Regional Review Workshop on Completed Research Activities

Proceeding of Review Workshop on Completed activities of Socioeconomics and Agricultural Extension Research Directorate held at Batu Fisheries and Other Aquatic Life Research Center, Batu Ethiopia 31 October-04 November 2022

Part 2: Socioeconomics Research

Editors:

Getachew Biru, Shelema Rafera, Birhanu Angasu, Beriso Bati and Solomon Ayale

Oromia Agricultural Research Institute

P.O.Box 81265, Finfinne, Ethiopia

Correct citation: *Getachew B., Shelema R., Birhanu A., Beriso B., and Solomon A. (eds.), 2022. Regional Review Workshop on Completed Research Activities of Socio-economics and Agricultural Extension Research Directorate held at Batu Fisheries and Other Aquatic Life Research Center, Batu Ethiopia 31 October-04 November 2022. Oromia Agricultural Research Institute (IQQO), Finfinne, Ethiopia. 311 pp .*

Organized by: - Communication Directorate

Table of Contents

Assessment of Poultry Production System in Arsi Zone, Oromia Regional State, Ethiopia

Ephrem Boka[1] Ibsa Dawud[2]
[1]Oromia Agricultural Research Institute (IQQO), Asella Agricultural Engineering Research Center
[2]Oromia Agricultural Research Institute (IQQO)-Asella Agricultural Engineering Research Center; Haramaya University School of Agricultural Economics and Agribusiness Msc student
Corresponding author's e-mail: - bokaephrem@gmail.com

Abstract

In developing countries, Poultry production has great role in the economies of a country and has also cultural and social benefits. Poultry production contributes for food security and has nutritional value. Despite the fact that, poultry products play an important role directly or indirectly in the livelihood of Ethiopian people particularly in Arsi zone, the Potential and Constraints aspects of poultry production have not yet studied and well documented. This research was initiated to assess poultry production potential and to identify constraints associated with poultry production system in the study area. Both primary and secondary data were used for the study. The data was analyzed using descriptive statistics. the result indicate that, in the study area village/backyard and small scale poultry production system is widely exercised and more than ninety six percent of the respondents produced less than fifty poultry per year. The average poultry holding of the respondents was 9 birds with minimum of 1 and maximum 400 birds. More than ninety percent of the respondents produced poultry feed by themselves due to unavailability and high prices of commercial feed. In the study areas poultry production is highly affected by poultry disease Newcastle and numbers of poultry is decreasing from time to time. Vaccination, good feed, good water, good housing and cleaning /disinfection are highly ranked as most important elements of poultry production. The respondents had information about improved breed and implement that used for feeding but they didn't utilize it due to unavailability and expensiveness of the technologies. Though there is access to credit for producers, they didn't utilize credit services due to high interest rate and religion case. Disease outbreak, High cost of commercial ration and Lack of production manual, were highly rated and ranked as poultry production constraints. Asella Agricultural Engineering Research Center and Regional and zonal livestock's expertise's should have to work on the technologies and constraints related issues.

Key words: Poultry, Production, Feed, Chicken, Eggs, Disease, Constraints

Introduction

In developing countries of the world Poultry production has great role in the economies of a country and has also cultural and social benefits that have higher contribution in the nutrition of family and poverty reduction. Poultry meat and egg production accounted for more than 28% of the total animal protein produced (*Tadesse et al., 2013;* Abera and Hussen, 2016,).

Poultry production and consumption provide different functions for the producer as compared to the other livestock production. Among the different functions, some are: Immediate source of cash income, Provides meat and egg for household consumption, Contributes for food security and creates employment, Source of organic fertilizer (Habte *et al.*, 2017), Requires low initial capital investment, small land and low labor input, Efficient feed converters and have a wide range of adaptability for different agro-ecologies, Their product is acceptable by most of the community and the meat and eggs contain, special proteins that allow children to grow strong and their brain to develop *(*Yenesew *et al.*, 2015).

Poultry is the most commercialized and has fast generation interval and high reproductive rate when compared to most other Ethiopian livestock agriculture. It is easy to rear and their output can be generally expanded more rapidly and easily than that of other livestock (Reta, 2009). Poultry products are highly marketable and poultry rearing as a business has high turnover rates, which increase village chicken contribution to the rural household economies (Dawit, 2010).

In tropical countries Poultry production is based on the traditional scavenging system and chicken are the most important poultry species. The largest proportion of eggs and poultry meat in Ethiopia is produced by village system (Tadelle, *et al.*, 2003). Poultry production in rural area has a tiny flock size (5-20 hens per home) and indigenous breed types rely on locally available feed as a supplement, as well as poor health care and other management techniques (Afras, 2018).

The poultry sector in Ethiopia can be characterized into three major production systems based on some selected parameters such as breed, flock size, housing, feed, health, technology, and bio-security (Bushira, 2012). These are village or backyard poultry production system (5-20 flocks), small scale poultry production system (50-200 flocks) and commercial poultry production system (1,000 – 10,000 flocks). The Ethiopian poultry population is projected to be around 56.06 million, with indigenous, hybrid, and foreign breeds accounting for 88.19 percent, 6.45 percent, and 5.36 percent of the total poultry, respectively (CSA, 2018). In Ethiopia, both types of chicken egg-laying and meat producing varieties are known as dual-purpose breeds (Fulas *et al.*, 2018*)*.

Modern poultry production started in Ethiopia about 40 years ago, mainly in colleges and research stations. The activities of these institutions focused on the introduction of exotic breeds and their distribution to farmers, along with appropriate management, feeding, housing and health care packages (Dawit, 2010). There are a few private modern production farms around Addis Ababa City and some state-run poultry multiplication centers have been established, with the aim of providing improved breeds to farmers through the extension service (Aklilu, 2007).

In Ethiopia there are about 60.64 million poultry population and distribution varies with regional states, higher in Oromia 20.8 million followed by Amhara Regional State 19.8 million and Harari Regional State 0.097 million has a lower poultry population (Alebachew *et al.*, 2018).

Beside the production there are many constraints that inhibit the productivity of poultry in Ethiopia. Dawit (2010) reported that, some of the constraints were shortage of exotic chicken, lack of good management practices, placing exotic and local chicken in one house which leads to diseases called New Castle (*Kinbil*), Salmonella and Chicken mites. The main problems of indigenous chicken in the tropic are that they are poor producers of egg and meat (Afras, 2018). According to Yared *et al*, (2019) major constraints of poultry producers were Disease outbreak, High cost of commercial ration, Unavailability of day old chicks in time, Market instability, Poor supply and quality of vaccine.

R.T. WILSON (2010) reported that, Percentage distribution share of Poultry production in Oromia was about 34. 45 percent and households owning domestic Poultry species in Arsi zone was 62 %. According to Arsi zone livestock resource development office annual report (2019), the total poultry population distributed in 26 Districts was 1,299,133 birds in which 1,108,727(85.34%) were local breed and 190,406(14.66%) were hybrids.

Despite the fact that, poultry products play an important role directly or indirectly in the livelihood of Ethiopian people, the Potential and Constraints aspects have not yet studied and well documented so for in Arsi zones of Oromia Regional state.
Thus, this study was initiated to assess the poultry production potential and to identify constraints associated with poultry production system in the study area

Research methodology
Description of the study area
The study was conducted in Arsi zone, located in Oromia Regional State of Ethiopia. Arsi zone is characterized by crop-livestock mixed farming system where crop production is dominant. The major crops grown are annual crops such as cereals, pulses, oilseed and vegetables (Samuel, *et al.*, 2017). The major livestock's reared in the area are cattle's, sheep's, Goats, horses, donkey's mules, Poultry and bee colonies (Mesay, *et al*., 2017). The total poultry population distributed in 4 Districts of the study area was 199,866 birds in which 170,573(85.34%) were local breed and 29,293(14.66%) were hybrids (Annual report 2019). The agro ecological zone of the study area is comprised of low altitude, mid altitude and high altitude.

Sample Size and Method of Sampling

The sampling frame of the study was poultry producer households which are found in selected Kebeles. A three stage sampling procedure was employed to select the specific respondents. In first stage, four representative potential poultry producer districts were selected purposively based on poultry producing potentials. In the second stage among the Kebeles of selected districts, two kebeles from each district were again purposively selected based on their poultry production potentials. In the third stage, using the population list of poultry producer farmers from sampled kebeles, the representative poultry producer households were randomly selected using simple random sampling technique. The intended sample size were determined by employing probability proportional to population size using formula given by (Yamane, 1967), at 5 percent level of precision.

$$\mathbf{n} = \frac{N}{1+N(e)^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

Where: n = the sample size,
N = 2140 total poultry producer households of selected kebeles,
e = 0.05 the level of precision
n = 2140/1+2140 (0.0025) = 337
Table 2.1. Sampled distribution of poultry producers in selected Kebeles'

Districts	Kebele	Total producers (N)	Sampled producers (n)
Lemu and Bilbilo	Ciba michel	282	44
	Bokoji negeso	274	43
Digalu and Tijo	Dgalu bora	275	43
	Kogo ashebeka	270	43
Lode hetosa	Melka jabbi	263	42
	Addamare	257	40
Dodota	Dodota alem	256	40
	Lode sharbe	263	42
Total		2,140	337

Source: Own computation, 2021/22

Data types, sources and methods of data collection

The study utilized both primary and secondary data. Those selected farm households involved in poultry production were used as a source for collection of primary data through structured interviews. A pre-test was conducted on some respondents and some adjustments were made to the questionnaire and the data used in the research was collected from 337 respondents.
In addition Focus Group Discussion (FGD) at each selected district and Key Informants' Interview (KII) with expert; at different level were employed using checklists to obtain additional supporting information for the study. Secondary data were collected from different published and unpublished sources, such as, the District and Zone Agricultural and Natural Resource Development Office (DANRDO), website and reports were utilized to generate relevant data on poultry production potentials and constraints.

Method of data analysis

In this study descriptive statistics was employed for analyzing the data collected from poultry producers. Data collected were analyzed using SPSS and Survey results were reported using descriptive statistics such as mean, frequency, percentage. Addition to descriptive statistic, tables and histogram were also used to present the data.

Results and Discussion

Demographic and socio-economic characteristics of respondents

Survey result indicates that in the study area, out of total samples 71.5 percent of the respondents were male, whereas 28.5 percent of the respondents were female. As marital status of respondent 92% married, 6.5% single and 1.5% widowed. The mean age of the respondent's household, was 38.75 with minimum and maximum of 20 years and 75 years respectively. The average education level of the respondents was 6.5 grades with minimum and maximum of grade one (1) to 1st degree, respectively. The average number of family size of the respondents was 4.9 with minimum and maximum of 1and 18 respectively.

Table3.1. Household Characteristics

Household characteristics	Observation	Min.	Max.	Mean	St.Dev.
Age of the household head	337	20	75	38.75	11.68
Household Educational status	337	1	15	6.48	3.34
Total family size	337	1	18	4.98	2.27

Source: survey result. 2021/22

Land and Livestock Ownerships

Land Ownership

The mean land holding of the respondents were 1.4ha for cultivated with minimum and maximum of 0.02ha to 8ha. The mean grazing lands of the respondents were 0.4ha, with minimum and maximum of 0.02ha to 2ha. The average homestead land of the respondents was 0. 22ha, with minimum and maximum of 0ha to 1.2ha.

Table3.2. Land ownership of household

Household Land owner ship	Observation	Min.	Max.	Mean	St.Dev.
Cultivated land of HH in ha	312	0.02	8	1.4	1.22
Grazing land in ha	88	0.02	2	0.4	0.45
Homestead land in ha	303	0.00	1.12	0.22	0.19

Source: survey result. 2021/22

Livestock Ownership

Livestock is one of the most important assets for the rural community of Ethiopia as a general and specifically for the study area. Livestock serve the community in different aspect of social and economic aspect, like being source of drafting power, food, source of income, insurance, and transportation services. The study areas are hallowed by livestock properties of different type like cattle, ship, goat, horse, donkey and poultry (chicken). The average poultry holding of the respondents were 9.19 birds with minimum and maximum of 1 and 400 bird's respectively.

Table3.3. Livestock ownership of household

Household Livestock ownership	Observation	Min.	Max.	Mean	St.Dev
Number of cows	199	1	6	1.45	0.72
Number of calves	140	1	3	1.32	0.49
Number of heifers	83	1	5	1.36	0.67
Number of oxen	241	1	8	2.06	0.98
Number of horses	97	1	4	1.32	0.65
Number of donkey	121	1	3	1.55	0.62
Number of mule	3	1	3	1.67	1.16
Number of goat	52	1	50	6.00	8.43
Number of sheep	158	1	50	6.11	6.02
Number of poultry	337	1	400	9.19	23.35

Source: survey result. 2021/22

Poultry production system in the study area

In the study area there are two major production systems are found, such as village or backyard poultry production system which contains less than fifty flocks and small scale poultry production system which contains more than fifty and less or equal to four hundred flocks. The common production system used in the area was mostly extensive (village or backyard) type that is characterized by small flock sizes. In the study area local poultries produce on average 40 eggs /year/hen while improved breeds produce an average of 250 eggs /year/hen.

Out of total respondents 61.7 percent engaged in layer chicken for eggs production whereas 2.1 percent of the respondents engaged in broiler chicken for meat production. From total respondents 36.2 percent engaged in both broiler and layers chicken for meat and eggs production. Concerning seed sources of poultry production for egg and meats production, 56.97 percent of the respondents utilized local markets as a seed sources for meat chicken whereas 32.05 percent of the respondents didn't engaged in production of meat chickens and only 10.98 of the respondents obtained meat chickens from commercial growers. From total respondents 78.3 percent of the respondents utilized local markets as a seed sources for layer chicken whereas

14 percent of the respondents obtained layer chickens from commercial growers and 7.7 percent of the respondents didn't engaged in production of layer chickens.

Table3.4. Types of poultry production in the area

Types of poultry	Frequency	Percent
Broiler poultry for meat production	7	2.1
Layers poultry for eggs production	208	61.7
Both broiler and layers	122	36.2
Total	337	100

Source: survey result. 2021/22

Table3.5. Sources of breeds for meat poultry production

Sources of breeds	Frequency	Percent
Meat poultries from local markets	192	56.97
Respondents didn't engaged in production of meat poultries	108	32.05
Meat poultries from commercial growers	37	10.98
Total	337	100

Source: survey result. 2021/22

Table3.6. Sources of breeds for layer poultry production

Sources of breeds	Frequency	Percent
Layer poultries from local markets	264	78.3
Layer poultries from commercial growers	47	14.0
Respondents didn't engaged in production of layer poultries	26	7.7
Total	337	100

Source: survey result. 2021/22

Types and Sources of poultry feed utilized by the respondents

Types of poultry feed utilized by the respondents

Out of total respondents about 62.3 percent of the respondents were utilized homemade feed for poultry production whereas 25.2 percent of the respondents utilized by mixing homemade and commercial feed for poultry production. Out of interviewed respondents only 12.5 percent of the respondents utilized Commercial feed for poultry production. The majority of the respondents utilized homemade feed for poultry production due to unavailability and high prices of Commercial feed for poultry production.

Table3.7. Types of poultry feed utilized by the respondent

Types of poultry feed	Frequency	Percent
Homemade feed	210	62.3
Commercial feed	42	12.5
Both Commercial and Homemade feed	85	25.2
Total	337	100

Source: survey result. 2021/22

Sources of poultry feed utilized by the respondents

The majority of poultry producer respondents produced poultry feed by themselves as indicated below. 65.6 percent of the respondents engaged in poultry production by preparing feeds by themselves, whereas 30.2 percent of the respondents engaged in poultry production by preparing feeds and mixing it with commercial feeds. Only 4.2 percent of the respondents utilized commercial feed for poultry production.

Table3.8. Sources of feed for poultry production

Sources of poultry feed	Frequency	Percent
Self-production	221	65.6
Feed company	14	4.2
Self-production and mixed with commercial feed	102	30.2
Total	337	100

Source: survey result. 2021/22

Annual poultry production capacity

From total respondents 96.1 percent of the respondents produced less than fifty (50) chickens in a year which is categorized as Village (backyard) poultry production system, whereas 3.9 percent of the respondents produced from 50 to 400 chickens in a year and categorized as small scale poultry production system. The classification is similar with the study conducted by (Bushira, 2012) and (Fulas *et al.*, 2018*)*.

Table3.9. Annual poultry production capacity

Poultry production capacity	Frequency	Percent
Village (backyard) < 50	324	96.1
Small scale from 50 -400	13	3.9
Total	337	100

Source: survey result. 2021/22

Annual egg production capacity

From total respondent 38.1 percent of the respondents produced more than one hundred to one thousands eggs in a year whereas 55.3 percent of the respondents produced more than one thousands and five thousands eggs in a year. Out of total respondents 3.6 percent of the respondents produced more than five thousands and ten thousands eggs per a year whereas only 3.0 percent of the respondents produced more than ten thousands eggs in a year.

