively fertile arable land for groundnut is available. Government suitable agricultural policies designed to support farmers at the grass-root level especially emphasis given for horticultural production in Growth and Transformation Plan (GTP) is the other opportunity dimension. Furthermore, provision of infrastructure facilities like roads, telecommunication, power supply and financial institutions are the infrastructural advantages that facilitate the production and marketing of groundnut in the study area. There are also various organizations such as Haramaya University that provide technical services to the farmers.

On the other hand, availability of market demand throughout the year, growing number of buyers, high experience in groundnut trade and growing demand for groundnut were some of the opportunities of groundnut by most of the producers. The natural proximity to market and transport access, soil of the area is the opportunities that enhance level of commercialization to woredas.

Farmer's Price, Marketing Costs, Margin and Consumer's Price

The main problem in agricultural commodity marketing is price fluctuation from harvesting time to cultivation time in the year. Similarly, the price of the groundnut varies from season to season.

In the study area the purchasing price of the groundnut was 35-36Birr/Kg at Wholesalers store. At retailers, the price of shelled and roasted groundnut is varies from 12-35birr/Tin or 40-45Birr/Kg in Babile market. 'Tin' is local groundnut measurement that farmers and retailers used to measure the groundnut. Similarly, the value-added of a sector is defined as the difference between its gross output (total production value of the sector) and its intermediary inputs (costs of production inputs). It measures the amount of value created by the sector, to be then shared between labor, capital and taxes. Value-added of a sector is a good proxy for its economic importance and its evolution provides insights on the sector's economic health.

Table 13. Average distribution of values across value chain

Category	Producers	Local assembler	Wholesalers	Retailers
Sale price (Birr/Kg)	21-23Birr/kg	Sp 23-32Birr/kg	Sp 35-40 Birr/kg	Sp 40-45Bir/kg
Total cost	ucp=12.4bir/kg	2 Birr per Kg	2.40 Birr/kg	2.9 Birr/kg
Value Added	10.50 Birr/kg	8 Birr/kg	5.6 Birr/kg	10.1Birr/kg

Source: Own survey results, Sp = Sale price of groundnut

As we are interested in the total costs of marketing, the percentage total gross margins can be obtained by the formula;

Total gross Margin (%)= Retail price –Farm gate price/Retail price*100

Table 14. Summary of groundnut price spread and Margin (Birr/Kg) in Babile market

Particular	Value in Birr/Kg
Producer sale price(Birr/Kg)	23
Retail price(Birr/Kg)	45
Producer-retailer price spread	22
Producers' share in consumers' price (%)	51.1
Total Gross Margin (%)	48.89

Source: Own survey

As revealed in the above table 16, the amount of farmers' share in consumers' price depends on the market prices which are flexible over time depending on the availability of groundnut in the market on one hand and bargaining power of the middlemen on the other. An increase in the share is taken as an evidence of increase in the efficiency of the marketing system in favor of the farmer, while a decrease in the farmer's share is taken as evidence of the fact that middlemen retain a larger share.

Traders marketing cost

Table 15. Marketing cost of chain actors per quintal

Description of cost	Wholesaler	Local Assembler	Retailer
Loading and unloading	4	4	10
Mobile	4	2	1
Sack price and selling material	4	4	34
Transport	60	20	
Tax	12	-	1.5
Personal expense	20	10	20
Other Expense	40	40	30
Roasting	-	-	20
Total cost	144	80	116.5
Total cost per Kg	2.40 Birr/Kg	2 Birr per Kg	2.9 Birr/kg

Source: Own survey results

Conclusion and Recommendations

Groundnut is one of the cash crops in lowland area of the Ethiopia. This study was conducted in Oromia National Regional State, East Harerghe Zone with the tile of groundnut value chain analysis in eastern Hararghe zone. Eastern Hararghe zone is one of the 20 zones of the Oromia National Regional State which located in the eastern part of the country. Specifically, the study was undertaken in Babile, Fadis and Gursum districts of eastern Hararghe zone. Both secondary and primary data source were used for this study. From the two districts three kebeles were selected while four kebele's were selected from Babile district using simple random sampling technique. Total of ten kebeles were interviewed from three districts from which a total of 245 farm communities and 36 respondents from traders (8 whaleseler,4 cooperatives, 6 retailer and 8 local assembler) were interviewed. Total of 281 respondents were interviewed for this study. To analysis the data percent, mean, standard devotion and gross margin and other were used.

The main processes of groundnut value chain include input supply, technical support (extension service), production, trading, processing, and consumption. In Babile, Fadis and Gursum woredas, the majority of the sample used their own seed. Producer Cooperatives, local assemblers, wholesalers and retailers were found as main channel actors. *However,* diseases and pests, insects, lack of pesticide, groundnut weeds, draught, lack of improved varieties and lack of capital and credit availability were found as main groundnut production constraint in the area. Additionally, lack of decorticator, low price of products, lack of storage, lack of transports, lack of market information, price asymmetry and price fluctuation were found as main marketing constraint for groundnut producers. Similarly, wholesalers are confronted by capital shortage, high payment for tax and competition with unlicensed traders.

In the study area, producers created 10.50Birr/kg as value, local assembler 8 Birr, wholesaler added 5.6Birr/kg as value while retailers added 10.1Birr/kg as value in groundnut value chain analysis. The result of the study revealed that, farmers share in consumers' price was found to be 51.1% that shows at that price of the time share of the farmers was small in percent which shows that farmers were not beneficiary as compared to other actors. Generally, the study area is moisture stress where rainfall pattern is uneven distributed. Groundnut in this area was used as both cash crop and drought risk minimization.

That mean farmers use as source of income diversification mechanism in the study.Since there is low access to improved variety which is high yielder, drought and disease resistance in the area, improved variety should be introduced and method of groundnut quality control should be adopted in the area with the help of the research center and government in general. To increase farmers benefit from groundnut production, decorticator machine should be developed and introduced to the community. Farmers should be cooperated to minimize broker problem and increase farmers share in consumers' price.

Farmers have an urgent need for money immediately after harvest. Even if the price of groundnut is always at lowest during that period, farmers badly needed cash during this period in order to pay their rent and debts as well as to buy certain necessities. During the peak season most farmers sell their groundnut at throw-away price and substantial quantities go to waste at harvest time. The way of extending farmers sell of groundnut should be arranged by the government by arranging refunded capital that solves urgent cash needed during this period. Time factors of groundnut price over time should be studied by other researcher as research gap identified. Study on disease resistance groundnut variety and comparative analysis of eastern Hararghe groundnut and other parts of eastern Ethiopia should be studied to select best variety that improve income within moisture stress area.

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Impact of Cattle Fattening on Household Food Security and Income Generation in Fadis District of Eastern Hararghe, Oromia, Ethiopia

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Abstract

Livestock plays a critical economic and social role in the lives of pastoralists, agro-pastoralists, and smallholder farmers. It is very important to identify the existing cattle fattening practices and marketing systems in the area. The main objectives of these studies are to analysis factors affecting participation in cattle fattening and its impacts on household income generation and food security in Fadis district. The data were collected by questionnaire from 124 sample respondents during April 20-May20/ 2017. The study implemented logit model to analysis factors affecting participation in cattle fattening. Logit model estimation also revealed that participation in cattle fattening is significantly influenced by five explanatory variables. Age of household head, labor force in family, number of livestock, market information and access to agricultural extension service are significant variables which affect the participation of the household in cattle fattening practice. Propensity score matching method was applied to analyze the impact of the cattle fattening on the household food security and farm income. In matching processes, kernel matching *with 0.25 band width is resulted in relatively low pseudo-R^2 with best balancing test was found to be the best matching algorithm. This method was checked for covariate balancing with a standardized bias, t-test, and joint significance level tests. Propensity score matching method results also revealed that household participated in cattle fattening practice have got* 977.80 *Kilocalories per adult equivalent per day (AE/day) of food and* 14071 *Ethiopian Birr (ETB) more farm income than those household that were not participated in cattle fattening practice*

Key words: *Cattle fattening, Food security, Logit regression, Propensity score matching*

Introduction

The Ethiopian economy is largely based on subsistence agriculture, which is almost entirely rain fed. Among the rural population 87 percent of the household receive their income from agriculture (World Bank, 2006). The agricultural sector accounts for 40 percent of national GDP, 90 percent exports, 85 percent of employment, and 90 percent of the poor (World Bank, 2007). Despite its importance in the livelihood of the people and its potential, the sector has remained at subsistence level. It is partly explained by land productivity of 1.15 ton/ha of cereals and labor productivity of US$ 144 per agricultural worker (World Bank, 2007). While most of the population depends on subsistence agriculture, 30 percent of the rural poor are net cereal buyers, caused by the decline in average per capita holdings from 0.50 ha in 1960s to 0.21 ha in 1999, and this reflects increasing vulnerability of the poor to fluctuation in rain fall and food prices (World Bank, 2007).

Mixed farming of crop and livestock production characterizes the major parts of the Ethiopia's agriculture, particularly in the highlands. About 81 percent of the farmers are involved in crop cultivation and livestock rearing. Livestock and livestock products contribute] 16 percent of the total GDP and 23 percent of value added obtained from agriculture (World Bank, 2007). The country has the second largest number of livestock population in Africa (World Bank, 2007). It has about 41.53 million cattle, 14.66 million sheep, 13.66 million goats, 1.50 million horses, 3.96 million donkeys, 0.44 million camels, 0.35 million mules and 42.92 million poultry (CSA, 2003). However, the contribution of livestock to the national economy is highly hidden, because livestock outputs such as draught power, milk, meat and egg are produced and consumed on farm, while only a small proportion enters rural market and some is exported (World Bank, 2007).

Livestock production is of strategic economic importance, not only because of its number and diversity, but also because the majority of the rural people either keeps livestock as a livelihood or use livestock for various other activities like farming and transportation of people and products (MoFED, 2006). In areas where mixed farming (crops and livestock production) undertaken, farmers use livestock for coping with adverse situations during crises of crop failure by selling animal products, as 72 percent of the households own cattle. With regard to direct food supply and/or cash income generation, livestock play an increasingly significant role (MoFED, 2007).

At the household level, livestock plays a critical economic and social role in the lives of pastoralists, agro-pastoralists, and smallholder farm households. In the case of smallholder mixed farming systems, livestock provides nutritious food, additional emergency and cash income, transportation, farm outputs and inputs, and fuels for cooking food. The government recognizes the importance of livestock in poverty alleviation and has increased its emphasis on modernizing and commercializing the livestock sub-sector in recent years. Eastern Hararghe is well known for its best practices and indigenous knowledge in cattle fattening. Enhancing the production and productivity in the area with available indigenous technical knowledge will help the improvement of the sector in increasing the sector contribution to national and agricultural GDP.

The livestock production system in East Hararghe is market oriented. In the study area, there is little information available on determinants of cattle fattening and impacts of smallholder cattle fattening on food security and income generation. Fattening is commonly practiced by some farmers in different places. Farmers keep a small number of oxen which are mainly purchased from market, fattened and sold for beef after a few month of work. Therefore, to plan and develop improved cattle fattening and information sharing, it is very important to identify the existing cattle fattening practices, determinants of cattle fattening and its impacts on household income generation and food security in selected study area.

Methodology

Description of the Study Area

The study was conducted in Fadis districts of eastern Hararghe zone of Oromia region. It is found in around 30km distance from Harar town. The climate of the area is characterized by warm and dry weather with relatively low precipitation. Agriculture is the major source of livelihood of the community. However, its productivity is dependent on the merit of rain-fed agriculture. The farming system is subsistence type dominated by smallholder farmers. Sorghum and maize crops take the largest proportion of crop production. Similarly, chat and groundnut are also the main cash crops in the area. Even though livestock keeping constitutes an important activity, many households lost their livestock assets due to recurrent drought.

Fedis district is also found at latitude between 8°22' and 9°14' north and longitude between 42°02' and42°19' east, in middle and low land areas: altitude range is from 1200 – 1600m.a.s.l meters,witha prevalence of low lands. The area receives average annual rain fall of 400 - 804 mm**.** The minimum and maximum temperature of the area is 20–25^{o}C and 30–35^{o}C, respectively.The population's livelihood mainly consists of agriculture, husbandry and small-scale trade.The farm units are small family holdings with an average agricultural land area of less thanone hectare. Agriculture is mainly rain-fed. Similar to areas in the Horn of Africa,two rainy seasons characterize the Fedis district's climate: the first, named *Belg*, is theshortest one and takes place between March and May, while the second and most important,named *Meher*, is between July and October. The rainfall distribution during the year is thenbi-modal, with a dry spell period during the months of June and July, depending on its duration, may affect crop growth. The *Meher*(Main) season is the most important one; when the intensity of farm practices and production increase.

Sampling techniques and method of data collection

Both primarily and secondary data source were used for this study. The data required for this study were collected from sample respondents using a questionnaire. A one day tutorial was given to the enumerators about method of data collection and the contents of the questionnaire. Secondary data that could supplement the primary data were collected from published and unpublished documents obtained from Eastern Hararghe zone. Total rural *kebele* in selected districts were identified and arranged .The total rural *kebeles* that are found in the Fadis district were categorized. Total sample size for each *kebele* was categorized as cattle fattening adopter and non-adopter for each sampled *kebele* .To select sample respondents from selected kebeles, first the household heads in the sampled *kebeles* was identified and stratified in to two strata: cattle fattening adopter and non-adopter. Then the sample from each stratum was selected randomly using simple random sampling technique. Then the samples from each stratum were selected randomly using simple random sampling technique.

Since the number of household heads in the two groups was almost proportional, related number of sample was drawn from each group, i.e 70 participants and 54 non-participants were selected. Then total of 124 respondents were interviewed using questionnaire

Data analysis techniques

Based on the objectives of study, both descriptive statistics and econometric models were employed to analyze both qualitative and quantitative data. From econometric model, logit model was applied to analysis factor affecting small-holder fattening and propensity score matching method (PSM) was also used for impact analyze.

Descriptive Statistics

By applying descriptive statistics, one can compare and contrast different categories of sample units with respect to the desired characteristics. It is used to explain the different socio-economic, institutional and other characteristics of the sample households. These include mean, percentage, standard deviation and frequency for fattening adopter (treated group) and non-adopter (non-treated group) farmers. The statistical significance of the variables were tested for both dummy and continuous variables using chi-square and t-tests, respectively

Econometric analysis for factor affecting small-holder cattle fattening

The logit and probit are the two most commonly used models for assessing the effects of various factors that affect the probability of cattle fattening of a given practice. These models can also provide the predicted probability of cattle fattening practice. Both models usually yield similar results. However, the logit model is simpler in estimation than probit model (Aldrich and Nelson, 1984). Hence, the logit model was used in this study to analyze the determinant of small-holder cattle fattening. Following Liao (1994), Gujarati (2003) and Aldrich and Nelson (1984) the logistic distribution function for the practice of small scale cattle fattening:

$$P_i = \frac{\mathbf{1}}{\mathbf{1+e^{-Zi}}} = \frac{e^{Zi}}{1+e^{Zi}} \qquad (1)$$

Where, Pi = is the probability of practicing small-scale cattle fattening for the i^{th} farmer and it ranges from 0-1.

e^{zi} = stands for the irrational number e to the power of Zi.

Zi = a function of n-explanatory variables which is also expressed as:

$$Zi = B_0+B_1X_1+B_2X_2+\ldots+B_nX_n \qquad (2)$$

Where, X_1, X_2… X_n are explanatory variables.

B_0- is the intercept, B_1, B_2 … B_n are the logit parameters (slopes) of the equation in the model.

The slopes tell how the log-odds ratio in favor of practicing small-holder cattle fattening changes as an independent variable change. The unobservable stimulus index Zi assumes any values and is actually a linear function of factors influencing decision of small-holder cattle fattening. It is easy to verify that Zi ranges from $-\infty$ to ∞, Pi ranges between 0 and 1 and that Pi is non-linear related to the explanatory variables, thus satisfying two requirements:

- As Xi increases Pi increases but never steps outside the 0 and 1 interval; and
- The relationship between Pi and Xi is non-linear, i.e., one which approaches zero at slower and slower rates as Xi gets small and approaches one at slower and slower rate as Xi gets very large. But it seems that in satisfying these requirements, an estimation problem has been created because Pi is not only non-linear in Xi but also in the B's as well, as can be seen clearly below.

$$Pi = \frac{1}{1 + e^{-(B_0 + B_1X_1 + B_2X_2 + \ldots + B_n)}} \qquad (3)$$

This means the familiar OLS procedure cannot be used to estimate the parameters. But this problem is more apparent than real because this equation is intrinsically linear. If Pi is the probability of practicing a given small- holder cattle fattening then (1-Pi), the probability of not practicing, can be written as:

$$1-Pi = \frac{1}{1 + e^{Zi}} \qquad (4)$$

Therefore, the odds ratio can be written as:

$$\frac{Pi}{1-Pi} = \frac{1+e^{Zi}}{1+e^{-Zi}} = e^{Zi} \qquad (5)$$

Now $\frac{Pi}{1-Pi}$ is simply the odds ratio in favor of practicing small-holder cattle fattening. It is the ratio of the probability that the farmer would practise the cattle fattening to the probability that he/she would not adopt it. Finally, taking the natural log of equation 5, the log of odds ratio can be written as:

$$Li = \ln\left(\frac{Pi}{1-Pi}\right) = ln\left(e^{Bo+\sum_{i=1}^{n} BiXi}\right) = Zi = Bo + \sum_{i=1}^{n} BiXi \qquad (6)$$

Where, Li is log of the odds ratio in favor of small-holder cattle fattening practices, which is not only linear in Xi, but also linear in the parameters. Thus, if the stochastic disturbance term,(Ui),is introduced, the logit model becomes:

$$Zi=B_0+B_1X_1+B_2X_2+\ldots+B_nX_n+U_i \qquad (7)$$

This model can be estimated using the iterative maximum likelihood (ML) estimation procedure.

In reality, the significant explanatory variables do not have the same level of impact on the fattening decision of farmers. The relative effect of a given quantitative explanatory variable on the fattening decision is measured by examining practice elasticity, defined as the percentage change in probabilities that would result from a percentage change in the value of these variables. To calculate the elasticity, one needs to select a variable of interest, compute the associated Pi, vary the Xi of interest by some small amount and re-compute the Pi, and then measure the rate of change as $\frac{dX_i}{dP_i}$ where dXi and dPi stand for percentage changes in the continuous explanatory variable (Xi) and in the associated probability level (Pi), respectively.

When dXi is very small, this rate of change is simply the derivative of Pi with respect to Xi and is expressed as follows (Aldrich and Nelson, 1984):

$$\frac{dX_i}{dP_i} = \frac{e^{Zi}}{(1+e^{Zi})^{.2}} B_i = P_{i(1-P_i)B_i} \qquad (8)$$

Impact Evaluation Methods using Propensity Score Matching (PSM) Method

The first step in PSM method is to estimate the propensity scores. A logistic model is used to estimate propensity scores using a composite of pre-participation characteristics of the sampled households (Rosenbaum and Robin, 1983) and matching is then performed using propensity scores of each observation. To analyze the factor affecting small-holder cattle fattening practice, dependent variable is dichotomous in nature and represents the observed cattle fattening. It was represented in the model as treated group (CatFat) =1 for a household that practices cattle fattening and non-treated=0 for a household that do not practice cattle fattening. In this study a Variance Inflation Factors (VIF (X_i) technique was employed to detect the problem of multicollinearity for all explanatory variables as (Gujarati, 2003).

The impact of small-holder cattle fattening on household income generation and food security is the difference in households' mean calorie intake of the treated farmers and non-treated farmers of cattle fattening. Thus, the fundamental problem of such an impact evaluation is a missing data problem. Hence, this study applies a propensity score matching technique, which is a widely applied impact evaluation instrument in the absence of baseline survey data for impact evaluation. According to Caliendo and Kopeinig (2005), there are steps in implementing PSM. These are estimation of the propensity scores, choosing a matching algorism, checking on common support condition and testing the matching quality. Imposing a common support condition ensures that any combination of characteristics observed in the treatment group can also be observed among the control group (Bryson *et al*., 2002). The common support region is the area which contains the minimum and maximum propensity scores of treatment and control group households, respectively.

For any cattle fattening practicing household, there should be non-practicing household with closest propensity score as the match. To accomplish the match, the nearest neighbor (equal weights version) was tested. The nearest neighbor method simply identifies for each household the closest twin in the opposite fattening group. Caliper matching which means that an individual from the comparison (non-treated) group was also tested as a matching partner for a treated individual that lies within a given caliper (propensity score range) and is closest in terms of propensity score and kernel matching estimators was also tested. However, for this specific study kernel matching was used to evaluate impact of cattle fattening on households food security and income generation. This is matching method whereby all treated units are matched with a weighted average of all controls with weights which are inversely proportional to the distance between the propensity scores of treated and controls Becker and Ichino (2002) Venetoklis (2004).

It then computes an estimate of the cattle fattening effect as the average difference in households' outcome variable between each pair of matched households. The impact of cattle fattening for an individual *i*, noted δ_i, is defined as the difference between the potential outcome in case of cattle fattening and the potential outcome in absence of small-holder cattle fattening group using PSM.

$\delta_i = Y_{1i} - Y_{0i}$ (9)

In general, an evaluation seeks to estimate the mean impact of the cattle fattening practice is obtained by averaging the impact across all the individuals in the population. This parameter is known as Average Treatment Effector ATE:

$ATE = E(\delta) = E(Y_1 - Y_0)$ (10)

where $E(.)$ represents the average (or expected value). Another quantity of interest is the Average

Treatment Effect on the Treated or ATT, which measures the impact of the treatment on those individuals who participated:

$ATT = E(Y_1 - Y_0 \mid D = 1)$ (11)

Finally, the Average Treatment Effect on the Untreated(ATU) measures the impact that the treatment would have had on those who did not participate in cattle fattening practice:

$ATU = E(Y_1 - Y_0 \mid D = 0)$ (12)

The problem is that, all of these parameters are not observable, since they depend on counterfactual outcomes. For instance, using the fact that the average of a difference is the difference of the averages, the ATT can be rewritten as:

$ATT = E(Y_1 \mid D = 1) - E(Y_0 \mid D = 1)$ (13)

The second term,$E(Y_0 \mid D = 1)$ is the average outcome that the treated individuals would have obtained in absence of treatment, which is not observed. However, we do observe the term $E(Y_0 \mid D = 0)$ that is, the value of $Y_0$for the untreated individuals.

$\text{ATT} = E(Y_1 \mid D = 1) - E(Y_0 \mid D = 0)$ (14)

Results and Discussion

Households' Demographic and Socio-economic Characteristics

In the study area the average age of all sample respondents was 39.14. On average participant household head have age of 37.3years while that of non-participants of cattle fattening have age of 41.48 years. There is a significant difference in their age years. The survey results showed that mean difference between participants' households in cattle fattening and non-participants were found to be significant at 5 percent significant level based on household head age in years (Table 1). Similarly, the average year of formal schooling of participant is around grade 3 while that of non-participant in cattle fattening is around grade 2.The mean difference of the two groups is statistically significant at 5 percent of probability level. It shows that, on average participant household have more year of formal schooling as compared to that of non-participants in cattle fattening practice.

Table 1. Socioeconomic characteristics of sample households

All Variables	All sample HH(N= 124)		Participants HH(N=70)		Non-participants HH(N=54)		Mean Difference	
	Mean	SD	Mean	SD	Mean	SD	Mean	T-Value
Age of HH	39.14	10.371	37.33	10.615	41.48	9.644	4.15	2.246**
Education of HH	2.21	2.257	2.61	2.561	1.69	1.669	-0.93	2.312**
Market distance	6.97	2.590	6.99	2.629	6.94	2.564	-0.04	0.08
Family Size	5.75	0.195	5.94	2.126	5.50	2.230	-0.44	1.13
labor force	3.19	1.389	3.50	1.432	2.80	1.234	-0.70	2.88***
Farm size in ha	1.03	0.614	1.13	0.631	0.91	0.571	-0.23	2.06**
Qty Produced	8.74	5.892	8.90	6.510	8.53	5.031	-0.37	0.35
Livestock(TLU)	1.89	1.256	2.17	1.217	1.53	1.222	-0.64	2.92***
FodSHrtgMnth	5.15	1.482	5.03	1.372	5.31	1.612	0.29	1.07

Source: Own survey result,

Farm size refers to the total area of farmland that a farm owned in hectares. In agriculture, land is one of the major factors of production. The average cultivated land of all sample respondents was 1ha. On average participant household have 1 ha while non-participants have 0.91ha. There is a significant difference in their cultivated land size. The survey results showed that mean difference between participant and non-participant in cattle fattening was found to be significant at 5% significant level based on cultivated land.

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 participant household have 2.17 while that of non-participant in cattle fattening is 1.52 in TLU. Participant households have larger livestock compared to non-participant households. The survey result revealed that, the mean difference between participant household in cattle fattening and non-participant household was significant at 1% level of significance based livestock holding in tropical livestock unit. Similarly, cattle fattening participants have more number of labor force compared to non-participants. The average number of labor force of participants was 3 persons and that of non-participant is 2 persons. The result showed that, the mean difference between numbers of labor forces of participants and nun-participants were also found to be significant at 1% significance level.

Sample respondents that do not accessed market information in the area is account for about 72.7 percent of the total non-participant of the cattle fattening respondents; while other group of the respondents that dot accessed market information is accounts for 26.3 percent of participants in cattle fattening in the area table 4. Similarly, it showed that, sample respondents that accessed market information from development agent account for about 69.2 percent of the non-participant and 30.8 percent of participants. Other group of non- participant that obtain market information by observing other market participant in the market are account for 33.3 percent while that of participant in cattle marketing account for 66.7 percent. Brokers and local farmers themselves also service as source of market information for other farmers in the study area. It was revealed that, comparison of the two groups depicted that a higher proportion of respondents that access market information are participants of cattle fattening practice than that of not-participant of the fattening. This difference is found to be statistically significant and the association between access to market information for agricultural product and participation characteristics of the sample respondents was found to be significant at 1 percent probability level for cross tabulation chi-square test.

Table 2. Source of market information for agricultural product in the study area

Source of info.		Household categories on fattening		
		Non-participant	Participant	Total
Non	Count	28	10	38
	% within source of information	73.70	26.30	100.00
DA	Count	9	4	13
	% within source of information	69.20	30.80	100.00
Market	Count	10	20	30
	% within source of information	33.30	66.70	100.00
Broker	Count	2	28	30
	% within source of information	6.70	93.30	100.00
Other	Count	1	2	3
	% within source of information	33.30	66.70	100.00
local farmers	Count	4	6	10
	% within source of information	40.00	60.00	100.00
Total	Count	54	70	124
	% within source of information	43.50	56.50	100.00
	$Chi^2 = 35.58$, p-value = 0.00, DF=5			

Source: Own survey results

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 3 above revealed that, out of total non-participant of cattle fattening practice, sample respondents that use chat as main source of income account for 66.7 percent while other group account for 25.9 percent, 1.9 percent, 1.9 percent and 3.7 percent from groundnut production, chat trading, livestock trading and other source of income generating activity, respectively. On the other hand, out of total participant of cattle fattening practice, participant respondents that use chat as main source of income account for 40 percent while other group account for 21.4 percent, 2.9 percent, 1.4 percent, 27.1 percent and 7.1 percent from groundnut production, chat trading, livestock trading, cattle fattening and other source of income generating activity, respectively. It was revealed that, comparison of the two groups depicted that a higher proportion of respondents that use non-cattle fattening as main source income are non-participants of cattle fattening practice than that of participant of the fattening. 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 participation characteristics of the sample respondents was found to be statistically significant at 1 percent probability level.

Table 3. Main source of household income in the study area

		Household categories on fattening		
		Non-participant	Participant	Total
Chat/coffee production	Count	36	28	70
	% within HH categories on fattening	66.7	40	51.6
Groundnut production	Count	14	15	29
	% within HH categories on fattening	25.9	21.4	23.4
Chat trading	Count	1	2	3
	% within HH categories on fattening	1.9	2.9	2.4
Livestock trading	Count	1	1	2
	% within HH categories on fattening	1.9	1.4	1.6

Cattle fattening	Count	0	19	19
	% within HH categories on fattening	0.0	27.1	15.3
Other	Count	2	5	7
	% within HH categories on fattening	3.7	7.1	5.6
Total	Count	54	70	124
	% within HH categories on fattening	100	100	100
	% of Total	43.5	56.5	100
	Chi^2 = 19.92, p-value = 0.001, DF=5			

Source: Own survey results

In the study area of Hararghe zone, farmers are facing different agricultural production constraints that challenging them in one or other ways. The descriptive result presented in table 4 above revealed that, out of total non-participant of cattle fattening practice, sample respondents that replied oxen shortage as main production constraints account for 16.7 percent while other group account for 11.1 percent, 55.6 percent, 7.4 percent and 3.7 percent as labor shortage, disease, drought, weed and shortage of farm land as main constraints of agricultural production, respectively. On the other hand, out of total participant of cattle fattening practice, sample respondents that replied oxen shortage as main production constraints account for 15.7 percent while other group account for 19 percent, 7.1 percent, 54.3 percent, 8.6 percent and 4.3 percent as labor shortage, disease, drought, weed and lack of pesticide and herbicide 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-participants of cattle fattening practice and that of participant of the cattle fattening 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 participation characteristics of the sample respondents was found to be insignificant by probability level. This implies that, sample respondents are facing similar agricultural production constraints even if the level of challenge differs between both groups.

Table 4. Agricultural Production constraints for sampled respondents in the area

Production Constraints		Household categories on fattening		
		Non-participant	Participant	Total
Oxen shortage	% within HH categories on fattening	16.7	15.7	16.1
	% of Total	7.3	8.9	16.1
Labor shortage	% within HH categories on fattening	5.6	10.0	8.1
	% of Total	2.4	5.6	8.1
Disease	% within HH categories on fattening	11.1	7.1	8.9
	% of Total	4.8	4.0	8.9
Drought	% within HH categories on fattening	55.6	54.3	54.8
	% of Total	24.2	30.6	54.8
Weeds	% within HH categories on fattening	7.4	8.6	8.1
	% of Total	3.2	4.8	8.1
Lack of pest & herb side	% within HH categories on fattening	0.0	4.3	2.4
	% of Total	0.0	2.4	2.4
Shortage of Land	% within HH categories on fattening	3.7	0.0	1.6
	% of Total	1.6	0.0	1.6
Total	Count	54	70	124
	% within HH categories on fattening	100	100	100
	Chi^2 = 6.27, p value = 0.39, DF=6			

Source: Own survey results

Participation in cattle fattening in the study area

What they feed and cattle management for fattening. Regarding why farmers select cattle fattening, respondents replied that 71.4 %of cattle fattening participants replied that they select fattening due to its higher profit while 25.7 % of participant has chosen for its short term income generation. Similarly, around 2.8 % of the participant farmers have selected cattle fattening for its simplicity of management. On the other hand, participant farmers were using different source of cattle fattening information. Around 51.4 % of participants were replied that, they obtain mostly cattle fattening information from other farmers as source of information while 34.3 % were used neighbor as source of fattening information. Other farmers replied as they used woreda information while 12.9 % of the participants replied as they used extension workers information as main source.

Table 5. Description of fattening experience and average fattening month

Variable	Obs	Mean	Std. Dev.	Min	Max
Fattening Experience	70	6.37	2.54337	1	14
Average fattening month	70	3.51	1.05971	2	7

Source: Own survey results

In the study area, the average cattle fattening experience of participant farmer was found to be around 6 years which ranges from 1 year to 14 years. Similarly, the average cattle fattening duration of participant farmer was found to be around 3.5months which ranges from 2 months to 7months.

Table 6. Market constraints for cattle fattening participants in the study area

Market constraints	Freq.	Percent	Cum.
Lack of good market	7	10	10
Low price for Cattle	36	51.43	61.43
Lack of Market Information	11	15.71	77.14
Broker problem	16	22.86	100
Total	70	100	

Source: Own survey results

The descriptive result presented in table 6 above revealed that, out of total participant of cattle fattening practice, sample respondents that replied lack of good market as main cattle fattening constraints account for 10 percent while other group account for 51.43 percent, 15.71 percent and 22.86 percent as low price for cattle, lack of market information and broker problem as main constraints of cattle fattening in the study area, respectively.

Table 7. When cattle fattening participants sell their cattle

Time of cattle sale	Freq.	Percent	Cum.
At fixed month	10	14.29	14.29
When fatten observed	12	17.14	31.43
Depend on price rise	44	62.86	94.29
As soon as money required	4	5.71	100
Total	70	100	

Source: Own survey results

Regarding when participants sell their cattle, participant sells their cattle at different time for various reasons. The descriptive result presented in table 7 above revealed that, out of total participant of cattle fattening practice, sample respondents that replied as they sell their cattle at fixed month account for 14.29 percent while other group account for 17.14 percent, 62.86 percent and 5.71 percent that sell when fatten observed, depend on price rise and sell as soon as money required, respectively for time of selling cattle in the study area.

Results of Econometric Analysis for Factor Affecting Small-holder Cattle Fattening

Before proceeding to analysis factor affecting small-holder cattle fattening, Variance Inflation Factor (VIF) was applied to test for the presence of strong multicollinearity problem among the explanatory variables.

Table 8. Logistic regression results for factor affecting participation in cattle fattening

Variable	Coef.	Odds Ratio	Std. Err	Z
Age of HH	-0.068	0.93	0.025	-2.7***
Sex of HH	-0.094	0.91	0.626	-0.15
Education of HH	0.125	1.13	0.122	1.03
Mrket Distance	-0.026	0.97	0.092	-0.28
Family Size	-0.076	0.93	0.142	-0.53
Labor Force	0.731	2.08	0.255	2.87***
Farm Size	0.410	1.51	0.416	0.99
Livestock(TLU)	0.395	1.48	0.206	1.92*
Market Information	1.537	4.65	0.533	2.89***
Access Extension	1.089	2.97	0.509	2.14**
Qtty Produced	0.002	1.00	0.042	0.04
Fod Short Month	-0.058	0.94	0.159	-0.37
_cons	-1.593		1.712	-0.93
Number of obser	= 124		LR $Ch^2(12)$	= 49.35
Pseudo-R^2	= 0.291		Prob> Ch^2	= 000
Log likelihood	= -60.2398			

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

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= 0.346) using STATA 11. The pseudo- R^2 indicates how well the repressors explain the participation probability. After matching there should be no systematic differences in the distribution of covariates between both groups and therefore, the pseudo- R^2 should be fairly low (Caliendo and Kopeinig, 2005).

It was found that participation in cattle fattening was significantly influenced by five explanatory variables. Age of household head, labor force in family member, size of livestock in tropical livestock unit, market information and access to agricultural extension service are significant variables which affect the participation of the household in cattle fattening practice. Age of household head shows negative relation with participation in small scale cattle fattening practice. This implies that an increase in age of household head tends to decrease participation in cattle fattening practice. This is possible because older farmers have not capable to manage cattle for fattening and resist to expenses for cattle. They lack use of best practice and better planning than the younger ones. As the age of household head increase the probability of household participation in cattle fattening practice decreases. The interpretation of the odds ratio also implies that if other factors are held constant, the odds ratio in favor of participation in cattle fattening practice decrease by a factor of 0.93 as age of household head increase by one year (Table 8).

In Ethiopia, as in most of other developing countries, labor is one of the most extensively used inputs of agricultural production. These are household member found between age of 15 and 64 .Furthermore, family is the major and sole source of agricultural labor. Households with large number of economically active members have more number of agricultural labors and hence, have more agricultural production and more income provided that there is sufficient land to employ the existing labor. Cattle fattening require large number of labor force in rural area. Households that have larger number of working group members were more likely to be included in small-scale cattle fattening practice in the study area. As it is reveled from estimation of the logit regression analysis indicate that, participation in cattle fattening has a positive and statistically significant association with use of higher labor, most likely due to the higher level of labor requirement during management and feeding activities involved cattle fattening. The interpretation of the odds ratio also implies that if other factors are held constant, the odds ratio in favor of participating in cattle fattening increases by factor of 2.08 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 small scale-cattle fattening. This variable was found to influence participation of household in cattle fattening 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 feed, medicine and other management that can be used to reduce the duration cattle fattening. Farmers who have large number of livestock might consider their asset base as a mechanism of insuring any risk associated with cattle fattening practice. Given this potential contribution of livestock to sustainable household farm input supply and cash generation, they encourage adoption of best practice in cattle fattening. The odds ratio of 1.48 implies that, other things kept constant, the odds ratio in favor of participation in cattle fattening increases by a factor of 1.48 for each increase in livestock in TLU (Table 8).This implies that livestock holding has an influence on the adoption of best fattening practice in different areas.

Market information is a dummy variable taking 1 if the respondents had access to market information and zero otherwise. It is hypothesized that updated market information is positively related to participation in cattle fatteningpractice (Table 8).Access to market information was found to influence participation of household in cattle fattening positively and significantly at 1 percent probability level. Keeping other things constant, the odds ratio in favor of participation in cattle fattening increases by a factor of 4.65 as a household has access to market information service in the study area.

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 income generation activity. Agricultural extension services are expected to enhance households’ skills and knowledge, link households with technology and markets (Lerman, 2004). Access to extension services on cattle fattening such as feeding system, cattle management and other best practice in cattle fattening received by households positively and significantly affected participation in cattle fattening at less than 5 percent probability level. Holding other things constant, the odds ratio in favor of participation in cattle fattening increases by a factor of 2.97 as a household has access to extension service.

Impact Estimation

Results of propensity scores matching

The logistic regression model was used to estimate propensity score matching for participant and non-participants households in cattle fattening. The dependent variable in this model is a binary variable indicating whether the household was a participant in cattle fattening or not. The model was estimated with STATA 11.2 computing software using the propensity scores matching algorithm developed by Leuven and Sianesi (2003). Results presented inTable 8 aboveshows the estimated model appears to perform well for the intended matching exercise. The pseudo-R^2 value is 0.291. A low pseudo-R^2 value shows that participant households do not have much distinct characteristics overall and as such finding a good match between participants and non-treated households becomes simple.

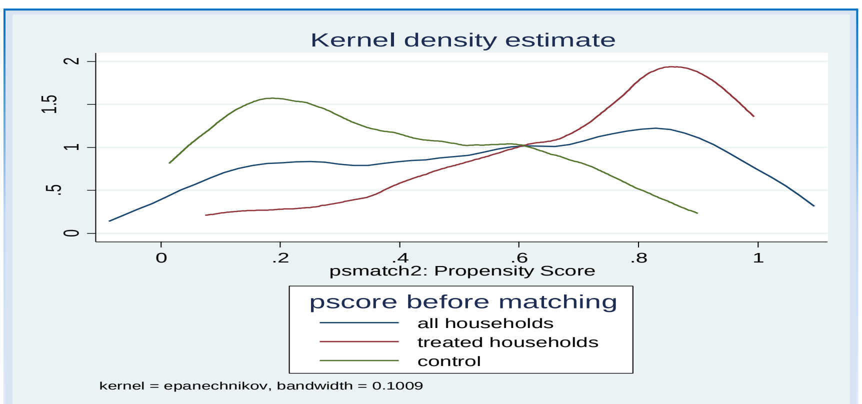

Figure 1. Kernel density of propensity score distribution

Figure 1 portrays the distribution of the household with respect to the estimated propensity scores .In case of participant households, most of them are found in the right starting from the middle of the distributed propensity. On the other hand, most of the control or non-participants of cattle fattening households are partly found in the center and with the most part of distribution found in the left side.

Matching participant and non-participant households

Three main tasks were accomplished before matching. First, predicted values of treatment participation (propensity scores) estimated for all participated households and non-participants. Second, a common support condition was imposed on the propensity score distributions of participant household in cattle fattening and non-participant household. Third, discard observations whose predicted propensity scores fall outside the range of the common support region.

Imposing a common support condition ensures that any combination of characteristics observed in the participant group can also be observed among the non-participant group (Bryson *et al*., 2002). The common support region is the area which contains the minimum and maximum propensity scores of participants or treated and control households, respectively. It requires deleting of all observations whose propensity scores is smaller than the minimum and larger than the maximum of participant and non-participant group, respectively (Caliendo and Kopeinig, 2005). For this study, the common support region would lie between0.0741972 and 0.8992712. In other words, households whose estimated propensity score is less than 0.0741972 and larger than 0.8992712 are not considered for the matching exercise. As a result of this restriction, 22 households (19 participant and 3 non-participant households) were discarded.

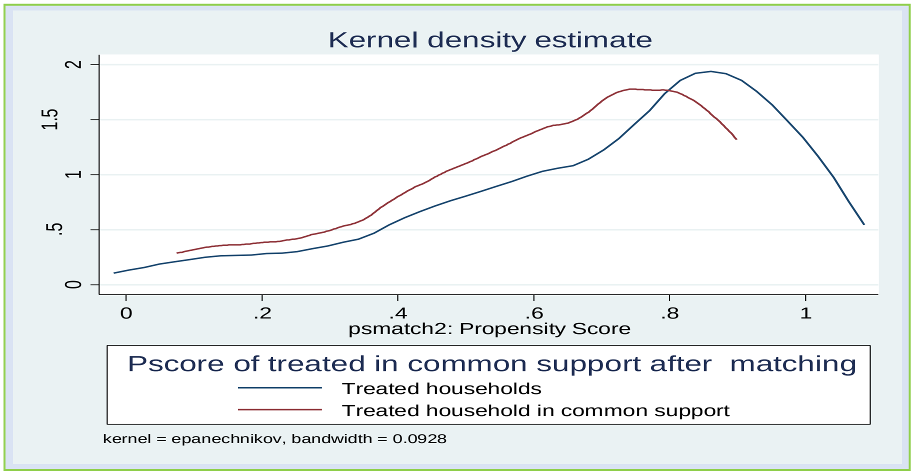

Figure 2. Kernel density of propensity scores of participant households

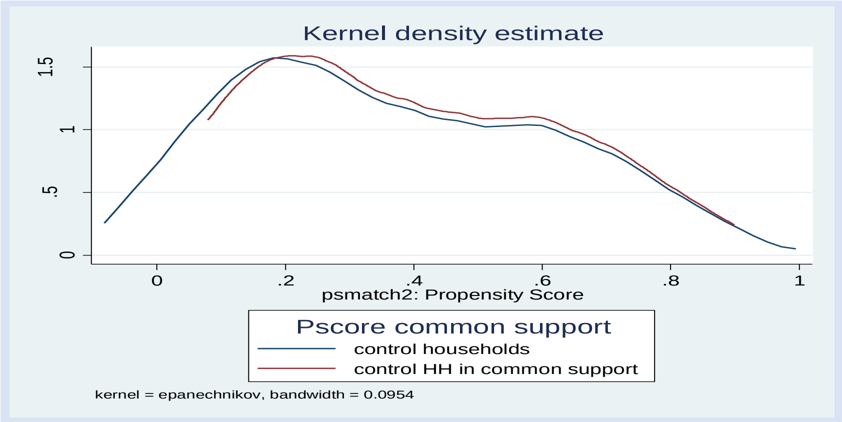

Figure 3. Kernel density of propensity scores of non-participant households

Choice of matching algorithms

Balancing test is a test conducted to know whether there is statistically significant difference in mean value of the two groups of the respondents and preferred when there is no significant difference after matched.

Table 9. Performance measures of matching estimators

Matching Estimator	Performance Criteria		
	Balancing test*	Pseudo-R^2	Matched sample size
Nearest Neighbor			
1 neighbor	7	0.143	102
2 neighbor	8	0.068	102
3 neighbor	10	0.047	102
4 neighbor	11	0.044	102
Caliper			
0.01	9	0.118	68
0.1	7	0.143	102
0.25	8	0.143	102
0.5	8	0.143	102
Kernel Matching			
With no band width	11	0.044	102
Band width of 0.1	11	0.036	102
Band width of 0.25	11	0.021	102
Band width of 0.5	11	0.050	102

Source: Own survey results

** Number of explanatory variables with no statistically significant mean differences between the matched groups of participants and non-participants households.*

Accordingly, matching estimators were evaluated via matching the participant and non-participant households in common support region. Therefore, a matching estimator having balanced or insignificant mean differences in all explanatory variables, bears a low pseudo- R^2 value and also the one that results in large matched sample size is preferred for matching exercise. In line with the above indicators of matching quality, kernel matching with 0.25 band width is resulted in relatively low pseudo-R^2 with best balancing test (all explanatory variables insignificant) and large matched sample size as compared to other alternative matching estimators indicated in Table 9. Then it was selected as a best fit matching estimator.

Testing the balance of propensity score and covariates

After choosing the best performing matching algorithm the next step is to check the balancing of propensity score and covariate using different procedures by applying the selected matching algorithm(in our case kernel matching). As indicated earlier, the main purpose of the propensity score estimation is not to obtain a precise prediction of selection into treatment or to participation, but rather to balance the distributions of relevant variables in both groups. The mean standardized bias before and after matching are shown in the fifth columns of Table 10, while column six reports the total bias reduction obtained by the matching procedure. In the present matching models, the standardized difference in covariate before matching is in the range of 1.6% and 82% in absolute value. After matching, the remaining standardized difference of covariate for almost all covariates lies between 1.4% and 13.5% which is below the critical level of 20% suggested by Rosenbaum and Rubin (1985). In all cases, it is evident that sample differences in the unmatched data significantly exceed those in the samples of matched cases. The process of matching thus creates a high degree of covariate balance between the participant and non-participant samples that are ready to use in the estimation procedure.

Table 10. Balancing test for covariate

Variables	Samples	Mean			% reduce	t-test	
		Treated	Control	%bias	/bias/	t	p >/t/
_pscore	Unmatched	0.7157	0.36854	145.7		8.03	0
	Matched	0.6302	0.58629	18.4	87.4	1.02	0.311
Age of HH	Unmatched	37.329	41.481	-40.9		-2.25	0.026
	Matched	38.137	37.992	1.4	96.5	0.07	0.943
Sex of HH	Unmatched	0.85714	0.77778	20.5		1.14	0.255
	Matched	0.82353	0.84865	-6.5	68.3	-0.34	0.735
Eductn of HH	Unmatched	2.6143	1.6852	43		2.31	0.022
	Matched	2.3333	2.4946	-7.5	82.6	-0.37	0.713
MrketDistnce	Unmatched	6.9857	6.9444	1.6		0.09	0.93
	Matched	7.0588	7.1971	-5.3	-235.2	-0.24	0.808
Farm Size	Unmatched	1.131	0.90509	37.5		2.06	0.042
	Matched	1.0602	0.99154	11.4	69.6	0.57	0.573
Livestock(TLU)	Unmatched	2.1708	1.5263	52.9		2.92	0.004
	Matched	1.9693	1.9121	4.7	91.1	0.24	0.811
MrketInformtn	Unmatched	0.85714	0.5	82		4.64	0
	Matched	0.80392	0.76536	8.9	89.2	0.47	0.64
Access Extentn	Unmatched	0.8	0.59259	45.9		2.57	0.011
	Matched	0.7451	0.68391	13.5	70.5	0.68	0.499
FodShrtgMonth	Unmatched	5.0286	5.3148	-19.1		-1.07	0.288
	Matched	5.0784	4.9978	5.4	71.8	0.27	0.79
Family Size	Unmatched	5.9429	5.5	20.3		1.13	0.262
	Matched	5.8039	5.6709	6.1	70	0.31	0.76
Labor Force	Unmatched	3.5	2.7963	52.6		2.88	0.005
	Matched	3.0392	2.8991	10.5	80.1	0.61	0.5

Source: Own estimated survey results

Similarly, t-values in tables 10 shows that, before matching more than half of the chosen variables exhibited statistically significant differences while after matching all of the covariates were balanced and become statistically insignificant.

Table 11. Chi-square test for the joint significance of variables

Sample	Pseudo-R^2	LR chi^2	p>chi^2
Unmatched	0.291	49.48	0
Matched	0.021	2.94	0.996

Source: Own survey results

The low pseudo-R^2 and the insignificant likelihood ratio tests support the hypothesis that both groups have the same distribution in covariates after matching (see Table 11). These results clearly show that the matching procedure is able to balance the characteristics in the participant and the matched non-participant groups. We, therefore, used these results to evaluate the impact of cattle fattening on outcome variables among groups of households having similar observed characteristics. This allows comparing observed outcomes for participants with those of comparison groups sharing a common support.

Sianesi (2004), suggests re-estimating the propensity score on the matched sample, i.e. only on participants and matched non-participants, then comparing the pseudo-R^2 before and after matching is important. The pseudo-R^2 indicates how well the regressors explain the participation probability. After matching there should be no systematic differences in the distribution of covariates between both groups and therefore the pseudo-R^2 should be fairly low. The low pseudo-R^2 (compared with other pseudo-R^2 resulted using different matching estimators) and the insignificant likelihood ratio tests (indicated by the higher p-value after matching) support the hypothesis that both groups have the same distribution in covariates after matching. All of the above tests suggest that the matching algorithms that have chosen were relatively best with the data we have at hand. Thus, we can proceed to estimate ATT for households.

Estimating treatment effect on treated (ATT)

Food security at the household level is measured by direct survey of income, expenditure and consumption and comparing it with the minimum subsistence requirement. In this regard, income and expenses are used to compute the status of food security. The minimum level of income, which is required per adult equivalent, was calculated on the basis of amount of food required by an adult person. The government of Ethiopia has set the minimum acceptable weighted average food requirement per person per day at 2100 kilo calorie. In order to solve the second objective, the following impact indicators of the treatment effect have been performed using propensity score matching model. In this section, the PSM results provides evidence as to whether or not the cattle fattening practice has brought significant changes on households' food security and farm income of households in Ethiopian Birr. The estimation result presented in Table 12 provides a supportive evidence of statistically significant effect of the cattle on household food security measured in calorie intake and household Farm in ETB.

Table 12. Average treatment effect on treated(ATT)

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
TotalFrmIncm	Unmatched	34257.86	17110.74	17147.12	2449.16	7.0
	ATT	32615.69	18544.67	14071.01	2702.58	5.2***
KiloCaloris	Unmatched	3259.43	2116.26	1143.17	244.31	4.7
	ATT	3072.21	2094.42	977.80	267.91	3.7***

Source: Own survey results

After controlling for pre-participation differences in demographic, location and asset endowment characteristics of the participants in cattle fattening and non-participants in cattle fattening households it has been found that, on average, the participant households' have increased physical food consumption by 977.80 Kilocalories. Similarly, the cattle fattening practice has increased income of participating households by 14071 ETB than that of non-participant households in cattle fattening.

Sensitivity analysis

Rosenbaum (2002) proposes using Rosenbaum bounding approach in order to check the sensitivity of the estimated ATT. The basic question to be answered here is whether inference about treatment effects may be altered by unobserved factors. In order to control for unobservable biases Table 13 below shows the result of sensitivity of cattle fattening impacts on different outcome variables.

Table 13 presents the critical level of e^{γ} (first row), at which the causal inference of significant cattle fattening impact has to be questioned. Rosenbaum bounds were calculated for cattle fattening impacts that are positive and significantly different from zero. The first column of the Table shows those outcome variables which bears statistical difference between participant and non-participant households in this impact estimate. The values which correspond to each row of the significant outcome variables are p-critical values (or the upper bound of Wilcoxon signify. level -Sig+) at different critical value of e^{γ}.

Table 13. Result of sensitivity analysis using Rosenbaum bounding approach

No	Outcomes	e^{γ}=1	e^{γ}=1.25	e^{γ}=1.5	e^{γ}=1.75	e^{γ}=2	e^{γ}=2.25	e^{γ}=2.5	e^{γ}=2.75	e^{γ}=3
1	KiloCaloris	0.0	0.0	0.0	0.0	0.0	1.1e-16	4.4e-15	7.1e-14	7.2e-13
2	TotalFrmIncm	0.0	0.0	0.0	0.0	1.1e-15	5.9e-14	1.4e-12	2.0e-11	1.8e-10

* e^{γ} (gamma) -log odds of differential assignment due to unobserved factors where Wilcoxon significance level for each significant outcome variable is calculated

Results show that the inference for the effect of the fattening is not changing though the participants and non-participant households has been allowed to differ in their odds of being treated up to (e^{γ} = 3**)** in terms of unobserved covariates**.** That means for all outcome variables estimated, at various level of critical value of e^{γ}, the p- critical values are significant which further indicate that we have considered important covariates that affected both participation and outcome variables. We couldn't get the critical value e^{γ} where the estimated ATT is questioned even if we have set largely up to 3, which is larger value compared to the value set in different literatures which is usually 2 (100%).Thus, we can conclude that our impact estimates (ATT) are insensitive to unobserved selection bias and are a pure effect of cattle fattening in the study area.

Conclusion and Recommendations

Given the expansion of improved cattle fattening and marketing systems, it is very important to identify the existing cattle fattening practices and marketing systems in the study area. This study was undertaken with the objectives of analyzing factors affecting participation in cattle fattening and its impacts on household income generation and food security in Fadis District of Eastern Hararghe Zone. Both primary and secondary data were collected for the study. The data were collected by means of a semi-structured questionnaire from 124 sample respondents during the period of April 20-May 20/2017.

This study applies a propensity score matching technique, which is a widely applied impact evaluation instrument in the absence of baseline survey data for impact evaluation. Answering this question requires observing outcomes of participant after and before participation for the household. Besides PSM, logistic model was used to analyze the factors affecting participation in cattle fattening in the study area. The study implemented binary logit regression model to analysis factors affecting participation in cattle fattening. Binary logit regression estimation also revealed that participation in cattle fattening practice is significantly influenced by five explanatory variables. Age of household head, labor force in family member, number of livestock in tropical livestock unit, market information and access to agricultural extension service are significant variables which affect the participation of the household in cattle fattening practice.

Propensity score matching method was applied to analyze the impact of the cattle fattening on the household food security and farm income. In matching processes, kernel matching with 0.25 band width is resulted in relatively low pseudo-R^2 with best balancing test was found to be the best matching algorithm. This method was checked for covariate balancing with a standardized bias, t-test, and joint significance level tests. Propensity score matching method results also revealed that household participated in cattle fattening practice have got 977.80 Kilocalories per adult equivalent per day (AE/day) of food and 14071 Ethiopian Birr (ETB) more farm income than those household that were not participated in cattle fattening practice. The average treatment effect on treated was found to be significant at less than 1% of significant level. The impact estimation results then indicate that there are significant differences in participants in cattle fattening and comparison households, which could be attributable to the participation in cattle fattening. The effect of the cattle fattening on total household calorie intake and farm income was higher for the participant households, which are statistically significant.

The number of economically active members in the family was found to be positive and significant at 1% significant level with participation in cattle fattening practice. In the farm community cattle fattening activity requires adequate number of labor force in rural area. The results of logit models shows a positive and statistically significant relationship between cattle fattening and use of higher labor, most likely due to the higher level of labor requirement during cattle fattening management activities involved.

Household those have larger number of livestock in tropical livestock unit and numbers of oxen were more likely to be participated in cattle fattening. The implication of the result was that livestock are an important source of cash in rural areas to allow purchase all feed that required for cattle fattening and reducing fattening duration. Farmers who have large number of livestock might consider their asset base as a mechanism of controlling any risk associated with cattle fattening and managing. Given this potential contribution of livestock and oxen to cattle fattening, it encourages food security and household income generation. Therefore, it is concluded that cattle fattening should be facilitated by government and non-government organizations. That means development partner should focus on strengthening capacity of household through providing credit facility in the direction of asset building like livestock purchase thought revolve funding system.

It is expected that Farm extension service widens household knowledge with regard to use of improved agricultural technology. Agricultural extension services are expected to enhance households' skills and knowledge, link households with technology and markets. Access to extension services such as information, training, field days, field visits and field tours received by households positively and significantly affected participation in cattle fattening. This implies farmers that have access to extension service may analysis cattle price information and sell their cattle at appropriate market price.

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Value Chain Analysis of Vegetables: The Case of Ejere District, West Shoa Zone, Oromia National Regional State of Ethiopia

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Abstract

This research attempted to analyze value chain of vegetables in Ejere district, Oromia Region of Ethiopia focusing on potato and onion crops. Potato and onion plays a significant role in increasing food security and income for the poor farmers of Ethiopia. Data for the study were collected from both primary and secondary sources. The primary data were generated by household survey using a pre-tested structured questionnaire and key informant interview using checklists. The data were collected from 120 farmers, 30 traders and 35 consumers and analyzed using STATA software. Vegetables value chain actors identified in the study include input suppliers, producers, rural collectors, brokers, retailers, wholesalers, processors and consumers. The chain is governed mainly by wholesalers with the assistance of brokers. Producers are price takers and hardly negotiate the price due to fear of post-harvest loss, in case the product is not sold. Five and six market channels were identified for potato and onion, respectively. The highest total gross margins are 53.78% in channel II for potato and 32.55% in channel II for onion. The highest gross marketing margin of producers in potato and onion markets channels are 65.76% and 72.84% in channel III and V, respectively. The two-stage least square regression model results showed that five variables such as productivity of potato, sex of household head, distance to nearest market, off/non-farm income and area of land allocated for potato significantly affect the volume of potato supplied to the market while four variables such as productivity of onion, education level, farming experience and land allocated for onion significantly affect the volume of onion supplied to the market. The multivariate probit model results indicated that quantity of potato sold, education level, sex of households head, family size, farming experience, distance to nearest market, off/non-farm income, trust in traders, ownership of motor pump, selling price of potato and area of land allocated for potato significantly influence potato producers choosing of market outlets for their produce while quantity of onion sold, extension contact, farming experience, distance to nearest market, non/off-farm income, selling price of onion, trust in traders, ownership of motor pump and land size allocated for onion were among determinants which affect significantly onion producers choice of alternative market outlets. Policy implications drawn from the study findings include the need to improve the input supply system,, improving farmers' knowledge and experience on vegetable production, encouraging adult education through extension service, improving productivity and volume sales of vegetables, strengthening the *linkage/interaction among vegetables value chain actors, expanding accessibility of market infrastructure and strengthening supportive institutions.*

Key words: *Value chain analysis; Vegetables; Potato; Onion; Marketing margin; Two-stage least square regressions; Multivariate probit; Ejere.*

Introduction

Agriculture is central to Africa's agenda, and efforts have made to link production with agribusiness for better growth in the sector. Now days, it earns an average of 24 per cent of its annual growth from its farmers and their crops value chains reveal common and well-known constraints, such as poor infrastructure; fragmented and risky markets; poorly functioning input markets; difficulties accessing land, water, and finance; and inadequate skills and technology. More revealing, however, is the big differences across value chains (World Bank, 2013).

Ethiopia has a comparative advantage in a number of horticultural commodities due to its favorable climate, proximity to European and Middle Eastern markets and cheap labour. However, the production of horticultural crops is much less developed than the production of food grains in the country. On average more than 2,399,566 tons of vegetables and fruits are produced by public and private commercial farms. This is estimated to be less than 2 percent of the total crop production. The total land area cultivated under fruits and vegetables is about 12,576 hectares in 2011. Of the total land area under cultivation in the country during the same year, the area under fruits and vegetables is less than one per cent (i.e. 0.11%), which is insignificant as compared to food crops (EIA, 2012).

The development of horticulture in general and vegetable production and marketing in Ethiopia in particular is constrained by a number of factors: Policy implementation gap, inadequate vegetable seed regulatory frameworks, inadequate quality control and certification mechanisms, limited public institutional capacity and capability supporting efficient and regular vegetable seed supply, inefficient seed importation and distribution system, high post-harvest losses, high incidence of diseases and insect pests, poor vegetable marketing and value chain development and weak linkage and integration among stakeholders (Bezabih *et al*., 2014).

According to Bezabih (2010), the major horticulture production constraints include lack of improved varieties and relying on own seed, high fertilizer cost and food prices and high price of fuel for pumping water for irrigation. Institutional factors in terms of provision of inputs and extension services and poor infrastructure are also limiting. The major constraints of marketing include lack of markets to absorb production, low price for the products, large number of middlemen in the marketing system, lack of marketing institutions safeguarding farmers' interest and rights over their marketable produces (e.g. cooperatives), lack of coordination among producers to increase their bargaining power, poor product handling and packaging, imperfect pricing system, and lack of transparency in market information system mainly in the export market.

According to Kumilachew *et al*. (2014) risks in vegetable production from the perspective of smallholder farmers' results suggest that production and price risks were generally perceived as the most important sources of risks. Of all the risk sources, output price fluctuation, drought, pests/diseases, termites/insect attack, high costs of inputs, flood/high rainfall, illness/injury/death of operator/member, changes in family relations, theft, conflict and violence, changes in policy and rules, and high cost of credit were of important concerns in that order of importance. Market risks may be due to factors affecting the timely delivery of produce to markets or quality of produce (e.g. poor feeder roads, non-existence of storage/transportation facilities, bulk and perishable nature of the produce). Consequently, farmers are forced to sell their produce to the traders at cheaper prices. The steep fall in market prices during the harvest season has been the most common grievance of farmers.

According to Bezabih and Hadera (2007), production of horticultural crops is seasonal and price is inversely related to supply. During the peak supply period, prices decline and vice versa. The situation is worsened by the perishability of the products and poor storage facilities. Thus, 25% of the product is spoiled along the marketing channel. The marketing of vegetables in Eastern Ethiopia is characterized by seasonal gluts and shortages which in turn affect the marketing behavior of producers, traders and consumers (Jemma, 2008).

Getachew *et al*. (2014) reveals that wholesalers are making the highest net margin as they have short channels between producers and consumers, and as they relatively charge a higher price using their market power. The net margin for the smallholder farmers is highest only when vegetables are sold to individual consumers through unions via consumer cooperatives thereby reducing the numbers of middlemen across the market chain. The development and upgrading of the value chains is an important agenda for the government, companies and other institutions. Entry into higher value markets (also global markets) requires an understanding of the requirements and dynamic forces within the value chain (Baker, 2006). Understanding of the existing vegetables inputs supply systems, production and marketing systems of vegetables is important for developing well organized value chain development in the study area.

Even though some related studies were carried out in different regions of the country, such study that provides empirical evidence for improving the production and marketing of vegetable has not been undertaken in the study area. Therefore, there is a strong need to make value chain analysis to identify the major vegetable value chain actors and their roles, to identify constraints and opportunities along vegetable value chain, factors that affect volume of supply of potato and onion, to estimate marketing costs and margins at different market channel and to identify factors affecting producer’s market outlets choice.

Objectives of the Study

The general objective of the study is to analyze value chains of potato and onion in the study area. The specific objectives of the study are:

- To identify vegetable value chain actors, their respective roles and to draw up value chain map of in the study area.
- To analyze respective marketing costs and margins across market channels
- To identify the determinants of quantity of vegetable supplied to the market in the study area; and
- To identify the determinants of market outlets choice decisions of vegetable producers.

Methodology

Description of Ejere District

Ejere district is located in Oromia Regional State, West Shoa Zone, with the capital located at 50 km west of Addis Ababa. It has an estimated area of 592.19 square km; it is bordered in the South by the Southwest Shoa Zone, in the West by Dendi district, in the Northwest by Jeldu district, in the North by Meta Robi, in the Northeast by Adda Berga district, and in the East by Walmara district (EWAO, 2015). The district has a total of 30 kebeles of which 27 are rural based kebele administration areas and 3 are town kebele. Total human population of the district is estimated at 89,168 of whom 45,352 are males and 43,816 females. Of the total households 88.36% are rural agricultural households (CSA, 2014). The altitude of the district varies from 2,060 meters to 3,185 meters above sea level. It receives an annual rainfall of 900-1,200 mm, and has an annual temperature range of 9^0c-18^0c. The district has two agro-ecologies which is Dega (45%) and Weina Dega (55%) (Fanos,2012).

The soils types in the district are predominantly red (58%), black (32%) and mixed (10%). The district is characterized by subsistence mixed farming system in which production of both crops and livestock is common economic activity. The total land of the district is estimated to be 56,918 ha, out of which 40,985 ha is cultivated land, 4,446 ha is grazing land, 4,456 ha is forest and 7,031 ha is covered with others (EWAO, 2015). The district is known for its high production potential of crops and livestock. Crop production takes the lion's share of consumption and income generation of the household. Cereals crops widely produced in the area include *teff*, wheat, barley and maize, pulse crops like chickpea, haricot bean, fababeans and noug are the major crops grown. Moreover, vegetables and root crops produced in the area include onions, potato, tomato, pepper, cabbage and sweet potato. Annual crops are predominant and rain-fed agriculture is mainly practiced using animal power. Livestock production is also another source of income and food source next to crop production. In addition, it is the source of traction power and used as a means of transpiration. Farmers keep a significant number of livestock (cattle, sheep, donkey and horse) for various purposes in the study area (EWAO, 2015).

Table 1. Annual productions of major vegetable in Ejere district with irrigation

	2013/14 production year			2014/15 production year		
Crops type	Area(ha)	Production (qt)	% production share	Area(ha)	Production (qt)	% production share
Onion	681.5	88595	24.88	508	73660	17.1
Potato	1075.5	171472.5	48.1	1033	170445	39.6
Tomato	37.5	6725	1.88	25	5750	1.3
Cabbage	220.5	44108	12.4	243	53460	12.4
Carrot	23	2319	0.7	50	6000	1.4
Beetroot	37	5340	1.5	74	8880	2.1
Abesha cabbage	36.5	15621	4.4	48	19200	4.4
Shallot	103	12959	3.6	46	5980	1.4
Garlic	169	6027	1.7	1055	47475	11
Pepper	42	2750	0.8	61.5	39975	9.3
Fosoliya	1.5	140	0.04			
Total	2427	356056.5	100	3143.5	430825	100

Source: Computed from EWAO, 2015.

Ejere district is suitable for vegetable production due to its favorable agro-ecology and availability of irrigation water. As depicted in Table 2, in 2013/14 production season total production of vegetable in Ejere district is estimated to be 356,056.5 quintals on 2,427 hectares of land. Whereas, in 2014/15 about 430, 825 quintals was produced on 3,143.5 hectares of land. This implies the production and coverage of lands by vegetables in Ejere district has increased even if water shortage was the major problem.

Vegetables were commonly grown during the two production cycles in Ejere district. Irrigable land is more intensively used in the two production cycle where relatively larger proportion of the farmers are engaged in vegetables production during this two cycles in the study area. The first season runs from September to January for potato and August to January for onion and the second round runs from February to June for potato and January to May for onion. The peak harvesting months are December and January for the first round and May and June for the second round production period. The first cycle planting time of potato was from September to October while planting time of onion was from August to September. The second cycle planting time for potato was from February to March while planting time of onion was from January to February.

Regarding the marketing time of potato the majority of farmers reported that December and January was the time of marketing potato produced by first cycle while November, December and January were a time for onion marketing produced by first cycle. The marketing time of Potato produced by second cycle was from May to June and marketing time of onion was from April to May. Map of study area is shown under figure 1.

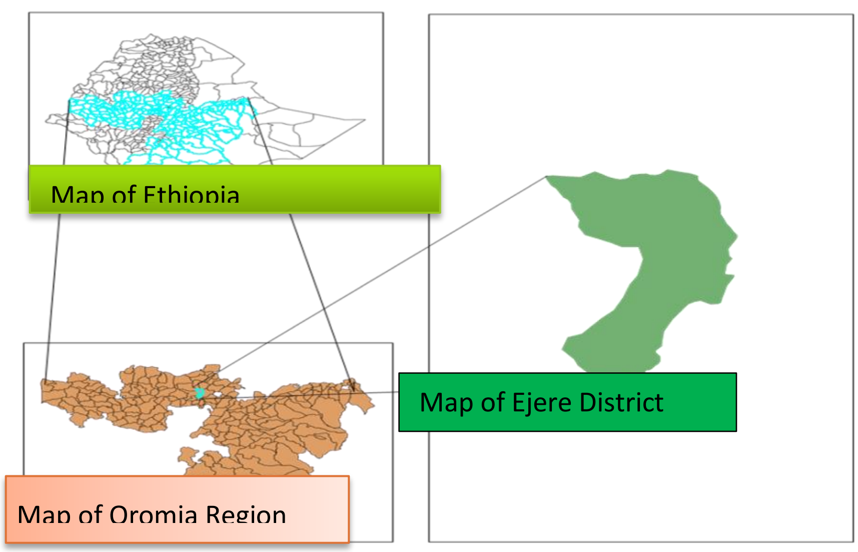


Figure 1. Map of the study area

Sources of Data and Method of Collection

Both primary and secondary data were used for this study. Secondary data sources include Ejere District Irrigation and Development Authority, Ejere District Bureaus of Agriculture, District Trade and Market Development Office and its associated primary cooperatives and Central Statistical Authority (CSA), published and unpublished reports, bulletins, and websites. Both qualitative and quantitative data were collected and used for the study.

Primary data sources were smallholder farmers from four purposively selected kebele and wholesalers, collectors, retailers and consumers. Primary data were collected using informal and formal surveys and key informants interviews. For informal survey Rapid Market Appraisal (RMA) technique like focus group discussion and key informant interview was used with checklists. The formal survey was undertaken through formal interviews with randomly selected farmers and purposively selected traders and consumers using a pre-tested structured questionnaire for each group. Focus group discussions were held with two groups based on predetermined checklists and a total of 15 key informants were interviewed from different organizations and institutions.

Enumerators who have college diploma were recruited and trained for data collection. Before data collection, the questionnaire was pre-tested on three 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.

Sampling Procedure and Sample Size

The sample for this study was drawn from all actors involved along potato and onion value chain such as producers, rural collectors, wholesalers, retailers and consumers. Three stages random sampling procedure was used for the selection of sample household heads. In the first stage, Ejere district was selected purposively based on the potential it has for vegetable production and LIVES project interest. In the second stage, with the consultation of District Irrigation and Development Authority experts, out of 27 kebeles of the district, 4 potential vegetables producers' kebeles namely Amaro, Hora, Arebsa and Kimoye were randomly selected.

In the last stage, from 3,200 vegetable producers' in Ejere district about 120 samples of household heads were randomly selected, using probability proportionality size following a simplified formula provided by (Yamane, 1967). Accordingly, the required sample size at 95% confidence level with degree of variability of 5% and level of precision equal to 9% are used to obtain a sample size required which represent a true population (Table 3).

$$n = \frac{N}{1 + N(e^2)}, \; \frac{3200}{1 + 3200(0.09^2)} \sim 120 \tag{1}$$

Where, n = sample size, N= population size (sampling frame) and e = level of precision considered 9%

Table 2. Sample distribution of vegetables producers in selected kebeles

No.	Kebeles	Total number of vegetable producers	Number of sampled households
1	Amaro	410	31
2	Hora	370	28
3	Arebsa	410	31
4	Kimoye	390	30
	Total	1580	120

Source: Ejere District Irrigation and Development Authority, 2015.

From 120 selected households 35 produced potato only, 42 produced onion only and 43 households produced both potato and onion during survey year. Data from traders and consumers were also collected. The sites for the trader surveys were market towns in which a good sample of vegetables traders existed. On the basis of flow of vegetables, three markets (Addis Alem, Holota and Addis Ababa Piassa Atikilt Tera) were selected as, the main vegetable marketing sites for the study areas. Here sampling was the very difficult task due to absence of recorded list of population of traders and the opportunistic behavior of the traders. Hence a purposive sampling method was used to select wholesalers, rural collectors and retailers from specified markets. As a result, 30 potato and onion traders were selected for the purpose of the study. Furthermore, 25 and 10 consumers were interviewed from Addis Alem and Holota, respectively, which were selected a purposively to obtain information related to consumers (Table 4).