Table.3.10. annual egg production capacity

Egg Production capacity	Frequency	Percent
Less than < 1000	127	38.1
From 1,000 to 5,000	188	55.3
5,000 to 10,000	12	3.6
> 10,000	10	3.0
Total	337	100

Source: survey result. 2021/22

Annual average poultry and eggs production capacity and share of market and consumptions

The mean poultry production capacity of the respondents was 14.92, with minimum of 1 and maximum of 400 per year. The mean Eggs production capacities of the respondents were 2378, with minimum of 100 and maximum of 109,500 per year. From annual poultry production the mean share of markets were 11, with minimum of zero (0) and maximum of 390 per year. From annual poultry production the mean share of consumption were 4 with minimum of 1 and maximum of 10. From annual eggs production the mean share of market were 1,934 with minimum of 50 and maximum of 108,000. From annual eggs production the mean share of consumption were 444 with minimum of 50 and maximum of 1500.

Table.3.11. Annual poultry and egg production and share of market and consumptions

Household Land owner ship	Min.	Max.	Mean
Annual poultry production capacity in chickens	1	400	14.92
Annual egg production capacity in eggs	100	109,500	2378.35
From annual poultry production share of market	0	390	11.30
From annual poultry production share of consumption	1	10	3.62
From annual egg production share of market	50	108,000	1934.42
From annual egg production share of consumption	50	1,500	443.93

Source: survey result. 2021/22

Information on poultry diseases

Out of total respondents 98.5 percent of the respondents have information on poultry diseases whereas 1.5 percent of the respondents have no information on poultry diseases. Almost all of the respondents have information on poultry diseases.

Table.3.12. Information on poultry diseases

Information on diseases	Frequency	Percent
Yes	332	98.5
No	5	1.5
Total	337	100

Source: survey result. 2021/22

Poultry disease found in the area

The Poultry disease found in the study areas are Newcastle, Fowl pox, Fowl typhoid, Salmonella and Gambaro. From total respondents 84.2 percent replied Newcastle was the most viral disease that attacked the poultry. Out of total respondents 11.6 percent of the respondents replied that Fowl pox was the viral disease that attacked poultry. Others disease Fowl typhoid, Gambaro and Salmonella consists 4.2 percent of the respondents.

Table.3.13. Poultry disease found in the area

Poultry disease	Frequency	Percent
Newcastle	284	84.2
Fowl pox	39	11.6
Fowl typhoid	5	1.5
Gambaro	4	1.2
Salmonella	5	1.5
Total	337	100

Source: survey result. 2021/22

Vaccination application for poultry diseases

Out of total respondents 67.1 percent applied vaccination for poultry diseases whereas 32.9 percent of the respondent's didn't applied vaccination to poultry diseases and one can concluded that almost one third of the respondents didn't applied vaccination for poultry diseases .

Table.3.14. Vaccination application for poultry disease's

Vaccination application	Frequency	Percent
Yes	227	67.1
No	110	32.9
Total	337	100

Source: survey result. 2021/22

Focus Group Discussion and Key informant interview

The results of FGD and KII indicate that the majority of poultry producer's farmers/individuals have got improved poultry breed from local markets and suffer due to poultry disease. The different kinds of poultry feed utilized in the area are: Corn, Corn powder, "Fino". Wheat, Barely, and "Mitin".and the poultry feed widely utilized in the study areas are Corn, Corn powder, Wheat and Barely.

The poultry disease found in the study area is Newcastle, Fowl pox, Fowl typhoid and Salmonella. Newcastle is the most dangerous disease that complicated the life of individuals engaged in poultry production. During discussion and interview the respondents replied the number of poultry is decreasing from time to time due to disease.

Traditional way of poultry production system is widely utilized in the study area and the producer farmers hold from one to twenty (1-20) flocks. From annual poultry production, concerning share of sale and consumption they replied that share of sale is 75 percent and share of consumption is 25 percent.

Important elements of poultry production

As an important elements of poultry production, different things like vaccination, Good starting stock, Use of medication, Good housing, Good feed, Good water, Skilled workers, Good weather and Cleaning /disinfection were listed to rank as Most important, Important and Less important. Accordingly vaccination, Good feed, Good water, Good housing and Cleaning /disinfection were ranked from first to fifth as most important elements for poultry production by scoring 78, 75.6, 73.6, 71.2 and 69.4 percent respectively. The results of focused group discussion and Key informant interviews also confirmed the ranking of important elements of poultry production.

Table.3.15. Important elements of poultry production

No	Factors	Level importance	Frequency	Percent	Rank
1	vaccination	Most important	263	78.0	1
		Important	72	21.4	
		Less important	2	0.6	
		Total	**337**	**100**	
2	Good feed	Most important	255	75.6	2
		Important	76	22.6	
		Less important	2	1.8	
		Total	**337**	**100**	
3	Good water	Most important	248	73.6	3
		Important	88	26.1	
		Less important	1	0.3	
		Total	**337**	**100**	
4	Good housing	Most important	240	71.2	4
		Important	93	27.6	
		Less important	4	1.2	
		Total	**337**	**100**	
5	Cleaning /disinfection	Most important	234	69.4	5
		Important	101	30.0	
		Less important	2	0.6	
		Total	**337**	**100**	
6	Use of medication	Most important	192	57.0	6
		Important	142	42.1	
		Less important	3	0.9	
		Total	**337**	**100**	
7	Good weather	Most important	176	52.2	7
		Important	149	44.2	
		Less important	12	3.6	
		Total	**337**	**100**	
8	Skilled workers	Most important	170	50.4	8
		Important	161	47.8	
		Less important	6	1.8	
		Total	**337**	**100**	

9	Good starting stock	Most important	124	36.8	9
		Important	108	32.0	
		Less important	105	31.2	
		Total	**337**	**100**	

Source: survey result. 2021/22

Access to information and services

From total respondents 63.5 percent of the respondents had information about improved breed and implement that used for feeding poultry production whereas 36.5 percent of the respondents had no information about improved breed and implement that used for feeding poultry production. Market information is not as such problems because 78 percent of the respondents had access to market information on poultry production, whereas 22 percent of the respondents had no access to market information on poultry production. Concerning access to credit services 78.6 percent of the respondents had no access to credit services on poultry production. The majority of the respondent didn't utilize credit services for poultry production due to religion case and high interest rate.

Table.3.16. Access to information and services

Access to information	Response	Frequency	Percent
Access to improved breed and implements	Yes	214	63.5
	No	123	36.5
	Total	**337**	**100**
Access to market information	Yes	263	78.0
	No	74	22.0
	Total	**337**	**100**
Access to credit services	Yes	72	21.4
	No	265	78.6
	Total	**337**	**100**

Source: survey result. 2021/22

Constraints of poultry production

As challenges of poultry production different items were listed to the respondents to respond as challenges and not challenges. Disease outbreak 98.5%, High cost of commercial ration 89.9%, Lack of production manual 83.1%, Lack of skill/training 81.3%, Unlicensed suppliers of chicken on the market 81.3%, Supply of young chicken from unknown sources 81%, Wild animals like birds ("*chilfit*") and others 78.9%, Lack of good management practices 78.3%, Supply of chicken without vaccination 77.7% and Market instability 77.7%, were items ranked from first to tenth as poultry production constraints.

Disease outbreak, High cost of commercial ration and Lack of production manual, were ranked from first to third as poultry production constraints. From these one can conclude that before engaging in poultry production the listed constraints mentioned above needs high attention in poultry production system.

Table.3.17. Constraints of poultry production

No	Factors	Level challenges	Frequency	Percent	Rank
1	Disease outbreak	Challenges	332	98.5	1
		Not challenges	5	1.5	
		Total	**337**	**100**	
2	High cost of commercial ration	Challenges	303	89.9	2
		Not challenges	34	10.1	
		Total	**337**	**100**	
3	Lack of production manual	Challenges	280	83.1	3
		Not challenges	57	16.9	
		Total	**337**	**100**	
4	Lack of skill/training	Challenges	274	81.3	4
		Not challenges	63	18.7	
		Total	**337**	**100**	
5	Unlicensed suppliers of chicken on the market	Challenges	274	81.3	4
		Not challenges	63	18.7	
		Total	**337**	**100**	
6	Supply of young chicken from unknown sources	Challenges	273	81.0	6
		Not challenges	64	19.0	
		Total	**337**	**100**	
7	Wild animals like birds ("*chilfit*") and others	Challenges	266	78.9	7
		Not challenges	71	21.1	
		Total	**337**	**100**	
8	Lack of good management practices	Challenges	264	78.3	8
		Not challenges	73	21.7	
		Total	**337**	**100**	
9	Market instability	Challenges	262	77.7	9
		Not challenges	75	22.3	
		Total	**337**	**100**	
10	Supply of chicken without vaccination	Challenges	262	77.7	9
		Not challenges	75	22.3	
		Total	**337**	**100**	
11	High cost of chicken drugs	Challenges	258	76. 8	11
		Not challenges	79	23. 4	
		Total	**337**	**100**	
12	Lack of medicine on Market	Challenges	254	75. 4	12
		Not challenges	83	24. 6	
		Total	**337**	**100**	
13	Unavailability of day old chicks in time	Challenges	250	74. 2	13
		Not challenges	87	25. 8	
		Total	**337**	**100**	
14	Lack of a day old chicken producers nearby	Challenges	249	73. 9	14
		Not challenges	88	26. 1	
		Total	**337**	**100**	
15	Lack of credit services	Challenges	240	71. 2	15
		Not challenges	97	28. 8	
		Total	**337**	**100**	
16	Lack of follow up from agri. extension services	Challenges	226	67. 1	16
		Not challenges	111	32. 9	
		Total	**337**	**100**	

Source: survey result. 2021/22

Conclusion and Recommendations

Conclusions

The types of poultry production system in the study areas were village (backyard) and small scale poultry production system and mainly focused on Layers and Broilers together. Though broiler and layers chickens were exercised in the study areas, layers chicken for eggs production is the dominant and more than seventy percent of the respondents engaged in production of layer chickens.

The majority of the respondents 78.3 percent utilized local markets as seed sources of poultry production and this shows poultry production in the study areas is of local types.

More than ninety percent of the respondents produced poultry feed by themselves and very few less than five percent of the respondents utilized commercial feeds from feed companies.

The majority of the respondents utilized homemade feed for poultry production due to unavailability and high prices of Commercial feed.

Village and small scale poultry production system are widely exercised in the study area, because more than ninety six percent of the respondents produced less than fifty poultry per year and more than ninety three percent of the respondents produced less than five thousands eggs per year. Data collected from poultry producers, focused group discussion and key informant interviews showed that poultry production in the study areas is highly affected by poultry disease called Newcastle and decreased numbers of poultry from time to time.Vaccination, good feed, good water, good housing and cleaning /disinfection are the most important elements of poultry production and highly ranked by different respondents of the study areas.

The majority of the respondents had information about new technologies of poultry production but they didn't utilized it due to unavailability and high prices of the technologies and the respondents also didn't utilize credit services for poultry production due to high interest rate and religion case.

From listed constraints, Disease outbreak, High cost of commercial ration and Lack of production manual, were highly rated and ranked by respondents as poultry production constraints. From these one can concluded that before starting poultry farms the constraints listed above needs high attention.

Recommendations

* The majority of the respondents used local markets as breed sources of poultry production and this shows poultry production in the study areas is of local types. The government bodies working at regional, zonal and districts level should work on it unless improved variety utilization is under question.
* Due to high prices very few respondents' utilized commercial feed from feed companies, since it has an impact on growth rate and eggs production, feed producer micro enterprises should be established and well trained to supply.
* The highly rated poultry diseases found in the study areas was Newcastle (fengel), and highly affects poultry production, so vaccination and certification before distribution training for producer is highly needed from expertise.
* The majority of the respondents had information about new technologies of poultry production but they didn't utilize it due to unavailability and high prices of the technologies, Asella Agricultural Engineering Research Center should have to work on the technologies.

* Vaccination, good feed, good water, good housing and cleaning /disinfection were highly ranked as important elements for poultry production, so awareness creation and detail training is needed from livestock experts unless the traditional way cannot improve production and productivity of the subsector.
* Disease outbreak, High cost of commercial ration and Lack of production manual, were the three highly rated constraints mentioned by poultry producers, so preparing production manual, working on poultry health, increasing production and productivity of this sub sector is highly needed from livestock and veterinarian experts.

References

Abera Anja and Hussen Temkatu (2016), Assessment Potential and Constraints of Poultry Production in Marako Woreda, Gurage Zone, Southern Ethiopia

Afras A, Review of Chicken Production in Ethiopia with emphasis on Meat Production, Munich, GRIN Verlag. (2018).

Aklilu Hailemicheal (2007), Village Poultry in Ethiopia; Socio-technical analysis and learning with Farmers PhD thesis, Wageningen University, the Netherlands.

Alebachew GW, Ejigu AK, Adnie LY and Gebeyehu ST (2018) Poultry Production and Marketing Systems in Ethiopia: A Review

Arsi zone Agriculture and Natural resource development office annual report (2019), the local and hybrid poultry population distributed in 26 Districts of Arsi zone.

Bushra B, Status of indigenous chicken production and poultry production in Ethiopia. International Journal of Poultry Science, (2012); 6,128-136.

CSA (2018), The Federal Democratic Republic of Ethiopia, Agricultural sample survey, Volume II, Report on livestock and livestock characteristics (private peasant holdings). Statistical bulletin, 587, April 2018, Addis Ababa, Ethiopia

Dawit Gebregziabher (2010) Market chain analysis of poultry: the case of Alamata and Atsbi-wonberta woredas of Tigray Region

Fulas H, Yohannis H, Yobsan T, Abirham K, (2018); Review on Challenges and Opportunities of Poultry Breeds. Dairy and Vet Sci J; 7(2): 555706. DOI:10.19080/JDVS. 2018.07.555706.

Habte T, Amare A, Bettridge J, Collins M, Christley R and Wigley P, (2017); Guide to chicken health and management in Ethiopia. ILRI Manual, (2017); 25, 1-25.

Mesay, Y., Bedada, B., and Getachew, L. (2017), Improving the competitiveness of dairy Production via value chain approach: The case of Lemu and Bilbilo district in Arsi highlands of Ethiopia

Reta Duguma (2009). Understanding the role of indigenous chickens during the long walk to food security in Ethiopia. *Livestock Research for Rural Development*. (21) 116.

R.T. WILSON (2010) Poultry production and performance in the Federal Democratic Republic of Ethiopia World's Poultry Science Journal, Vol. 66, September 2010

Samuel, W., Rijalu, N., and Fikadu, M. (2017), Value Chain Analysis of Malt Barley (Hordeumvulgarel.): A Way Out for Agricultural Commercialization? The Case of Lemu Bilbilo District, Oromia Region, Ethiopia.

Tadelle Dessie, Million Tadesse, Alemu Yami and K.J. Peters, (2003). Village chicken Production systems in Ethiopia: 2. Use patterns and performance valuation and chicken products and socio-economic functions of chicken; *Livestock Research for Rural Development (15) 1.* Retrieved September 6, 2011, from http://www.lrrd.org/lrrd15/1/tadeb151.htm

Tadelle, D., D. Nigusie, and K. J. Peters. (2007), The feed re-source base and its potentials for increased poultry production in Ethiopia. Worlds Poult. Sci. J. 58:77–87.

Tadesse D, Singh H, Esatu AMW and Dessie T, Study on productive performances and egg quality traits of exotic chickens under the village production system in East Shewa, Ethiopia. African Journal of Agricultural Research, (2013); 8(13), 1123-1128.