Table 3. Sample distribution of traders of potato and onion

Traders	Addis Alem	Holota	Addis Ababa (Atikilt Tera	Total
Rural Collectors	3	1	-	4
District Retailers	7	5	-	12
Central retailers	-	-	6	6
Wholesalers	-	-	8	8
Consumers	25	10	-	35
Total	35	16	14	65

Source: Own survey results, 2015.

Methods of Data Analysis

Three types of data analysis, namely descriptive statistics, value chain analysis and econometric analysis were used for analyzing the data from producers, traders and consumers. Descriptive statistics such as frequency, mean, percentage, and standard deviation was used. In addition to this, descriptive tools such as tables, and pie chart were used to present data. Inferential statistics such as t-test, chi-square and F-test (log-likelihood ratio test) were used.

Value chain analysis is the process of breaking a chain into its constituent parts in order to better understand its structure and functioning. The analysis consists of identifying chain actors at each stage and discerning their functions and relationships; determining the chain governance, or leadership, to facilitate chain formation and strengthening; and identifying value adding activities in the chain and assigning costs and added value to each of those activities (UNIDO, 2009).

To understand the characteristics of the chain actors of vegetable and the relationships exists between them, including the identification of all actors in the chain; the flow of product through the chain; the work features and the destination; information was obtained by conducting interviews, focus group discussion and by collecting secondary data from various sources. The study has employed value chain analysis which is very effective in tracing product flows, showing the physical value adding stages, qualitative and quantitative flow of product along the chain with identified key actors, their relationships with other actors in the chain and measured distribution of their benefits. This could be captured through mapping the value chain. Mapping the chain facilitates understanding of sequence of activities, key actors and relationship involved in the value chain. This analysis was undertaken in qualitative terms.

Marketing margins are calculated at different points along the value chain and then compared with consumer price. Once the basic structure of a marketing channel is established, it is relatively easy to collect information on the price at which the product is bought and sold at each stage in the production process (Smith, 1992). Estimates of marketing margin are the best tools to analyses performance of market. The cost and price information used to construct marketing cost and margin have been gathered from vegetables value chain actors such as, producers, collectors, retailers, wholesalers and consumers. Computing the total gross marketing margin (TGMM) is always related to the final price paid by the end buyer and is expressed as percentage (Mendoza, 1995).

$$\text{TGMM} = \frac{\text{Final Consumers' Price} - \text{Producers' Price}}{\text{Final Consumers' Price}} \times 100 \qquad (2)$$

Where, TGMM is total gross marketing margin

It is useful to introduce here the idea of “producer participation”, “farmer’s portion” or “producer’s gross marketing margin” (GMM) which is the portion of the price paid by the end consumer that belongs to the farmer as a producer. It should be emphasized that growers that as middlemen also receive an additional marketing margin. The producer’s margin or share in the consumer price (GMMp) is calculated as:

$$\text{GMM}_{\text{P}} = \frac{\text{Consumers Price} - \text{Marketing Gross Margin}}{\text{Consumers Price}} \times 100 \text{ or}$$

$$\text{GMM}_{\text{P}} = 1 - \text{TGMM} \qquad (3)$$

where, GMMp is = the producer’s share in 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. Thus the net marketing margin is calculated as:

$$\text{NMM} = \frac{\text{Gross Marketing Margin} - \text{Marketing Costs}}{\text{Consumer Price}} \text{X}100 \qquad (4)$$

Determinants of volume of the vegetable supplied to market and decisions of farmers' choice in market outlet was analyzed using two-stage least square regressions (2SLS) and multivariate probit models respectively. Multiple linear regression model (OLS) was appropriate to analyze factors affecting volume sales because all sampled households producing vegetable participated in marketing. However, when some of the assumptions of the Classical Linear Regression (CLR) model are violated, the parameter estimates of the above model may not be Best Linear Unbiased Estimator (BLUE). Thus, it is important to check the presence of heteroscedasticity, multicolliniarity and endogeniety problem before fitting important variables into the regression models for analysis.

The problem of endogeniety occurs when an explanatory variable is correlated with the error term in the population data generating process, which causes, the ordinary least squares estimators of the relevant model parameters to be biased and inconsistent. The source of endogeneity could be omitted variables, measurement error and simultaneity (Maddala, 2001). Both Hausman test and Durbin-Wu-Hausman (DWH) test were applied to check the presence of endogeneity. In case of this study, there is a potentially endogenous variable, which are productivity of potato and onion, included in the explanatory variables that could cause endogeneity bias if OLS is applied. Therefore, in identifying the determinants of farm level marketed surplus of potato and onion, a two-stage least square (2SLS) model was used. Two-stage least square is similar to OLS except that uses two completely separate stages during the analysis phase in order to avoid problems of endogeneity (Wooldridge, 2010).

Econometric model specification of supply function in matrix notation is as follows:-

$$\text{Structural equations}: Y = \beta_0 + X_k{}'\beta_1 + \delta Y_1 + U \qquad (5)$$

where; Y is a vector of quantity of potato and onion supplied to market, X' is exogenous variable that is assumed to affect vegetable marketed surplus, Y_1 is a vector of endogenous variables which are productivity of potato and onion, β_0, β_1 and δ are a vector of parameters to be estimated, and U is a vector of disturbance terms.

As the name suggests 2SLS involves using OLS regression in two stages, in the first stage a reduced form of the structural equations is estimated where the endogenous variable productivity of both crops are regressed on all the exogenous variables in the system separately.

$$\text{Reduced form: } Y_{1i} = \pi_0 + \pi_1 X_i + \pi_2 Z_i + v \qquad (6)$$

where, Y_{1i} is endogenous variable (productivity of potato or onion, X_i is vector of exogenous variables (SHH, EduHH, famsz, DNMKT, exper, offarm, areapotato, ownmotor and Extcontact), Z_i is a vector of excluded instruments (amount of fertilizer applied for potato, amount of fertilizer applied for onion and improved seed); π is the coefficients to be estimated; and v is the errors terms, symmetrically distributed around zero. In order to obtain consistent estimators in this case, we need some additional information. These instruments (in this case Z) must satisfy two conditions; uncorrelated with U, also called orthogonal to the error process (exogeneity condition i.e. Cov (Z, U) =0) and correlated with Y_1 the endogenous variable (relevance condition i.e. Cov (Y_1, Z) ≠ 0) (Wooldridge, 2010). This means Z is a variable directly affecting the endogenous variable and may not directly be related to the dependent variable Y.

By subtracting the residual of the regression of equation (6) from the actual value of productivity variable (YILDPOT and YILDONI), a fitted value $\hat{Y}$ of the productivity variable is obtained that is uncorrelated with the error term. In the second stage, by substituting the yield variable in structural equations (5) with the fitted value of yield, the right-hand side of the equations no longer contains any endogenous variables. It is vital to make different tests before 2SLS estimations. Furthers, multicolliniarity problem among explanatory variables had been checked using the Variance Inflation Factor (VIF). As a rule of thumb, if the VIF is greater than 10 (this will happen if R^2 is greater than 0.90), the variable is said to be highly collinear (Gujarati, 2003). A measure of multicolliniarity associated with the variance inflation factors is computed as:

$$\mathrm{VIF}(\mathrm{X}_{\mathrm{j}})\mathrm{X} = \frac{1}{1 - \mathrm{R}_{\mathrm{j}}^{2}} \tag{7}$$

where; R_j^2 represents a coefficient for determining the subsidiary or auxiliary regression of each independent continuous variable X. Conversely, test for heteroscedasticity had been undertaken for this study. There are a number of test statistics for the detect heteroscedasticity. For this study, Robust method of was employed for correcting the problem.

Multivariate probit model (mvprobit) was applied for household variation in the choice of a market outlet and to estimate several correlated binary outcomes jointly. Multivariate probit approach simultaneously models the influence of the set of explanatory variables on choice of markets outlets, while allowing for the potential correlations between unobserved disturbances, as well as the relationships between the choices of different market outlets (Belderbos *et al*., 2004, cited in Hailemariam *et al*., 2012).

The observed outcome of market outlet choice can be modeled following random utility formulation. Consider the i^{th} farm household (i=1, 2…... N), facing a decision problem on whether or not to choose available market outlets. Let U_0 represent the benefits to the farmer who chooses wholesalers, and let U_k represent the benefit of farmer to choose the K^{th} market outlet: where K denotes choice of wholesalers (Y_1), retailers (Y_2), consumers (Y_3) and rural collectors (Y_4). The farmer decides to choose the K^{th} market outlet if $Y^*_{ik} = U^*_k - U_0 > 0$. The net benefit (Y^*_{ik}) that the farmer derives from choosing a market outlet is a latent variable determined by observed explanatory variable(X_i) and the error term (ε_i):

$$Y^*_{ik} = X'_i\beta_k + \varepsilon_i \qquad (k = Y_1, Y_2, Y_3, Y_4) \tag{8}$$

Using the indicator function, the unobserved preferences in equation (8) translates into the observed binary outcome equation for each choice as follows:

$$Y_{ik} = \begin{cases} 1 \ \ if\ Y^*_{ik} > 0 \\ 0 \ \ Otherwise \end{cases} \quad (K = Y_1, Y_2, Y_3, Y_4) \tag{9}$$

In multivariate model, where the choice of several market outlets is possible, the error terms jointly follow a multivariate normal distribution (MVN) with zero conditional mean and variance normalized to unity (for identification of the parameters) where $(\mu_{y1}, \mu_{y2}, \mu_{y3}, \mu_{y4})\ MVN \sim (0, \Omega)$ and the symmetric covariance matrix Ω is given by:-

$$\Omega = \begin{bmatrix} 1 & \rho_{y1y2} & \rho_{y1y3} & \rho_{y1y4} \\ \rho_{y2y1} & 1 & \rho_{y2y3} & \rho_{y2y4} \\ \rho_{y3y1} & \rho_{y3y2} & 1 & \rho_{y3y4} \\ \rho_{y4y1} & \rho_{y4y2} & \rho_{y4y3} & 1 \end{bmatrix} \tag{10}$$

Of particular interest are off-diagonal elements in the covariance matrix, which represent the unobserved correlation between the stochastic components of the different type of outlets. This assumption means that equation (10) generates a MVP model that jointly represents decision to choice particular market outlet. This specification with non-zero off-diagonal elements allows for correlation across error terms of several latent equations, which represents unobserved characteristics that affect the choice of alternative outlets.

Following the form used by Cappellarri and Jenkins (2003), the log-likelihood function associated with a sample outcome is then given by;

$$\ln L = \sum_{i=1}^{N} \omega_i \ln \Phi(\mu_i, \Omega) \tag{11}$$

where ω is an optional weight for observation i, and Φ_i is the multivariate standard normal distribution with arguments μ_i and Ω, where μ_i can be denoted as;-

$$\mu_i = (k_{i1}\beta_1 X_{i1}, k_{i2}\beta_2, k_{i3}\beta_3 x_{i3}), \text{While } \Omega_{ik} = 1\ for\ j = k\ and \tag{12}$$

$$\Omega_{jk} = \Omega_{kj} = k_{ij} k_{ik} \rho_{jk}\ \ for\ j \neq k, k = 1,2,3.....with\ k_{ik} = 2y_{ik} - 1 \tag{13}$$

Results and discussions

This chapter presents the results of the study. Descriptive analysis is employed to describe the socio-demographic characteristics of sampled farm households, traders and consumers. Value chain analysis presents value chain analysis of potato and onion which includes value chain map, actors and their roles, value chain governance, challenges and opportunities along value chain, marketing channels, marketing costs and margins, and benefit shares of actors in the value chain discussed. Econometric analysis was employed to identify determinants of potato and onion market supply and the determinants of outlet choice of vegetable producers.

Socio-economic characteristics of sampled farm households

This sub-section explains the profile of sampled respondents with regard to their age, sex, family size, and experience, level of education, dependency ratio, access to extension services, access to markets information, distance from nearest market and development agent**.**

Sex of household respondents

Gender was analyzed by checking the number of male and female headed households. The sample population of farmer respondents considered during the survey was 120. As shown in Table 4, out of total households head interviewed 80.8% were male headed households while 19.2% were female headed households.

Education level of respondents

The survey result shows that about 41.67% of the sampled household heads were illiterate. However, 41.67% and 15% attended primary school and secondary school, respectively, whereas the smallest proportion 1.67 % are certificate holders and above (Table 4). In both theoretical and practical situations, education level plays an immense role in ensuring household access to basic needs such as food, shelter and clothing. Skills and education amplify the working efficiency resulting into more income and food security. Furthermore education is important to manage the business as well as in decision making (Kadigi, 2013).

Age of the household respondents

The survey on this major demographic factor, measured in years, provided a clue on working ages of households. The mean age of the sample household heads was 41.8 years with the minimum and maximum age of 22 and 74 years, respectively (Table 4).

Family size and experience

The mean family size of the total sample households was 6.66 persons ranging from 1 to 15 and this might assist them for a better participation of households in the vegetable markets (Table 4). According to Bezabih and Hadera (2007) the horticulture production system is often intensive and requires more labor for cultivation than the cereal production does. The household provides a major source of labor for crop production. The labor available for work per household is directly proportional to the family size. The respondents have an average of 4.31 years of farming experience in vegetable production with a standard deviation of 2.53 years. As indicated in the Table 7, F-test results shows that mean age, family size and farming experience of sampled producers is no significance difference by type of vegetables produced.

Table 4. Demographic characteristics of sampled producers

Variable	Indicators	Type of vegetable produced								
		Potato (N=35)		Onion (N=42)		Both potato and onion (N=43)		Total (N=120)		F/χ^2-value
		N	%	N	%	N	%	N	%	
Sex	Male	31	25.83	32	26.67	34	28.33	97	80.8	2.02
	Female	4	3.33	10	8.33	9	7.5	23	19.2	
Education	Illiterate	16	13.33	18	15	16	13.33	50	41.67	7.52
	Primary school	14	11.67	13	10.83	23	19.17	50	41.67	
	Secondary school	4	3.33	10	8.33	4	3.33	18	15	
	Certificate and above	1	0.83	1	0.83	-	-	2	1.67	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Age		44.08	11.32	39.67	10.88	42	11.5	41.79	11.3	1.48
Family size		6.85	2.64	6.14	2.95	7	2.99	6.66	2.88	1.06
Experience		3.86	1.98	4.4	2.58	4.58	4.58	4.31	2.52	0.84

Source: Own survey result, 2015.

Dependency ratio

Accounting for children below 14 and elders of above 64 years as dependents, the dependency ratio was calculated. The survey result indicated that the average dependency ratio for households is 79.6% in Ejere district implying that every 100 person within the economically active population groups supported not only themselves but also additional 79.6% economically dependent persons with all necessities.

Table 5. Age category and dependency ratio

Age Category	Frequency	Percent	Dependency ratio
1-14	348	43.5	
15-64	445	55.7	79.6%
>64	6	0.8	
Total	799	100	

Source: Own survey result, 2015.

Land size and use pattern

One of the most important factors that influence crop production is resource endowment, availability of land for crop production. Land is the basic asset of the sample farmers. The survey revealed that the mean land size of sampled households was 3.5 hectares and ranges from 0.25 to 12.25 hectares in Ejere district (Table 6). Moreover, about 0.6 ha of land was irrigable area. The result also shows that the land allocated for potato is an average per household allocation of 0.3 hectares and the standard deviation of 0.14 and ranges from 0.013 to 0.5 hectares during survey year. The average allocation of land for onion per household was 0.42 hectares with standard deviation of 0.35 and ranges from 0.03 to 2 hectares during survey year.

Table 6. Land size of household respondents and allocated pattern

Variables	Observation	Mean	Std. Dev	Min	Max
Farm size (ha)	120	3.5	2.29	0.25	12.25
Irrigable area (ha)	120	0.6	0.48	0.06	3
Land allocated for potato (ha)	78	0.3	0.14	0.013	0.5
Land allocated for onion (ha)	85	0.42	0.35	0.03	2

Note: Std. Dev=standard deviation, ha=hectare

Source: Own survey results, 2015.

Access to institutional service of farm households

Access to extension service

Table 7 depicts that out of the total respondents of vegetables producing sample households, about 94.2% of the farmers reported that they had access to extension service in 2015 production season. Only 5.8% of the farmers reported that they had no access to extension service. The extension services providers were office of agriculture experts, DAs and innovative farmers. The extension services provided were about vegetables production, input use, seedling raising, harvesting and post-harvest handling. The frequency of extension services provided for producing farmers is indicated in Table 10.

Table 7**.** Farmers' extension agent contact frequency

Description	**Frequency**	**Percent**
No contact	7	5.8
Weekly	35	29.2
Once in two weeks	33	27.5
Monthly	23	19.2
Twice in a year	4	3.3
Once in year	4	3.3
Any time I ask	14	11.7
Total	120	100

Source: Own survey result, 2015.

Access to credit service

Finance is the crucial element starting from land preparation up to the marketing of the product. As depicted in Table 8, only 12.5% of sampled producers had access to credit in Ejere district. The main objectives of the credit were to purchase fertilizer (78.6%) and seeds/seedling of vegetables (24.4%). The reason behind refusal of credit was because the majority of farmers cover cost of production of vegetable by selling grain produced by rain fall. Although credit was accessible and available for poor farmers to build asset and food secured by purchasing the different packages designed by the regional government, there is lack of attention to access and avail credit for vegetables producers.

Access of market information

Closer look at access to market information shows that there is no system in place for systematically collecting, analyzing and disseminating information relevant to the needs of different actors**.** However, almost all (90%) of sampled farmers had access to market information from different sources and only 10% had no access to market information (Table 8). The type of information provided were (53.33%) about output price information, (15%) price and buyers information, (8.57%) market place information's, (4.76%) demand information and others combinations of those (Appendix Table 1). The sampled respondents revealed that the major source of market information were traders, brokers, radio/television, friends/ relatives, district and kebeles administrations and combinations of those. From Table 11, it is possible to generalize that there is a significant difference between producers by type of crop produced with access to market information at 1% significance level.

Access to own transport facility

The availability of well-functioning transport network is very important because it creates place utilities of the product. According to the survey result, about 76.67% of households have their own transport facility and about 23.33% have no transport facility. Moreover, the results revealed that the main means of transport were transport animals, vehicles and cart.

Off/Non-farm income activities

In the study area, motor renting, sheep and oxen fattening, daily labor, petty trade (small shops and retailing of horticulture and grain in the market) were found to be some of the off/non-farm income generating activities in which sampled farmers were participating. From sampled households about 38.3% were participating on off/non-farm income activities and 61.7% were not participating on off/non-farm income activities (Table 8).

Table 8. Access to service of sampled households

Variable	Type of vegetable produced									
	Item	Potato (N=35)		Onion (N=42)		Both potato and onion (N=43)		Total (N=120)		χ^2 - value
		N	%	N	%	N	%	N	%	
Extension service	Yes	32	26.7	40	33.3	41	34.2	113	94.2	0.67
	No	3	2.5	2	1.67	2	1.67	7	5.83	
Credit	Yes	3	2.5	6	5	6	5	15	12.5	0.699
	No	32	26.7	36	30	37	30.83	105	87.5	
Market information	Yes	26	21.7	40	33.3	42	35	108	90	13.7***
	No	9	7.5	2	1.67	1	0.83	12	10	
Own Transport	Yes	27	22.5	32	26.7	33	27.5	92	76.7	0.01
	No	8	6.67	10	8.33	10	8.33	28	23.3	
Off/Non-farm income	Yes	16	13.3	12	10	18	15	46	38.3	2.73
	No	19	15.8	30	25	25	20.8	74	61.7	

Note: *** is statistically significant at 1% probability level.

Source: Own computation from survey result, 2015.

Distance from development center and nearest market

Development centers are an important factor in making information available and help them. Hence, from the Table 9, one can observe that sample producers in the study area travels average walking minutes of 24.33 with ranging from 2 to 60 walking minutes to access development center or FTC. Distance from producer's house to nearest market was also the factor which determines producer's vegetables supply to market. As observed from Table 14, the average distance needed for producer's to travel to nearest market place was took average walking minutes of 143.48 with range from 10 to 240 walking minutes. The F-test result indicates that distance from development center and nearest market were found to be significant at 5% and 1%, respectively; indicating that there were significant differences between sampled household heads of the three groups.

Table 9. Distance to nearest market and development center (in walking minutes)

Variable	Type of vegetable produced								F-value
	Potato (N=35)		Onion (N=42)		Both potato and onion (N=28)		Total (N=120)		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Distance from development center	26.8	15.47	19.28	14.2	27.2	17.17	24.33	16	3.35**
Distance from nearest market	114.6	77.0	142.9	57.8	167.5	37.33	143.5	61.6	7.95***

Note: ** and *** is statistically significant at 5% and 1% probability level, respectively.
Source: Own survey results, 2015.

Demographic characteristics of sampled traders

Table 10 summarizes the demographic characteristics of traders in terms of age, family size, experience, sex, marital status, education, language and religion. The average family size of the traders is 2.9 persons and ranges from 1 to 8. The average age of the traders was 34 years and range from 22 to 50 years. The traders have an average of 8.6 years of experience in vegetables trading (ranging from 1 to 20 years trade experience). The survey further indicates that 53.3% of the sample traders were males while 46.7% of them were females. This implies that both women's and male's participation in vegetables trading was high. The age composition of traders was between the age group 18 to 65 which is the productive age group. About 63.3% of traders were Orthodox Christians while the remaining 26.7% and 10% were Muslims and Protestants, respectively. From sample traders 86.7% were married and 13.3% of them are single.

Table 10. Demographic characteristics of sampled traders

Variable		Addis Alem		Holota		Addis Ababa/ AtikiltTera		Total	
		(N=10)		(N=6)		(N=14)		(N=30)	
		Ferq.	%	Ferq.	%	Ferq.	%	Ferq.	%
Sex	Male	1	11.1	4	66.7	11	78.6	16	53.3
	Female	9	88.9	2	33.3	3	21.4	14	46.7
Religion	Orthodox	6	60	5	83.3	8	57.2	19	63.3
	Muslim	3	30			5	35.7	8	26.7
	Protestant	1	10	1	16.7	1	7.1	3	10
Marital Status	Single			1	16.7	3	21.4	4	13.3
	Married	10	100	5	83.3	11	78.6	26	86.7
Language	Amaric	1	10	1	16.7			11	36.7
	Amaric and Guraginga	7	70	3	50	9	64.3	13	43.3
	Afan Oromo and Amaric	2	20	2	33.3	3	21.4	6	20
Education Level	Illiterate	4	40	3	50	2	14.3	4	13.3
	Primary school	5	50			3	21.43	11	36.7
	secondary School	1	10	2	33.3	10	71.43	13	43.3
	Certificate and Above			1	16.7	1	7.14	2	6.7
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Family size		4.7	2.21	2.67	1.21	1.71	1.07	2.9	2.02
Age		37.1	6.59	36.17	9.54	30.86	6.06	34	7.39
Experience		12.9	6.92	2.83	3.125	8	5.75	8.6	6.69

Source: Own survey results, 2015.

With regard to the level of education of traders, the survey results show that about 13.3% of the respondents are illiterate. However, 36.7% and 43.3% attended primary school and secondary school respectively whereas 6.7 % are certificate holders and above. In terms of the language of traders about 43.3% of them can speak both Amaric and Gurageing while 36% and 20% of traders can speak only Amaric and both Afan Oromo and Amaric, respectively (Tables 10).

Socio-economic characteristics of sampled traders

Socio-economic characteristics include financial assets such as initial capital, working capital, Source of capital and source of loan. The initial and working capital could be one of the indicators of the financial position of a given through it does not necessarily show the financial progress of the firm. As depicted in Table 11 the average initial capital of sampled vegetables traders were birr 5,316.7 with ranges from 500 to 20,000 birr. With, regard to current working capital, the survey result shows in 2015 average working capital of sampled vegetable traders was birr 44,226.7 ranges from 500 to 300,000 birr.

Table 11. Financial capital of sampled traders

Variable	Number	Mean	SD	Minimum	Maximum
Initial capital	30	5316.7	4987.02	500	20,000
Working capital in 2015	30	44,226.7	79415.7	500	300,000

Note: SD= standard deviation

Source: Own survey results, 2015.

As indicated in Table 12, most of traders' working capital originated from internal source than external sources. About 43.33% of sampled traders were using their own capital while about 30% through loan and 16.7% were function by share. The smallest proportions about 6.67% and 3.33% source of traders' working capital were through gift and combinations of own and loan, respectively. Further, the survey results revealed that about 66.67% of traders borrowed working capital from relatives/family while about 16.67% borrowed from Micro Finance Institution's, 8.33% were from privates money lenders, and 8.33% of traders borrowed from friends .

Table 12. Source of working capitals and source of loan of sampled traders

Source of capital	**Frequency**	**Percent**
Own	13	43.33
Loan	9	30
Gift	2	6.67
Share	5	16.67
Own and Loan	1	3.33
Total	30	100
Source of loans		
Relatives/Family	8	66.67
Private money lenders	1	8.33
Friends	1	8.33
Micro Finance Institutions	2	16.67
Total	12	100

Source: Own survey results, 2015.

Demographic characteristics of sampled consumers

The survey results as it is portrayed in Table 13, sampled consumers were dominated by females; i.e., 80% and the remaining 20% were males. This implies that female's involvement in the purchase and preparation of vegetables was high. The respondents are adults of ages ranging from 16 to 64 years with an average of 35 year. The average family size of the consumers is 3.4 persons and ranges from 1 to 11. The consumers have an average of 28.2 years of experience (minimum 6 and maximum 60 years) in purchasing vegetables for consumption. Regarding marital status of the consumers, the majorities 65.7% of the consumers were married, 25.7 were single and the rest 5.7% and 2.9% of sampled respondents were divorced and widowed/widowers, respectively. The educational level of consumers result shows that 14.3% were illiterate, 42.9% were attended primary school, 34.3% were attended secondary school and the left 8.6 had certificates holders and above.

Table 13. Demographic characteristics of consumers

	Variable	Ejere town		Holota town		Total	
		Ferq.	%	Ferq.	%	Ferq.	%
Sex	Female	16	76.2	12	85.7	28	80
	Male	5	23.8	2	14.3	7	20
	Married	14	66.7	9	64.3	23	65.7
Marital status	Single	6	28.6	3	21.4	9	25.7
	Divorced	1	4.7	1	7.1	2	5.7
	Widowed/widower	0	0	1	7.1	1	2.9
Education	Illiterate	4	19.05	1	7.1	5	14.2
level	Primary school	10	47.62	5	35.7	15	42.9
	Secondary school	7	33.33	5	35.7	12	34.3
	Certificate and Above	0		3	21.4	3	8.6
Age	Mean	34.9		35.21		35.03	
	SD	12.07		10.58		11.34	
Family size	Mean	3.67		3.07		3.4	
	SD	2.56		2.13		2.4	
Experience	Mean	29.67		26		28.2	
	SD	12.14		12.57		12.3	

Note: Ferq. =frequency (number) of consumers, % =percentage and SD=standard deviation Source: Own survey results, 2015.

Means of livelihood of the consumers

The consumers earn their income from different sources and the purchasing power of the consumer depends on his/her income level. About 42.9 % and 31.4% of consumers were earns its income from trading and employment, respectively. About 14.3% of the sampled consumers were earn their income from hotels and renting of house and 5.7% were earns from daily laborer works. Small percent of consumers were involved in farming activity and earns pension monthly. The survey results also revealed average monthly income and proportion of income expands for consumption of vegetables. The results shows that average monthly income of sampled consumers is birr 1887.6 with ranging from 400 to 10,000 birr. On average about 476.86 of the income is spent for vegetables consumption per month and ranges from 100 to 5000 birrs.

Table 14. Consumer's monthly income and proportion spent for purchase vegetables

Location	No. of respondents	Mean income (Birr per month)	Mean income for spent for consumption of vegetables (birr/month)
Ejere	21	1779.4	488.1
Holota	14	2050	460
Total	35	1887.63	476.85

Source: Own survey results, 2015.

Vegetable Production

Types of vegetables produced by sampled households in Ejere district

In Ejere district, different types of vegetables are grown with different intensities in terms of land and other input allocation, purpose of production and marketability. The survey results revealed that most commonly grown vegetables in terms of the number of sampled growers are onion (70.8%), potato (65.0%), cabbage (18.33%), pepper (12.5%), tomato (10.83%) and Garlic (8.33%).

Table 15. Proportion of sampled households producing vegetables (in 2015 production year)

Crops type	No. of producers	Percent	Relatives importance
Onion	85	70.8	1
Potato	78	65.0	2
Cabbage	22	18.33	3
Pepper	15	12.50	4
Tomato	13	10.83	5
Sweet potato	11	9.1	6
Garlic	10	8.33	7
Carrot	6	5	8
Beetroot	4	3.33	9
Shallot	2	1.66	10

Source: Own survey results, 2015.

Profitability of vegetables production in Ejere district

Table 16 compares the profitability of potato and onion production per hectare of land. Potato and onion can be produced in two cycles during a year. This will permit crop rotation and effective use of land. Based on the survey data, the costs of production and returns at the prevailing prices were used to estimate the benefits. This section aims at identifying and quantifying different costs, which are incurred by the farmers in production process. The cost involved in potato and onion cultivation can be subdivided in two ways: variable cost and fixed cost.

Table 16. Average cost of production and profitability of selected vegetables (Birr/ha)

Items	Vegetable type	
	Potato (N=78)	Onion (N=85)
Seed (Birr)	4760	6919.41
DAP (Birr)	2171.79	2979.52
Urea (Birr)	1580	2520
Labor for crop management(Birr)	852.31	1246.23
Labor for Harvesting(Birr)	649.61	1126.24
Fuel (Birr)	3150	3436.23
Chemicals (Birr)	2693.65	5229.23
Total variable cost (Birr)	**15,857.36**	**23,456.86**
Rental value of land (Birr/year)	4000	4000
Depreciation of farm implements (Birr)	429.23	538.47
Total fixed cost (Birr)	**4,429.23**	**4,538.47**
Total production cost (Birr/ha)	20,286.59	27,995.33
Yield (qt/ha)	110	118
Income	44,110	98,530
Net return (income)	**23,823.41**	**70,534.67**
Cost (Birr/qt) (Production cost)	**184.42**	**237.25**

Source: Own computation from survey result, 2015.

The labor cost given in Table 16 was estimated based on the price or wage of labour in locality per man day. Family labour was evaluated at the prevailing wage rates of hired labour at the village level. Women and children age between 7-14 years were converted in to man day equivalents based on the ratio of wage rates (Appendix Table 3). Urea and DAP were valued at Birr 1200 and 1400 per qt, respectively. Chemical costs, seed cost, fuel cost and, rental value of land were reported by the sampled respondents. The mean productivity of potato and onion was 110 and 118 qt/ha, respectively which were reported by sampled households. Rental value of land was imputed by taking into account the prevailing rents in the study area per hectare per year for vegetable. Depreciation charges on farm implements were calculated using the straight-line method, i.e., by dividing the original cost of item (less salvage value) by the expected life of the item. Average potato and onion output were valued at farm gate price of households which were on average about Birr 401 and 835, respectively. Income from potato and onion are the value of total production at the farm gate price. Accordingly, the total average cost of production of potato is Birr 184.42 per quintal while total average cost of production of onion is Birr 237.25 per quintal. The net income per hectare of potato is Birr 23,823.41 while net income per hectare of onion is Birr 70,534.67. The overall analysis shows that potato requires smaller production cost and also gives smaller net return per ha of land, compared to onion.

Value Chain Analysis

The value chain activities identified by the respondents are qualitatively analyzed in-depth to establish which factors influence the value chain activities in the organization. The analysis of the value chain is divided into the primary activities, support activities and factors that influence the value chain activities. A tangible vegetable volume is moved from its production field to markets and consumed by final beneficiaries. It is essential to know at first what the current situation is and what strategy needs to be adopted in order to overcome the bottlenecks.

Vegetables value chain actors and major functions

Value chain is a sequence of related business activities (functions), from the provision of specific inputs for a particular product to primary production, processing, sales and distribution, to final consumption. It is clear that along with the farmers, a number of actors participated in the marketing of vegetables from the production point to the consumer point. From an institutional perspective, a value chain can be defined as the organizational arrangements linking and coordinating the producers, processors, traders, and distributors who perform these functions (Joshi and Gurung, 2009). The main actors involved in the Vegetables value chain, their roles and inter relationships are discussed below.

Inputs suppliers

Agriculture value chain analysis begins at the input supply level. Inputs such as seeds, fertilizer, pesticides, and farm implements are supplied by cooperatives, BoA, Holota Agricultural Research Center, traders, and informal farmers to farmer's exchange. Adequacy and quality of vegetable seeds are crucial for increased production. Sampled producers were asked whether they use local or improved variety of seed and the largest proportion of the producers (54.2%) used improved varieties while 23.3% both improved and local varieties and (22.5%) only local varieties of vegetable seed (Figure 3).

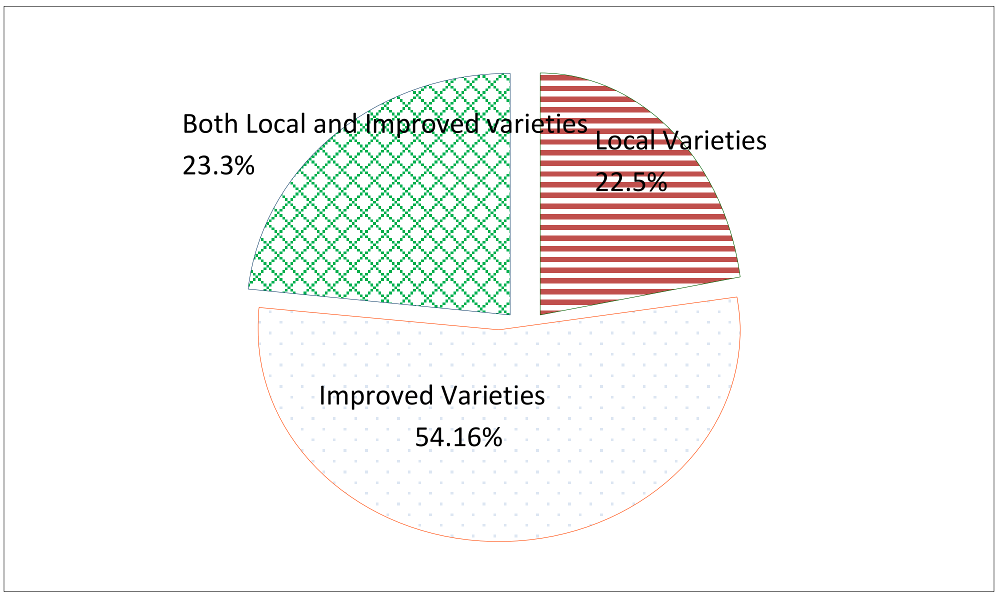


Figure 3: Type of vegetables seed used by sampled producers
Source: Own survey results, 2015.

For major vegetable produced in Ejere district, the majority of the sampled producers used seed by purchasing from market. The survey results indicates that about 56.4% and 80% of sampled producers purchased seed from market for potato and onion production, respectively (Table 20). The majority of farmers prepared their own seedling.

Table 17. Sources of potato and onion seeds for sample respondents

Source of seed	Crops types			
	Potato (N=78)		Onion(N=85)	
	Frequency	%	Frequency	%
Own seed	12	15.4	-	-
BoA	12	15.4	16	18.8
Market	44	56.4	68	80.0
Fellow farmers	7	9.0	-	-
Research Center	3	3.8	-	-
Cooperatives	-	-	1	1.2
Total	78	100	85	100

Source: Own survey results, 2015.

Regarding fertilizers, the majority of producers used inorganic fertilizer (DAP and Urea) depending on the land size allocated to vegetables and the soil fertility status as perceived by the producers while some producers used inorganic fertilizer (manure and compost). The results indicated that most of the sampled producers who used fertilizer procured it from cooperatives (55.5%), from BoA (41%) and from local market (3.42%) while source of organic fertilizer is producers themselves.

Table 18. Sources of fertilizer and chemicals use for potato and onion production

Fertilizers use (inorganic fertilizer**)**		
	Frequency	Percent
Yes	117	97.5
No	3	2.5
Total	**120**	**100**
Source of fertilizers		
BoA	48	41.0
Market	4	3.4
Cooperative	65	55.6
Total	**117**	**100**
Source of chemicals (pesticides and herbicides**)**		
Private traders (Market)	98	84.48
BoA	9	7.76
Cooperatives Shops	9	7.76
Total	**116**	**100**

Source: Own survey result, 2015.

The survey results further revealed that in Table 18, farmers purchase pesticides and herbicides from different sources. The major suppliers of chemicals are private traders from market, cooperative shops, and through the agriculture and rural development office. Regarding farm implements, the major suppliers are local market, agriculture office, and fellow farmers.

Labor is an important factor of agricultural production. The labour is employed in vegetable production from land preparation to harvest. As depicted in Table 19, about 41.67% of the respondents used both family labor and hired labour for the production of vegetables followed by only family labour with 16.67% (Table 22). About 11.67% of farmers used both family labor and labour exchange and 10.83% used hired labor and labor exchange for vegetable production.

Table 19. Sources of labor for potato and onion production

Source of labor	Frequency	Percent
Family labor only	20	16.67
Hired labor only	11	9.17
Labor exchange only	3	2.50
Family labor + Hired labor	50	41.67
Family labor + Labor exchange	14	11.67
Family labor + Hired labor + Labor exchange	9	7.5
Hired labor + Labor exchange	13	10.83
Total	**120**	**100**

Source: Own survey result, 2015.

Producers

Farmers are the primary and most valued actor in the vegetable value chain. Two categories of farmers were noticed in production areas: subsistence farmers and small investors' farmers. Producers decide, what input to use, when to seed and harvest, how much to consume, and how much to sell, considering the available resource. They perform most of the value chain functions right from farm inputs preparation on their farms to post harvest handling and marketing. The major value chain functions that vegetables producers perform include land preparation, growing/planting/, fertilization, irrigating, protecting from weed, pest/disease, harvesting and post-harvest handling and marketing.

In Ejere district vegetables are produced based on irrigation and small number of farmers indicated that they had used rainfed system. From sampled producers about 90% are engaged on vegetable production using irrigation and remaining 10% produced vegetable under rain fed. Water for the irrigated agriculture is fundamental resource otherwise it could not be possible to cultivate vegetables. Berga River and its catchments is the major source of water for sampled respondents. The survey results depicted that, about 93.58% of sampled households' access irrigated water from River while about 4.59 and 1.83% of irrigated waters comes from pond and hand dung hall, respectively. Most of the farmers in the districts rely on River for irrigation this was the means of water reduction. From the sampled farmers 51.7% of them have owned motors and the rest 48.3% of them rented or farmed in partnership apart from those who have motors and pumps (Table 20).

Table 20. Proportion of households with their own motor and source of water for irrigation

Source of irrigation water	Frequency	Percent
Rivers	102	93.58
Ponds	5	4.59
Hand dung Halls	2	1.83
Total	**109**	**100**
Owned motor for irrigation		
Yes	62	51.7
No	58	48.3
Total	**120**	**100**

Source: Own survey results, 2015.

As it is depicted in the Table 21, 96.67% of sampled respondents were producing vegetables by sole cropping and small proportion 3.33% were producing by inter cropping with others short cycled products. Most farmers sell the majority of their vegetable products at harvest time, keeping only small amount for home consumption and for seed. Farmers are producing potato and onion for market and they sell to wholesalers at farm gate and village markets. They also sell to different types of actors such as rural collectors, consumers and retailers (with varying volume of sell) at local market.

Table 21. Vegetable production mechanism of producers

Vegetable growing	Frequency	Percent
Sole cropping	116	96.67
Inter cropping	4	3.33

Source: Own survey result, 2015.

Rural collectors

Rural collectors are independent operators at primary markets who assemble and transport vegetables from smallholder farmers, using pack animals and small trucks for sale to larger markets. The local traders play the key role as in the vegetable value chain in area; their trading activities include buying and assembling, repacking, sorting, and selling to wholesalers typically transport on donkeys or cart to nearest town. Their major sales outlets are relatively wholesalers. And most of these outlets own or rent storage but usually do not store for more than two or three days. These local traders collect vegetables for wholesalers and wholesalers purchase from rural collectors by covering all cost and also additional fee for their services.

Brokers/middle men

Brokers in the district have regular and temporary customers from major towns and cities across the country. Brokers facilitate transaction by convincing farmers to sale his vegetables and facilitating the process of searching good quality and quantity vegetables to wholesalers. The share of profit that goes to brokers varies from farmer to farmer and from trader to trader. The brokers sometimes go beyond facilitation of transaction and tend to set prices and make extra benefits from the process. A few wholesalers go straight to farmers fields without using brokers to purchase the vegetables products from the farmers where they negotiate prices. Brokers do not follow proper business conduct and as a result they constrain the marketing system more than they facilitate. In case the producer is not sold through broker, they forced to sell at the lower price because of perishability of the product. The broker travel to the rural areas and contact producers, they inspect the product quality, estimate output, set price and come back to communicating with wholesalers to purchase and transport. The farmers have no idea of the price paid by the wholesalers and only receive what has been bargained with the broker.

Wholesalers

Wholesalers are traders that buy vegetables from rural collectors and also directly from farmers, usually those in surplus areas for resale in deficit, to larger market centers and retailers with better financial and information capacity. Wholesalers are the major buyers of vegetable as they buy at least a truck load of vegetable at a time from farmers. They mostly purchase from farmers and local collectors. There are no wholesalers who have the license to do wholesale in the study district. But the majority of wholesalers are located outside the districts mainly in Addis Ababa (Atikilt Tera). Wholesalers mostly purchase in bulk from the districts, transport and sell the produce to the major towns like Assosa, Wollega and Addis Ababa. Wholesalers buy vegetable from producers through brokers who represent them in vegetable buying activities. They have better storage, transport and communication access than other traders.

Processors

Processing of vegetables in the sense of preserving and value addition is not as such practiced in the study areas. Processing function is undertaken by juices house, cafés, hotels or restaurants in which case fresh and cooked vegetables are sold to consumers. Potato and onion are commonly consumed in the form of cooked meals in different traditional *dishes* or "*wat*". Nowadays, consuming potato chips, crisps, and roasted potato are becoming common in major towns of the study areas.

Retailers

Retailers are key actors in vegetables value chain within and outside the study area. These are known for their limited capacity of purchasing and handling products and low financial and information capacity. They are the last link between producers and consumers. There are two types of retailers in the study area district retailers and central retailers. District retailers are buying vegetable either from farmers or wholesale traders. While central (urban) retailers in major cities mostly they buy from wholesalers and sell to urban consumers. The supermarket and shops are mainly in the major cities and commonly buy vegetable from wholesalers. During the market visit, it was observed that retailers keep small amount of potatoes, onion, tomato, and other vegetables. Consumers usually buy the product from retailers as they offer according to requirement and purchasing power of the buyers.

Consumers

Consumers are final purchasers of vegetable products mostly from retailers for consumption purpose. Vegetable consumers are individual households (rural and urban dwellers) hotels and institutions. The majority of sampled consumers preferred smooth white, medium size and undamaged potato and followed by large size and clean potato. Further, the survey results revealed that dry, large size and red color onion are preferred by majority of consumers and followed by dry, medium size and clean onion (Appendix Table 4). Restaurants, hotels and cafes preferred larger size, dry and undamaged potato while dry, large size and red onion. Almost all sampled consumers 94.29% preferred fresh vegetables products while small proportion 5.71% consumers preferred packed vegetables products. Consumers think that if the chain becomes shorter and shorter the price of vegetables will be reduced.

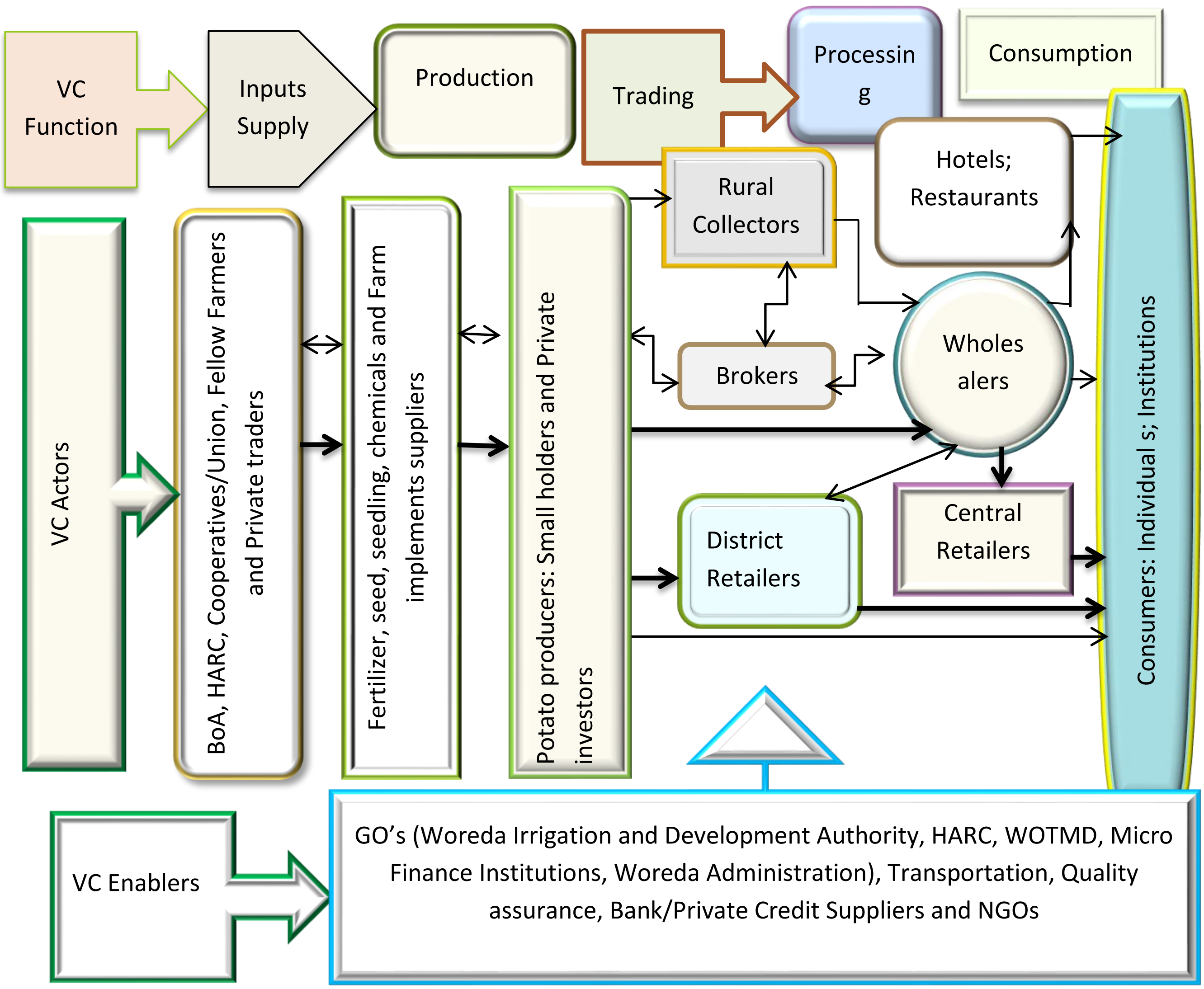
Enablers and facilitators

In a value chain, enablers include all chain-specific actors providing regular support services or representing the common interest of the value chain actors. The supporting function players for the vegetable value chain are those who are not directly related to the vegetable value chain but provide different supports to the value chain actors. The support functions include different services (e.g. credit), research and development, infrastructure, and information. Support service providers are essential for value chain development 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 vegetables value chain in one way or another. The most common support providers are District Agriculture Office, District Irrigation and Development Authority, District Trade and Market Development Office, Cooperatives, Oromia Micro Finance Institutions, Private transporters, and Holota Agricultural Research Center. Some service providers extend services beyond one function and others are limited to a specific function.

District Irrigation and Development Authority and Agricultural Development Office provide agricultural extension services to producers through experts and development agents. The office provides advisory service, facilitate access to inputs and provide technical support in seed bed preparation, fertilizer application, crop protection and post-harvest handling. The key informant's interview point out that the producers get extension service on general agriculture and it is not sufficient to improve the technical skill of the producers. Holeta Agricultural Research Center is involved in developing improved variety of vegetables seed for wider adaptation, high yielding and resistant to biotic and abiotic stress especially, on potato. The most common sources of loan are Oromia Micro Finance Institutions and relatives/friends, since they do not require collateral. Moreover, it was found that NGOs and Banks are operating in providing technical service and offers credit support to the farmers. But the farmers are not receiving sufficient service regarding finance related issue in the study area. In the study areas, cooperatives do not support producers in the value chain of vegetables as expected, they supply only fertilizer and sugar/oil for producers. This is due lack of adequate capital to supply inputs and lack of emphasis of district administrations to organized cooperatives in each peasants associations and functions efficiently.

Value chain map of potato and onion in the study area

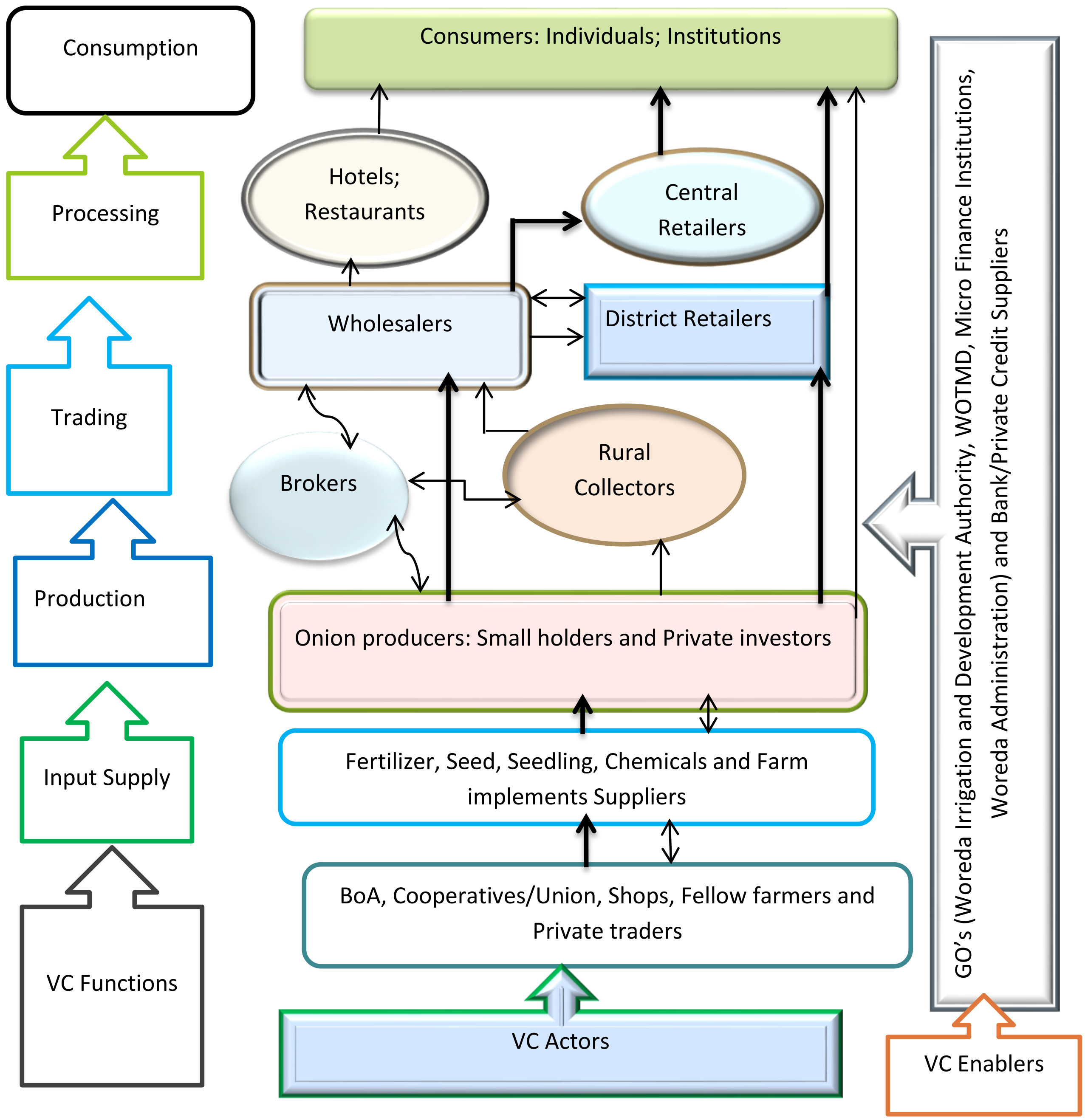
Mapping a value chain facilitates a clear understanding of the sequence of activities and the key actors and relationships involved in the value chain. Mapping of value chain functions is considered to show the relationships and integrations of the processes and activities performed along the value chain. Major functions include input supply, production, trading, processing and consumption. Figure 5 and 6 displays the functions or processes in potato and onion value chain map, respectively.



Note: ⟶ : Weak product flow: ➞ :Strong product and input flow ⟷ Information flow

Figure 4: Value chain map of potato in the study area

Source: Own sketch from survey result, 2015.



Note: → : Weak product flow; ➔ : Strong product and input flow;

↔ : Information flow

Figure 5: Value chain map of onion in the study area
Source: Own sketch from survey result, 2015.

Value chain governance

The governance structure gives information about the position of the smallholders in the chain and the relations between smallholders and purchasers. The producers' position in price negotiation is not good in the study area. Due to lack of valuable market information and not well organized producers' heavily depend on traders. Hence, they are price takers and hardly negotiate the price due to fear of post-harvest loss, in case the product is not sold. From focus group discussion producers reported that co-ordination among the value chain actors was low and also there were the complexity of information and knowledge sharing among the chain.

The assessment made indicates that the wholesalers assisted by the brokers are the main vegetables value chain governors. Moreover, the study also revealed that the governance structure exercised was favorable to wholesalers and retailers and leaves smallholders and consumers in a weak position with other value chain actors. Wholesalers have sufficient information about the supply of vegetable and which direction it flows along the marketing channels and markets in different parts of the country. The wholesalers in Addis Ababa markets are well networked with each other's as well as with brokers but informally. These traders exchange information on vegetables prices, local supply situation and the prospects of harvest in their area. Then, they agree on the price at which the buyer is willing to take the price so that the seller determines the farmers' price taking into account his profit margins. Except this networking and business relation, there is no formal collateral when the transaction takes place.

In general, the governance structure in the study area was characterized by low coordination among the value chain actors in information exchange and knowledge transfer and low involvement in changing the rules and regulations that was exercised in the study area. Therefore, care should be taken in order to create a co-ordination mechanism among the value chain actors and encouraged all actors in changing the rules and regulations that was exercised in the study areas.

Challenges and opportunities of actors along vegetable value chain

One of the merits of value chain analysis is that it helps to clearly identify bottlenecks to the development of the chain right from input supply up until the consumption level in intense way. Accordingly, a number of constraints and opportunities are explained by different actors through focus group discussion and questionnaire. From results major constraints which are currently hindering the development of the vegetable value chain can be categorized according to the three basic stages: the farm level, the marketing/traders stage and consumer stage (Table, 22).

At the farm-level, key constraints faced by farmers are the shortage of good quality seed, high cost of inputs, lack of availability of adequate pesticides/herbicides, reduction of irrigation water, low irrigation facility, limited knowledge on the proper plantation, harvesting and post- harvest handling activities, diseases and pest attacks, lack of storage, and inadequate credit service. Concerning inputs supply, about 78.33% and 74.17% of sampled farmers reported problem of high cost of inputs and shortage of good quality seed, respectively. About 90% of sampled producers faced shortage of irrigation water use due to reduction of River. This will fears producers to not expand vegetables production and marketing.

Farmers suffer from poor post-harvest handling techniques, leading to significant losses, which affect returns to the farmer and traders. Furthermore, farmers do not have good storage facilities available at the farm level, and this forces them to sell their product immediately after harvest. Moreover, about 79.17% of producers reported disease and pest attacks - mainly fungal disease on potato as the major problems in the district. Sampled farmers reported that they were not well trained on pest and diseases control measure on their vegetables cultivation. Summary of constraints and opportunities of vegetable value chain actors are shown in Table 22.

Table 22: Summary of constraints and opportunities along vegetable value chain

Stage of value chain	Constraints	Opportunities	Intervention needed
Inputs supply	-Shortage of good quality seed, herbicides/pesticides, farm implements -High cost of inputs	-High demand for purchase quality seed, chemicals and farm implements -Being neighbors of HARC -Demand for compost application	-Government support for easy access to inputs -Strengthen linkage between input suppliers and farmers -strengthening research center
Production	-Reduction of irrigation water availability -Limited knowledge on recommended agronomic practice and post-harvest handling -Low irrigation facility -Diseases and pest attacks -Lack of storage and high post-harvest loss	-Availability of underground water -Availability of daily laborer and human resource development -Favorable climatic conditions and fertile land for vegetables production -Enabling policy environment and support from public organization and NGOs	-Concerned bodies should give attention to underground water -Conduct trainings to farmers for improved quality production and post-harvest handling -Training to smallholders on disease/pest control method -Strengthen credits service providers institutions and improve storage facility
Marketing/Trading	-Poor transport facility -Price setting problem -Product quality problem -Presence of unlicensed traders -Lack of product standard -Low price for the products and perishability of the product -Limited function of cooperatives -Limited market research and credit service	-Government investment on infrastructure development -Establishment of cooperatives -High market demand for vegetables product -Establishments of credit providers -Closeness of study areas to Addis Ababa city -Government encourage research	-Strengthen functions of farmers cooperatives -Control unlicensed traders -Increase credibility and market linkages of vegetables value chain actors -Domestic market and export market promotion -Improving farmers bargaining power by supporting farmers cooperatives
Processing	-Lack of processing facility	-Active involvement of private sector in the industry	-Encourage private to invest on the sector
Consumers	-Income shortage -Lack of consumers cooperatives -High price of product	-High consumption preference	-Improve consumers awareness on consumption habits of vegetables

Source: Own survey results, 2015.

Marketing Channels and Marketing Margin

Marketing channel

Marketing channel and marketing margins were used in the analysis of supply chain performance. Four parameters are necessary to measure the efficiency of a channel. These are quantity handled, producer's share, total marketing margin, and rate of return. Out of these volumes handled, producer's share and marketing margin were considered for all the potato and onion in this study. Consequently effectiveness is defined as the ability of the marketing channels to result to (or offer) proper service outputs or the right services in relation to consumer preferences. In essence therefore, identification of the marketing chain precedes its analysis. Marketing channels are defined as alternative routes of product flows from producers to consumers, (Kohls and Uhl, 1990). According to Adugna (2009), a marketing channel involves a series of intermediaries through which vegetables pass from producers to consumers. This section presents results for the identified marketing channels.

Potato marketing channels

Producers sell potato through different channels. Five marketing channels of potato are exhibited in the study areas. It was estimated that 1676 quintals of potato were supplied to market by sampled farmers. Wholesalers and retailers were the main receivers of potato with percentage shares of 53.8% and 20%, respectively (Figure 6). The market channels identified during the survey were:

Channel I: Producer-Consumer: This channel is the shortest channel at which producers directly sell to consumers at market day. It represented 15.2% of the total potato marketed which amounted to 254.8 quintals of potato during the survey period.

Channel II: Producer-Rural collector-Wholesaler-Central retailer-Consumer: Rural collectors are buying potato from producers in the study area and they sell to wholesaler. It accounted for 11% of total potato marketed 184.36 quintals during the survey period. The channel was found to be the second least important in terms of volume.

Channel III: Producer-District retailer-Consumer: District retailers in the production area buy with or without the involvement of brokers depending on the volume of the product and resale to consumer. It represented 20% of total potato marketed 335.2 quintals during the survey period. The channel was found to be the second most important marketing channel in terms of volume.

Channel IV: Producer-Wholesaler-Central retailer-Consumer: This is the largest and most important channel, accounting for approximately 44.39% of total marketed volume of potato 744.14quintals during survey year. Wholesalers buy potato at the farm gate or at local market through brokers or directly from producers and sell it to retailers in Addis Ababa.

Channel V: Producer-Wholesaler-Processor-consumer: The only difference between the channel IV and channel V is that the wholesaler buys from producer and sold to hotels, café or institutions. It accounted for 9.39% of total potato marketed (157.5 quintals) during the survey period.

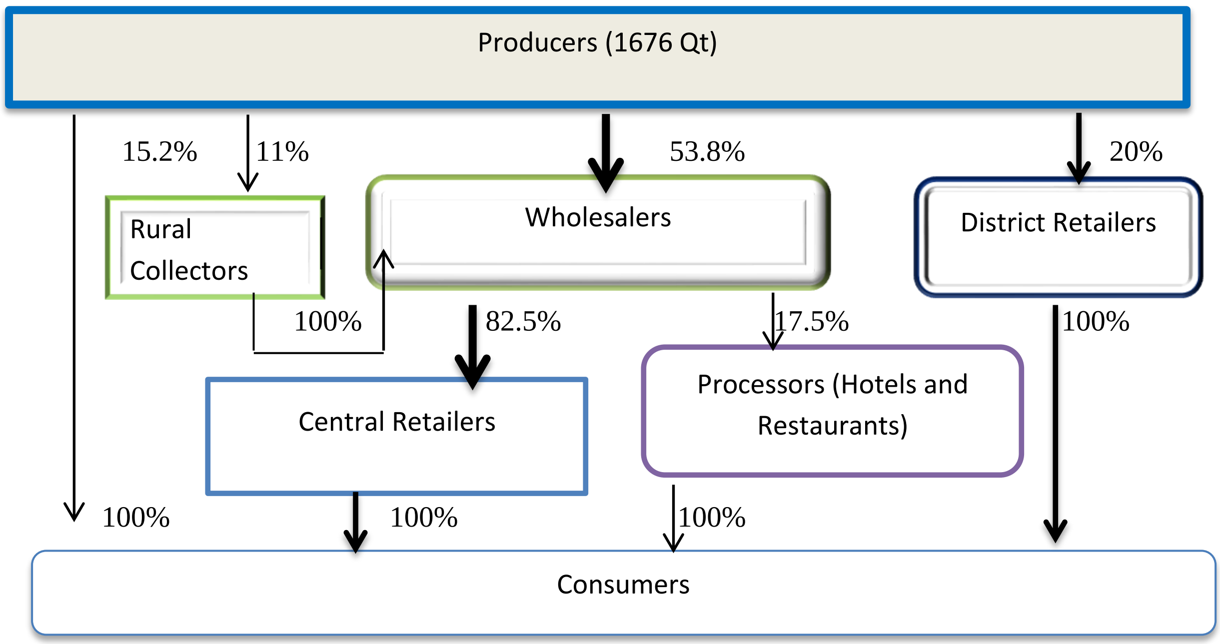


Figure 6: Potato marketing channel

Source: Own sketch from survey result, 2015.

Onion marketing channels

Six main alternative channels were identified for onion marketing. These marketing channels were identified from the point of production until the product reaches the final consumer through different intermediaries with proportion of onion marketed as indicated in Figure 8. The amount of onion transacted in these market channels was different. Out of total 4,083.75 quintals of onion marketed by sampled households during survey year 1,732.7quintals was marketed through channel IV and 910.67 quintals was through channel III which were found to be dominant in terms of onion volume of transaction. The survey results revealed that wholesalers and retailers were the dominants receivers of onion with percentage share of 54.7% and 22.3%, respectively in terms of volume of onion supply (Figure 7).

Channel I: Producer-Consumer: This channel is the shortest channel at which producers directly sell to consumers at market day. It represented 14.7% of the total onion marketed which amounted 600.31quintals of onion during the survey period.

Channel II: Producer-Rural collector-Wholesaler-Central retailer-Consumer: Rural collectors are buying onion from producers in the study area and they sell to wholesaler. It accounted for 8.3% of total onion marketed (338.95quintals) during the survey period.

Channel III: Producer-District retailers-Consumer: Districts retailers in the production area buy without the involvement of brokers depending on the volume of the product and resale to consumer. It represented 22.3% of total onion marketed 910.67quintals during the survey period. The channel was found to be the second most important marketing channel in terms of volume.

Channel IV: Producer-Wholesaler-Central retailer-Consumer: This is the largest and most important channel, accounting for approximately 42.4% of total marketed volume of onion 1,732.7quintals during survey year. Wholesalers buy potato at the farm gate through brokers or directly from producers and sell it to retailers.

Channel V: Producer-Wholesaler-Processor-Consumer: The only difference between the channel IV and channel V is that the wholesaler buys from producer and sold to hotels, café or institutions. It accounted for 7.49% of total onion marketed (306.12quintals) during the survey period.

Channel VI: Producer-Wholesaler-District retailer-Consumer: Wholesalers are buying vegetable from onion producers in the study area and they distribute to district retailers. It accounted for 4.77% of total onion marketed 195quintals during the survey period.

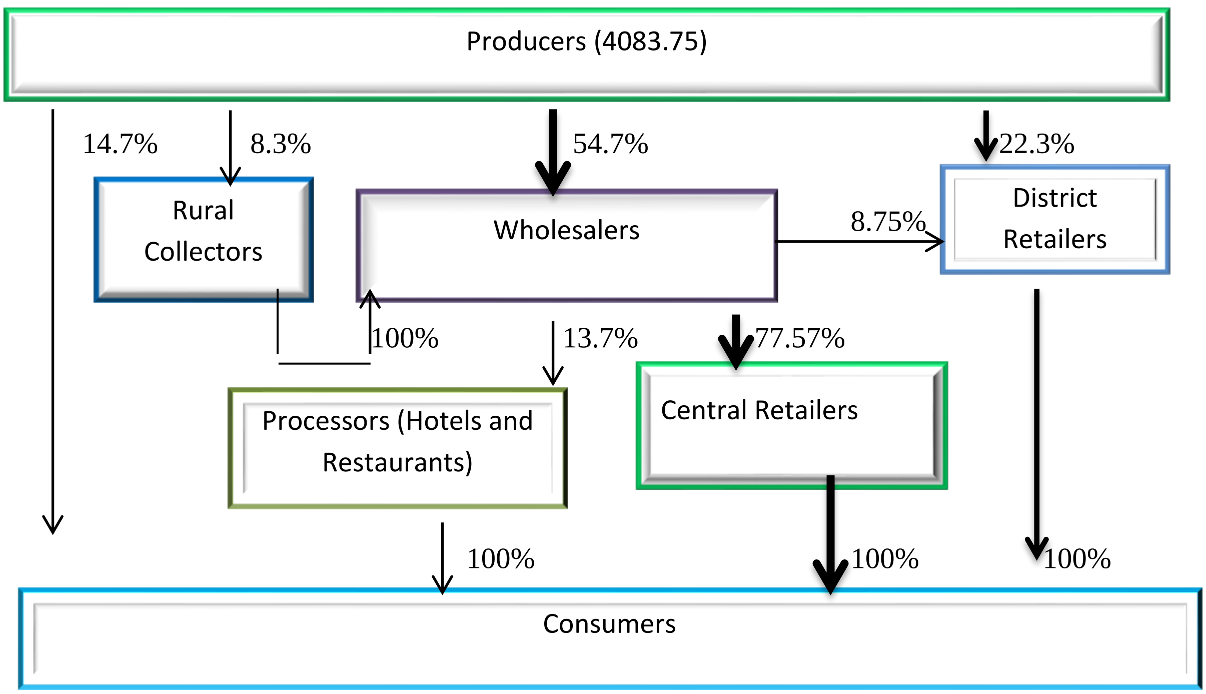


Figure 7: Onion market channel

Source: Own sketch from survey result, 2015.

Marketing margin analysis

Margin determination surveys should be conducted parallel to channel surveys based on price (payment) received or selling price to calculate the margin. A systematically recording of prices at different levels of marketing chain during a two to three week period is sufficient to calculate quite accurately the relevant marketing margins (Pomeroy and Trinidad, 1995).

Potato marketing cost and margin analysis

Marketing costs are estimated to compute the share of profit captured by key actors in the marketing chain. Table 23 shows the average marketing costs incurred by every actor during transaction. The highest marketing cost was incurred by the wholesalers (132.51 birr/qt) followed by rural collectors (92 birr/qt). This is because wholesalers transport costs is higher to reach Addis Ababa market and specialized labor for the packing, loading and unloading is relatively expensive in the terminal market. Average production cost of producers was (73.03 birr/qt) when they sold to consumers and district retailers while 43.03 birr/qt when they sold to collectors because no transportation cost.

Table 23. Potato average marketing costs for different marketing agents (Birr/qt)

Cost of marketing	Actors				
	Producers	Rural collectors	District retailers	Wholesalers	Central retailers
Sack	10.3	10	10	10	10
Load/unload	11.5	7	18.43	10.17	5.5
Labor for packing		5	7.43	5	
Transport	30	25		40	
Storage cost				6.67	10.45
Telephone cost		5	2	3	
Wastage Loss	17.23	9	10	12.67	15.45
Personal expense				8	
Brokerage				10	
Tax	4	7	7.57	12	12
Others cost		24	15	15	10
Total cost	**73.03**	**92**	**70.43**	**132.51**	**63.4**

Note: - qt=quintals

Source: Own computation from survey results, 2015.

Tables 24. Potato marketing margin for different channels (Birr/qt).

Agents		Potato marketing channel				
		I	II	III	IV	V
Producers	Purchase price					
	Production cost	184.42	184.42	184.42	184.42	184.42
	Marketing cost	73.03	43.03	73.03		
	Selling price	500	416	413.33	418.5	418.5
	Market profit	242.55	188.55	155.88	234.08	234.08
	GMM_P (%)	100	46.22	65.76	46.5	53.32
Rural collectors	Purchase price		416			
	Production cost					
	Marketing cost		92			
	Selling price		550			
	Market profit		42			
	GMM_{RC} (%)		14.89			
District retailers	Purchase price			413.33		
	Production cost			-		

	Marketing cost			70.43		
	Selling price			628.57		
	Market profit			144.81		
	GMM_{DR} (%)			34.24		
Wholesalers	Purchase price		550		418.5	418.5
	Production cost					
	Marketing cost		132.51		132.51	132.51
	Selling price		785		785	785
	Market profit		102.49		233.99	233.99
	GMM_W (%)		26.11		40.72	46.68
Central retailers	Purchase price		785		785	
	Production cost					
	Marketing cost		63.4		63.4	
	Selling price		900		900	
	Market profit		51.6		51.6	
	GMM_{CR} (%)		12.78		12.78	
	TGMM (%)	0	53.78	34.24	53.5	46.24

Source: Own computation from survey results, 2015.

Table 24 clearly depicted differences between the total income from potato trading and the costs incurred in the process of potato trading which gives the marketing profit of each actor namely producers, rural collectors, district retailers, wholesalers and central retailers. The results showed that to potato producers market profit was highest when they direct sell consumers in channel I which is 242.55 birr/qt and wholesalers in channel IV and V which is 234.08 birr/qt while take lowest market profit when they direct sell to district retailers and collectors which accounts, 155.88 birr/qt and 188.55 birr/qt, respectively. This implies producers are more profitable if they sold to wholesalers and consumers. From traders wholesalers shared the highest profit 233.99 birr/qt when they made direct purchase from producers in channel IV and V and they sold to central retailers and processors. District retailers gained the second highest profit 144.81 birr/qt on channel III, if they bought from producers and they sold to consumers. Potato rural collectors made a profit of 42 birr/qt on channel II. This implies that district retailers and wholesalers were received the highest remuneration from potato marketed in the study area while central retailers and rural collectors took the smallest profits shares from potato value chain (Table 24).

As indicated in Table 24, total gross marketing margin (TGMM) is highest in channel II and IV which was 53.78% and 53.5%, respectively and lowest in channel III which was 34.24%. Producer's share (GMMp) was highest in channel III which account 65.76% from the total consumers' price and lowest in channel-II and IV which is 46.22% and 46.5, respectively. This difference might support the theory that as the number of marketing agents increases the producers share decreases. The reason being, the higher number of middlemen in the commodity market, the more profit they retain for their services whether they add value to the item or not. The results also shows that the maximum gross marketing margin from traders was taken by wholesalers, which accounts 46.68% of the consumers' price in channel V and 40.72% in channel IV followed by district retailers which was 34.24% in channel VI. This implies share of market intermediaries in the consumer's price was substantial and there was a need to reduce market intermediaries to minimize the marketing margins and thereby enhance the producers' income. The minimum gross margin is taken by central retailer which was 12.78% in channel II and IV.

Onion marketing cost and margin analysis

Table 25 indicates different types of marketing cost related to the transaction of onion by producers, rural collectors, district retailers, wholesalers, and urban retailers. The different average transaction costs associated with the marketing process of a single quintal till it reached the next dealer was assessed. The highest marketing cost is incurred by the wholesaler which was 131.58 birr/qt while central retailers incurred the lowest market cost which was (46.9 birr/qt). Average marketing cost of producers was 93.23 birr/qt when they sell to consumers and district retailers while 63.23 birr/qt when they sell to collectors.

Table 25: Onion average marketing cost for different marketing agents (Birr/qt)

Cost of marketing	Actors				
	Producers	Rural collectors	District retailers	Wholesalers	Central retailers
Sack	10.3	10	10.42	9	10
Load/unload	12	7	15	12.91	10
Labor for packing		5		5	
Transport	30	25		35	
Storage cost			12.5	15	10.45
Telephone cost		3	2	3	
Wastage Loss	30.23	12.4	20.5	12.67	5.45
Personal expense				5	
Brokerage				12	
Tax	4	4	7.57	12	12
Others cost	6	10	15	10	10
Total cost	**93.23**	**76.4**	**82.99**	**131.58**	**57.9**

Source: Own computation from survey results, 2015.

The difference between the total income from onion trading and the costs incurred in the process of onion trading gives the marketing profit of traders. As depicted in the Table 26, producers marketing profit share was highest 606.5 birr/qt when they directly sell to wholesalers in channel IV, V and VI followed when they sell to consumers which accounts 569.52 birr/qt in channel I while took lowest profit when they direct sell to district retailers and collectors which accounts, 507.02 birr/qt and 537.02 birr/qt in channel III and II, respectively. From traders the highest marketing profit was taken by district retailer 259.51 birr/qt in channel III followed by wholesalers which is 182.97 birr/qt in channel IV and V and the lowest market profit share was taken by central retailers which is 25.5 birr/qt in channel II and IV.

Tables 26: Onion marketing margin for different channels (Birr/qt)

Agents		Onion Marketing Channel					
		I	II	III	IV	V	VI
Producers	Purchase price						
	Production cost	237.25	237.25	237.25	237.25	237.25	237.25
	Marketing cost	93.23	63.23	93.23			
	Selling price	900	837.5	837.5	843.75	843.75	843.75
	Market profit	569.52	537.02	507.02	606.5	606.5	606.5
	GMM_P (%)	100	67.45	70.98	67.95	72.84	70.32
Rural collectors	Purchase price		837.5				
	Production cost						
	Marketing cost		76.4				
	Selling price		950				
	Market profit		36.1				
	GMM_{RC} (%)		9.1				
District retailers	Purchase price			837.5			1000
	Production cost						
	Marketing cost			82.99			82.99
	Selling price			1180			1200
	Market profit			259.51			117.01
	GMM_{DR} (%)			29.02			16.67
Wholesalers	Purchase price		950		843.75	843.75	843.75
	Production cost						
	Marketing cost		131.58		131.58	131.58	89.58
	Selling price		1158.3		1158.3	1158.3	1000
	Market profit		76.72		182.97	182.97	66.67
	GMM_W (%)		16.78		25.33	27.16	13.02
Central retailers	Purchase price		1158.3		1158.3		
	Production cost						
	Marketing cost		57.9		57.9		
	Selling price		1241.7		1241.7		
	Market profit		25.5		25.5		
	GMM_{CR} (%)		6.72		6.72		
	TGMM (%)	0	32.55	29.02	32.05	27.16	29.68

Source: Own computation from survey results, 2015.

As indicated in Table 26, total gross marketing margin (TGMM) is highest in channel II and IV which was 32.75% and 32.05, respectively and lowest in channel V which was 27.16%. The survey results also showed that the maximum producer's share (GMMp) is highest in channel V which was 72.84% from the total consumers' price and lowest in channel II and IV which was 67.45% and 67.95%, respectively. From traders, district retailers' obtain maximum gross margin, which is 29.02% of the consumers' price in channel III and followed by wholesalers' which accounts, 27.16% and 25.33% in channel V and IV, respectively. The lowest gross marketing margin was taken by central retailers' and rural collectors in channel II which is 6.72% and 9.1%, respectively.

Econometric Results

In this section, the selected explanatory variables were used to understand the determinants of volume of potato and onion supplied to market and for estimates determinants of producers' market outlet choices decisions.

Determinants of volume supplied to market

Analysis of determinants affecting farm level volume supply of potato and onion were found to be important to identify factors constraining potato and onion supply to market. Prior to fitting multiple linear regressions, the hypothesized explanatory variables were checked for existence of multicolliniarity, heteroscedasticity and endogeniety problem.

Test of multicolliniarity: All VIF values are less than 10. This indicates absence of serious multicollinearity problem among independent variables. If there is presence of multicolliniarity between independent variables, it is impossible to separate the effect of each parameter estimate in the dependent variables. It is thus, important to test multicolliniarity between explanatory variables.

Test of heteroscedasticity: Since there is heteroscedasticity problem in the data set, the parameter estimates of the coefficients of the independent variables cannot be BLUE. Therefore, to overcome the problem, Robust OLS analysis with heteroscedasticity consistent covariance matrix was estimated.

Test of endogeneity: When a variable is endogenous, it will be correlated with the disturbance term, hence violating the OLS assumptions and making our OLS estimates biased. Testing for endogeneity of productivity of potato and onion were carried out in the model using both Hausman test and Durbin-Wu-Hausman (DWH) test and endogeneity problem were found in productivity variable in both potato and onion. Hausman test result indicated that, the predicted productivity was statistically significant with (p= 0.084 for potato and p= 0.036 for onion) when included as additional explanatory variable in structural model which implies hypothesized productivity variables endogenous due to correlated with error term. Durbin Wu-Hausman test results also shows that the null hypothesis of exogeneity of the productivity of potato and onion were rejected at 10% and 1% probability level (χ^2 =3.011 and P-value = 0.082) and (χ^2 =8.155 and P-value = 0.004), respectively using estat endogenous STATA command after ivregress. Therefore, two stages least square (2SLS) method was used to address the endogeneity problem.

Two-stage least squares is a poor strategy for estimation and hypothesis testing when instruments are weak and the model is over-identified. To overcome the endogeneity issue that two stage least technique requires valid instrumentals variables. Therefore, for this study relevance tests of excluded variables were made using F statistic from the first stage regression using estat firststage STATA command. The F test result for productivity of potato was"24.14" and for productivity of onion was "37.15" (a general rule of thumb is that if F test is less than 10 there is cause for concern). So we should reject the null hypothesis presence of weak instruments hence our statistics greatly exceeded the critical values (Appendix Tables 7 and 8). Overidentifying restrictions test was also tested using Hansen-Sargan test and Basmann test using estat overid command. The results of Basmann test show a P-value of 0.6133 and 0.5148 for potato and onion, respectively, and which indicated the model is correctly specified and the instruments are valid.

Determinants of volume of sales of potato

Two stages least square (2SLS) method was used to identify factors affecting the volume of potato sold to the market by potato farmers in the study area.

Table 27: Determinants of farm level volume sales of potato (2SLS estimates)

Variables	Coef.	Robust Std.Err	t-value
Constant	-12.248***	3.772	-3.25
Productivity of potato	0.270***	0.031	8.66
Sex of households heads	4.563**	1.855	2.46
Education status of households	-1.105	1.458	-0.76
Family size	-0.380	0.294	-1.29
Distance from nearest market	0.033***	0.011	3.04
Farming experience	0.251	0.383	0.66
Off/non-farm income	2.611*	1.479	1.77
Land allocated for potato	84.561***	6.829	12.38
Ownership of motor pump	1.701	2.188	0.78
Extension contact	0.032	0.057	0.56
Number of observation		78	
F(10, 67)		32.21	
Prob>F		0.0000***	
R-Squared		0.8480	

Note: Dependent variable is quantity of potato supplied to market in quintal in 2015.
***, ** and * are Significant at 1%, 5% and 10% level of probability, respectively.
Source: Own computation from survey result, 2015.

In the first stage of 2SLS method, regressions was run and analyzed using eleven explanatory variables including instrumentals variables and the result shows that, amount fertilizer application, improved seed and sex of the households head were affects positively and significantly the productivity of potato. Amount of fertilizer applied for potato production and improved seed were used as instruments for productivity. In second stage of 2SLS from hypothesized ten explanatory variables five variables productivity, sex of households, distance from nearest market, access of off/non-farm income and land allocated for potato significantly influence volume sales of potato.

As depicted in Table 27, the model was statistically significant at 1% probability level indicating the goodness of fit of the model to explain the relationships of the hypothesized variables. Coefficient of multiple determinations (R^2) was used to check goodness of fit for the regression model. Hence, R^2 indicates that 85 percent of the variation in the quantity of potato supplied to market was explained by the variables included in the model. The explanation on the effect of the significant explanatory variables is discussed below.

Productivity (YILDPOT): As hypothesized the regression coefficient of potato productivity was positively and significantly related with potato quantity supplied to market at 1% probability level. The positive and significant relationships between the two variables indicate that potato productivity household is very important variable affecting household head volume of potato supply. The coefficient for productivity of potato implies that an increase in productivity of potato by one quintal per hectare resulted in an increase in farm level marketed surplus of potato by 0.270 quintals, keeping other factors constant. Previous studies for example, Rehima, (2006); Kindie, (2007) and Bosena, (2008) showed that the amount of red pepper, sesame, and cotton produced by households significantly and positively affected the marketable supply of each of the commodities, respectively. Ele *et al*. (2013) also found that total quantity of crops produced have a significant and positive relationship with the degree of commercialization.

Sex of Household Head (famsz): This variable was found to be positive and statistically significant influence on potato volume supply to market at 5% level of significance. The positive sign shows being a male head of a household significantly increase potato quantity supplied to market by 4.563 quintals as compared to that of female-headed households, keeping other variables constant. The reason behind male headed households supplied more potato to market than female headed households, is that females can take higher care than males about households consumption by saving from produce to feed household; this can reduce the quantity to be sold. This is consistent with the finding of Mahlet *et al*. (2015) who found that gender of the household head positively and significantly influenced potato marketed supply of potato. The authors stated as the reason that male headed households have better financial capability, better land size, better extension contacts, and better access to market information than female headed households. Toyiba *et al*. (2014) also found that the sex of the household head had a positive and significant effect on the volumes of papaya sold in to the market.

Distance from the Nearest Market (DNMKT): This variables result contrary to the hypothesis, showed distance from the nearest market was found to be positive and significant influence on the volume of potato supplied to market at 1% probability level. As the distance from the nearest market increases by one walking minutes, it resulted in increased farm level marketed surplus of potato by 0.033 quintals, keeping other factors constant. These variable affected dependent variables positively because of the households far from nearest markets have more access of irrigation water use and have large size of farmland which assist them to increase their potato production and sales of the crops compared to households closer to market. Similar to this, the results by Sebatta (2013) and Habtamu (2015) found that distance from the nearest market had a positive and significant effect on potato farmer's decision to participate in the market in Uganda and Hadiya Zone of Ethiopia, respectively.

Off/Non-Farm Income (offarm): This variable was significant (10%) and positively influenced the household heads volume sales of potato. This is just a contrary to the hypothesis set earlier. The result shows that households who earn income from non/off-farm activity sold 2.611 quintals more potato than those who did not have access, by holding other factors constant. This may due to the fact that farmers who had cash from these sources used as supplementary income to purchase inputs like improved seed, fertilizers, chemicals and farm implements for vegetable production and thus supplied more potato to market than those who had not because they are business oriented. This result is consistent with Adenegan *et al*. (2012) who found that access to non-farm income influenced volume of maize supplied to market positively and significantly. They explain that farmers with an additional source of income will be willing to take risk in producing more for the market.

Land Allocated for Potato (areapotato): The result shows that land allocated for potato has significant effect on volume of sales of potato at 1% significant level with expected positive sign. The positive sign of the coefficient implies that the larger the land size allocated for potato production the larger the quantity produce and thereby increasing the quantity of produce available for sale. Thus, the per unit production costs will be lower due to the economics of scale. Increase in the size of one hectare of land allocated for potato is increase volume sales of potato by 84.561quintals, keeping other factors constant. In support of the finding here, Wubshet (2010), Alemnew (2011), and Toyiba *et al*. (2014) indicated that the area of land allocated for coffee, red pepper and papaya production affected farm level marketed supply of each commodity significantly and positively.

Determinants of volume sales of onion

In the first stage of 2SLS method, regressions was run and analyzed using eleven explanatory variables including instrumentals variables and the result showed that, amount fertilizer application, improved seed and education level of household head affects significantly the productivity of onion. Amount of fertilizer applied for onion production and improved seed are used as instruments for productivity variables.

As depicted in Table 28, in second stage of 2SLS ten explanatory variables was used to influence the volume sales of onion; from those four variables productivity of potato, education level of household, farming experience, and area of land allocated for onion were affects positively and significantly the amount of quantity of onion supplied to market. The result shows that the model was statistically significant at 1% level indicating the goodness of fit of the model to explain the relationships of the hypothesized variables. Coefficient of multiple determinations (R^2) was used to check goodness of fit for the regression model. Hence, R^2 indicates that 83% of the variation in the farm level marketed supply of onion was explained by the explanatory variables included in the model.

Productivity (YILDPONI): As hypothesized the regression coefficient of onion productivity variable was positively related with onion quantity supplied and significantly at 1% probability level. The value of the coefficient for productivity of onion implies that an increase in productivity of onion by one quintal per hectare resulted in an increase in farm level volume sales of onion by 0.210 quintals, keeping other factors constant. The higher the onion productivity the greater the tendency for the farmers to supplied onion to market. The reason for this could be attributed to the low rate of onion consumption by the household members, which makes large quantity of onion the produced per hectare large available for sale in the market. This result matches with earlier findings by Muhammed (2011) and Amare (2013) who found that the amount of teff and pepper produced by household affected marketable supply of each of the commodities significantly and positively, respectively. Similarly the study by Mahlet *et al*. (2015) indicated that potato quantity produced affects marketed supply of potato positively and significantly

Table 28: Determinants of farm level volume sales of onion (2SLS estimates)

Variables	Coef.	Robust Std.Err	t-value
Constant	-25.042*	13.237	-1.89
Productivity of onion	0.210***	0.068	3.08
Sex of households	-1.024	5.851	-0.18
Education status	8.074*	4.418	1.83
Family size	0.777	0.659	1.18
Distance from nearest market	0.036	0.045	0.79
Farming experience	2.060**	0.884	2.33
Off/non-farming income	1.446	4.154	0.35
Land allocated for onion	106.095***	14.849	7.14
Ownership of motor pump	-2.037	4.216	-0.48
Extension contact	0.263	0.187	1.40
Number of observation		85	
F(10,74)		12.51	
Prob>F		0.0000***	
R-Squared		0.8353	

Note: Dependent variable is quantity of onion supplied to market in quintal in 2015.
***, **and * Significant at 1%, 5% and 10 level of probability, respectively.
Source: Own computation from survey result, 2015.
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Education Level (EduHH): Education has showed positive effect on onion quantity supplied to market with significance level at 10%. The survey results revealed that, if onion producer gets educated, the amount of onion supplied to the market increases by 8.074 quintal, keeping other factors constant. This may be because majority of the farmers in the study area have minimum education requirements to make them market oriented and thus enable them to have better skills and better access to information to supply more onion to market. This is also in line with previous studies conducted by Astewel (2010) and Ayelech (2011), who found that if paddy and avocado producer gets educated, the amount of paddy and avocado supplied to the market increases, respectively. Amare (2013) also reported that education level of farmers exhibited a significant and positive effect on the marketed surplus of pepper.

Farming Experience (exper): The result showed that vegetables farming experience of households has significant effect at 5% significant level for onion quantity sold with expected positive sign. Thus, the result implied that, as farmer's experience increase by one year, the onion supplied to market increased by 2.060 quintals, keeping others factors constant. This means that the farmers with more experience in onion production and marketing have higher ability to sell more onion produces in the market than less experience because they have more marketing network and information. This is in line with finding of Abay (2007), Ayelech (2011), and El *et al*. (2013) who illustrated as farmer's experience increased the volume of tomato, avocado and crops supplied to the market has increased, respectively.

Land Allocated for Onion (areaonion): The result has showed significant effect at 1% significant level for onion with expected positive sign. Increase in the size of one hectare of land allocated to onion resulted in an increase in volume of onion by 106.095 quintals, keeping other factors constant.

Households with larger land size are relatively better off because it allows the household to have a surplus production above subsistence needs and enable them to sell products for market. An increase in farm size naturally implies an increase in output which leads to increase marketed surplus. This a line with previous study by Aman *et al*. (2014) who found that the size of land allocated for horticultural crops affected the smallholder commercialization of horticultural crops positively and significantly Kindie (2007) also found that the area of land allocated for sesame production in Metema district significantly and positively affected farm level marketable supply of sesame.

Determinants of market outlet choices

Based on findings of the multivariate probit (MVP) models, the difference, similarities and significance of the determinants influencing producers' decision in market outlet choice were discussed in this section. Empirical results of the multivariate probit models showed that the correlation coefficients of the error terms in models had positive as well as negative signs, indicating that there is interdependency between the different market outlet choices by the farmers. In other words, these opposite signs of the correlation coefficients revealed that there are complementarities (positive correlation) and competitive (negative correlation) between different markets outlets option being used by the farmers.

Determinants of potato producers' market outlets choice

The model fits the data reasonably well. The Wald test $(\chi^2(48) = 163.73, \mathrm{p} = 0.000)$ is significant at the 1% level, which indicates that the subset of coefficients of the model is jointly significant and that the explanatory power of the factors included in the model is satisfactory. Furthermore, results of likelihood ratio test in the model $(\mathrm{LR}\,\chi^2(6) = 20.567,\ \mathrm{p} > \chi^2 = 0.0022)$ is statistically significant at 1% level, indicating that the independence of the disturbance terms (independence of market outlets choice) is rejected and there are significant joint correlations for two estimated coefficients across the equations in the models. The likelihood ratio test of the null hypothesis of independence between the market outlets decision ($\rho_{21} = \rho_{31} = \rho_{41} = \rho_{32} = \rho_{42} = \rho_{43} = 0$) is significant at 1%. Therefore, the null hypothesis that all the ρ (Rho) values are jointly equal to 0 is rejected, indicating the goodness-of-fit of the model. Hence, there are differences in market outlet selection behavior among farmers, which are reflected in the likelihood ratio statistics.

Separately considered, the ρ values (ρ_{ij}) indicate the degree of correlation between each pair of dependent variables. The ρ_{31} (correlation between the choice for wholesaler and consumer outlet) and ρ_{42} (correlation between the choice for retailer and rural collector outlet) are negatively interdependent and significant at the 1% probability level indicating a competitive relationship of wholesaler outlet with consumer outlet and retailer outlet with rural collector outlet (Table 29). This shows that in potato marketing producers used consumer outlets as substitute for wholesaler outlets, and rural collector outlets as substitute for retailer outlets in Ejere district. The simulation results also indicate that the probability that potato producers choose wholesaler, retailer, consumer, and rural collector market outlet were 73%, 66%, 68%, and 55%, respectively. The joint probabilities of success and failure of the four variables also suggest that it would be unlikely for households to choose all the four market outlet simultaneously, for their likelihood to do so was 11.9%.

As depicted in Table 29 below some of the variables used in the model were significant at more than one market outlets while some others were significant in one market outlet but not in the other outlet. Out of twelve explanatory variables included in multivariate probit model, four variables significantly affected wholesaler market outlet; one variable significantly affected retailer outlet; two variables significantly affected consumer outlet; and six variables significantly affected collector market outlet choices at 1, 5 and 10 percent probability levels.

Quantity of Potato Supply to Market (VVSpot): The finding reveals that, potato quantity sold was positively and negatively influenced the likelihood of choosing wholesaler and rural collector market outlet at 1% and 5% significance level, respectively. This implies that the larger potato quantity sold the more a farmer was likely to sell to wholesaler and less likely to sell to rural collector outlet. The positive coefficient further implies that households tend to increase association with wholesaler when the amount they sold increase because wholesaler has capacity to purchase large volume of potato. This may be because farmers producing small quantities have little opportunity to sell through wholesaler outlet and more likely to sell to rural collector outlet. This is a line with Bezabih *et al*. (2015) reported that the likelihood of choosing collector and retailer only market outlet was negatively and significantly affected by potato quantity sold.

Family Size (famsz): Family size is positively and significantly associated with selling potato to wholesalers at 1% significance level. This result shows that those households with large family size are more likely to choose wholesaler outlet than other market outlets. This may imply large household size is an indicator of labour availability which enables farmers to produce more potato and sell to wholesaler outlets. This is a line with Tewodros (2014) who reported that family size was positively significantly influences wholesale market participation.

Sex of households (SHH): Gender was positively and significantly associated with use of collector outlet at less than 1% significance level. It is also interesting to note that male head producers are more likely to deliver potato to collector outlet than female head households. Hence, by being male, a farmer had higher chances of selling potato to the different market outlets because male farmers have more contacts that are social with buyers whom they often meet in markets. Findings from other studies for instance Fischer and Qaim (2011) in a study to determine factors that affect group membership in Kenya also showed that female farmers were more likely than male farmers to join a marketing group, thus would most likely sell to a marketing group or cooperative.

Table 29. Multivariate probit estimations for determinates of potato producers outlets choice

Variables	Wholesalers		Retailers		Consumers		Collectors	
	Coef.	RSE	Coef.	RSE	Coef.	RSE	Coef.	RSE
Constant	-1.279	1.192	-0.372	1.086	1.785	1.126	-1.288	1.034
VVSpot	0.087***	0.026	-0.002	0.018	-0.001	0.020	-0.038**	0.018
SHH	-0.197	0.527	0.714	0.493	-0.127	0.457	1.408***	0.469
EduHH	0.607	0.442	-0.516	0.358	-0.719*	0.378	-0.399	0.344
famsz	0.266***	0.069	-0.097	0.062	-0.021	0.061	0.007	0.060
DNMKT	-0.007**	0.003	0.001	0.003	-0.001	0.003	-0.001	0.003
exper	0.170*	0.093	0.001	0.078	-0.026	0.072	0.097	0.059

offarm	0.161	0.398	0.386	0.354	0.793**	0.346	-0.651**	0.318
pricepot	0.001	0.001	-0.002**	0.001	0.001	0.001	0.001	0.001
ownmotor	0.263	0.436	0.035	0.371	0.098	0.394	-0.678*	0.364
TURST	-0.591	0.489	0.398	0.418	-0.136	0.437	-0.756**	0.380
Extcontact	-0.021	0.013	0.018	0.014	-0.009	0.015	0.008	0.014
areapotato	-2.465	2.035	-1.482	1.85	-1.472	1.931	4.261**	1.836
Predicted probability		0.730	0.666		0.679			0.551
Joint probability(success)							0.119	
Joint probability (failure)							0.001	
Number of draws (#)							5	
Observations							78	
Log Likelihood							-149.983	
Wald(χ2(44)							163.73	
Prob > χ2							0.0000***	

Estimated correlation matrix

	ρ_1	ρ_2	ρ_3	ρ_4
ρ_1	1.00			
ρ_2	-0.179 (0.244)	1.00		
ρ_3	-0.569*** (0.203)	-0.290 (0.185)	1.00	
ρ_4	0.298 (0.209)	-0.504*** (0.155)	-0.061 (0.179)	1.00

Likelihood ratio test of: $\rho_{21} = \rho_{31} = \rho_{41} = \rho_{32} = \rho_{42} = \rho_{43} = 0$:

$$\chi^2(6) = 20.567$$

Prob > χ2=0.0022***

Note: *, ** and *** indicate statistical significance at 10, 5 and 1%, respectively. RSE is Robust standard error, Y_1=Wholesalers, Y_2=Retailers, Y_3=Consumers and Y_4=Collectors,

Source: Own computation from survey result, 2015.

Education Level of Households (EduHH): Education level of households has negative and significant effect at less than 10% probability level on choosing of consumer outlet. The more educated a farmer is the less likely to sell potato through consumers because more educated farmers are less time spend on doing marketing activities. The negative relationship between education level and selling to consumer outlet can be explained by the fact that being educated enhances the capability of farmers in making informed decisions with regard to the choice of marketing outlets to sell their farm produce based on the marketing margin and marketing cost. A study by Nyaupane and Gillespie (2010) on factors influencing producers' marketing decisions in the Louisiana Crawfish Industry found that farmers with college degrees are more likely to sell their product via wholesalers and less likely to market via processors.

Distance from the Nearest Market (DNMKT): The result shows that, distance from nearest market is negatively associated with likelihood of farmers selling to wholesalers at 5% level of significance. It reflects the difficulty of remote households in delivering vegetables to wholesalers due to lack of market information and poor road facility to sell their product in wholesaler market outlet and sold to available outlet in local market. The finding of Chalwe (2011) showed that distance to nearest market was significantly and negatively related to best channel choice decision. The author reason out that most beans farmers are poor in resource endowment and lack transport resources, transportation costs associated with moving the produce to the market therefore discourage farmers to participate in markets far from their premises.

Farming Experience (exper): The likelihood of choosing wholesaler outlet was also positively and significantly affected by farming experience at 10% levels of significance. This result indicated that more experienced households in potato production were more likely to deliver potato to wholesaler outlet than less experienced farmers. The many years engaged in potato production and marketing gives the farmers desire to adjust their market links; trying alternative marketing outlets to increase sales volume or better prices all this to maximize profits. The relationship also implies that experienced farmers had better knowledge of cost and benefits associated with various potato marketing outlets; consequently they are likely to increase the quantities supplied through the wholesalers to benefit from economies of scale. Riziki *et al*. (2015) found that households with more experience in agro-pastoralism are assumed to be more exposed and venture into commercial activities like African indigenous vegetables marketing because they aware marketing and differences in profitability in the different marketing outlets.

Average Current Farm Gate Price of Potato (2015) (pricepot): Price is associated negatively and significantly at 5% level of probability with choosing retailer outlet. A negative sign on its coefficient indicates that as price of potato increase farmers were less likely to sell potato to retailer outlet. This may be due to the fact that retailer outlet offer low price for potato compared to others outlet which discourages farmers to choose retailer outlets. Therefore, market outlets that offer high potato price induce farmers to supply them more potato volumes. Marketing outlets that offered price premiums to farmers received lot of potato compared to those outlets which were offering low prices.

Off/Non-Farm Income (offarm): Contrary to prior expectation**,** availability of off/non-farm income has negative and significant relation with the likelihood of choosing collector outlet at 5% probability level. Farmers who have access to off/non-farm income have less possibility to choose rural collector outlet compared to those who have no access to off/non-farm income. The result may imply that producers with availability of off/non-farm income had capacity to transport their product to the nearest markets and sold to alternatives outlets.

Trust in Buyers (TURST): The variable was negatively and significantly associated with use of collector outlet at less than 5% significance level. The negative and significant results showed that households who trust in buyers are less likely to deliver potato to collector outlet. The study by Getachew and Nuppenau (2009) confirm this result who found that households' trustworthiness of traders rise sold their banana through wholesaler outlets than those who do not.

Ownership of Motor Pump (ownmotor): Ownership of motor pump has significant and negative relation with the likelihood of choosing collector outlet at 10% probability level. The negative sign indicate that farmers who had own motor pump are less likely to choose collector outlet compared to those who had not owned motor pump. This may be because ownership of motor pump enables farmers to produce more potato which induce them to choice large buying outlet (wholesaler).

Land Allocated for Potato (areapotato): Finally, those farmers who allocated more land for potato production was positively and significantly associated with collector outlet at 5% significance level. The positive sign on the land allocated for potato variable showed that a farmer with large land allocated for potato, compared to farmers with small potato land size would more likely to sell to a collector. This is a line with the finding of Mutura *et al*. (2015) who found that the size of the farm possessed by a household was positively related to choice of farm gate market channel over through cooperatives.

Determinants of onion producers' market outlets choice

The model fits the data reasonably well the Wald test $(\chi^2(48) = 118.91, p = 0.000)$ is statistically significant at the 1% level, which indicates that the subset of coefficients of the model are jointly significant and that the explanatory power of the factors included in the model is satisfactory. Furthermore, results of likelihood ratio test in the model $(\text{LR } \chi^2(6) = 13.903, \text{prob} > \chi^2 = 0.0319)$ is statistically significant at 5% level, indicated that the independence of the disturbance terms (independence of multiple market outlets) is rejected and there are significant joint correlations of the several estimated coefficients across the equations in the models. The likelihood ratio test of the null hypothesis of independency between the market channel decision ($\rho_{21} = \rho_{31} = \rho_{41} = \rho_{32} = \rho_{42} = \rho_{43} = 0$) is significant at 5%. Therefore, the null hypothesis that all the ρ (Rho) values are jointly equal to 0 is rejected, indicating the goodness-of-fit of the model. Hence, there are differences in market outlet selection behavior among farmers, which are reflected in the likelihood ratio statistics.

The ρ_{42} (correlation between the choice of rural collector and retailer outlet) and ρ_{43} (correlation between the choice of rural collector and consumer outlet) are negative and statistically significant at the 10% probability level, indicating a competitive relationship of collector outlet with retailer outlet and consumer outlet while ρ_{32} (correlation between choice of consumer and retailer outlet) are positive and statistically significant at 1% level of significance indicating complementarity relationships between retailer and consumer outlet (Table 33). This shows that in onion marketing producers use rural collector as a substitute for consumers and retailer outlets in Ejere district. The simulation results indicate that the probability that onion producers choice wholesaler, retailer, consumer, and rural collector market outlet were 75%, 64%, 60%, and 58%, respectively. The joint probabilities of success and failure of the four variables also suggest that it would be unlikely for households to choice all the four market outlet simultaneously, for their likelihood to do so was only 14.1%. As depicted in Table 30 out of twelve explanatory variables included in multivariate probit model, two variables significantly affected wholesaler market outlet; three variables significantly affected retailer outlet; five variables significantly affected consumer outlet; and three variables significantly affected collector outlet choices at 1, 5 and 10 percent probability levels.

Quantity of Onion Supply to Market (VVSonion): The likelihood of choosing wholesaler positively and significantly affected by volume supply to market at 1% levels of significance (Table 30). This result implies households who supply large output of onion accessed wholesaler market outlet compared to households who supply less because of wholesaler capacity to purchase large amount of onion product. The implication is that if the quantity of onion to be sold is large farmers' search a market outlet which buys large volume with high price. But, if the quantity to be sold is low, farmers are not forced to search price and market information. This finding is in line with findings of Muthini (2015) who found that farmers with a large number of mango trees were more likely to sell to export market relative to brokers. Similar findings explained the direct or positive relation between market channel choice decisions of different products with quantity sold (Chalwe, 2011 and Bezabih *et al*., 2015).

Table 30. Multivariate probit estimations for determinates of onion producers outlets choice

Variables	Wholesalers		Retailers		Consumers		Collectors	
	Coef.	RSE	Coef.	RSE	Coef.	RSE	Coef.	RSE
Constant	-3.187*	1.657	1.425	0.925	2.034**	0.938	-0.632	0.959
VVSonion	0.048***	0.016	0.010	0.007	0.007	0.008	-0.004	0.008
SHH	0.312	0.597	-0.228	0.366	-0.556	0.380	-0.024	0.397
EduHH	-0.352	0.451	-0.218	0.328	0.067	0.326	-0.033	0.323
famsz	-0.110	0.080	0.063	0.055	0.013	0.055	0.040	0.058
DNMKT	0.004	0.005	0.007**	0.003	0.0009	0.003	-0.006*	0.004
exper	0.085	0.116	-0.017	0.075	0.150*	0.082	-0.101	0.073
offarm	-0.093	0.471	-0.742**	0.363	-0.012	0.333	0.030	0.355
Priceoni	0.001	0.001	-0.001	0.001	-0.001*	0.001	0.001	0.001
ownmotor	-0.622	0.449	0.287	0.340	0.546*	0.329	0.402	0.336
TURST	0.265	0.448	-0.303	0.347	-0.765**	0.339	0.621*	0.342
Extcontact	0.057***	0.019	-0.010	0.012	-0.017	0.013	-0.001	0.012
areaonion	1.628	1.882	-2.496***	0.955	-2.108**	0.847	2.127*	1.218
Predicted probability		0.752		0.647		0.60		0.588
Joint probability(success)							0.141	
Joint probability (failure)							0.005	
Number of draws (#)							5	
Observations							85	
Log Likelihood							-165.248	
Wald(χ2(48)							118.91	
Prob > χ2							0.0000	

Estimated correlation matrix

	ρ_1	ρ_2	ρ_3	ρ_4
ρ_1	1.00			
ρ_2	-0.336 (0.252)	1.00		
ρ_3	-0.496 (0.303)	0.487***(0.176)	1.00	
ρ_4	0.322(0.255)	-0.340*(0.191)	-0.324* (0.187)	1.00

Likelihood ratio test of: $\rho_{21} = \rho_{31} = \rho_{41} = \rho_{32} = \rho_{42} = \rho_{43} = 0$:

$$\chi^2(6) = 13.802$$

Prob > χ2=0.0319**

Note: *, ** and *** indicate statistical significance at 10, 5 and 1%, respectively. RSE is Robust standard error, Y_1=Wholesalers, Y_2=Retailers, Y_3=Consumers, and Y_4=Collectors,

Source: Own computation from survey result, 2015.

Extension Contact Frequency (Extcontact): Number of extension contact has positive and significant influence with wholesaler outlet choice decision at 1% significance level. Households who were visited more by extension agent were more likely to deliver onion via wholesaler outlets than households less visited by extension agent. Extension contact enables the farmer to improve production methods hence leading to more output which in turn more likely to sell onion via wholesaler market outlet. This result is in line with the result obtained by Abraham (2013) who found negative impact of agricultural extension service on the probability of choosing collector and retailer outlets compared to wholesale outlet in vegetable market outlet choice.

Average Current Farm Gate Price of Onion (priceoni): This variable is associated negatively and significantly at 10% level of probability with selling onion to consumers. A negative sign on its coefficient indicates that farmers are less likely to sell onion to consumer outlet as farm gate price increase. The rationale behind is that price is the main driving force of suppliers, producers less likely to sell onion to consumer outlet when price rise because consumer purchase small amount when price high. Tsougiannis *et al*. (2008) noted that the choice of a marketing channel by dairy farmers heavily depended on the price offered by that channel.

Farming Experience (exper): The likelihood of choosing consumer outlet was positively and significantly affected by number of years that a farmer had been growing onion at 10 % levels of significance**.** Farmers who had been growing onion more years were found to be more likely to selling onion to consumer outlet than those with less year of experience. The positive associations may imply that more experienced farmers had better knowledge of cost and benefits associated with various onion market outlets; consequently they were more likely to choose consumer outlet to benefits by retailing to consumers at market day.

Distance to Nearest Market (DNMKT): Contrary to priori expectations, distance to the nearest market influences positively and negatively the likelihood of choosing retailer outlet and rural collector outlet at 5% and 10% significant level, respectively. Households whose residence are far from nearest market are more likely to sell their produce to retailer outlet and less likely to sell to collector outlet.

Off/Non-Farm Income (offarm): The probability of choosing retailer outlet is negatively and significantly influenced by availability of off/non-farm income at 5% significance level. This implies producers who are engaged in off/non-farm activities are less likely to sell onion to retailer outlet as compared to producers who not. This may be due to low price offered by retailer outlets the farmers prefer selling onion to others outlet than retailer outlets because they are profit seeker. Riziki *et al*. (2015) also found that off-farm income influence the choice of marketing outlet at the farm gate and local open air market.

Ownership of Motor Pump (ownmotor): Ownership of motor pump had a positive and significant influence on the choice of consumer outlet at 10% probability level. The positive sign show that farmers who have own motor pump are more likely to sell onion to consumer outlet compared to those farmers who had not. This may imply that farmers who had own motor pump for irrigation produce more onion and thus deliver their product to any of available outlets compared to those farmers who had not.

Trust in Buyers (TURST): The variable was positively and negatively associated with rural collector outlet and consumer outlet at less than 10% significance level. The positive and negative results showed that farmers who trust in traders are more likely to choose rural collectors for their onion product and less likely to choose consumer outlet. A good reputation and trustworthiness of traders increase farmers' commitment to these trader because it reduces opportunistic behavior and promotes cooperation and commitment in the relationship.

Land Allocated for Onion (areaonion): Finally, as expected, those farmers who allocated more land for onion production negatively and significantly associated with retailer and consumer outlet at 1% and 5%, significance level, respectively while positively and significantly associated with choice of collector outlet at 10%, significance level. This a line with Getachew and Nuppenau (2009) and Berhanu *et al*. (2013) who found that large land allocated for banana and potato positively and significantly affects the proportion sold through wholesale traders and cooperative milk market outlets, respectively.

Summary, Conclusion and Recommendations

Summary and Conclusion

Vegetable production provides an opportunity for market integration for smallholder farmers in west Shoa zone. Ejere district is suitable for vegetable production due to its favorable agro-ecology and availability of irrigation water. As survey results revealed in 2013/14 production season total production of vegetable in Ejere district was estimated to be 356,056.5 quintals on 2,427 hectares of land and, in 2014/15 about 430,825 quintals was produced on 3,143.5 hectares of land. This implies the production and coverage of lands by vegetables in Ejere district is increasing even if reduction of water availability was a major problem.

This study has analyzed vegetable value chain by focusing on potato and onion in Ejere district. The specific objectives of the study were identifying vegetable value chain actors, their respective roles and to draw up value chain map, analyze vegetables marketing cost and margins across market channels, analyzing the determinants of quantity of vegetable supply and market outlet choice decisions of vegetable producers. To address the objectives of the study, both quantitative and qualitative methodologies were used. The data were generated from both primary and secondary sources. The primary data were collected through personal interviews form a total of 185 respondents (120 producers, 30 traders and, 35 consumers) using structured and semi-structured questionnaires. Qualitative data were also collected through focus group discussions, key informants interviews and observations.

Descriptive statistics, gross margin and econometric model were used to analyze the data collected using (STATA Software Package). Two stage least square regression (2SLS) model was adopted to understand the determinants of potato and onion supply to market and multivariate probit model (MVP) to analyze factors affecting market outlet choice of farmers. The findings of this study are summarized as follows.
Out of 120 total households heads interviewed 80.8% were male headed while 19.2% were female headed households. The results revealed that 58.3% of sampled households had education while 41.7% of the sampled household heads are illiterate. The survey revealed that the mean land size of sampled households was 3.5 hectares and from total farm size 0.3 hectares and 0.42 hectares are land allocated for potato and onion, respectively.

The major actors involved in potato and onion value chain include input suppliers, producers, rural collectors, wholesalers, retailers, processors and consumers. Most producers sell their products to the traders while some of them sale for consumers. However, it is also found that wholesalers, retailers and collectors directly purchase the vegetables from the farmers. The study results indicate that the wholesalers assisted by the brokers are the main vegetables value chain governors. The producers' position in price negotiation and product quality definition is not good in the study area.

The overall vegetable value chains are constrained by a number of factors which hinder the development of vegetable value chain. At farm level, the major production constraints are shortage of good quality seed, high cost of inputs, lack of availability of adequate pesticides/herbicides, reduction of irrigation water, low irrigation facility, limited knowledge on the proper plantation, harvesting and post- harvest handling activities, diseases and pest attacks, lack of storage, and inadequate credit service. At marketing/trading stage, poor road and transport facility, price setting problem, poor market information, product quality problem, presence of unlicensed traders, lack of product standard, price fluctuation and perishability of the product as the major problems of vegetable marketing.

About five different potato market channels have been identified with each channels having different marketing margin. The results showed that potato producer's market profit was highest when they sell to consumers in channel I which is about 242.55birr/ qt and wholesalers in channel IV and V which is about 234.08 birr/qt while took lowest market profit when they sell to district retailers and collectors which is about 155.88 birr/qt and 188.55 birr/qt, respectively. The total gross marketing margin (TGMM) was highest in channel-II and IV which was about 53.78% and 53.5%, respectively and lowest in channel-III which was about 34.24%. Producer's share (GMMp) is highest (65.76%) from the total consumers' price in channel-III and lowest in channel-II (46.22%) because of the involvement of the intermediaries in this channel. It is observed that as the number of intermediaries' increases, the producer's share in consumer's price decreases.

About six different market channels of onion are also identified in the study area. Producers marketing profit share was highest (606.5 birr/qt) when they directly sell to wholesalers in channel IV, V and VI and lowest when they directly sell to district retailers which was about (507.02) birr/qt in channel III. From traders the highest onion marketing profit was taken by district retailer which was about (262.01 birr/qt) followed by wholesalers which was about (191.72 birr/qt). The total gross marketing margin was maximum (32.55%) in channel II and the minimum (27.16) in Channel V. Total gross marketing margin (TGMM) was highest in channel II and IV which accounts, 32.75% and 32.05, respectively and lowest in Channel V which was 27.16%. The maximum producer's share (GMMp) is highest (72.84%) from the total consumers' price in channel V and lowest (67.45%) in channel II.

Econometric result of the two stage least(2SLS) regression model indicated that yield of potato produced per hectare, sex of household head, distance to nearest market, access off/non-farm income and area of land allocated for potato are significantly determining the quantity of potato supplied to the market. Moreover, quantity of onion supply to market was significantly and positively affected by yield of onion produced per hectare, education level of households', farming experience and area of land allocated for onion.

The multivariate probit model applied in this study was specifically intended to investigate factors influencing the potato and onion farmers in choosing marketing outlets. The correlations between the potato producers choice of wholesaler and consumer outlet was negative and statistically significant, and correlation between retailer and rural collector outlet was also negative and significant. This shows that in potato marketing producers used consumer outlets as substitute for wholesaler outlets, and rural collector outlets as substitute for retailer outlets in Ejere district. This study has also shown that the potato farmers in the study area have made their choice of market outlets for their produce based on quantity of potato sold, education level of households, sex of households, family size, farmers experience, distance to nearest market, current farm gate price, access of off/non-farm income, trust in traders, ownership of motor pump and area of land allocated for potato.

Finally, multivariate probit results for onion producers outlets choice shows correlation between the choice of collector and retailer outlet and correlation between the choice of collector and consumer outlet are negative and significant while correlation between choice of consumer and retailer outlet are positive and significant. This shows that in onion producers use rural collector outlets as a substitute for consumers and retailer outlets in Ejere district while they used retailer outlets and consumer outlets as complementary. This study has also shown that from variables hypothesized to influence onion producers choice of market outlets, quantity of onion sold, extension contact, farmers' experience, distance to nearest market, access of off/non-farm income, current farm gate price of onion, trust in traders, ownership of motor pump and land size allocated for onion were among determinants which affect significantly onion producers to choose the alternatives market outlets.

Recommendations

The findings of this study enabled us to make the following recommendations for policy makers, developments actors and researchers who have strong interest in promoting vegetables production and marketing for equal benefits among value chain actors.

1. It is highly recommended to improve the input supply system so that farmers receive the right type of production inputs, quantity and quality needed at the right time. Improving system will protect farmers from purchasing low quality inputs by high inputs cost. The role of research institutes and universities are crucial in identifying high yielding and disease resistant varieties to improve production and productivity of vegetables.

2. In order to overcome irrigation water shortage government should give attention to scaled up underground water and other water sources to expand vegetables production and productivity. In the study area the irrigation practices and water management of the farmers are mostly based on instinctive knowledge, with no scientific support from the extension system. So that improving farmers' skill, knowledge and experience in use of the irrigation water efficiency will minimize problem of water shortage and create the capacity to expand production and increase the supply during high price seasons. Therefore, concerned bodies should give attention in introduction of various irrigation water techniques and agronomic practices.

3. Improving the business planning skills of smallholders' to produce diversified vegetables which can be targeted both for national and international markets is priority issues. Due to the lack of business knowledge and marketing system, farmers are unable to take farming as business. Therefore, there is a need to capacitate farmers by providing continuous training on production and marketing of vegetables.

4. Strengthening the linkage/interaction among value chain actors, there is a need to change the outlook of actors, by developing ground rules that will bind the relationship between producers and traders. In particular, positive attitudes toward partnership, interaction, networking and learning need to be developed among main actors in the value chain. So the chain actors should work in an integrated way to improve production, reduce post-harvest losses, and to strengthen sustainable market linkage in the study areas. In additions to this, organizing (voluntarily) traders and producers and establish trustful and strong trade agreements between the two institutions is crucial to minimize unfair price created by brokers. With a strong relationship between traders and producers, searching for market information and dissemination will be crucial.

5. Econometric analysis results of the study suggested that increase productivity of vegetables per unit of area of land through efficient utilization of land resource in the area. The concerned bodies should focus on increasing the productivity of vegetable crops per unit area of land through promoting and providing; improved seeds, training on production skill, technical support to farmers in agronomy practices, technical support in post-harvest handling that would increase productivity of smallholders and enables them to link up with crops output market.

6. The distance to the market places has also become important determinants of farmers in the marketing of potato crops. As a result, improving rural infrastructure in developing market infrastructure in the form of establishing produce collection points across rural areas would assist poor farmers for faster delivery of farm produces especially perishable commodities of vegetables crops. To improve the marketed surplus across farmers there is a need to focus on the female head households by improving, facilitating and giving priority for increasing production and market supply. Basing on the finding that smallholder off/non-farm incomes encourage volume of potato supplied to market, it is recommended, therefore, that potato farmers are promoted on investment of off/non-farm incomes as well as potato production.

7. As onion are the major cash crops in the area improving technical knowhow of farmers on vegetables farming experience and facilitating adult education are recommended for improvement of production and productivity of onion and to increase marketed surplus of onion in the study area. Land allocated for vegetables have also a positive influence on market supplied of potato and onion. So concerned bodies should focus on intensification of land to compensate through cash crop production and crop selection is the dominant strategies pursued by farming communities by using irrigation water wisely.

8. The econometric analyses of multivariate probit findings indicated that farmers have been influenced by different factors to choose appropriate marketing outlets to sell their vegetables product. The results of this study suggest several ways in which smallholder farmers can actively market their produce. The findings suggest that an adjustment in each one of the significant variables can significantly influence the probability of choice market outlets. Initially, expanding equal accessibility of infrastructures such as road and transportation facilities needs government intervention to promote the effective marketing of vegetables through all outlets.

9. The findings point to the need for increasing the quantity of potato and onion sold for choice of appropriate market outlets by improving productivity of vegetables. Policy makers should focus more on enhancing producers' marketed surplus of vegetable which could be attained through providing the marketing infrastructure, technical and organizational assistance, and access to markets and support to improve the farmers' bargaining power by establishment of farmers' organizations. Moreover, the concerned authority should be able to increase the awareness of households about the importance of adult education and about the school age at which their children should join the school to choice appropriate market outlets. Distance from the farm to the nearest market significantly affect market outlets choice decision, government should ensure developing markets for vegetables within reach this will motivate a lot of farmers to participate in vegetables supply their by increase their income and choice of appropriate outlets.

10. Price is also an important factor observed to influence choice of appropriate market outlets. Increasing production alone is not enough without getting a reasonable selling price and marketing linkage. Offering reasonable price per quintal can inspire vegetables farmers to sell vegetables through the best market outlets. To enhance producers and traders associations farmers should apply better farming practice, proper post-harvest handling, and produce good quality product. The study results have also policy implications to increase fair market share by building trust between producers and traders by improving price information networks and establish well defined linkages.

11. Finally, further studies on the value chain are recommended to identify best upgrading practices agreed by different chain actors so that a well-organized regional and national vegetable production and marketing can be implemented.

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Characterization and Analyses of Farming System in the Major Agro-Ecology of West 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 West Wollega Zone of Oromia National Regional State. The data were collected from both primary and secondary sources where the primary data for this study were generated structured questionnaire, Focus Group Discussions and key informant interview. The primary data was collected from total 105 households' heads and analyzed using SPSS and STATA 13 software. The farming systems in the west wollega zone were 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. However, crop production was confronted 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 are 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 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. 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, West Wollega.*

Introduction

Agriculture is the most important sector in EthiopiaI which 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 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 be 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.

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 (MoA, 2011). This shows that the overall economy of the country and the food security of the majority of the population depend on small-scale agriculture. However, Ethiopian agriculture has been characterized by low productivity, mainly, caused by low soil fertility and absence of efficient, sustainable and site specific soil fertility management practices (Abush et al, 2011), among others. Agriculture; value added (% of gross domestic product, GDP) in Ethiopia was last reported at 41.87 in 2011 (World Bank, 2012).

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). One of the immediate problems facing Ethiopia today is land degradation, particularly loss of vegetation cover, soil fertility depletion and soil erosion that significantly contribute to low agricultural productivity (Kahsay, 2004). According to the West wollega zone (WWZANRO, 2015), the major challenges of agricultural production of the zone is marked by problems of low agricultural productivity, land degradation, soil erosion, termite, deforestation and lack of improved technologies. Any attempt 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.

Methodology

Description of Study Area

Farming system characterization survey was undertaken in West Wollega Zone of Oromia National Regional State. West Wollega is one of the 18 administrative zones of Oromia National Regional State. It is located between $8^{0}12'$ – $10^{0}03'$N latitudes and $34^{0}08$ – $36^{0}10'$E longitudes bordered with Benishangul Gumuz Regional state in the North West, North East and East, Qellem Wollega Zone in the West, East Wollega Zone in the East, Gambella Regional state and Illubabor Zone in the South. The land size of the zone is estimated to be 13,131 square Kms. It has 21 districts, of which 19 are rural districts and 2 are urban administrations which are again subdivided into 543 kebeles (489 peasant associations and 54 urban dweller associations) where its capital town is Gimbi. It is located at a distance of 441 km from Addis Ababa (WWZANRO, 2015).

The zone is characterized by mean annual temperature varies from 15^0c to over 25^0c and mean annual rainfall of the zone range from 1300-2600mm. From total of 21 districts of the zone, the three districts namely Nedjo, Guliso and Kondala are selected for this study based on variation altitude and agricultural resource. These districts were selected for this study with the consultation of Zonal Agricultural and Rural Development Bureau to represent the major agro-ecology of West Wollega Zone in Western Oromia.

Description of selected districts

This study was focuses on three districts Nedjo, Guliso and Kondala of west Wollega zone. Layers of spatially explicit data sets including altitude, soil types and rain fall were indexed and used to select these sites.

Guliso

Guliso is one of 19 districts of West Wollega Zone located at 490 km West of Addis Ababa. It has an estimated area of 631.90 square km bounded by Boji Chokorsa in the northeast, Gawo Dale in the west, Ayira in the South and Lalo Asabi in the East. Total human population of the district is estimated at 91,471 of whom 45,525 are male and 45,946 were female. Of the total households 89.5 % is rural agricultural households (GWANRO, 2016). The district has a total of 28 kebeles, of which 26 are rural based peasant associations and 2 are urban dwellers Associations Kebele. From total rural passant associations 18 of them categorized to mid highland agro-ecology and 8 kebeles allocated to lowlands agro-ecology. The altitude of the Woreda varies from 1650 meters to 1700 meters above sea level. It receives average annual rainfall of 720 mm and has an annual temperature range of 9^0c-18^0c. In terms of agro-ecology, the district is categorized as Weina Dega (69%) and Lowland (Kola) (31%) (GWANRO,2016). The soils types in the district are predominantly red (58%), black (32%) and mixed (10%).

Nedjo

Nedjo is a western Ethiopian district (9.5°N and 35.5°E). It is located in West Wollega Zone of the Oromia Regional state, with the capital located at 516 km away from Addis Ababa. It has an estimated area of 958 square km. Total human population of the district is estimated at 148,431 of whom 72,756 are male and 75,681 are female. Of the total households 89.5 % is rural agricultural households (NWANRO, 2016). The district has a total of 53 kebeles, of which 49 are rural based peasant associations and 4 are urban dwellers associations. From total rural passant associations 47 of them categorized to mid highland agro-ecology and 2 kebeles allocated to lowlands agro-ecology. The altitude of Nedjo woreda varies from 1600 meters to 2,200 meters above sea level. It receives an annual rainfall of 1,350-1,600 mm, and has an annual average temperature of 23^0c and range from 18^0c-28^0c. The district has two agro- ecology which is mid highland (Weyna Dega) (98%) and Lowland (kola) (2%) (NWANRO, 2016). The soils types in the district are predominantly red sandy and red loam.

Kondala

Kondala is located in West Wollega Zone of the Oromia Region. It has an estimated area of 938.66 square km. Total human population of the district is estimated at 113,251 of whom 53,084 are male and 60,167 are female. Of the total households 92.15 % is rural agricultural households (KWAO, 2015). The district has a total of 33 kebeles; of which 32 are rural based peasant associations and 1 are urban dwellers associations. From total rural passant associations 23 of them categorized to mid highland agro-ecology and 9 kebeles allocated to lowlands agro-ecology. The altitude of Kondala woreda varies from 1,350 – 2,300 meters above sea level. It receives average annual rainfall of 1200 mm, and has an annual average temperature of 18.5^0c and range from 16^0c-21^0c. The district has two agro- ecology which is mid highland (Weyna Dega) (70%) and lowland (Kola) (30%) (KWANRO, 2015). The soils types in the district are predominantly Loam and salty soil.

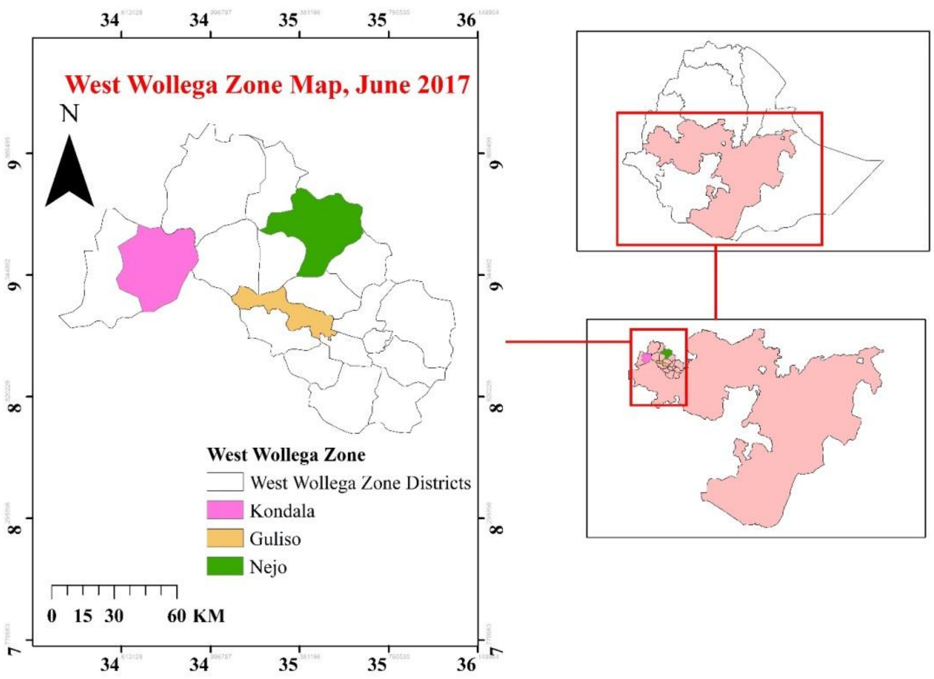


Figure 2: Map of selected districts of West Wollega Zone

Sampling Technique and Sample Size

A multidisciplinary team from Haro Sabu Agricultural Research Center staff conducted the survey using structured questionnaires with individual interview and focus group discussions method. Three stages sampling procedure was used for the selection of sample household heads. In the first stage, three representatives' districts namely Nedjo, Guliso and Kondola were selected purposively out of 19 districts of West Wollega Zone of Oromiya Regional State. In the second stage, a total of six kebeles from three districts were surveyed. 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 105 samples of household heads were randomly selected.

Table 1: List of study sites

No.	District	Kebeles	Number of sampled households
1	Kondala	Hofa Fargashi	18
		Mada Jalala	12
2	Nedjo	Gida Kumbi	21
		Warqe Nase	15
3	Guliso	Seda Birbir	13
		Chaliya Wera	26
Total			105

Source: Own survey results, 2015.

Types of Data and Methods of Data Collection

For this study both primary and secondary data were used. The secondary data were explored from different sources including West Wollega Zone and selected district Agricultural and Natural Resource Managements Offices, West Wollega Zonal and selected district Livestock and Fishers Resource Developments Offices, Central Statistical Authority (CSA) and published literatures. On the other hand, separate questionnaires and checklists were prepared and employed to collect primary data from producers. To collect data, data collection tools such as individuals interviews, Focus Group Discussions (FGD), key informant interviews, field observations, and document analyses were employed. The formal survey was undertaken through formal interviews using structured questionnaire where 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 Statistical Package for Social Science (SPSS) and 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

Socio-Economic Characteristics of Sampled Households

Out of total households heads interviewed about 97.12 percent were male headed while 2.86 percent were female headed households. In terms of education, the survey results show that about 16.19% of the sampled household heads were illiterate where 83.81 percent of sampled household attended formal education. The average age of sampled farm household heads were 43.019 year with a range of 20 to 80 years. A family size ranging between 1 and 10 is witnessed in the farming households. The available data indicates that average family size in each household is 6.26 (Table 2).

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

Variables		**Guliso**		**Nedjo**		**Kondala**		**Total**	
		Freq	%	Freq	%	Freq	%	Freq	%
Sex	Male	37	100	37	94.6	28	93.33	102	97.1
	Female	0	0	1	6.4	2	7.77	3	2.9
Education	Illiterate	3	8.1	4	10.5	10	33.3	17	17.2
	Formal education	34	91.9	34	89.5	20	66.7	88	83.8
		Guliso		**Nedjo**		**Kondala**		**Total**	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD
Age (year)		46	12.83	44.29	15.10	37.73	11.47	43.02	13.66
Family size (number)		6.18	1.47	6.31	2.09	6.27	1.91	6.26	1.82

Source: Own survey results, 2015.

Land use systems

One of the most important factors that influence crop production is resource endowment, availability of land for crop production. Land is the basic asset of the sample farmers. The survey revealed that the mean own land size of sampled households was 2.62, 2.61 and 2.50 hectares in Guliso, Nedjo and Kondala districts, respectively. As depicted in Table 3, also that the land allocated for crop production using RF were 1.59, 1.63 and 2.24 in Guliso, Nedjo and Kondala, respectively, while under irrigation 0.31, 0.51 and 0.16 hectares of land in Guliso, Nedjo and Kondala districts, respectively were allocated for crop production per years. The average grazing land sizes of sampled households were 0.48, 0.41 and 0.26 hectares in Guliso, Nedjo and Kondala districts, respectively.

Table 3: Land use and Land Allocation for Crops

Item	Guliso		Nedjo		Kondola		Total	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Own land size (ha)	2.62	1.93	2.61	1.81	2.50	1.69	2.58	1.81
Crop land by RF (ha)	1.59	1.27	1.63	1.22	2.24	1.44	1.78	1.31
Crop land by Irrig (ha)	0.31	0.25	0.51	0.38	0.16	0.07	0.38	0.33
Grazing land (ha)	0.48	0.57	0.41	0.42	0.26	0.10	0.41	0.45
Frost land(ha)	0.88	0.75	0.43	0.68	0.59	0.52	0.61	0.69
Degraded land (ha)	0.91	0.94	0.28	0.21			0.42	0.51
Residential land size (ha)	0.26	0.24	0.17	0.13	0.19	0.24	0.21	0.21
Land shared	1.65	0.38	1.82	0.39	1.72	0.45	1.73	0.44

Source: Own survey results, 2015

Farming systems and means of livelihood

The farming systems in the west wollega 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. Major sources of income generation of producers in selected districts are crop and livestock production. As indicated in Table 4, about 64.86, 78.95 and 70.00 percent of sampled households in Guliso, Nedjo and Kondala districts, respectively, earn their living from crop farming and livestock production as primary source. Maize cluster is considered as the second major means of livelihood of the producers in each district. Rain-fed maize, sorghum, finger millet, teff, haricot bean and anchote are the main sources of food in the farming system while coffee, sesame, noug and hot pepper are mostly grown for market.

Table 4: Farming system and cluster type in selected district of west wollega zone

No	Cluster type	Guliso		Nedjo		Kondala		Total	
		Freq	%	Freq	%	Freq	%	Freq	%
1	Crop based farming system	2	5.41	1	2.63	2	6.67	5	4.76
2	Mixed farming system	24	64.86	30	78.95	21	70.00	75	71.43
3	Maize cluster	9	24.32	4	10.53	7	23.33	20	19.05
4	Coffee cluster	2	5.41	0	0	0	0	2	1.90
5	Teff cluster	0	0	3	7.89	0	0	3	2.86
	Total	37	100	38	100	30	100	105	100

Source: Own survey results, 2016.

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 are 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 intercropping. 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 west wollega zone was cereal with pulse and oil crops, cereal with cereal, cereal with horticultural crops and pulse with horticulture crops.

Crop Production

Major Crops Produced Under rainfed 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. West Wollega Zone has endowed favorable climatic condition with wide range varieties of crop production. Maize, Sorghum, teff, millet, wheat, horse beans, chick peas, field peas, haricot beans, nug, sesame and rapeseed are some of the major crops produced in the zone (ZBANR, 2015). The major crops produced in selected districts are maize, sorghum, teff, barely, wheat and finger millet among cereal crops; haricot bean, faba bean, field pea and chickpea among pulse crops, sesame, nug and soybean among oil crops (Table 5). As indicated in Table 5, sweet potato, potato, sugarcane, onion, yam and anchote is the major root and tuber crops produced, whereas, hot pepper, cabbages and tomatoes are the major vegetables crop produced in selected district. The major fruits and spices produced in selected district coffee, mango, avocado, banana and ginger. Maize, sorghum, finger millet and haricot bean are the major food crops. According to the focus group discussion, coffee is the most and the dominant cash crop produced in the all districts for income generation otherwise hot pepper, sesame and some horticultural crops (vegetables, fruits and spices) follow it for market production.

Table 5: The major crops produced in under rainfed selected districts

Crop category	Type of major crops produced		
	Guliso	Nedjo	Kondala
Cereals	Rank	Rank	Rank
	Maize Finger Millet Sorghum Barley	Maize Teff Finger Millet Wheat Sorghum Barley	Maize Sorghum Finger Millet Teff
Pulse crops			
	Haricot bean	Haricot bean Fababean Field pea	Haricot bean Faba bean
Oil crops			
	Sesame Noug Linseed Soybean	Sesame Noug Soybean	Soybean
Root & Tuber			
	Sweet potato Potato Sugarcane Onion Yam Carrot	Yam Potato Onion Sugarcane Sweet Potato Carrot	Potato Onion Sweet potato Sugar cane Yam Anchote
Vegetables			
	Hot Pepper Cabbage Tomato	Hot Pepper Cabbage Tomato	hot pepper Cabbage
Fruit Crops			
	Mango Banana Avocado Orange Papaya	Banana Avocado Mango Orange Papaya	Mango Banana Orange Anchote
Coffee and Spice			
	Coffee Ginger Cardamom Turmeric	Coffee Ginger Fenugreek Cordamom Black Cumin Basil Turmeric	Coffee Ginger Turmeric

Source: Own survey results, 2015. (The crop is ranked as area coverage and number of farmers involved in crop production).

Crop productivity and area coverage under rainfed in Selected District of West Wollega Zone

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 6 shows productivity of the main crops cultivated during main cropping season/meher period of 2014/15 in selected district of west wollega zone. The average productivity of maize was 38.60, 28.75 and 42.20 quintals per hectare for Guliso, Nedjo and Kondala district respectively, in 2014/15 main production season. The mean average yields of maize crop were above national yield in Guliso and Kondala districts and below average national yield in Nedjo districts (CSA, 2016). The reason below average national yield in Nedjo districts was due to high infestation of termite and low soil fertility in that district relative to others two districts. Average productivity of sorghum was highest in Kondala district which is 27 qt/ha relative to others two district, this may due to good soil fertility and management practices. The survey results revealed that productivity of barley and wheat are 17 and 16.42 quintals per hectare respectively, in Nedjo district. Average productivity of haricot bean is 17, 16 and 18.8 quintal per hectare in Guliso, Nedjo and Kondala in 2014/15 main production season (Table 6). 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 6.

Table 6: Summary of Crop Productivity and area coverage produced under rainfall in selected districts.

Crop type	**Guliso**		**Nedjo**		**Kondala**	
	Average area allocated (ha)	Average yield (Qt/ha)	Average area (ha)	Average yield (Qt/ha)	Average area (ha)	Average yield (Qt/ha)
Maize	0.50	38.60	0.98	28.75	0.92	42.4
Sorghum	0.27	17.68	0.25	20.52	0.77	27
Finger millet	0.26	18.19	0.26	14.46	0.42	25
Barley			0.11	17		
Wheat			0.16	16.42		
Teff			0.63	10.43		
Haricot bean	0.17	17	0.09	16	0.19	18.8
Faba bean	0.05	13	0.13	15.5	0.13	13
Pepper (dry fruit matter)	0.06	16	0.13	16		
Sweet potato	0.13	107	0.08	34		
Potato	0.13	80	0.16	55		
Coffee	1.22	15.32	1.27	12.42	0.91	12.62

Source: own survey results, 2015.

Major Crops Produced Under Irrigation in Selected Districts

Both traditional and modern irrigation are practiced in the West Wollega Zone. A total area of 1,486,968.25 and 1238.7 hectares of land was under traditional and modern irrigation, respectively, in 2014/15 production year (WWZANRO, 2015). The major crops produced in selected districts under irrigation are onion, potato, cabbage, carrot, red root, garlic, hot pepper, sweet potato, anchote and maize (Table 7).

Table 7: The major crops produced under irrigation in selected districts

Districts	Cereal crops	Pulse and oil crops	Horticulture crops	Spice and industrial crops
Guliso	Maize	Haricot bean	Onion, potato, carrot, hot pepper, cabbage, red root and tomato	Coffee and sugarcane
Nedjo	Maize	Haricot bean and faba bean	Onion, potato, carrot, sweet potato, cabbage, red root, garlic, tomato and anchote	Coffee and sugar cane
Kondala	Maize	Fababean	Potato, onion, tomato, anchote and garlic	Coffee and sugar cane

Source: Focus group discussion, 2016.

Major Crop Productivity and Area Coverage under Irrigation in Selected Districts

Table 8 shows productivity of the main crops cultivated under irrigation in 2015 production years in selected district of west wollega zone. The average productivity of maize produced by irrigation/bone was 29.60, 20 and 29.61 quintals per hectare for Guliso, Nedjo and Kondala district respectively, in 2015 production season. Average productivity of potato was highest in Guliso district which is 56 qt/ha relative to Nedjo, this may due to good soil fertility and management practices. The survey results also revealed that average productivity of tomato and onion are 48 and 80.8 quintals per hectare respectively, in Guliso district. Average productivity of faba bean is 16 quintal per hectare in Nedjo 2015 production season. The summaries of productivity of major crops produced by irrigation are indicated in Table 8.

Table 8: Summary of crop productivity and area coverage produced under irrigation in selected districts.

Crop type	**Guliso**		**Nedjo**		**Kondala**	
	Average area allocated (ha)	Average yield (Qt/ha)	Average area (ha)	Average yield (Qt/ha)	Average area (ha)	Average yield (Qt/ha)
Maize	0.26	29.6	0.38	20	0.16	29.61
Fababean			0.09	16		
Potato	0.15	56.28	0.20	30.18		
Tomato	0.06	48			0.09	36
Onion	0.11	80.8	0.12	43.25		
Garlic	0.13	45	0.11	20.8		
Cabbage			0.19	256		
Carrot			0.09	180		

Source: Own survey results, 2015**.**

Agricultural calendar for major crops and method of planting/sowing

The farming systems of smallholders in kellem Wollega Zone are 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 are 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 9); 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 is 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 9: Crop calendar and method of planting of major crops produced in west 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	April- May	June-July	November-January	Row and broad casting	Chemeda, Gemedi and Laaloo
3	Teff	June-July	July-August	August-September	December-January	Row and broadcasting	Kuncho
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	June-July	July	August-Sept.	November-December	Broadcasting	Boneya
6	Haricot bean	March	April-May(1st) and July-August(2nd)	May-June(1st) and July-September (2nd)	July-August(1st) and November-December (2nd)	Row and broadcasting	Nassir and ICAP-0056
7	Fababean	April-June	June-July	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			Row planting	Balo
11	Potato	March-April	May-June	June-August	August-September	Row planting	Not available
12	Anchote	March-April	April-June	June-July	September –December	Row and broadcasting	Not available
13	Coffee	May-June	May-July	August-September	November-January	Row planting	Jimma-742

Source: Own survey results, 2015.

Major Diseases and insect pests

West 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 in maize are turcicum leaf blight, gray leaf spot, common smut diseases, head smut and maize streak virus (Tabel 10). Whereas in sorghum the major diseases are head smut, leaf blight and anthracnose. Bird damage is also the major problem of sorghum related to yield reduction. The major diseases of wheat are stem rust, yellow rust and root rot, and in finger millet the major disease are leaf blight, head smut and head blight. While rust and fusarium wilt on teff, common bacterial blight and leaf blight in faba bean and in haricot bean angular leaf spot, chocolate spot, common bacterial blight, eye spot and Ascochyta blight are the major disease reduced production of these crops in west wollega zone. Fusarium wilt, leaf blight, pod rot, root wilt, and late blight disease are raised as an important disease that hampered hot pepper production in the districts. The major diseases of coffee are Coffee Berry Disease (CBD), Coffee Wilt Disease (CWD) and Coffee Cherry disease (CCD)(Table 10).

Table 10: 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 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, Leaf Blight and Anthracnose	Stalk borers, Shoot fly, weevils and termite	Crop rotation Bell/ring for bird attack	Cynodon dactylon Snowdenia polystachya	Hand weeding Frequently plowing
3	Teff	Rust and Fusarium Wilt	Termites	Crop rotation	No specific weed	Hand weeding chemical application (2-4D, pallas)
3	Finger millet	Leaf Blight, Head Smut and Head Blight	Termites	Early planting and crop rotation	No specific weed	Hand weeding and Frequently plowing
4	Wheat	Stem Rust, Yellow Rust and Root Rot	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	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	No control option	No specific weed	Hand weeding Frequently plowing
8	Potato	late blight	Termites	Applying chemical	No specific weed	Hand weeding and Frequently plowing
9	Avocado	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	Termites	No control option	No specific weed	Hand weeding
12	Coffee	Coffee Berry Disease (CBD), Coffee Wilt Disease (CWD) and Coffee Leaf Rust (CLR)	Termites	Cutting affected coffee and remove out	No specific weed	Hand weeding Hoeing

Source: Own survey results, 2015.