Yared A. Ebsa, S. Harpal and Gebeyehu G. Negia (2019), Challenges and chicken production status of poultry producers in Bishoftu, Ethiopia

Yamane, T. (1967), Statistics, an introductory analysis, 2nd edn. Harper and Row, New York

Yenesew Abebe, Agraw amane, Yihenew G.Selassie and Dessalegn Molla, (2015). Poultry production manual, BDU-CASCAPE working paper 14

Impact of Contract Farming in Ethiopia: The case of Malting Barley in Highlands of Central and Southern Oromia

Tamrat Gebiso[1], Ephrem Boka[2], Ibsa Dawud[2]
[1]Oromia Agricultural Research Institute (IQQO)-Asella Agricultural Engineering Research Center; Haramaya University School of Agricultural Economics and Agribusiness PhD candidate
[2]Oromia Agricultural Research Institute (IQQO)- Asella Agricultural Engineering Research Center
Corresponding author's e-mail: - gebisochalla@gmail.com

Abstract

Contract farming, can be defined as an agreement between farmers and processing and/or marketing firms for the production and supply of agricultural products under forward agreements, frequently at predetermined prices. Malt barley producer smallholder farmers are practicing contract farming with different processors malt factories and breweries in Arsi and west Arsi zones. And hence, this research activity was initiated with objectives of identifying and characterizing contract farming models, identify factors that affect farmers' participation in malt barley contract farming and estimating impact of participation in malt barley contract farming practices. According to the result of FGD, secondary data and KII, the contract farming model that are followed in the study area are intermediary and resource providing contracts types. Furthermore, household educational background, participation in crop output marketing to cooperatives, participation in technology evaluation of malt barley (participatory technology demonstration and evaluation activities), participation in off/non-farm activities and size of land allocated for malt barley are significantly and positively affecting participation in malt barley contract farming practices. ATT for household income is 38685 Birr and statistically significant that implies participation in malt barley contract farming has positive and significant impact on income. However, the result on inputs intensity (improved seed, chemicals and fertilizer), size of land allocated for malt barley production, malt barley production per household and land productivity are statistically insignificant. The result of ATE reveals that amount of fertilizer application on malt barley increases by 2.95 Kg per household, while household income and malt barley production increased by 24462 Birr and 6.34qt respectively due to malt barley contract farming participation.

Keywords: contract farming; malt barley; PSM; participant; non-participant;

Introduction

The concept, contract farming, can be defined as an agreement between farmers and processing and/or marketing firms for the production and supply of agricultural products under forward agreements, frequently at predetermined prices (Eaton and Shepherd, 2001, ETA, 2016). According to The Food and Agriculture Organization (FAO) of the United Nations contract farming was also defined as "agricultural production carried out according to a (formal) contract between a purchaser and farmer which establishes conditions for the production and marketing of a farm product or products" (FAO, 2012). The arrangement often involves the purchaser in providing a degree of production support through, for example, the supply of inputs and the provision of technical advice. It is a form of vertical coordination whereby agribusiness firms contract farmers to produce for distant markets or to grow raw material for their processing facilities under various conditions (Prowse, 2012). A fundamental feature of contract farming is the shifting of risk from producers to processors since it is a form of futures market. These conditions might include providing seed, other inputs, credit, and technical services to smallholders while guaranteeing supply to the agribusiness firm. It is a mechanism by which agribusinesses replace or supplement primary agricultural production with supply from smallholders (Glover and Kusterer, 1990).

Contract farming has been used in both developed and developing nations as globalization; population growth and the development of rural infrastructure have opened new market opportunities for high value crops, certified crops and livestock production. Many countries like China, India, Latin America and African countries are promoting contract farming. For example, in Brazil 75% of the poultry marketing is under contract farming while in Vietnam, 90% of cotton and fresh milk, 50% of tea and 40% of rice production are under contract farming system (Sununtar Setboonsarng, 2008).

This model of farming has benefits both for agricultural producers (specially smallholders) and agribusiness firms (buyers). Contractual arrangements can facilitate smallholder access to inputs, technology, and extension services and connect smallholders to more lucrative regional and international markets. Studies have shown that smallholders engaged in contract farming schemes see their income increase as much as 44 percent (Roehlano, and Galang, 2014). For buyer firms, sourcing agricultural products by contract ensures a stable source of supply at a consistent quality, provides flexibility in annual procurement, and mitigates the risks of investing in production directly. Moreover, Contract farming is seen as a way to link smallholder farmers to markets, thereby addressing a major challenge in the transformation of agriculture in developing countries from subsistence farming to market-driven production. But it is not without any challenges.

Some exponents consider contract farming as a win-win arrangement and an efficient mechanism for reducing market failure and reaping mutual benefits for the actors involved from both sides. The other school of thought known as “Food First”, refers to contract farming as a “win-lose” arrangement. Detractors of contract farming stress the vulnerability and powerlessness of smallholder farmers in the contract relationship. In many contract farming schemes, there is disparity in price information between the farmers and the firm. Also, due to high prices of inputs, smallholder farmers may be locked into the arrangement due to the debts they accumulate. The “Food First” school sees contract farming as supporting the penetration of cash crops at the expense of food security. Yassin (2014) gives more details on this debate, which is also linked to the issue of “land grabbing”, or acquisition by external investors. Many see contract farming as a way to modernize agriculture in an equitable way. Others stress the inherently weak position of smallholders and consider contract farming as only marginally better than land grabbing. In Ethiopia, even though this debate is very much alive at the moment, the arrangement of contract farming is well supported by policy makers and a continuing activity.

According to the United States Department of Agriculture (**USDA**) estimates on September, 2022 and AtlasBig.com (2022), Ethiopia is the first largest barley producer in Africa and the seventeenth world barley producer. The number of smallholder farmers producing barley, size of land allocated for barley production and total amount barley produced are increasing from time to time in Ethiopia. For instance, CSA (2015) and CSA (2014) evidences these increments. However, land allocation and production of barley decreased by -2.59% and -1.64% respectively while yield increased by around 1% between 2019 and 2020 (CSA, 2021). But the share of malting barley is too small nearly 10% of total barley production and the demand for malting barley are in a deficit while the country is even exporting some amount of food barley (Alemu *et.al*, 2014) and the gap for malting barley being fulfilled by import and this deficiency is at an increasing rate. For instance, while in 1994, the net import bill amount for malting barley was US$240 thousand it was increased to US$40 million in 2014 and if this trend continues, it will increase to US$240 in 2025 (Shahidur., *et.al*, 2015). Teach

In contrast with the food barley where around 80% is consumed at household level, 70-80% of the malting barley produced is sold, with the balance for home consumption and for seed. Malting barley is predominantly grown as a cash crop, so market access is very important. The government of Ethiopia initiates the contract farming arrangement through ATA with number of objectives. Off many of them; as the demand of malting barley is increasing because of the increase in demand for beer in Ethiopia since the per capita consumption of beer is increasing, the government of Ethiopia invited two world's biggest breweries to the country and the current brewing malt are not enough for domestic consumption. As a result, the government plans to initiate the smallholder farmers to produce to fill this gap through different incentives like offering premium price. By doing this the breweries and malting factories are guaranteed for sustainable supply of malt, the farmers are also assumed to get better price, share risk of crop failure, and get sufficient input supply.

Oromia region's barley production as whole, accounts for about 52% of total national barley production (Shahidur R. *et.al*, 2015). The research was conducted in Arsi, West Arsi zones of south part of Oromia where barley production is more known practice due to agro-ecological favorability and good relative market opportunities because of Asella Malt factory establishment. Given the Arsi and west Arsi highland plain which is the most suitable (conducive) environment for barely production, Arsi zone is the most important and number one barley producer zone in Ethiopia and followed by Bale zone (Bekele *et al*, 2004).

With the consideration of all these situations, Diageo started contract farming arrangement formally with farmers of Arsi, W/Arsi and Bale zones in 2012 and followed by Heineken and Dashen breweries each having their own models. Later on other breweries also perceived the successfulness of contract farming and expressed interest in developing their own contract farming models. For instance, Habesha piloted and started contract farming in Arsi and Debrebrehan while Raya brewery already signed and started contract farming with farmers of Tigray.

Asella Malt Factory is also working with farmers from Arsi, west Arsi zones since 2005/6 (E.C) production season. Within six years period of contractual farming experience of Asella malt factory, number of participant farmers increased from 240 in 2005/06 to 20,000 in 2010/11 production season, while total malt barley covered farmland was increased from 175ha to 23,261ha and the financial support for input purchased was increased from 2,130 ETB to 35,078,985ETB in 2010/11E.C production season. Following the privatization of malt factory, the contractual farming agreement was expanded to include farmers from Bale, south-west

Shewa and west-Shewa zones in 2010/11 E.C production season (personal discussion with input supply director).

But even though there is expansion of contract farming of malting barley in Ethiopia with malt factories and breweries initiation and government of Ethiopia’s intervention, there is no impact studied on contract farming model being implemented in Arsi and W/Arsi on household income, land allocation to malting barley production, size of production, input utilization and others. Therefore, the research activity was initiated to study the impact of contract farming on household income and production intensification of participant farmers with the following specific objectives: 1) identifying and characterizing the contract farming models under implementation in the study areas, 2) identifying determinants of farmers participation in contract farming and 3) estimating impact of participating in contract farming on households’ income and inputs utilizations.

Research Methodology

Study area description

This research was conducted in Arsi and west Arsi zones. Arsi zone is located in central Oromia and Asella is the capital town that is 175 Km South east direction from Addis Ababa. The zone is also situated between 6˚45'N to 8˚58'N latitude and 38˚32'E to 40˚50'E longitude (EEIDP, 2002). It has a surface area of about 23,881 km^2 and characterized by mixed farming system. Due to its variation in altitude, the zone has different agro-ecologies that enabled it to produce different vegetations. In general, the mean annual temperature of the Zone ranges between 20˚C - 25˚C in the low land and 10˚C -15˚C in the central high land (BOFED, 2012). It is also known for its surplus production and knows as wheat-belt of Ethiopia (Gebremariam, 1992). West Arsi zone is also divided into eleven administrative districts and one administrative town, Shashamane, which is the capital town of the zone. West-Arsi zone has land area of about 1,177,440 hectares or 12,938 km^2. Crop-livestock mixed farming and pastoral and agro-pastoralism are commonly practiced in all highlands, and mid and lowlands. Similar to Arsi zone, this zone has also variant agro-ecologies that ranges from highland to lowlands and that enables the zone to diversified crop types and off which malt barley is the one.

Data type, data sources and data collection methods

Both qualitative and quantitative data types were collected from primary and secondary data sources. Primary data sources include but not limited to malt factories, breweries, farmers, office of agriculture and rural development, research centers and other NGOs working on malting barley. Secondary data sources were published and unpublished official reports and research outputs. Data were collected through literature reviewing, focus group discussion, KII and household level interview using checklists and structured survey questionnaires.

Sampling methods and Sample Size

Multi-stage sampling was employed. First districts with high potential of malting barley were identified based on secondary data from central statistics authority and zones’ agriculture office and two districts from each zone, where there is high practice of contract farming were selected.

From each selected district two peasant associations (PAs)/*kebeles* having more contract farming participants and production potential of the malting barley were selected purposively. Finally, 248 households were selected from the eight selected *kebeles* with the probability proportional to size (PPS) at district level for household interview. The sample size is determined by using formula given below based on design effect of cluster random sampling (Suresh and Chandrashekara, 2012).

$$N = \frac{Z^2 pq * D}{E^2} \qquad 1$$

Where P is the prevalence or proportion of event of interest for the study, E is the Precision (or margin of error and 5% is taken for this study with Z=1.96) with which a researcher wants to measure impact. Generally, E will be 8% of P and Z is normal deviate for two-tailed alternative hypothesis at a level of significance. D is taken to be 1.5 for this purpose.

The questionnaire was pre-tested before final interview and the final face-to-face household survey was conducted by researchers from Asella AERC after training on the survey questionnaire. One FGD was conducted at each district and secondary data from each district and other stakeholders like malt factory and breweries was collected by using checklists and through telephone interview.

Data Analysis methods

Two types of data analysis, namely descriptive statistics and econometric analysis were used for analyzing the data collected. Descriptive statistics such as, mean, percentage, and standard deviation and inferential statistics such as t-test, chi-square were used
Among the econometric model propensity score matching was employed to evaluate the impact. In this research the impact of malt barley contract farming on households' total income, amounts of different inputs used like fertilizer, pesticides and weedicide chemicals, improved seed and on malt barley production and productivity were estimated using propensity score matching (PSM) methods.

The PSM method was conducted following Caliendo and Kopeinig (2005) five steps procedures. The first steps to to be followed are pscores estimation, choosing matching algorithm, checking for common support, matching quality/effect estimation and sensitivity analysis. According, logit model was employed for propensity score estimation using pcore procedure which can solve self-selection problem by conditioning probability of receiving a treatment (participation in contract farming) of observed characteristics (Rosenbaum and Rubin, 1983). Matching of contract farming participants with those of non-participants was done using pscore method on the basis of average effects of contract farming participation by calculating the mean differences in outcomes of the two (treated and non-treated) groups. The treatment effects for participant T=1 and non-participant T=0, were calculated on the following analytical frameworks:

$$\tau_i = Y_i(1) - Y_i(0) ----------------------------------(2)$$

Where $\mathcal{T}_i$ was treatment effect, Y_i was the outcome on a participant i, whether a participant T_i had participated on malt barley contract farming or not. Since both Y_i (T=1) and Y_i (T=0) couldn't be observed at the same time on the same participant, there was counterfactual outcome. Due to this, estimating individual treatment effect $\mathcal{T}i$ was not possible. For this shifting to estimating the average treatment effects of the population was required. Based on this, the average treatment effect on the treated ($\mathcal{T}_{ATT}$) was defined as:

$\mathcal{T}_{ATT}=E(\mathcal{T}|T=1) = E[Y(1)|T=1]-E[Y(0)|T=1]$……………………….…………………………..(3)

Based on Caliendo and Kopeinig (2005), the true average treatment effect of treated ($\mathcal{T}_{ATT}$) parameter can only be estimated with the absence of self-selection bias and can only be true with the assumption of conditional independence assumption (CIA) and common support assumptions. According to CIA, a set of covariates X are not affected by treatment assignment and the treatment assignment (selection) was also based on those observable characteristics. Similarly, all variables that affect treatment assignment and outcome variables are observable. According to Rosenbaum and Rubin (1983) balancing scores, if potential outcomes are independent of treatment conditional covariates X, they are also independent of treatment conditional on balancing score *b(X)*. Therefore, based on the probability of propensity score, CIA could be defined as:

(0), (1) $\coprod T|(X),\forall X$……………………………………………..……………………….(4)
Where P and ∀ denoted probability and for both groups, respectively

Common support assumption was conducted to check for overlaps and identification of common support region for both participant and non-participant groups. According to Mulugeta and Hundie (2012) the common support condition requires the existence of sufficient overlap in the characteristics of the participant and non-participant units to find adequate matches and this common support condition is one of the further required for perfect predictability of treatment for a given covariate X. the assumption was defined as:

$0<(T)=1|X<1$……………………………………………………………….……………………… (5)

Hence, considering the CIA and common support assumptions the PSM estimator for ATT is the mean difference in outcomes over the common support (p-score distribution) expressed as:

$$\tau_{ATT}^{PSM} = E_P(X)|T = 1\{[Y(1)|T = 1, P(X)] - E[Y(0)|T = 0, P(X)]\} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Where P(X) was the propensity score computed on the covariate Xs.

Choosing of Matching Algorithm

The matching estimator methods: caliper radius nearest neighbor and kernel were employed to choose the best matching algorithm for matching of participant and non-participants.

The procedure for all matching estimators was similar and they compare the outcome of treated individual with outcomes of untreated (Caliendo and Kopeinig, 2005). Therefore, after estimating the probability values on the observable covariates, matching was done using the selected a matching algorithm based on the available data at hand. Balancing test was done to choose appropriate matching estimator based on the test result that gives relatively low pseudo-R^2 value, larger covariates and largest matched sample size (Dehejia and Wahba, 2002).

Checking Overlap/Common Support Region

PSM can only define the average treatment effect on treated (ATT) and average treatment effect (ATE) on population within the common support region. The common support region is the region within the minimum and maximum propensity scores of treated (participant) and control (non-participants) groups, respectively. following this, the common support region for this study is calculated by discarding those observations whose pscores were smaller than the minimum and greater than the maximum of both the participants and non-participants (comparison groups).

Assessing Match Quality/Effect Estimation

Following the choice of the best fitted matching estimator, testing of the covariate balance to check the balancing property of the covariates by comparing the significant test difference before and after matching using the selected matching algorism is also conducted. Caliendo and Kopeinig (2005) suggested that to check the balance distribution of relevant variables in both the control and treated groups, the before and after covariates matching should be checked. In this study, balance test was conducted to know whether there was significant difference in mean value of per-treatment characteristics of both participant and non- participant respondents. According to Rosenbaum and Rubin (1985) standardized bias (SB) is used to assess the marginal distance of covariates and *t*-test is used to check whether there is a significant difference in covariate means for both groups in the common support region (check matching quality). It is suggested that a matching estimator having insignificant mean differences in all covariates, having low pseudo-R^2 value and resulting large matched sample size is preferred as a best matching quality (Tolemariam, 2010). Since testing the statistical significance of treatment effects and computing their standard errors is not straightforward (Caliendo and Kopeinig, 2005), bootstrapping method (popular method) was used to solve this problem and to compute the standard error for the estimate of the participation impact (Lechner, 2002; Mulugeta and Hundie, 2012).