Livestock production

Livestock production is an important source of income and means of livelihood in West Wollega Zone. Livestock are kept for various purposes including source of food for the family (mainly meat, milk and milk byproducts), draught power, transport, income generation (sale of products and live animals) and manure production for soil fertility management. 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 12. 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 12, on average about 4.26, 3.07 and 4.16 local cows were holds by sampled households in Guliso, Nedjo and Kondala districts, respectively. According to survey results, crossbreeds cows almost not available in Nedjo and Kondala 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 coffee from fields to coffee 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 West 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 bee. On average 23.53, 20.42 and 6.09 number of hives sampled households hold traditional hives in Guliso, Nedjo and Kondala respectively (Table 11). Besides, farmers' holds average 3 and 2 modern hives in Guliso and Nedjo districts, respectively.

Table 11: Hives types and average numbers of hives per households in three districts

No	Types of Hives	Guliso Mean	Nedjo Mean	Kondala Mean	Purpose
1	Traditional hive	23.53	20.42	6.09	Honey production at home and for market
2	Transitional hive	5	4.14	6.5	Honey production at home and for market
3	Modern hive	3	2		Honey production at home and for market

Source: Own survey results, 2015.

Table 12: Livestock population and purpose of rearing in selected districts

No	**Livestock type**	**Guliso** Mean	**Nedjo** Mean	**Kondala** Mean	**Purpose of rearing**
1	Local cow	4.26	3.07	4.16	For milk, meat, draft power, market and for manure
2	Cross breed cow	1.75			For milk, meat, for market and manure
3	Local oxen	2.3	1.94	3	Meat, draft power, for market and manure
4	Cross breed oxen	2			For breed, draft, meat and market and for manure
5	Local heifers	2.95	2.67	2.85	For meat, market and for manure
6	Local calf	2.45	2.23	2.25	For meat, market and for manure
7	Local Bull	2.5	1.78	2.17	For draft, meat, market and for manure
8	Goat	8.28	4	3.4	For meat and marketing
9	Sheep	3.8	4.05	2.87	For meat and marketing
10	Local poultry	4.53	6.27	11.96	For egg production, meat and for market
11	Improved poultry			3.25	For egg production, breed source, meat and market
12	Donkey	1.54	1.88	1.78	Transportation
13	Mule	1	1	1	Transportation
14	Horse	1		3	Transportation

Source: Own survey results, 2015.

Breed type and Breeding system

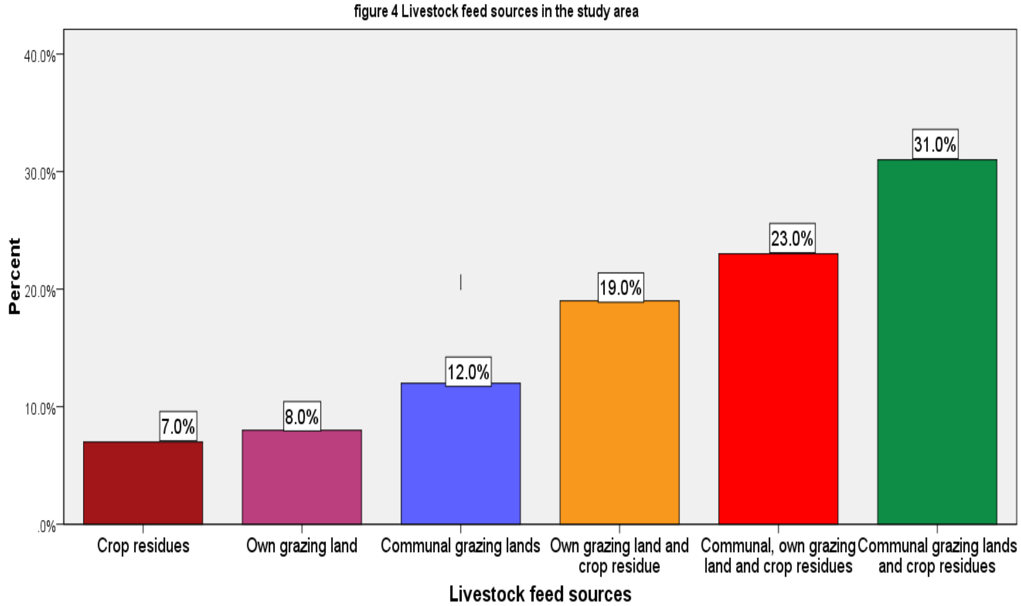
During the focus group discussion and survey farmers reported that open natural mating with available local bulls is the common mating system for livestock in the study areas. Crossbreds are available only for cows, oxen and poultry which are insignificant in numbers. According to focus group discussion 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. Average milk local and improved breed cows give are 1.7 and 1.8 liter per cow per day in the study area. 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 is by moving their animals to rivers and hand hole (ponds). Open grazing 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 feed. As indicated in Figure 3, about 31% 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 combination of communal grazing, own grazing and crop residues (Figures 3).

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, desho grasses and cow pea as the most important improved forage. Supplementary feed farmers used for their animals during shortage of animals feed are powder of crops, amole salt, concentrate (local name Fagulo and Frushka), molasses and local beverage by product (Atella).

figure 4 Livestock feed sources in the study area



Feed seasonality

Livestock feed is seasonal. Grazing of natural pasture constitutes the main source of animal feed throughout the year in three districts. However, relative shortage of feed is ensued since farmers in the study area do not have a tradition of conserving and keeping the excess forage for the dry season. Accordingly, as indicated in Table 13 about 85.92% of sampled households respond that during the dry season (January to May) livestock's faced feeds shortages in the study areas. Moreover, about (14.08%) of the respondents reported that there is also shortage of feed during main rainy season (July to September) in the study area. About 93.24 sampled farmers' reports that storing of crops residues and moving livestock from place to place for search natural pastures are the main coping mechanisms practiced during feed shortages (Table 13).

Table 13: Seasons of livestock feed shortages and coping mechanisms

Seasons	Districts						Overall	
	Guliso		Nedjo		Kondala			
	N	%	N	%	N	%	N	%
Dry season (January-May)	14	73.68	28	93.3	19	86.36	61	85.92
Rain season (July-September)	5	26.32	2	6.67	3	13.64	10	14.08
Coping mechanisms								
Storing crops residues and move livestock to forests and shrubs areas	24	92.31	26	92.86	19	95.00	69	93.24
Purchase supplementary feed	1	3.85					1	1.35
Both	1	3.85	2	7.14	1	5	4	5.41

Source: Own survey results, 2015.

The major disease and parasites of livestock

The major livestock's diseases identified during focus group discussions are Trypanasomiasis (Gandi), bloating (bokoksaa), Mouth and foot diseases, Pastoryolosis (Gororsa), Hooks disease, Anthrax (Abba sangaa), Dhittessaa, Sambaa, Mandaraa, Ciittaa, Cabsaa (bishoftu) and Guba. The major animal health problems listed in Table 14.

Table 14: 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, Guba, Citaa, Contagious bovine pleuropneumonia (CBPP) and TB ❖ Internal and external 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	➢ Tryipanomiasis	➢ Vaccination

	donkey	➢ Internal and external parasites	
4	Horse	➢ Tryipanomiasis, African horse sickness ➢ Internal and external parasites	➢ Vaccination
5	Poultry	➢ New castle disease (NCD), Typhoid, Pastoryolosis ➢ Internal and external parasites	➢ Vaccination
6	Apiculture	➢ Bacterial brood diseases ➢ Ants, monkey, wax moth (Galleria mellonella), spider	

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

Natural resources and management

Forestry and Agroforestry

According to the reports from key informants, the forest and woodland resources of west wollega zone can be categorized into four major types of vegetation. These include natural forests, plantation forests, agroforestry and shrubs and bushlands. 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 West 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. Agroforestry 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 bushlands and shrublands in the study woredas, 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 15.

Table 15: 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 and fence
Waddessa	Cordia africana	Tree	Coffee shade, beekeeping, wood, timber and fence
Bakanisaa	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

Soil characteristics and management practiced

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 colour, 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. These soil types vary in their properties and management requirements. The characteristics of the four soil types are indicated in the following table 16.

Table 16: Soil types and management practices in West Wollega Zone

Soil type	Major soil characteristics		Farmers' management		
	Physical	Chemical	Physical	Biological	Chemical
Clay soil	Red soils High moisture holding capacity Deep soil and good rooting depth	Soils low base saturation-less than 50 per cent PH value-less than 5.5 (NAE,1988:8)	Soil/stone bund Check dams Terraces	Planting of grass on soil bund (grass strip). Crop rotation Crop residue/manure Intercropping Minimizing tillage	Fertilizer (NPS, DAP & UREA) application
Silt soil	Moisture storage capacity of these soil is moderate	The PH is less than 5.5 Available p contents are very low Base saturation is low	Soil/stone bund Check dams Terraces	Planting of grass on soil bund (grass strip). Crop rotation Intercropping Crop residue/manure Minimizing tillage	Fertilizer (NPS, DAP & UREA) application
Loam soil	Black clay soil productive at moisture is available Soils occur in flat land along river	non-calcareous having a base saturation of 50 per cent or more	Soil/stone bund Check dams Terraces	Planting of grass on soil bund (grass strip). Crop rotation Intercropping Crop residue/manure Minimizing tillage	Fertilizer (NPS, DAP & UREA) application
Sandy soil	Dominated by sand Low water holding capacity Physical fertility status is low Soil colour is brown Shallow in depth	Chemically these soils are good They have base saturation of over 50 percent	Soil bund Check dams Terraces	Planting of grass on soil bund (grass strip). Crop rotation Intercropping Crop residue/manure Minimizing tillage	Fertilizer (NPS, DAP & UREA) application

Source: Secondary data and focus group discussion, 2016.

Water resources and managements practices

The main sources of water identified in the present study areas were rivers, lakes, bore holes, ponds, dams and spring water. The majority (45.8%) of the households in the mixed crop–livestock system obtained water from rivers, while 24.2% from pipe water, 10.8% from lake, 10% from spring, and the rest from other sources. With regard to urban producers the majority (71.8%) obtained water from pipe water. Although relative, all the interviewed dairy producers perceived that they provide good quality water to their cattle.

Soil and water conservation practices

As indicated in Table 17, farmers practiced different physical, biological and chemical soil fertility management practices methods in the study area. Terraces and bunds are 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, 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.

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

Sheet erosion, rill erosion, gully erosion and rain drop /splash erosion were the common erosion types observed in Guliso, Nedjo and Kondala districts. 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.

Table 17: The major causes of soil erosion in selected districts

Soil erosion type	The major causes of soil erosion	Rank
✓ Sheet erosion ✓ Rill erosion ✓ Gully erosion ✓ Rain drop splash	Slope steepness of land	1
	Over cultivation or absence of fallowing,	3
	Deforestation	2
	High intensity of rain fall	4
	Overgrazing	5

Source: Focus group discussions, 2016

Enablers and Supportive Institutions of Agricultural Development in the study area

Institutions play a vital 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 service

As depicted in Table 18, about 95.24% of the farmers reported that they had access to extension service in 2015 production season. Only 4.76% of the farmers reported that they had no access to extension service. The extension services providers were 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 18).

Table 18: Households access to extension services and services providers

No.	Items		Frequency	Percent
1	Access to extension services	Yes	100	95.24
		No	5	4.76
Total			105	100
2	Extension services providers	Woredas experts and DAs at FTCs	91	91
		NGOs	1	1
		DAs at FTCs and NGOs	8	8
Total			100	100
3	Type of extension services provided for farmers	Extensions advices	8	8
		Training and visits	22	22
		Only visits	4	4
		Extensions advices, training and visits	66	66
Total			100	100

Access to credit service

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, water pumps, 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 19, only 35.24% 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 (48.65%), to purchase improved seeds/seedling (8.11%) and for family consumptions (5.41%). The providers of credit services were micro finance institutions (94.74%), relatives/friends (2.63%) and IMX (2.63%). The major problems farmers reported related to credit services were high loan interest rates (46.43%), unequal handlings of farmers by credit providers in providing loans (21.43%), inappropriate time of loan repayments (7.14%) and high loan interest rate and discriminations in giving credit service (25.00%).

Table 19: Access to credit service and problems of credits services of sampled households

No	Items		Frequency	Percent
1	Access to credit services	Yes	37	35.24
		No	68	64.76
	Total		105	100
2	Source of credits	Microfinance Institutions	36	94.74
		Relatives	1	2.63
		IMX	1	2.63
	Total		38	100
3	Purpose of credits taken	For purchase fertilizers	18	48.65
		For purchase improved seed	3	8.11
		For family consumptions	2	5.41
		To purchase agricultural inputs	14	37.84
	Total		37	100
4	Problems related to credit services	High loans interest rate	13	46.43
		Unequal handlings of farmers by credit providers in providing loans	6	21.43
		Inappropriate time of loan repayments	2	7.14
		High loan interest rate and discriminations in giving credit service	7	25.00
	Total		38	100

Source: Own survey results, 2015.

Inputs suppliers

The main input suppliers are service cooperatives, unions, WANRMO, WLFRDO, WIDAO, research center, NGOs and private traders. They supply fertilizers, improved seeds, farm implements, water pumps and chemicals. Farmers may obtain these technologies on credit and/or in cash. Particularly, the use of fertilizers is constantly increasing from time to time across the study areas. During the group discussions done in this study, farmers pointed out that the input systems are characterized by protracted delays, high prices, poor quality and some inputs are completely unavailable. As indicated in Table 20, about 95.24% of sampled households were access to agricultural inputs, while about 4,76 households reported that they had no access. The results also indicated that most of the sampled producers obtained agricultural inputs from cooperatives/unions (80%), from BoA (13.73%) and NGOs (4.90%). Haro Sebu Agricultural

Research Center is involved in developing improved variety of vegetables seed for wider adaptation, high yielding and resistant to biotic and abiotic stress especially, on potato.

Table 20: Access to agricultural inputs and sources of inputs

No	Items		Frequency	Percent
1	Access to agricultural inputs	Yes	100	95.24
		No	5	4.76
	Total		105	100
2	Sources of agricultural inputs	Research center	2	1.9
		Cooperatives/unions	80	78.43
		NGOs	5	4.90
		Agricultural offices	14	13.73
	Total		101	100

Agricultural marketing systems in West Wollega Zone

Crop marketing systems

Crop production in the West 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, noug, sesame, hot pepper, teff, onion, potato, avocado, banana, maize, yam, anchote, sweet potato and sugarcane. Coffee 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.

The crops marketing channel involves in West Wollega Zone are producers, product collectors/assemblers at farm level, local traders, brokers/agents, and wholesalers in the transitory or terminal markets such as districts markets (Nedjo, Guliso and Kondala), Gimbi, Nekemte 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 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.

Marketing system 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. 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. According to Focus group discussion farmers stated that no transparency between seller and buyer due to middle men or brokers. Further farmers reported that all producers sold their livestock and livestock product to nearby town and there have no chance to sell their livestock to national market or export.

Constraints of Agricultural Production

Major Crop Production and Marketing Constraints in West Wollega Zone

The major problems of crop production in selected districts include disease and pest problem, land shortage and soil fertility problems, termite problem, shortage of improved varieties and weather fluctuation. In addition to these high input cost, pesticide shortage and weed were affecting to a less extent. As shown in Table 21, the extent or rank of the problems of Guliso and Nedjo districts is almost similar with some differences.

Table 21: Crop production problems and their rank in selected districts.

Major crop Constraints	Guliso	Nedjo	Kondala
	Rank	Rank	Rank
Disease and pest problem	1	1	1
Soil fertility problem and land shortage	2	2	5
Termite problem	3	3	4
Shortage of improved varieties	4	4	6
High inputs costs	5	6	3
Weather fluctuation	6	5	2

Source: Focus group discussions, 2016.

According to the result obtained from the survey depicted on Table 22 about 13(35.14%), 22 (57.89%) and 14(46.67%) of sampled households in Guliso, Nedjo and Kondala, respectively, responded that there were a problem of cop disease and insect-pest. Additionally, farmers stated that soil fertility problems was the second serious problems which reduce production and productivity of crops in Nedjo and Kondala districts whereas weather fluctuation problem in Guliso districts. Termite attack, high inputs costs and shortage of improved varieties were also the major challenges that reduce production and productivity of crops in the selected districts.

Table 22: Crop production constraints frequency and percentage in west wollega zone

Major crop Constraints	Guliso		Nedjo		Kondala	
	Freq.	%	Freq.	%	Freq.	%
Disease and pest problem	13	35.14	22	57.89	14	46.67
Soil fertility problem and land shortage	6	16.22	7	18.42	5	16.67
Termite problem	4	10.81	5	13.16	4	13.33
Shortage of improved varieties	4	10.81	1	2.63	1	3.33
High inputs costs	3	8.11	1	2.63	2	6.67
Weather fluctuation	7	18.92	2	5.26	4	13.33
Total	37	100.01	38	100	30	100

Source: Own survey results, 2015.

According to Focus Group Discussions held with farmers 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 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 (Table 23).

Table 23: The major challenges of crops marketing and their ranks in West Wollega Zone

No	Constraints	Districts			Total (Rank)
		Guliso (Rank)	Nedjo (Rank)	Kondala (Rank)	
1	Transportation problem	9	1	5	6
2	Fluctuation of product price	2	2	1	1
3	Oversupply of product during harvest	3	3	2	2
4	Low quality of product	4	4	8	4
5	High involvement of brokers/middleman	5	5	3	3
6	Low price of product	8	6	4	7
7	Unfair/cheat weighing of crops products	1	9	6	4
8	No linkages with national markets	6	8	7	8
9	High involvement of Unlicensed traders on coffee marketing	7	7	9	9

Source: Focus Group Discussions and key informants interviews, 2016

Livestock production and marketing problems

The major problems and their priority ranking according to farmers are presented in Table 24. In all three districts seemed to have similar ranking of their problems and the major problems of livestock 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. As depicted in

Table 24, about 54.29, 45.95 and 48.28 percent of sampled households in Guliso, Nedjo and Kondala, respectively, identified diseases as the most important problem.

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 disease and shortage of improved breeds are the major constraints of households faced in the three districts (Table 24).

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 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. As indicated in Table 24, about 66.67%, 66.67% and 75% in smallholders in Guliso, Nedjo and Kondala districts, respectively, responds that shortage of bee forage as the first and most pressing constraint of beekeeping followed by agro-chemical application.

Table 24: The major problem of livestock production in selected districts of West Wollega Zone

No	Constraints	Guliso		Nedjo		Kondala	
		Freq.	Percent	Freq.	Percent	Freq.	Percent
	The major constraints of cattle						
1	Disease and parasites	19	54.29	17	45.95	14	48.28
2	Shortage of animal feed and improved forage	9	25.71	13	35.12	7	24.14
3	Lack of improved breed	3	8.57	4	10.81	3	10.34
4	Shortage of veterinary service and AI services	3	8.57	1	5.41	3	10.34
5	Wild animals	0	0	2	5.41	1	3.45
6	Lack of grazing land	1	2.86	0	0	1	3.45
	Total	35	100	37	100	29	100
	The major constraints of small ruminants						
1	Disease and parasites	12	80.00	20	80.00	9	81.82
2	Lack of improved breed	0	0	2	8.00	2	18.18
3	Shortage of feed	3	20.00	3	12.00	0	0
	Total	15	100	25	100	11	100
	The major constraints of equine						
1	Disease and parasites	18	100	21	100	4	66.67
2	Wild animals	0	0	0	0	2	33.33
	Total	18	100	21	100	6	100
	The major constraints of poultry						
1	Disease and parasites	19	57.58	9	31.1	18	62.1
2	Lack of improved breed poultry	14	42.42	20	68.9	11	37.9

	Total	33		29		29	
	The major constraints of honey bee						
1	Lack of bee flower	8	66.67	6	66.67	6	75.00
2	Agro-chemical	1	8.33	2	22.22	1	12.50
3	Wild animal (monkey) problem	2	16.67	1	11.11	1	12.50
4	Theft	1	8.33	0	0	0	0
	Total	12	100	9	100	8	100

Source: Own survey results, 2015.

The main marketing problem of livestock were 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. 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 25. As depicted in Table 26, farmers stated that unorganized marketing system (54.17%), lack of market information and lack of cooperatives at farmers level (25%), involvements of brokers /middlemen in marketing (8.33%), poor road and transportation facilities (5.21), high tax fee for agricultural products sold and Low price and lack of market for the products were the major marketing problems of agricultural production (crops and livestock's) in the study area.

Table 25:-Markets Problems of livestock production in the three districts

No	Constraints	Districts			Total
		Guliso	Nedjo	Kondala	
		Ranks	Ranks	Ranks	Ranks
1	Involvement of brokers/middle men in marketing of livestock	1	1	1	1
2	Low price of livestock and livestock products	2	2	2	2
3	Fluctuation of market price of livestock and livestock products	3	3	4	3
4	No linkages with national markets	4	4	3	4
5	Lack of market information	5	5	5	5
6	Lack of cooperatives	6	7	6	6
6	Unfair weighing of livestock product	7	6	7	7

Source: Focus Group discussion and key informants' interviews, 2016.

Table 26: Market related problem of agricultural production in West Wollega Zone

No	Constraints	Frequency	Percent
1	Unorganized marketing system	52	54.17
2	Low price and lack of market for the product	2	2.06
3	High tax fee for products sold	5	5.21
4	Involvements of brokers/middlemen in market	8	8.33
5	Lack of market information and lack of cooperatives at farmers level	24	25.00
6	Poor road and transportation facilities	5	5.21
	Total	96	100

Source: Own survey results, 2015.

Natural resource management constraints in selected districts of West 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 deforest ion intensity are high in resettled area and resettlements of farmers are the main cause of deforestation in the west wollega zone. Overgrazing is also the major problem of natural resource degradation in the area.

According to survey results, the major constraints to 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 (Table 27). Farmers at three districts revealed that soil are highly exposed to severe erosion due to several factors including lack of awareness for conservation and fertility management as well as severe deforestation. They also indicated that soil acidity and termite attacks are the severe problem in all three districts which reduce the productivity of crops.

As indicated in Table 27 about 36.84% and 43.24% of sampled households in Guliso and Nedjo respectively, responds that soil acidity, soil erosion, termite attack and deforestation are the major constraints of natural resource managements. Soil nutrient depletion has become a common feature in the West Wollega zone although the degree varies from district to districts. The problem is prevalent in Nedjo due to the acidic nature of the soil, termite problems and other associated constraints. In Kondala district about 30% of sampled households respond that termite attacks are the major problems of natural resources which reduced the productivity of crops. 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. Farmers also stated that lack of sustainable managements of bund constructs during offseason and lack of protection from animals in all districts were the major challenge of natural resource managements.

Table 27: The major constraints of natural resource managements in selected districts

No	Constraints	Districts					
		Guliso		Nedjo		Kondala	
		Freq	%	Freq	%	Freq.	%
1	Termite attack	3	8.11	10	26.32	9	30.00
2	Soil acidity	6	16.22	4	10.53	5	16.67
3	Soil erosion	3	8.11	4	10.53	1	3.33
4	Soil erosion, soil acidity, termite attack and deforestation	16	43.24	14	36.84	4	13.33
5	Overgrazing, soil acidity and termite attack	6	16.22	5	13.16	5	16.67
6	Lack of sustainable bund managements	2	5.40	1	2.63	6	20
7	Heavy rain	1	2.70	0	0	0	0
	Total	37	100	38	100.01	30	100

Source: Own survey results, 2015.

Table 28: The major agricultural production constraints in the west wollega zone

No	Major constraints	Frequency	Percent	Rank
1	Lack of improved varieties of crops and animal feed	7	10.45	6
2	Disease and insect-pests	13	19.40	2
3	Lack of improved varieties and disease	16	23.88	1
4	High price of inputs and low price of products	9	13.43	3
5	Lack of improved varieties and low price of the product	8	11.94	4
6	Disease, termite problem, lack of animal feeds and soil erosion problem	8	11.94	4
7	Lack of improved varieties, diseases of crops, and lack of animal feeds	3	4.48	7
8	Lack of road and scarcity of farm land	3	4.48	7
	Total	**67**	**100**	

Source: Own survey results, 2015.

Conclusion and Recommendations

Farming system characterization survey was undertaken in West Wollega Zone of Oromia National Regional State. From total of 21 districts of the zone, the three districts namely Nedjo, Guliso and Kondala are selected for this study based on variation altitude and agricultural resource. From three districts six kebeles and about 105 samples of household heads were randomly selected and interviewed. Data collection tools such as interviews, Focus Group Discussions (FGD), key informants' interviews, field observations and document analyses was used by developing questionnaires and checklists. The farming systems in the west wollega 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.

West Wollega Zone has endowed favorable climatic condition with wide range varieties of crop production. Maize, sorghum, teff, millet, wheat, horse beans, chick peas, field peas, haricot beans, nug, sesame and rapeseed are some of the major crops produced in the zone. 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. Both traditional and modern irrigation are practiced in the West Wollega Zone. The major crops produced in selected districts under irrigation are onion, potato, cabbage, carrot, red root, garlic, hot pepper, sweet potato, anchote and maize. The major cropping systems in the study area are mono cropping, intercropping, double cropping and crop rotations systems. The major crops calendar of maize, sorghum, barely, haricot bean, potato, sweet potato and coffee; Land preparation (March-April), planting (May-August), weeding (June-September), harvesting (November-January) and threshing (December-February). The major problems of crop production in selected districts include disease and pest problem, land shortage and soil fertility problems, termite problem, shortage of improved varieties 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 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 West Wollega Zone. Livestock are kept for various purposes including source of food for the family (mainly meat, milk and milk byproducts), draught power, transport, income generation (sale of products and live animals) and manure production for soil fertility management. Every household keeps livestock such as cattle, sheep, goats, horse, donkey and poultry. Local cows are dominant species followed by local oxen for all selected districts. 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. The feed resources in the selected districts are primarily natural pasture (communal and own grazing), cultivated forages, crop residues and purchased feed. The major problems of livestock rearing 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. The main 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. Eucalyptus saligina, Syzgium guineense, Cordia africana, Croton marcrostachyus, Vernonia amaygdalina, Accaia abyssinica, Cuppressus lustanica, Masea Lanceolata, Aningeria Altissima, Albizia gummifera, Ficus vasta and Myrica salicifolia are common trees and shrubs found in West wollega zone. 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. Sheet erosion, rill erosion, gully erosion and rain drop /splash erosion were the common erosion types in the study area. The main causes of soil erosion are slope steepness of land, over cultivation or absence of fallowing, deforestation, high intensity of rain fall and overgrazing. 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, the following recommendations are given:

- ✓ Ensure the provision and supply, distribution of crops technologies and improved agronomics practices for the study area
- ✓ Ensures an adequate supply of fertilizes and agro-chemicals and promote farmers' effective demand for fertilizers and agro-chemicals usages.
- ✓ Ensure the continued supply of improved seeds and supplying high quality seeds of important crops
- ✓ Training farmers and developments agents on improved crops technologies packages
- ✓ Capacitates farmers on integrated pest managements (IPM) to reduces chemical based measures
- ✓ Disease, insect and weed control technologies should be developed as the zone is highly prone to crop diseases, insect pests and weed
- ✓ Capacitates farmers' indigenous knowledge on disease and insect-pest managements and should be supported scientifically for better control of crop pests.
- ✓ Strengthen agricultural research on crops disease and termite control and use crop agriculture research findings for similar agro-ecologies
- ✓ Increase production and productivity of the major crops by proper agricultural land utilizations and improved technologies
- ✓ 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
- ✓ Expanding equal accessibility of infrastructures such as road and transportation facilities needs government intervention to promote the effective marketing of crops.

Livestock Productions

- ✓ Enhance livestock productivity and production through breed improvements
- ✓ Promote animal feed production and forage seed developments in the study area
- ✓ Improve farmers awareness on crop residues usages for their animals and improve quality of crops residues
- ✓ Enhance improved forage seed production and pasture developments
- ✓ 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
- ✓ Develop and expands honey productions through introduce and popularize apiculture technologies for the zone.
- ✓ 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 PRA result of the findings the recommendations below has been given for future natural resource improvement and the sector development in the study areas.

- ➢ Developing and popularizing well adapted multipurpose trees species to the suitable agro-ecologies should be given an attention by woredas concerned bodies and forestry research programme
- ➢ Strengthen and developing nursery site for multiplying of different multipurpose trees species and for developments of agro-forestry practices in the study areas.
- ➢ Research should expands forest developments technologies and encourages indigenous farmers tree plantations activities practiced through trainings and capacity buildings
- ➢ 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
- ➢ 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 practiced 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.

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Impact Assessment of Beekeeping Technology Intervention through Demonstration and Scaled Up/Out of Improved Hive Technology in Central Oromia, Ethiopia

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Abstract

The study was undertaken in Central Oromia National Regional State, Ethiopia with the objective of to assess the changes that can be attributed to intervention of demonstration and scaling up/out chefeka hive technology and effect on treated group in Central Oromia, Ethiopia. Semi structured questionnaire was employed for the study. Purposive and simple random sampling techniques were employed to select beekeepers from four zones of Oromia regional state. The sample size used in the study was 81 respondents and analyzed by using SPSS version 20. The result of the study revealed that the average numbers of hives owned by treated and controlled group in respective were 9.04 and 5.42; 5.91 and 1.23; 5.31 and 0.58 traditional, transitional and frame hive, respectively. The beekeepers earned about 8,303.03 and 729.72 ETB per annual income from honey by the treated and controlled group, respectively. This indicates that a reasonable income can be earned from beekeeping in the study area and significant intervention impact on the technology user. So, it recommends the technology should be expanded for none user in unfathomable.

Key words: *Bee keeping; Introduced hive; Impact; Demonstration; Scaled Up/Out*.

Introduction

There is no well-documented evidence that indicates when and where beekeeping practice started in Ethiopia. But it is believed that it has a long history in Ethiopia. However, beekeeping research and development activities were initiated in 1965 with the establishment of the then Holeta Beekeeping and Demonstration Station, now Holeta Bee Research Center, with the aim of improving the productivity of the subsector (Workneh, 2007). Properly planned extension activities, nonetheless were started in 1978 (Ethiopian Beekeepers Association, 2005).

Ethiopia has huge potential for beekeeping production because of its endowment with diversity in climate and vegetation resources offering potentially favorable conditions for beekeeping. These have enabled Ethiopia to take the total share of honey production around 23.58% and 2.13% of the African and world's respectively (Workneh and Puskur, 2011). The subsector is contributing much to the improvement of the livelihood of beekeepers. It is also an important integral part of the economic activity. It accounts 1.3% of agricultural GDP (Demisew, 2016) and create job opportunity to about 2 million people (CSA, 2011). Although the number of farmers engaged in honey production is not well known, estimated that above 1.8 million households are actively participated (MoA, 2012). Towards the development of apicultural sector in the country, diverse governmental and non-governmental organizations and private sectors have been made effort to adopt, demonstrate, and scale up/out modern beekeeping technologies. As reported by Demisew (2016), Government of Ethiopia efforts towards the sector development through establishment of the competent authority MoLF to ensure apiculture development by strengthening extension delivery system. Inline of this Oromia Agricultural Research Institute (OARI), specifically Holeta Bee Research

Center (HBRC) exerted much effort in generation, modification and dissemination of beekeeping technologies that fit with socio-economic and real situation of beekeepers, to increase production and productivity and then improve rural smallholder livelihood. Among these, transitional chefeka and frame box bee hive are the one.

Cognizing of this fact and based on its objectives, the center with collaboration of relevant organizations have generated, demonstrated, and scaled up/out a number of beekeeping technologies. Even though the defined outcomes and tangible impacts of the programs were not evaluated or assessed and documented, it had been reported that the indications of the interventions have positive impact in terms of providing good lesson for researchers, extension workers and farmers in the intervention areas (Workneh, 2007). Therefore, it is vital to assess the unaddressed research gaps in order to answer the questions regarding the evaluation of defined outcomes and tangible impacts of the technologies. So that this study was initiated with the objectives of assess the changes that can be attributed to intervention of demonstration and scaling up/out chefeka hive technology and effect on treated group in Central Oromia, Ethiopia

Methodology

General issues of impact evaluation

The purpose of an impact evaluation is to compare outcomes for beneficiaries of a program to what those outcomes would have been had they not received the program. The difference between the observed outcomes for beneficiaries and these counterfactual outcomes represent the causal impact of the program. The fundamental challenge of an impact evaluation is that it is not possible to observe program beneficiaries in the absence of the program; the counterfactual outcomes for beneficiaries are unknown. All evaluation strategies are designed to find a method for constructing a proxy for these counterfactual outcomes. Most evaluations measure counterfactual outcomes for beneficiaries by constructing a comparison group of similar households from among non-beneficiaries. Collecting data on this comparison group makes it possible to observe changes in outcomes without the program and to control for some other factors that affect the outcome, which reduces bias in the impact estimates.

Description of the study area

The study was conducted in four zones (West shewa, South shewa, North shewa and Special zone of surrounding finfine) of oromia regional state, Ethiopia. From these, eight districts were selected based on the potential for beekeeping and honey production. The study result portrays the potentiality of the study area which was generated through key informant interview. In view of that, about 3,950 beekeepers with 15,500 traditional hives, 1,400 transitional hive and 500 modern hives were found at survey time in Tokke kutaye (LFDO, 2015). As the same information, 6,750 of beekeepers with 6,100 traditional hives, 520 transitional hive and 130 modern hives were found in Warra Jarso district of North shewa zone and also about 6,120 beekeepers having 10,089 traditional hives, 720 transitional hives and 100 modern hives had been addressed in Jaldu district. The corresponding district expert also reports that Chaliya district own 870 beekeepers with 7,424 traditional, 903 transitional and 115 modern hives. As the general, west shewa zone own 71,040 male and 5,857 female beekeepers with 304,486 traditional, 28,570 and 5, 324 modern hives (LFDO, 2015). From these figures one can easily understand that traditional hive is leading. This is in line with different previous study result. Haftu et al. (2015) reported that, traditional hives are used in 97% of bee colonies on average, and they have an average production of 7 kg of honey per colony per year, but there are significant regional differences. About 56 % of traditional hives are found in Oromia region which contributes 40% towards national traditional hive honey production. Likewise, the Amhara, Tigray and SNNP regions have 19% of the traditional hives and contribute 27% of national honey production (GDS, 2009).

Districts: Chaliya, Jaldu, Tokke kutaye and Ejere were from west shewa zone; Yaya gulalle and Warra jarso from North shewa and Bacho from south shewa and Walmara from oromia Special zone of surrounding finfine. For the study data 81 respondents were used having 56 treated groups and 25 untreated groups (Table 1). The treated group is those the intervention had been addressed and disseminated by Holeta Bee Research Center, while the untreated one are those who didn't get the access directly from the center and development agents. However they may get from the neighbor. The aim of this study was to know the impact of the intervention on the beekeepers who have actually received the technology. Actually, to evaluate impact of certain intervention, base line data and at least one to two follow up data should be required; however this study couldn't fit this situation. Due to lack of baseline data, the study couldn't consider other income to compare the groups rather using income generated from honey production only. However detail information was collected through formal survey for farmers and other check list for bee expert and DAs to triangulate the facts. Accordingly, formal survey was conducted using semi structured questionnaire, with open-ended and closed-ended questions with the help of experienced researchers. The questionnaire was designed to capture information such as: household demographics, honey production, honey yield, hive types, honey marketing, price trend, constraints and opportunity of beekeeping.

Table 1. Zones and crosstab result of sample households across districts and groups

Zone	Frequency	Percent	Cumulative Percent
West shewa	44	54.3	54.3
Special zone of surrounding finfine	25	30.9	85.2
South shewa	5	6.2	91.4
North shewa	7	8.6	100.0
Total	81	100.0	
Districts	**Group**		
	Treated	**Controlled**	**Total**
Chaliya	10	5	15
Jaldu	5	2	7
Ejere	10	2	12
Tokke kutaye	5	4	9
Yaya gulalle	4	3	7
Warra jarso	3	2	5
Bacho	3	1	4
Walmara	15	7	22
Total	56	25	81

Source: Own computational survey, 2015

Methods of Data collection and Analysis

Data relevant to the study were collected through formal survey, secondary sources, key-informants interviews and field observations. Supplement information was further collected through discussions with the district experts, DAs, PA administrators, key informants and from other relevant institutions that play significant role in beekeeping activities of the district. The qualitative data that was collected through check list and was analyzed through explanation of idea, opinion, and concept. However the quantitative data collected using semi structured interview schedule was analyzed using statistical tools like mean, frequency and percentage that has been displayed using tables and graphs. The sample size used in the study was 81 respondents and analyzed by using SPSS version 20.

Results and Discussions

Household socio-economic characteristics

The demographic features of sampled farmers are shown in Tables 2 and 3. About 88 percent of the sampled households comprise those that have attained the age between twenty to fifty years with overall average of 43.09 years. Household size is an important source of labor supply to agricultural activity as general and it could initiate a farmer to participate on off farm activity. The farmer who has large family size would manage agricultural production on time and can handle other income generating activity. The sampled farm households' average family size was 6.41 persons. Experience on beekeeping has effect on beekeeping new technology adoption. On average about 10.75% of sample households have experience on beekeeping activity. The experience can be traditional experience or that can be obtained from professionals.

Besides the technological and biological factors; the socio demographic conditions of bee keepers observed to play significant role in the adoption of technologies. Most of the farmers had attended education which range from illiterate to grade 15 (degree level), and most of the sampled households (58%) did pass through formal schooling. From this about 72.4 % of the sampled households are those accepted the new beekeeping technology. In other words about 58 of the respondents have attended any education. Out of that, 42 of them were from the treated group while 16 of respondents were from controlled (Table, 3). This indicates that educated person is sensitive to adopt new technology. Educational level of the farming households may have significant importance and determining the type of development and extension service approaches (Taye and Marco, 2014). So, education is an important and one entry point for fast transfer of knowledge on improved beekeeping.

Table 39. Age, household size and beekeeping experience of sample households

Variables	N	Min	Max	Mean	Std. Deviation
Age of the household head(year)	81	18	87	43.09	10.931
Total Family size (number)	81	1	15	6.41	2.893
Highest grade of school attended	64	1	15	6.86	3.563
Household experience in beekeeping (year)	81	2	40	10.25	7.566

Source: Own computational result, 2015

As indicated in Table 3, 85.18 % of sample households are male participated in beekeeping activity while 14.8 % are female. This implies that male headed constitute a greater percentage in the participating the activity even though the activity is also affordable and can be participated by no differentiating age and sex. About 87.65% of the sampled households were married and 4.93 % were single. This may implies that youth participation in the beekeeping is low, and need more attention. From the sampled households, 79% is Oromo ethnic group members whereas the remaining 20.98% belongs to Amhara ethnic groups.

Table 3. Formal education, sex and marital status

Variables		Group		Total
		Treated	**Untreated**	
Sex	Female	7	5	12
	Male	49	20	69
	Total	56	25	81
Ethnic	Oromo	45	19	64
	Amhara	11	6	17
	Total	56	25	81
Attended formal education	Yes	42	16	58
	No	14	9	23
	Total	56	25	81
Marital status	Single	4	0	4
	Married	49	22	71
	Widow	1	1	2
	Divorced	2	2	4
	Total	56	25	81

Source: Own computational result, 2015

Household characteristics

The study result shows that about 57.2 of the sampled respondents were user of introduced hives through HBRC, while 43.8% were those not intervened but they have used through own initiation effort adopting from different sources like friends, relatives (Table, 4). However, users of traditional hive were viewed in large figure from the controlled group (91.7) while 8.3% was from treated group (Table, 4). This result may come from different reason that make the respondent (8.3%) drop the introduced one and move to traditional. Most of the respondents raised lack of equipment and cost of the material hinder to use the introduced technology though the yield difference between the hives is apparent. Different studies also noted, some beekeepers challenged using of improved beehive technologies. For instance, Nebiyu and Mesele (2013) reported that most of the beekeepers of the Gamo Gofa zone of Southern Ethiopia preferred traditional beehives over transitional and modern beehives because of cost of constructing materials of transitional beehives and unaffordable cost of modern and transitional beehives. Similarly Haftu et al. (2015) also reported that most beekeepers of Weri'e Leke district of Tigray region (60 %) said that the ever increasing cost of improved beekeeping inputs to have its own effect on the successful operation of the beekeeping business.

In other case, lack of the equipments is also one factor that hampered to use modern hives in the region. Welay and Tekleberhan (2017) have conducted research on Honey Bee Production Practices and Hive Technology Preferences in Jima and Ilubabour Zone of Oromia Regional State reported that respondents gave varied reasons why they do not prefer a frame hive technology. Accordingly, lack of equipment was the first factor. Similar authors have mentioned that affordability, availability, quality of materials specially hive, inferior quality of wax and lack of accessories were the major factors that hampered to use modern hives in the area. So, if development actors consider material provision and make accessibility of market for material at reasonable price, user and beneficiary of the technology may enlarge to 100%.

With regard to landholding, 98.76 % own land either for cultivation, forest, uncultivated and multiple of them. The remaining 1.24% of the respondent replied as land less and this is from the treated group those who have adopted the technology (Table, 4). This indicates that beekeeping activity is requiring little or no land. Bee farming requires little land and therefore is an ideal activity for small scale resource-poor farmers (Jinanus and Tamiru, 2016**).**

Table 4. Respondent category and land ownership across Group Cross tabulation result

Variables		**Group**				**Total**	
		Treated		Controlled			
		N	**%**	**N**	**%**	**N**	**%**
Respondent category	User of introduced hives only	4	57.2	3	43.8	7	8.64
	User of Traditional hives only	1	8.3	11	91.7	12	14.81
	User of both	50	80.6	12	19.7	62	76.54
	Total	55	67.9	26	32.1	81	100
Land holding	Yes	54	67.5	26	32.5	80	98.76
	No	1	100	0	0	1	1.24
	Total	55	67.9	26	32.1	81	100

Source: Source: Own computational result, 2015

Honey production and productivity

According to the survey result, the mean number of traditional beehives owned per household was 7.87 with minimum and maximum beehives of 0 and 82 following on average 4.41 and 3.79 of transitional and modern bee hives respectively (Table, 5). The productivity of the beehive was different due to differences in management and type of hives. But result observed from table 5 below indicates that honey product per sampled household rather than productivity per hives. The yield difference was viewed due to different reason like number of hives type owned, availability of bee forage, feed supplement and skill difference. The mean honey production of traditional, transitional and modern beehive was 723.05, 415.39 and 1034.72 kg/5 years/hh, respectively (Table, 5). It could be concluded that on average a farm household might gain about 144.6, 83.1 and 206.9 kg of honey per year from traditional, transitional and modern bee hive, respectively. From the study result one could clearly understand on average about 18.37, 19 and 54.6 kg of honey productivity obtained annually per traditional, transitional and modern hives, respectively.

Honeybee flora and dry season feeding

Although honeybees store honey for their own consumption during the period of feed scarcity, there is exploitation of honey by beekeepers. However, at times of feed scarcity the bees face starvation. To overcome the feed shortage during the dry season, some farmers usually take different measures like supplementary feeding. In this study, it was found that 64.2% of the beekeepers provided supplementary feed for the dearth period (Table, 5). The supplementary feed included *besso*, *shiro*, sugar syrup and honey with water. Honeybees collect nectar and pollen for their own consumption and store honey for the dearth period. Bee forage types affect the amount of honey yield obtained per colony. According to the beekeepers the existence of some special bee forages in the district results in the production of high quality and quantity honey. In the study area there has been an encouragement by HBRC and nongovernmental organizations to plant and to cultivate different bee forages. Thus, the beekeepers grow indigenous bee forages around homesteads, in area closure and, in and around their apiary sites. According to this study, about 71.6 % of beekeepers cultivated different local bee forages.

Current practices and replacement of bee colony

In the study area, 61.7% of total sampled households were practiced construct of bee hive shading. The hives in the shade colonized earlier due to the cool temperatures under the shade as compared to the high unfavorable temperatures in the open sun (Kugonza et al., 2009). From similar outers, colony size for hives in the shade could have been higher than for hives in the open sun due to a favorable micro-climate. Colony multiplication is one type technology generated and disseminated by HBRC to the study the area to improve beekeepers income from honey beekeeping activity beside of Agricultural activity. In similar fashion about 79% had practiced colony multiplication. Most of the respondents (58.2%) replied that they have got their colonies by catching swarms and followed by 30% of them obtained from purchasing and the a few of them through multiplying. This is in line with Addis and Malede (2014) who noted that 49.2% of the bee keeper started by catching swarm. From this, one can concludes that catching swarm is the main sources of honey bee colonies in the study areas. All (100%) of the beekeepers in the study areas kept their hives around their homestead (back yard) (Table, 5)

Table 5. Type of Beehive owned in 2015 of survey year, honey product since 5 year and beekeeping practices per sample households

Variables	N	Min	Max	Mean	Std. D
Type of Bee hive					
Traditional Hives	81	0.00	82	7.876	12.97
Transitional Hives	81	0.00	100	4.407	11.68
Modern Hives	81	0.00	22	3.790	4.90
Honey and wax product /hh/5 year in kg					
From Traditional hive	66	6	34000	723.1	4170.6
From Transitional	46	10	10000	415.4	1462.4
From modern hive	57	0.00	35000	1034.7	4621.6
Total Wax product	81	0.00	250.00	15.23	47.62

Shade hive constructed	Response	Frequency	Percent
	Yes	50	61.7
	No	31	38.3
Provided supplement feed	Yes	52	64.2
	No	29	35.8
Plant bee flora planted	Yes	58	71.6
	No	23	28.4
Colony multiplication	Yes	17	21.0
	No	64	79.0
	Yes	40	49.4
Extraction of honey practice	No	41	50.6
	Total	81	100.0
Replace Colony	Catching swarm	39	58.2
	Purchasing	20	29.9
	Multiple colony	4	6.0
	From family	2	3.0
	No replaced	2	3.0
	Total	67	100.0
Where keep honeybees	Back yard	81	100.0

Sources: Own computational result, 2015

Economic impact at household level

The economic impact discusses the income at the household level with intervened and controlled beekeepers. The difference in income was done by the mean comparison which was generated by beekeeping activity. To get the impact of improved beekeeping, matched result was discussed.

Difference in gross income of households: treated and controlled beekeepers

The result implies beekeeping has both as a source of income and food diet. The average gross income of households with modern and traditional beekeeping is given in Table 6. The results showed that the average numbers of traditional, transitional and frame hive owned by treated and controlled group were 9.04 and 5.42; 5.91 and 1.23; 5.31 and 0.58 at the survey year, respectively. The mean of revenue obtained from honey product were 50,593.84 ETB with standard deviation of 69338.65 by treated group whereas for controlled group 4,974.58 ETB with 7686.42 standard deviation per household per five years. By taking into account the total expense for beekeeping activity, net income per household was calculated. Accordingly, 41,515.13 ETB/ five year /hh for treated group where as on average about 3,648.577 ETB / hh been generated by controlled group. It is also easily calculated from the result revealed in Table 6 that the beekeepers earned about 8,303.026 and 729.715 ETB net income/year from honey by the treated and controlled group, respectively. This indicates that a reasonable income can be earned from beekeeping in the study area and observable difference is real between the groups.

Despite other income was not considered to evaluate net income difference among the groups rather income generated from honey production only, about 91.92 % ETB was the income difference observed between the groups. The partial budgeting result reveals that the beekeepers are profitable due to adopting transitional chefeka bee hive (Wongelu, 2014). The outer also summarizes that the incremental net benefit of transitional chefeka hive was 462.12 ETB. This shows that the beekeepers increased their benefit from chefeka bee hive by more than 2.9 fold compared to traditional hive (Wongelu, 2014). Chefeka bee hive is one type improved hive which intermediate between traditional and frame hive. One can conclude that the intervention impact is positive to the beneficiary group. Yield is an important determinant factor to identify the difference between groups and then leads us to know impact of the intervention. The yield difference had been observed above were easier to convince any development actors to improve the small scale farmers' income through introducing and compose adopting off-farm activities like beekeeping. Even the treated group was not intervened with full package. If they get interference with full package, they might be improved more.

Table 6. Bee hives owned and net income from beekeeping activity among the groups

Parameters			**Treated group**	**Controlled group**
Type of bee hives				
	Traditional hives (number)	Mean (Std. Dev)	9.04(14.22)	5.42(9.57)
		Maximum	82.00	50.00
		Minimum	0.00	0.00
	Transitional hives (Number)	Mean (Std. Dev)	5.91(13.93)	1.23(1.53)
		Maximum	100	4.00
		Minimum	0.00	0.00
	Frame hives (Number)	Mean (Std. Dev)	5.31(5.26)	0.58(1.14)
		Maximum	22.00	4.00
		Minimum	0.00	0.00
Income				
	Total honey product/5 year (kg)	Mean (Std. Dev)	1775.58(5147.17)	109.00(89.90)
		Maximum	35250.00	330.00
		Minimum	55.00	10.00
	Revenue from honey / 5 year (ETB)	Mean (Std. Dev)	50571.655(69282.05)	4974.04(7684.21)
		Maximum	344400.00	25600.00
		Minimum	660.00	60.00
	Revenue from wax (birr) since 5 year	Mean (Std. Dev)	22.1818(56.60)	0.54(2.21)
		Maximum	250.00	11.00
		Minimum	0.00	0.00
	Total revenue from beekeeping activity(ETB)	Mean (Std. Dev)	50593.84(69338.65)	4974.58(7686.42)
		Maximum	344650	25611
		Minimum	660	60
	Total Expense	Mean (Std. Dev)	9078.70(11675.28)	1326.00(1229.09)
		Maximum	50000.00	5000.00
		Minimum	40	0.00
	Net Income	Mean (Std. Dev)	41515.13(57663.37)	3648.58(6457.33)
		Maximum	294650	20611
		Minimum	620	60

Sources: Own computational result, 2015

To triangulate the study result, one way ANOVA analyses to test mean difference among the groups in beekeeping products was estimated. Accordingly, the result of test of mean difference using one-way ANOVA shows that there was significant mean difference among groups categories at 1% significance level with (F = 11.124) in revenue obtained from honey product among groups categories (Table, 7). This showed that the honey product has positive effect to income of beekeepers in the study areas. So, if the interventions develop in to uniform with full package of beekeeping activity, the beekeepers income further be enhanced and then the livelihood of smallholder farmers will be improved in general.

Table 7. One way ANOVA analyses to test mean difference among the groups in honey products

Total revenue from honey product	Degree of freedom	Mean Square	F	P value
Between Groups	1	36705850707.74	11.124	.001***
Within Groups	79	3299700271.157		
Total	80			

Source: Field survey result, 2015.

Honey marketing

Beekeepers of the study area sell their honey at different places and have different costumers. Sample respondents who produce and sell honey were asked their main selling place. Accordingly, they mostly sell their honey at nearby town (53.2%), *tej* house (22.8), and farm gate (11.4%) and to cooperatives was very minimal (3.8%) (Table 8).

Table. 8. Place of honey market sells

Honey market place	Frequency	Percent
Nearby town	42	53.2
Farm gate	9	11.4
Cooperative	3	3.8
Tej house	18	22.8
Honey verandah	5	6.3
Road side	2	2.5
Missing	2	
Total	81	100.0

Sources: Own computational result, 2015

Honey Price Trend

It is a continuous variable measured in birr per kilogram. When the price of the product is promising, farmers are motivated and encouraged to add value to their produce and market. Every product is valued by its market price and farmers also depend on the previous price to decide the future product (i.e, what to produce). When compared to preceding years, there is an increase in the prices of honey. Even though the early price history was very low (below 60 ETB) the respondents feel price increase fairly remain stable and becoming motivate the product attractiveness and open path to accept the product intensifying technology.

Beekeeping extension service

Moreover, in addition to the farmers indigenous knowledge, the HBRC with the corresponding districts of agricultural bureau, have distributed modern beehive and offer training to the beekeepers. According to the information from the farmers and apiculture experts of the districts, extension service was the main related to beekeeping activity and input different improvement in beekeepers income and skill development. The treated group also agreed that the sub sector is given more attention in the district along with demonstration and disseminating the technology generated by HBRC. The treated group had gained better support from the extension agents as it can be observed from the table 9. This showed that due to strong extension support for the intervened group (significant at 1% of probability of level), the mean difference of income which had been observed in table 6 was recorded.

Table 9. One way ANOVA test of mean difference among the groups in extension support

Parameters		Degree of freedom	Mean Square	F	Sig.
GET assist from extension agents	Between Groups	1	6.430	45.254	.000***
	Within Groups	80	.142		
	Total	81			
Aware the introduced hives	Between Groups	1	1.113	14.417	.000***
	Within Groups	80	.077		
	Total	81			

Sources: Own computational result, 2015

Beekeeping opportunities and constraints

The study area has immense natural resource for beekeeping activity. However, like any other livestock, this sub sector has been ceased by complicated constraints. According to the districts apiculture experts and key informant interview result, the districts are highly potential and have many opportunities to the beekeeping sector due to high involvement of HBRC and other developmental activities. About 64.2 % of the beekeepers pointed out that beekeeping are profitable in the districts due to the districts' extension and HBRC support like training and input supply where as 22.2% of the respondents replied that availability of different bee forage species also measured as opportunity (Table, 10). The beekeepers generally explained that the profitability of the sector in the study areas is very good and encouraging to engage in this activity. All problems may not be equally important to the sector. The most important constraint that hampered the development of beekeeping sub-sector arises from pest and predators. The majority of respondents (42 %) listed pest and predators as a major constraint.

Pests and predators cause a serious devastating damage on honey bee colonies with in short period of time and even over night. The interviewed beekeepers were stated the major bee pests and predators in the study area were: ants, wax moth, spider, bee-eater birds, honey badger and beetles are the most serious problems to beekeeping development. This result agrees with the report of Taye and Marco (2014), ants, honey badger, bee-eater birds, wax moth, spider, and beetles were the most harmful pests and predators in order to decreasing importance of beekeeping in Oromia region. So, concerned body should consider problem minimizing finding. Lack of material and chemicals accounted 24.7% and 13.6% of the constraint of beekeeping, respectively. In addition to this, 7.4 %, 6.2 % and 4.9 %, of the beekeepers were constrained by lack of extension support, absconding and lack of skill, respectively (Table, 10). However, lack of the extension support was raised from the controlled group mainly.

Table 10. Beekeeping Opportunity and Constraints in the study area

Opportunity	Frequency	Percent
Extension and HBRC support	52	64.2
Market availability	11	13.6
Flora availability	18	22.2
Total	**81**	**100.0**
Problem		
Lack of material	20	24.7
Pest and predators	34	42.0
Shortage of bee flora	1	1.2
Chemicals	11	13.6
Lack of extension support	6	7.4
Absconding	5	6.2
Lack of skill	4	4.9
Total	**81**	**100.0**

Sources: Own computational result, 2015

Conclusions and Recommendations

The study was conducted in Central Oromia national regional state, Ethiopia to assess Impact of Beekeeping Technology Intervention through Demonstration and Scaled Up/Out of chefeka hive technology. Semi structured questionnaire was employed for the study. The study used desk research, key informant interviews, surveys and visual observation as methods in seeking answer to research questions. Purposive and simple random sampling techniques were employed to select beekeepers from four zones of Oromia regional state. The sample size used in the study was 81 respondents and analyzed by using SPSS version 20. The result of the study revealed that the average numbers of hives owned by treated and controlled group in respective were 9.04 and 5.42; 5.91 and 1.23; 5.31 and 0.58 traditional, transitional and frame hive, respectively. The mean of revenue obtained from honey product were 50,593.84 ETB with standard deviation of 69338.65 by treated group while, 4,974.58 ETB with 7686.42 standard deviation per household per five year from controlled group. By taking into account total expense for beekeeping activity, net income per household was calculated. Accordingly, 41,515.13 ETB/ five year /household for treated group, whereas on average about 3,648.58 ETB/ 5 year/ hh been generated by controlled group. The beekeepers earned about 8,303.03 and 729.72 ETB per annual income from honey by the treated and controlled group, respectively. This indicates that a reasonable income can be earned from beekeeping in the study area and significant intervention impact on the technology user. So, it recommends the technology should be expanded for none user in unfathomable.

Based on the findings from field survey, the following recommendations have been proposed for treated and controlled beekeepers to promote the income of small scale farmers and improve the livelihood of local beekeepers. Firstly, conduct a baseline survey to understand the detail production capacity. The study was insufficient due to not considering the baseline and follow-up data as well as not rich with required information. So, it is recommended that concerned body should conduct a baseline survey with all existing beekeepers to have a better understanding about their current production capacity and lead to careful understanding of intervention impact if such like study be conducted. The baseline survey is very critical for two reasons. Firstly, the baseline survey can serve as the benchmark for comparison. Secondly, the survey can also provide stakeholders with some general ideas about the project's current performance and explore the viability of different options based on current production capacity. For beekeepers, they may develop the sense of record keeping and understand their own position through the survey. The baseline survey can be conducted as the supplementary session for any general assembly where beneficiaries are gathered to discuss major issues.

Secondly, offer the intervention in wide site since the study overview indicates income improvement on treated group. Such information is becoming even more critical as concerned body try to extensively scale up and conduct unreached farmers. Thirdly, awareness and training is a sustainable method to motivate beekeepers and give them incentives to drive their own future. From the study result, the treated group is significantly different from untreated group in terms of training and awareness made. The goal is to demonstrate what success looks like and to motivate beekeepers towards a new objective. A training of this sort would demonstrate the honey income potential by providing information on honey production using introduced hives, as well as show casing successful honey production managements. So, continue to focus on increasing the production capacity of local beekeepers through training is one of the key issues to solve agricultural risk minimizing and income diversifying issues that small scale farmers face.

Fourthly, Even though yield difference among bee type is observed, traditional hive is till leading in the study area. Some percents of respondents from treated group currently using traditional hives. This may be due to different problem. So if Perception of Beekeeper on type of hives in the study area is due attention, the difficulty will be reduced. Finally, the first constraint of honeybee production is pest and predators and lack of beekeeping equipment. Pest and predators will cause unacceptable economic damage. So, intervention should be made to reduce pest damaged portion of the product through technology of most effective and least disruptive to natural pest controls.

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Assessment of Indigenous Knowledge of Farmers on Intercropping Practices in West Hararghe Zone; Oromia National Regional State, Ethiopia

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Abstract
The study was conducted in three districts of West Hararghe Zone with the objectives of identifying and document indigenous knowledge of farmers towards intercropping, and identify constraints and opportunities of intercropping in the study area. A multi-stage sampling technique was used for the study. Total sample size of 149 households was interviewed and generated both qualitative and quantitative data. Two Focus Group Discussion at each district and generally of six Focus Group Discussion were also formed and generated qualitative data. Descriptive statistics and an index score were used to analyze data. Majorly intercropped crops were Maize with Haricot Bean followed by Sorghum with Haricot Bean. Khat and Coffee were also intercropped with different crops. The study indicated that drought, lack of knowledge about fertility management and lack of improved technology of intercropped crops were major constraints of intercropping legumes with other crops in the study area. However, declining of land holding size as a result of rise in population, increase in market demand and early maturity of legumes such as Haricot Bean which is mostly intercropped with other crops, and expansion of Khat were major opportunities of intercropping in the study area. The study indicated that any research conducted on any intercropping practice in the area should incorporate farmers practice such as times of sowing and types of intercropped crops on intercropping trail, awareness creation on soil fertility improvement should be promoted and introduction of improved intercropped technology should be given special emphasis since intercropping is mostly practiced in the study area.

Key words: *Double intercropping; Drought; Grain yield reduction; West Hararghe*

Introduction

Ethiopia's economy is largely based on agriculture, which provides 80-85 percent of employment and 61% of the total export (NABC, 2015) and 38.5% of Gross Domestic Product in 2014/15 (NPC, 2016). Hence, the growth of agricultural sector is very important, as it constitutes the bulk of the national economy in terms of human and material resources. However, this sector is characterized by low productivity of land and labor that it failed to make substantial contribution to the country's economic growth and to ensure food self-efficiency (Fenta, 2006).

In Ethiopia absence of effective linkage between indigenous knowledge and conventional ones has been identified as one of the major problems that hinder effectiveness of the development of the agriculture in general and of agricultural research and extension system in particular (Fenta, 2006). The importance of indigenous knowledge has been realized in the design and implementation of sustainable development projects (Ajani *et al.,* 2013). Integration of appropriate indigenous knowledge systems in to development programs has already contributed to efficiency; effectiveness and sustainable development impact (World Bank, 2000). Considering such a problem, there had been various attempts both by extension and research organizations to invigorate linkages. Yet, the linkages remain as weak as the number of times solutions were sought to further strengthen them.

Indigenous knowledge has been defined as institutionalized local knowledge that has been built up on and passed on from one generation to other by words of mouth (Ajani *et al.,* 2013). Indigenous knowledge systems are the complex arrays of knowledge, know-how, practices and representations that guide human societies in their innumerable interactions with the natural milieu: agriculture and animal husbandry; hunting, fishing and gathering; struggles against disease and injury; naming and explaining natural phenomena; and strategies for coping with changing environments (Nakashima and Rou', 2002). It is the basis for local level decision making in many rural communities. Indigenous knowledge has value not only for the culture in which it evolves but also for scientists and planners striving to improve conditions in rural localities. Intercropping is cultivation of two or more crops simultaneously on the same field. It also means the growing of two or more crops on the same field with the planting of the second crop after the first one has completed its development. The rationale behind intercropping is that the different crops planted are unlikely to share the same insect pests and disease-causing pathogens and to conserve the soil.

Intercropping is an important feature of cropping systems in the tropics (Francis, 1986; Connolly *et al.,* 2001). The common bean and maize (*Zea mays L.*) intercropping is a common feature of crop production in densely populated areas of Eastern Africa such as highlands of Hararghe. The system is very important for the intensification of crop production and contributes to increased returns to small-holder farmers in the highlands of Hararghe having a limited land holdings (0.6 ha per house hold size of 5.4 members) (CACC, 2001). Intercropping legumes with non-legume is an important feature of many cropping systems in the tropics (Willey, 1979; CIAT, 1986). There are several socio-economic (Ofori and Stern, 1987), and biological and ecological (Van Rheen *et al.,* 1981; Aggarwal *et al.,* 1992; Chemeda, 1996) advantages to intercropping relative to sole-cropping for small-holder farmers. Introduction of legume-cereal intercropping in to mixed farming systems increases farm income and reduces pressure on land resources (Kassie, 2011).

West Hararghe Zone is known to be densely populated area and has limited land holdings and well known for its best practices and indigenous knowledge in different intercropping types. Enhancing the production and productivity in the area with available indigenous technical knowledge will help the improvement of the sector in increasing the sector contribution to National and Agricultural Gross Domestic Product. Identifying and documenting indigenous knowledge of farmers towards intercropping was used to develop appropriate technology for improvement and set clue for police makers to understand gap concerning different practices. Therefore, the study aimed at assessing the indigenous knowledge of small-holder farmers towards intercropping practices in the study area to identify and document indigenous knowledge of farmers towards intercropping and to identify constraints and opportunities of intercropping in the study area.

Research Methodology

Description of the Study Area

This study was conducted in three districts (Gemechis, Habro & Mieso) of West Hararghe Zone known in intercropping practices very well. Gemechis is located at 343km East of Addis Ababa and about 17 km South of Chiro, which is capital town of the Zone. The district is bordered with Chiro district in West and North, Oda bultum district in South, and Mesala district in East. The district is found at altitude ranges from 1300 to 2400msal. Agro-ecologically, the district has three sub-climatic zone highland (15%), midland (45%) and lowland (40%). The district is mainly characterized as steep slopes and mountains with rugged topography. It receives annual rainfall of 850mm and average temperature of 20^{o}C.

Habro district is located at 404 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. The altitude of the district ranges between 1600-2400 m.a.s.l. with maximum and minimum temperature of 16^{0}c and 20^{0}c, respectively. The district receives annual average rainfall of 650mm to 1000mm (Aman Tufa & Anteneh Temesgen, 2010). Major food crops grown in this district were maize, sorghum and haricot bean, and major cash crops grown were coffee and Khat.

Mieso is located at 304km to East of Addis Ababa and 25km to West of Chiro. It is bordered by Doba district in East direction, Afar Region in West, Chiro district in South and Somali Region in North. The district has an area of 257,344 ha. It is located at the latitude of 9^{o}13'59.99" and longitude of 40°45'0". The altitude of the district on average is 1332 m.a.s.l. with maximum and minimum temperature of 37^{0}C and 25^{0}C, respectively. The annual rainfall of the district ranges 500mm to 700mm.

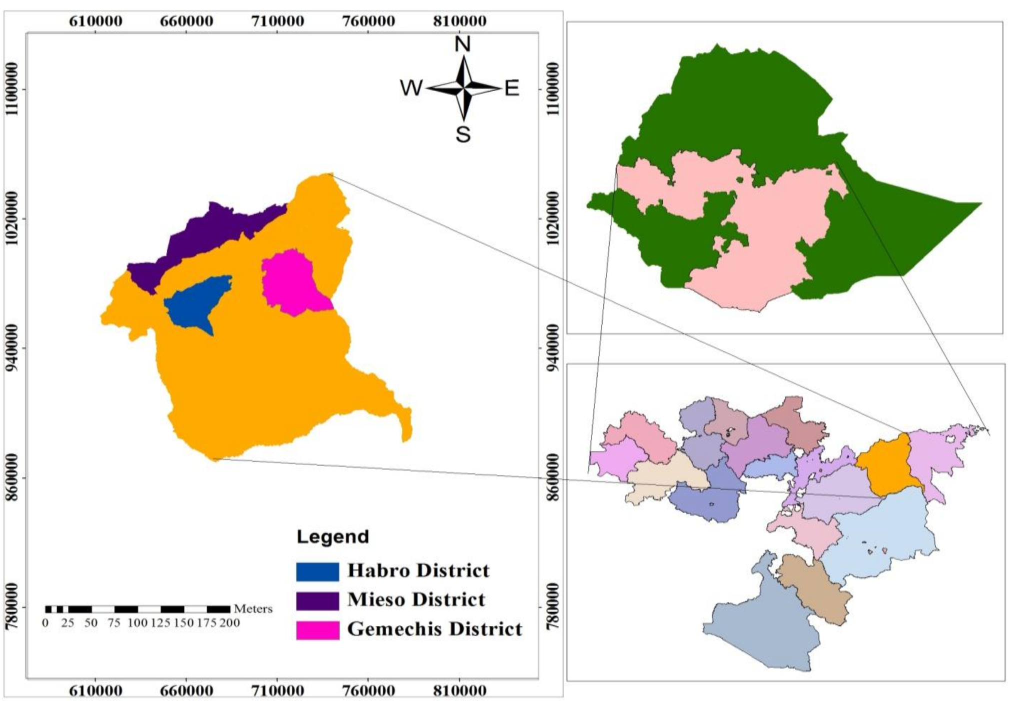

Figure 1: Political map of the study area
Source: Own computation from GIS data, 2017

Sampling Techniques

Districts and Kebeles were selected purposively in collaboration with zonal and district Office of Agricultural and Natural Resource depending on their agro-ecology and potential of intercropping practices. Accordingly, Gemechis, Habro and Mieso districts were selected. Then, Oda Bal'a and Gorbo Anani Kebeles from Mieso district, Lelisa and Bareda Kebeles from Habro district, and Kuni segariya and Hara Bafana Kebeles from Gemechis district were selected. A sample of 149 households which consist 129 male and 20 female were selected randomly by taking in to account probability proportional to population size.

Data Sources and Method of Data Collection

Data were collected from both primary and secondary sources. The primary data was collected from 149 sampled households through structured interview schedule. Secondary data was collected from Zonal and District, Agricultural Offices and Natural Resource. Two Focus Group Discussion from each district and generally of six Focus Group Discussion were formed and generated qualitative data. Both qualitative and quantitative data were collected from sampled households through structured interview schedule. Five enumerators were trained and involved in data collection. Data was coded and entered in to SPSS version 20 software for statistical analysis and management.

Method of Data Analysis

Descriptive statistics such as mean, standard deviation, frequency distribution and percentage were used to understand socio-economic situation and indigenous knowledge of farmers on intercropping practices. An index score was calculated and used to provide overall ranking of major intercropped crops and constraints of intercropping legume crops with other crops. Qualitative data were also analyzed through narration and description.

Results and Discussion

In this chapter, the results of the study along with previous research findings are briefly presented and discussed as follows.

Demographic and socio economic characteristics of sampled households

Sex, marital and educational status

In this study, of the total interviewed farmers, 86.6% were males, while 13.4% were females. Regarding marital status, 9.4%, 87.9% and 1.3% of the respondent were single, married, divorced and widowed respectively. Education is a crucial factor for skill development and enhancing farmers' decision making in resource allocation for agricultural activities. Accordingly, the result of the study indicated that about 69.1% of the respondents were literate while 30.9% were illiterate.

Table1: Sex, marital and educational status of the sampled respondents

		Frequency	Percent
Sex	Male	129	86.6
	Female	20	13.4
Marital status	Single	14	9.4
	Married	131	87.9
	Divorced	2	1.3
	Widowed	2	1.3
Educational status	Literate	103	69.1
	Illiterate	46	30.9

Source: survey result, 2017

Age, family size and intercropping experience of households: The average age of households in the study area was 39.04 ± 11.24 years and average family size was 6.18 ± 2.38 years. Experience plays an important role in intercropping activities and production efficiency and system of handling of their products. Average years of intercropping experience of households were 16.56 ± 10.45.

Table 2: Age, family size and intercropping experience of households

No.	Variable	Mean ± Standard deviation
1	Age of HHs	39.04 ± 11.24
2	Family size	6.18 ± 2.38
3	Intercropping experience of HHs	16.56± 10.45

Source: Own survey result, 2017.

Total land owned, and allocated for sole cropping and intercropping: Average land holding size of households in the study area was 1.09± 0.95, and land allocated for intercropping and sole cropping were 0.77± 0.69 and 0.54± 0.41, respectively (Table3). This indicated that land allocated for intercropping exceeds land allocated for sole cropping in the study area.

Table 3: Average land holding, land allocated for intercropping and sole cropping in Ha

No.	**Land**	**Mean ± Standard Deviation**
1	Total land owned	1.09± 0.95
2	Land allocated for intercropping	0.77± 0.69
3	Land allocated for sole cropping	0.54± 0.41

Source: Own survey results, 2017

Farmers' indigenous knowledge on intercropping practice

Cropping systems: The results of the survey revealed that all sampled respondent were practicing intercropping. Similarly, Gosa Alemu (2016) argued that the major cropping system practiced in the area was intercropping. Major crops which could be grown solely were Sorghum (*Sorghum bicolor*), Maize (*Zea mays*), Onion (*Allium cepa*), Haricot Bean (*Phaseolus vulgaris*), Teff (*Eragrostis abyssinica*), Barely (*Hordeum vulgare*), Faba Bean (*Vicia faba L*.),Wheat (*Triticum aestivum*), Ground Nut (*Arachis hypogaea*), Finger Millet (*Eleusine coracana*), Khat (*Khat edulis*), Chickpea (*Cicer arietinum*), Hot Pepper (*Capsicum annuum*), Sweet Potato (*Lopmoea batatas*) and Pea (*Pisum sativum*).