Sensitivity Analysis

Sensitivity analysis shall be done when ATT t-test has shown significant value. The basic question that sensitivity analysis can answer is that whether unobserved fac tors can alter inference about treatment effects. One wants to determine how strongly an unmeasured variable must influence the selection process to undermine the implications. There are two approaches for sensitivity analysis which are for continuous outcomes and binary outcomes. The DiPrete and Gangl (2004) of an ado-file (rbounds) helps to test sensitivity for continuous-outcome variables, whereas a command mhbounds focuses on binary-outcome variables. According to (Keele, 2010), when outcome indicators showed significant, two things should be done in sensitivity analysis in order to check whether there are hidden biases or not. These are sensitivity analysis on the p-values and see how the p-value increases for increasing values of degree of departure from random assignment of treatment (Γ) and how the magnitude of the treatment effect changes with an increasing Γ where each sensitivity test is built on a specific randomization test for a type of outcome. However, since respondents' participation in contract farming has no significant effects on ATT t-test and hence, sensitivity analysis will only be done for those variables that have significant p-values.

Variable Definitions

After matching and balancing procedures there are fourteen (14) variables covariates that are included in the model and one treatment and four (4) outcome variables.

Table 1. Variables types and their definition

Variable Type	Variable definition
Treatment variable	Participation in malt barley contract farming (0=No, 1=Yes)
Covariates variables	Sex of household head (0=Female, 1=Male)
	Educational background of household head (year of schooling)
	Total Family size of household (number)
	A household participate in off/non-farm activities (0=No, 1=Yes)
	Land size allocated for Malt barley production (ha)
	Total Landholding (ha)
	Total livestock in Tropical Livestock Unit
	Farming experience in year
	Malt barley production experience (in year)
	Distance to cooperative office (in walking minutes)
	Distance to main market (in walking minutes)
	A household sell malt barley to cooperatives (0=No, 1=Yes)
	A household is membership to cooperatives (0=No, 1=Yes)
	Participate in malt barley technology evaluation (0=No, 1=Yes)
Outcome variables	Amount of chemical fertilizer applied to malt barley (Kg)
	Amount of pesticides applied to malt barley (litters)
	Amount of improved seed applied malt barley (Kg)
	Household total income (Birr)
	Total malt barley production (quintals)

Types of Contract Farming Models: Literature Review

Different scholars classified contract farming models based on different views. For instance, Scholars like Bijman (2008) Eaton and Shepherd (2001) and Key and Runsten (1999) have distinguished 3 types of widely-used contracts models based on types of contract agreement specifications as: market specification contracts, resource providing contracts and production management contracts.

The Market specification contracts widely specify product's quality, price and timing with minimal or non- provision of inputs. Producers are in charge of most of the decisions to be made in production. As a result, they bear most of the risk. While the resource specification contracts usually specify that buyers will provide inputs and extension services at various stages of production to producers on credit. The inputs and extension services will have to be paid for when the crops are sold. The production-management contracts involve higher levels of coordination than the previous two types of contracts and the buyer makes decision over production and harvest. In this type of contract, the buyer provides technological guidelines on the production process and equally, the buyer assumes most of the risk.

On the other hands contract farming model can also be classified based on the types of agreement like formal or informal (oral and written), involved contracting parties and others. From these points of view, Will (2013) identified about five types of contract farming model types: Informal model, Intermediary model, Multipartite model, Centralized model and nucleus estate model.

Informal model: van Gent (n.d. p.5) described this model as the most transient and speculative of all contract farming models, with a risk of default by both the promoter and the farmer. However, this depends on the situation: interdependence of contract parties or long-term trustful relationships may reduce the risk of opportunistic behavior. In the intermediary model the buyer subcontracts an intermediary (collector, aggregator or farmer organization) who formally or informally contracts farmers (combination of the centralized/ informal models). The third model, the multipartite model, can develop from the centralized or nucleus estate models, e.g., following the privatization of parastatals. And this involves various organizations such as governmental statutory bodies alongside private companies and sometimes financial institutions.

In the centralized model, the buyers' involvement may vary from minimal input provision (e.g. specific varieties) to control of most production aspects (e.g. from land preparation to harvesting). Finally, in nucleus estate model, the buyer sources both from own estates/ plantations and from contracted farmers. The estate system involves significant investments by the buyer into land, machines, staff and management.

Result and Discussion

Results of Descriptive Statistics

Table 2 below presents the descriptive statistics result used to explain the phenomena of the sampled households. the result reveals that mean age of malt barley contract farming participant and non-participant households are not significantly different while combined mean for the total sample is around 41 years. contract farming participant household farmers are slightly more educated than non-participants and difference is also not significant. The mean land holding and mean land size allocated for malt barley production for participant and non-participant households are statistically significant both at 10% level. total landholding for participant is 3.03ha and for non-participants is 2.51ha while plots size allocated for malt barley production for participants is 0.92ha and for non-participants is 0.76ha and statistically significant at 10%. Contract farming participant households have total livestock holding in TLU, income from crop selling including malt barley and income from selling of other crops excluding malt barley and all are statistically significant at 10% level of significance. The mean difference for participant and non-participant households is also statistically significant at 5% level with higher mean income for participant group. Mean malt barley production in quintal is also significantly higher for participants (5% level of significance) while mean productivity is insignificant statistically.

Table 2. Performance of malt barley contract farming participation among smallholder farmers

		Mean		
Variables	Non-participant	Participant	Combined	t-value
Age_HHH	40.41(1.16)[a]	41.56(1.10)	41.03(.80)	-0.71
Education	6.17(.32)	6.78(.32)	6.50(.23)	-1.33
TFamily	7.76(.32)	8.41(.38)	8.11(.25)	-1.29
Farm_Exp	19.24(1.10)	19.63(1.01)	19.45(.74)	-0.26
MBarley_Exp	8.58(.70)	9.8(.67)	9.24(.48)	-1.26
Landholding	2.51 (.18)	3.03(.18)	2.79 (.13)	-2.01*
Mbarley_Land	.73(.04)	.92(.06)	.84(.04)	-2.35*
MBarley_Qt	20.85 (1.61)	30.49(3.99)	26.10(2.29)	-2.11**
MBarley_Prodvty	27.59(1.19)	30.18(1.54)	28.99(.99)	-1.30
TLU	7.55(.46)	8.94(.52)	8.30(.35)	-1.97*
LS_Income	7765(1734)	9432(1777)	8664 (1246)	-0.66
Offarm_Income	5395 (2101)	8389(1966)	7010 (1436)	-1.04
Mbarley_Seed	177 (27)	198 (32)	189 (21)	-0.49
Chem_litters	1.61(.12)	1.65(.10)	1.63(.08)	-0.30
Crop_Income	60571(6766)	86788(8349)	74713(5531)	-2.39*
Total_Income	73732(8407)	111573 (9018)	94144 (6323)	-3.03**
Fert_Amount	1.45(.15)	2.47(.77)	2.00 (.42)	-1.20
NMKT_DIST	36.57(3.10)	39.27(2.91)	38.02(2.12)	-0.63
MMKT_DIST	50.70(4.28)	49.53(4.03)	50.07(2.93)	0.20
DA_DIST	28.24 (2.52)	29.31(2.45)	28.82 (1.76)	-0.30
Coop_DIST	25.51(2.24)	25.65(1.97)	25.58(1.47)	-0.05
OtherCrop_Inc	20068(3044)	34783(3786)	28006(2517)	-2.96*

*, ** t-value significant at 10% and 5% level of significance respectively

[a] Numbers in parenthesis are standard errors of the mean

Malt Barley Production System and Purposes

Malt barley is one of the major cash crops in the study area that is produced widely during the main season in highlands of Arsi and west Arsi. The mean malt barley farm size is 0.60, 0.72, 1.06 and 0.95ha in Kofele, Dodola, Digelu-Tijo and Lemu-bilbilo districts respectively and the overall mean of malt barley farm size per household is 0.84ha. mean plot size per household of malt barley is higher in Arsi zone and statistically significant at $P \leq 0.05$. Mean malt barley production is the highest for D/Tijo and L/Bilbilo districts with mean of 51 quintals each per household while Kofele has the lowest mean which is around 10 quintals (Table 3). In the study area, the production of malt barley is totally rainfed and the land preparation is mainly done by oxen. However, recently primary tillage operation is being done by tractors and while malt barley is mostly harvested by combine harvester.

Malt barley is mainly a commercial crop that is produced for market purpose and major share is sold for malt factories. As a result, except human and animal power used in production process almost all production inputs are commercialized. Accordingly, all farmers are using commercial chemical fertilizer, improved seed and agro-chemicals so that they can meet quality requirement expected from them. in addition to this, considerable number of households (36.70%) are using organic fertilizer/compost for production of malt barley. According to the result of survey, around 75% of the malt barley produced is suppled to market. Asella malt factory was the dominant buyer (customer) in previous years while recently, Henieken brewery, Souflet malt and Dashen brewery were appearing as new entrant to the market.

Table 3. Malt barley production and Marketing of sample households

Variable description	Mean	Standard Deviation	Min.	Max.
MBarly_Prodn	35.44	34.06	0	195
sold_Barley	27.97	30.83	0	185
Marketed proportion	0.75	0.19	0	1

	Mean per household production across districts**				
Variables	kofale	Dodola	D/Tijo	L/Bilbilo	Combined
MBarley_Prodn	10(7)	30(17)	51(42)	51(40)	35(34)
MBarly_Land	0.60(0.43)*	0.72(0.37)	1.06(0.89)	0.95(0.57)	0.84(0.64)**
Landholding	1.72(1.33)	3.26(2.20)	3.13(1.92)	3.22(1.98)	2.85(1.99)**

*Numbers in parenthesis are standard deviation; ** Mean difference (F) is significant at $P \leq 5\%$
Sources: author's computation, 2022

Types of contract models in the study area

When we see the contracting model in the study area, the main promoters are Asella malt factory, Soufflet malt (a French food and agriculture group) and Gallia/Heineken brewery. The Asella malt factory follows the intermediary model where the factory has formal contract agreement with unions and the unions will in turn have an agreement with primary cooperatives (PCs). Then the PCs will organize member farmers and collect malt barley at their locality and delivery to the factory. The factory can only contact farmers through unions and PCs. The factory was previously supplying chemicals and improved seed while currently they are mainly working on supplying improved seed only through unions and PCs on credit basis in collaboration with Oromia seed enterprise and the supply of chemicals and other inputs can only be treated in case of series problems. Technical support on production and quality maintenance is being provided by training through PCs and DAs to farmers while factory experts as facilitators. The factory sets prices based on market assessment during the production season and payment will be done through unions and PCs. The unions and PCs will also have some amounts of commissions per quintals of malt barley they supplied to the factory. Gallia/Heineken brewery also follows a contract farming scheme/model similar to that Asella malt barley factory.

Soufflet malt follows a model of resource providing contracts type where it provides improved seed, chemicals and fertilizers in credit basis. There is direct legal and formal contract agreement between the company and individual farmer. They select representative farmers who can organize and facilitate their meetings and take responsibility to dispatch (distribute) inputs in specific area (peasant associations). The price is set by factory based on production cost and other competitors price in the market. Payment after purchase is directly made to farmers and in most cases farmers prefer to work with Soufflet malt to avoid challenges of bureaucracy they face with Asella malt factory.

The produced malt barley is sold to different buyers. There are also side-sellings by breaking contract agreements specially in case of Asella malt factory. Since the price of the factory stay fixed until its re-adjustment, the farmers are selling to other parties whenever, they need cash. The major buyers are cooperatives (29.4%), village markets (25%) and other contract promoters like Soufflet malt and Heineken (27%).

Results of Econometric Models

Factors determining household's participation in Malt barley Contract farming

Propensity Score Estimation

Prior to econometric model, Variance Inflation Factor (VIF) test for continuous covariates and contingency coefficient test for categorical variables were less than 10 and 0.75, respectively. Similarly, Breusch-Pagan/Cook-Weisberg test for heteroskedasticity among covariates had P=0.6523 which is insignificant. These imply that there were no multicollinearity and heteroskedasticity problems existed among the covariates thus no variable was dropped from the model.

Table 4 shows the estimated propensity score model outputs. The model has a fairly low Pseudo-R^2 value (0.1367) and that indicates the covariates included in the matching fit to the data for the study. Studies revealed that to get a good match between treated and non-treated groups, the allocation of the treatment has to be fairly random and treatment households do not have diverse characteristics and that can be justified by reasonably low Pseudo-R^2 value (Caliendo and Kopeinig, 2008; Pradhan and Rawlings, 2002). Educational background of the household was found to affect participation of a household in malt barley contract farming in the study area significantly at 5% level. Education is a base for any new technology and innovation (idea) adoption and studies revealed that education positively affects household's contract farming participation (Nazifi and Hussaini, 2021; Kiwanuka and Machethe, 2016). In similar ways, participation in crop output marketing to cooperatives (unions) is also positively affecting participation in contract farming significantly at 1%. This is mainly due to the fact that one type of contract farming model is through primary cooperatives specially Asella malt factory and others are signing an agreement through cooperatives and unions.

The third variables that affects participation in malt barley contract farming is farmers participation in malt barley technologies like improved, agronomic practices and chemicals demonstration and participatory evaluation activities and it is statistically significant at 1% level. Similarly, the logit estimated intercept was (4.905) negative and significant at 1% of significance. In addition to these, household's participation in off/non-farm activities and size of farm size allocated for malt barley production are variables that affect participation significantly at 5% level of significance each.

Table 4. Estimated Propensity score for explanatory variables /covariates

Variables	dy/dx	Std. err.	Z-value	P-value
Off/non-farm Participation	0.211	.08	2.42	0.016**
Tropical Livestock Unit	-0.007	.01	-0.66	0.511
Total Family size	0.007	.01	0.59	0.556
Land for Malt barley (ha)	0.304	.12	2.55	0.011**
Total Landholding (ha)	-0.008	.03	-0.27	0.784
Distance to main market	-0.001	.001	-0.39	0.697
Educational background	0.028	.01	2.01	0.044*
Farming experience	0.008	.001	1.47	0.142
Malt barley production experience	-0.003	.007	-0.50	0.615
Distance to cooperative office	0.003	.002	1.52	0.129
Sex of household head	-0.034	.26	-0.13	0.893
Sell malt barley to cooperatives	0.580	.08	7.19	0.000***
Membership to cooperatives	0.180	.21	0.84	0.401
Participate in malt barley technology evaluation	0.220	.09	2.43	0.015**
Number of observations=241; LR chi2(14) =45.48; Prob > chi2=0.0000; Pseudo-R2 =0.1367; Log likelihood = -143.56008				

*, **, *** is for P significance at 10%, 5% and 1% respectively

Impacts of Contract Farming on Households' Income and other variables

Choice of Matching Algorithm

The nearest neighbor (NN 2) matching estimator fulfilled the balancing test (equal means) criteria. As indicated in Table 5 all covariates were included in the model with insignificant mean differences between the two groups after matching, it has relatively low pseudo-R^2 value (0.015) and resulted in largest sample size (matched sample size=241). Hence, NN (2) is identified as the best model fitted matching estimator for this study. In pscore estimation and performing initial balance of the covariate, 5 numbers of blocks were identified that ensured the mean pscore was not different for participants and non-participants in each block.

Table 5. Matching performance of different estimators

	Performance criteria		
Matching estimator	**Balance test***	**Pseudo-R2**	**Matched sample size**
Radius Caliper			
Caliper (0.0)	14	0.029	241
Caliper (0.25)	14	0.029	241
Caliper (0.5)	14	0.029	241
Nearest neighbor			
NN (1)	14	0.029	241
NN (2)	14	0.015*	241
NN (5)	14	0.035	241
Kernel			
BW (0.1)	14	0.018	241
BW (0.25)	14	0.024	241
BW (0.5)	14	0.063	241

Source, Authors computation from survey data (2022)

Identification of Common Support Region

The region of common support is from pscore estimated to be ranging from 0.09548855 to 0.9731892. The result of pscore shows that 7 observations were out of common-support region with six from below and one from above were discarded where all are from non-treated group. Figure 1 below shows that estimated propensity score for both groups resembles normal with higher amplitude for contract farming participant households and skewing to right than non-participant farmers.