Table 4: Cropping systems practiced by sampled respondents

		Frequency	Percent
Cropping systems	Intercropping only	54	36.2
	Sole cropping and intercropping	95	63.8
	Total	149	100.0

Source; Own survey results, 2017.

Types of intercropped crops in the study area: The major intercropped crops in the study area were maize with haricot bean (*Zea mays* + *Phaseolus L.*) followed by sorghum with haricot bean (*Sorghum bicolor* + *Phaseolus L.*) and other intercropped crops which are depicted in the Table 5. Coffee and chat were also intercropped with different crops. Similarly, Tolera and Gebremedin (2015) also reported that coffee was intercropped with different crops such as maize, sorghum and haricot bean in West Hararghe Zone. The reason of intercropping in the study area were; shortage of land (shrinking of cultivated areas per household as a result of rise in population), to maximize profit and to minimize risk. The reason of intercropping are profit maximization and risk minimization (Ashish *et al.*, 2015 and Tenaw, 2013) and intercropping is an alternative for decreasing of cultivated land per household as a result of increase in population (Getachew *et al.*, 2013) were in line with the reasons of intercropping in the study area. In addition, availability of khat and coffee, and early maturity of component crops such as haricot bean were also another reason of intercropping in the study area. Khat and coffee are perennial crops and in line with the reality of land shortage in the area, they intercropped with different crops (Table 5).

Table 5: Types of intercropped crops listed and ranked by sampled respondents

No	Intercropped crops	Intercropped crops by their rank in selected districts			Index score	Rank
		Mieso	Gemechis	Habro		
1	Maize with haricot bean	1		4	0.133	1
2	Sorghum with haricot bean	4	2		0.120	2
3	Maize with haricot bean and barley/teff		1		0.095	3
4	Sorghum with maize and sesame	2			0.089	4
5	Khat with maize and haricot bean			1	0.063	5
6	Sorghum with maize	3			0.051	6
7	Sorghum with maize and haricot bean		3		0.051	6
8	Maize with chickpea			2	0.051	6
9	Coffee with maize and haricot bean			2	0.051	6
10	Khat with haricot bean				0.038	10
11	Khat with maize		4	5	0.038	10
12	Coffee with maize and barley			5	0.038	10
13	Onion with tomato		5		0.032	13
14	Maize with tomato			8	0.032	13
15	Khat with maize and barley			7	0.032	13
16	Sorghum with common vetch			10	0.025	16
17	Coffee with sorghum			9	0.025	16
18	Khat with sorghum			11	0.019	18

19	Coffee with finger millet, sweat potato, chickpea and groundnut	12	0.013	19
20	Khat with finger millet, linseed, sweat potato, chickpea and groundnut	13	0.006	20

Source; Own survey result, 2017.

Index for a particular intercropped crops = [8 for rank1 + 7 for rank2 + 6 for rank3 + 5 for rank4 + 4 for rank5+ 3 for rank6 + 2 for rank7 + 1 for rank8] divided by sum of [8 for rank1 + 7 for rank2 + 6 for rank3 + 5 for rank4 + 4 for rank5+ 3 for rank6 + 2 for rank7 + 1 for rank8] for all intercropped crops.

Types of intercropping practiced and times of sowing: Intercropping has four general subcategories. There is mixed, no distinct row arrangement; row intercropping, at least one crop is planted in rows; strip intercropping, growing crops in strips wide enough to separate them yet narrow enough to allow intercropping between them and relay intercropping, growing two or more crops during differing parts of their cycles (Stephen, 2009). Accordingly, farmers of the study area practiced mixed, row and relay intercropping. Coffee and Khat were intercropped with different crops (Table 6) and one up to three rows of different crops were used between coffee or khat rows.

Time of sowing is critical for optimal production of cereal grain with forage legumes (Ashish *et al., 2015*). The best time depends on the cereal and legumes in question and needs to be determined experimentally. Farmers of the study area practiced both sowing simultaneously (at the same time) and at knee height stage (sowing component crops when base crops reach for cultivation). Apart from Gemechis district, in which sorghum is intercropped with haricot bean simultaneously and at knee height stage, the rest have intercropped simultaneously. Sorghum and maize were intercropped simultaneously, and at knee height stage of sorghum and maize, haricot bean was intercropped. Maize was intercropped with haricot bean simultaneously and after haricot bean is harvested in June, either barely or teff is sown in August. Sorghum was also intercropped with haricot bean in April and after harvesting haricot bean in July, again haricot bean is sown in August. This indicated that there is double intercropping practice in the study area. Similarly, Wondimu *et al.,* (2016) intercropped maize with soybean simultaneously and indicated that cost of fertilizer is reduced and total productivity is maximized. Tamado *et al.,* (2007) also intercropped maize with haricot bean simultaneously and reported the agronomic and economic feasibility of double intercropping of common bean under small holder farming systems of Eastern Ethiopia. On the other hand, Getachew *et al.*, (2013) intercropped maize with vetch and lablab fifteen days after emergence of maize, and indicated that row intercropped vetch at 50% seed rate was more advantageous than maize-lablab intercrop. Alemu and Tikunesh (2014) also intercropped maize with forage legumes (*Vigna unguiculata*, *Lablab purpureus and Vicia atropurpurea*) at knee height stage of maize and suggested that maize grain yield and biomass yield of intercrops can be maximized for both human and livestock feeding by integrating *L. Purpureus* with maize.

Table 6: Spatial arrangement and times of sowing listed by respondents

		Spatial arrangement			Times of sowing		
No	Intercropped crops	Mieso	Gemechis	Habro	Mieso	Gemechis	Habro
1	Maize with haricot bean	Mixed			S		
2	Sorghum with haricot bean	Mixed	Mixed		S	S and K	
3	Maize with haricot bean and barley/teff		Mixed			S and double intercropping	
4	Sorghum with maize and sesame	Mixed			S		
5	Khat with maize and haricot bean			Row			
6	Sorghum with maize	Mixed			S		
7	Sorghum with maize and haricot bean		Mixed			S and K	
8	Maize with chickpea			Relay			After maize is matured
9	Coffee with maize and haricot bean			Row			
10	Khat with haricot bean		Row				Haricot bean in April
11	Khat with maize			Row			
12	Coffee with maize and barley			Row			
13	Onion with tomato		Mixed			Onion in July and tomato in August	
14	Maize with tomato			Row			
15	Khat with maize and barley			Row			
16	Sorghum with common vetch			Rely			After sorghum is matured
17	Coffee with sorghum			Row			
18	Khat with sorghum			Row			
19	Coffee with finger millet, sweat potato, chickpea and groundnut			Row			
20	Khat with finger millet, linseed, sweat potato, chickpea and groundnut			Row			

Source; Focus Group Discussion, 2017.

Times of sowing: S=Simultaneously; K=Knee height stage

Reduction of yield due to intercropping: The reduction in grain yield due to intercropping may be acceptable to subsistence farmers if it is below (10% - 15%) (As cited in Getachew *et al.,* 2013).

Accordingly, 28.4% of the respondent had no willingness to expand intercropping cereal crops with legumes because of drought which intensifies competition for nutrients and grain yield of cereal crops is reduced as a result of intercropping (Table 7). Similarly, Abubeker *et al.*, (2006) indicated intercropped lablab depressed grain yield of maize by 26% when planted simultaneously with maize and Wondimu *et al.*, (2016) reported that grain yield of maize was significantly reduced by 31.7% due to intercropping with soybean. Contrary, Mergia (2014) indicated that compared to pure stand maize, inclusion of vetch, cow pea and lablab increased grain yield of maize by 7.4%, 5.9% and 5% respectively. However, it was 71.6% of the respondent that had willingness to continue intercropping of cereal crops with legumes because of land shortage, profit maximization, early maturity of legumes, animal forage, weed control and to reduce risk from crop failure. Intercropping systems resulted into significantly higher productivity (Alemu and Tikunesh, 2014; Hossein *et al.*, 2014; Mergia, 2014; Wondimu *et al.*, 2016 and Tenaw, 2014). Selection of crops that differ in competitive ability in time or space is essential for an efficient intercropping system, and as well as decision on what to plant and at what density.

Table 7: Willingness to expand cereal-legumes intercropping

		Frequency	Percent
Willingness to expand cereal-legumes intercropping	Have willingness	106	71.6
	Have no willingness	42	28.4

Source; Own survey results, 2017

Major Constraints of intercropping legume crops with other crops

Intercropping of cereal crops with legumes is a widespread focus for current research (Getachew *et al.*, 2013, Douglas, 2014, and Tenaw, 2013). Intercropping of legume crops such as haricot bean, chickpea and vetch are common practice in West Hararghe Zone (Table 8). However, currently, drought was the main constraint of intercropping in the study area. It increases competition among intercropped crops and also because of not raining on time, it reduces the number of intercropped crops. Similarly, Wondimu *et al.*, (2016) argued that the lower stand count in intercropped maize compared to sole cropped maize may due to competition for the same resource with soybean or due to shortage of moisture during early vegetative growth. The other constraints of intercropping legumes with other crops in the study area were lack of promotion on intercropping practices and lack of improved technology of intercropped crops (Table 8). Similarly, Douglas (2014) argued that the main reason of not practicing intercropping in Ethiopia has been the promotion of mono-culture by governmental and non-governmental agencies. Intercropping creates difficulty in weeding and cultivation, and shortage of information and knowledge about fertility management were also other constraints of intercropping legumes with other crops in the study area. This result is consistent with the study conducted by Ashish *et al.*, (2015) which indicated that one of the disadvantage of intercropping is creating extra work. The study conducted by Wondimu *et al.*, (2016) Tenaw, (2014), Stephen (2009), Hossein *et al.*, (2014) and Getachew *et al.*, (2013) indicated that legumes crops improve soil fertility when intercropped with other crops. However, only 39.5% of the respondent knew that legume crops improve soil fertility and 60.5% did know that legume crops improve soil fertility. Biological nitrogen fixation is the major source of nitrogen in legume-cereal mixed cropping systems when nitrogen fertilizer is limited (Ashish *et al.*,2015). In organic fertilizers have environmental damage such as nitrate pollution and legumes grown in intercropping are regarded as a suitable and alternative way of introducing N into lower input agro ecosystems.

Table 8: Constraints of intercropping legume crops with other crops ranked by focus group discussion in the study area

No	Constraints	Rank1	Rank2	Rank3	Rank4	Rank5	Index score	Rank
1	Shortage of improved technology of intercropping	16.67	*	50	*	*	0.167	3
2	Lack of information and knowledge about fertility management	*	*	*	33.33	*	0.048	5
3	Intercropping creates extra work in agronomic management	*	16.67	33.33	*	16.67	0.131	4
4	Lack of promotion (awareness creation) on intercropping of legumes with others	16.67	50	*	16.67	*	0.226	2
5	Drought	66.67	*	*	16.67	*	0.310	1
6	Incompatibility of intercropped crops	*	16.67	*	*	*	0.048	5

Source: own survey, 2017 *Index score for a particular intercropping constraints = [5 for $Rank_1$ + 4 for $Rank_2$ + 3 for $Rank_3$ + 2 for $Rank_4$+ 1 for $Rank_{45}$] divided by sum of [5 for $Rank_1$ + 4 for $Rank_2$ + 3 for $Rank_3$ + 2 for $Rank_4$+ 1 for $Rank_5$] for all intercropping constraints*

Opportunities of intercropping practices in the study area

The rising population density and then declining of land holding sizes are compelling the local people to practice intercropping crops for intensively use their land. As a result, intercropping practice can significantly benefit farmers of the study area within the existed land. Expansion of Khat was also another opportunity of intercropping in the study area. Khat is perennial crops and because of land shortage it is intercropped with different crops. The increase in livestock fattening and shortage of animal forage in the area may also increase demand of forage-cereal intercropped technology. In addition, availability of indigenous knowledge on intercropping and accessibility of market for legumes crops like Haricot bean can be another opportunity of intercropping in the study area.

Conclusions and Recommendations

Intercropping was the major cropping systems in the study area. The reason of intercropping different crops in the study area were; land shortage, profit maximization, risk minimization and availability of perennial crops such as coffee and khat. The major intercropped crops were maize with haricot bean followed by sorghum with haricot bean. Khat and Coffee were planted in rows and intercropped with different crops such as Maize, Sorghum, Haricot Bean, Barely, Groundnut, Finger Millet, Sweet Potato, Chickpea and Linseed. One up to three rows of different crops were intercropped between two rows of coffee or khat. Haricot bean was also intercropped between two plants of coffee. Maize was intercropped with haricot bean simultaneously and after harvesting haricot bean in June, either barely or teff was sown in August. This indicated that there is double intercropping practice in the study area. Reduction in grain yield due to intercropping, drought, lack of promotion on intercropping practice and lack of knowledge about fertility management were major constraints of intercropping in the study area. However, declining of land holding size as a result of rise in population, expansion of khat and rise in demand for animal forage were major opportunities of intercropping in the study area.

Depending on the results of the finding, the following recommendation has been given to make intercropping technology effective and improve farmers' profit per unit land in the study area.

- Introduction of improved cereal-legume intercropped technology should be given special emphasis to improve soil fertility and farmers' profit.
- Strengthening and intensification of compatible intercropped crops should be enhanced.
- Most of the farmers in the study area were not aware of that legume crops do improve soil fertility. Therefore, awareness creation on soil fertility improvement should be promoted.
- Haricot bean has been intercropped with cereal crops simultaneously. Therefore, any research conducted on any cereal-legume intercropping should take this practice into account.

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Factors Affecting Market Outlet Choice for Wheat in Sinana district, Bale zone, Ethiopia

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Abstract

Sinana is one of Bale zone districts which are particularly known for their extensive wheat production. Wheat is an important crop for its contribution as an income support and used for consumption to a large proportion of the rural households. However, enhancing wheat producer farmers to reach markets and actively engage in the markets is a key challenge influencing wheat production in Sinana district. Therefore this study was undertaken to identify factors influencing wheat market outlet choices in Sinana district of Bale zone. Data were collected from120 randomly selected wheat producers. Descriptive and multinomial logit model were used for analysis. The multinomial logit model result indicated that the likelihood to choose wholesalers market outlet was significantly influenced by frequency of extension contact, distance from market place, own price of the commodity and membership to cooperative compared to accessing assemblers wheat market outlet. The likelihood of accessing cooperative wheat market outlet was significantly influenced by price given to the commodity and distance from market place compared to accessing assembler market outlet. The likelihood of accessing processors market outlet was significantly influenced by price of commodity, ownership of transportation facilities and distance of processors from production place. Therefore policy implications that consider decision of farmers in participation of value added wheat producing to enhance value creation and improve market share and profitability of the smallholder farmers shall be an important.

Key word: *Market outlets, wheat market outlet choices, Wheat belt, Multinomial logit, Bale*

Introduction

In Ethiopia, cereal production and marketing are the means of livelihood for millions of small holder households and it constitutes the single largest sub-sector in economy. Wheat is among the most important cereal crops in Ethiopia, ranking fourth in total cereals production 13.25% (1.63 million hectares) next to maize, sorghum and teff (CSA, 2012/13). The development policy of Ethiopia has placed emphasis on increasing agricultural production to serve as a base for rural development. Even though there has been an increase in agricultural production, there were drawbacks in the absence of many households participation in the markets. The lack of market participation that many agricultural households face is considered to be a major constraint to combating poverty (Best *et al*., 2005). This shows that an efficient, integrated and responsive market that is marked with good performance is of crucial importance for optimal allocation of resources and stimulating households to increase output (FAO, 2003).

Bale zone is particularly known for its extensive wheat production and sometimes called "wheat belt'' of Ethiopia. There are also different market outlets chosen by households for selling their produce. This implies that each alternative marketing outlet choice entails different private costs and benefits, and hence different utility, to a household decision maker. The basic question to ask is factors influencing farmer's choice of wheat market outlets in the study area. Although the area is interesting, there are hardly any publications done on wheat market outlet choices in Ethiopia. Additionally, it is prudent to note that none of past studies identified factors affecting wheat market outlet choices in Sinana district despite the high potential of wheat production and marketing in the study area. Therefore, this study focused on identifying factors influencing wheat market outlet choices, in order to narrow the information gap and contribute to an understanding of the challenges and assist in developing improved market development strategies to the benefit of smallholder farmers, traders, and other market participants. The result of the study can also assist in developing improved market development strategies to benefit all stakeholders that are participating in wheat value chain study area.

Methodology

An overview of Sinana district

Sinana district is located in the north western part of Bale zone. The total area of the district is about 1168 km^2. The district has 20 peasant associations. The altitude of the district ranges from 1650 to 2950 m a.s.l. From the total area of the district about 73.54 % is plain land, 3.7% is hills, 9.6 % is mountains, 12.3 % is rugged and 0.86 % is gorge. The annual average temperature is 16.5^oc where as the minimum and maximum temperature is 9^oc and 23^oc respectively. The annual average rainfall is 1105mm where as the minimum and maximum rainfall is 1060 and 1150mm respectively (BOFED, 2009). Farmers in the district experienced mixed farming system of both crop and livestock. The major crops produced in the district are wheat, barley, pulses and oil crops. Rainfall pattern of the district is characterized by bi-modal rain fall distribution. The district has two distinct seasons, i.e. Belg which extends from March to July and Meher which extends from August to January (BZADO, 2012).

The presence of Sinana Agricultural Research Center (SARC) and Oromia Seed Enterprise creates good opportunity for the farmers in the study area. Farmers in the study area have access to improved agricultural technologies mainly because of their proximity to Sinana Agricultural Research Center and Oromia Seed Enterprise, Bale branch compared to others which are far from these institutions.

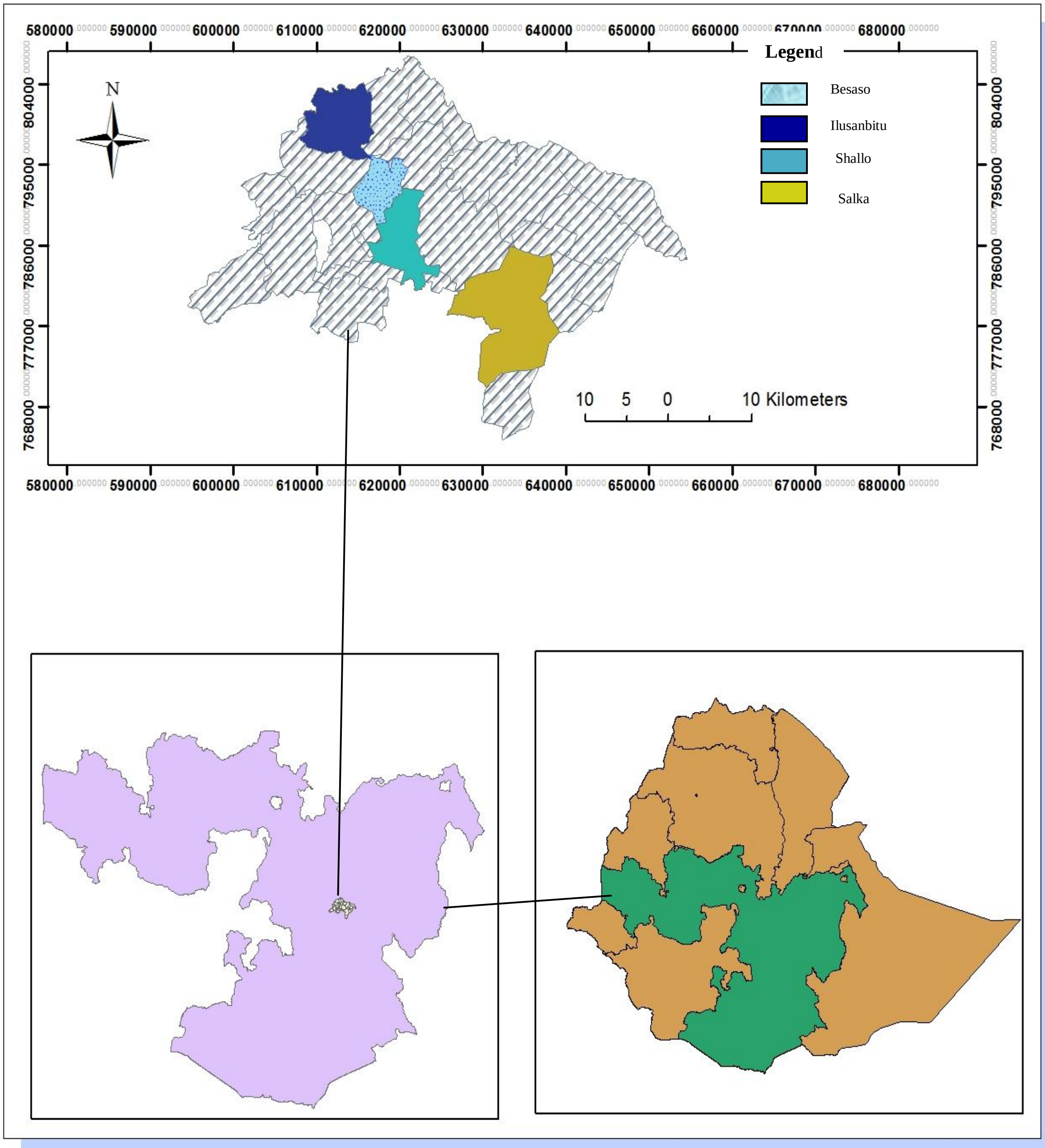

Figure : Map of the study area

Sampling procedure, Method of Data Collection and Data Sources

The data for this study were collected from primary and secondary sources. Formal and informal sample survey methods were used to collect both primary and secondary data. Primary data were collected from producers, wholesalers, assemblers, retailers, processors in Robe town, cooperative at each kebele and agricultural input suppliers.

In addition to farmer households, sample wholesalers, assemblers, millers, and retailers were interviewed. The lists of wholesalers, millers and retailers were obtained from the district Office of Trade and Industry (OoTI). Based on the number of wholesalers available in the district, ten wholesalers and ten assemblers were selected randomly. Since processing/milling of wheat is only conducted in zonal town Robe, all five flour mills available in Robe town were interviewed. In addition, 10 wholesalers, 10 assemblers and 5 retailers from the four peasant associations were randomly selected and interviewed. Finally four cooperatives, one from each PA were interviewed.

A multistage purposive random sampling procedure was used to select representative households in the study area. In the first stage, Sinana district was selected purposely as it has maximum area under wheat production in the study zone. In second stage out of 20 PAs of Sinana district, four Kebeles were selected randomly as all kebeles are producers of wheat in the district. To identify factors affecting wheat market outlet choices, multinomial logit model was used. If there are a finite number of choices (greater than two), multinomial logit estimation is appropriate to analyze the effect of exogenous variables on choices. The multinomial logit model has been widely used by researchers such as Schup *et al*. (1999), and Ferto and Szabo (2002). It is a simple extension of the binary choice model and is the most frequently used model for nominal outcomes that are often used when a dependent variable has more than two choices.

Data Analysis

To identify factors affecting wheat market outlet choices, multinomial logit model was used. If there are a finite number of choices (greater than two), multinomial logit estimation is appropriate to analyze the effect of exogenous variables on choices. The multinomial logit model has been widely used by researchers such as Schup *et al*. (1999), and Ferto and Szabo (2002). It is a simple extension of the binary choice model and is the most frequently used model for nominal outcomes that are often used when a dependent variable has more than two choices.

This study assumes that farmer's decision is generated based on its utility maximization. This implies that each alternative marketing outlet choice entails different private costs and benefits, and hence different utility, to a household decision maker. The analytical model is constructed as follows. Suppose that the utility to a household of alternative *j* is U_{ij}, where j = 0, 1, 2…. From the decision maker's perspective, the best alternative is simply the one that maximizes net private benefit at the margin. In other words, household *i* will choose marketing outlet j if and only if U_{ij} > Uik, ….. ≠ K. It is important to note that household's utility cannot be observed in practice. What a researcher observe are the factors influencing the household's utility such as household and personal characteristics and attributes of the choice set experienced by the household. Based on McFadden (1978), a household's utility function from using alternative j can then be expressed as follows:

U (Choice of j for household i) = $U_{ij} = V_{ij} + \varepsilon_{ij}$
Where,
U_{ij} is the overall utility,
V_{ij} is an indirect utility function and
ε_{ij} is a random error term.
The probability that household i select alternative j can be specified as:
$P_{ij} = \Pr(V_{ij} + \varepsilon_{ij} > Vik + \varepsilon_{ik})$
$P_{ij} = \Pr(\varepsilon_{ik} < \varepsilon_{ij} + Vij - V_{ik}$, □ $K \neq j)$

Assuming that the error terms are identically and independently distributed with type i extreme value distribution, the probability that a household chooses alternative j can be explained by a multinomial logit model (Greene, 2000) as follows:

$$P_{ij} = \frac{\exp(\beta_j X_{ij})}{\sum_{j=0}^{J} \exp(\beta_j X_{ij})}$$

X_{ij} is a vector of household of the i^{th} respondent facing alternative j

β_j is a vector of regression parameter estimates associated with alternative j.

Following equation (9) above, we can adapt the MNL model fitting to this study can be expressed as follow:

$$P(\text{Choice}_{ij} = j) = \frac{\exp(\beta_j X_{ij})}{\sum_{j=0}^{J} \exp(\beta_j X_{ij})}$$

Where,
i represents i^{th} farm household, and i=1,2,3,…,154.
j represents different marketing outlets, j=1 for sale to wholesalers, j=2 for sale to cooperatives j=3 for sale to assemblers and j=4 for sale to processor.
P = represents the probability of wheat marketing outlet j to be chosen by farm household i;
$CHOICE_{ij}$ = j means that wheat marketing outlet j is chosen by farm household i;
X_i = is independent variables
It is a common practice in econometric specification of the MNL model to normalize equation by one of the response categories such that βj = 0. In this regard, the MNL model can alternatively be specified as follow:

$$P_{ij} = \frac{\exp(\beta_j X_{ij})}{\sum_{j-1}^{J-1} \exp(\beta_j X_{ij})} \qquad (11)$$

The coefficients of explanatory variables on the omitted or base category are assumed to be zero.
The probability that a base category will be chosen can be calculated as follows:

$$P_{ij} = \frac{1}{\sum_{j-1}^{J-1} \exp(\beta_j X_{ij})} \qquad (12)$$

The marginal effects of the attributes on probability of choice are determined by differentiating equation 12.

$$\delta_j = \frac{\partial P_j}{\partial X_j} = P_j = P_j\left[\beta_j - \sum_{j=0}^{J}(P_j)\left(\beta_j\right)\right] \text{ for j=1, 2, 3… J} \quad (13)$$

Where,

P_j is the probability that farmers choose market outlet j

β_j is a vector of regression parameter estimates associated with alternative *j* .

In the case of this study, farmers have four market outlets to sell most of their wheat produce, *J* = 4, and the alternatives *j* = 1, 2, 3, 4 represent sale outlets to wholesalers, cooperatives, assemblers and to processors, respectively. The dependent variables (the marketing outlet (CHOICE) chosen) in the analysis are measured by the probability of selling wheat to either of these markets outlets.

Dependent variable

Market outlets are those pathways where agricultural products pass through to reach end users. In this regard, it is a categorical variable that represents wheat market outlets in the study area. It assumes 1 for wholesalers, 2 for cooperatives, 3 for processors and 4 for assembler’s market outlet choices available for farmers to sale.

Explanatory variables used in MNL model

Family size: This is a continuous independent variable that is measured in the number of members in a household. Household size increases domestic consumption requirements and may render households more risk averse. Controlling for labor supply, larger households are expected to have lower market participation. Lapar *et al*. (2003), Edmeades (2006) and Berhanu and Moti (2010) found out negative relationship between household size and market participation of households. Therefore, it is hypothesized that it will affect accessing cooperative wheat market outlet choice positively as compared with accessing other wheat market outlets.

Access to extension services: This is a dummy independent variable taking the values 1 if the wheat producer farmers have access to extension services and zero otherwise. It is expected that wheat extension service widens household knowledge with regard to use of improved wheat technologies. Birhanu (2013) found that access to dairy extension services such as dairy technology information, training, field days, field visits and field tours received by households positively and significantly affected accessing cooperative milk market outlet as compared with accessing individual consumer milk market outlet .Different studies conducted previously revealed that extension agent visits had direct relationship with market outlet choices (Holloway and Ehui, 2002; Rehima, 2006). Thus access to wheat extension service is hypothesized to affect accessing cooperative wheat market outlet choice positively as compared with accessing other wheat market outlets.

Distance to nearest market: This is a continuous independent variable measured in kilometre. The closer a household to the nearest urban center, the lesser would be transportation costs, loss due to spoilage and better access to market information and facilities. 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 affect the likelihood of accessing cooperative wheat market outlet positively as compared with accessing other wheat market outlets.

Membership to cooperative: This is defined as dummy variable that takes 1 if the household is member of cooperative and 0 otherwise. Farmers who are members of cooperative are supposed to sell to cooperative rather than other market outlets. Abraham (2013) found that membership to cooperative affects negatively and was significant related with retail outlet choice. His result indicated that those households who were members of cooperatives the probability of choosing collector outlet decreased by 23.4% compared to base category. Hence, membership to cooperative is hypothesized to affect accessing cooperative market outlets positively as compared to accessing other market outlets.

Income from non/off farm activities: This is treated as a dummy variable and measured as 1 if the household obtained income from off/nonfarm activities, and 0 otherwise. Rehima (2006) found that if pepper producer have non-farm income, the amount of pepper supplied to the market decreases. Again, farmers who gain more income from non/off farm income want to supply their vegetable to any nearest market outlet with low price than to go far. Therefore it is hypothesized that off/non-farm income influence market outlet choice decision of wheat producers positively.

Access to credit: This is a dummy variable that takes 1 if the household takes loan and zero otherwise. Access to credit would enhance the financial capacity of the farmer to purchase the inputs, thereby increasing production and market share size. Therefore, it is hypothesized that access to credit would have positive influence on level of production and sales. Alemnewu (2010) and Muhammed (2011) found that if pepper and teff producer gets credit, the amount of pepper and teff supplied to the market increased. Due to these, it is hypothesized that access to credit will have influence on wholesale market outlet choice decisions.

Ownership of market transport facilities: Specifically vehicles, carts and transport animals would be used to measure the availability of produce transportation facilities by households. In cases where households owned transportation facilities, the variable took the value of one, and zero if the household did not own any form of transport facility. This variable is expected to have influence on the market outlet choice of wheat producers positively. The availability of transportation facilities helps reduce long market distance constraint, offering greater depth in marketing choices (Jagwe *et al*., 2007).

Own price of the commodity: It is continuous variable, which is, price given for the commodity with different market outlets per quintal. Each market outlet average price will be asked. According to Birhanu (2013) price offered by milk market outlet per liter of milk significantly and negatively affected accessing cooperative milk market outlet as compared with accessing individual consumer milk market outlet. Hence, it is hypothesized that price given by market outlets can negatively affect cooperative market outlet choice.

Results and Discussions

Multinomial logistic regression was used to analyze factors affecting choice of wheat marketing outlets with four alternative categories. If there are a finite number of choices (greater than two), multinomial logit estimation is appropriate to analyze the effect of exogenous variables on choices. The model was tested for the independence of irrelevant alternatives (IIA) assumption based on Hausman test. The possible heteroscedasticity and multicolleaniarity problems are also corrected. The command robust (in Stata) was used to correct for heteroscedasticity. There is no multicolleaniarity problem because the result of VIF is less than 10 for all variables.

Producers choose their marketing plans and assess outside options that are available before participating in any marketing outlet. The producer's choice of a marketing outlet is based on utility maximization among the existing alternatives. After identifying choices of outlets, they choose where and for who to sell based on comparative advantage in bargaining and accessibility of outlets for farm products.

The alternative "assembler" was used as a base category. This implies that the discussion of the results focuses on the impact of the explanatory variables on a use of cooperatives, assembler and processors category relative to use of wholesalers (the base category). The result of MNL and its marginal effect is explained below in Table 11.

Distance from market place: Distance from the closest market place positively and significantly affected accessing millers/processors market outlet as compared with accessing assembler market outlet. It also affected wholesaler market outlet negatively and significantly. The marginal effect indicates that probability of choosing millers/processors increases by 0.02% as compared with accessing assembler market outlet for a unit decrease in kilometre. The likelihood of accessing wholesaler market outlet decreases by 0.4% for a unit increase in kilometre from market place.

Table 11**.** Results of Multinomial Logit and marginal effects for choice of wheat market outlets

	Coefficient	Robust Std.err	p-value	dy/dx	Robust Std.err	p-value
Wholesalers						
FREXTNCO	0.85*	0.452	1.88	0.211	0.112	1.89
COPMEMB	1.223*	0.725	1.69	0.307	0.180	1.7
PRICE2006	0.068***	0.016	4.26	0.017	0.004	4.36
OWNTRAN	-0.771	0.712	1.08	-0.182	0.178	-1.02
ACCECRE	0.464	1.684	0.28	0.102	0.423	0.24
OFFARMI	0.657	0.644	1.02	0.156	0.159	0.98
DISTMRK	-0.168*	0.099	-1.71	-0.040	0.025	-1.64
FAMILSZ	-0.065	0.086	-0.76	-0.015	0.022	-0.72
Constant	-55.02***	11.523	-4.78			
Cooperatives						
FREXTNCO	0.076	0.480	0.16	-0.008	0.012	-0.72
COPMEMB	-0.099	0.644	-0.15	-0.017	0.023	-0.73
PRICE2006	-0.030*	0.017	-1.75	-0.001	0.001	-1.41
OWNTRANS	-0.936	0.981	-0.95	-0.012	0.024	-0.52
ACCESSCRE	1.190	1.033	1.15	0.022	0.039	0.56
OFFARMINC	0.678	0.650	1.04	0.008	0.014	0.49

DISTMRKT	-0.150*	0.091	-1.64	-0.001	0.002	-0.60
FAMILSZ	-0.094	0.113	-0.83	-0.001	0.003	-0.48
Constant	20.314	12.933	1.57			
Processors						
FREXTNCO	-1.418	0.896	-1.58	-0.000	0.00008	-0.25
COPMEMB	-0.609	1.794	-0.34	-0.000	0.00006	-0.25
PRICE2006	0.107***	0.021	4.99	8.170	0.00000	0.25
OWNTRANS	-2.957**	1.478	-2.00	-0.0003	0.00012	-0.24
ACCESSCRE	1.671	1.586	1.05	0.0002	0.00007	0.22
OFFARMINC	-0.469	1.224	-0.38	-9.070	0.00004	-0.21
DISTMRKT	1.404*	0.787	1.78	0.0002	0.00006	0.28
FAMILSZ	0.069	0.210	0.23	1.160	0.00001	0.18
Constant	-95.29*	20.587	-4.63			

Number of observation =120, Log pseudo likelihood = -68.51***, Pseudo R^2 = 0.49, Wald chi -square(24) = 74.27, ***, ** and * are statistically significant at 1%, 5% and 10% respectively

Source: own computation from survey result

Frequency of extension contact: Frequency of extension contact positively and significantly affected accessing wholesales market outlet choices as compared with assembler market outlet choices at 10% probability level. The marginal effect result shows that the likelihood of accessing wholesale market outlet choice increases by 21.1% as compared to assembler market outlet choices for a unit contact of extension services.

Own price of the commodity: It is continuous variable, which was, price given for the commodity with different market outlets per hundred kilograms. Hence, it was hypothesized that price given by market outlets can negatively affect cooperative market outlet choice. Price offered by wheat market outlet per kilogram significantly and negatively affected accessing cooperative wheat market outlet as compared with accessing assembler wheat market outlet. It also affected wholesaler and processor wheat market outlets positively and significantly at 1% probability level respectively. The marginal effect result shows that the likelihood of accessing cooperative wheat market outlet decreases by 0.1% for a birr increase per kg, the likelihood of accessing wholesaler outlet increases by 1.07% for a birr increase per kg and the likelihood of accessing processor outlet increases by 81.7% for a birr increase per kg of wheat as compared with accessing assembler wheat market outlet. The study by Birhanu (2013) also found out that price offered by milk market outlet per liter of milk significantly and negatively affected accessing cooperative milk market outlet as compared with accessing individual consumer milk market outlet.

Membership to cooperative: It influences positively and significantly wholesaler market outlet as compared to accessing assemblers wheat market outlet. The likelihood of accessing wholesaler market outlet increases by 30.1% for those persons who were member of cooperatives as compared to base category.

Ownership of market transport facilities: This variable affects negatively and significantly accessing processors wheat market outlet. Ownership of market transport facilities decreased the likelihood of choosing processors market outlet by 0.03% compared to accessing assemblers' market outlet.

Conclusion and Implication

The study was conducted in Bale highland of Oromia region, South Eastern Ethiopia with objective of identifying factors affecting wheat market outlet choices. In order to undertake this research, data were collected from 120 farm households and analyzed using descriptive statistics and multinomial logit model. Since wheat is major crop which is produced for consumption and marketing purpose in Bale highland, producers choose their marketing plans and assess outside options that are available before participating in any marketing outlet. The producer's choice of a marketing outlet is based on utility maximization among the existing alternatives. After identifying choices of outlets, they choose where and for who to sell based on comparative advantage in bargaining and accessibility of outlets for farm products.

Results from the discrete model (multinomial logit model) indicated that the likelihood to choose wholesalers market outlet was significantly influenced by frequency of extension contact, distance from market place, own price of the commodity and membership to cooperative as compared to accessing assemblers wheat market outlet. The likelihood of accessing cooperative wheat market outlet was significantly influenced by price given to the commodity at different outlets as compared to accessing assembler market outlet. Similarly the likelihood of accessing processors market outlet was significantly influenced by price of commodity given at different market outlets, ownership of transportation facilities and distance of processors from production place.

Improving the households' educational background and equipping them with some technical skills through extension education would help to increase delivery of quality products across wheat value chain. Therefore, as one factor to improve farmer's knowledge in wheat market outlet choice, extension education should be redesigned and strengthened its implementation strategies to train and qualify more producers with appropriate modern skills that help to sustain production and marketing. Additionally, giving training for cooperative members on pricing system and awareness creation on importance of cooperative can strengthen producers bargaining power and can help them in selection of appropriate market outlet choices.

Smallholder farmers are not a homogenous group; they differ in their resources and capabilities. The household economic portfolio provides a link between smallholders' resource levels and their abilities to respond to participate in wheat market value chain opportunities. They may be unable to invest in agricultural upgrading due to shortages of working capital and lack of liquidity for longer term upgrading investments. Therefore, it is important to create credit access and simplify way of provision for farmers because it will help farmers to participate in wheat production and marketing activities which will increase their income.

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Value Chain Analysis of Durum Wheat in The Case of Bale Zone, South Eastern Oromia, Ethiopia

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Abstract

Analysing value chain for durum wheat in Bale zone helps to upgrade the wheat market value chains sector which takes into account the systematic review of the problems and opportunities that exists across the value chain from input supply to marketing of the final product. Accordingly, this study focused on the analysis of durum wheat value chain in Agarfa, Ginir and Gololcha districts of Bale zone with specific objectives identifying value chain actors and mapping durum wheat value chain; assessing structure, conduct and performance of durum wheat market and identifying determinants of durum wheat market supply in the study areas. Primary data and secondary data were used for fulfilling this research. Primary data was collected from durum wheat producer farmers and traders involved in durum wheat trade. Descriptive statistics and Econometrics models were used to analyse the collected data. Results show that the main wheat value chain actors in the study area are input suppliers, farmers/producers, assemblers, wholesalers, processors, and cooperatives. The result of 2SLS indicated that size of

landholding, livestock ownership, family size and quantity of wheat produced influences amount of wheat supplied to market significantly. Volume of durum wheat supplied to market was influenced positively and significantly by quantity of wheat produced, livestock ownership (TLU) and total area of farmland owned by farmers. Family size in the household negatively affected volume of durum wheat supplied to market. Therefore, in order to enhance volume of wheat supplied to market, these variables should get attention and promoted. Additionally, increasing surplus production through promotion of appropriate input technologies such as seed of improved varieties, recommended fertilizer rates, pesticides and other appropriate agronomic recommendations can improve production and productivity of wheat in the study area.
Key words: *Value Chain, Wheat, Actors, Mapping, 2SLS, Surplus*

Introduction

Ethiopia is the second largest wheat producer in Sub Saharan Africa next to South Africa. Wheat is one of the major staple crops in the country in terms of both production and consumption (FAOSTAT, 2014). It is cultivated on over 1.6 million hectares of land, accounting for 13.33% of the total grain crop area, with an annual production of 4.2 million tons, contributing about 15.81% of the total grain production (CSA, 2015). In terms of caloric intake it is the second most important food in the country behind maize (FAO, 2014). Wheat is mainly grown in the highlands of Ethiopia, which lie between 6 and 16°N and 35 and 42° E, at altitudes ranging from 1500 to 2800 meters above sea level and with mean minimum temperatures of 6°C to 11°C (Hailu, 1991; MOA, 2012).

There are two varieties of wheat grown in Ethiopia: durum wheat, accounting for 40 percent of production, and bread wheat, accounting for the remaining 60 percent (Bergh et.al., 2012). Oromia accounts for over half of national wheat production (54 percent), followed!by Amhara (32 percent); Southern Nations, Nationalities and Peoples (SNNP) (9 percent); and Tigray (7 percent) (CSA, 2013). Of the current total wheat production area, about 75 percent is located in the Arsi, Bale and Shewa wheat belts (MOA,2012).Arsi, Bale, and parts of Shoa are considered the wheat growing belt. Bread wheat is the major variety of wheat grown in Ethiopia. However, farmers grow durum and bread wheat (mixed together) in some parts of the country. Wheat is cultivated on approximately 120,000 ha in the Bale zone (average yield 2.3 t/ha), and on about 150,000 ha in the neighboring Arsi zone (yield 2.2 t/ha). (National average yield is1.8 t/ha - data 2010/11, for main/*Meher* crop season).

Durum wheat has been cultivated in Ethiopia for thousands of years, although it has gradually been displaced by bread wheat. Demand for pasta (spaghetti and macaroni) is growing faster as the demand of durum wheat grain. Low volumes and poor quality of national wheat production, obliged Ethiopian pasta industries to import the required raw material (mainly hard wheat). Durum wheat is more commonly used in semolina, pasta, and many other local dishes. At present, there are about 20 different companies producing pasta and macoroni in Ethiopia. Despite the huge genetic diversity and potential environments for wheat production, large amounts of durum are imported annually to meet the requirements of local pasta factories. The major limiting factor for local pasta-makers has been the, low supply of durum wheat in the country, few productions with inadequate quality and seasonality/no sustainable supply of the product year round. As a consequence, industries have been forced to rely on import for durum wheat and therefore they have been affected by the huge import costs and by the recurrent scarcity of hard currency in the Ethiopian bank system (AVCO, 2013).

Additionally, the internal demand of pasta is not yet fulfilled, so a huge importation of pasta is also taking place. According to Mohammed Hassena (2009) upgrading the wheat market value chains sector takes into account the systematic review of the problems and opportunities that exist across the value chain from input supply to marketing of the final product. To reverse this situation and improve durum wheat production and marketing, the area calls for development of well-performing marketing system which satisfies consumer demands with the minimum margin between producers and consumer prices. Well-functioning marketing system is not limited to stimulation but it also increases production by seeking additional output. However, durum wheat value chain and their characteristics have not yet been studied and analysed for different parts of the country, especially in Bale zone which are known in the production of surplus durum wheat for commercial purpose. So that studying value chain for durum wheat is an important area and also proposed with the following objectives.

- To identify value chain actors and map durum wheat value chain
- To assess structure, conduct and performance of durum wheat market in the study area
- To identify determinants of durum wheat market supply

Materials and Methods

Description of the study Area

Bale zone is one of the 20 administrative zones in Oromia regional state which is located in south-eastern Ethiopia. It has 18 districts out of which 9 of them are located in highland agro-ecology. The zone is found in Southeast of Oromia Regional State that extends from 5^{o} 22'S – 8^{o} 08'N latitude and 38^{o} 41'W – 40^{o} 44'E longitudes. It has borderlines with Arsi, Guji, West and East Hararge zones as well as Somali and Southern Peoples' Regional States. The altitude ranges from below 1000 in the lowlands to 4377m above sea level in the highlands.

Total area of Bale zone is about 63,555 km^2 which is 16.22% of Oromia region. About 10.6% of the land is arable land used for crop production, 24.6% grazing land, 41.8% forest, and others 25% (BZADO, 2012). Most of the districts in Bale highlands are known for their bimodal rainfall patterns and are therefore highly suitable for agriculture. They have two distinct seasons i.e. Belg (from March to July) and Meher (from August to January). About 274,785 hectares of land in Bale zone is cultivated during Belg season while 371,628 hectares is cultivated during Meher season. Total production was 4,631,417 and 7,316,287 Qts during belg and meher 2011/12 respectively. Bale zone has four agro-ecological zones namely extreme highlands 0.04%, highland 14.93%, midland 21.5%, and lowland 63.53%. The topography of the area includes plain land, plateaus, hills and ragged mountain system. The area receives an average annual rainfall of 400-2500mm and min and max temp 3.5^{0}c and 35^{0}c and altitude ranges from 300 to 4377masl.

Ginnir

Ginnir District is located in Bale Zone south eastern Oromia,. Its total area is estimated to about 2351 km^2. The district has 40 kebeles, three towns and four urban kebeles. The altitude ranges from 1200 to 2406 masl. From the total area of the district about 85 % is plain land, 3% is mountains, and 12 % is rugged and gorge. The annual average temperature is 25.45 whereas the minimum and maximum temperature is 23.2^{o}c and 27.7^{o}c respectively. The annual average rainfall is 700mm whereas the minimum and maximum rainfall is 200 and 1200mm respectively. Rainfall pattern of the district is bi-modal, i.e. two distinct seasons, *Belg* from March to July and *Meher* from August to December. Mixed farming system of crop and livestock production is the common farming practice of the district. Field crops such as teff, wheat (bread, durum and emmer), barley, sorghum, maize, chickpea, field pea and haricot bean are the major field crops produced in Ginnir District. Major horticultural crops produced are papaya, mangos, avocado, banana, pepper, potato, tomato, onion, garlic, beet root, carrot, chat, and spices such as fenugreek, cumin, and coriander, etc. Dominant crops produced in the district are wheat, barley, teff, maize, chickpea, field pea, haricot bean, papaya, mango, avocado, banana, pepper, tomato, onion, potato and chat.

Agarfa

Agarfa District is located in the north western part of Bale Zone. The district has 19 kebeles of these seven (37%), nine (47%), and three (18%) are located in the highlands, midlands and lowland agro-climatic zones, respectively. Besides, there are three towns in the district having four urban kebeles. The altitude of the district ranges from 1256 to 3750 masl. Topographic coverage of the district is about 25% is plain, 10% hills, 5% mountains and 60% undulated areas. The mean annual temperature is 16.5^{o}C, whereas the mean minimum and maximum temperature is 8 and 25^{o}C, respectively. The average annual rainfall is 850 mm and the range is 600 to 1100mm. Rainfall pattern of the district is characterized as bi-modal, i.e two distinct seasons, *Belg*, March to July and *Meher*, August to December. Production system practiced in the district is mixed farming (crop and livestock) (District Agriculture and Natural Resource Development Office). The major crops produced in Agarfa district include teff, wheat (bread, durum and emmer), barley, maize, field pea, faba bean, chickpea, lentil and linseed. The major horticultural crops produced are potato, tomato, onion, pepper, carrot, cabbage, shallot, spices such as fenugreek, etc. Dominant crops produced in the district are wheat (bread and durum), barley, teff, linseed, faba bean, lentil, field pea, potato, tomato, onion and pepper.

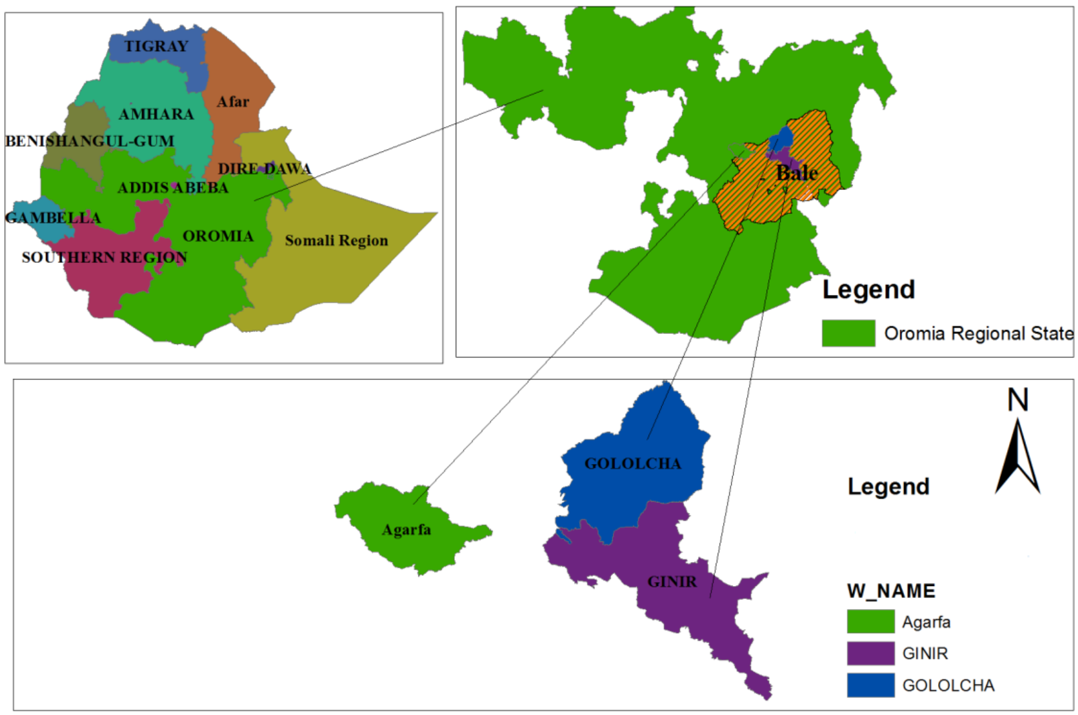

Figure 1: Map of the study areas

Sampling Procedure and Sample Size

A multistage purposive random sampling procedure was used to select representative households in the study area. In the first stage, Ginir, Golocha and Agarfa districts were selected purposely as they are potential producers of durum wheat in Bale zone. In second stage two kebeles from each district, totally six Kebeles from all districts were randomly selected. In order to select representative number of sample households, a list of wheat producers along with area allocated under durum wheat was prepared by the researcher and development agent. Finally appropriate numbers of sample farmers from six kebeles were selected in proportional to population size using Yemane formula.

$$n = \frac{N}{1+\mathrm{N}(e^2)}$$

Where, n = sample size, N= Population size and e = level of precision assumed 9%.

Using the above formula, totally 120 farm household heads were selected from the total district farmer household heads.

In addition to farmer households, sample traders, cooperatives and processors were interviewed. The lists of wheat traders and processors were obtained from the district Office of Trade and Industry (OoTI). Based on the number of wholesalers available in the district, ten wholesalers and ten assemblers were selected randomly. However, there was no processor that uses durum wheat for pasta making. They use only soft bread wheat for making flour, macaroni and other side outputs. So that, we directly followed the chain of durum wheat trade and arrived at food complex processing companies located in Finfine. A lot of pasta processing food companies use durum wheat grain sourced from Bale zone as raw material input.

However, only Kaliti food complex company was willing to allow as for interviewing and gathering relevant information.

Method of Data Collection and Data Sources

Data Sources and Types

The data for this study were collected from primary and secondary sources. Formal and informal sample survey methods were used to collect both primary and secondary data. Primary data were collected from producers, traders, processors and cooperative at each kebele. The main data types collected include production, buying and selling, pricing, input delivery and distribution, market supply of wheat, constraints and opportunities, etc characteristics of the actors involved in durum wheat crop production and marketing in the study area. Secondary information were gathered from sources like (published and unpublished materials), district agriculture and rural development offices, farmers' organizations (cooperatives/unions) and input suppliers from different development organizations of the study area.

Methods of Data Collection

Primary data were collected using structured interviews through key informant interviews, personal observation, Rapid Market Appraisal (PRA) tools such as formal and informal interviews and through questionnaire preparation. Informal survey was conducted using Rapid Market Appraisal (RMA) technique using checklists. Formal survey was undertaken through structured interviews with randomly selected farmers, assemblers, wholesalers, processors, input suppliers and cooperative representatives using a pre-tested structured questionnaire for each group. Secondary data relevant for this study were gathered from published and unpublished materials.

Method of Data analysis

Descriptive statistics, inferential statistics and econometric analysis were used to analyse the data collected from durum wheat producers and traders involved in wheat marketing.

Descriptive statistics

Descriptive statistics such as mean, maximum, minimum, standard deviation, frequencies, percentages and graphs in the process of examining and describing demographic outputs and marketing functions was applied.

Value chain Mapping

This will help to understand the characteristics of the chain actors and the relationships among them, including the study of all actors in the chain, the flow of product through the chain, employment features, and of the destination and volumes of domestic sales. This information was obtained by conducting surveys and interviews as well as by collecting secondary data from various sources.

Structure-Conduct-Performance (S-C-P) of wheat market

The model examines the causal relationships between market structure, conduct, and performance, and is usually referred to as the structure conduct and performance (S-C-P) model.

a) Structure of market

Market structure is defined as characteristics of the organization of a market which seem to influence strategically the nature of competition and pricing behavior within the market. Structural characteristics like government participation, product differentiation, barriers to entry, and diversification, were some of the basis to be considered.

b) Market conduct

Market conduct refers to the patterns of behaviour that firms follow in adapting or adjusting to the markets in which they sell or buy. There are no agreed up on procedures for analysing the element of market conduct. It is a systematic way to detect indication of unfair price setting practices and the conditions under which such practices are likely to prevail. More specifically they cover the following topics: The existence of formal and informal marketing groups that perpetuate unfair price setting practices; Formal and informal producer groups that affect bargaining power; The availability of price information and its impact on prevailing prices; The distance from the major market and its impact on prices; and the feasibility of utilizing alternative market outlets.

The features or elements of market conduct include (1) cooperation, (2) integration, (3) strategies, and (4) services. Generally the conduct of a market can be characterized by the following practices:

1. Pricing strategy – predatory, exclusionary,collusive;
2. Product strategy;
3. Responsiveness to change; and
4. Research and innovation.

c) Market performance

Market performance refers to the impact of structure and conduct as measured in terms of variables such as prices, costs, and volume of output. By analysing the level of marketing margins and their cost components, it is possible to evaluate the impact of structure and conduct characteristics on market performance. For most countries, it is generally acknowledged that a distribution system displaying acceptable performance is one that (1) allows technological progress, (2) has the ability to adapt, (3) innovates and utilizes resources efficiently, and (4) transmits prices that reflect costs.

The major indicators or measures of market performance are: Net returns, marketing margins; marketing costs; producer's share; and value added and the analysis of market channel efficiency. A large number of studies have analysed the marketing margins for different types of commodities to examine the performance of agricultural products marketing (Wohlengenant and Mullen, 1987; Schroeter and Azlam, 1995; Holt, 1993) and (Sexton *et al*. 2005 as cited on Jema, 2008) argued that even though variations in the margin over time might be attributable to marginal marketing costs under perfect computation, additional factors such as seasonality, technological changes, and sales volume may also explain the variations in the margin. For this study marketing margin is selected to analyse the performance of marketing systems in study area.

Marketing margin was calculated taking the difference between producers and retail prices. The producers' share is the commonly employed ratio calculated mathematically as, the ratio of producers' price (ex-vessel) to consumers' price (retail). Mathematically, producers' share can be expressed as:

$$PS = \frac{P_x}{p_r} = 1 - \frac{MM}{P_r} \quad (1)$$

Where: PS = Producers' share
Px = Producers price of wheat
Pr = Retail price of wheat which is consumer price
MM = marketing margin
Total marketing margin is given by the formula:

$$\text{TGMM} = \frac{\text{Consumer price} - \text{Farmer's price}}{\text{Consumer price}} \text{ x } 100 \quad (2)$$

Where TGMM-Total gross marketing margin

$$\text{TGMMp} = \frac{\text{Price paid by consumer} - \text{Market gross margin}}{\text{Price paid by consumer}} \text{ x } 100 \quad (3)$$

Where GMMp- Producers' participation

Econometric models

Econometric models which are useful to analyze factors affecting supply of wheat to the market, factors determining choices of market outlet and factors influencing value addition are specified below.

Factors affecting market supply

In estimating factors that affect household's levels of market participation, OLS model is applicable if and only if all the households participate in the marketing of the commodity of interest. If participation of all households in marketing of the commodity is not expected, using OLS model by excluding non-participants from the analysis introduces selectivity bias to the model. Tobit, Double Hurdle and Hackman two stage procedures have been suggested to overcome such problems. If only probability of selling is to be analysed, Probit and Logit models can adequately address the issue. In Bale highlands almost all farmers produce wheat for selling purpose. Barley and emmer wheat are mostly used for household consumption. For studying factors affecting wheat market supply in the study area, multiple linear regression model was used since all sample farmers interviewed participated in supplying wheat to the market in 2005/6 production year. This model is also selected for its simplicity and practical applicability (Greene, 2000). Econometric model specification of supply function in matrix notation is given as below.

$$\text{Y} = \text{X}'\beta + \text{U} \quad (4)$$

Where:
Y = quantity of wheat supplied to market
X = a vector of explanatory variables
β = a vector of parameters to be estimated
U = disturbance term

Results and Discussions

Demographics and Socioeconomics Characteristics of Households

Most of the respondents were male headed households which was 93.6 percent (Table 1). Age is one of the important characteristics of the community. It reflects on the productivity of the population as it has a bearing on the overall health situation within the community. It has a bearing on the employment pattern, spatial mobility and quality of work done. Age plays a significant role in any kind of business, particularly in agriculture, because the use of child labor on the farms is quite high. The mean age of the sample respondent is 41.5 which shows productive age category (Table 1).

Table 1: Demographics characteristics of households

No	**Household characteristics**		**Percent of categories**
1	Sex		
	Male		93.6
	Female		6.4
2	Marital status		
	Married		94.5
	Single		5.5
3	Religion		
	Muslim		68.2
	Christian		31.8
No	Household characteristics	Mean	Std. deviation
1	Age of household head	41.5	12.1
2	Education level	6	3
3	Family size of respondent	7	3

The life of rural farm households mainly relies on agriculture which requires more labor for various activities like land preparation, planting, weeding, cultivation, harvesting, threshing, animal keeping, fetching water and fire wood collection and so on. The family size with age composition is important to carry out different agricultural activities. Larger family size with the productive age category is important in rural households to share the variety of agricultural duties. Regarding family sizes, the mean family size per a household of the study area was 7 (seven) with 3 (three) standard deviation (Table 2). Education is one of the influential socio-economic factors which play's considerable roles in the lives of the community. The educational level of a person represents the development of character or mental power. It helps the farmers in raising their understanding and the level of acceptance of, or receptivity to, new farming techniques. Accordingly, the respondents average schooling was grade 6 (six).

Farmland allocation

On average farmers of the study area owns 3.09 hectare of land (Table 2). They additionally rent and share in from different for further production of crops. On average farmers of the three study districts allocate 1.67 hectare of their land for durum wheat production purpose.

Table 2: Land use pattern

No	Land use	Average hectare operated	Std. deviation
1	Own land	3.09	1.69
2	Rented in land	1.44	1.21
3	Shared in land	1.05	0.57

Comparing the three districts Gololcha districts allocates more of their land for durum wheat production and also produces more yields per household. This is because the soil type of Gololcha district is more suitable for durum wheat production. Bale highland districts mostly produce bread wheat compared to durum wheat.

Table 3: Durum wheat production

No	Study area (District)	Average land allocated to DW production (ha)	Average quintals produced per household
1	Average land allocated for durum wheat	1.67	55.25
2	Agarfa	1.6	50.07
3	Gololcha	1.87	63.13
4	Ginir	1.2	40.48

Access to services

Durum wheat production

As tried to explain in previous chapters, there are two varieties of wheat grown in Ethiopia namely; bread wheat accounting for 60% of production, and durum wheat, accounting for the remaining 40% (Bergh et al., 2012). Both are widely cultivated in the highlands of the country largely in the areas of South East, Central and North West parts. In terms of area cultivated and annual production wheat is the third most important cereal crop in Ethiopia following maize and Teff (CSA, 2015). The two species of wheat crop, bread wheat (Triticum aestivum L) and durum wheat (Triticum turgidum) are both worth mentioning for the purpose of the value chain and wheat industry study in Ethiopia. Although both crop species are highly important for agro-processing industries, bread wheat variety has gained much popularity over durum wheat due to the attention given by many researchers to improve its genetic potential as well as several other studies made to adopt suitable agronomic practices for higher crop productivity.

On the other hand, durum wheat variety known for its hardness, protein, and intense characteristics has been cultivated in Ethiopia for thousands of years and used to pre-dominate the Ethiopian wheat production systems. This wheat crop species which was mainly utilized for the preparation of local traditional recipe was gradually replaced by the common bread wheat species. But, recently efforts were being hastened by different research centres to develop and release improved durum wheat varieties. Additionally different responsible bodies were involved in production and distribution of improved durum wheat seed, as well as seed multiplication to aggressively expand durum wheat cultivated area coverage. There is a growing demand for durum wheat, its unique grain quality attributes is always of highest preference within the food-based industries.

Bale zone is one of the surplus producers of wheat crop in the country. Accordingly, Wheat is cultivated on approximately 120,000ha of land, in the Zone (CSA, 2015). Durum wheat is produced in most districts of Bale zone, especially Sinana, Ginir, Goro, Agarfa, Gololcha and Gasara districts. Most farmers who were engaged in durum wheat production in the study districts produce for commercial purpose. In view of the current rapidly growing rate of urbanization, coupled with an increased expansion of the existing as well as newly emerging food processing industries, both bread and durum wheat species will be point of focus as a raw material products that are highly demanded to become an important part of daily diet in the urban and rural areas of Ethiopia.

Mapping of market channel

Farmers/producers, primary cooperatives, unions, collectors/assemblers, wholesalers, commission agents and processors were the major durum wheat trade market actors in the study area.

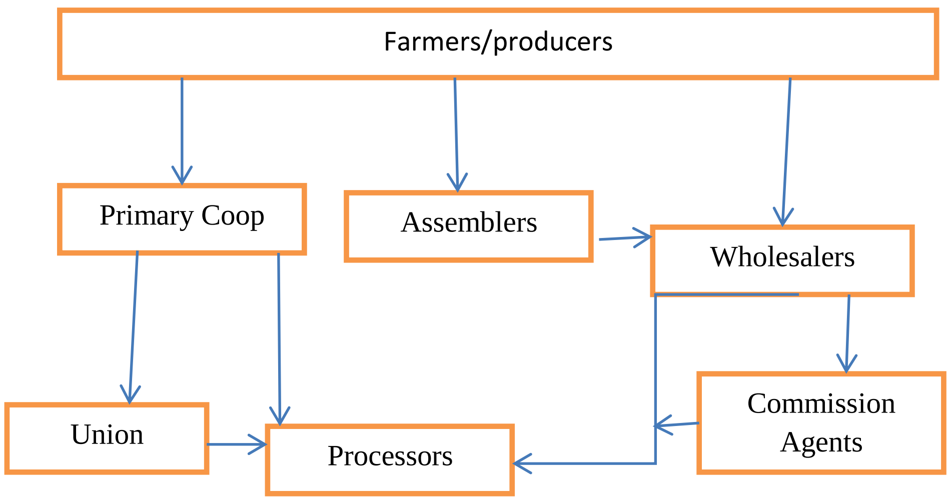

Figure 2: Map of durum wheat value chain

Farmers/producers: Producers are smallholder wheat producer farmers. They are major actor who is involved in production and marketing of surpluses they produce. Mainly they start from input preparation, produce, store and provide surplus to market. Wheat producers in the three study districts supply their product either to nearest market or zonal market using horse cart, pack animal or traders come to farm gate and buy from them.

Assemblers (Collectors): Assemblers play an important role in collecting produce from smallholder producers at farm gate and delivering to wholesalers at different levels. They are the first actor that links producers to other participating traders.

Wholesalers: These were those participants of the marketing system who used to buy wheat on the farm field with a larger volume than other actors. Wholesalers buy wheat grain mainly from individual farmers, some collectors/small traders and a few other wholesalers within the district and districts around the business. Wheat wholesalers sell grain to individual farmers, processors, collectors and wholesalers from within the district and beyond district.

Processors: The major suppliers of wheat to the processors include grain wholesalers, primary cooperatives and unions. Kaliti, Dire Dawa and Kebron Food complex factories are some of the processors that use durum wheat grain as raw material input from Bale zone

Commission agents: Agent middlemen who physically handle products for buyers and sellers and paid for the service they delivered per quintal bases. Mostly they work between producers and processors. Wholesalers informed that, they pay 5 birr per quintal for commission agent who involved in facilitating their trade.

Cooperatives: Cooperatives in the study area play crucial role in supplying inputs to the farmers. They are involved in buying agricultural output from farmers at harvest time. Especially in one of kebele used for this study cooperatives help member farmers through providing credit during harvesting time and also serving as storage point for output. However, they are not efficient enough in terms of timely provisions of agricultural input, buying of harvested products and financial management.

Structure-conduct and performance of Durum Wheat Market

Market structure

In agricultural marketing studies, market structural characteristics are used as a basis for classification of three categories of market: competitive, oligopolistic and monopolistic.

Barriers to entry

Licensing procedure: Wholesalers involved in wheat buying and selling activity were also all licensed. They paid some amount of money every year as per the Inland Revenue decision. Wholesalers buy wheat and transport to different marketing routes such as Addis Abeba, Shashamane, Hawasa, and Adama. However, retailers and assemblers indicated shortage of capital limited them from expanding their business venture. Even though availability of credit providers was admitted, there was no simplified credit system to solve capital limitation systems faced by retailers and assemblers. Some of them explained that religious believes limited them from taking credit.

Although, theoretically it is compulsory to have license to enter into the grain market, the simplicity to have grain license and absence of strong restriction to enter into the grain market with respect to licensing made grain marketing relatively free to enter. Traders explained that informal rural assemblers (which doesn’t own license) were involved in buying and selling of wheat especially during peak production season and high demand time. There is no strong regulatory action that controls non licensed market participant at kebele level and small towns in the district.

Skill (experience): The survey result indicated that traders experience ranges from 4 up to 20 years with an average experience of 11.13 years. The existence of wider gap between traders indicated that experience was not a barrier to enter in to wheat trading in the study area.

Capital: Capital requirements serve as an entry barrier because only those who can afford such a monetary can enter the market. This is the fact that in order to handle reasonable quantity of the commodity, traders need sufficient amount of money that assists there business to operate in healthy way.

Product differentiation

According to the response obtained during discussion, traders in the study area classified wheat into hard wheat and soft wheat and pay different prices. They used variety to classify wheat in to hard and soft wheat. According to traders response hard wheat was directly supplied to pasta and macoroni processing factory. Additionally traders consider quality of seed (size), cleanness and season of production to afford different price for suppliers. Respondent farmers also approved that different price was paid based on variety difference; quality of product supplied and season of production.

Market Transparency

Market information supply was not transparent between levels that created high price variability and difference among farmers engaged in selling of wheat. Wholesalers got information from their partners far in Addis, Hawasa, Dilla, Shashamane or Adama using mobile phone while farmers not get relevant information. The low returns of agriculture produce to smallholder farmers are associated to lack of market access and the marketing information (Ekola, 2005). Due to lack of reliable market information, farmers were failing to negotiate better on the prices of their produces and thus are paid a little. Market information sources for the farmers of the study area included traders, neighbours, friends, development agents, radio and television. The finding indicated that farmers exchange each other market information than other sources which was 98.3%. About 70% of information was also acquired from traders. However, information provided by traders was not up-to date and mostly not true. They used to depress price of products down by delivering historical and biased information to producers.

Market conduct

Price setting strategy

The survey result indicated that 52.5% of the respondents reported that wheat price decision was set by traders. About 46.7% of the respondents reported that market price was through negotiation of farmers and traders. The remaining 0.8% reported that they decide on the price of their product taken to market themselves.

Buying and selling strategy

Out of the interviewed farmers, majority of them (63.3%) decide to sell their product by assessing market price. The remaining 46.7% of respondents supply to market when they need money for different purposes. All of the respondents confirmed that price was the determining factor which influences them for whom to sell among the buyer outlet choices. All respondents indicated that the selling system was based on cash payment. Additionally, respondents pointed out that some traders cheat on weighing scales by manipulating installations of the instrument. Once they identify traders behaving like this, they will not sell to him/her again.

Table 4: Selling time and decision

No.	Selling strategy (N=120)	Percent
1	By assessing market price	63.3
2	Whenever need money	46.7

Marketing constraints and opportunities

The major marketing constraints raised by farmers and traders of the study area were: unfair pricing and cheating of traders on balance; lack of timely and sufficient market information; low price of commodities at harvest time; high price of seeds, chemical fertilizers and pesticides; weak market linkages among value chain actors and less bargaining power of farmers in the market. There are also regular market fluctuations and shortage of storage facilities in addition to poor transportation.

Processors main challenges were lack of uniformity in quality of flour for bread, cakes and cookies all which do not have standards established for them. There are also high production costs relative to selling price, unstable prices of flour, unfair competition from illegal traders and finally frequent electric power and water interruptions were also mentioned as constraint. Different actors involved in wheat production and marketing acknowledge that there are different quality problems. Quality problem was not only from side of producers, it was caused by different actors involved in wheat market value chain. There are also quality problem in the actual production and harvesting of cereal grains. This is related to poor weeding and inferior harvest management techniques. In addition to this, rain during the harvesting period sometimes spoils large volumes of grains. The small scale farmer does not have an insurance mechanism that safeguards its harvest from natural hazards, such as unwanted rain. Due to the above problems farmers supply different quality products to actors involved in wheat business in the study area.

Traders collect their merchandise from different sources, places and individuals and don’t have quality standards. What traders tend to do is to purchase any quantity from anyone offering the same price for whatever quality or offering a lesser price for inferior quality products. After purchasing, the traders then don’t pack the products they have collected in accordance with the different grades of quality. Rather they tend to mix up the good and bad quality grains together and sell it at the price of good quality as the prevailing price doesn’t give quality premium. Traders do this for two reasons, first they increase their profit margin and secondly because buyers are unable to check the quality and do not pay additional premium price for quality produce supplied to them.

The potential marketing opportunities of the area are the build-up of asphalt road that connects zone market to different towns in the country which creates potential demand for the products produced in the area. Obviously the increased demand would be followed by better farm price for producers. As a result farmers will have an incentive to expand their output. Furthermore, the increasing food processing plants in and around Robe town is creating additional demand for agricultural commodities like wheat. Consequently, this contributes for commercialization of rural economy and creates many off-farm jobs opportunities. Furthermore, provision of infrastructure facilities like telecommunication, power supply and financial institutions (Banks, Micro-Finance) supports the marketing activities in the study area.

Factors affecting durum wheat supply to market

Factors that determine supply of wheat to the market was estimated using OLS model was since all respondents used for this study supplied their wheat to the market. Among the potential variables assumed to influence marketable supply were: Access to market information, access to extension service, access to extension service, size of land holding, livestock (TLU), farming experience, quantity produced of wheat, lagged price, educational level of household head, own price of the commodity and age of household head.