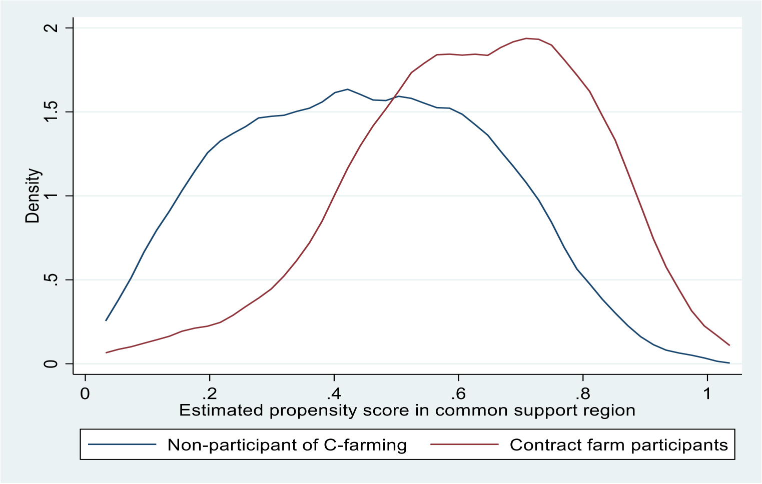


Figure 1. Kernel density of non-contract farming participant and participant households in the common support region

Table 6. Distribution of estimated propensity score after matching

Group	Observation	Mean	Standard Error	T-value
Participant	130	0.620	0.016	-7.16***
Non-participant	111	0.445	0.018	
Combined	241	0.539	0.013	
Difference		-0.176	0.025	

*** difference significant at 1% level

Testing Matching Quality/Effect Estimation

Around 36% (five) pscore estimates were significant before matching but all turned out insignificant after matching. Reduction in the mean standardized bias (SB) between the matched and unmatched respondents and equality of means for participant and non-participant households tested using t-test were considered for determining the balancing efficiency of the estimator. Before matching the absolute value of mean of standardized bias (SB) was ranging from 0.6 to 54.6 percent while after matching this value reduced to range of 0 to 16 with five covariates (35.71%) were significant. Similarly, all covariates became insignificant after matching while the Pseudo-R^2 reduced from 0.136 to 0.015 with all insignificant t-test values after balancing in the model (Table 7).

Table 7. Covariates balancing test for participant and non-participant households

	Unmatched	Mean			%Reduction	T-test	
Variable	Matched	Treated	Control	%bias	/bias/	t	p>t
OFFarm_Partc ip	U	0.292	0.25	9.0		0.69	0.49
	M	0.292	0.25	9.5	-5.6	0.77	0.44
TLU	U	8.93	7.55	25.7		1.97*	0.05
	M	8.93	8.89	0.8	96.7	0.06	0.95
TFamily	U	8.40	7.76	16.8		1.29	0.19
	M	8.40	8.47	-1.7	90.0	-0.13	0.89
Maltbrl_Land	U	0.92	0.73	30.9		2.35**	0.02
	M	0.92	0.88	6.6	78.6	0.53	0.60
Landholding	U	3.03	2.50	26.1		2.01**	0.04
	M	3.03	2.94	4.5	82.9	0.33	0.74
MMKT_dist	U	49.5	50.70	-2.6		-0.20	0.84
	M	49.5	55.60	-13.3	-417.9	-1.10	0.27
Educ	U	6.77	6.17	17.3		1.34	0.18
	M	6.77	6.21	16.0	7.3	1.31	0.19
Farm_Expr	U	19.6	19.20	3.3		0.26	0.80
	M	19.6	21.20	-13.9	-314.9	-0.95	0.34
Malt_Exprce	U	9.80	8.57	16.3		1.26	0.21
	M	9.80	10.90	-15.7	3.8	-1.03	0.30
Coop_dist	U	25.6	25.50	0.6		0.05	0.96
	M	25.6	23.80	7.9	-1229	0.67	0.50
Sex	U	0.98	0.98	2.0		0.16	0.87
	M	0.98	0.98	0.0	100.0	0.00	1.00
Sell_Coop	U	0.92	0.72	54.6		4.31***	0.00
	M	0.92	0.93	-2.1	96.2	-0.24	0.81
Coop_Memb	U	0.97	0.93	18.7		1.47	0.14
	M	0.97	0.97	0.0	100.0	-0.00	1.00
MBarly_Techev	U	0.65	0.49	32.3		2.51**	0.01
	M	0.65	0.66	-2.4	92.7	-0.20	0.84

Source: author's estimation from own data (2022)

*, **, *** significant at 10%, 5% and 1% levels respectively

Estimation of the Average Treatment Effects (ATT) on Treated Groups

The average treatment effects of participation in malt barley contract farming on different outcome variables of households were indicated in Table 8. The impact was calculated for inputs utilization/intensification (amount of improved malt barley seed, chemical utilization for malt barley in litters, amount of chemical fertilizer in Kg, and land allocation for malt barley production) and malt barley production (Kg), productivity per hectare (Kg) and total household income (Birr). The result shows that participation of a household in malt barley contract farming has positive and significant impact on households' total income. this result is consistent with the result of Addisu, et al. (2020), Seba (2016), Gemechu et al. (2017), Maertens and Velde (2017), and Dubbert (2019) who observed that farmers who participated in contract farming obtained significantly higher income as compared to non-contract farmers in malt barley, chickpea, vegetable, rice and cashew production respectively in Ethiopia and elsewhere. According to the model output, participation in malt barley contract farming increases the income of a household by 38685 which is around 36.25% than that of non-participant households after matching or after controlling for pre-contract farming participation differences.

Table 8. The ATT of malt barley contract farming participation on outcome indicator variables

Outcome Variable	Participants	Non-Participants	Difference	S.E.	T-stat
MBarly_Seed	198.17	189.35	8.82	61.78	0.14
Chem_Litrs	1.65	1.54	0.11	0.22	0.50
MBarly_Qt	30.49	27.14	3.35	4.97	0.67
Fert_Amt	2.47	1.51	0.96	0.82	1.16
MB_Productivty	30.18	29.08	1.10	2.64	0.42
Maltbrl_Land	0.92	0.88	0.04	0.10	0.39
Total_Inc	106998	68313	38685	15694	2.46**

		Malt Barley Contract Farming				
Variable	Sample	Participant	Non-Partic	Difference	S.E.	T-stat
Total_Inc	Unmatched	106998	65779	41218	13045	3.16
	ATT	106998	68313	38685	15694	2.46**

** Mean difference significant at P≤5% level

Sources: Author's computation from own data, (2022)

The result from Table 9 also shows the overall average treatment effect (ATE) of participation in malt barley contract farming on the study population. The result revealed that ATT for amount of fertilizer applied by participant households, total household income and malt barley production per household are statistically significant at P≤10%, 1% and 5% levels respectively. As it can be seen from Table 9, participation in contract farming increases amount of fertilizer application by 2.95Kg. Similarly, participation in malt barley contract farming has positive effects on overall population's understudy of total income and quantity of malt barley production where it increases income by 24462 Birr and malt barley production increases by 6.34 quintals.

Table 9. Average Treatment Effects (ATE) of Participation in malt barley contract farming for population in consideration

	ATE	Sta. Error	Z	P>z
Total_Inc	24462	8970	2.73	0.006***
Fert_Amt	2.95	1.60	1.85	0.049*
MBarley_Qt	6.34	2.64	2.40	0.016**
MB_Productivity	1.36	1.49	0.91	0.362
MBarley_Seed	-9.22	38.98	-0.24	0.813
Chem_Litters	0.02	0.12	0.14	0.890
Maltbrl_Land	0.01	0.03	0.42	0.673

Sources: Author’s computation from own data (2022)

Sensitivity analysis

The sensitivity of the ATT estimates to unobserved heterogeneity or hidden bias. In the PSM technique, selection to treatment is only based on observed characteristics, and it does not control for hidden bias due to unobserved factors (Caliendo and Kopeinig, 2008). Heterogeneity may arise when contract and noncontract farmers differ on unobserved variables that simultaneously influence assignment to treatment and the outcome variable. We checked this using the bounding approach (Rosenbaum 2002). This method relies on the sensitivity parameter gamma (log-odds ratio) that determines how strong an unobservable variable must be to influence the selection process so as to bias the results (DiPrete and Gangl 2004). Following DiPrete and Gangl (2004) and Girma and Gardebroek (2015), we consider various critical gamma value levels. We reported the results of mhbound tests in Table 10. In a study free of hidden bias, i.e., where Γ = 1, the *Q*MH test statistic is 1.97 and would constitute strong evidence that participation in malt barley contract farming results in increased total household income. The result shows that the assumption that we have overestimated the treatment effect, i.e., Q^{+}_{MH} , or underestimated the treatment effect i.e., Q^{-}_{MH} is robust only at selection bias free assumption (Table 10).

As the Γ-value deviate from 1 the result becomes insignificant. However, according to Becker and Caliendo (2007), this test cannot directly justify the unconfoundedness assumption. Hence, we cannot state whether the conditional independence assumption does (not) hold for the given setting (including among others the used data, the chosen covariates, and the specification of the propensity score). However, the results are sensitive to possible deviations from the identifying unconfoundedness assumption, hence, further study may be needed to justify the impact of participation in malt barley contract farming.

Table 10. Mantel-Haenszel (1959) mhbounds sensitivity analysis

Gamma	Q_mh+	Q_mh-	P_mh+	P_mh-
1	1.98	1.98	.0328	0.032
1.5	0.175	-0.175	0.420	0.420
2	0.275	-0.276	0.480	0.480
2.5	.	-0.276	.	0.480
3	-0.275	-0.276	0.430	0.430

Sources: Author’s computation from own data, (2022)

Conclusion and Recommendations

Conclusion

The study is conducted in sample districts selected from highlands of Arsi and west Arsi zones namely Kofele and Dodola from west Arsi and Lemu-bilbilo and Digelu-Tijo from Arsi zone. Two sample PAs from each district were also selected and a total of 240 households out of which 52% are malt barley contract farming participants and 48% are non-participant were interviewed. The mean age of household heads is 41 years and non-participant households have mean age of 41 years while participants are a year aged than non-participants on average. Mean educational background of the households was 6.5 years of schooling and participants have little higher education years that is 7 years of schooling. The mean experience in malt barley production is 10 years for participants. In similar manner, malt barley production for participant households is around 31quintal per household and it is statistically significant at $p \leq 10\%$ level of significance.

The contract farming model that are followed in the study area are intermediary and resource providing contracts types. Majority of farmers in contract farming scheme are working under intermediary contract model of Asella malt factory since Soufflet is a newly establishing company in the country and it is not popular in the study area. Soufflet malt company has direct contractual agreement with farmers through local model farmers and payment for barley output is made directly to farmers in cash. Hence, farmers are more comfortable with them.

Household educational background, participation off/non-farm activities, participation in crop output marketing to cooperatives, participation in technology evaluation of malt barley (participatory technology demonstration and evaluation activities) and size of land allocated for malt barley production are significantly and positively affecting participation in malt barley contract farming practices. The propensity scores matching ATT result further revealed that participation in malt barley contract farming practices has significant impact on household income. The result of ATE reveals that amount of fertilizer application on malt barley increases by 2.95 Kg per household as a household participate in malt barley contract farming. Similarly, household income also increases by 24462 Birr while malt barley production increases by 6.34 quintal for participant households and the results are statistically significant at $P \leq 1\%$, $P \leq 5\%$ and $P \leq 10\%$ level of significance for household income, malt barley production and amount of fertilizer respectively. Moreover, the newly released and introduced varieties of malt barley name as “traveler and misicals” are competent to food barley varieties and preferred by farmers even for household consumption purposes and are being replacing food barley in areas where there is good market opportunities (contract farming is practiced).

Recommendations

The most important advantages of contract farming according to the focus groups discussion and descriptive analysis is that it smooths the access of malt barley production inputs like improved seed, weedicide and chemical fertilizer through credit basis. Furthermore, it also secures the access for market at predetermined 15% premium prices based on the current (up-to-dated) market price. Even, when it is in cash basis, contract farming participants have the privileges to get inputs. In terms of other outcome variables that are included in the model, even though the differences are positive for malt barley contract farming participants, the differences are not statistically significant. In general farmers prefer to be participant in malt barley contract farming scheme mainly to be secured in getting improved seed timely and in credit basis. Hence, expanding contract farming practices towards other non-participants can have wider impact in improving productivity and inputs use intensity. Therefore, to increase farmers participation, awareness creation through participating farmers in technology evaluation and including households as cooperative members can be useful. Moreover, expanding informal education can also enhance farmers participation in contract farming. Furthermore, the resource provision types of contract faring model where the promoters are providing inputs like seed, fertilizer and chemicals on credit basis are the most farmers' preferred contract type and hence, other parties like Asella malt factory, who are involving in intermediary type of contract farming model shall shift towards such models which are preferred by the farmers and more advantageous.

Furthermore, households' participation in malt barley contract farming has significant positive impact on household's income that may increase households' welfare. Therefore, expanding contract farming practices towards those groups within the area and to other new areas (districts) where malt barley production is newly introduced is very important for both parties involving in the industry (farmers and breweries and malt factories). However, there are inconvenience in decision of selling time and farmers are complaining that they are forced to sell their product during pick production season immediately after harvest when there is high supply and low prices for the repayment of inputs loans they received from their promoters. Hence, farmers should be tolerated until they get reasonable price that compensate their production costs and reasonable profit from their produces and decision of when to sell shall be made by themselves. Furthermore, by increasing number of farmers under contract farming scheme thereby increasing market opportunity, it is possible to shift more land size under food barley towards malt barley since malt barley is more preferred both for consumption and market purposes.

In the other hand, other researchers' investigation showed that contract farming may have negative impact on households' food security due to potential changes in the households' own food production, time allocation, and gender roles (Bethelhem, et al., 2021; Olounlade, et al., 2020) and there are cases where participation in contract farming may positively affects income but negatively affects food dietary security. Specially, the type of effect may depend on type of contract model. For instance, Bethelhem, et al. (2021) find that marketing contract has significant negative impact while resource providing contract has positive impact on household dietary diversity status. Hence, further research is needed to quantify the impact of contract farming on wider economic welfare of households like food security and dietary diversification in the study area.

References

Addisu Bezabeh, Fekadu Beyene, Jema Haji and Tesfaye Lemma. 2020. Impact of contract farming on income of smallholder malt barley farmers in Arsi and West Arsi zones of Oromia region, Ethiopia.

AtlasBig.com, 2022. Top Barley Producing Countries. Available at https://www.atlasbig.com/en-us/countries-barley-production (accessed on October 28, 2022).

Ayelech Tiruwha Melese. 2010. Contract farming in Ethiopia: An overview with focus on sesame. Development Cooperation, Ministry of Foreign Affairs Government and

Wageningen UR.
Bethelhem Legesse Debela, Ruml, A. and Qaim, M. 2021. Effects of contract farming on diets and nutrition in Ghana. Appl Econ Perspect Policy. 2022; 44:911–929.
Bijman, J. 2008. Contract farming in developing countries: an overview; Working Paper; Wageningen University; available online at:http://edepot.wur.nl/1763.
Caliendo M, Kopeinig S. 2005. Some practical guidance for the implementation of propensity score matching. Discussion paper series, No. 1588, Germany.
Caliendo M, Kopeinig S. 2008. Some practical guidance for the implementation of propensity score matching. Journal of Economic Surveys 22(1):31–72.
CSA (The Federal Democratic Republic Of Ethiopia Central Statistical Agency). 2021. Agricultural Sample Survey 2020/21 (2013 E.C.) Volume I Report On Area And Production Of Major Crops (Private Peasant Holdings, Meher Season). Statistical Bulletin No 590, Addis Ababa.
CSA (The Federal Democratic Republic of Ethiopia Central Statistical Agency). 2014. Agricultural Sample Survey 2013/14 (2007 E.C.) Volume I Report on Area and Production of Major Crops (Private Peasant Holdings, Meher Season). Statistical Bulletin, Addis Ababa.
CSA (The Federal Democratic Republic of Ethiopia Central Statistical Agency). 2014. Agricultural Sample Survey 2014/15 (2008 E.C.) Volume I Report on Area and Production of Major Crops (Private Peasant Holdings, Meher Season). Statistical Bulletin, Addis Ababa.
Dehejia RH, Wahba S. 2002. Propensity score-matching methods for non-experimental causal studies. Rev. Econ. Stat., 84: 151-161.
Delelegne A. Tefera and Jos Bijman. 2021. Economics of contracts in African food systems: evidence from the malt barley sector in Ethiopia. Agricultural and Food Economics, (9)26:1-26.
Diprete TA, Gangl M. 2004. Assessing Bias in the estimation of causal effects: Rosenbaum bounds on matching estimators and instrumental variables estimation with imperfect instruments. Socio. Meth., 34: 271-310.
Dubbert, C. 2019. Participation in contract farming and farm performance: Insights from cashew farmers in Ghana. *Agricultural Economics*, 1–15.
Eaton, Charles and Andrew W. Shepherd. 2001. Contract farming – Partnerships for growth: A guide; FAO [Food and Agriculture Organization of the United Nations] Agricultural Services Bulletin 145; available online at: http://www.fao.org/docrep/014/y0937e/y0937e00.pdf.
Ethio-Italian Development Project (EIDP), 2002. Atlas of Arsi Zone. Arsi Agricultural and Rural Development Bureau, Assela, Ethiopia.
Gebremariam, H. 1992. Availability and Use of Seed in Ethiopia. Program Support Unit, Canadian International Development Agency (CIDA), Addis Ababa.
Gemechu, M., Jema, H., Belaineh, L., & Mengistu, K. 2017. Impact of participation in vegetables' contract farming on household's income in the central rift valley of Ethiopia. *American Journal of Rural Development*, *5*(4), 90–96.
Gent, Rudy van (n.d.): Contract farming; paper prepared by AGRIDEV Consult Ltd., Lusaka; available online at: http://apf-contractfarming.wikispaces.com/file/view/WUR+WI+Contract+Farming+Presentation+070706.pdf.