Robust regression option was used in STATA to analyse and correct heteroscedasticity problem. Multicollinearity problem was also tested using VIF. The result indicated no multicollinearity problem since VIF was less than 10 for all variables used in the model. The independent variables included for analysis explained 92.06% of the variation in dependent variable. Test of endogeneity showed that the quantity of wheat produced is endogenous to the model. This problem can be overcome by using two stages least square (2SLS) method for wheat market supply. Totally eleven variables were used to predict producers wheat market supply. From the first stage of 2SLS total livestock owned (in TLU), farmers experience in wheat production, total farmland owned by farmers positively and significantly affect wheat production. Amount of fertilizer applied to wheat per hectare wheat positively and significantly affected wheat production. This shows that as the amount of fertilizer increased, the production of wheat will increase.

Table5: Factors affecting production of durum wheat

Variables	Coefficient	Robust Std.Err	t-value	p > |t|
TOTALTLU	5.19***	0.66	7.92	0.00
EXTENCONT	-18.42	13.04	-1.41	0.16
MARKETINFO	5.40	6.12	0.88	0.38
ACCESSCRE	-3.81	5.57	-0.68	0.50
TOTAREA	14.54***	2.94	4.95	0.00
FAMILSZ	2.12*	1.11	1.90	0.06
EDUCNLEV	0.36	3.04	0.12	0.90
AGEHH	0.20	0.35	0.55	0.58
DISTMRKT	0.26	0.63	0.41	0.68
FERTPERH^{IV}	-0.11*	0.06	-1.90	0.06
FARMEXP^{IV}	0.53*	0.29	1.81	0.07
Constant	-17.35	36.93	-0.47	0.63

N=120, F=26.08***, R^2= 0.86, ***, ** and * are statistically significant at 1%, 5% and 10% respectively. FERTPERHECT^{IV} and FARMEXP^{IV} is instrumental variable for quantity of wheat produced.

Quantity produced of wheat: It is the total amount of wheat produced in quintals in 2014/15 production season in the study area. It was hypothesized that quantity produced of wheat affects volume supply positively. Accordingly the result indicated that quantity of wheat produced affects market supply positively and significantly at 1% probability level. Positive sign of coefficients indicate that increase in production of durum wheat by one quintal resulted in an increase in farm level volume sale of durum wheat by 0.623 quintals, keeping other factors constant. Ayelech (2011) found that the amount of tomato, papaya, avocado and mango produced by farming households has augmented marketable supply of the commodities significantly. Abraham (2013) also found that the amount produced of tomato, potato and cabbage significantly affects quantity supplied to market.

Size of landholding: It is a continuous variable refers to the total area of farmland a farmer owned. It is assumed that the larger the total area of the farmland the farmer owns, the larger land is allocated for wheat and the higher would be the output that influences large quantity of wheat supplied to market. So it is hypothesized that size of land holding positively and significantly at 1% probability level influences volume of wheat supplied to market. Accordingly the size of landholding affects quantity of wheat positively and significantly. As the area of landholding by farmer increased by one hectare, the quantity of wheat supplied to market would increase by 4.25. The finding by Alemayehu (2012) also indicated that a unit increase in land allocated for ginger, would give rise to 11.1qt increase in the amount of ginger supplied to market.

Table 6: 2SLS results for factors influencing volume of wheat supplied to market

Variables	Coefficients	Robust Std.Err	t-value	p > |t|
QUANPRO	0.623**	0.309	2.02	0.046
TOTALTLU	0.374**	0.180	2.08	0.039
EXTENCONT	-2.905	7.506	-0.39	0.700
MARKINFO	2.924	3.342	0.87	0.384
ACCESSCRE	0.536	2.867	0.19	0.852
TOTAREA	4.257**	1.756	2.42	0.017
FAMSZ	-0.051*	0.534	-1.73	0.086
EDULEVEL	0.119	1.312	0.09	0.928
AGEHH	-0.194	0.233	-0.84	0.405
DISTMKT	-0.022	0.031	-0.74	0.464
Constant	-22.151	23.900	-0.93	0.356

N=120, R^2=0.92, ***, ** and * significant at 1% , 5% and 10% respectively
Source: own computation from survey result

Livestock (TLU): It is a continuous variable measured in tropical livestock unit. It affects quantity of wheat supplied to market positively and significantly. As farmers livestock ownership increased by one unit the amount of wheat supplied to market is increased by 37.4%. This is because livestock ownership in highlands of Bale are an important input for wheat production.

Family size: It is the number of members living household. The variable affects supply of wheat to market negatively and significantly. The negative effect of the variable shows that as the number of household members increased more part of wheat produce is allocated for household consumption. As the member of household is increased by one, volume of wheat supplied to market is decreased by 0.5%.

Conclusion and Recommendation

This study was conducted in Ginir, Golocha and Agarfa districts of Bale zone in Oromia region. The main focus of this study was analyzing durum wheat market value chain. Wheat (durum and bread) is widely produced crop and the area is known for surplus production which is supplied to market. The specific objectives of the study include identifying and mapping durum wheat market actors, analysing the market structure-conduct-performance of durum wheat markets in the study area; and identifying the determinants of durum wheat supply to the market in the study area. Different respondents at all stages were interviewed to conduct this study. The data were analyzed using econometrics and descriptive statistics tools by employing SPSS and STATA software packages. The main wheat value chain actors in the area are input suppliers, farmers/producers, assemblers (collectors), wholesalers, processors, commission agents and cooperatives/unions. OoARD, primary cooperatives/ union and private input suppliers are the main source of input supply of the study area.

Out of eleven independent variables included for affecting wheat production total livestock owned (in TLU), farmers experience in wheat production, total farmland owned by farmers positively and significantly affect wheat production. Amount of fertilizer applied to wheat per hectare of wheat farm negatively and significantly affected wheat production. Quantity produced of wheat, size of landholding, livestock ownership positively and significantly affected volume of wheat supplied to market. Family size affected volume of wheat supplied to market negatively and significantly. So that improving the production and productivity of wheat in the study area resolving the prevailing production problems deems a necessary condition. Additionally it is important to develop high yielding varieties that combine durable resistance because Bale highlands are mostly susceptible to rust races that immediately breaks resistance of bread wheat varieties and lead to complete loss of harvest. In order to strengthen farmer's production potential, making available credit to farmers for input purchase also needs attention.

To solve shortage of improved varieties seed, improving farmers' knowledge in quality seed production through training is important. Improving knowledge of farmers on production of quality seed by themselves will solve shortage problem and save expenditures incurred by farmers. In addition farmers also reported the existence of grass weed problem in the study area influences production and productivity of the crop. This was caused because of wheat mono-cropping cycles not only in the study districts but also over all in Bale highlands. In order to avoid the effects of grass weed in Bale highlands promoting importance of crop rotation through training and strengthening the present crop protection services through availing important chemicals are solution.

Market information dissemination is an important issue for producers to help them decide on marketing their products. So it is important to disseminate market information to all the wheat value chain actors throughout the year. In addition to print and electronic media, district trade and industry office could extend this information in collaboration with agricultural extension agents.

The enhancement of wheat producers' bargaining power through cooperatives is the best measure that should target increasing farmer's share of benefit from his marketable produce. Creating access to flexible credit system for traders is also a necessary condition which targets at reducing the oligopolistic market structure in the Robe town market. Strengthening horizontal and vertical linkages of the wheat value chain actors in the study area is also an important input that improves the marketing system of the crop in the study area.

The result of econometric analysis indicates that volume of wheat supplied to market is influenced positively and significantly by quantity of wheat produced, livestock ownership (TLU) and total area of farmland owned by farmers. Therefore, in order to enhance volume of wheat supplied to market, these variables should get attention and promoted. Increasing surplus production through promotion of appropriate input technologies such as seed of improved varieties, recommended fertilizer rates, pesticides and other appropriate agronomic recommendations can improve production and productivity of wheat in the study area. Livestock categories like oxen, small ruminants and equines are used as better input that supports wheat production and this lead to surplus produce by farmers in the study area.

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Characterization of the farming systems in Borana zone, Oromia Oromia National Regional State, Ethiopia

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Abstract
Farming system of the Borana pastoral area become diluted unlike the earlier decades where livestock stands as the backbone their economy from Anecdotal evidence. Unlike the historical appellation of the pastoralists, the shift and diversification of the farming system become increasing. This tempts the appropriate interventions to improve the livelihood of the society in the Borana zone where this study was undertaken to classify, characterize and map the farming system, prioritize the system constraints and opportunities and identify future intervention areas. To address the issue primary data were collected using checklists and questionnaires based household survey, FGD and key informant interview beside secondary data review. With this regard, 160 households from both pastoral and agro-pastoral area selected based on multistage sampling techniques. From the study shortage of water, shortage of forage, shortage of rainfall, drought and livestock disease dominates the livestock production system where weed, insect, disease, fertilizer, market problem and lack of improved seed dominates the crop production. Finally, improving the access to water, livestock feed, strategic pastoral policy setting, livestock health, livestock marketing need urgent interventions in agro-pastoral area where as water development, conducive livestock market, unethical veterinary drug use, sophisticated early warning system and improving milking goat breeding need urgent recommendation in pastoral area. Additionally, improving apicultural practices, poultry production and eco-tourism need typical interventions to improve access to non-pastoral income of the households. Moreover, watershed based soil erosion and afforestation need further attentions pastoral context where eco-tourism based wildlife protection demands urgent.

Keywords: Agro-pastoralism; Borana; Farming system; Livestock; pastoralism.

Introduction

Livestock is the main backbone of Borana pastoral economy which have a long history in Borana zone. However, due to climate variability is the greatest threat to livestock production system, which recurrently erodes the livestock asset before full recovery achieved (Angassa and Oba, 2007). As a result, Borana pastoralists are much poorer today than they were in decades, as livestock per capita has declined from 4.1 to 2.3 TLU1 and more recently found 1.9 (Desta, 1999; Bekele, 2011). The decline in livestock per capita and resultant shifts in households' wealth ranks over a period of years reflect the erosion of the pastoral economy (Little et al., 2006).

However, the dramatic desirous are undertaking in pastoral area for survival from impacts of climate variability. As a result, different farming system, pastoralists, agro-pastoralists and farmer, have been emerged in Borana zone to overcome the challenges in climate changes. Pastoralists were largely depending on livestock husbandry to make a living whereas agropastoralists depending on both growing crops and raising livestock (Coppock, 1994). However, sometimes most agro-pastoral households did not get any harvest due to rain shortages and subsequent crop failures because of climate variability.

However, since recent times the livelihood based on only livestock production has been declining. Even though pastoralism was the most common livelihood system of Borana zone, most of the pastoralists strained to diversify into agricultural production (Ayana, 2007). The Borana pastoralists were practicing small scale crop farming to fulfill the food requirement of their family even though it is ad hoc gambling game with climate condition. In whatever case, an opportunistic cultivation is become one of the few alternatives that pastoralists have partially compensate for such a long-term trend livestock restocking. Increased cultivation was attributable to a declining ratio of livestock to people as exacerbated by human population growth and drought (Tache, 2008). In most cases, the depletion of smaller herds from the poor pastoralists induces the permanently shift into farming unfortunately. Now days, forestry resources have been extremely degraded attributed mainly to firewood collection, logging and agricultural expansion. The forest can no longer provide fuel and construction material as it did in the past. Traditionally, the forest provides women with firewood, which they sell in urban areas or use for household animal fodder and traditional medicine.

Thus, it is required to identify the major farming system of Borana zone for further research and development interventions in appropriate ways. Specifically, due to various emergences of different farming system the challenges that bottlenecked the agricultural productivity was hardly identified. As a result, it has been a great headache for the research activities to solve the production and productivity challenges in the Borana zone. Therefore, this study has addressed the major farming system in Borana zone, its emerged challenges, further opportunities and ways forward across research and development contexts.

Methodology Descriptions of Study Area

Borana zone is among the 18-zone located in Oromia which located at the southern tips of Ethiopia which share a single borderline with Kenya. The topography of the zone is categorized as 10% highland, 20% temperate and 70% lowland. The average temperature of the zone range between 18-28^{0}cwhile the altitude lies between 500 and 2500m*asl* (Ibrahim, 2005). The average annual rain falls ranges from 450-650mm. The rainfall of the area is characterized by two-fold where 70% of the rainfall in main rain season and only about rainfall occurs during short rain season. Borena Zone is Home for about 1,020,000 populations where about 83.9% of total population resides in rural areas of the zone.

Borana zone among the zones comprised in oromia that located at about 570km from Addis Ababa at Addis Ababa- Moyale maian road to its center Yabello town at the southern Ethiopia. Astronomically Borena zone is located $3^{0}26^{'}$ to $6^{0}32^{'}$N latitude and $36^{0}43^{'}$ to 40046'E longitudes extending for about 3^{0} or 331.6kms North to South and for about 4^{0} or 442.06kms East to West. It comprises 13 district and one town administration, *Yabello* town. The common districts in Borana zone includes *Teltele, Dire, Miyo, Moyale, Arero, Wachile, Surupa, Elwoya, Dubluq, Guchi, Dilo and Dhas district.* For this document, the description of study area was used the data from Borana zone Socio-economics profiles.

The zone covers a geographical area of 63,939 km^2 which occupied by pastoralists, agro-pastoralists and farmers in the lowland, mid-highland and highlands part respectively. It is bordered by Guji zone in the East, Somali regional state in South east, Southern Nation's Nationalities and Peoples of Southern Ethiopia in the North and West and 521kms long international boundary with Kenya government. The zone is dominated by semi-arid climate with the altitude below 1500 above sea levels. Mostly part of a zone is characterized by lowland which covers larger parts of Moyale, Dire, Arero, Dillo, Teltelle and Yabelo district. The area with the altitude above 1500 above sea level are found in north central and southern parts of the zone particularly some parts of Yabello and central parts of Dire district. Yabello and Mega plateau; the extension of southern highland which rises to 2000m asl are the known as mountains of the zone.

Generally, about 56% of the total climatic condition of the zone is characterized by tropical climatic condition while about 31% and 13% of the total area of the zone characterized by sub-tropical mid-highland and highland agro-climatic conditions respectively. Borana zone is endowed with various natural occurring inorganic and organic minerals with a definite chemical and physical composition. he minerals deposits can be sub divided in to metallic minerals, nonmetallic minerals and gemstone. Although it is not much exploited, Borana zone have found that nickel, cobalt, rare metals (columbines tantalite), kaolin, feldspar and quartz, talc, graphite muscovite, asbestos, lime stone, gypsums, olivine and garnet found in different parts of Borana zone. The major soils in the Borena zone are traditionally classified as clay loam, clay, Sandy loam and Sandy soil. Similarly, high forest, broad leafed forests, wood land, bush and shrub land, grass land and plantations trees are found in the zone. The diverse climate and topography of the zone has provided a range of natural environment supporting a wide variety of fauna and flora. Wildlife is one of the most important natural resources which the zone is endowed with. The secondary data from the earlier *Boorana* indicates that the land use of different agro-ecology are hardily proportional across the region. In the pastoral dominated lowlands, the bush and rangeland cover most of the area where as are agro-pastoral dominated lowland is covered bush land, degraded land, grassland and cultivated land. Due to expansion of the crop farming in the region, the deterioration of the grazing land creates a significant fractional depreciation of grazing land per-capita as compared to the earlier practices. As a result, degradation of rangeland due to overgrazing could be a problem.

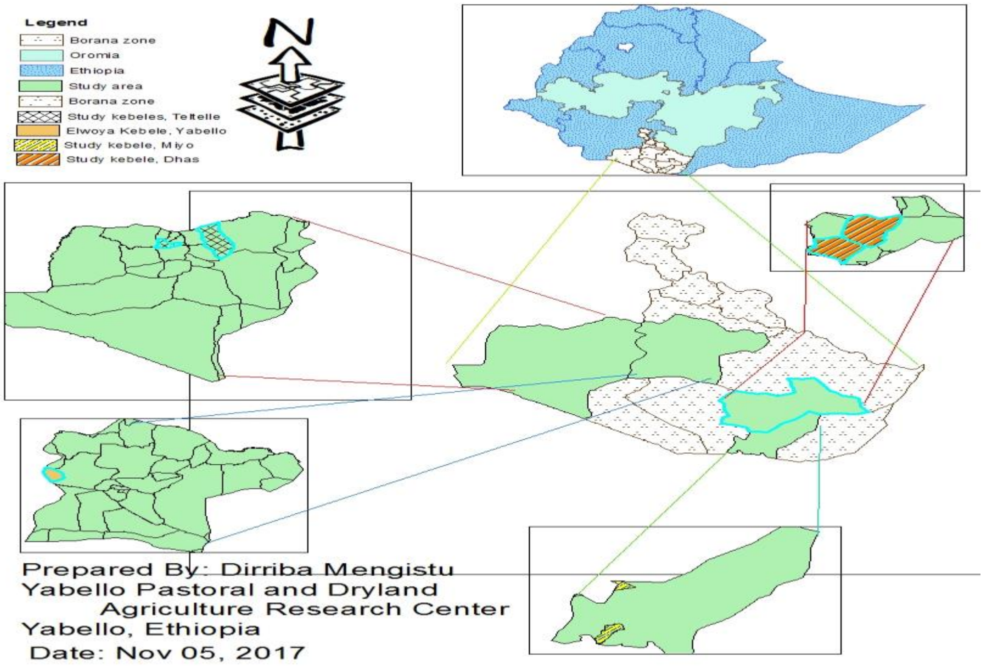

Figure 3. Study area

Methods of Data Collection

In this study, both primary and secondary data were used. Primary data were collected from sample households using a semi-structured questionnaire. Survey questionnaires were pre-tested before commencing the actual data collection to make important modification. In order to capture better socio-economic context of the area, qualitative data collection such as focus groups discussion (FGD) and key informants interview were conducted using checklist questionnaires.

In the data collection, DA in the respective PAs was participated after they aware introduced to questionnaire two weeks before the process of data collection. FGD with members of 6-12 with a combination of youth, women, elder men households undertaken in each respective PAs. Additionally, three discussion and interviews with key-informants were conducted to verify the information from survey with respective experts of different level of professional aptitude. Moreover, secondary data were collected from respective office from Borana zone and respective districts' fiancé and development offices to enrich the data collected by the households. Moreover, farmers' abilities to see problems and opportunities in their farming system are often limited by the narrow range of their experiences, particularly if they have little communication outside of their immediate area (Shaner *et al*., 1981). Thus, secondary information reviews also need to be addressed to make this document comprehensive.

Methods of Data Analysis

Descriptive statistics such as mean, percentage, frequency and standard deviations were used to analysis the socio-economic characteristics of the sample households. Additionally, χ^2 was employed for comparison of the explanatory variables with the dependent variable. Quantitative data will be analysed using SPSS software and the result will be presented in descriptive statistics. Qualitative data will be analysed using content analysis and categorization of the information under the main themes.

Sampling Size and Sampling Design

Sampling is the procedure through which we pick out an item, from a set of units that make up the object of study (the population), a limited number of cases (sample) chosen based on cost of data collection; time required for the collection and processing of data among the major (Corbetta, 2003). In this study, a stratified sampling method followed by simple random sampling was used to select sample households from the population in the district. Stratified sampling technique is generally applied in order to obtain a representative sample where a population from which a sample is to be drawn does not constitute a homogeneous group (Kothari, 2004). Under stratified sampling the population is divided into several sub-populations that are more homogeneous than the total population, (the different sub-populations are called 'strata'). Then, the sample households were selected randomly from each stratum finally. Based on this principle, Borana zone was stratified into three (3) homogeneous group based on its livelihood system; namely pastoral, agro-pastoral and agriculture. From each category, 1-2 presumed representative sample districts were randomly selected. Then these selected districts were also stratified into pastoral, agro-pastoral and agriculture PAs. From these stratified PAs in the districts representative sample PAs will be randomly selected. Finally, representative sample households were randomly selected.

Based on this, 123 households (Table 2) were drawn out at 95% CI with 0.5 degree of variability at 9% precision level (Tora, 1987). Finally, households were selected from each PAs on proportionality basis.

Results and Discussion

Socio-economics characteristics

The proportion of male and female in the household is on average constitute a one-to-one (1:1) ratio with the mean of six family size on average (Table 1). The average male and female constitute proportional with a minimum of 3 for both and a maximum of 11 and 8 for male and female respectively. The age of sample households was the mean of 42 years (Table 1) with a maximum of 96.

Table 40. Age and family size of sample household

Description		N	Minimum	Maximum	Mean	Std. Error
age		114	22	96	44.54	1.24
Education level (Grade)		23	2.00	13.00	5.39	0.60
Family size	Male	112	1.00	11.00	3.64	0.15
	Female	115	1.00	8.00	3.02	0.12
	Total	115	2.00	16.00	6.62	0.21

Source: Own survey, 2016

Most of the sample households were male-headed households, which constitute about 83% of the sample households, and only 17% of the sample households were female-headed (Table 2).

From all sample households only about 28% can 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 the respondents were attending a maximum of 8 and about 1% 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, there is a significant difference between the literate and illiterate on which the livelihood system they are inclined to.

Table 41. Sex composition of sample households

Description		Farming		Pastoral		Agro-pastoralm		Total		Chi-square
		N	%	N	%	N	%	N		
Sex	Male	8	100	19	73.08	70	97.22	99	90	24.45***
	Female	0	0	7	26.92	2	2.78	11	10	
Education status	Literate	4	50	2	8.7	19	28.79	26	25	12.23*
	Illitrate	3	37.5	21	91.30	46	69.70	3	75	
	Youth	1	12	0	0	1	1.52	.2	1.8	
Religion	Muslim	3	37.5	1	3.85	8	11.94	12	11.43	10.51
	Protestant	2	25	2	7.69	9	13.64	14	13.33	
	“Waaqeffataa”	***3***	37.5	23	88.46	50	74.63	79	75.24	

Pearson χ^2 *is significant at 1%, 5% and 10% significance level respectively*

Sources: Own survey

The area is dominated implicit traditional religion called “waaqeeffataa” followed by Evangelical and Muslim. The Muslim and Evangelical religions are the recently expanded religion unlike the original “Waaqeffataa” religion in the zone. These tow religions are expanding at the expenses of their traditional religion

Farming system characterization

Farming system is 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 whereas the household, its resources, and the resource flows and interactions at this individual farm level are together referred to as a farm system (Dixon *et* al.,). However, the concept of farming systems has been defined differently by different people and its classification was done accordingly.

Nevertheless, the farming system characterization is specific to the situation in the study area along with the objectives of the research. Though the characterization is based on the situation, the main target of the farming system research is to identify and prioritizes challenges and opportunities of the farming and comes with a priority solution regardless of the methodology of farming system characterization. Based on this context, the farming system of the study area can be characterized based the livelihood practices of the study area. However, these farming systems have no discrete boundary of classification of identity in Borana Zone which makes difficulty to acquire data for further discrete analysis. Thus, the use of livelihood practices-based-agro-ecology eases the life for further detail discussion. Accordingly, the Borana zone can be classified into different farming system based on the traditional livelihood basis, as Pastoralists, Agro-pastoralists and farming/TOPs farming system.

Though it is difficult again to assign discrete definition of household as within each livelihood system, scholars have assigned the subjective definition of each farming system. According to Swift,

"*Pastoral households are commonly defined as households which obtains more than 50% of their total gross income (i.e. includes the value of own production that consumed within the households) from mobile livestock rearing on unimproved, communal pasture. Similarly, agro- pastoral households are households which obtains more than more than 25% but less than 50% of their total gross income (i.e. includes the value of own production that consumed within the households) from livestock on communal grazing land and more than 50% from cropping activities.* (Swift, 1988)

Additionally, Rass also defined these households in similar manner as:

"Pastoralists are livestock keepers residing in the area which receives less than 400mm of rainfall per year with a length of growing period 0-75 days, where cropping is not practiced and driving more than 50% of agriculture from livestock rearing through opportunistic tracking on communal land. Similarly, agro-pastoral are livestock keeper obtains more than 25% but less than 50% of agricultural income (i.e. includes the value of own production that consumed within the households) from livestock keeping on communal land in area with an annual rainfall between 400 and 600mm and length of growing periods of 75 to 90 days." (Nicola Rass, 2006).

Moreover, the key-informant and experts agreed pastoralists are those whose livestock and livestock product are their principal income source whereas Agro-pastoralists are those households depends on both livestock and crop to nourish their livelihood, but with a slight reference to the crop production. Moreover, the farming/Tops farming system is the livelihood in which their income is derived from crop production dominantly.

Generally, based on the current zonal classification, Borana is remains within the lowland geographic location. Thus, rather than agro-ecology basis, pre-defined farming system based characterization can address the details of farming system practices in Borana zone. Rather, the zone is characterized by the arid and some arid climatic condition which disproof its highland practices. Accordingly, farming system of Borana Zone can be disaggregated as pastoral, agro-pastoral and farming area. However, due to no pure farmers in the zone, this analysis focuses only on pastoral and agro-pastoral farming system. Additionally, it was difficult to classify this faming system due to lack of updated disintegrated shapefiles.

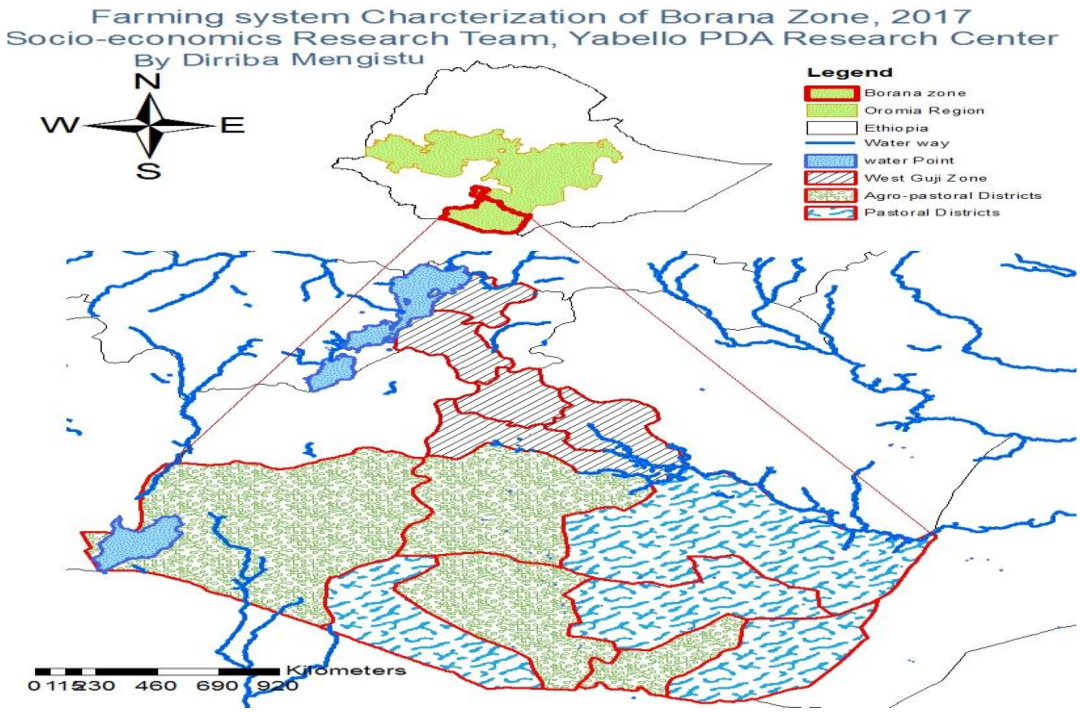

Figure 4. Farming system classification

Livelihood Activities

Pastoralism is the endogenous livelihood system of the societies in the Borana zone across all vicinity. However, the shortage of income due to frequent loss of livestock enforces to look for another livelihood option besides the livestock production. The survey result indicates that in the last 20 years most probably the shift from pastoralism to agro-pastoralism is elevated. Before 20 years ago, the number of households practicing crop production is minor. Even before 10 years, the involvements of crop production are relatively low. However, due to various factors, majorly droughts, the expansion of land farming become a common livelihood option. Particularly, the low productivity and production of livestock (e.g. Milk) enforces the households to look for another income sources. Past study undertaken by Hurst *et al*. also support that the current 10-20 animals are incompetent as compared to forty years ago when one or two lactating animals was sufficient to sustain the livelihood of pastoral households (Hurst *et al*., 2012).

As a result, looking for crop farming as a livelihood source become the major option of for the households with low livestock sizes to meet the unmet demands of food. Note that the crop farming is not due to the genuine demands of the pastoralists but enforced by recurrent mutation of their livestock production system that exacerbate the food insecurity. The χ^2 *result also indicated the shift* from one farming system is significant at 95% confidence interval. Graphically, it clearly displays that the livestock production become decreasing over a period of 20 years where the involvements in farming become increasing. However, it doesn't mean that crop production is not practiced 20 years ago. However, it indicates that there is high trade-off between crop production and livestock production.

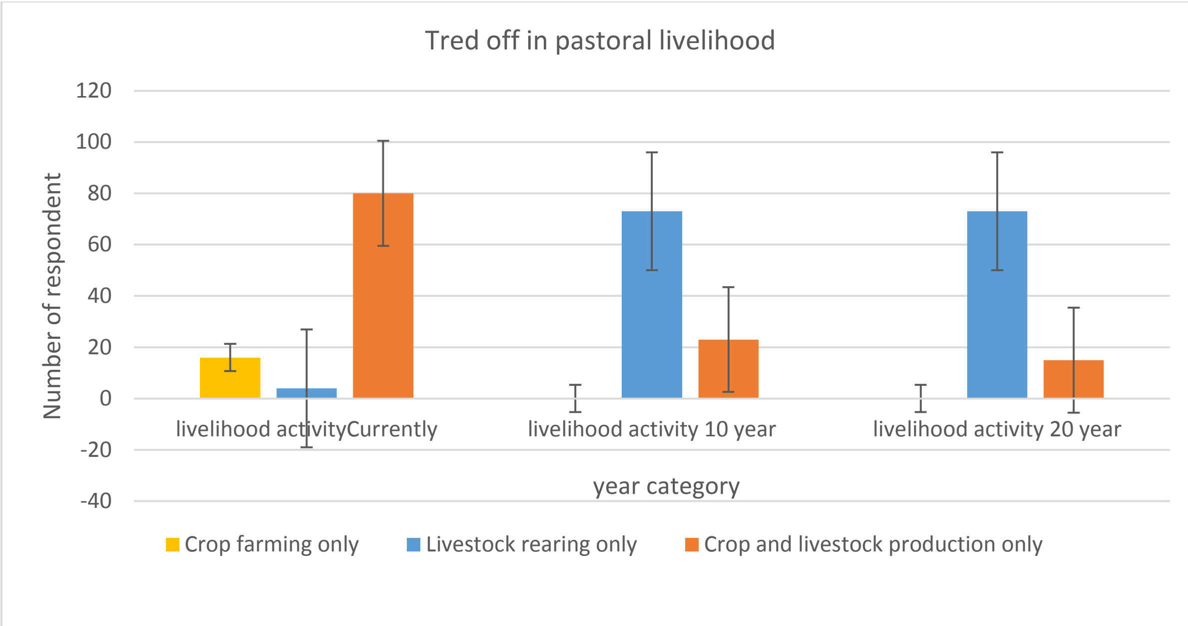

Figure 5. Livelihood trade-off

Crop production practices

The production of different crops was given due attention based on their awareness and access to the seed and seedling. Regardless of the area of production, seed sources, availability of seed and producers experience, the community in Borana zone are practicing all types of crops. Though cereal and pulse crops are the dominant types, the production of oil crops, vegetables, tubers, cash crops and fruits become practiced. In response to climate change which imposes increased frequency of erratic drought, long dry season, high temperature, high flooding and short intensive rainfall, the communities are practices all types of crops regardless of production experiences and skill. Besides access to seed, the farming skills exacerbate the frequent crop failure in the zone.

Cropping calendar

Crop production is undertaken in the specific time periods in the zone as the other parts of the country. The FGD undertaken in the zone identifies that both the specific time of crop production and the production season in zone. Accordingly, most crops are production is undertaken from March – June and major crops could also undertake from September – November.

In general sense, the crop practices undertaken from February-August and from September to December when all practices crop related activity considered. However, the intensity of these practices depends on the expectation of the rainfall. In the zone, not all years are a production year due to the expected frequency of drought occurrence once within 3-5 years.

Table 42. Cropping activity calendar in Borana zone

Varies calendar	Months											
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Rainfall												
Ploughing												
Weeding and hoeing												
Harvesting												
Collection												
Threshing												

Source: Own survey results, 2015.

Major crop produced

Crop production is currently become a major livelihood option of community beyond alternative livelihood practices. Majorly, almost all types of crops that can be adapted in the lowlands are practiced though the size of production and productivity matters. Typically, maize, teff and haricot bean are the dominant crops that majorly produced by agro-pastoral households. This implication was proved during field survey where almost all crops production was revealed by FGD.

Table 43. Crop produced in the lowlands of Borana zone, Agro-pastoral

Cereal crop		**Pulse crops**		**Fruit crops**		**Other crops**	
Name	**Score**	**Name**	**Score**	**Name**	**Score**	**Name**	**Score**
Teff	14.5	Haricot bean	14.5	Coffee	5	Cabbage	10
Maize	14.5	Chick pea	5	Pumpkin	4	Kchat	9
Wheat	12	Lentil	3	Papaya	4	Moringa	6
Barley	12	Ground nut	-	Mango	3	Sweet potato	4
Sorghum	4.5			Avocado	3	Coriander	2.5
				Pomegranate	1.5	Tomato	2
				Lemon	1	Potato	1
						Pepper	0.5

Sources: Own FGD,2016.

Moreover, the data from the secondary source, PDO, indicated that the larger proportion of land was allocated to teff, maize and haricot bean. The field survey also confirms that about 65% of the proportion of land is allotted top three crop produced namely, teff, maize, and haricot bean. Though teff was become a dominant due to its high price on the local market, mostly maize is the dominant staple crops.

Table 44. Crop produced in the study area

Crop type	N	Land allocated			%
		Minimum	Maximum	Mean ± SE	
Maize	101	0.10	5.00	0.96±0.07	22%
Haricot bean	82	0.10	7.00	0.93±0.12	21%
Teff	50	0.10	5.00	0.98±0.13	22%
Wheat	4	0.25	1.00	0.50±0.18	11%
Barley	8	0.10	1.00	0.43±0.13	10%
Chat	16	0.10	0.50	0.34±0.03	8%
Banana	2	.10	.20	0.15±0.05	3%
Coffee	3	.10	.20	0.13±0.05	3%

Source: Own survey results,2016.

Though the crop production is highly infant in pastoral area, now days the urge for crop production knocks the conscience of every pastoralists regardless of the production skill and know-how. From the survey result, about 85%, 65% and 30% of the pastoral respondents confirm that produces maize, haricot bean and teff. Similarly, these pastoralists allocated about 85% of their land for maize production fallowed by haricot bean and teff.

Cereals

Cereal crops are among the dominant crop types in Borana zone with the favor that it is their dominant staple crops. Among the major cereal crops with priority of size of production; Teff, Maize, wheat and barley are the dominant cereal crops. Though there is a discrepancy between Teff and Maize as major cereal crops, in general maize is the dominant crops in Borana zone. In relation to consumption pattern, maize is the sole dominant staple food from cereal crops in Borana zone.

Beyond its consumption importance, Teff is the dominant cash crops followed by haricot and maize respectively with respect to its cash generation. Particularly, Teff is preferred due to its high demand in town, relatively adaptive and can be consumed at household level. Maize is the also a dual purposes cereal crop in the lowland of Borana. It is majorly used for consumption purpose from Borana history as well as marketing though the price of maize is very low relative to Teff and haricot bean.

Additionally, though the local varieties of cereal crops are tempted by shortage of rainfall, it is highly productive during good rainy season. These black shades the introduction of introduced new varieties unless otherwise the newly introduced varieties ought to outshine in relation to the productivity and market demands.

Pulses

Pulse crop is among the second dominant crop produced in Borana zone. Specifically, haricot bean and faba bean, ground nut, field pea, lentil and chick pea were identified among the produced crops in dryland of Borana. Except haricot bean, the other pulse crops are practiced in small size either for evaluating its adaptability or practiced by a few elites in small plot. However, haricot bean is the main stable crop equally either with maize or following maize.

Moreover, relative to another pulse crops haricot bean is highly preferred. Specifically, it is characterized by short maturity duration where its yield size depends on rainfall duration and humidity. As the duration of rainfall extends to its maturity humidity requirement, its productivity is very high otherwise provide small amount of yield with meager rainfall. Moreover, it is highly adaptable to the environment where every household in the region are producing it. Interestingly, the total loss of haricot been is less common during rainfall failure which can bear yield with small rainfall.

However, due to small scale production, the access to good market opportunity is far challenges for small producers in Borana zone. As a result, through the production of red-type haricot bean is far better than other types, due to its poor market opportunity, the willing of the producers is explicitly very low. On the other hand, it has high effect to ensure the food security of the society which need high market mobilization. Moreover, the adaptation of improved seed varieties along the demands of the society is still not satiated. Consequently, illegal seed import from Kenya by producers themselves become a common problem in the zone. Moreover, the imported seed have extreme demand in Kenya with relatively high price than common local haricot bean in Ethiopia also. This effort has pauses synergies of high yield adaptable seed in the country.

Other crops Fruits

Fruit crops are rare to expect in the dryland and semi-dryland unless intensive management practices undertaken. However, *banana, papaya, lemon, mango, avocado, orange, Casimir, gishta and sugar cane were among the fruit crops identified in Borana lowlands*. Though these crops were not produced on large farm, risk-taker households are practicing in their home yard and around small irrigation outlets. Explicitly, papaya is commonly practiced around home yard where as sugarcane is also common around colluvial soil area.

However, it was difficult to obtain the generic data on the contribution of these fruits to the income of households due to its uneven distribution of production, seasonal productivity and size of harvest. Yet, it is an evidence that most fruit crops can be grown in dryland of Borana though it need intensive care and management than other crops. Moreover, most of the fruit crops grown by those elite in dryland of Borana is mostly sourced from other area where agro-ecology is not similar.

Vegetables

Vegetable crops are practiced in all Borana zone where there is possibility to use water. Among the major onion, cabbage, carrot, tomato and pepper are rarely practiced in the whole of Borana zone. Though most of these crops are limited to irrigation facility, cabbage is mostly produced during rainy season by most of the household. Otherwise, production of other vegetable crops is limited to irrigation practices in most case. However, the practices of irrigation scheme are limited in Borana zone due to types, size, quality and quantity of water sources. Pond is the major sources of irrigation water that limits its expansion as much as expected. Otherwise, the other sources of irrigation such as deep well, cistern and natural spring water is rarely observed. In most case, the irrigation practiced commonly as overspill of water during dry season.

Tubers and root crops

It is not common due to the rainfall situation of Borana zone. However, Sweet potato and potato are among the crops basically identified that practiced by some elite households around their home stead and water drainage area. Though its production is few to express, it is an indication for the possibilities of the crop production through some intercession such as water development and supply of early maturity seed.

Beyond the aforementioned crops, some crops are difficult to confidentially assign under a single crop category due to their different characteristics. Such crops include kchat, Moringa and coriander that were identified during the study of FGD. Particularly, though coriander is not a such expanded, kchat and moringa are the most common in Borana zone. Exclusively, the production of kchat is low unlike its the consumption pattern where its consumption is expanding throughout aged demographic structure of the society. Currently, it is the most demanded income sources though its market is less benefit the producers' society due to the deceiving behavior of the middlemen.

Similarly, moringa is a drought resistant ever green crop/tree where its leaf consumed just like that of cabbage. Beyond consumption, it is a multi-purposes crop/tree mostly valued for its high medicinal amenity especially for diabetes and blood pressure victims. Though intensive production is not common, it is among the most popular home garden tree particularly around urban and peri-urban areas.

Cropping pattern

The crop production becomes expanded in Borana zone at the expense of rangeland. Though teff, maize and haricot bean are the most produced crops in terms area allocation, the FGD output out-shows larger land is allocated for maize, followed by haricot bean and teff respectively. Maize is the most staple food crop followed by haricot bean even from historical background of the Borana pastoralists.Their consumption pattern is dominated by maize followed by haricot bean. However, recently the consumption of teff and other crops was being expanded particularly in peri-urban. The secondary data similarly indicates that maize followed by haricot bean and teff are the top major crop produced in agro-pastoral area. In whatever case, maize and haricot bean dominates the crop production pattern of the households in Borana zone as indicated on the following Table 6.

Table 45. Crop pattern

Major crops	Maize	Sorghum	Teff	Wheat	Barely	Haricot Bean	Chick pea
Area coverage	38521.5	17389.7	20408.7	20546.3	7721.6	31541	3452
Cropping Pattern	26%	15%	16%	13%	4%	24%	3%
Productivity (Yield/ha)	11.34	4.07	5.54	13.28	9.63	10.54	15.59
App. Maturity	90	90	60	60	60	52	60

Sources: Secondary data from Pastoral Development Offices, Borana Zone.

The survey data output indicates that larger land is allocated for teff followed by maize, haricot bean, wheat and barley relatively. This indicates that teff become an important crop in Borana zone largely due to its market demands. The FGD result also confirms that teff become the most important crops in pastoral area due to its high price and relatively drought resistant as compared to other crop, particularly maize. Furthermore, teff is hardly affected by disease and pests as compared to other crops particularly for storage.

However, the funny thing is that the household are hardly consuming teff as a stable food. They producing teff as a commercial crop that can generate higher income relative to other crops. However, the producers post-harvest management challenges their income. The producers have poor crop storage experience where most they transport to the market immediately after harvest where it induces low price of the product due to high supply.

Uses of agricultural inputs

Agricultural inputs are among factors that simulates the productivity of agricultural output in Borana zone. However, due to various factors the use of these input is not common, particularly fertilizers. In dryland area, producers are less willing to use fertilizers largely due fear of risks of crop failure which could raises the production cost. Definitely, the crop production practice is the gambling with climate change in dryland area of Borana zone**.** Usually, the community choose the dry sowing to use the first drop of the rainfall. However, no one is sure that the current rainfall is sufficient for normal production that exacerbate the fear of risks. Thus, the confidential use of these crop is highly challenging in pastoral area due to moisture stress besides the low productivity.

Unlike other parts of Ethiopia, the productivity of crop products is low sometimes below average national crop yield. However, though there are various improved agricultural practices, due to different factors the community could not uses it. With this regards, various organization such YPDARC, PDO, NGOs and MARC have been supplying various the improved agricultural inputs. Among the major, teff, wheat, maize and sorghum with different varieties were introduced by these organizations though its sustainability is questionable. Particularly, From field survey, about 32% of the respondents have been using one or more of the production and productivity boosting agricultural production, particularly improved seed. However, due to various reason, only about 31% of the previous users are using during this survey one of the production and productivity boosting agricultural technologies. Besides these varieties, the use of other productivity boosting agricultural technologies have been increasing though the general use of agro-input was very low relatively. However, the low supply of these agro-input except fertilizer is affects its uses.

Challenges in Crop Production

Crop production is relatively an infant livelihood option for Borana pastoralists as compared to the endogenous pastoral livelihood system. As a result, the crop production system has been tempted by various factors besides infant experiences and environmental stress.

Table 46. Challenges of Crop production (Survey Result)

Challenges of crop production	Top one		Top two		Top three	
	N	χ^2	N	χ^2	N	χ^2
Weed	**26**	52***	11	22***	14	6***
Insect	20	40***	27	54***	3	3*
Disease	3	-	16	16***	29	87***
Fertilizer	-	-	15	45***	20	60***
Market problem	21	21***	3	3	8	16***
Lack of improved seed	13	26***	25	50***	21	63***
Shortage of Labor	1		2	-	1	-
Shortage of farm land	20	40***	4	4	2	-
Bush encroachment	2	-	3	3	7	7*

Shortage of rainfall

The agriculture totally dependent on natural rainfall situation. However, the zone is characterized by erratic rainfall across time, spatial and even amount. As a result, dozens of challenges faces the production of agricultural practice unlike other area of Ethiopia. On average, the rainfall fluctuation become relatively more serious than ever over a period of time. As an evidence, Yabello obtained from EMA indicates that the average rainfall is decreasing from time to time from a period of 1989-2015 at a rate of 0.28 over a period of years and 2.366 per month on average.

Similarly, the customary evidence shows that the usual rainfall situation has been more erratic as compared to the earlier decades in Borana history. The key informants and FGD also assured that the duration of rainfall has been shorted besides the shift of rainfall beginning and ends. Now days, though the rainfall was expected to fall on mid-March, it was shifted to the ends of March and beginnings of April. However, though the rainfall was supposed to ends on mid-May, now days it ends before the expected season. Generally, the rainfall period was shorted unusually.

Improved agricultural inputs

The agricultural input includes improved seed, pesticide, insecticide, herbicides, improved farming tools. During key informant interviews, they were articulated that different improved seed varieties was supplied by PDO such as Maize (Melkass I and Melkas IV), wheat and *Teff*. Similarly, some improved seed were supplied by organization such as other donor organization, for example Melkassa-4 at Miyo district. However, most of the seeds were not to the interest of the community due to its backfire of adaptability. Moreover, the supply was not sufficient to address the demand of the doers. Even, the supplied seed was hardily to adapt to the environmental. As an example, the teff variety called "***boset***" supplied by PDO was not properly adapted to the environment. Specially, the productivity boosting inputs suh as fertilizers are supplied by the CBO such as cooperatives to the demand of the community expressed via PDO. However, the price of fertilizer along with the divisibility of package limits the use of fertilizer particularly small holders. The chi-square result indicates that there is the significance difference among the agro-input uses in general.

Table 47. Status of supply and use of improved seed

Description	N	%	χ^2
Used improved seed	33	27.5	99***
Current use of improved seed	26	21.7	78***
Maize	16	12.2	48***
Teff	1	1.1	-
Haricot bean	1	1.1	-
Maize, Teff and Haricot bean	4	4.4	-
Fertilizer	7	7.8	14.1***
Insecticide	5	5.56	180***

****, **, * Pearson χ^2 is significant at 1%, 5% and 10% significance level respectively*

Source: Own survey results,2016.

However, the users of agricultural input are reducing though the number of users expected to be reduced. Inconsistent and rain shortage are the major bottle neck of agricultural input use. Moreover, the supply of improved mechanized agricultural tool was also important input rise during this study. Though there is high potential for agricultural production, besides the long-term experience of the community on farm practices, lack of potential farm tools was again another challenge.

Weed infection:

Weed was another challenge in the agro-pastoral area to expand their farming practices. Specially, in study area, Taltalle district, weeds like peritoneum, *chogogiti*, *macara (grass)*, and some new unknown herbs were the major infestation in crop production. No one can doubt that these weeds are challenges to the crop production and productivity along with the infant practical skill of the society.

Disease and pest infestation

Disease and Pests are among the evils factors that seriously affects the crop production and productivities. During field data collection different types of pests and diseases were identified both from FGD and key-informants point of view. From the insects, the key informants were articulated Quela quela, *Army worm*, Grasshopper, Sitostroga cerale Z.mays, *Boll worm, Termite, Cut worm/ Stalk borer and Beetle are among the major top pests and insects identified.* Due to lack of pesticides and insecticides, the problem of these insects and pests magnified particularly to store for long periods. Even if it is available, it is not sufficient to the demands of the community.

Additionally, the common crop disease such as aphids and rust were the identified problems. Specially, aphid was common to most horticultural crops whereas rust is challenges to most cereal and pulses crops. To prevent these insects, shortage of pesticides, insecticides and herbicide were a serious challenge. Moreover, the damage by the wildlife is high. Among the major wildlife animals Wart pig (*Golja*), porcupine (*Dhadde*), pig (*Booyyee*) were the most common, especially around Teletelle district. However, government was banned the killing of wildlife without legal sanction. Though these animals are important for various purposes such attraction of tourism, rather they were a threaten the crop production. While government encourage its conservation, the small holders were suffering of the crop damage. It is an alarming stage for the local administration to delineate the conservation sites for these animals due to the conflict of interest with individual farmers. Unless otherwise the government enhance their management, the assassination of wild animal may occur by individual farmers otherwise they live at the expense of someone income from crop.

Table 48. Lists of major crop disease, pests and insects in Borana zone

Vernacular name	**Common name**	**Vernacular name**	**Common name**
Girrisa	Quela quela	Hamphee	*Aphids*
Waagii	*Puccinia sorghi or Haricot bean rust*	Rimmee	*Termite (Mold forming)*
Awaannissa	*Army worm*	Buqata	*Cut worm/ Stalk borer*
Korophi	Grasshopper	Qinqinni	*Beetle*
Dana'o	Sitostroga cerale Z.mays	Kottessa	*Viral disease*
Xuuxii	*Termite)*	Raammoo	*Boll worm*

Source; own survey results,2016.

Access to market

Crop produces are income sources of the agro-pastoralists especially during harvesting season. However, though the crop production is still expanding in agro-pastoral area, the beneficence of the crop production is not as to its production. Apart from the temptation of erratic rainfall, the crop selling behavior of the producers is a big challenge. Particularly, immediately after threshing they supply to the market at an existing price (Dirriba and Tamiru, 2016) regardless of the low prices, allied with high supply during harvesting. On the other hand, the traders agree on the agricultural prices and compete for the commodity not for prices.

Though about 52% of the respondents are access to market information most informally, mostly thiey are selling at the existing market price. Even if the households are access to market information, the practical use of market information is low due to the unpredictability of the information sources. On average, the households travel about 15km from the market for supplying their products immediately after harvest.

Table 49. Distances to the market

	distance from market place	distance from livestock market	Distance from town
N (Valid)	88	84	87
Mean± SE	15.73±0.93	16.18±1.01	17.02±0.92
Std. Deviation	8.69	9.27	8.57
Maximum	36.00	36.00	36.00

Agricultural policy

Agricultural policy is another challenges especially in relation to agro-input supply. Normally, the seed multiplication practices of ESE/OSE was consistent with the central and highlander production practices. In the lowland of Borana the main production season (***Ganna)*** is from mid-March to mid-May. However, the rain fed seed production practices of the ESE/OSE lies in May-October. This seasonal discrepancy between the highland and lowland production practices influences access to improved seed in crop production. In the agro-pastoral of the study area, PDO is the major agro-input supplier where the use of the fertilizer and insecticide are significantly very low.

On the other hand, the improved seed obtained from different research institute such as Melkasa Agricultural Research Center, Hawassa Research Center and Yabello Pastoral and Dryland Agriculture Research Center was not sufficient to the extent of the demand of the producers. The survey result indicated that the supply followed by shortage of rainfall significantly affects the use of agro-input in the study area. As a result, currently only about 28% of the respondents were using the improved seed as compared 30% in the past years due to these challenges.

Livestock production

Livestock population

Among the livestock types raised cattle, goat, sheep, camel, poultry, donkey horses and mule listed as their importance across different criteria. In livestock production, besides social recognition still cattle dominate the population of livestock in in Borana zone. Cattle are chosen as the most important livestock types relative to other livestock type raised because of their relative drought resistance with better economic value, sources of draft power, high social importance and its product such as milk, butter and meat. From the customary point of view, cattle were the indicative of social position and the utmost desired for cultural ceremonies. Similarly, based on the secondary data from Borana zone, cattle dominate both in figurative quantity or TLU units of livestock population in Borana zone. The household survey also confirms that the cattle population followed by goat, sheep and camel in rank. Particularly, the

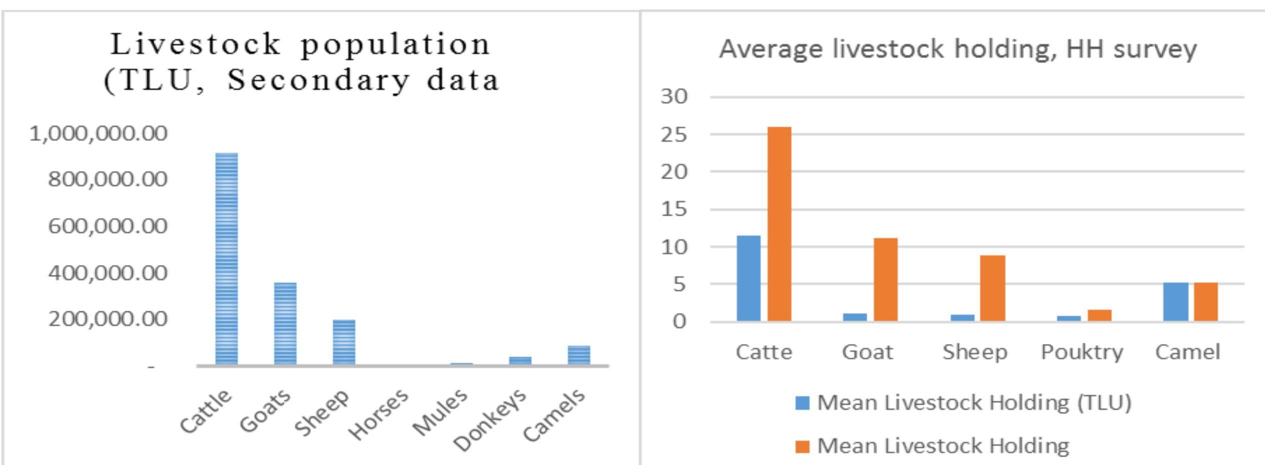

Figure 6. Livestock population in Borana Zone

Source: Socio-economics report of Borana zone report (2015) Excluding data of districts in west Guji

female livestock dominates the proportion of livestock sizes.

From cattle, female cattle dominates the male cattle explicitly. In the lowland of the study area, though cattle are the dominant livestock type, the demand for the drought resistant livestock types have been increasing from time to time. On average a households have about 11 livestock (TLU) where cattle cover larger proportion of livestock asset. Though the livestock holding was small as compared to earlier eras, still the livestock production outweighs the livelihood of the pastoralists. Though the proportion of average camel holding outshine, only less than 10% of the respondents own camel whereas more than 80% of respondent own cattle and small ruminant. Similarly, about 50% of the respondents own poultry as their production unit.

Table 50. Average livestock holding

Total livestock (TLU)	N	Min	Max	Mean±SE	Std. Deviation
Cattle	97	0.34	60	9.88±0.91	8.95
Shoat	98	0.06	6.59	1.43±0.12	1.19
Camel	11	1.25	17.5	5.91±1.52	5.03
Poultry	55	0.01	0.15	0.06±0.01	0.04
Horse	2	1.1	11	6.05±4.95	7
Donkey	39	0.7	14	1.47±0.35	2.17
Total	**108**	**0.02**	**62.28**	**11±1**	**10.7**

Though the population of cattle outweigh on average unit, figuratively, the population of the small ruminant's ownership highly outweigh the population of cattle. Particularly, goat dominates the population of small ruminant due to its drought resistant, browser characteristics, early production, milk sources, easy to slaughter for family and easy production as compared to livestock. As a result, the trends of small ruminant population in the livestock production is increasing.

Livestock preference characterization

History conveys that livestock is the foundation of cultural, social and economic basis of Borana pastoralists. Particularly, cattle play a leading role in all aspects of the society. However, the practical visibility of the changing climate of the world, particularly east Africa disturbs this production system of the pastoralists. As a result, the production preference of the pastoralists was disturbed. With this regard, the livestock characterization has been evaluated from the community and expert point of view. From the community point of view, they have been prioritized based on various reference. Accordingly, livestock preferences were prioritized with regards to the production, consumption and selling. Though the livestock preferences differ from place to place based their environmental potential, in pastoral area, though cattle outweigh the outlook of every pastoralist, the survey result indicated that the combination of cattle with goat and camel significantly outweigh the production preferences of the society**.** Though cattle are important, due to climate change the combination was significantly preferred to reduce risks. In production, cattle are preferred by 54% and 37% than goat and camel respectively. Similarly, the consumption of goat dominates the preference of pastoralists as compared to other livestock in consumption preferences. The survey result indicates that goat is preferred by 207% and 291% than cattle and camel respectively for consumption purposes.

Table 51. Livestock preference across various criteria

Livestock category	Production			Consumption			Selling		
	N	χ^2	%	N	χ^2	%	N	χ^2	%
Cattle only	15	30***	16.7	7	7*	7.8	7	-	7.8
cattle, sheep and goat	2	-	2.2	4	4	4.4	1	-	1.1
Cattle and camel	6	12**	6.7	-	-	-	1	-	1.1
Cattle, goat and Camel	12	24***	13.3	-	-	-	-	-	-
Goat	5	5*	5.6	19	38***	21.1	1	-	1.1
Camel	4	8*	4.4	-	-	-	16	32***	17.8
Sheep and Goat	5	-	5.6	3	-	3.3	2	-	2.2
Goat and camel	2	2	2.2	11	11***	12.2	3	6	3.3
Sheep and cattle	3	6	3.3	4	4***	4.4	2	-	2.2
Goat and Cattle	10		11.1	5		5.6	12	-	14.3
Total	64			64			46		

On the other hand, the demands for cash income is very important in pastoral area due to all important income resources is from market except livestock product. As a result, to generate the higher income the pastoralists prefer to sell camel due its higher price per unit as compared to other livestock. The preference of cattle for selling is higher by 38% and 633% than cattle and goat respectively. However, in agro-pastoral area with regards to production preferences, the survey result significantly justifies that cattle is significantly preferred as compared to other livestock explicitly. Moreover, with a combinations of other livestock cattle dominates the preference value of the livestock production demands. The study generally indicates that the cattle is preferred by 87% as a compared to other livestock.

Accordingly, cattle, goat and sheep remain the top priority preferred by the community. Furthermore, poultry, camel and donkey are among the next top major important livestock. With this regard, to cross-check the views of the community, experts have been tried to justify the reasonable background of pastoral preference. Similarly, goat preferred by 52% as compared to other livestock types whereas camel preferred by 44%. Other livestock types such as such sheep are less preferred as compared to cattle, goat and camel.

On the other hand, the FGD preferred cattle by 25% as compared to other livestock types followed by goat, poultry, sheep and camel in aggregate demands such as for production, consumption and marketing as an income generating activities. Generally, cattle, goat and camel are the most important for livestock the agro-pastoral area. However, the original Borana cattle, highly productive, was hardly accessible particularly in agro-pastoral area. The low productivity of cattle, however, has an implication for food insecurity which rises the cost of livestock production as compared to its return. Unless the community ignores own labor costs, the production of livestock relatively benefits less as compared to other productivity asset.

The key informant reviews that, cattle are the most preferred livestock due to higher price, socially valuable, historical production experience, sources of drafting power and source of consumption. Similarly, goat remains the second important livestock types preferred in agro-pastoral area. specifically, goat is also among the livestock with high demand due to low feed requirement, early maturity and drought resistant relatively. In recent time, the use of goat milk has been become a common milk utilization in Borana zone particularly for children. As a result, the importance of goat become increasing from time to time. Similarly, camel is among the top most important livestock types in Borana zone though its production is limited due to cost of purchases and cultural proscriptions. However, due to its phonological characteristics of drought resistance adds a genuine demand on camel production.

Generally, though cattle share the tiger preference of the society the demands for another livestock production are increasing. However, the adaptation for improved technology was very low in Borana zone where the inflated demands have been existing.

Challenges of livestock production

The normal livestock productions system of the pastoralists was disturbed by drought, livestock disease, livestock feed, water shortage, expansion of farmland, bush encroachments and settlement structure. Particularly, drought is the most killer and stagnant of livestock production in Borana zone, which occurs recurrently. Moreover, livestock disease is another killer in Borana zone especially during drought where shortage of feed and water. The most common livestock disease consists of CBPP, CCPP, trypanosomiasis, camel pox, black leg, anthrax and external and internal parasites (BZFEDO, 2010). Especially during drought, disease is the top killer that aggravates the impacts of drought on livestock death.

The challenges of livestock production perceived similar attention both in the pastoral, agro-pastoral and Mixed farming system of the study area. The difference is only focuses on the priority demand for further intervention. In a general way, the survey result indicated that shortage of livestock feed, livestock market problem and lack of improved breed significantly fits the most top three livestock production challenges followed by livestock disease, water shortage and toxic plant threat in Borana zone (Index 1). Though these challenges are common to the whole study area, each farming system has its own priority area. Specifically, in agro-pastoral farming system livestock disease receive similar ultimate attention followed by feed shortage and market problem as the second and third priority problems.

Table 52. Challenges of Livestock Production

	Top first			**Two**			**Three**		
Challenges	N	%	χ^2	N	%	χ^2	N	%	χ^2
Livestock disease	25.00	20.8	50***	21.00	17.5	42***	25.00	20.8	75***
Feed shortage	47.00	39.2	141***	28.00	23.3	84***	13.00	10.8	13***
Market problem	8.00	6.7	16***	28.00	23.3	56***	33.00	27.5	99***
improved breed	6.00	5.0	12*	6.00	5.0	6**	27.00	22.5	81***
Water Shortage	17.00	14.2	17***	23.00	19.2	23**	7.00	5.8	14*
Toxic Plant	5.00	4.2	-	2.00	1.7	-	1.00	.8	-
Labor	-		-	-			2.00	1.7	-

However, the result from the FGD indicated that shortage of water, shortage of forages, shortage of rainfall, drought and livestock disease fits the top five challenges to the livestock production.

Table 53. Major challenges in livestock production (FGD[3])

No	Challenges	Score	Rank	No	Challenges	Score
1.	Water	7	**1**	2.	Clan conflict	3
3.	Forage	6	**2**	4.	Market problem	2.25
5.	Shortage of rainfall	5.5	**3**	6.	Toxic plant	1
7.	Drought	4.5	**4**	8.	Human population growth	1
9.	Livestock disease	3.5	**5**	10.	Bush encroachment	1
11.	Rangeland shrinkage	3	**6**	12.	Predators	0.5
13.	Land degradation	3	**7**	14.	Livestock population	

Shortage of water

Water is another important resource in agro-pastoral as equal as livestock feed. However, it is another immense challenge that affects the production and productivity of livestock. The available water resources are hardly enduring during dry season. As a result, livestock travels long distant to find water particularly in dry season. Initially, the key informants have verbalized that though there were numerous sources of water viz. pond, well and motorized pump, the water management have its own defies. Especially, poor management of the catchment area seriously contributes to the poor amount of water quantity. As a result, most of the ponds were characterized by siltation and spillover which limits the amount of the water content. Consequently, during dry season most of the ponds are dried-out which imposes the migration. Finally, the deep wells become the major water sources for livestock.

However, the traditional deep well is characterized by salty water which even affects the health of livestock during insufficient livestock feed. In the contrary, during dry season the shortage of livestock feed is common particularly around water source due to mass feeding system around water point.

Table 54. Water Source

Water source	Main water source for livestock						Main water source for human					
	Dry season			Wet season			Dry season			Wet season		
	N	%	χ^2	N	%	χ^2	N	%	χ^2	N	%	χ^2
Pond	10	11.6	20**	43	50.0	86***	4	4.7	-	24	27.9	48***
Deep well	56	65.1	168***	17	19.8	34***	49	57.0	147***	27	31.4	54***
Flooding	-	-	-	1	1.2	-	-	-	-	-	-	-
River	4	4.7	-	9	10.5	-	-	-	-	-	-	-
Spring	7	8.1	-	7	8.1	7***	23	26.7	23***	20	23.3	344***

However, during wet season the priority of water sources changed due to availability of water source opportunities such as rainfall and flooding. The survey result indicated that pond is the main water sources during wet season unlike the dry season. Basically, the survey is similar to the other empirical finding undertaken in Borana zone. Generally, during dry season deep well is the major water sources whereas during wet season pond is the major water sources in the agro-pastoralists area in particular and study area un general. The reality is pond was affected by both the flooding and evapotranspiration. The managements of watershed around pond is very poor where it surrounded mostly by either farmland or degraded land. As a result, the pond would have filled with siltation which reduces the water content.

On the other hand, deep well is rarely affected by both siltation and evapotranspiration due to its deep location sometimes to the lengths of 8-16 average human height. As a result, it can stay for a long time except the challenge with the saltiness of its water. Whatever the case, it remains the major water source during dry season. However, the competition between livestock and human on the use of the same water point is another big challenge. Particularly, the key informants were shortlisted that in some particular area community and livestock uses the same water resources; ponds and deep well, at the same time from the same pot. Moreover, the key informants were identified that livestock size is another challenge in the use of available water. As the livestock size increase, the probability of dry-out of the existing water resources increased. As a result, traveling long distances for search of the water resources on regular basis or seasonally would be the last reward. However, traveling from place to place expedite disease transmission, body weight loss, livestock emaciation and distance from infrastructure and services. Moreover, expansion of farming and settlement arrangements also makes the traveling more difficult.

Livestock feed

Livestock feed is the key detrimental resources that the agro-pastoralists were highly depending on for better livestock production. The FGD has articulated that natural grazing/browsing is the dominant livestock feeding system where most of the pastoralists were practicing regardless of wealth status-quo. Earlier study also confirmed that given that commercial feed production and cultivation of feed has not been adopted in most areas of Ethiopia, natural pasture and crop residues are the major source of Borana livestock feeding (Dejene *et al*., 2014). Especially, the supplementary feeding system such as haying and commercial feeding style was not as such common especially during normal season except the conventional mineral supplementary practices.

Moreover, privatization of forage land remains a prohibited practice in the pastoral area. As a result, unless the household have her/is own farmland, private enclosure is difficult mode of forage development. Yet, communal enclosure of the rangeland has some deep-rooted practices in the Borana history. However, sociologists describe communal rangeland managements will lead to tragedy of common though this philosophy recently phases another. Moreover, accessibility and management of communal rangeland is undertaken communally based on major group decision. Commonly, it is difficult to aware the efficient private forage development within a communal range management that limits the practices of rangeland management.

Particularly, the availability of livestock feed was affected by different factors such as bush encroachment, high livestock population and expansion of farmland besides other ecological factors. Especially, bush encroachment is the major bottleneck in the area that devastate the availability of forage in Borana zone. The ecological experiment undertaken in Borana zone also proved that the grazing system of the Borana plateau has become increasingly unsuitable in recent decades due to rangeland degradation in the form of woody plant encroachment (Negasa *et al*., 2014). Similarly, about half of the Borana rangeland is covered by unwanted bushes (Eyasu E. and Feyera A., 2010), in which the bush encroachment spread rapidly that threatened the livestock asset holding. It was also one of the underlying causes for the genetic erosion of this important breed in this region with other factors including changes of ecological characteristics, recurrent droughts, poor herd management, difficulties in access to markets and civil strife (K. Zander, 2005). Additionally, it has a detrimental role in increasing grazing pressure and changes in the nature of grazing which in turn affects the environment and the size and composition of the wildlife population (Abraham F., 2002).

Moreover, most of these bushes are unsuitable for forage development and other use. Additionally, poor grazing practices and grazing land management also contributes to the rangeland failure to provide sufficient feed of the livestock. Maintenance of grazing land was poorly addressed beyond the indigenous practices of the pastoralists.

Shortage of rainfall

Agriculture is a growing infant livelihood option in Borana zone. It is highly dependent on rainfall. However, the zone is characterized by erratic rainfall across time, spatial and even amount. Besides the common erratic nature of rainfall, one in 3-5 years, the rainfall failed to provide sufficient moisture for forage and crop development besides the insufficient water in the pond and deep well. During this occasion a long dry season persist that result in massive devastation in the livelihood of the society. This occasion is called drought that result in the failure of adequate rainfall for the two-consecutive rainy season.

Drought

Drought is a common terrific phenomenon in the lowland of Borana. Particularly, increase in drought duration, intensity and coverage aligned with erratic, highly intensive and short duration rainfall has effective impact on the livestock production. During this field study, the FGD allot drought as a first priority problem in the livestock production. Moreover, the earlier study undertaken in 2011 indicated that the frequency of drought coupled with the recovery periods of livestock is highly disrupts the livestock size and compositions (Dirriba, 2016). As a result, today the households without livestock are eventually increasing that enforced to search for other livelihood system specially to crop farming.

Moreover, different studies were indicated that the cattle loss, the main asset of the pastoralists, eroded severely from time to time over a long period. On average the pastoralists have losses about 58% of their livestock within a period of 1973-2011 approximately within four decades only to the drought. The data from different study. Besides, different studies have been indicated that drought is eroding the livestock on the hand of the community. In addition to cattle, drought have been killing the livestock in Borana zone. In each drought season, cattle are the most affected livestock types whereas camel is the least victim of drought. Particularly, calves are the most victim of this drought from the cattle followed by cow. Generally, drought focused on the productive performance and deletion of livestock where calves and female are the most victim of it. Various study undertaken following the drought broke out at different victim of Borana zone indicated that drought has deleted about 58% of cattle production.

Generally, drought is a significant contributors' hardship in Borana zone. Particularly, it is a leading disaster that exacerbate the poverty in southern Ethiopia. Moreover, except traditional practices, the external interventions to improve the drought resistant of Borana livestock was worthless. As a result, the relatively productive and drought resistant cattle, particularly, even diluted with less productive and drought resistant livestock types. Due to this, the breakout of drought result with huge livestock loss in Borana zone.

Table 55: livestock asset erosion to drought

Year	Losses	Reported by
1973	88% of cattle, 69% camels	Dahl and Hjort 1979
1973-4	80% cattle, 50% sheep, 30% camels and goats	Ayalew 1980
1983-84	90% calves, 45% cows, 22% mature males	Coppock 1994
1984-86	37% cattle	Coppock 2000
1991	42% cattle	Coppock 2000
1997-2000	67% cattle	Melakou T, 2004
1999-2000	60% of cattle	Coppock 2000,
2000	18% cattle	Beruk Y., (2004
2010/11	**69% cattle**	Zewdu et al (2011)

Sources: Socio-economics Report (Unpublished, 2012)

Livestock disease

Livestock disease prevalence is another challenge raised during this field study. Though the prevalence of the livestock disease is decreasing in the recent days, it is the most common challenges during dry season coupled with feed and water shortage. Besides the irregular disease breakout, other issues related to curing these disease is some deep-rooted challenges in Borana zone.

The field result indicates that though some disease has its own medication, the supply of drugs was not sufficient. The users could not access these medications in nearby veterinary post or drug venders. Beyond accessibility, some drugs are not available in the area. Moreover, medication for some disease prevalence such as FMD is sometimes costly even to access. As a result, pastoralists were sometimes preferring to use traditional medicine rather than using industrialized drugs.

Additionally, unethical use of drugs was also identified during field survey. The pastoral mostly uses two specific drugs availed on open market namely; '*Teramish Gurraacha'* or *'Teramish Adii'* on black recommendation. In fact, the uses of these drug have its deep-rooted long history tough the sources of these drugs were normally misty. Beyond the sources, its management such storage, sunlight exposure, dosage and supply was blurry. However, pastorals were using these drugs more intensively on layman (kiosk seller) recommendation. Beyond medical recommendation, the pastoralists were treating their livestock in ***faith***. As a result, the provided drugs were restoring the diseased livestock regardless of the required medical treatment dose prescription such as amount, frequency, duration, time and types of drug.

Livestock market

The livelihood of Borana pastoralists' directly or indirectly allied with livestock production. Beyond emerged livelihood option like crops farming, non/off farm activities, livestock is the principal foundation of their income. However, efficient livestock market is a challenge in most parts of the zone which result in poor market set-up. In most parts of the zone, lack of potential traders was the core problems where livestock market was dominated by local traders and pastoralists. However, the purchasing capacity of local trader could not coincide with the livestock supply where local traders purchase with the maximum of their financial purchasing capacity. In most case, number of buyers were limited by the infrastructural network. Particularly, coupled with remoteness of the area access to suitable all weathered road limit the numbers of participant traders. This transitively affects the price of livestock due to low price competition among the livestock traders. Moreover, it results in low livestock prices due to small oligopsony manners of local traders' informal cartel. Typically, the pastoralists are suffering for price failure and on the other hand low probability to sell their livestock in the market due to few numbers of buyers.

As a result, distances to the market are other challenges in livestock market. Most of the producers brought their livestock to the market from long distances (remote) sometimes after a journey of about two days from their home stead or rangeland. Along the journey, producers are facing different challenges including lack of water, livestock disease and weight loss of livestock. Beyond this, there is a probability of disappointment where the pastoralists are forced to either stay around to wait for the next market days or sell at a very low price.

Similarly, access to adequate market information is a very important bundle for all market participant particularly producers, traders and consumers. However, the use of market information is owned to the awareness of the users, its reliability, and availability and up to datedness. Nevertheless, this type of information is limited to only the formal market information sources. However, access to such information could not embrace much influence on the pastoralists due their conversional marketing strategy otherwise it needs intensive efforts.

Whatsoever, the pastoralists have their own mechanism of generating and accessing market information in their experience. The most common generation mechanism including visiting of market and/or collection of *daa'imtu*[4] before offering their livestock. However, the practical usage of the information is limited to the household with planned marketing strategies. Otherwise, most of producers decide to sell regardless of the market information at the existing situation. In whatever case, the pastoralist exchanges market information on market price of their own kinds of livestock and the relative market prices of the other livestock. Moreover, the marketing linkage among market actors is a critical challenge for livestock market. Especially, it limits access to market information even from their counter attackers to supply to the intent of demand for better price. Moreover, zero linkage or informal cartel linkage creates a burden on the pastoralist to harvest better income from their produces.

Generally, few number of traders, distance to market, lack of market information, low livestock price, lack of buyers, lack of market place, poor market infrastructure, poor road structure, weak market linkage etc. were the major livestock market related problems. However, most of these problems needs macro-policy interventions beyond micro level. However, further research interventions to recommends the wayout is very critical to improve the income of the pastoralists.

[4] **D*aa'imtuu*** *–literally meaning* ***"New information"****. It is a pastoral naming for new information where the pastoralists ask each other as "****daa'imtuun jirtii?****" which means '****is there new information?'***

Livestock breed

The livestock production is characterized by traditional production system of past experiences though it was among the best livestock breed in arid and semi-arid of Ethiopia. Beyond the indigenous knowledge (IK) of the pastoralists, the Borana breed improvement practice is hardly noticeable. As a result, the best breed in Ethiopia; Borana breed, on the hand of the society fails to sustain in the environment due to various situation. As a result, the existing Borana cattle was diluted across different breed such as konso cattle, Guji cattle and other somali livestock types which are currently accepted as Borana Breed by most of the non-elite producers. Subsequently, nowadays it is hardly possible to acquire the pure original Borana cattle locally called ***Qortii*** especially around center of Borana zone.

The key informant revealed that there were no known breed improvement interventions in Borana zone except the meager supply of male pure Borana breed. Though demands for these original livestock is high, even the bull supply of these original breed is generally insufficient. Beyond this, the introduction of the exogenous breed and AI services was naught. As a result, the productivity of livestock today on the hand of the pastoralists is very low extremely. The study undertaken in Borana zone also indicated that the productivity of livestock was reduced in which 10-20 animals, as compared to forty years ago, when one or two lactating animals was sufficient to sustain the ivelihood of pastoral households (Hurst *et al*., 2012). Alongside, the FGD declare that the community are less valuable the externally induced awareness support due to their rich IK i.e. low adoption of induces awareness.

Apiculture production

The apicultural production system is occasionally practiced by elite households as an off-time production practices to generate additional income. However, this practice is a gambling with wildlife such as monkey that hanged on tree branches. From the survey result, the households own about 8 bee colonies that could generate about 8000ETB per annual. The production of honey and honey production is much common in agro-pastoral area though is not practiced as the main livelihood activity.

Table 56. Average honey quantity, price and income from honey sold

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Average honey produced	5	7.00	50.00	20.4000	17.18430
Average Honey price	5	160.00	1500.00	605.0000	546.05403
Total Income from Honey	5	1155.00	30000.00	12647.0000	11978.39075

Source; Survey results, 2016.

The production of honey is practiced as an off-farm production practices which can generate an additional income for pastoralists. However, due to the production is hardly undertaken by all individual, it challenges the production characterization during this study confidently. Moreover, this characterization was already addressed by the team.

The honey production is dominated by traditional practices on tree branches even in deep forest where the access to livestock and human disturbance is relatively difficult. Once the household is hanging the bee hives on big tree branches, in most case the owners visits the hives during the honey extraction a month after the ends of rainy season. Similarly, the collection of honey from the hall of big trees, big cave, and other unexpected trees. However, it is hardly common to find households that works on bee hive as a main income sources. Yet, it is among the best alternative income sources for the households with poor agricultural income sources. In responses to food security it can plays a major role with no cost particularly for traditional hiving system.

Poultry production

Poultry production is another livelihood option in drylands of Borana. However, due to low social value of poultry product in the community, the attention to poultry production received low attentions. On the other hand, the production of poultry is expanding in the area as an alternative income sources.

Particularly, it is women who are largely using poultry and its product as an additional income sources. During field survey, the respondent households have about 6 chickens on average during this field observation. Though it was not larger enough to conclude that poultry could be an alternative income sources, it is an indication that poultry and its product is an additional income to support the income of the households. From the survey result, the households can get plenty amount of income from poultry production per annum.

Table 57 .Poultry production, descriptive statistics

Description	N	Minimum	Maximum	Mean
Numbers of local breed	47	1	15	5.51±
Poultry sold (Wet Season)	6	1	2	1.67±0.21
Poultry sold (Dry Season)	8	1	100	13.63±12.34
Price of poultry (wet season)	7	50.00	80.00	73.57±4.19
Price of poultry (Dry season)	9	40.00	110.00	70±8.16
Income from poultry		71.79	3661.04	548.86

Source: Survey Results, 2016.

The secondary data, however, indicates that the population of poultry production has no consistent data. However, the primary data revealed that the respondent households have about 6 chickens per households on average.

Challenges to Poultry production

Poultry production is commonly practiced in Borana zone; though it received low attention due to social attitude on poultry consumption. As a result, the demands for improved poultry production was very low though some elite households were practicing. Besides wildlife attack, the access to improved breed is very low. Similarly, prevalence of various poultry diseases is also commonly breakout.

Opportunities to Poultry production

The demand for poultry and its product is very in Borana zone. The existing products could not fill the unmet demands this call for further poultry development and improvements. Though improved breed distribution is common, it could not fit the unmet demands.

Natural resources and environmental change

Forest

The natural forest is declining from time to time in all forest types such as high forest, broad leafed forests, wood land, bush and shrub land, grass land and plantations trees are found in the zone. the secondary dat from the zone indicated that the forest covers about 1.13% the land where woodland cover about 63.3 and shrub land 28.53% of the forest land. Though a lot have been done to improve the degradation of forest, in Borana zone it have been endangered by long dry season to sustain. As a result, the diminution of forest decreasing exacerbated from time to time whereas bush encroachment is expanding overtime. Though it need deep analysis, the natural forest is decreasing overtime in Borana zone. On the other hand, the bushland followed by degraded land.

Water and soil

Water is the major important resource for the sustainability of pastoral livelihood with livestock feed. However, different types of water sources reign as the main water sources based on seasonal categories. For the livestock, traditional deep well followed by open ponds are the main water sources in dry season. During dry season, due to high temperature most of the open water resources dried out in most case except some huge open water resources. Naturally, there is no open water sources in the zone except artificial made pond. As a result, the traditional deep well withstand the effects of high temperature due to its depth. However, the deep well is blamed for highly salty characteristics of its water content which is difficult to frequently use as water source. Nerveless, the community are using due to lack of option though it can cause different livestock disease coupled with feed shortage though it can be managed by modern medicinal threats.

However, in wet season pond is the dominant livestock water source due to open pods would filled with rain water. However, due to poorly managed watershed surrounding the ponds, it affected by siltation which reduces its water content to sustain in dry season. As a result, ponds are rarely opted in dry season as water sources except few ponds which can sustain for years' in dry season though their water contents shrinks to the center of the pond as a dry season long sustain.

In Borana history, it is the livestock and human being use water resources from the same pots both due to lack of excluded sufficient water sources and traditional respects for their livestock. Still, the use of water from common spot is common. Similar to livestock, deep well provides water for human being during dry season. Similarly, the use of pond is common during wet season. However, other water source such as cistern, roof harvesting, hand pump and water network are increasing in the study area though it is unaddressed in this study due poorly accessed in the selected study area. Particularly, around school and health pasts/centers the roof harvesting is common. Similarly, the expansion of cistern water is rarely common as compared to pond and deep well.

Moreover, the ownership of private water is not common but communal resources. However, more recently, some elite households are developing their own water resources for irrigation in their home garden production. In general, the available water resources are not sufficient as compared to the past 10 years in Borana zone though the water development have been as increasingly efforts. Specifically, increasing of livestock population, rises of livestock population, shortage of rainfall, shortened frequency of drought and distances from water point is common. Generally, the households prefer pond water than deep water in general though other water sources are better than both of theme.

Table 58. Characterizations water use

Description	Own Private water source		water is sufficient compared to past 10 years				Irrigation water	
			Human		Livestock			
	N	%	N	%	N	%	N	%
Sure	6	7.0	17	19.8	15	17.4	5	5.8
Not at all	79	91.9	65	75.6	66	76.7	75	87.2

Source: Survey Results, 2016.

Soil

Soil is another important natural resource which need some particular intensions. The most common soil type is the zone locally common includes sandy soil, clay soil and loam soil. However, the existing soil have been declining due to high soul erosion in the zone. The major soil erosion is caused by wind and flooding erosion. Generally, the soil of the zone is highly susceptible to either wind or flooding soil erosion. Particularly, due to highly intensive short duration rainfall, the risk of flooding is high particularly on soil erosion. The WSD practices has been undertaken in Borana zone though it has been tempted by drought and long dry season.

Wild life

As the whole Borana zone is characterized by potential in natural rangeland that cover ample of land. This rangeland is the home for a variety of wildlife from smallest to largest wildlife. Among the wildlife, tari, gugguftu, gadamsa, Monkey, lion and hyena are the wildlife identified during key informant interview. The secondary data also indicates that wildlife such as buffalo, elephant, grevl’s zebra, burchell’s zebera, lesser kudu, greater kudus, Grant’s gazelle, reticulated giraffe and common water buck are found in the zone. The socio-economic profile of the zone developed indicated that besides the aforementioned wildlife, numerous birds such as prince ruspoli’s tauraco, white tailed swallow and Stresemann’s bush crow are endemic to the zone (BZMMD, 2005).

However, the number of these wildlife is decreasing overtime due to lack of appropriately protected sanctuary. Mostly, destruction of natural vegetation; forest, is highly affected the population of these wildlife overtime. Additionally, beside lack of protective home, these wild lives are affected by drought due to lack of water point and feed. Though governments try to conserve these wild lives by establishing controlled hunting area, these wild lives have no protective security site. Even though the society accepts that conservation of these wildlife, the nature by itself eradicating the reproductive performance this wildlife unless otherwise the urgent measure would take into place.

The population of wild life has been decreasing from time to time by unstructured settlements either due though migration or starvation. While drought effect was given attention to livestock, wild life also equally dies, suffering and starved. However, the wildlife receives low attention that exacerbates its extinction. It has been normally, the wildlife can be among the income sources of the society as a tourism center, lack of appropriate wildlife sanctuary. Particularly, the most endemic wildlife exists only in

Borana zone can be the most important tourism attraction center. Particularly, it could be the employment opportunity for unemployed youth that can plays a dual role as employment opportunity in tourism center and wildlife conservation.

Cross-cutting issues

Climate change and its outcome

Climate change is among the bottleneck in the livelihood of the pastoralists where it affects all arena of the livelihood of the households. As a result, rise in the frequency of drought, high temperature; high soil erosion, shortage and high intensity of the rainfall become increased in the pastoral area. As a result, more stress on the livelihood of the pastoralists were increased than before whereas the resistant capacity of the pastoral households reduced. The survey result indicates that climate change results in multifaceted problems such as increase in land degradation, soil erosion, bush encroachment, disease and pest manifestation, conflict over resources and other manifold problems. Larger respondent households have been observed the change in these factors have been aggravated over time that tempts the livelihood of the society.

Table 59. Hypothetical trends of climate related changes

Trends of change due to climate change	Increasing			Decreasing		
	N	%	χ^2	N	%	χ^2
Land degradation	74	87.1	222***	10	11.8	20***
Soil erosion	74	87.1	222***	10	11.8	20***
Wild life	7	8.2	-	75	88.2	225***
Access to firewood	66	77.6	198***	16	18.8	32***
Bush encroachment	81	95.3	243***	2	2.4	-
Livestock disease	78	91.8	234***	6	7.1	12
Pests and disease infestation	78	91.8	234***	6	7.1	6**
Grass coverage	16	18.8	48***	68	80.0	204***
Farm land	70	82.4	210***	14	16.5	42***
Mobility	74	87.1	222***	10	11.8	10***
conflict over resources	75	88.2	225***	2	2.4	-

Source: Survey Results,2016.

Similarly, larger respondents have been observed that these problems are become sever over time which demands another critical intervention. The trends of severity bear a burden for the next generation.

Table 60. Hypothetical severity of climate related changes

Severity of climate change on various aspect	High			Medium			Low		
	N	%	χ^2	N	%	χ^2	N	%	χ^2
Land degradation	61	71.8	183***	9	10.6	18***	4	4.7	4*
Soil erosion	43	50.6	129***	25	29.4	75***	4	4.7	4*
Wild life	27	31.8	54***	41	48.2	123***	3	3.5	-
Access to firewood	38	44.7	114***	32	37.6	98***	2	2.4	-
Bush encroachment	61	71.8	183***	9	10.6	9***	-	-	-
Livestock disease	62	72.9	186***	8	9.4	16***	1	1.2	-
Pests and disease	56		168***	14		28***	1		-
Grass coverage	51	60.0	153***	18	21.2	54***	2	2.4	2
Farm land	23	27.1	69***	46	54.1	138***	2	2.4	-
Mobility	24	28.2	72***	38	44.7	114***	9	10.6	9***
Conflict over resources	33	38.8	99***	31	36.5	93***	5	5.9	-

Source: Survey Results, 2016.

Conclusion and Recommendation

Agro-pastoralists

Crop production is not an endogenous livelihood system in borana zone though it was deep rooted in agro-pastoral area. Unfortunately, mobilization of new improved crop technologies becomes the major motives of dryland farming experts though it was at a cost of rangeland. Expansion of farmland is an encroachment for livestock production which on the otherhand exacerbates exposure of livestock to drought.

This calls for some policy interventions to balance the farmland expansion with livestock production. Moreover, before introduction of the new varieties, it demands understanding of the characteristics of the local seed and producers' demands. Otherwise, the introduction of new technology phases manifold challenges due to introduction of new varieties demands multifaceted characteristics such as high yield, early matured, drought resistant, pests and disease resistant and high market demands. It demands multidimensional variety evaluation to improve the income and food security status of the producers. Besides the high yield of improved varieties, it also needs other package such as nutritional analysis and market linkage or development to enhance the contribution of improved technology. At the same times, it is a call for further research investigation to improve access to agro-ecology based improved seed as to supports the economy of the society and nutrients security.

On the other hand, the producers are trekking their crop immediately after harvest to the market at the exiting marketing price. However, post-harvest managements and technology need another important attention if the incomes of the society need to be improved. The ugly thing is that during harvesting season, there is high supply of crop on market with relatively constant buyers which have a clear indication for price. Similarly, market is the dominant sources seed for crop production, regardless of its genetic history. it demands improving the ***supply*** of short maturity crop varieties. however, the early matured crop variety need to be competent with both in market demands and productivity with the local crop variety. Otherwise, the new technology hardly helps the community besides its devalue the acceptances of the interventionists. Furthermore, d**ue** to rainfall is the key important in crop production, the link of EWI system need tiger efforts. Otherwise, besides the low income during drought season the producers exposed to high expenditure with no return.

Notices that Borana zone is not ought to receive early maturing crop varieties with low productivities. However, the productivity of crop production depends on the duration of rainfall where the crop production various with the fluctuation of rainfall. During the good rainy season, the production of crops is high particularly Teff, maize and haricot bean. Generally, the early maturing crop production fervor is not aligned with the pastoral demands due to its low productivity. However, the adaptations of crop varieties with a competent amount of productivity have higher demands than solo early maturing crops. Similarly, besides early maturity and productivity characteristics, the attractive marketing system needs additional demands.

On the other hand, livestock are still dominating the income of households. However, in reality the livestock population is not a challenge but number of water point, types of water, seasonal calamity and other factors that affects the availability water. Thus, improving the access to water is an important issue which however demands a water development with good watershed management. Otherwise, the capability of water contents of the water point would have affected by siltation and evapotranspiration. On the other hand, community mobilization demands another effort to build community demand driven water development. Otherwise, they perceive the water development and management as the responsibility of other stokeholds.

Moreover, the water utilization and management need further efforts. In some areas, the use of water resources for human and livestock from the same pot need a further attention with regards to water completion and health of human being. It need urgent interventions for explicit water development for both human and livestock.

The water development has strong kinship with livestock feed in Borana zone which need further attentions. Particularly, during dry season larger livestock migrate to the potential water sources where the environment surrounding water point exposed to land degradation. Moreover, beyond the use of natural grazing it is mandatory to invest in protected forage development on degraded land with zero grazing besides other techniques. Additionally, most of the land use in Borana indicates that the bushland covers the largest share of land use in Borana zone where as the shortage of the livestock feed remains the prominent challenges. Thus, creating a community based synergy to systematically reduce the allopathic effect of unimportant bush on natural forage is important. Besides this, community based application of the identified bush controlling techniques for rangeland rehabilitation is important. More importantly, the expansion of these unimportant trees need a further pastoral policy attention if the rangeland perceives an important value due to its contribution in the country's GDP.

Drought is not a new phenomenon in the pastoralists that naturally destock their livestock for nothing with significance of food insecurity and poverty. From Borana history, commonly from 1973 the drought erodes larger proportion of their livestock recurrently. Astonishingly, the society hardly prepared to overcome the risk of drought though they know its frequency besides its effect. On the other hand, the interventions in pastoral area are busy to save the lives of the pastoralists not their livelihood of the pastoralists. Thus, it need a strategic pastoral policy setting that save the livelihood of the pastoralists due to the pastoralists is the top most income source particularly foreign currency generation.

The livestock health is another important concern in pastoral area. Particularly, the medical related ethical issues ought to be addressed to improve the understanding on the use of drugs and its medication. Otherwise, the illegal uses of medicines will be common smuggling methods.

Similarly, livestock marketing need urgent interventions to improve the income of the pastoralists whereas number of intermediaries, market linkage and access to marketing information is a challenge. To improve the market role in the pastoral livelihood, it need the interlinked action from production to final livestock market in the zone. From production level it need an integrated action to improve the kinds of livestock supply which demands access to market information from reliable sources. Moreever, it need intensive training on the use of the market information that enable to use the available opportunities. Moreover, it is important to regulate the operation of brokers to the economic level though they are more important to facilitate the marketing system.

The apicultural practices are still dominated by traditional practices with less concern. As the result, the apicultural practices could not provide the significant income for the drought susceptible agro-pastoralists. Thus, current mode of modern hive expansion need a further revision due to the modern hives are highly susceptible to wildlife attack than traditional one due to challenges in positioning. Moreover, modern apicultural farm is important. Particularly, rather than household based modern apicultural practices demonstration, establishments of participatory apicultural farm for best skill demonstration is important.

Poultry production has a long history in Borana zone though it was not as old as livestock. However, its production is dominated by traditional practices where poultry is the least susceptible to drought. Though it can support the income of households during drought, it is limited to some elite households. Besides the propagandas of poultry production to support household's income, also it is important to mobilize and demonstrate the poultry meet and egg consumption to enhance the protein supply of the households incase access to milk and meat is a matter.

The afforestation in dryland need further attention beyond the traditional watershed development as a policy of Ethiopia. Unlike other area, the amount of rainfall and the water hold capacity of the soil need further care. Thus, the forest development must undertake experimental forest development to expand the best performing forestation methods to improve the endurances of the planted tree. Moreover, the afforestation should also be administrated under a management of explicit team/committee to improve the sustainable monitoring, protection and management of newly established forests. However, it needs strong attention to improve the watershed development practice around water points to address the poor management. Besides development of new water resources, improving the managements of water point such as watershed development, splitting of water point for livestock and human use is also gaps for further attention.

On the other hand, the cost of soil erosion is high in the zone though it was not yet quantified. Unless otherwise the integrated soil conservation jointly with water is undertaken, the periodic soil erosion exacerbates feed shortage, water shortage, and food insecurity. Besides the nutrition's erosion, the soil erosion causes land degradation such belly land, it exacerbates the expansion of unusable land.

The wildlife could be important income sources of the society as an ecotourism particularly for the youth as employment opportunities. Though there is a lot of wildlife, there is no appropriate safety for which increases their exploitation. However, it could be golden income source opportunity for the unemployment besides its ecotourism based foreign currency generation of the country. However, ignorantly it was endangered from its origin. Moreover, expansion wildlife sanctuary that can jointly improve the forest development and reduces soil erosion is important. Moreover, quantification of types and quantity of wildlife helps to attract attentions for further conservation.

Pastoral production system

The crop production is already started long years ago. However, further efforts of interventions to boost food security either by alternative seed or improving productivity is important. Moreover, market is the most source of seed regardless of its maturity duration, productivity, drought and disease resistant. Thus, it is important to improve access to improved crop varieties beside demonstration of improved crop varieties.

Like agro-pastoral households, pastoralists have poor saving habits of crop production after harvest particularly teff. Immediately after harvest, the producers track to the market at the existing prices where the price is much higher during production season. Thus, it is important to work on the post-harvest technology to improve the saving habit of the community which even has an indication on food security. Additionally, working on their marketing practice need another attention to improve their income.

Notice that in pastoral area, if crop production allowed to expand, the demonstration of early maturity crop need further attentions due to they are gambling with seed available in the market. Because, already they are producing on small scale farming with the duration of rainfall to overcome the food insecurity due to the declining of productivity of livestock as compared to past decades. Additionally, skill development also need urgent demands. Even the practices of farming related issues need further attention due to high soil erosion. Interestingly, it is important opportunity to build successful faming demonstration where their IK is low due to infant practices of crop production.

The recurrent drought and shortage of rainfall become a continuum risk in the production system of the zone. To overcome this challenge, establishment of functional autonomous pastoral EWI center in pastoral area with strong link with Metrological detection is important. Moreover, due to there are numerous traditional Early warning information services, it is also important to create strong linkage between traditional and modern early warning information services. Moreover, establishments of sophisticated delivery system need another further job.

Similar to agro-pastoral area, in pastoral households are producing crops regardless of soil caliber analysis. It is important to evaluate **the soil characteristics** to improve the crop production of the area. Equally, it is also important to arrange the farming practices in relation rangeland management though the community practices crop production.

Food security is the most common challenges in the pastoral area where drought erodes the livestock population as compared past eras. As a result, consumption of goat either in meat or milk become the dominant preference in pastoral society. Thus, it demands intensive work to improve the production and productivity of goat in pastoral area. Moreover, improving the productivity of goat, particularly milk and meat improvement, demands further technical characterization. Additionally, adaptation of milking goat need further attentions due to the pastoralists area communally depends on rainfall.

The **livestock feeding system** of the pastoralists are mostly dominated by natural grazing/browsing. However, today the natural practice facing is a serious challenge in pastoral area where bush encroachment imposes the larger problems. However, communal practice is a development force if used economically to build a common crew. Thus, it is more beneficial to use the communal resources management as an opportunity to improve the communal resource as pull force. Additionally, adoption of intensive hay development can serve as a supplementary feed resource for dry season besides reducing the invasive expansion of bush encroachment during high development.

Similarly, lack of conducive ***livestock market*** is a serious challenge in pastoral area. Typically, the pastoralists are suffering for price failure and on the other hand low probability to sell their livestock at fair price. Though it takes time to build accessible road network, it is important to improve the marketing practices of the pastoralists. The failure of market is also one of the most serious factors which intense the massive drought loss of livestock. Thus, livestock market needs a serious intension which can have a strong link with livelihood and food security status of the pastoralists. Moreover, market price is not a static as the expectation of the pastoralists where the currency changed within a parcel of seconds. However, conventionally pastoralists decide the price based on the adjacent livestock types sold on the precede week price on local market day which could not be the fair reference.

Veterinary drug related ethical issues are also ought to be addressed to improve the understanding on the use of drugs and its medication similar to agro-pastoral area. Otherwise, the unethical use of veterinary drugs will call for further veterinary drug smuggling. Besides the supply of adequate veterinary drug supply at a local veterinary drug store, it is an economical to improve the medical ethnicity for healthy livestock production.

Drought is a natural phenomenon that can be detected by natural occurrences. It is important to work on preparedness to the level of nothing loss to drought to tackle the challenges. This need intensive works on preparedness before any sign of drought which demands strong linkage with metrological agencies and conventional prediction system to mediate the conflict between traditional and modern prediction system. However, it demands establishments sophisticated early warning system to provide integrative early warning information.

Finally, though water shortage is a top priority demand in pastoral area, the effort to improve the access to water remains low. Particularly, the efforts to develop adequate pond and watershed management is hardly addressed. As a result, the suffering for lack of adequate and quality water for better health life persisted. Still there is huge flooding water that flow out from the environment with carrying huge amount of soil content. Thus, it is important to evaluate techniques of flooding water harvesting, management and utilization capacity. Additionally, water development need to be jointly undertaken in pastoral area where the pastoralists are migrating either to look for water or feed sources or both resource. However, during field observation both are the key challenges to the pastoral households.

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Economic Valuation of Wetlands Attributes: In Case of Jimmaand IlubaborZones Oromia Regional State, Ethiopia

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Abstract

The paper estimates the value of improvement of wetland quality using choice experiment approach of stated preference valuation techniques. The study is based on household level data collected from 120 randomly drawn respondents living around four wetlands within a radius of five kilometers in southwestern Ethiopia. Results show that the local communities are highly concerned about the economic evaluation of the wetlands and about willing to pay for the improvement of selected attributes of the wetlands. The most preferred attribute is found to be brick making. Marginal willingness to pay for brick making is about 3.10 ETB while this value is about 2.5 ETB for water purification attributes of the wetland. The compensating surplus, which reflect the overall willingness to pay of respondents for changes from the status quo to alternative improved scenarios, show that respondents are willing to pay 35.6 ETB for the improved wetland management interventions. The paper concludes by highlighting strategies that may help in halting the ongoing degradation of the wetlands in the study area.

***Key words**: Wetlands, valuation, attribute willingness to pay, Oromia.*

Introduction

Wetlands are a distinctive group of habitats intermediate between aquatic and terrestrial ecosystem, have specialized vegetation which copes with varies of fluctuating water tables, the chemical oddities of anaerobic soil and problems of stream with saline water. Over years, wetlands were defined in different forms in different parts of the world and more than fifty definitions provides by Ramsar bureau is gaining more acceptance at worldwide. It defines wetland as " area of marsh, fen, peat land, or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including area of marine water the depth of which at low tide does not exceeds six meters.

Ethiopia, with its different geological formations and climatic conditions, is endowed with considerable water resources and wetland ecosystems, including twelve river basins, eight major lakes, many swamps, floodplains and man-made reservoirs. According to EFAP (1989), 110 billion cubic meters of water runs off annually from the above sources. Major river and lake systems, together with their associated wetlands, are fundamental parts of life interwoven into the structure and welfare of societies and natural ecosystems. Wetlands are productive ecosystems that can play an important role in socio-economic development if they are effectively utilized on a sustainable basis.

The extent to which water and wetland resources can potentially contribute to Ethiopia's development has barely been considered. Ethiopian wetlands are currently being lost or altered by unregulated over-utilization, including water diversion for agricultural intensification. Water resource and wetland development need environmentally sound planning systems and to make room for long-term ecological productivity and the welfare of local communities. It is therefore crucial to develop strategies for national wetland programs so that wetland values can be accrued. Amongst many other benefits, these values include ecological and hydrological functions as well as the goods and services wetlands provide to human beings.

The indirect uses of wetlands are their hydrological and ecological functions, which support various economic activities, life support systems and human welfare. This includes ground water recharge, flood control, nutrient cycling, erosion control and sediment traps, climate regulation, habitats for migratory wildlife and pest control (Dugan, 1990). As such, wetlands produce an ecological equilibrium in the environment by maintaining the integrity of life support systems for sustainable socio-economic development. Yet, many wetland ecosystems particularly floodplains and swamps are regarded as wastelands and continue to be depleted at an alarming rate throughout the country. Moreover, national economic policies that priorities crop production, severely affects sensitive ecosystems including wetlands through extensive land development schemes that have no concern for environmental costs. The main causes of wetland degradation include the conversion of wetlands for intensive irrigation agriculture, the expansion of human settlement, pesticides and water diversion for drainage. Wetland conversion often results in water depletion, the displacement of populations, the destruction of traditional production systems, habitat degradation, salinity increases of waterborne diseases and other adverse ecological impacts (WCED, 1987).

Many development decisions are made on economic grounds on different land escape in oromia regional state but anything did not work on wetland. As you know the wetland is “the kidneys of the landscape", because of the functions they perform in the hydrological and chemical cycles, and as "biological supermarkets" because of the extensive food webs and rich biodiversity they support by providing a means for measuring and comparing the various benefits of wetlands, economic valuation can be a powerful to aid and improve wise use and management of wetland resources in Jimma and Ilubabor Zones. Still today, the wetlands have been undervalued because many of the ecological services, biological resources and amenity values they provide are not bought and sold and hence are difficult to value using market price. So, promoting new methods of economic valuation to demonstrate that wetlands are valuable and should be conserved and wisely using have unquestionable importance. So it is important to investigate wet land ecological resource attributes; socio-economic factors contributing to the decision making of users, resource use modeling choice, its relation to natural resource base degradation and users’ willingness to pay for the sustainability of attributes of the Jimma and Ilubabor Zones. Therefore, the objectives of this study was to estimate economic values of ecological, social and economic services that wetland provides in the value system, to investigate socio economic and geographic factors determining the difference in wetland derived benefit sharing among users, and to investigate the effect of socio economic and geographic factors affecting the sustainability of wetland rendered services and degradation of wetlands in the study area.

Methodology

Description of the study area

This study is conducted in Ilubabor and Jimma zones in South Westrn Oromia regional state of Ethiopia. Jimma zone is located in the south-west (about 350 km South Westrn of Addis Ababa) whereas Ilubabor zone is located in the same direction (600km of Addis Ababa). From this two those four sites were chosen as our study area because they good potential of wetlands, those are Tulube, Burusa, Alebuya and Anderacha, located at Jimma and Ilubabor zones. The Zones were characterized by a tropical highland climate with heavy rainfall, warm temperatures and a long wet period. The mean annual rainfall ranges between 1,200 mm and 2,500 mm, with mean annual temperature of 20 to 250c.

According to the population projection of the Central Statistical Agency the major ethnic groups are Oromo (81.6 per cent), Yem (5.3 percent), Amhara (4.9 percent), Dawro (2.9 percent) Kaffa (1.8 percent) and others (3.5 percent). Oromiffa and Amharic are the most widely spoken languages. The crude population density is 175 persons per km^2. About 38.3 percent of the total population is economically active.

Methods of data collection

Economic valuation focuses on how to estimate the impact of changes in goods and services support decision making. Revealed preference (RP) and stated preference (SP) are approaches used to estimate value of non-market goods and services (Freeman, 1993). The RP approach includes travel cost, hedonic pricing, expenditure, and benefit transfer methods in which the values of goods and services are inferred indirectly by observing individuals' behavior in actual or simulated market. The SP approach elicits the value of goods and services directly from respondents by asking their preferences. It relies on constructed, hypothetical markets in which respondents state their Willingness to pay (WTP) for various conservation and management interventions of natural resources (Birol *et al*., 2005). The SP approach includes Contingent Valuation Method (CVM) and Choice Experiment (CE) valuation methods.

In this study we used the CE method of the SP valuation techniques. When designed appropriately, the CE methods allows to examine respondents willingness to pay for the different attributes (or characteristic) of the resource that are useful for wetland conservation and management interventions (Alpizar *et al*., 2003). The designing of the CE includes selection of attributes, assignment of corresponding levels and construction of the choice sets are very critical (Birol *et al.,* 2005). This is usually done through literature reviews, consulting experts and focus groups discussions (FGD).

The second section of the questionnaire was the choice experiment. It presents alternatives, the choice sets used in choice experiment design. Using orthogonal design, the most common approach in economic applications the possible number of wetland improvement scenarios/alternatives that can be generated from 3 attributes, 1 with 3 levels and 2 with 2 levels, From the point of view of maximizing the amount of information, it would be desirable if all individuals could face possible attribute levels combinations according to their preferences. However, this would be too cognitive as well as time consuming, so the cognitive nature of the choice experiment needs to be reduced (Louviere *et al.*, 2000).

Then fractional factorial design was used to ensure that all different attributes can be estimated independently of each other. After reducing identical combinations, different alternatives were identified and grouped into choice sets to be presented to respondents. Commonly, choice sets comprise *status quo* (Hanley *et al.,* 2001; Birol *et al.*, 2005). The final version of the choice experiment section of the survey questionnaire had 6 choice sets, each formed by the *status quo* plus two management alternatives.

Respondents were asked to choose their preferred alternative, *i.e.* the alternative yielding the highest utility to them. In each choice sets respondents were asked to choose between three alternatives.
The first alternative was the base alternative, in which there would be no improvements to the wetland area at no cost. The two other alternatives implied improvements to the wetland area. Individuals' preferences were revealed by their choices. The survey was randomly selected head of households living around wetlands within a radius of five kilometers using trained interviewers under close supervision of researchers.

Methods of data analysis

Choice experiment (CE) is based on a principle that the utility of goods and services depend on its characteristics, or attributes, which is consistent with the Lancasterian microeconomic approach (Lancaster, 1966). Theoretical model specification of the CE is therefore based on the 'Lancasterian' model of consumer choice, the random utility theory (McFadden, 1974), which can be specified as:

$$p_{ij} = {exp(v_{ij})} \Big/ {\sum_{k=1}^{J} exp(v_{ik})} \qquad (1)$$

Where X_{ij} is a vector of attributes describing alternative *j* or price associated with alternative *j*.
The indirect utility function may be partitioned into two components, so it can be rewritten as follows, V (X_{ij}) is the observable part of the indirect utility function that individual *i* gets when individual chooses *j* and $\mathcal{E}_{ij}$ the random part of this function. According to random utility theory, individual *i* will choose alternative *j* from the choice set; let's say *t*, if the indirect utility of *j* is greater than that of any other choice *k*. Thus, individual i will choose alternative *j* over alternative *k* if and only if:

$$U\ ij > U\ ik \leftharpoonup V\ (X_{ij}) + (\mathcal{E}_{ij}) > V\ (X_{ik}\ ) + (\mathcal{E}_{ik}),\ k \neq j;\ j,\ k \qquad (2)$$

Where *Uik* is the value taken by the indirect utility individual *i* gets when he chooses alternative *k*. Then, the probability of alternative *Yi* attribute is chosen can be specified as:

$$P\ (Yi = j/\ t) = P\ (Uij) > Uik), \square\ k \neq j;\ j,\ k\ \epsilon t = P\ (V\ (\ ) + (\mathcal{E}_{ik}) > V\ (X_{ik}) + (\mathcal{E}_{ik})),\ \square\ k \neq j,\ i,k\ \epsilon t \qquad (3)$$

The probability of an alternative attribute chosen as the most preferred among a definite set of alternatives is commonly expressed in terms of the logistic distribution, which results in different econometric model specifications with different assumptions (McFadden, 1974).brick

To analyze the importance of the choice set attributes explaining respondents preferences for the three scenarios, the status quo option and two economic evaluation of wetland in terms of its attributes (Brick making, water purification and agriculture), and three expected indirect utility functions were considered. Such that each utility function present utility generated by respective scenario. Scenario 3 is the status quo. Scenarios 1 and 2 involve an improvement in environmental attributes, relative to the status quo, which is scenario 3. The utility for each of the functions is determined by the level of attributes in the choice sets.

$$V_t = ASC_1 + \beta agriculture\ A + \beta water\ W + \beta payment\ P \qquad (4)$$

Where *i* =1, 2, and 3 and where *ASC* =0 for the *status quo* and 1 for scenario 1 and scenario 2, or more specifically the three indirect utility functions can be represented as:

$$V_1 = ASC_1 + \beta agriculture\ A + \beta water\ W + \beta payment\ P \qquad (5)$$

$V_2 = ASC_2 + \beta agriculture\ A + \beta water\ W + \beta payment\ P$ (6)

$V_3 = ASC_3 + \beta agriculture\ A + \beta water\ W + \beta payment\ P$ (7)

Alternative specific constant (ASC), which captures the effects on utility of any attributes not included in choice specific attributes. The β values (*βgrass*, *βwater*, and *βpayment)* are the coefficients associated with each of the attributes AGRICULTURE (A), WATER (W) and PAYMENT (P) respectively. There are two alternative specific constants (ASC1 and ASC2) in this model for improvement scenario/option 1, and 2. The alternative specific constants for scenario 1 and 2 is constrained to be equal, because an experimental design that was close to orthogonal was used to develop the choice sets and hence we included one common alternative specific intercept for the two alternatives that imply changes (Bennett and Blamey, 2001; Carlson *et al.,* 2003). These constants can be thought of as representing all other determinants of utility for each option not captured by the attributes, and they are not related to specific attributes/characteristics so they cannot easily be used to predict the effects of changes due to changes in attributes. Alternative specific constants ASCs do however improve the overall model performance and should be included in the estimation (Adamowicz *et al.,* 1998).

Estimation of marginal willingness to pay (MWTP)

The parameters (β coefficients) estimated in the regression models can be used to estimate the rate at which respondents are willing to tradeoff one attribute for another. This estimated tradeoff is the marginal willingness to pay (MWTP) or implicity price. The MWTP is useful in understanding the tradeoff between individual attributes and the relative importance that respondents hold for them (Hanley *et al.*, 2001; Carlsson *et al.,* 2003).

Finally, using 720 choices elicited from 120 respondents (120 respondents * 6 choice sets), a logistic regression with linear specification was estimated using Stata statistical software. Following (Cameron and Trivedi, 2005) the logistic regression model can be specified mathematically as:

$$P_t = Pr\left[Yt = 1 \,\middle|\, Xt\right] = \frac{e^{(\beta o + \beta iXi}}{1 + e^{(\beta o + \beta iXi}} \qquad (8)$$

If P_t is the probability of preferring option *t*,

Prior to fitting the regression model, descriptive statistics such as frequency and percentage were used to describe socio-economic and demographic characteristics of sample respondents and their perceptions on economic evaluation of wetland and problems of the wetlands in the study areas.

Results and discussion

Respondents' perception about environmental problems of the wetland

Descriptive analysis results show that more than 79% of the sample respondents have lived in their present area of residence for long time. The sample respondents were also asked as to how often they go to the wetlands. Most of them, about 57.5%, mentioned that their family members seldom go to the wetlands mainly for harvesting grass while about 17.5% replied that their family members go to the wetlands frequently and the remaining 15% of the respondents reported that they had no experience of visiting the wetlands. Respondents we also asked to identify the type of family members engaged in some of the activities taking place in and around the wetlands.

Table 61.Descriptive statistics of sampled farm households in the study areas

Household characteristics	Description	Mean	Std. dev.
Male	1 if the household head is male and zero other wise	0.50	
Household size	Number of household members who share the same food stock	5.18	2.04
Experience	Farming experience of the household head in years	25.38	11.64
Off farm work	1 if at least one member works off-farm and zero other wise	0.32	
No of dependent	Number of dependents with no labor or money contribution in the household	1.15	1.45
Agricultural output surplus	1 if the household is a net-seller of agricultural outputs and zero other wise	0.27	
Farm and livestock characteristics			
Land shortage is major problem	1 if the household head considers land shortage to be the primary problem and zero other wise	0.64	
Total land size (in hectares)	Total land size operated by the household	0.75	0.52
Land size per capita	Total land size per household member	0.15	0.088
Livestock value (in ETB)	Total value of livestock (including poultry and bee hives) currently owned by the household	5006.5	4745.5
Access to infrastructure and extension services			
Average distance to household services (in minutes)	Average walking distance to basic infrastructure and services	48.24	27.07
Participate in extension programs	1 if the household has been participating in the agricultural extension programand zero other wise	0.7	
Experience in extension programs	Years of participation in agricultural extension program	4.12	5.226

[b]Services include electricity, piped water, telephone, primary school, secondary school, all weather roads, and wetland utilization. Respondents were asked to specify the walking distance (in minutes) to each type of service, and an average walking distance to services was then calculated for each respondent.

The result presented in Table 2 shows that about 42.5%, respondents were reported that they don't know which family member was engaged in activities affecting the wetlands. However, when we compared men and women household members, mostly of the family members associated with activities undertaken in and around the wetlands were found to be women, about 28% of respondents reported that women were engaged in activities different activities in and around the wetlands (Table 2). The result indicates that each member of the households were subject to activities in and around the wetlands in one-way or another ways.

Table 62. Association of family members to activities in and around wetlands

Family members	Numbers of households	%
Men	14	11.7
Women	34	28.3
Children	11	9.2
Whole family	10	8.3
Other member/don't know	51	42.5
Total	120	100

Source: Computed from own field survey data

Human activities in the catchments have imposed undesirable impacts on wetlands. There are various kinds of human activities such as settlement, grass and reed collection, grazing, brick production, agriculture taking place in and around the wetlands. For instance, there are five legally organized vegetable producers' associations that depend on the wetland area. They induced deforestation and siltation, which increasing threatened the ecosystem service provision of the wetlands.

Sample respondents were asked to how they evaluated the change they observed about the wetlands in their lifetime and about 52.5% of the respondents believe that the wetlands is shrinking while 23.3% of the respondents think that the wetlands tend to expand during wet season and shrinking in dry season. On the other hand, about 17.5% of the households perceived that the wetlands were expanding in size. The remaining 6.7% of the households surveyed stated that they have no observed considerable changes on the wetlands size in their lifetime.

Those respondents believe the wetlands are shrinking were asked to elaborate underlying causes of the change as open ended question. They identified expansion of agricultural land, scarcity of farm land households to the wetland for farming, and the growing brick making activities in the area. Similarly, those who believe the wetland areas increased were asked to state the possible causes they think cause expansion of the wetland.

The survey asks respondents to give their opinion as to whether they believe that wetlands will disappear or not, and about 78.3% of households mentioned their concerned that the wetlands will dry up in the near future unless expansion of farming and settlement is halted. The remaining 21.7% of the respondents mentioned that they are not worried that the wetland will dry up. Respondents were asked who they think should be most responsible for managing the wetlands. About 50.5% of the respondents believe that government as the most responsible for managing the wetlands, while about 25% and 24.5% of the respondents believed that local community and both local community and the government are responsible for managing the wetlands, respectively.

Logistic regression model results

The logistic regression model was fitted to show the importance of the choice set attributes in explaining respondents preferences between the status quo and improved scenarios. It is worth mentioning that there were three expected indirect utility functions, however, all the respondents choose improvement scenarios. None of the respondents choose the current situation (status quo scenario) indicating that they want a policy change. Therefore the utility functions for grazing and water purification attributes were analyzed using logistic regression model. Prior to fitting the model, existence of multicollinearity problem was checked among the explanatory variables. The results of variance inflation factor shows that the data has no seriously problem of multicollinearity. As ported in Table 3, the McFadden's σ^2=0.23 shows the overall goodness of fit of the specified models. According to Hensher and Johnson (1981), the McFadden's σ^2values between 0.2 and 0.4 indicate that the specified model fits the data well.

Results of the logistic regression model presented in Table 3 show that the coefficients of the attributes are positive and statistically significant at 1% significance level except for payment. The positive sign imply that change from the *status quo* scenario to the corresponding level of attribute increases the probability of choosing improvement option over the status quo. That means respondent's value wetlands improved scenarios, more grazing and wider barrier strip with fields, as being an improvement of the wetlands environmental quality. The payment attribute is found to be insignificant which indicated that it hardly has effect on utility of choosing a choice set, may be because both rich and poor households have a similar preference on improvements of wetland attributes regardless of the payment level. This could also strengthen the fact that none of the respondents choose the current situation (status quo scenario).

Table 63. Results of logistic regression model

Variable	Coefficient	Standard error
ASC	0.00	0.00
Grazing	1.26***	0.21
Water	0.05**	0.01
Payment	-0.25	0.41
Summary statistics		
Log likelihood	-376.19	
Pseudo	0.23	
Number of observation	520	

Source: Computed from own field survey data

As shown in table 4 the willingness to pay is higher for brick making attribute compared to the 'water purification attribute'. i.e., respondents gave more value for brick making than water purification attribute.

Table 64. Estimates of marginal willingness to pay (ETB)

Variables	**Marginal WTP**
WTP brick making	3.10
WTP water purification	2.5

Source: own survey data

Welfare implication of conservation interventions

Respondents' willingness to pay for a change from the current situation can be seen from the estimates that, the Compensating Surplus(CS) for the change from the *status quo* to the scenarios considered increases as we move towards improved conservational conditions of the wetlands (Table 5). The value of the utility of the alternative option is estimated in a similar way, except that the coefficient for the alternative specific constant is included and the attribute levels associated with the changed scenario are used. The compensating surplus for changes from the *status quo* to the new scenario is then estimated by calculating the difference between these two values, and multiplying this by the negative inverse of the coefficient for the payment attribute.

As shown in table 5 CS for medium impact improvement scenario 2 is 14.3 ETB, and under the medium impact improvement scenario 1 as high as 35.6 ETB, where as greater improvements in conditions of the wetlands under the high impact improvement scenario increases WTP to 15.78 ETB. The findings are, in general, in line with prior empirical studies (Birol *et al*. 2005) that local households show positive willingness to pay for improved environmental scenarios as compared to the status quo. However, the magnitude and types of contribution various considerably due to characteristics of the resources and respondents.

Table 65. Estimation of compensating surplus (CS)

Alternative wetlands improvement scenarios	Mean WTP (ETB)
High impact improvement scenario	15.78
Medium impact improvement scenario 1	35.6
Medium impact improvement scenario 2	14.3
Low impact improvement scenario	-

Source: Computed from field survey, high, medium and low (depend on figure of compensation interest)

Table 66.Characteristics of four study wetlands

Name wetland	Altitude	Size (ha)	Hydrological classification	Water source	Drainage	Hydrological condition
Tulube **(**regenerating**)**	1680	10	Small Headwater	Springs / runoff	artificial drainage	high water table throughout year
Alebuya **(**fullydrained**)**	1784	7	Small Headwater	Springs / runoff	artificial drainage	high water table throughout year
Burusa (partially drained**)**	1760	11	Small Headwater	Springs / runoff	artificial drainage	high water table throughout year
Anderacha (partially drained**)**	1870	8	Small Headwater	Springs / runoff	artificial drainage	high water table throughout year

Source: secondary data

Results of the choice experiment model

The choice experiment data was used to analyze the Economic valuation of wetlands attributes and socio-economic factors on respondents' wetlands attributes. The wetland' attributes were varied (technically designed) to investigate the tradeoffs' effect on choice response of the households. CL model was estimated from the attribute based choice data (a model of wetland attribute data) to investigate the effect of wetland attributes on households' choice decision. RPL model was estimated from the attribute based choice data specifying all attributes except cost component to be random variables to investigate the presence of attribute preference heterogeneity among wetland user's households'. The CL model with socio-economic variables (interacting socio-economic factors with wetland attributes) was estimated to investigate the source of preference heterogeneity among the households. Welfare analysis was conducted for all the models and the improvement of estimation was dealt with. The models were estimated using STATA. The results of the models were presented sequentially in the sub-section below.

Conditional logit model result

The results of the CL model indicated that, the result of a model fitted under the assumption of homogeneous 'household preference and IIA. Among economic valuation of wetland attributes in the choice experiment, the parameters of cattle grazing and brick making from households' are highly significant.

For evaluation, also estimate a standard conditional logit model. By include one common alternative-specific intercept for the two alternatives that imply changes in the design of the wetland area, i.e. the non-base alternatives, since these were presented in a general form. We let the cost variable be fixed, and not randomly distributed, for two reasons: (i) the distribution of the marginal willingness-to-pay for an attribute is then simply the distribution of that attribute's coefficient, and (ii) we wish to restrict the price variable to be non-positive for all individuals. The non-price attributes are all randomly distributed with a normal distribution, with the exception ''Surrounding vegetation''. This variable was insignificant in the conditional logit model, and in the random model both the mean and standard deviation were insignificant. Therefore treat the variable ''Surrounding vegetation'' as fixed in the random model. In addition, a number of individual characteristics are included as fixed coefficients. These characteristics interact with the alternative-specific intercept. The results of the estimations for both the conditional and the random parameter logit model are presented in (Table 7).

Since the CL model was estimated under the assumption of IIA, the model needs to be estimated including socio-economic factors as interaction terms or by employing other models that relax the IIA assumptions, such as random parameter logit model to ride of the strict fulfillment of IIA assumption. Both models were employed with different purposes.

Random parameter logit model result

Conditional logit model estimation was employed under its basic assumption of homogeneous preferences across wetland user's households. Yet, economic evaluation of wetland attribute across households can be heterogeneous and estimation of unbiased estimates of individual preferences needs accounting for this heterogeneity to enhance the accuracy and reliability of estimates (Greene, 2000). Random parameter logit model is useful model to test the presence of attribute preference heterogeneity to account in the model of welfare analysis.

Results of conditional and random parameter logit models

The estimated results of the conditional logit and random parameter logit (RPL) models were presented in (Table 7). The results of the RPL model indicated the result of a model fitted relaxing the IIA assumption. Among economic evaluation of wetland attributes in the choice experiment, the parameters of brick making and water purification from households 'was highly at significance 5% level.

The significance of the estimated standard deviations is a sign of heterogeneity in preferences among the respondents. There is also a correlation in the heterogeneity of preferences between attributes. This together with the substantial increase in the likelihood ratio index indicates the advantage of applying the random parameter model instead of the conditional logit model. All attributes except for ''Surrounding vegetation'' are significant in the conditional logit model. This attribute is also insignificant in the random parameter logit model. All other attributes and their standard deviations are significant in the random parameter model, except for the mean coefficient for brick making. This implies that there is heterogeneity in preferences for these attributes. Furthermore, the relative magnitude of the standard deviations implies that there is a probability that people have the reverse preference for a particular attribute. This can also be seen from column (5) in Table, which reports the probability that the coefficient will have the reverse sign, compared to the mean estimate. The mean coefficient was negative for both ''fenced water line and brick making, so it is more likely that the respondents dislike these attributes and all other attributes are significant and have a positive coefficient estimates.

Even though, the estimated standard deviations are high, and even for these attributes there is a non negligible probability that respondents dislike the attributes. Among the socio-economic characteristics, only age is significant. The negative sign indicates that elder respondents are less likely to choose an improved and more costly wetland.

Table 67. Estimation of conditional and random parameter logit model

Attributes	Conditional Logit Coefficient (p-value)	SE Coefficient (p-value)	Random parameter logit Coeff std. (p-value)	SE Prob. reversed ign
High Biodiversity,β_1	0.872 (0.00)	2.303 (0.00)	2.540 (0.00)	0.19
Fenced waterline, β_2	-0.155(0.01)	0.513(0.01)	2.322(0.00)	0.26
Walking facilities, β_3	0.752(0.00)	1.008(0.00)	2.059(0.00)	0.37
Medium Biodiversity, β_4	0.305(0.00)	0.892(0.00)	2.367(0.00)	0.52
Clay (brick making), β_5	-0.132(0.02)	-0.166(0.22)	1.881(0.00)	0.64
Thatch roofing , β_6	0.403(0.00)	0.978(0.00)	2.647(0.00)	0.46
Intercept	1.021(0.00)	1.778(0.00)		
Surrounding vegetation	-0.053(0.05)	-0.033(0.77)		
Cost	-0.0011(0.00)	-0.0032(0.00)		
Male	-0.232(0.01)	0.127(0.67)		
Female	0.251(0.06)	-0.053(0.87)		
Age	-0.017(0.00)	-0.022(0.02)		
Log-likelihood	-1565	-1361		
Likelihood index ratio	0.11	0.21		

Source: Computed from own field survey data, SE= standard error

Conclusions and recommendation

The how local household's value the various wetland attributes associated with the wetlands and depicted how development interventions that improve conservation and management of the wetland can contribute to the welfare of the local communities. The study was conducted based on household level data collected from 120 randomly drawn respondents living around four wetlands within a radius of five kilometers in southwestern Oromia region state of Ethiopia. The study employed choice experiment approach of the stated preference methods to estimate local households' willingness to pay for selected attributes of the wetland.

Human activities such as settlement, grass and reed collection, grazing, brick production, agriculture taking place in the catchments have imposed undesirable impacts on wetland. The descriptive analysis shows that more than half of the surveyed respondents believe the wetlands are shrinking. Particularly, about three-fourth of the total respondents mentioned their concerns that the wetlands will dry up in the near future unless expansion of farming and settlement is stopped. the result of the study also showed that about two third of the sample respondents believe that government is responsible for managing the wetlands.

The result of the study indicated that the respondents' have a positive willingness to pay for alternative improvement scenarios of wetlands. This can be evidenced from the estimates that, the compensating surplus changes from the *status quo* to scenarios increase with improved environmental conditions of the wetlands, particularly, cattle grazing and improving water quality. Compensating surplus estimates which reflect overall willingness to pay for each change, from the *status quo* to three alternative improvement scenarios. The mean WTP for the high impact improvement scenario was estimated to be 15.78 ETB, for medium impact improvement scenario-1 is about 35.6 ETB and for medium impact improvement scenario-2 is 11.3 ETB. It is also found that the welfare of the local households can be maximized under medium impact improvement scenario-1 wetland management interventions and that sustainable efficient utilization of the resource can be achieved.

In sum, the results of the study show that most of the local households are aware of the adverse impact of human activities on all wetlands. It also appears that they are willing to contribute to development interventions that improve some of the attributes of the wetlands such as surrounding vegetation. It implies that management strategies that fully involves local households at all levels of the implementation, starting from preferred attributes selection, may help development planners and practitioners to address the problems.

The identified a number of attributes that either increase or decrease the utility derived from a wetland area. The results are contextual, i.e. the result of a certain study conducted in a specific community recommended as follows:

Environmentalists, NGOs and other interest groups (farmers, tourism industries) often voice their views strongly and try to influence decision makers. They are supposed to represent the diversity of public views and opinions but they do not always do so in a coherent way! As the basic constituency of decision makers, they are more or less influential.

In order to alert the public to the values and functions of wetlands and the need for their wise use, a series of public awareness movements are needed. These should include the production and distribution of awareness materials (posters, leaflets and fact sheets), involve the mass media to carry features on wetlands and conduct a series of awareness raising seminars and workshops. Develop a national policy and legal framework for the conservation, management and wise use of wetlands, ratify conventions and agreements on waterfowl and wetlands of international importance, promote the wise use of wetlands, and create wetland reserves and lease with other parties on issues of wetland conservation.

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Economic Evaluation of Selected Wheat Threshing Mechanisms in Arsi Zone Oromia Regional State, Ethiopia

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Abstract

Wheat is one of the most popular crops in Arsi zone produced covering major farmlands specially on mid-highlands and parts of highland areas. Its production system is more advanced and supported by both biological and mechanical technologies relative to other crops in this area. But the mechanization of wheat is threatened by topographical inaccessibility in most highland areas of the zone. To solve this problem Asella Agricultural Engineering research center developed and tested its third version multi-crop thresher. This research activity was initiated with objective of evaluating financial, economic and social feasibility of the machine vis-à-vis traditional and combines harvesting methods. Accordingly two four PAs were selected from two districts and socioeconomic and on-field performance data were *collected for the three threshing mechanisms namely, traditional animal trampling, the result of partial budgeting shows that the financial profitability after varying cost were 11591.55, 19247.91 and 19957.37 ETB/ha for manual, multi-crop thresher and combine harvesting mechanisms respectively while the machine pay-back-period and IRR for Asella model-III multi-crop thresher were two and half years and 44% respectively. As a result, the newly developed Asella model-III multi-crop thresher was found to be financially economical compared to traditional animal trampling method. Moreover, the machine was preferred over both mechanisms in terms of its chopping advantage as the straw is the main feed source in the study areas and most farmers were willing to buy the machine individually or in group and the rest were willing to use the machine if rental service is available. Therefore, facilitating supply of the technology through promoting credit and transferring the manufacturing activity should be the next step from development interventions side.*

Key words: *Economic evaluation, Multi-crop thresher, partial budgeting, pay-back period, internal rate of return (IRR)*

Introduction

The history of agricultural mechanization in Arsi goes back to 1960th when Chilalo Agricultural Development Unit (CADU)'s farm implement promotion and improvement section started the evaluation and comparison of especially, local (conventional) harvesting and threshing farm implements against improved machineries and found substantial output loss in case of conventional harvesting and threshing techniques (CADU, 1969, 1970, 1971). After that evaluation, CADU continued the promotion of pre harvest, harvest and postharvest farm machineries until the program was forced to discontinue by policy makers in 1972, even though the economic feasibility and technical viability of the new methods were confirmed (Johnson, 1972). The main consequences of promoting the new methods during 1972 were reported to be the eviction of tenants, increased unemployment and soil erosion (Kifle, 1972; Holmberg, 1972; Michael S., 1973).

Since 1974, the use of Agricultural mechanization machineries by individual small scale farmers was totally forbidden and only producer cooperatives were allowed to use those machineries until the producer cooperatives were dismantled by 1991 (Hassena M. *etal*, 2000). After the political and economic structural reform of 1991, small scale farmers started benefiting from the use of farm machineries by hiring from private investors and some multipurpose cooperatives. Wheat is one of the most cereal crops grown in Arsi zone both in terms of area coverage and production especially in mid-highlands and parts of highland areas. Its production system is more advanced and supported by both biological and mechanical technologies relative to other crops in this area. Unless the farmer is resource poor to use, tractor, tractor mounted planters and combine harvester are all available through renting from cooperatives and private machinery holders. But this mechanical technology intervention is constrained by inaccessibility due to topography of most parts of the zone.

There have been different arguments between mechanization favoring and disfavoring groups in Ethiopian and all over the world's agriculture regarding the impact of agricultural mechanization on production and productivity. The mechanization favoring groups argue that net productivity gained due to farm mechanization while the agricultural mechanization disfavoring group who considered agricultural mechanization as the substitute for animal and human labour displacing technology, argue that there is no significant net efficiency gains in terms of higher output and no reduction in production cost. Even if there higher production output, it will be offset by higher production cost specially when resources are valued in terms of social efficiency price rather than private efficiency prices (Michael S., 1973; Binswanger, 1978).

Most farmers having good topography of farm lands are hiring combine harvesters while some of the others are buying and/or hiring the stationary motorized (engine driven) threshers. Different organizations including Asella Agricultural engineering research center, are manufacturing different models of this stationary engine driven threshers type and farmers are using these technologies. However, the economic feasibility and social viability of those alternative methods of threshing and harvesting must be assessed and compared with conventional methods before embarking on mass production and recommendation of the techniques. Therefore, this study is initiated to assess the economic and social feasibility of stationary engine driven threshing method vis-à-vis the combine harvesting and conventional methods/a comparative assessment of a manual sickling and motorized stationary machine threshing Vis-à-vis a combine harvesting and traditional threshing in Arsi specific objectives describing the current threshing technologies and assess and comparing the socioeconomic profitability of alternative harvesting and threshing technologies in Arsi zone.

Methodology

Description of the study area

This research was conducted in Arsi zone two districts namely Lemu-Bilbilo and Hetosa selected based on preliminary information for the exposure/experience to stationary engine driven threshing machine and combine harvester for hiring in the area. Wheat is the main crop in terms of land allocation and production in both districts. There are also efforts which have been done to mechanize wheat farms in these areas and the effort of Asella agricultural engineering research center can be mentioned as one which develop, modify and adapt different pre-harvest and harvest technologies. Recently, tractor and combine harvesting are expanding in most parts of highland areas. There are some threshing technologies being transferred to farmers in this area while their comparative advantages over combine harvesting and traditional harvesting were not studied.

Sample and sampling procedure

Arsi zone was selected purposively because of wheat production potential as the region as well in the country, agricultural mechanization history and accessibility. The two districts; Lemu-bilbilo and Hetosa were also selected purposively based on accessibility and representativeness for both combine harvesting and stationary engine driven multi-crop thresher. Lemu-bilbilo was selected mainly to represent topographically inaccessible areas for combine harvesting and used for on-field comparative evaluation of Asella model-III stationary engine driven multi-crop thresher while Hetosa was used as comparison for combine threshing mechanism. From each district two peasant associations (PAs) were selected randomly. Accordingly Meraro and Lemu-dima from Lemu-bilbilo and Oda-jila and Deye'a-debeso PAs from Hetosa were selected.

Data type and methods of data collection

Both primary and secondary data types were used in this research. Primary data were collected from the farmers using checklists and structured questionnaire. To compute the comparative economics of the three wheat threshing mechanisms, OARI-Asela model-III multi crop thresher was used, and primary data were collected on farm fields. The data collected include demographic and socioeconomic characteristics of the respondents, information on wheat production and threshing (wheat farming characterization). Additionally, Focus Group Discussions (FGDs) were undertaken with key informants like model farmers, DAs, investors of agricultural machineries rent service providers, and other stakeholders at different levels. To collect harvesting and threshing cost of each mechanism (i.e. to make comparison among the three threshing mechanisms), actual and estimation by respondents at each PAwas collected during the season using Asela model-III multi crop thresher, combine harvester and local ortraditional animal trampling mechanism on plate of field locally called *Hogdi/Awudima*.

Data analysis methods

Data analysis method is determined by objective of the research, and type of data collected. In this research activity, there are qualitative data which are views and comments from different experts, farmers and development agents and these data were analyzed qualitatively. To summarize the demographic and socioeconomic characteristics of the respondents, descriptive and inferential statistics were employed. To conduct the comparative analysis of wheat threshing techniques, partial budgeting was employed. To estimate the economic feasibility of threshing techniques, internal rate of return and machine pay-back period of engine driven threshing method were calculated.

Results and discussion

Socioeconomic characteristics and resource ownership of the respondents

The result in Table 1 shows that the mean age of respondents was about 45 years while the mean education year was 4.97 years. The highest education level of the sample households was 12 grades complete. The mean family size of the respondents' household was about six persons while on average each household has around two economically dependent family members as shown in Table 1. In Hetosa household's head age was higher than in L/Bilbilo and they are more educated. Dependency was also higher in Lemubilbilo district and the values are all significant. Land is the most important resource in farming business and the average landholding of the respondents was 2.59 hectares with maximum holding of 10.88 hectares and minimum holding of 0.13 hectare per household.

Table1. Socioeconomic characteristics of of the households_

Characteristics	Lemu-bilbilo	Hetosa	Total
Household head Age	40.58[1]	51.17	45.28
Household head education	4.23[2]	6.54	4.97
Dependent household member	2.00[3]	1.37	1.75
Family size of household	5.92	5.69	5.83
Landholding	2.57	2.61	2.59
Annual income (ETB)	45066	37157	39689.88
Livestock in TLU	7.57	6.58	7.05

[1,2 and 3] t-value for mean difference are significant at 1, 5 and 10% level.

Description of current wheat harvesting and threshing mechanisms

There are two majorly used threshing mechanisms in the study areas while the third one is on introduction stage. Manual harvesting and threshing methods are the most dominating one in highlands of Lemu-Bilbilo district while in Hetosa, combine harvesting is commonly and widely used method of harvesting. Combine harvesting was re-introduced after downfall of *Dergue* regime by investors and unions. The third engine driven stationary thresher is under introduction by ATA and Asella agricultural engineering research center. Selam type thresher was multiplied by ministry of agriculture and distributed to selected districts of Oromia region and Lemu-bilbilo district was the one included in the program. Asella model-III thresher was under modification and pre-extension demonstration since long time and currently, some farmers in Sire, Tiyo and Lemu-bilbilo districts have bought and using the technology by renting as well.

Manual sickling and animal threshing/trampling

Traditional threshing method of wheat comprises activities of harvesting, heaping, transporting wheat bundles, trampling wheat on the field. This shows how much the traditional harvesting system is labor intensive and full of drudgeries. More than 75% of farmers in Lemu-Bilbilo district and only around 3% in Hetosa threshes their wheat crop manually (in traditional ways) while the remaining is being threshed by combine harvester.

In areas where traditional (manual) harvesting is common, wheat crop is harvested by sickle and stacked in the field for some period until the farmer finishes harvesting of his others fields. Then using either back of pack animals or *hoballo* (sledge) drawn usually by pair of oxen or in some areas some animal drawn cart, the bundle of crop will be transported to threshing field called *awudima* usually prepared around the homestead where it is convenient for looking after. Bundle of wheat is transportation is done to the nearby plate field not only for convenience but because the straw is highly needed for feeding livestock and also be sold for house. Transportation means could also be human labor depending on the availability of transporting animal or distance of the farm field from the threshing plate. Then crop bundle will be stacked or heaped again for sometimes or may directly be threshed and this will depend on need for the grain either for home consumption or market purpose, availability of animals for trampling and weather conditions suitability for threshing activity. Then the field will be cleaned of grasses and other materials and the crop will be threshed and the straw is winnowed, cleaned, measured and transported to the grain storage or warehouse sometimes.

Each activity is accomplished by human being manually using family labor or other waged labor. According to data collected using focus group discussion and checklist, harvesting (sickling) is usually done based on contract basis and the cost is between 1800 ETB and 2000ETB based on crop density while it took 16 to 20 man-days to harvest a hectare of wheat. For this research purpose average of the maximum and minimum values which was 18mandays was considered to compute the comparative advantages of different threshing mechanisms. The labor needed for heaping was calculated and on average 0.95 man days per hectare was required while 0.9 man-days were needed at trampling plate. Around Meraro PAs, bundle transportation is done usually on back of pack animals (horse and donkey) while sledges (drawn by pair of oxen) and horse drawn carts were used around Lemu-dima PA. Even though it is not common around Lemu-dima PA animal renting for wheat crop transportation and trampling was common around PAs of Meraro (one of the sites this research was conducted) and it was adapted for Lemu-dima’s area and used as proxy and the average rental price of 60 ETB/animal day was used for computation. Most farmers in the study areas keep large number of horses and oxen for trampling purposes for short period of time and some other farmers rent animals for trampling purposes.

For computation of this research work, the widely used back of pack animals; donkey and horse was used. On average to transport a hectare of crop bundle 15 donkey days and 20 man-days were used. Optionally one can also use contracting out of heaped bundle and hectare of crop was usually heaped at four places and each heap costs about 1200 ETB to transport to threshing plot. Average cost of hiring a donkey-day was 75 ETB/day.

Combine harvesting method

In some plain areas of Arsi and Bale, combine harvesting is commonly used and substantially reduces labor for wheat production and agricultural drudgery as a whole. Most farmers in these areas preferred the production of wheat over other crops because of its ease of production especially in weeding and harvesting processes. The result from Table 2 revealed that 39% and 38% of the sampled farmers using combine harvesting and tractor plowing respectively. In Hetosa more than 97% of the respondents use combine harvester while it is only around 26% in Lemu-Bilbilo which is mainly due to the inconvenience of topography in the area.

In previous time there were different sources of combine harvesters rent services like Agricultural Mechanization Service Stations, private owners, state farms, farmers and agricultural development experts training centers like Ardayta,. But currently the market is dominated by private owners and in some areas like Hetosa; unions are providing combine rent services. Galema Union also started combine harvesting service provision with two combine harvesters. Service providers are moving from place to place and their working areas are not bounded. They usually move following the crop maturity calendar from east Shewa to Bale zones. Threshing/harvesting starts in Asasa from mid-October and continues while in Hetosa it starts from November. In some highlands of Lemu-bilbilo and others it will continue up to January.

Yield estimation is done based on weight basis by operators and a quintal is equivalent to 100 kg while farmers measure their grain yield after re-cleaning using a polyethylene bag which contains 115 to 120 kg which they considered as one quintal. Sometimes this difference which is created because of misunderstand became source of dispute and loss of trust between operators and farmers. Therefore, for this computation purpose, the yield measured by farmers after re-cleaning was adjusted by the average of the difference between the two measurements. Hence, the adjusted yield was used to calculate the gross return and cost of harvesting. The adjustment value was taken to be 17.5 kg (i.e. a quintal of yield measured by farmers after re-cleaning was considered to be 117.5 kg).

Re-cleaning of the combine harvested grain requires 0.08 man-days per quintal which is around 4.59 ETB/qt based on current wage in the study area where comparative assessment of engine-driven stationary thresher vis-à-vis manual threshing was conducted (60 ETB/day). Daily laborer’s wage was around double in Hetosa during the same period and one can simply observe that how computing with the two labor intensive mechanisms in the area is too tough in this area. After re-cleaning, the grain will be packed and transported to home by animal drawn cart or pack animal and on average it costs around 5

ETB/qt and this cost is common for all the three threshing methods. Cost of combine harvesting includes hire of combine harvester, transport with trailer, labor for re-cleaning and in most cases tip for operator. But since tip for operators is not legal and it is not uniform throughout, some farmer pay while the other were not paying, it was difficult to estimate and was not included in the cost.

Table2.Households' use status of tractor and combine harvesting machine

Mechanization technology	User	Non-user
Tractor	46(38.33)*	74(61.67)
Combine harvester	47(39.2)	73(60.80)

*Number in parenthesis is percentage

Performance of Asella model-III multi-crop thresher

On farm practical participatory performance evaluation of Asella model-III multi-crop thresher was conducted atMeraro and Lemu-dimaPAs of Lemmu-Bilbilo district. Two equal wheat crop fields (0.125 ha each) were prepared at each site and randomly assigned to traditional (animal trampling at *hogdi/awudima*) and Asella model-III engine driven stationary threshing machine methods. The crop was first harvested by sickle and transported to threshing fields' of respective farmers. The threshing machine was operated at optimum operation speed of average drum speed 786.67 RPM, and average fun speed of 1450 RPM. Fuel consumption was calculated to be 1.2 litters per hour. From table 3, it revealed that the machine (Asella model-III engine driven thresher) was threshed 3.53 quintals of wheat per hour while the average cleaning efficiency was about 88% which is out of total threshed output, about 12% was impurity.

Table 3. Machine Vs traditional method performance comparison for different parameters

	Grain-straw ratio (wt/wt)	cleaning efficiency	threshing capacity	yield/ha (thresher)	yield/ha (combine)	yield/ha (traditional)
Site1	2:1	85.84	3.6qt/hr	30	24.57	24.53
Site2	1.875:1	85.36	4.5qt/hr	35	30	42.76
Site3	2:1	94.00	2.5qt/hr	18.7	16.92	27.81
	-	-	-	-	-	20.60
Average	1.958:1	88.40	3.53	27.90	23.83	26.17

Costs from harvesting to transportation were all the same with that of traditional animal threshing methods and the difference is cost of threshing and cleaning. Since the straw of wheat in Arsi was used as animal feed, the wheat bundle has to be transported to nearby plate called *awudima/hogdi* and heaped for some times for two main reasons. The first reason was to dry out moisture of the straw for ease of threshing and the second reason was to get time until they finish harvesting other crops from their fields.