Girma J, Gardebroek C.2015. The impact of contracts on organic honey producers' incomes in southwestern Ethiopia. Forest Policy and Economics 50:259–268.

Holtland, G. (ed.). 2017. Contract farming in Ethiopia: Concept and practice. Arnhem, The Netherlands: AgriProFocus.

Keele L. 2010. An overview of rbounds: An R package for Rosenbaum bounds sensitivity analysis with matched data.

Key, N., and D. Runsten. 1999. Contract Farming, Smallholders, and Rural Development in Latin America: The Organization of Agro-processing Firms and the Scale of Out-grower.

Kiwanuka, R. N. L. and Machethe, C. 2016. Determinants of Smallholder Farmers' Participation in Zambian Dairy Sector's Interlocked Contractual Arrangements. Journal of Sustainable Development: 9(2).

Lechner M. 2002. Some practical issues in the evaluation of heterogenous labour market programmes by matching methods. J. Royal State Soc., 165: 59-82.

Maertens, M., & Velde, K. V. 2017. Contract-farming in staple food chains: The case of rice in Benin. *World Development*, *95*, 73–87.

Mishra AK, Kumar A, Joshi PK, D'Souza A (2016) Impact of contracts in high yielding varieties seed production on profits and yield: the case of Nepal. Food Policy 62:110–121.

Mulugeta T, Hundie B. 2012. Impacts of adoption of improved wheat technologies on households' food consumption in South Eastern Ethiopia. Selected Poster prepared for presentation at the International Association of Agricultural Economists Triennial Conference, Foz do Iguaçu, Brazil, 18-24 August (2012).

Nazifi, B. and Hussaini, Y.I. 2021. Determinants of Participation in Contract Farming among Smallholder Maize Farmers in North-Western Nigeria. Acta Sci. Pol. Agricultura 20(4) 2021, 147–160.

Olounlade, O.A., Li, Gu-Cheng, Kokoye, S.E.H., Dossouhoui, F.V., Akpa, K.A.A., Dessalegn Anshiso and Biaou, G. 2020. Impact of Participation in Contract Farming on Smallholder Farmers' Income and Food Security in Rural Benin: PSM and LATE Parameter Combined. Sustainability 2020, 12, 901.

Pradhan M, Rawlings LB (2002). The impact and targeting of social infrastructure investments: Lessons from the Nicaraguan Social Fund. The World Bank Econ. Rev., 16: 275-295.

Roehlano, B. M., and Galang, I.M.R. 2014. Linking small farmers to modern markets: The role of contract farming, Philippine Institute for Development Studies, Policy Note No. 2014-09.

Rosenbaum PR (2002) Observational studies Springer New York. https://doi.org/10.1007/978-1-4757-3692-2

Rosenbaum PR, Rubin DB. 1983. The central role of the propensity score in observational studies for causal effects. Biometrika., 70: 41-55.

Rosenbaum PR, Rubin DB. 1985. Constructing a control group using multivariate matched sampling methods that incorporate the propensity score. Am. Stat. Assoc., 39: 33-38.

Seba, S. 2016. *Impact of Contract Farming on smallholders in Ethiopia: The case of chickpea growers* [A thesis submitted in partial fulfillment of the requirements for the Degree of Master of Commerce (Agricultural) at Lincoln University].

Shahidur Rashid, Gashaw T. Abate, Solomon Lemma, James Warner, Leulsegged Kasa, and Nicholas Minot, 2015. The Barley Value Chain in Ethiopia. International Food Policy Research Institute: Washington DC.

Sununtar Setboonsarng, 2008. Global Partnership in Poverty Reduction: Contract Farming and Regional Cooperation.

Suresh, K.P and Chandrashekara, S. 2012. Sample size estimation and power analysis for clinical research studies. Journal of Human Reproductive Sciences. 5(1):7-13.

The Food and Agriculture Organization (FAO) of the United Nations, 2012. Guiding principles for responsible contract farming operations Production. World Development 27, no. 2(1999): 381.

The National Regional Government of Oromia, Bureau of finance and Economic Development-Regional Statistics (BOFED), 2012. http://www.oromiabofed.org/

Tolemariam A (2010). Impact assessment of input and output market development interventions by IPMS Project: The case of Gomma Woreda, Jimma Zone. MSc Thesis, Haramaya University, Ethiopia.

Will, M. 2013. Contract farming handbook: A practical guide for linking small-scale producers and buyers through business model innovation. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Germany.

World Agricultural Production, 2022. World Barley Production 2022/2023, September 2022 report. Available at http://www.worldagriculturalproduction.com/crops/barley.aspx (accessed on October 28, 2022).

Yassin, A. 2014. Transnational large scale agricultural firms in Gambella, Ethiopia: local potentials, opportunities and constraints for market linkage and contractual farming schemes. Futures agricultures consortium research paper. http://www.future-agricultures.org.

Appendix-I. Identified Common Support for Matching

Treatment assignment	Common Support		
	On Support	Out of support	Total
Untreated	111	0	111
Treated	130	0	130
Total	241	0	241

Appendix II. Multicollinearity test results

A. Collinearity Diagnostics for continuous covariates (Variance Inflation Factor-VIF)

Variable	VIF	SQRT VIF	Tolerance	R-Squared
Tropical livestock unit (TLU)	1.06	1.03	0.9463	0.0537
Total Family	1.15	1.07	0.8680	0.1320
Malt barley land	1.63	1.28	0.6129	0.3871
Total landholding	1.62	1.27	0.6180	0.3820
Main market distance	1.11	1.05	0.9036	0.0964
Educational background	1.31	1.14	0.7640	0.2360
Farming Experience	2.03	1.42	0.4933	0.5067
Malt barley experience	1.75	1.32	0.5721	0.4279
Distance to cooperative	1.06	1.03	0.9435	0.0565
Mean VIF	1.41			

B. Contingency Coefficient (CC) value for dummy variables

	Off_Farm	Sex	Sell Coop	Coop. Member
OFF_Farm				
Sex	0.64			
Sell_Coop	0.73	0.22		
Coop. Member	0.62	0.72	0.75	
MBarly_Tech evaln	0.52	0.68	0.52	0.62

Assessment on enset production, processing and marketing systems in Jimma zone

Lemma Gutema[1], Hussein A/Gissa[2]

Oromia Agricultural Research Institute, Jimma Agricultural Engineering Research Center

P.O. Box, 386, Jimma, Oromiya, Ethiopia

*Corresponding author e-mail:- lemigada@gmail.com

Abstract

Enset is widely cultivated crop in south and southwestern parts of Ethiopia. It is source of income for farmers in Jimma zone. Although, enset production and enset product marketing has many constraints. Hence, this research activity was initiated with objectives of identifying to assess production, processing and marketing of enset and to identify the constraints and opportunities in enset production and marketing system. For this study, the descriptive research design was employed. This was due to the fact that the study primarily focused on assessing the production, processing and marketing enset in selected districts of Jimma zone. Thus, the study area composed of rural kebeles among these three (3) kebeles were purposely selected from each districts based on their kocho production potential. The data were collected using open and close ended questionnaires, key informant interview, filed observation and focus group discussion. The result of the study clearly indicated that the majority of the respondents (90.11 %) were females, whereas, male household heads (9.89%) of the total sample population. Men are responsible for the propagation, cultivation and transplanting of Enset, while women are responsible for harvesting, processing and marketing the Enset products in the study area. As the farmers responded, enset was cultivated in both home garden and main field. The farmers grow different type of enset varieties crops in different manner of association. Based on the information obtained from the respondents, most of the farmers highly practiced sole cropping (51.6%) and followed by intercropping (48.4%) mode of production. As such potential of enset for food security and income generation has not been fully exploited. The 76.7% of the respondents shared the same idea that major reasons of enset production is for house hold consumption. Enset processing is carried out by women using traditional tools and the process is laborious and tiresome.

Keywords: Enset, production, marketing

Introduction

Background and Justification

Ethiopia's diversified agro-climatic condition makes it suitable for the production of a broad range of crops. The wide range of altitude, ranging from below sea level to over 3000m above sea level, gives it a wide range of agro ecological diversity ranging from humid tropics to alpine climates, where most types of crops can be successfully grown. Enset is one of the crops, largely produced in of Ethiopia (*CSA, 2017*).Central Cushitic speaking peoples of northern Ethiopia began to grown enset and wide range of other crops, and were quick to incorporate wheat, barley, cattle, goats, and sheep in to their economy once these domesticates where introduced in to Ethiopia(*Abraham, 2016).*According to 2021 Central statistical Agency (CSA) report about 57.2, 63.5, and 1.9 million quintals of enset yield in forms of amicho, kocho, and bulla, respectively, were produced from a total of 206.7 million enset crops in 2021/2021 cropping season (*CSA, 2021*).

Enset (Ensete ventricosum (Welw) Cheesman is a crop dominantly growing in south and southwestern Ethiopia. It has both the cultivated and wild types. The existence of the wild type in Ethiopia has been described by many researchers only from south and south western Ethiopia (Borrell et al, 2019).Enset is one of the crops, largely produced in Ethiopia (*CSA, 2017*). Outside Ethiopia, the use of enset was reported from Vietnam, where it provided an emergency food during the Second World War. Enset occurs in wild forms in East, Central and South Africa (*Gadisa, 2021*).

Enset is a multipurpose crop where all portions of the plant are used for different purposes and serve as a staple food for more than 20 million people in the south and Southwestern Ethiopia (*Borrell et al., 2019; Haile et al., 2020 and Mulatu, 2021*). Enset benefits the surrounding ecosystem by improving soil nutrient balance (Elias et al., 1998), providing shade and therefore cooling the environment, and being a part of farming systems with high biodiversity (*Bizuayehu, 2008; Zerfu et al., 2018*).

Enset has different vernacular names in different regions, Asat (in Gurage), Weise (in Kembata), Warqee (in Oromiya), Koba (in Amhara), and Wassa (in Sidama) (Yemataw, 2018). Enset is relatively high drought tolerant, survive high rainfall, flooding, and frost damage (*Garedew et al., 2017; Zerfu et al., 2018*). Enset is processed in to different food types depending on the needs of the household. There are main products of enset, Kocho, bulla and amicho (*Tane, 2018*).

Despite its huge potential, enset production has not been fully exploited and promoted in the Jimma zone. Several factors, such as poor marketing infrastructure, use of traditional technologies, limited supply processing with traditional material and other factors have contributed to under exploitation of enset production potential (*Hailu, 2016; Mulatu, 2021*).

Enset is cultivated in subsistence farming systems with little connection of the producer with the market, low prices and production mainly for household food consumption (*Tane, 2018*).Enset production was limited to consumption purpose and most of farmers sold small amounts of its products (*Alemayehu, 2018; Ijigu, 2021).* Enset is mostly produced for consumption purpose and it has poor connection to market. Despite all these desirable attributes, the enset farming system has received very little research attention compared to that given to cereal based cropping system. Specifically, in Jimma Zone production and marketing constraints of enset product is not investigated so far. Given the importance of enset crops understanding the production, processing and marketing of enset, as well as constraints and opportunities in enset production is crucial. Thus, this study was aimed at investigating enset production, processing and marketing systems in Jimma zone.

Objectives

- To assess production, processing and marketing of enset in Jimma zone
- To identify the constraints and opportunities in enset production and marketing system

Research Methodology

Description of Study area

This study was carried out in Jimma zone. Jimma zone is one of the administrative zones in Oromia Regional State which was found at a distance of about 350 km away from Finfinnee. Jimma zone is one of the 17 zones in Oromiya Regional state its altitude varies from 800 to 3360 m.a.s.l and the mean annual rain fall ranges from 1200mm to 2650mm. The average minimum and maximum annual temperature is 12.9°C and 26°C respectively.

Data types, sources, and method of data collection

In this study, both primary and secondary data sources were used to gather necessary data regarding the demographic and socio-economic profile of enset producers and situations of enset production and marketing. The structured questionnaire was used to generate the primary data from the selected sample producers.

The primary data was collected from the selected sample respondents. In addition, focus group discussions (FGDs) and key informants interview also used to gather necessary information to supplement data collected from selected respondents. Furthermore, the primary data results were supported by relevant secondary data sources like journals, thesis, books, Central Statistics Agency (CSA), zonal and district reports.

Sampling techniques and sample size determination

The target population for this study was smallholder enset producer households. To select sample households for this study, three stages sampling was employed. In the first stage, from the zone, four major enset producing districts namely, Dedo, Manna, Gomma and Omo Nadda were purposively selected based on enset production potential.

In the second stage, from districts, three kebeles were selected by the same process from each district based on their accessibility and enset production potential.

In the third stage, by taking the list of enset producing farmers from each selected Kebeles as a sample frame, 182 representative enset producer households were randomly selected in probability proportion to size of each Kebeles population.

Finally, from a total of (1458) enset producing farmers households in the four districts, 182 sample enset producing farmers were selected randomly based on probability proportional to the population size of the selected kebeles by using Taro Yamane (1967) formula; with 93 percent confidence interval.

$$n = \frac{N}{1+N(e)^2} = \frac{1458}{1+1458(0.07)^2} = 182$$

Where;

n = the sample size, N= total population of enset producer households, and e= the level of precision which is ±7%.

Table-1: The distribution of sample households across sample kebeles

Districts	Samples kebeles	Number of enset grower	Sample house holds
Dedo	Sito	151	23
	Garima Gudda	122	15
	Garima Lammessa	133	20
Manna	Buxure	124	14
	Obora Bako	120	16
	Lammi Lalisa	132	20
Omo Nadda	Nadda Cala	120	15
	Doyyo yayya	91	9
	Nadda Dawwe	110	11
Gomma	Bula	113	15
	Baqqoo	122	10
	Qada Massa	120	14
	Total	1458	182

Source: District and kebele offices, 2020

Methods of data analysis

The sample respondents' demographic and socioeconomic conditions as well as enset production and marketing situations was computed using descriptive statistics like mean, standard deviations, frequency and percentage. Tables and figures were used to elaborate the research work.

Result and Discussions

This chapter discusses the major findings of the study such as descriptive results of demographic, farm characteristics, socio-economic characteristics and opportunity and constraints of sample enset producing farmers. Overall findings of the study are presented under different sections.

Socioeconomic and Demographic Characteristics

Enset was harvested, processed and marketed by female farmers. Among the respondents, majority of them were female enset producer farmers. Among the sample respondents, 164 (90.11 %) were female headed and the remaining 18 (9.89 %) were male headed enset producers. Based on survey data, 95% of the respondents were married, 1.10% of the respondents were widowed and 3.85% of the respondents were divorced, from this the majority of the respondents were married. Education is a base for development. Based on the data results, 56.59% of the household heads were illiterate couldn't read and write, 43.41% of respondents were literate could read and write, elementary grade and the remaining were high school certificate (table 1).

Table 2: Sex, Marital and Educational Status of Respondents

Variables	Frequency	Percent	Cum
sex			
male	18	9.89	9.89
female	164	90.11	100.00
Marital status			
un married	-	-	-
married	173	95.05	96.15
divorced	7	3.85	98.9
widowed	2	1.10	100
Education			
illiterate	103	56.59	56.59
literate	79	43.41	100.00

Source: survey of 2020/21

Based on the finding, the age of respondents ranged from 23 to 67 years with a mean of 39 years. The mean family size of the total sample households in the study area was about 6.667, with minimum and maximum family size of 2 and 12 respectively.

Cultivable land is productive asset which was the most important factor of production in rural area. In the study area, the mean land holding of respondents was 1.375 ha, where the minimum is 0.25 and the maximum is 5ha (Table 2).

Table 3.age, land size and family size of respondents

Variables	Observation	Mean	STD.DEV	Minimum	Maximum
Age	182	39	15.962	23	67
Family Size	182	6.667	3.502	2	12
Land size	182	1.375	1.835	0.25	5

Source: survey of 2020/21

Size of land occupied and number of enset plant households in the study area

Based on the survey data result, 43.3% had 11-25 enset plants per farm and 37% had between 1-10 enset plants per farm and about 14.7% and 6% have 25-50 and >50 enset plants per farm respectively. Land allocated for enset production varied among households, 82% of farmers have <0.25 ha enset farm. About, 15.7% and 3.3% have, 0.25-0.5 and >0.5ha of enset farm respectively. Based on this data most of farmers have <0.25 hectare of enset farm land (table 3).

Table-4 Farm land covered by enset and number of enset plant per households

Variables	Respondents	
	frequency	%
Farm land covered by enset(ha)		
<0.25	149	82
0.25-0.5	28	15.3
0.5-1	5	2.7
Number of enset plant per households		
1-10	67	37
11-25	78	43.3
25-50	26	14.7
>50	11	6

Source: survey of 2020/21

Enset production in the study area

The based on the survey data result, farmers were cultivate enset in their home garden (85.2%), main field (3.3%) and both home garden and mainfield (11.5%) respectively. Therefore, enset was cultivated in both home garden and main field study area. According to (*Magule, et al. 2018*) enset was produced both in home garden and main field. Farmers grow enset commonly in their homesteads so as to make it accessible for the application of animal manure and any waste products that can be used as organic source of fertilizer it gives high yield in the study area.

In the area, the farmers were growing enset as sole crop and with different crops like coffee, khat and with different fruit. Based on the information obtained from the respondents, they were practiced sole cropping (51.6%) and followed by intercropping (48.4%) system of cultivation (table 4).

Table.5.Enset production site and production system in the study Area

Variables	Respondents	
	Frequency	Percent
production site		
Home garden	155	85.2
Main field	6	3.3
Home garden & main field	21	11.5
Production system		
Sole cropping	94	51.6
Inter cropping	88	48.4

Source: survey of 2020/21

Purpose of enset production in the study area

The farmers of the study area produce enset next to coffee, khat and cereal crops. Based on survey data, 76.7% of the respondents were produce enset for household consumption. The rest of respondents, 23.3% of respondents were produce for both consumption and market (figure 3). Therefore, in the study area production of enset was mainly for household consumption. According to (*Marge, 2015*) enset was mainly cultivated for food and also as income generating crop.

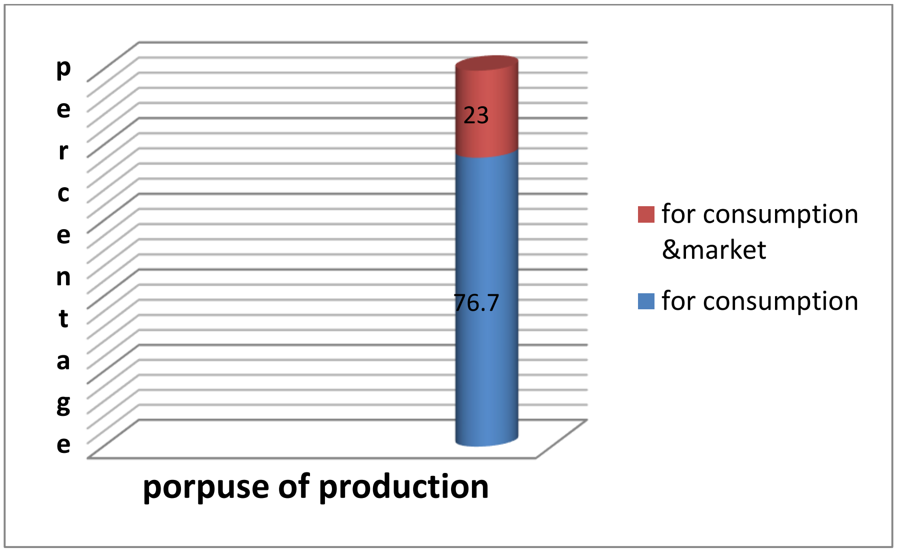


Figure.1. Purpose of enset production

The gender participation in enset production, processing and marketing in the area

In the study area, traditionally, men plant enset, both men and women weed the crop and women do the bulk of harvesting and processing. For the processing of enset, men are not involved. They are involved only in keeping the plantation weed free and at the time of planting. Men don’t know how to process. Hence, enset is one of the crops that is cultivated by men, but harvested, processed and marketed by women in the study area. Table below showed that, 70.33 percent of respondents said, females play major role in enset production while males were 29.67 percent (table 5). According to (*Borell, 2018*) showed that, men are responsible for the cultivation of enset, while women are responsible for harvesting, processing and marketing of enset products.

Table.6: Gender participation in the study area

Variables	Respondents	
	Frequency	**Percent**
Gender		
Male	54	29.67
Female	128	70.33

Source: survey of 2020/21

Productivity of enset in the study area

Table below showed that, the mean amount of products (kocho, bulla and fiber) produced from single plant of enset was, 41.6, 3.07 and 0.7 kg with the minimum 8, 1.5, 0.15kg and the maximum of 75, 51.82kg respectively (table 4). According to Tesfaye Abebe (2013), the amount of kocho and Bulla produced from a single enset plant varies from plant to plant and from area to area.

Table 7. Productivity of enset

Variable	Observation	Mean	Std. Dev.	Min	Max
Amount of products produced from single plant of enset in(kg)					
Kocho	182	41.62	26.02	8	75
Bulla	182	3.071	1.205	1.5	5
Fiber	182	0.70	0.617	0.15	1.82

Source: survey of 2020/21

Status of enset production in the study area

Table (5) showed that the amount of enset production in the study area, 64.81% of farmers responded that there was decrease in amount of enset production and 30.86% of respondents responded that the amount of enset production no change over the last five years the rest of respondents 4.32% responded that there was increased in enset production over the last five years (table 5). Due to different factors such as diseases, insect pests, lack of soil fertility, expansion of other crops, the use traditional production and were some of reasons respondents mentioned for decline of enset production in Jimma zone.

The data result showed that, the amount of enset production in the study area, 64.81% of farmers responded that there was decrease in amount of enset production and 30.86% of respondents responded that the amount of enset production no change over the last five years the rest of respondents 4.32% responded that there was increased in enset production over the last five years.

In addition, enset production was limited to consumption purpose due to the focus given from government extension support was weak to encourage the enset crop producers (*Alemayehu, 2018*).

Table 8. Status of enset production

Variable	Response	Frequency	%
Status of enset production over the last five years	decrease	118	64.81
	increase	8	4.32
	no change	56	30.86

Source: survey of 2020/21

Enset harvesting, processing and storage in the study area

In the study area, harvesting time was just when the enset plant flowers because of the quality of kocho and bulla became high when enset fully matured. The maturity stage ranges from 3 to 7 years. In the study area, harvesting and processing of enset was undertaken by women using traditional materials.

Harvesting was done during the dry season mainly, from November to January to avoid excess water content, which may affect the taste and quality of the food. However, under extreme situation, like food shortage in the household, processing is practiced during rainy season as well by preparing fermentation pits on an elevated ground, carefully covering the opening of the pit and constructing drainage furrow around it to avoid flood water from entering. The work of harvesting and processing of enset for food was generally laborious and tiresome. At harvest, the matured plant is selected, the oldest enset before seed setting is always preferred and easily up rooted by pushing it side way. Thereafter, older leaves from the matured and uprooted plant are removed using sharp instruments.

The working area used for decortications was, therefore, prepared from these cut leaves and outer leaf sheath. Following this, the internal leaf sheaths are peeled off from the pseudo stem and cut about one-meter workable size. At the same time, the underground corm dug out was grated using wood locally called leman. The scraped pseudostem and chopped corm tissue are mixed and then squeezed to extract bulla, before they are placed in a pre-prepared pit lined with enset leaves for fermentation.

Identification of matured enset plants

Identification of mature enset plant, preparation of fermentation pit and the processing area, pulverization and decortications, bulla extraction, fermentation of the pulverized mass in the pit, and mixing and check-up of the fermenting mass were identified as major steps of enset processing in study area, Jimma zone.

The study showed that, 78.8% of respondents Said that enset plants reached maturity between the age of 3-5 years, 12.9% and 8.3% of respondents Said that enset plants reached maturity at age of ≤3 and 6-7 years, depends on enset variety respectively (table 7). Additionally appearance of inflorescence confirmed the maturity of the plant. According to the respondents, the enset plant at flowering stage would give high quality yields of bulla and Kocho. The number of harvested enset plant and storage duration depends on the size of family members in the house and presence of other crops in their home.

Table 10.maturity age of enset

Time to harvest enset	Number of respondents	Percent
≤3 years	24	12.9
3-5 years	143	78.8
6-7 years	15	8.3

Source: survey of 2020/2021

Traditional processing of enset in the study area

Sample respondents responded that, different traditional instruments (decorticator/which was made from bamboo to decorticate the pseudo stem and pulverize corm. Then decorticated and pulverized corm was mixed together and wrapping with fresh and dry enset leave. During fermentation, various processing steps such as remixing and changing leaves were done at varying interval of time and will continue until the mixture ferments to what referred Kocho (figure 5).

In the study area, processing of enset for food was based on traditional knowledge of the people and mainly performed by women using different traditional materials. The fermented enset was ready for consumption after 30-60 days from the initial processing day depends on agro ecology. The two main primary food product prepared from enset was Kocho and bulla and byproduct was fiber. Kocho is the main enset food product. Bulla is small in quantity as compared to Kocho, but it fetches higher price than other products of enset. Bulla is the water-insoluble starchy product.

According to (*Yemataw et al., 2016*) when leaf sheaths and corms pulverized, the liquid squeezed out, and allowed concentrating into a white powder.

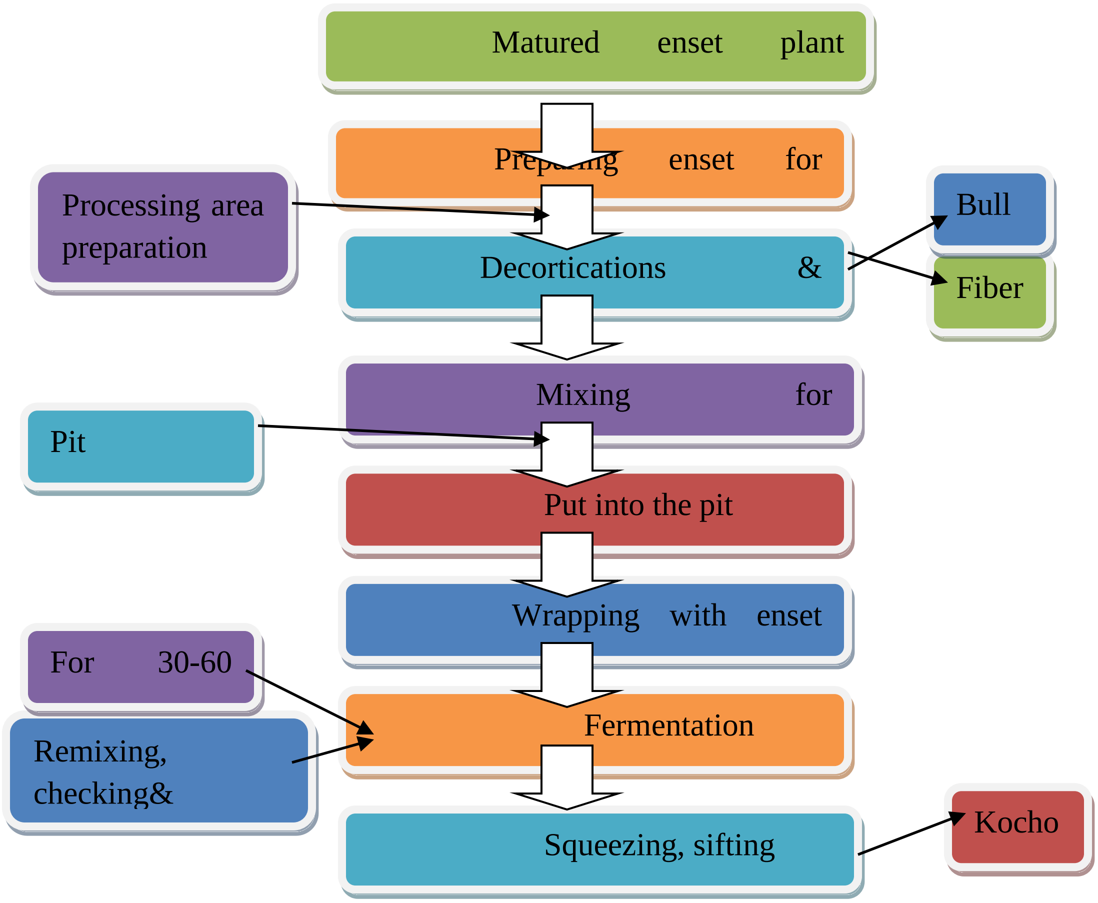


Figure 2. Traditional enset processing steps

Enset marketing in the study area

Women play significant role in Kocho, bulla and fiber marketing because all kocho, bulla and fiber processed by them were supplied to the market only by female. That means kocho, bulla and fiber marketing activities performed by female group than male and it is taboo for male group to sale the processed kocho, bulla and fiber to the market. Based on the group discussion and key informant interview, enset producer households were sold their enset products to consumers, collectors and retailers respectively. However, majority of respondents sold enset products direct to consumers. There is no immediate market to which farmers deliver their products particularly for enset. They sell their enset product either in villages or take to the nearby town.

Enset products market price trends in the study area

Regarding the trend of kocho and bulla market price during last five years, majority of sampled respondents responded that the market price trend of kocho and bulla increasing. That is important to reduced food insecurity and source of income in the study areas. As indicated in below (Table 11). Out of total respondents 82.96% of enset producers responded that market price trend during last five years is increasing in the areas due to agricultural product price increment locally as well as nationally.

Table.11. Enset products market price trend of last five years

Variable	Trends	Frequency	Percent
Enset products market price trend	increasing	151	82.96
	decreasing	5	2.75
	same	26	14.29

Source: survey of 2020/21

Income generated from enset in the study area

As shown in figure below, over 27.77% of the total respondents reported that their annual income from enset product was 500-1000 ETB ,while the remaining 65.43%, and 6.8%, had their annual income between 1500-2500ETB and >3000 ETB respectively(table 6). Both in group discussion and interview, the respondent reason out low income earn from sale of enset product. Enset crop plays a major social and economic role for a wide range of farm households in south and southwestern parts of the country (Almaz, 2001; Tane, 2018). Enset is cultivated for home consumption, only small portion of enset products are sold in the local market in the area.
Hence, women can take a portion of processed kocho for sale to the nearby market to fulfill household needs at hard time. Thus, the income earned from enset is used for covering costs of shopping goods and to pay social obligations.

Table 9. Income generated by selling of enset in the study area

Variable	Response	Frequency	Percent	Cum
Income earned by selling of enset product in a year	500-1000 ETB	119	27.77	65.43
	1500-2500ETB	51	65.43	93.2
	>3000 ETB	12	6.8	100

Source: survey of 2020/21

Extension service and training on enset production in the area

Extension agent plays a very great role in the implementation and diffusion of innovation, extension act as an agent for change and as a communication media. Also extension services popularize the innovation by providing necessary information, appropriate knowledge and special skills, which enable farmers to apply the innovation. The data result showed that, 93% of farmers responded that, have not access to extension contact on enset production in the study area. Training is mechanism of promoting farmers knowledge, technical information for new technology and skills about production and adoption activities which increase farmers' decision making ability. Therefore, household heads that have an opportunity of participation in training of the enset production in study area. Most of, 77% of enset producers were indentified that they haven't got training and technical advice in the study area. The previous studies by Hadush (*2015) and Akalu et al. (2016*) also found that farmers participate in agricultural trainings facilitate adoption of new improved technologies.

Table .12. Extension service

Variables	Frequency	Percent
Did you get Extension service?		
Yes	13	7
No	169	93
Did you get training?		
yes	42	23
No	140	77

Source: survey of 2020/21

Major constraints and opportunities of enset production in the study area

Major constraints of enset production in the study area

The major challenges in enset production in study area was, lack of enough research in enset Production and marketing, drought, disease, lack of improved clone, lack of disease resistant variety, shortage of training to producers how to cultivate, lack drought tolerance variety; lack of improved processing and storage technologies, improper or traditional agronomic practice, long time maturity and food shortage/starvation.