Table 4. Man-days requirement for different threshing mechanisms

Wheat operation	Type of Labor	Amount required/ha	Cost per Unit (Br)	Total cost/ha
Manual Harvesting:				
Harvesting	Human	18	65	1170.0
Heaping in field	Human	0.95	65	61.75
Heaping at threshing plot	Human	0.90	65	58.50
Transportation	Human	20	65	1300.0
Transportation	Donkey	15	75	1125.0
Threshing	Human	9	70	630.00
Threshing	Animal	45	65	2700
Winnowing and bagging	Human	6	65	390.00
Transportation (grain)	Lump sum		5	119.15
Stationary Engine Driven Thresher Threshing Method:				
Harvesting	Human	18	65	1170
Heaping in field	Human	0.95	65	61.75
Heaping at threshing plot	Human	0.9	65	58.50
Transportation	Human	20	65	1300
Transportation	Donkey	15	80	1125
Machine cost	Machine	1		355.75
Fuel cost	Fuel	1.2lit	16.16	153.3
Operator	Human	3	65	192.70
Winnowing	Human	0.08/qt	65	145.1
Transportation (grain)	Lump sum		5	139.5
Total variable cost for engine driven threshing mechanism				**4701.6**

Financial profitability analysis of the mechanisms

To compare financial profitability of the three threshing mechanisms, traditional manual harvesting and animal trampling, manual harvesting and stationary engine driven machine threshing and combine harvesting techniques, partial budgeting was employed. For the two threshing mechanisms (manual and motorized thresher) even though threshing/harvesting cost per quintal is different as grain yield per quintal is different for the two threshing mechanisms, sinceown combine harvesting at small scale farming level like that of Ethiopia is unthinkable therefore, cost of harvesting by combine harvester was calculated based on cost of hiring the machine on quintal basis. In some cases, when the operators perceived that land productivity of specific farm is not good, they prefer to cost based on land size. But since this happen in rare cases, only cost per quintal basis was used for this particular research.

For motorized stationary engine driven threshers, since owing the machine at least in group basis is possible, the threshing cost if the machine was owned was calculated. Cost of threshing in this case includes machine owing costs, machine operating cost, and harvesting and transportation costs.

Table 5. Financial profitability (Birr/ha) of wheat harvesting and threshing technologies in study area

	Manual	Thresher	
CombineDescription	Harvesting	Harvesting	harvesting
Yield (qt/ha)	23.83	27.90	26.17
Gross return[a]	20255.55	23715	24590.50
Cost of manual harvesting:			
Labor for Harvesting	1170	1170	-
Labor for Heaping	120.25	120.25	-
Labor for Transportationb	1300	1300.0	-
Labor for Threshing[c]	1200	-	-
Labor for winnowing[d]	630	-	-
Animal labor[e]	3825	1125	-
Material cost	58.75	58.75	-
Labor for operation	-	192.51	-
Labor (re-cleaning and weighing)	-	145.08	-
Machine cost[f]		355.50	
Cost of combine harvesting (ETB/ha)			
Hire of combine harvester			1731.60
Transport with trailer			288.60
Labor (re-cleaning and weighing)			136.08
Transport with cart/donkey			130.85
Total costs that vary	8304	4667.092287.13	
Net income after varying cost	11591.55	19247.91	19957.37

[a] average price of 850ETB per quintal was taken (data from farmers and DAs)
[b]for transportation of wheat bundle, 1.33 man-day is needed per a donkey (20man-days vs 15 donkey days)
[e]animal labor for manual threshing includes animal for threshing and transporting bundles from field to awdima while in motorized thresher case it includes only animal labor for transportation
[f]machine cost calculation was shown in detail in Appendix I and III

Economic Advantages of wheat threshing mechanisms

Machine payback period and sensitivity Analysis

A machine pay-back period is a consecutive time in a machine's expected economic life that a machine's purchase price could be re-gained from its services. It was assumed that one human day is equivalent to eight hours working and three human days was needed to work on a machine. A machine was estimated to work for about 200hrs and can thresh a total of about 706 quintals of wheat per a year. Labor to thresh this amount of wheat was three person-days per a day times twenty five (which means if a machine works for full day which is for eight hours, it took twenty five days in a year to work for total of 200 hours) days.

Table 6. Cost and returns of machine per a year when rented out[5]

Cost item	quantity	unit price	total amount
Total labor cost	3PD*25days	65	4875/year
Fuel cost	1.2lit/hrs*200hrs	16.16	3878.4/year
Total variable cost			8753.4ETB/year
Total machine owing cost/year (200hrs)	45*200hrs		9000.00
Total overall cost per year			17,753.4ETB
Gross annual return (rent of machine)	706qt	55ETB/qt	38,830
Net income per a year			21,076.60

Currently farmers who bought engine driven multi-crop threshing machine from Asella AERC are renting a machine for 55ETB per a quintal and machine owners only supply machine operator (one person-day per a machine). The gross return per a year from machine rent will be 3.53qt/hr*200hrs/year*55ETB/qt which is equals to 38,830ETB. The net income from the rent of threshing machine will be (if a farmer can buy and rent out) the difference between gross return and total overall cost per year and it is 21,076.60ETB per year. Therefore, if one buy and rent a machine the machine pay-back period will be around two and half years.

Sensitivity analysis of the investment should be assessed at three stages, under normal, intermediate and worst scenarios. In this case the worst scenario could be when the service charge is reduced to charges equivalent to combine harvesting charges given around Etheya and GedebAsasa districts where topography is more suitable for combine harvesting and there is large supply of service. In these areas, the hiring service market is at competitive basis and the charge during period was 40ETB per quintal. Therefore, if the service charges of engine driven wheat thresher reduced to 40ETB/qt, the net income will be reduced to 19,486.60 ETB and the pay-back period will be around two years.

Internal Rate of Return (IRR) for Asella Model-III Multi-crop thresher

The Internal rate of return (IRR) for an investment is the percentage rate earned on each birr invested for each period it is invested. Mathematically, internal rate of return (IRR) is the interest rate at which the net present value of all the cash flows (both positive and negative) from a project or investment equal zero. In this case it is the IRR for investment on the OARI-Asella model-III multi-crop thresher. The cash flow includes initial investment and the net income from the rent of machine for the next consecutive ten years. The result revealed that the internal rate of return for the machine was 44% which is much higher than the interest paid on saving by commercial banks (Table 7). This amount is also by far greater than the loan interest rate (17%) levied by financial institutions like Oromia Credit and Saving Association (WALQO) at a time this study was conducted.

[5] Machine (multi-crop thresher) related costs are calculated and shown in Appendices I and III

Table 7. Machine Investment Cash Flow

Year	Cash Flow Amount (ETB)
Year 0 (investment)	-47,000.00
Years 1-10	21076.60/year
IRR	**44%**

Source: Researchers' own computation

Need assessment for willing to use Asella model-III multi-crop thresher

Simple assessment was conducted on farmers who attended during evaluation of the machine at Lemu-Bilbilo district and others who were not there during evaluation but knows about Asella multi-crop thresher both in Hetosa and Lemu-bilbilo through questionnaires were filled to find if they were willing to use the machine and if they are willing, the mode of owning the machine. Accordingly, all the participants were willing to use the machine either through buying in group or through renting. Respondents from Hetosa district preferred the machine as an option and for some pocket and inaccessible plots while those in Lemu-bilbilo district; the machine under evaluation was the only choice to mechanize their farm at current situation. Around 28% (34 out of 120) of farmers were willing to buy the machine in group while around 69% (47 out of 65) of them were willing to use in rental basis and around 3% percent were willing to buy the machine individually.

Conclusions and recommendation

For this research activity data were generated in two way namely survey type and on field economic evaluation of the three threshing mechanisms (combine harvesting, engine driven stationary multi-crop thresher threshing and manual threshing). Generally, the result of survey revealed that in Arsi zone, wheat farm is the most relatively mechanized enterprise specially in districts located on main road from Adama to Bale and have conducive topography for large agricultural machineries namely tractor and combine harvester. In Hetosa, one of the most accessible districts in Arsi zone, more than 90 percent and 75% of the households were using combine harvester and tractor for wheat production respectively. For those inaccessible areas, the most dominantly used wheat threshing mechanism was manual sickling and animal trampling mechanism. The stationary engine driven threshing mechanism was at popularization stage by ministry of agriculture and Asella agricultural engineering research center. The center released its' third model thresher which has overall performance of 3.53qt/hour threshing capacity and 88.4 percent clearing efficiency. Cost of threshing were 2287.13, 4667.09 and 8304ETB for combine harvesting, engine driven thresher and manual harvesting mechanisms while the net income after varying costs were 19957.37, 19247.13 and 11591.55ETB respectively. The payback period for engine driven stationary threshing machine was calculated to be around two and half years. The thresher has additional advantage of straw chopping which facilitates its' palatability for animals as feed. Moreover, the machine is profitable if one buys and rent for others with internal rate of return of around 44%. From the result of both survey and economic analysis on farmers' field it can be concluded that specific recommendation is important.

Based on the result from on field economic evaluation of the threshing mechanisms, engine driven stationary threshing mechanism was economical over the traditional mechanism. Therefore, further and wider promotion should be planned jointly with stakeholders and the technology transferring mechanism to private manufacturers should be built. In mean time the government should interfere to create demand for private manufacturers through pre-scaling up of the technology using different approach like availing credit facilities, cooperatives and unions and grouping farmers for further use. Furthermore, the center's farm machinery research team should work on the improvement of the threshing capacity of the machine as the price of machine including its engine and its capacity are not comparable to maximize the benefit of farmers'/users' from their investment on the machine.

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Farming System Characterization of Arsi, Zone, Oromia National Regional State, Ethiopia.

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Abstract

Developing a typology constitutes an essential step in any realistic evaluation of the constraints and opportunities that exist within farm households for forwarding appropriate technological and policy interventions, demand driven technological intervention and policy support needs identification and characterization of farm types. Therefore, this activity was initiated with objectives of having/gaining an overall understanding of farming and livestock production system of the area, identifying key/important areas of intervention with currently at hand available agricultural mechanization and other technologies and identifying key/important priority areas of agricultural technologies research. KII, FGD and household level survey methods were utilized collect data. Accordingly Arsi zone was classified into seven farming system clusters as agro-pastoral/pastoral, irrigation based, coffee-khat tree, highland barley-root crops based, maize-sorghum based, mechanized wheat-teff and non-mechanized wheat-teff based farming system each having different features of production system and production constraints. For each farming system the constraints were identified prioritized. The production constraints were prioritized and solutions were also recommended for each constraint.

Key words: Farming system characterization, farming typology, farming system clusters, Arsi zone

Introduction

As it is mentioned in Country factbook, Ethiopia Economy Profile (2017), even though it's contribution surpassed by service sector in GDP contribution, agriculture in Ethiopia is still playing a dominant role in the economy by its contribution around 36% of GDP and providing an employment for about 73% of the nation's labor force. The government of Ethiopia clearly indicated that agriculture will continue to be the main source of growth and development and employment sector in the country (FDRE National Planning Commission, 2006).

There is high demand increment for food self-sufficiency all over the world and especially critical for developing countries. To be successful in this direction, enabling the small-scale farmers to produce to their maximum need is unquestionable. Therefore, researchers should search for agricultural technologies which made agriculture more economically viable and policy makers also should make intervention for such development (FAO, 1994). In turn, precise technological intervention and policy support needs identification and characterization of farm types.

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 (FAO, 1990). Assortment/typology of farming system is dictated by climate, production goals and culture of a society. Specially, the 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 and use of improved agricultural mechanization technologies (Dixon, Gulliverand Gibbon, 2001). Tittonell(2010) further explained that the factors that define/determine farm typology vary greatly from study to study and/or from region to region which may be as diverse as agro ecological, socio-economic, managerial, infrastructural and broader issues of livelihoods.

But unfortunately, both in agricultural and social sciences, complexity and diversity have remained ignored and undervalued, and excluded from government statistics and policy framework (Chambers, Pacey, and Thrupp, 1989). The heterogeneity in production system and agricultural technology utilization across different regions as well as variation in different farms are influenced by a host of biophysical (e.g. climate, soil fertility, slope etc.) and/or socio-economic (e.g. preferences, prices, production objectives etc.) and agricultural extension services factors (Ojiem, Ridder, Vanlauwe, and Giller, 2006).

From time to time, agriculture in developing countries has assumed commercial and mechanized proportion, replacing its traditionally subsistence and hand and hoe nature of dealing with agriculture. Hence, farm typology delineation based on improved technology intervention seems to be a pragmatic/realistic approach. Developing a typology constitutes an essential step in any realistic evaluation of the constraints and opportunities that exist within farm households for forwarding appropriate technological and policy interventions (Ganpat, and Bekele, 2001; Timothy, 1994, and Vanclay, 2005).

With agricultural mechanization technologies characterization utilization of farms as the objective at hand, the researcher assumes that identification of farms' resources utilization give more effective insights regarding farm ways of intervention and policy making. So far there are no such activities attempt to characterize the farming system of the area. Therefore, this research was initiated with objective of identifying, and characterizing the farming systems and agricultural mechanization technologies utilized in Arsi zone with specific objectives ofhaving an overall understanding of farming system of the area,identifying key/important areas of intervention with currently at hand available agricultural mechanization and other technologies and identifying key/important priority areas of agricultural technologies research in Arsi zone.

Methodology

Description of the study areas

The study was conducted in Arsi zone. The zone was purposively selected since it is the main station of Asella agricultural engineering research center and most of the center's interventions were in this zone. Moreover, similar research works were undertaken by other research centers in the zone. Arsi Zone is found in the central part of the Oromiya National Regional State. The zone astronomically lies between 6^0 45' N to 8^0 58'N and 38^0 32 E to 40^0 50' E. It shares borderlines with west Arsi, Bale, west/Hararghe, and east Shewa zones. It has 25 administrative districts including one especial district. Asela is the capital town of the Zone. It is located at 175 km from Finfinne on Finfinne-Adama-Bale Robe main road.

Because of its great diverse in altitude, Arsi zone has great physiographic diverse also. Based on the altitude there are four major identified physiographic divisions. The first one is the cool agro-climatic zone with altitude of above 3500masl, which covers the highest altitudes areas of the zone and constitutes about 2.74% of the total area of the zone. The second one is the cool temperate agro-climatic zone that includes the mountain ranges, massifs and high plateaus of Arsi (2500-3500m) lies in the central part of the zone, stretching from the border of NNPSE (Nations, Nationalities and People of Southern Ethiopia) to Aseko district and belongs to the Arsi-Bale Massifs. It covers about 22.74% of the total area of the zone. The third is the warm temperate agro-climatic zone (1500-2500m), which comprises low plateaus of the zone and covers about the 49.60% of zonal land surface. While the fourth is lowlands of the zone (less than 1500m) constitute about 24.92% of the total area of the zone. This type of physiographic region of the zone is found in the Awash River valleys and southeastern lowlands. In general, the zone has the lowest altitude in extreme east of Seru district located in Wabe gorge which is 805masl and highest point on peak of mount Kaka 4195masl.

There are three major/dominant soil types in Arsi zone. The first group was Chromic and PellicVertisols which has characteristics of water holding and heaviness for plowing during rainy seasons due to high clay content and covers about 30 percent of total. The second group is Cambisols (23 percent) dominantly occur on the steep slopes and are often shallow or have many rock outcrops and those developed on gentler slopes, however, have good base saturation and fertility and can highly be used for agricultural purposes. The third was Luvisols which is good for agriculture with base saturation and weatherable minerals and dominant on the high land parts of the zone and it covers about 13 percent of total area of the zone. Lithosols is another soil type having good base saturation and fertility status and constituting about 6 percent of total and Fluvisols, constitutes about 2 percent of the total soil groups' coverage in the zone, and found in the lowland parts of Gololcha, Merti&ZiwayDugda districts of the zone.

Sample and sampling procedures

Multi-stage sampling techniques were used to select districts and peasant associations (PAs). Even though it was tried to stratify the zone into three based on traditional agro-ecological based classifications as highland, mid highland and lowland, considering the accessibilities and other production factors which have impacts on farming system characteristics, the zone was further stratified as mid highland wheat-belt and mechanized areas, high land barely belt areas, mid to low land teff-maize and spices majoring areas, mid altitude heavy soil areas, lowland maize majoring areas, mid highland and highland un mechanized wheat-barley belt areas and coffee and fruits majoring areas. From each cluster one district was sampled and from each district one or two peasant associations were selected for focus group discussions (FGDs. A total of 15 farmers FGD were held with each group having eight to fifteen group members who were systematically selected based on their farming experience, gender, educational background and etc. Discussion with experts from each area of agriculture, natural resource management, and livestock were also conducted at each level. Development agents (DAs) at each PA were considered as key informants and they were interviewed separately. Finally, household level interview was conducted to supplement those community level data.

Data type, source and method of collection

Both primary and secondary data sources were employed in this research. Primary data sources were farmers, agricultural and natural resource development offices and livestock resource development, health and marketing agency at different levels (regional, zonal, districts, and PAs), rural land administration offices, different NGOs and stakeholders working on rural development. Secondary data were collected from different research output materials and other official reports of different offices. In general data were collected by Rapid Rural Appraisal (RRA) and Participatory Rural Appraisal (PRA) methods and household level interview methods through structured and unstructured survey schedule and focus group discussion and key informants interview and discussion.

Table 1: Basic Information of sampled districts

a. Agro-ecologies and altitudes of sample districts

		Percent of agro-ecology			
List of district	**Highland**	**Mid-highland**	**lowlands**	**High alt.**	**low alt.**
Lemunabilbilo	80	20.00	0.00%	4180	1500
Shirka	24	56.00	20%	3700	500
Zuwaydugda	0	10.30	89.7%	1750	1600
Hetosa	26	47.80	26%	400	1700
Arsi-robe	24	62.00	14%	1150	800
Cholle	50	22	28%	3574	1040
Merti	10%	29%	61%	NA*	NA

b. Temperature and rainfall of the sample districts

District	**Average rain**	**Average temperature**
Lemunabilbilo	1100	16
Shirka	1000	12.50
Zuwaydugda	650	25.50
Hetosa	800	21.00
Arsi-robe	1000	22.50
Cholle	1000	16
Merti	-	26

Source: Arsi zone and respective district's office of agriculture and rural development

*NA= not available

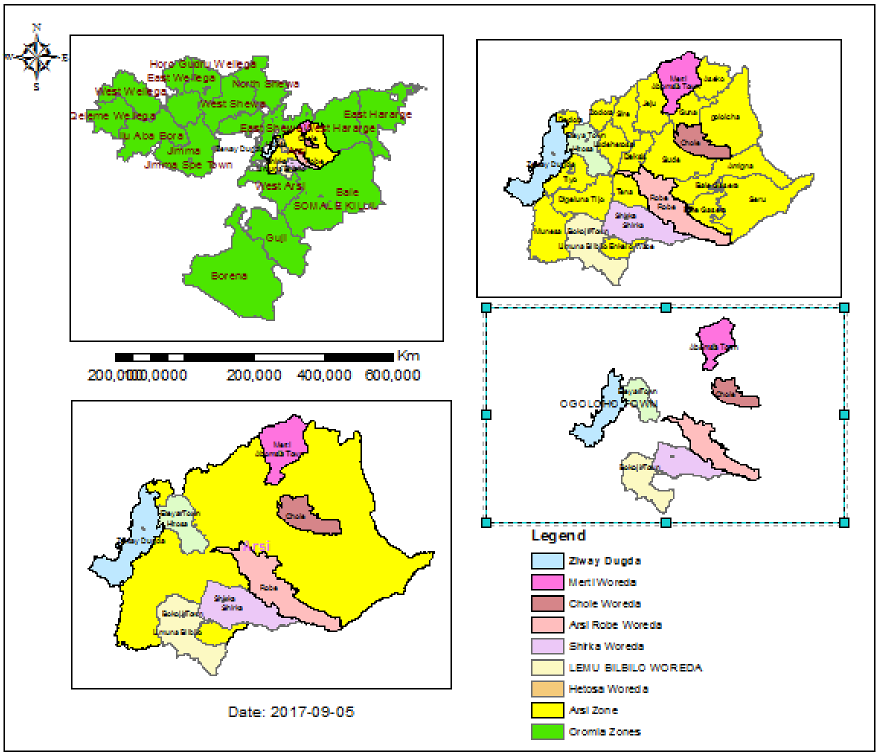

Figure 1. Map of Study area and sample districts

Data analysis method

Data analysis technique to be used a research is determined by types of data collected and purpose of research output (report). Therefore, in our case since the data that were collected were more of qualitative in nature descriptive and inferential statistics such as mean, median, cross tabulations and bar-graph methods of analysis were utilized in this study. The qualitative data collected through FGDs, KII and transect walk were analyzed qualitatively using narration methods.

Results and Discussion

Farming system of Arsi zone

The farming system of the zone can be broadly classified into two major clusters as *crop-livestock mixed* farming and the *pastoral/agropastoral*farming system. The pastoral/agro-pastoral farming system is found in lowland areas of Merti and Gololcha districts. The crop-livestock mixed farming is further clustered into three sub-farming clusters as cereal based, irrigation-based and coffee-*khat* (*chat*) tree based farming. The cereal sub-cluster is also further clustered into barley-root crops based, wheat-teff based and maize-sorghum based farming system. The wheat-teff belt farming sub cluster can also be further clustered into mechanized and nun mechanized farming sub-clusters. There is also further clustering based on number of cropping per a year as double cropping and single cropping. Most barley-root crops based and part of wheat-teff farming clusters have two rain fed cropping seasons. The rest sub-clusters have single cropping system unless supported by irrigation.

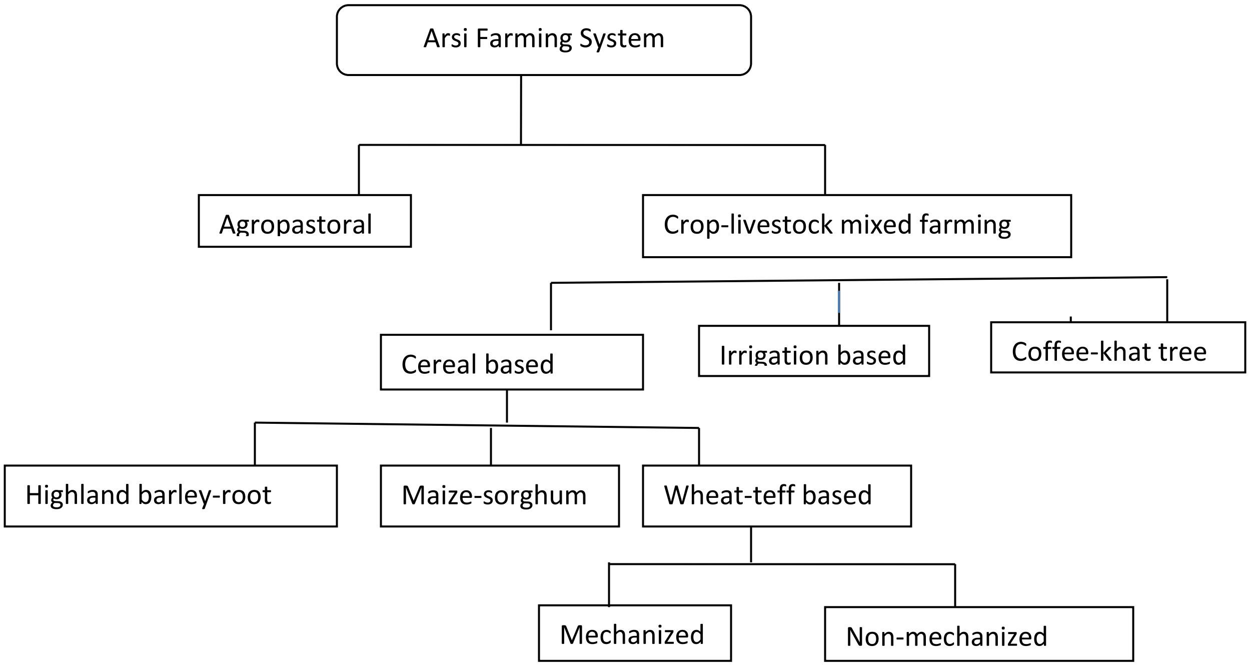

Figure1: Broad hierarchal classification of farming system in Arsi zone

Socioeconomic characteristics and resource ownership of households

Around 53 and 45 percent of the sampled households were Muslims and Orthodox Christianity followers respectively. Around 94 percent of the household was male headed and the rest 6 percent was female headed. The mean age of the household head was around 45 years while the mean educational status was 5.28years of education. Household's spouse educational status was found to be lower than that of household head which was 2.8 years of education. On average there was one family member which is not educated. There were 6.26 family members per a household on average with standard deviation of 2.26. The number of male and female family members per a household was found to be 3.45 and 2.81 respectively (Table 3). Majority of the household (40.67% of the households) have land size between 1 and 2 hectare while only around 3 percent have landholding of above five hectares. In general more than 75% of the households have landholdings of less or equal to two hectares only (Table 2). The mean landholding of households was 2.39ha with mean cultivated land size of 2.33ha. When we see the land use pattern, land allocated for crop production accounts for large proportion followed by grazing land and residential land each having mean of 1.8ha, 0.28ha and 0.18ha respectively. Each household possessed livestock of mean 7.54 TLU. The total mean number of houses that household possessed was 2.7 houses.

Table2: Landholding distribution by household percent in Arsi zone

Range of landholding	Percent of holders	Std. Deviation	Cumulative Average
Less than 0.5 hectare	9.83	7.2	9.83
Between 0.5ha and 1ha	25.4	13.65	35.23
Between 1ha and 2ha	40.67	23.17	75.9
Between 2ha to 5ha	20.9	16.72	96.8
Above 5ha	3.2	3.52	100

Source: Districts office of agriculture and natural resources development

The result revealed that there was considerable land allocation for forest and grazing while the degraded (land of no use) is also significant which is because of soil degradation due to miss-use of the land. From both FGD and household level survey result, there is no communal grazing land except in pastoral and agro-pastoral areas of Merti district (Table 4).

Table 3: Own land use pattern of household

No.	Land use	Mean value (ha)	Std. Deviation of mean
1	Rain fed crop production	1.77	1.4
2	Grazing land	0.28	0.49
3	Residential land	0.18	0.17
4	Forest land	0.07	0.22
5	Irrigated crop production	0.04	0.14
6	Degraded land	0.03	0.11
7	Others	0.01	0.04
8	Total landholding	2.39	1.80

Source: own household survey

Table 4: Mean income and their sources distribution across farming system in Arsi Zone

Variables	Farming system cluster							
	Mechanized Wheat belt	highland barley belt	non-mech. wheat-teff	Maize-sorg lowland	pastoral/ agro-pastoral	irrigation based	coffee- chat tree	total
N	53	14	46	18	35	12	12	190
Total Family size	6.06	5.50	6.00	7.17	6.71	6.08	6.50	6.26
Male family size	3.45	2.57	3.67	4.05	3.51	3.33	2.91	3.45
Female family size	2.60	2.93	2.41	3.11	3.20	2.75	3.58	2.81
House number	3.06	3.46	2.43	2.22	2.63	3.08	1.83	2.69
Adult man-equivalent	3.32	2.80	3.48	3.50	3.30	3.22	2.85	3.28
Livestock (TLU)	9.62	7.55	7.20	6.66	6.36	6.53	5.43	7.54
Total land holding	2.89	3.17	1.54	2.80	2.04	2.48	2.74	2.39
Total cultivated land	3.20	2.85	1.60	2.38	2.18	1.60	2.22	2.33

Households off-farm activities and food security status

Household's off-farm income sources could be both farms and non-farm activities. When a household member works on other's farm activity to earn additional income as a paid laborer during his off-time, it will be farm activity worked as off-farm activity. But when the household member works on non-farm activities like petty trade, skilled labor as carpenter, salaried worker as guard e.t.c., it will be non-farm off-farm income source activity.

Accordingly, around 30 percent of the total respondent households have participated on different off-farm activities because of different reasons like seeking additional income (17.4%), inadequate farmland (8%) and fear of crop failures (Table 5). Food security status of the household was assessed through simple interview by asking whether the household is food secured throughout the year or not. Accordingly, around 52% of total respondents answered that they were food unsecured and were not producing enough food for their family consumption. Furthermore, it was observed that there were food aid program in each sample districts.

Table 5: Reasons for participation on off-farm activities and food security status

No.	Description	Response (percent of "Yes" answer)
1	Seeking additional income	17.40%
2	Inadequate farmland	8.00%
3	Fear of crop failures	2%
4	The HH is food secured	48%
5	The HH is not food secured	52%

Enabling institutional facilities for agricultural production in Arsi Zone

In order to the farmers to produce, there are many enabling institutional facilities that have to function properly. These facilities includes but not limited to market, potable water, communication facilities, rural energy (lightening, and cooking), extension service provisions, credit facilities and so on. Most farmers get market information (about 80%) but it is not from well-known sources. Farmers do not trust information from DAs and most information sources were neighboring farmers (25.8%) followed by traders (12.1%) while only 3.7% of farmers get market information from cooperatives. This shows how the cooperatives are not functional in agricultural output trading. Most market related constraints would have been answered by farmers' primary cooperatives and unions but from FGD and individual household survey results, the cooperatives tend to profit making institutions.

Only 40.5% of the households have access to potable water while 27.4% have electricity power either grid or solar and more than 75% of them has cell phone. In the two years period around 37% of total households have used credit services from different sources for different purposes. About 53 percent of the households do not need credit because of different reasons while around 37 percent of the total sample was using credit for different purposes. The major purposes were purchasing agricultural inputs like fertilizer and seed followed by buying animals for small fattening or breeding and petty trading. Therefore, this indicates that credit facility is important service to farmers especially for resource poor farmers (Table 5 and 6).

Table 6: Credit service use and purposes of cedit

No.	Description of Variable	Percent
1.	Use credit service	37.4
2.	To purchase fertilizer	38
3.	To purchase improved seed	15.5
4.	For schooling children	1.4
5.	For petty trade	5.6
6.	Buy animal for fattening/breeding	35.2
7.	Others	4

High interest rate and collateral problems were ranked as priority credit use constraints by 25.8 and 12.6 percent of respondents while money shortage and credit source inaccessibility were third and fourth.

Table 7: problems related to credit service provisions

Description of problem	Frequency	Percentage
High interest rate	48	25.8
Collateral problem	24	12.6
Limited money (money availability)	10	5.3
Absence of credit sources	5	2.6
I do not need credit	102	53.7
Total (N)	190	100

The respondents' perception was assessed on the strength of extension service provision by different bodies and according to most respondents' perception; the service was strongly biased towards biological aspects of crop and slightly to livestock production (Table 7a and 7B) while it was poor for natural resource conservation and agricultural engineering technologies.

Table 8a. Extension service provision rate for crop and livestock production

	Crop production		Livestock production	
Rate of service	Percent	Cumulative percent	Percent	Cumulative percent
Very strong	6.3	6.3	2.1	2.1
Strong	47.9	54.5	41.1	43.2
In between	36.3	91.0	35.8	78.9
Weak	8.9	100	20.00	98.9
Very weak	0	0	1.1	100

Table 8b. Extension service provision rate on natural resource and agricultural engineering

Rate of service	NR conservation		Agricultural Engineering	
	Percent	Cumulative percent	Percent	Cumulative percent
Very strong	0.5	0.5	0.5	0.5
Strong	28.4	28.9	6.8	7.4
In between	50.5	79.5	18.9	26.3
Weak	18.9	98.4	61.1	87.4
Very weak	1.6	100	12.6	100

The result of the survey revealed that more than 73% of the respondents perceived that the extension service on mechanization was below average which was weak or very weak. The FGD result and experts discussion output also revealed that there was weak extension services provision on agricultural engineering technologies because of structural problem where there was no expert on this discipline even at office level (neither district nor zonal level).

Households' income sources and livelihood diversification

Most households have diversified income sources. The diversification could be by enterprise diversification or engaging into different off-farm and non-farm activities. Both FGD and household survey results were used to rank the income sources. The main household income sources were identified to be crop production, cattle rearing and small ruminants rearing. Dairy production was the most significant income source in Shirka district with annual mean value of 5187.69ETB which revealed that there is high potential for this sub-sector.

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 agro-pastoral of Merti and maize-majoring Zuwaydugda areas), poultry birds, 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 were shortage of land both for livestock keeping and crop production.

The small ruminant production/ rearing (sheep and goat) activities were dominant in highland barley-root crop based farming system, pastoral and agro-pastoral and wheat-teff and spices dominating (Shirka) with mean value of 2047.17, 1267.69 and 2091.43 ETB respectively. When we see specific potential for the enterprises, sheep is dominant in Lemu-bilbilo, because of highland agro-ecology; goats are dominant in Zuway-dugda while both sheep and goats have equal potential in Shirka districts. Therefore, attention should be given accordingly to improve the development of each sub-sector. In all agro-ecologies small ruminants and poultry birds were listed as most important but less recognized enterprises both from development workers side and even producers.

Small fattening (both small ruminants and cattle) has significant household income share in Shirka, Lemi-Bilbilo and Hetosa districts with mean annual value of 3784.6, 1698.11, 1457.14 ETB respectively. In Hetosa even though livestock population was relatively small, the survey result revealed that there was good practice of fattening at household level.

In general the mean off-farm income of the zone was 4018.32 ETB but with greater standard deviation (9488.18). Non-farm income sources have also significant contribution in income of households. For instance, trading different commodities like household consumables, livestock, crop and working on others farm as a laborer and as other activities were the major income sources. In Lemunabilbilo district trading has mean annual contribution of 2377.36 ETB while it has mean annual contribution of 2307.69 ETB in Shirka district while working as a labor on either farm or non-farm activities has contribution to income in Lemunabilbilo, Merti and Zuway-dugda with mean value of 279.25, 250 and 142.86ETB per annum respectively.

Households' farm labor availability

In most subsistence farming the labor sources are family members. Each of the household has an average of 3.28 adult man equivalent family labors. Most respondent (70%) households responded that they faced labor shortage on at least one of their farm operation. Harvesting/threshing was the most important operation where most farmers face labor shortage (47.4% of respondents) followed by weeding/cultivation, land preparation and planting facing 31.6% and 30% and 23.7% of farmers respectively. The major coping mechanisms used by farmers during labor shortage were labor exchange/wonfel (45.8%), employing casual labor (32.10%), and employing permanent labor (13.2%). Some farmers (around 6.3% and 4.2%) households rent in agricultural machineries mainly tractor and combine harvester and rent out their farmlands as labor shortage coping mechanisms respectively.

Table 9: Labor shortage, coping mechanisms in Arsi zone

	Description	Percent of respondent	
		Yes	No.
	Face labor shortage	70	30
Coping mechanism	Use labor exchange/wenfel	45.8	54.2
	Employ casual labor	32.1	67.9
	Employ permanent labor	13.2	86.8
	Rent agricultural machineries	6.3	93.7
	Rent out farmland	4.2	95.8
Constraints in labor	Low labor quality	24.2	75.8
	Shortage of required number of labor	36.8	63.2
	High wage rate	48.4	51.6

Table 10: Mean income and their sources distribution across farming system in Arsi Zone

	Farming system cluster							
Income Sources	Mechanized Wheat belt	highland barley belt	non-mech. wheat-teff	Maize-sorg lowland	pastoral/ agro-pastoral	irrigation based	coffee- chat tree	total
Crop production	23776.60	13371.43	25040.22	6558.33	19171.43	12591.83	5433.33	18971.4
Cattle rearing	7358.50	2214.29	6086.96	2716.67	6237.14	2416.67	3858.33	5492.10
Beekeeping	50.94	42.88	80.43	0.00	348.57	183.33	16.67	113.68
Trading	811.32	2964.29	1684.78	55.56	171.43	1083.33	0.00	957.89
Dairy product	273.58	285.71	1466.09	66.67	200.00	0.00	291.67	513.89
Small ruminant	869.81	4628.57	862.60	644.44	2091.43	166.67	379.17	1273.32
Laborer	0.00	1057.14	0.00	0.00	142.86	0.00	250.00	120.00
Fattening	2471.69	714.29	1069.59	0.00	0.00	0.00	916.67	1058.95
Off-farm income	4556.60	6664.29	7445.20	100.00	457.14	4241.67	1458.33	4018.33
Poultry	496.23	438.57	270.65	222.22	268.88	16.67	253.33	323.89
Rent house	3.77	0.00	2032.20	44.44	142.86	616.67	41.67	565.16

Characteristics of sub- clusters farming systems

Barley-root crops based farming system

This farming system is found in highland and mid highlands of Lemunabilbilo, Honkolo-wabe, Shirka, Tiyo and the like which follows the basis/massifs of Chilalo mountain. Previously in this sub-cluster most land was under communal pasture and gradually due to population pressure the pasture land become under crop production. The major crop type in this sub-clusters were barley, wheat and rain fed based root crops like potato, carrot, beetroot garlic etc. In addition large varieties of other crops especially pulses like faba bean, field pea, and lentils, rapeseeds etc. are grown in this farming system. These crops were used as rotational crops for cereal crops to maintain the fertility of soil.

Malt barley is the most favorable sub-enterprise in this sub-cluster and it accounts for about 36% of total land allocation while barley as a general including food barley and malt barley is grown on about 54% of the total farm land followed by wheat, linseed and root crops each covering about 27%, 8% and 4% of total land respectively. Pulse crops like faba bean, lentils and field peas were also grown on considerable size of farmland covering around 7.5 percent of total cultivated land. Mean productivity of malt barley was 39.45qt per hectare and for food barley was 19.51 which shown that there is high potential for malt barley production in this area. Livestock production specially cattle breeding, sheep, dairy production and beekeeping were also the most important enterprises in this sub-cluster farming system.

Major production constraints of the barley-root crops based sub-cluster

Pair-wise ranking was employed to prioritize the major barley production constraints of the sub-sector during FGD with farmers and discussion with agricultural experts at district level. Accordingly, in malt barley production the major production constraints were absence of high yielding varieties (variety options), and lack of mechanization technologies. The use of heavy duty machines like tractors and combine harvester is difficult because of land topography, and farmland fragmentation. Crop disease (rust) was the major constraint for wheat growing farmers. This problem resulted into other problems like increase in production cost, low productivity and crop complete devastation (failure) in most cases.

In general 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 perishability 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.

*T*able11: Major crop production constraints in barely-root crops based sub farming system

Major constraints:	Score in pair-wise ranking	Rank
1. Absence of high yielding malt barley variety	8	1
2. Crop diseases (wheat rust)	6	2
3. Lack of mechanization technologies (chemical sprayer etc)	4	3
4. Absence of varietal option (high yielding, disease resistant)	4	3
5. Increase in input price (fertilizer, weed killers and other pesticides)	3	4
6. Improved seed supply shortage	2	5
7. Erratic rainfall	1	6
8. Soil fertility decrease and invasive grass weed	1	6
9. Perishability and lack of storage facilities for vegetable (root crops)	1	6

Wheat-teff and oil crops based sub-cluster of farming system

This farming system is found in mid highlands/sub-tropical of the zone and mostly known by growing wheat, teff, barley, oilseeds and spices crops. In Arsi zone this sub-cluster is further classified into two sub-farming systems as highly mechanized farming cluster and non-mechanized farming system. Mechanized farms are found in most parts of Hetosa, Lode-Hetosa, pocket areas of Tiyo, Lemunabilbilo and DigalunaTijo, and most parts of Munesa districts. Especially in Hetosa, around 50% and 100% of the households were using tractor and combine harvesting constantly each year respectively. Wheat productivity was also the highest in this sub-sector which was 45 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. The soil of this sub-cluster was majorly black but no too heavy (medium) type.

The second sub-sector was non-mechanized cluster where wheat production has slightly higher share but other small seeded crops like teff and oilseeds like Niger seed, sunflower, linseed, and rape seeds and spices like black commune, hot-pepper (have largest share in Shirka district with around 16% of total cultivated land coverage) etc. have significant share of land allocation. Pulse crops like chickpea and lentils have also considerable land coverage but threatened by wilting pests. This sub-cluster is widely dominating in most areas of east part of Shirka, Dida'a and Arba-gugu districts. Use of BBM is common in most parts of the area where there is vertisol.

Major production constraints of wheat-teff and oilseeds based sub-cluster

Teff is being dominating in this area (shifting of enterprises from wheat and pulse crops to teff) because of change in both raining calendar and rain intensity. The FGD result revealed that, since 10 to 15 years there is erratic rainfall, late entering but huge raining which causes water logging and leaching out of soil minerals and decreased soil fertility. Lack of improved seed for all crop types, high price of different chemicals low land productivity, low seeds productivity, supply shortage and illegal market of chemicals where private traders set unreasonable price, and inappropriate chemicals were most production constraint in the area.

Table 12: major crop production constraints in barely-root crops based sub farming system

Major constraints:	**Score in pair-wise ranking**		**Rank**	
	Mechanized	non-Mech.	Mechanized	Non-Mech.
1. Climate change	4	9	6	1
2. Mono-cropping	9	0	1	8
3. Crop diseases (Wheat rust, wilt etc.)	8	3	2	5
4. Seed related problems (type and amount)	7	5	3	4
5. Low soil fertility (NR degradation)	3	8	7	2
6. Invasive grass weed	6	1	4	7
7. Chemical related (High prices, supply gap)	5	6	5	3
8. Problem on vertisol management	1	6	9	3
9. Week extension service (technical aspects)	2	4	8	5
10. Absence of agricultural mechanization	0	3	10	6

Source: FGD and experts discussion at district level

According to the PRA result most production constraints are inter-related like the case of mono-cropping which is cause for invasive grass weed, poor soil fertility and aggravates wheat rust and other pests. Week extension service provision which was cause for low technical skill and knowledge, low awareness on agronomic practices was the major cause for poor vertisol management. Seed related problems include absence of improved seed for most alternative cash and other crops like pulse crops, oilseed, teff, hot-pepper and the like and absence of varietal options for some existing seeds. Even though pulse crops are known as a rotational crop to improve soil fertility and break mono-cropping problems by farmers, absence of disease resistant varietal options is pushing the enterprise out of production system. Land degradation, shortage of grazing land, continuous crop failure which result into absence of crop residue for animal feed are becoming the main causes for shortage in farm draught animal power (plowing and threshing).

Large seeded cereals *m*aize-sorghum based sub-cluster farming system

This farming system was found in moderately hot sub-cluster of the zone including majority of Z/dugda, Dodota, Merti, Aseko, Gololcha, half of Chole and the like districts. The most important crop enterprises in this farming system are maize, sorghum, haricot bean, teff and others. The average landholding of this sub-cluster was 2.64ha per household. Soil fertility is relatively good but crop production is challenged mostly by low moisture. Except Z/dugda and Dodota areas, this sub-cluster is characterized by low use of improved technologies (both mechanical and biological). To justify this data was collected both from office of agriculture and natural resource development and household survey. The result revealed that use of mechanical technologies (tractor and combine harvester) was almost nil because of different reasons like low awareness, accessibility, low service purchasing power of the farmers, and others.

Major production *c*onstraints of *m*aize-*s*orghum *b*ased *f*arming *s*ystem

Erratic rainfall and moisture stresses are the most important production constraint followed by high input prices like fertilizer, and chemicals, poor input supply system like timeliness, poor quality inputs due to illegal traders control over the market, and supply shortage, crop diseases like smut, stock borer (for maize), expansion of witch weed striga weed (severe in Merti and Chole areas), lack of mechanization technologies were the most important production constraints (Table 13). Similar way of pair-wise 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. On the other hand introduction of striga resistant sorghum and awareness creation should be the priority action.

Table 13: prioritized major agricultural production constraints

No.	Major constraints	Indexed Score	Rank
1.	Poor inputs (chemicals, fertilizer, seed) supply system	0.14	2
2.	Crop pests (striga and poisoning grass weed in teff)	0.19	1
3.	Erratic rainfall and moisture stress	0.19	1
4.	Draught power shortage	0.10	3
5.	Backward mechanization technologies use	0.14	3
6.	Land degradation and poor soil fertility	0.14	4
7.	Wild animals	0.10	4

In Z/dugda district it was reported that teff (*Eragrostistef)* straw is not being used as animal feed because of deadly poisoning teff grass weed which kills livestock if consumed with teff straw. They reported they couldn't get any mechanism to control the weed and it is causing dual problem, loss of production and makes the straw out of use as animal feed.

Rain fed coffee-khat (chat)-tree based sub-cluster farming system

This sub-cluster farming system is found in Merti, Gololcha, Chole, Aseko, Guna districts. These districts are known for coffee production in the zone but only Gololcha coffee is recognized in national market. The main enterprises in this sub-cluster are perennial tree plants like coffee, khat, banana and other fruits like orange and lemon. The average landholding of the area is around 1.44ha/HH. From the survey result conducted data, around 30 percent of total landholding was covered by coffee which is the largest share followed by maize which is around 25 percent of total landholding.

Table14: landholding and allocation in coffee-khat (chat)-tree based farming

No.	Description of Variable	Mean Value	Std. Deviation
1.	Total landholding	1.44ha	0.52
2.	Maize farm	0.36ha	0.25
3.	Coffee farm	0.43ha	0.32
4.	Share of coffee farm from total farm land	29.73%	

Source: data from FGD participants

Coffee is not only the grown on more share of land but it is the most and first ranked livelihood activity in the area followed by other cereal crops like maize, sorghum and teff. Khat is the third most important livelihood activity next to cereal crops production.

Major production constraints in *c*offee-khat (chat)-*t*ree *b*ased *f*arming

The major coffee production constraints were categorized into two major groups by the farmers as production side and harvest and postharvest handling and market related problems constraints. From production side, the entire traditional production system is the main one. In this regard, there is no research and development intervention (support) which means there is no improvement in quality and productivity of coffee seed, production techniques, high disease incidence but no identified protection or treatment methods (no chemical or agronomic practices). In other hands, poor soil fertility, erratic rain fall, deforestation which causes loss of coffee shades were other pertinent constraints.

The second constraint category was market and institutional related problems which includes absence of coffee processing and storage facilities, absence of legal market outlets, and low price of produce. Farmers process and store their produces by skill and technologies they acquired traditionally. Except for Gololcha district, coffee produce of rest districts is not registered and recognized/legalized in national market. Therefore, farmers are forced to sell their produce to coffee collectors and other illegal traders who set price themselves. The second production constraints (market related) is the most severe one which is much discouraging the producers. Because of this problem farmers reported that there is shift of enterprise from coffee to khat (*chat*) (replacing coffee farm by khat trees). Therefore, much has to be done on market development of the product before the farmers devastate their coffee farms and replace by khat.

In this sub-cluster farming system since there is production of other cereals their production constraints were also identified and prioritized in order of their economic importance. Change in climatic conditions, crop pests like shoot fly, stock borer, and wheat rust were the most important constraints.

Table 15: Major production constraints in coffee-khat based farming system

Non-coffee crops farm constraints	Coffee production constraints	Rank
Erratic rainfall	No research and development intervention	1
Poor soil fertility b/c of high erosion &	Seed and other inputs supply shortage	2
Limited farm size	Poor natural resource base (soil and forest)	3
Chemicals supply and high prices	Coffee disease	4
Invasive weed	Poor market and postharvest handling facility	5
	Low price of coffee produce	6

Irrigation *b*ased *s*ub-*c*luster *f*arming *s*ystem

Modern irrigation schemes are found in four districts of Arsi zone namely L/bilbilo, Tiyo, Zuway-dugda and Merti. For this research purpose irrigation based production constraints were collected using farmer FGD and household survey in Zuway-dugda district while discussion with districts experts was conducted in Merti and Zuway-dugda districts. Total landholding in this sub-cluster farming system was around 1.4ha per household. The farmers hold on average about 0.5ha of irrigated farm. But from discussion made with districts' experts, FGD held with farmers and HH survey, it was understood that most irrigated farms were rented out to non-PA member individuals who migrates from neighboring districts and regions (Tigray, Amhara and SNNP). The major irrigated crops were potato, onion, cabbages, head cabbage, carrot, papaya, beet roots, garlic and the like. In some cases cereals like maize are also produced using irrigation system.

Major crop production constraints in irrigation *b*ased sub-cluster farming system

The major production constraints were identified in this sub-cluster farming system. The most important ones were; high supply shortages for pesticides, fertilizers, and seeds. High price and ineffective chemicals, high involvement of brokers and illegal traders both in input supply and farm output selling, absence of credit facilities for resource poor farmers to get working capital and inactive involvements of irrigation users associations (producers' cooperatives) in input supplying and output marketing. Because of its relative remoteness, access to agricultural support institutions like research centers, seed enterprises, and mechanical technologies providers was another serious constraint of irrigated farm in Arbagugu districts like Merti. Furthermore, high postharvest loss and low price of products were other challenges due to poor technological intervention for storage preservation. Furthermore, excessive use of chemical fertilizers and pesticides were practiced which may cause contamination of ground table water and disturbs soil properties unless it is treated with natural fertilizers which may take long time. However, further specific research is needed to give more recommendation on this issue specifically.

Pastoral and agro-pastoral sub-cluster farming system

This farming system is found in eastern part of Arsi zone. The registered pastoralist and agro-pastoralist kebeles (PAs) were found in Merti district. According to the report from district's office of agriculture and natural resource development there are two pastoralists and one agro-pastoralist PAs. The main staying livelihood of this farming system was livestock keeping. The major livestock types were cattle, goats, camel, equine animals and poultry. The agro-pastoralists are practicing crop production and the main crops were maize and sorghum. Large size of land was allocated to pasture/grazing land in this farming system at household level. According to data from district's rural land administration office, pasture land is greater than crop cultivated land by around 42 percent.

The main production constraints in this farming system were drought, which causes feed and water shortage, animal diseases and absence/shortage of health service centers, supply shortage of medicines, logistic problems at district level (like vehicle, budget for per diem) to deliver services. Even though there is large number of camel population in the district, it was reported that there is low attention given to this sub-sector which can be demonstrated by no research and development interventions. To overcome the constraint in this area there must be joint plan between research centers, districts' agriculture office and livestock agency on water saving technologies, demonstration of short maturing and drought resistant forage varieties. Further study on ground water table should be conducted and wind and solar pump technologies should be introduced by agricultural engineering research centers.

Peri-*u*rban *s*ub-*c*lustered *f*arming *s*ystem *c*haracteristics

There is high expansion of peri urban farming in developing countries because of high rate of urbanization. In general there are two kinds of farmers in most peri urban areas. The first group was those who have their own farmland and produce themselves on their own farmlands, while the second groups those who are dwelling in towns but rent/shared in some farmlands and produce agricultural and livestock products. From discussion made with farmers and districts' experts, those living in peri urban areas and working on agricultural activities were the most updated farmers and technology user in both livestock and crop production. Their production goal is also market targeted; they have higher productivity per unit. But in the case of second group, even though they are using more inputs since they are not members of PA, and in most of the cases they work on farm as secondary activity, they do not get extension services (training and participation on demonstration activities) they lack skill and knowledge which lead to low productivity.

Agricultural mechanization technology use in Arsi Zone

Absence of or supply shortage of agricultural mechanization technologies were the most important production constraint in almost all farming system of Arsi. In all farming system clusters shortage of animal feed resulted in farm power shortage which needs solution from agricultural mechanization by searching for alternative inanimate farm power.

In all wheat, barley and teff growing areas, even though farmers understood the importance of row planting, absence of row planting technologies were the most important bottleneck. There was misapplication of different types of chemicals reported from bureau of agriculture and natural resource development at each district. The existing chemical sprayer equipment (knapsack) which was carried on human's back is unsafe for the operator and tiresome. Therefore, in addition to training farmers on chemical application safety, modernizing/further mechanizing the technology was mentioned as a solution from experts (FGD at district level). In areas where combine harvesting was not used because of availability or inaccessibility due to topography, harvesting and threshing/shelling technologies were the most important demanded technologies. Therefore, availing at hand technologies like walking behind wheat-barley harvester evaluated by Asella agricultural engineering research center, multi-crop thresher for wheat, barley, teff and sorghum and maize sheller should be the first priority action.

According to data from office of agricultural and natural resource development respective districts, there was no registered data for intermediate agricultural mechanization technologies and even in most districts the technologies were not known by experts except BBM use in almost all vertisol areas like DigelunaTijo, parts of LemunaBilbilo, Shirka, Arsi-robe and the like districts. However, there is estimated number of farmers (in percent) who were using large mechanization technologies specially for crop production like tractor and combine harvesters. Combine harvester is entirely used for wheat crop because of two main reasons. The first reason was lodging nature of most barley crops and the second reason was that farmers don't want wastage of barley straw because of its palatability as animal feed.

Table 16: Agricultural mechanization technologies use status across districts

		Percent of technology using households for technologies				
No.	Districts/farming system	Tractor	Combiner	Cart*[6]	BBM**[7]	Warehouse*
1.	Highland barley-root crop	7.5 (5%)	24.5 (10%)	20	1.9	5
2.	Non-mechanized wheat-teff	0(0)	0(5%)	1	15.4	50
3.	Irrigation based	2.9(1%)	8.6 (1%0	50	0	5
4.	Mechanized wheat belt	85.7(55%)	97.1 (100%)	5	0	40
5.	A/Robe (non-mech)	0(20%)	0 (10%)	2	44.4	20
6.	Chole (Coffee-non-mech)	0(0)	0 (0)	0	12.5	29
7.	Merti (pastoral/irrigation)	0(0)	0(0)	5	0	0

Numbers in brackets are data from district's office agriculture while those out of brackets were computed from HH survey

[6]*data is from HH survey result
[7]**data is district offices of agriculture and natural resources development

In non-mechanized farming system lack of awareness, accessibility, and inappropriateness of the topography, high price of services for tractor and combine harvester were the main constraints to use mechanization technologies. Lack of awareness and accessibility of technologies were main constraints in wheat-teff based mixed farming system while affordability of the service prices specially for tractor and combine harvesting machineries were the main constraint in lowland areas of resource poor maize-sorghum based mixed farming system and some parts of wheat-teff based mixed farming system in Arsi-robe surrounding districts. Topography and lack of appropriate technologies for their topography was the most important constraint in barley-root crops based sub-cluster farming system.

Most completed and on-going agricultural engineering research, pre-extension demonstration and pre-scaling up activities by Asella agricultural engineering research center were focusing on and biased towards highlands and mid-highlands wheat-barley growing farming systems and little attention was given to lowland moisture stressed areas of the zone. Therefore, following expansion of drought from time to time in the zone, besides conserving soil and water resources, technologies that enable farmers/pastoralists/agro-pastoralists to use existing water efficiently should be given due attentions from researchers side while the existing at hand technologies should be identified and availed for demonstration and pre-scaling by concerned bodies.

Livestock production system

Livestock was found to be the most important farm activity in both agro-pastoral and crop-livestock mixed farming system. The overall mean livestock holding of the household was 7TLU. However there is difference in livestock type based on climate and intensity of crop farming across districts. The major livestock type was cattle with overall mean of 6.2 followed by poultry birds and sheep having means of 3.9 and 2.9 each respectively. In Merti district there were around 36283 head of camel population. There was lowest cattle possession in Hetosa district which may be due to extensive crop production as expected and the highest cattle possession per household was found in Shirka, Chole, L/Bilbilo, Arsi-robe and Zuway-dugda districts respectively.

Livestock breed improvement in Arsi zone

According to CSA, 2015, Arsi zone was ranked first in livestock population having 2.5 million cattle, 1.66 million of sheep 0.74 million of goats, .24 million of horse, 0.02 million mules, 0.4 million donkeys, 0.03million camels, 1.88 million poultry birds and 0.12 million of beehives which shows that there is huge potential of this sector. In general when we see the composition of cattle herd, each household has on average 1.2 cattle per household with largest mean in Shirka and Lemu-bilbilo each possessing 3.2 and 2.2 crossed breed respectively.

Shirka district has largest proportion of crossed breed (about 34 percent) followed by Lemuna-bilbilo, Chole and Arsi-robe districts with mean proportion of 26, 21 and 13% respectively. Only 27 percent of the households used AI service to improve their breed quality while 32% used neighbors' bulls for free and 8 percent used rented neighbors' bull. Around 10 percent of them were using their own bull and the rest were not using improved breed (Table 19).

Even though there is high livestock potential in the lowland maize-sorghum based farming system, there is no significant activity done so far to improve livestock breed. The KII resultfrom Zuway-dugda revealed that the Asella is the main milk and other dairy product supplier to Ogolcho town.

Table17: Livestock population in Arsi zone

Livestock type	Total population	Indigenous	Hybrid	Exotic
Cattle	2528903	2,404,996	111,85212,055	
Sheep	1,662,797	1,662,797	-	-
Goats	738,729	-	-	-
Horses	240,559	240,559	-	-
Mule	20,337	20,337	-	-
Donkey	421,733	421,733	-	-
Camel	28,942	28,942	-	-
Poultry	1,885,492	1,784,449	70,947	30,096
Beehives	122,779	121,815[8]	0[9]	964[10]

Source: CSA, 2015

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 Arsi zone was around 2.2 liters per a household per day. The productivity of local cow per day was 1.52 litter/day/cow and productivity of crossed cow was 3.16 which was not as such significant. But the potential for both local and crossed breed were much higher than mean value, 6 and 26 liters/day/cow respectively. Therefore, working on all aspects of the dairy cows like feed and health can improve the production and productivity. Furthermore, livestock in 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.

Livestock production constraints

Cattle and small ruminant production constraints

In general the livestock production constraints were tried to be identified and prioritized in order of their importance in each farming system. Overall constraints were categorized into five clusters as feed related

[8] Traditional beehives

[9] Intermediate beehives

[10] Modern beehives

constraints, health related constraints, breed related constraints, and financial and human power related constraints (Table 18). Feed related constraints are ranked first in both farmers FGD, discussion made with experts at each district and household level survey data in all farming system clusters.

Regarding feed, shortage of grazing land due to expansion of farm land to marginal areas, inaccessibility and high price of supplementary feeds, lack of improved forage varieties, lack of awareness and skill on improving nutritional value and palatability of aftermaths and straws due to poor extension service on livestock sector were the main production constraints in all clusters. High water shortage for their stocks were reported by lowland maize based crop-livestock mixed farming, agro-pastoralists of Merti areas and parts of wheat-barely based mid highland parts around Lemu-bilbilo districts (Sirbo, Siraroetc PAs).

Table 18: Livestock production constraints in Arsi zone across different farming system

	District							
Constraint	L/bilbilo	Shirka	Z/dugda	Hetosa	A/robe	Chole	Merti	Overall
Feed related	81%	77	86	94	78	79	100	85%
Health related	45.3%	54	49	29	33	38	58	42%
Breed related	11.3	0	0	3	17	13	25	8%
Labor shortage	58%	36	48	72	39	23	51	47%
Capital shortage	12%	16	51	13	76	34	69	39.7%

The main problems related with health were absence of vaccines and medicines, poorly equipped animal clinics, shortage of skilled staffs in the clinics, and location of health posts/clinics at distant places from farmers' villages. These problems forced farmers to use non-prescribed medicines without the knowledge of health professional and created drug resistant diseases, opened black marketing of drugs trading; high priced drugs and invited expired and ineffective drugs to the market.

Main problems related to breeds were absence of AI service in most districts and its ineffectiveness in most of the cases. According to the information from districts' experts the ineffectiveness was due to three main reasons. The first one was unskilled inseminators, and the second was wrong approach of the hormone synchronization campaign which is centrally planned at regional level and didn't consider the situation at each specific area. For instance in some areas, program may start during peak dry season when animals body conditions were not appropriate for conceiving pregnancy. The third reason was inadequate facilities for AI service provision.

Absence of breeding policy as general where everybody was doing without any control (uncontrolled breeding activities) was harming even the merits of local breeds, poor market linkage for output, low mechanization technological interventions both at production and processing stages, poor research and extension service on animal feed improvement were most important constraints identified by discussion with districts' livestock experts. For small ruminants livestock, there was no recorded improved breed in Arsi zone which is similar with CSA, 2015 report which shown that there were no attempt to improve the existing breed. In Ethiopia in general improved breeds of sheep were only found in Amhara region which may be due to high research and development intervention in the region. In Oromia also there were two research centers (Yabello and Adami-Tullu) which were working on small ruminant improvements and Arsi zone has to use this opportunity to improve the breed in the zone. In case of small ruminant absence of (supply shortage of) vaccine and medicines for treatment, feed shortage, low productivity of the breeds, and low extension support were the major constraints.

Table 19: Livestock possession of householdsacross districts

District	Oxen	Cow	Total cattle	Cross cattle	Ratio*	Sheep	Goat	Donkey	Poultry
L/Bilbilo	2.28	1.86	6.47	2.20	34%	4.2	1.9	1.4	2.5
Shirka	2.77	2.30	9.23	3.20	34%	4.9	0.7	1.4	3.6
Z/dugda	1.83	2.40	6.10	0	0%	2.4	1.8	0.9	3.3
Hetosa	2.37	0.94	4.80	0.5	6%	1.4	0.7	1.2	5.8
A/robe	1.83	1.90	6.40	1.40	13%	2.3	1.0	1.1	2.0
Chole	1.86	2.00	6.80	1.20	21%	2.9	1.3	0.5	4.3
Merti	1.50	1.40	5.30	0.40	6%	2.3	0.7	1.3	8.0
Total	2.11	1.80	6.20	1.20	15%	2.9	1.3	1.1	3.9

*Proportion of crossed breed cattle with total cattle

Poultry production and its constraints in Arsi zone

Highest proportion of households keeping improved poultry breed were found in Shirka, Arsi-robe, and Merti districts each accounting for about 54, 44 and 33 percent of households respectively. But the highest improved poultry breed proportion was found in Hetosa district followed by Shirka and Arsi-robe each having 2.03, 1.69 and 1.33 birds per households. The overall mean poultry kept were 0.88 improved and 2.97 local poultry birds (Table 19 and Table 20).

Table 20: Overall poultry possession in Arsi zone

	Breed Type	Mean number of birds	Sta. Deviation
1.	Improved breed	0.88	4.2
2.	Local breed	2.97	4.8

Disease was the first ranked poultry production constraint; vaccine and medicine were not available or there is problem of indivisibility of vaccine that challenges extension service provision. The available poultry vaccine was packed for 500 poultry birds and it doesn't consider the small scale production system of Ethiopia's farmers where a household is keeping about 3 to 5 poultry birds. The second constraint was shortage of improved breeds and infertility of existing commercial improved breed followed by lack of poultry feed supply.

Beekeeping activities and its production constraints in Arsi zone

Only around 17% of the households practice beekeeping and around 83 percent of the households didn't practice beekeeping because of different reasons. The most important reason that was ranked first was because of own ignorance while chemical applied to crops was also the most important cause for not practicing beekeeping (Table 21 and 22).

Table 21: Reasons for not participating in beekeeping activities

Reasons for not practicing beekeeping	Frequency	Non-practicing Percentage	Rank
Inconvenience of weather condition	16	8.4	6
Ignorance	60	38.0	1
Fear of chemical	34	21.5	3
Feed shortage	23	14.6	4
Fear of stinging	20	12.7	5
Labor shortage	5	31.6	2

Table 22: Constraints of beekeeping activities in Arsi Zone

Beekeeping constraints	Number of respondents	Rank
Chemicals applied to different crops	26	1
Bee forage and water shortage	15	2
Predators	7	3
High price and supply shortage of modern beehives	4	4
Labor shortage	1	5
Land shortage	1	5

Livestock feed availability status

The most important livestock feed types were own crop residue like straw (used by 78%), purchasing straw, grazing land etc (74%), crop aftermath (63%), own grazing land (57.4%), cut and carry (45%) and use of concentrate about 34 percent of total respondent. There is no single way of feeding animal and all household use one or more combination of these feeding systems (Table 23).

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Table 23: Feed type and season of their availability in the year

Feed type	Percent of users	Time of most availability
Communal grazing	21.6	June-October
Own grazing	57.4	June-October
Crop residue	75	throughout the year as contingency
Fodder	5.8	July-September
Crop aftermath	63	October to February
Cut and carry	45	July to September
Concentrate	34	when livestock get weak
Purchasing straws and grazing land	74	April to October
Prepare feed at home from grains	19	time of land preparation for oxen
Move livestock to other places	4	July to September

From table above it can be observed that forage production culture is too low (only around 6% of the respondents are producing) and there must be technological support in household level livestock feed preparation which could improve both nutritional and palatability of feeds like straw, crop aftermaths, and grasses.

From table 24 below one can observe that livestock feed is ample during the months September, and October, at normal status during November, December and January while there is high feed shortage during February, March, April, and May.

Table 24: Animal feed availability status across the months of the year

Status	Sep	Oc.	Nov.	Dec.	Jan.	Feb.	Mar.	Ap.	May	Jun	Jul	Aug.
Ample	56	52	42	28	11	5	4	3	5	24	35	44
Short	20	11	10	15	38	55	56	57	56	42	35	30
Normal	23	37	47	56	50	40	40	40	40	34	30	26

During period of feed shortage, farmers supplement their feed by buying other fodder, straws, hay from purchased grazing land and concentrates. The per-annual mean cost of purchasing supplementary animal feed was estimated to be about 2105.47 Birr. The highest cost for supplementary feed purchase was recorded in Lemu-bilbilo, Shirka and Hetosa districts with 4030, 2790 and 2005 ETB per annum respectively.

Soil and water conservation practices in study area

As it was shown in Table 25, most farmers (around 92 percent) responded that they were practicing both physical and biological soil and water conservation activities on their own farm lands. Soil bund construction and cutting check-dam were the widely used in physical conservation while planting multi-purpose trees and grasses were among the biological types of conservation. Most farmers grow different types of trees on their land but the widely practiced one is eucalyptus tree.

Table 25: SWC practices in the study area

Description	Frequency	Percent
Practices SWC activities	174	91.6
Construct soil bunds	142	74.7
Practices check dam	44	23.2
Planting grasses	34	17.9
Planting MPT	65	34.2

Almost all (around 97%) farmers practiced different soil fertility improvement activities. The most widely used practices were chemical fertilizer, composts, and crop rotation each practiced by around 78, 86 and 48 percent of farmers respectively. Even though the level of use and its preparation skill the farmers have is not studied, at least the start and level of awareness on compost use was encouraging and further study on level and skill should be studied (Table 26).

Table 26: Soil fertility improvement activities

Description	Frequency	Percentage
Practice soil fertility improvement activities	185	97.4
Use chemical fertilizer	149	78.4
Use compost	164	86.3
Use crop rotations	92	48.4

Farmers' perception towards change in farming systems

More than 84 percent of the total respondents perceived that there is change in their farming system since five years due to one or more factors (Table 27). Out of these around 26 percent of them responded that the change they perceived is due to climate change which affected time of raining, amount of rain per season, consistency of rain while around 54 percent of them responded there is change in farming system due to awareness, skill and knowledge they get from extension services provided to them by different bodies on advantages of using production inputs both in cop production and livestock production which increased their level of fertilizer, improved seeds and livestock breeds, pesticides and agronomic practices like land preparation, row planting, weed management and mechanization technologies use. Considerable number of respondents also perceived the change due to crop diseases like wheat rust, striga and smut (especially maize and sorghum farmers in Arbagugu districts like Chole and Merti).

According to the respondent, there is change in farming system in terms of time of planting mainly due to climate change, shifting from one enterprise (both crop and livestock) to another due to awareness change because of change in production goal (from household consumption to market oriented production) and there is also change/shift in enterprise due to disease and pest (for instance shifting from maize and sorghum to teff in Merti and Chole due to striga), while there is shifting of enterprise from pulses and wheat to teff and maize in Dida'a areas due to climate change (late entering of rain and high rainfall which leads to water logging due to large clay content of the soil of the area. There is also shift in enterprise from coffee production to khat (chat) due to poor market development in most coffee producing districts of Arsi except Gololcha district where their coffee is registered and recognized in national market. Most farmers change their dependence on agriculture and shift to non-farm activities like petty trade because of frequent crop failure, farmland shortage and search for better living standards in urban areas (Table 28).

Table 27: Dimension of change in farming system in Arsi zone (farmers' perceptions**)**

No.	Change Dimension	percent of respondent "Yes"
1.	Perceived change in farming system as a whole	84.20
2.	Change in time of planting	47.60
3.	Shifting of enterprises (both crop and livestock)	80.52
4.	Change in ways of production (agronomic practices)	38.87
5.	Use of improved inputs (both crop and livestock)	71.54
6.	Production frequency	9.23
7.	More dependency on crop production than livestock	81.2

Source own survey data result

Table 28: Cause of change in farming system in Arsi zone (farmers' perceptions)

No.	Cause of farming system change	percent of respondents
1.	Climate change	25.8
2.	Technological advancement	53.7
3.	Awareness, skill and knowledge change due to Extension service provision	60.3
4.	High crop disease incidence	87.53
5.	Soil fertility decrease due to frequent cultivation, poor Soil and water conservation	29.78
6.	Emerging use of irrigation facilities	11.3
7.	Decrease in grazing land and farmland	59.5

Conclusions and Recommendations

From the survey result it could be concluded that farming system in Arsi can be classified into two broad groups as agro-pastoral and crop-livestock mixed farming system and the later can also be sub-clustered into irrigation based farming system cluster, cereal crop based sub-cluster farming and coffee-khat tree sub-cluster farming system. The cereal based sub-cluster also further clustered into wheat-teff based farming system, barley-root crop farming and large seeded cereals (maize-sorghum) based sub-cluster farming system. In general even though each sub-cluster has its own specific production potentials and constraints, production inputs/technology accessibility, land shortage, natural resource degradation, lack of appropriate agricultural mechanization technologies for both livestock and crop production, malfunctioning of farmers' service providing institutions like credit, cooperatives, extension services, high crop and livestock disease incidences were the most important production constraints.

Major production constraints in Arsi zone were identified and they cannot be solved by single body rather they need integrated action of all sectors and sub-sectors. The for most constraints could be solved by pre-extension demonstration of existing technologies and wider extension activities while other challenges need further research activities both by biological researchers and engineering researchers. Production constraints occurring due to lack of awareness, like mono-cropping shall be solved by training and mass awareness creation while those created due to inaccessibility like that of agricultural mechanization technologies, improved seeds should be solved by improving extension service provision. The rest production constraints which need further researches shall be the agenda for respective disciplines researchers.

In most cases Arsi was haphazardly generalized as an area having highly advanced production system while the advancement in using mechanization and other improved biological and agronomic practices was limited to mid-highland and some highlands of the zone found along the main road from Adama to Bale. But the rest part of the zone is still characterized by backward production system, limited improved technologies like seed and mechanization technologies utilization and the situations were more aggravated by climatic change and poor natural resource basis.

Recommendations

For relatively non-mechanized part Arba-gugu and Did'a areas rehabilitation of natural resource basis, introduction of improved technologies like seed and mechanization technologies are best solutions. For areas where mono-cropping are problems, research on alternative rotational crops like faba beans should be conducted strongly both in availing disease resistant variety and mechanization technologies. Strengthening seed system, pesticide chemicals supply system, product marketing system and strong water resource utilization (development of irrigations) in all potential areas to solve farmland shortage by producing two to three times per a year and supplementing erratic rainfall are best way to overcome these problems.

In livestock production even though Arsi is one of the most known livestock keeping in the country, so far there is noresearch support especially in alleviating animal health and feed related production constraints. Therefore, the researchers recommend the establishment of livestock research in the zone.

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