Poor agronomic and traditional cultural practice such as frequency of transplanting, spacing, fertilization, pruning and so on are done blanket that significantly affects both production and productivity of enset in the area. Once again frequent transplanting and cultivation also has direct relation to crop maturity, productivity and efficient utilization of labor, land and time as well. More over the farmers in the area do not have any know how about the amount, type and method of fertilizer application that significantly affects its production since the crop by nature highly respond to applied fertilizers be it organic or inorganic (*Abraham et al., 2012 & Lisanu, 2020*).

Focus group discussions were held with enset growers in each of the selected kebeles. During the discussion with these groups, one of the discussion agenda was the major constraints in enset production, processing and its products marketing. Accordingly, constraints such as lack of processing technology, lack of market information, disease, limited government attention, and land shortage were explained by the discussion groups.

Based on group discussion, they rate the constraints of enset production in percentage. They were the problems of disease/ bacterial wilt/ 37%, lack of processing technology, 32.3%, shortage of land, 21% and others wild animals like pig and porcupine, 8.7% were major constraints which was enset production in the study area(figure 6). The other problems were improper storage, loss of product during processing, poor agronomic practices, lack of improved varieties and extension contact in the area.

According to the information collected from group discussion, enset plants were lost due to severity of disease, but no solution was found by any concerned body to control the diseases. The finding of this study were in line with studies conducted in Gurage zone by Adanech Jarso (2017) explained that enset disease/bacterial wilt/ had great impact on enset production. Similar factors have been described as major constraints of enset production in Wolaita (*Shembulo et al.*

2012). Zeberga et al. (2014) also reported bacterial wilt, caused by the bacteria Xanthomonas campestrisp, is the most threatening to the enset.

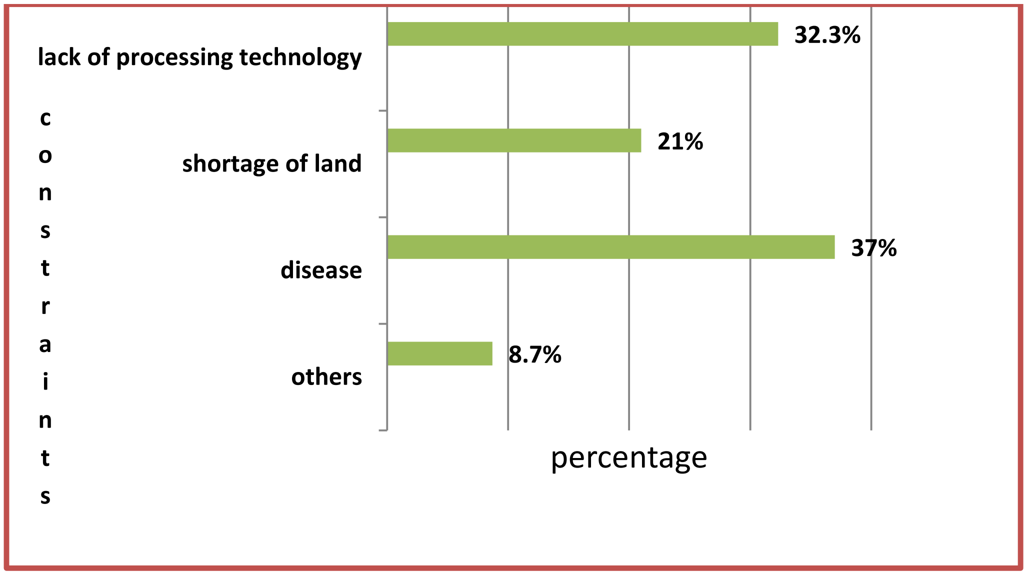


Figure. 3. Major constraints of enset production

Enset marketing constraints in the study area

The most of enset products marketing constraints in the study area were, lack of market information, price of the kocho, bulla and other products are low, most of the product sold in the local market, low demand of kocho and its products most of the people do not have experience how to consume and prepare enset products(kocho, bulla) in the area. According to(*Anbes et al.,2015& Lisanu,2020*)the market and marketing challenge in most part of Kocho marketing are lack of composed market information, price of the kocho and other products are low, most of the product sold in the farm, there no demand of kocho and its products in most part of the country, Most part of our country do not have knowledge how to consume kocho and its product, have high water contents make it not easily to market and lack of enough transport access to collect product to the market.

Opportunities of enset production in the study area

Because of favorable environmental condition, this was appropriate for enset productions. The situation, governments and NGOs were placing more emphasis on enabling farmers to increase their level of competitiveness, to produce for an identified market, rather than trying to sell what they have already produced and also seeking new market opportunities that offer higher levels of income. Enset plant was able to withstand or quickly recover from difficult conditions (drought and climate changes) and can be stored for long periods. The high yield from small plot is one of the best opportunities for the producer farmers and for those who has small area of land. According to **(***Ghimiray et al. 2007& Lisanu,2020*), confirm that higher yield potential is considered as an important factor particularly for farmers' innovation not only because it provides food security at household level but also because surplus production can be sold to generate cash for other expenditure.

For the farmers produce enset nearest to the town and cities was one of the most important opportunities for the enset producer farmer to sell their products (Bulla, Kocho, Fiber and fresh enset leaf) as well. Enset products kocho, bulla, and enset by product fibers and enset leaves are traded within and outside the district and zone market increases the market value. These products are traded mainly to nearest zonal market.

Conclusion and Recommendations

Conclusion

In the study site ,Jimma zone, most of the respondents shared the same idea that major reasons of enset production was for house hold consumption and small portion of enset products were sold in market. In current research finding Enset processing and marketing main activities hold on the shoulder of female than male in the community. Then, women could take enset primary products (kocho and bulla) and byproduct (fiber), sold to the nearby market to buy shopping goods and to pay social obligations. However, its production has been decreasing for the last five years due to various reasons.

Traditional way of production, lack of improved harvesting, processing and value addition technology and expansion of other crop production let farmers to have little experience of money making from enset production. Moreover, enset processing with traditional processing material is not easy task for women where there is no improved technology to do so. Due to this condition, enset production was limited to consumption purpose and most of farmers sold small amounts of products like kocho, bulla and fiber. Market imperfections in the area also challenged sustained enset farming and the conservation practices of the enset production. This could be revealed through the existence of thin markets with few buyers and farmers with poor access to market information.

The main problem in Enset producer household in study area was the inability to produce at a commercial scale and the loss of its product during processing, the improper storage of the final produce before consumption. In addition, enset production is highly affected by diseases, insect pests and the use of backward and inefficient traditional methods and equipment in production, processing and marketing activities, and low attention from existing extension component on protection and promotion of the crop.

Enset farming has received very little research attention compared to that given to other crop production. As a result, the potential of its production has not fully utilized. Enset processing was time consuming job which needs technology, to get efficient production and lighten the burden on women. Enset plants were lost due to disease problem/bacterial wilt/, but no solution was found by any concerned bodies.

Recommendation

- Research towards the development of processing technology is important to meet farmer's needs and reduce burden on women.

- Further studies needed from research centers, government bodies and NGOs working in the area to control enset disease.

- Farmers should be made aware on how to prevent the transmission of the enset disease until scientific solution to be found by concerned body.

- Different stakeholders' involvement is needed to establish market oriented production of enset crop through capacitating farmers for better production and market supply to have higher amount of income from the commodity.

- Therefore, it would be better zone agricultural office in collaboration with research centers and other concerned bodies work on introduction, demonstration and widely dissemination of improved technology around enset processing and marketing in the area.

References

Ayalew, Abay, and Mikias Yeshitila. "The response of enset (Ensete ventricosum (Welw.) Cheesman) production to rate and frequency of N and P nutrients application at Areka, in southern Ethiopia." *Innovative Systems Design and Engineering* 2 (2011): 26-31.

Bonso, Amanuel Berhanu, Geremew Motuma Jabessa, and Bacha Gebissa Negeri. "Does enset (Ensete Ventricosum) production upshot smallholder farmers food security and income: Evidence from Dedo Woreda, Jimma zone, Ethiopia." *Journal of Agriculture and Food Research* 10 (2022): 100349.

Borrell, James S., Manosh K. Biswas, Mark Goodwin, Guy Blomme, Trude Schwarzacher, J. S. Heslop-Harrison, Abebe M. Wendawek et al. "Enset in Ethiopia: a poorly characterized but resilient starch staple." *Annals of Botany* 123, no. 5 (2019): 747-766.

Borrell, James S., Manosh K. Biswas, Mark Goodwin, Guy Blomme, Trude Schwarzacher, J. S. Heslop-Harrison, Abebe M. Wendawek et al. "Enset in Ethiopia: a poorly characterized but resilient starch staple." *Annals of Botany* 123, no. 5 (2019): 747-766.

Borrell, James S., Mark Goodwin, Guy Blomme, Kim Jacobsen, Abebe M. Wendawek, Dawd Gashu, Ermias Lulekal, Zemede Asfaw, Sebsebe Demissew, and Paul Wilkin. "Enset-based agricultural systems in Ethiopia: A systematic review of production trends, agronomy, processing and the wider food security applications of a neglected banana relative." *Plants, People, Planet* 2, no. 3 (2020): 212-228.

Borrell, James S., Mark Goodwin, Guy Blomme, Kim Jacobsen, Abebe M. Wendawek, Dawd Gashu, Ermias Lulekal, Zemede Asfaw, Sebsebe Demissew, and Paul Wilkin. "Enset-based agricultural systems in Ethiopia: A systematic review of production trends, agronomy, processing and the wider food security applications of a neglected banana relative." *Plants, People, Planet* 2, no. 3 (2020): 212-228.

Brihanu, Zerihun Tsegaye. "Community indigenous knowledge on traditional fermented enset product preparation and utilization practice in Gedeo zone." *JBES* 5, no. 3 (2015).

Daba, Tadessa, and Masayoshi Shigeta. "Enset (Ensete ventricosum) production in Ethiopia: its nutritional and socio-cultural values." *Agriculture and Food Sciences Research* 3, no. 2 (2016): 66-74.

Duguma, Belay, and Geert Paul Jules Janssens. "Assessment of feed resources, feeding practices and coping strategies to feed scarcity by smallholder urban dairy producers in Jimma town, Ethiopia." *SpringerPlus* 5, no. 1 (2016): 1-10.

Duguma, Belay, Veronique Dermauw, and Geert Janssens. "The assessment and the farmers' perceived ranking of feed resources and coping strategies with feed scarcity in smallholder dairy farming in selected district towns of Jimma Zone, Ethiopia." *Tropical animal health and production* 49, no. 5 (2017): 923-935.

Garedew, Belachew, Aklilu Ayiza, Bewuketu Haile, and Habtamu Kasaye. "Indigenous knowledge of enset (Ensete ventricosum (Welw.) Cheesman) cultivation and management practice by Shekicho people, southwest Ethiopia." *Journal of Plant Sciences* 5, no. 1 (2017): 6.

Garedew, Belachew, Aklilu Ayiza, Bewuketu Haile, and Habtamu Kasaye. "Indigenous knowledge of enset (Ensete ventricosum (Welw.) Cheesman) cultivation and management practice by Shekicho people, southwest Ethiopia." *Journal of Plant Sciences* 5, no. 1 (2017): 6.

Haile Geleta, Shisho. "Assessment of Selected Proximate and Heavy Metals in Enset Products Collected from Tepi Market, Southwestern Ethiopia." *Journal of Food Quality* 2022 (2022).

Haile, Ashenafi, Berhanu Megerssa, and Rijalu Negash. "Enset (ensete Ventricosoum) value chain in Dawuro zone, southern Ethiopia." *International Journal of Agricultural Science and Food Technology* 6, no. 1 (2020): 126-150.

Kudama, Gezahagn, Tadesse Tolera, and Lemane Gebeyehu. "Good farm practices and improved processing technology of enset for sustainable hunger solution in Ethiopia." *Journal of Innovation and Entrepreneurship* 11, no. 1 (2022): 1-20.

MacEntee, Katie Katie, Jennifer Thompson, and Sirawdink Fikreyesus. ""Enset is a Good Thing"." *Ethiopian Journal of Applied Science and Technology* 1 (2013): 103-109.

Mulualem, Tewodros, and Tesfaye Walle. "Farmers indigenous knowledge and assessment of enset (Ensete ventricosum Welw. Cheesman) cultivars for major insect pests in Ojojia water shade Kembata-tembaro zone, South Ethiopia." *Sky Journal of Agricultural Research* 3, no. 6 (2014): 112-119.

Shumbulo, Abrham, Yishak Gecho, and Melese Tora. "Diversity, challenges and potentials of enset (Ensete ventricosum) production: in case of Offa Woreda, Wolaita Zone, Southern Ethiopia." *Food Science and Quality Management* 7, no. 1974 (2012): 24-31.

Shumbulo, Abrham, Yishak Gecho, and Melese Tora. "Diversity, challenges and potentials of enset (Ensete ventricosum) production: in case of Offa Woreda, Wolaita Zone, Southern Ethiopia." *Food Science and Quality Management* 7, no. 1974 (2012): 24-31.

Taboge, Endale, and Dereje Bacha. *Enset Production in West Shewa Zone*. Ethiopian Agricultural Research Organization, 2003.

Tedla, Mehtzun, and Yewelsew Abebe. "Study of" Enset" Processing and Development of" Enset" Processing Tools in the Southern Region of Ethiopia." (1994).

Wake, Alemayehu Abebe. "Demonstration and scale-up of improved post-harvest Enset processing technology at Somodo Kebele, Mana Woreda, Jimma Zone, Oromia regional state, Ethiopia." (2020): 14-18.

Wondimu, H., and A. Kebede. "The process of Enset cultivation and its transplantation in Cheha Woreda South-Western Ethiopia." *Academia Letters* (2021): 2.

Yemata, Getahun. "Ensete ventricosum: a multipurpose crop against hunger in Ethiopia." *The Scientific World Journal* 2020 (2020).

Yemataw, Zerihun, Hussein Mohamed, Mulugeta Diro, Temesgen Addis, and Guy Blomme. "Enset (Ensete ventricosum) clone selection by farmers and their cultural practices in southern Ethiopia." *Genetic Resources and Crop Evolution* 61, no. 6 (2014): 1091-1104.

Assessment of Irrigation practices and its Potential in Jimma and Bunno Bedelle Zones, Western Oromia

Lemma Gutema[1], Hussein A/Gissa[2]

Oromia Agricultural Research Institute, Jimma Agricultural Engineering Research Center

P.O. Box, 386, Jimma, Oromiya, Ethiopia

Corresponding author e-mail: -lemigada@gmail.com

Abstract

Small-scale irrigation has a great impact on enhancing farmers' livelihoods in south western Oromia; however this opportunity was not well used in the study area. Thus, this study was conducted to assess the existing irrigation practices, challenges and opportunities of small-scale irrigation. A sample of 214 households was taken using random sampling method. Questionnaire, group discussion, KII and field observation were used to obtain primary data. Collected data was analyzed by using simple descriptive statistics method. As per the findings of the study indicated the majorities of the respondents have access to spring, swampy, stream and river and get abundant rain water. Despite this, 72.86% do not utilize water resources for small-scale irrigation. The findings of the study revealed that households who practice irrigation ensure better food security as compared to those households that do not utilize water resources for small-scale irrigation. There are many operational problems that impeded the efficiency of small-scale irrigation. For efficient of water resources for small-scale irrigation, the households need supports such as guidance, skilled manpower, access to loan services, fertilizers, selected seeds, access to market, cooperation, water pumps. Thus governmental and non-governmental bodies found at different levels should endeavor to do all what is expected of them in this regard.

Keywords: irrigation, constraints and opportunities

Introduction

Background and Justification

Agriculture is the leading sector of Ethiopian economy as well as the overall economic growth of the country depends on the sector and the share of agriculture in GDP was 34.9% (*NBE, 2018*). However, Ethiopian agriculture is characterized by small-scale subsistence production systems where crop and livestock yields are very low. The agricultural practices are mainly traditional and using rainfed systems. Rainfall is highly variable in the region, which resulted in periodic drought (*Tessefa, 2018*). The rainfed agricultural system needs to move in the direction of irrigated agriculture to sustain livelihoods and ensure food security for smallholder farmers in the region. Irrigation plays a significant role to address the adverse effect of rainfall variability and improve agricultural production. It is believed that the country has a large potential of land feasible for irrigation (*Tessefa, 2018*).

In Ethiopia small scale and traditional irrigation accounts for more than 55% of the total irrigated land. In such conditions, farmers practice irrigation water management mostly from indigenous knowledge (*Agricultural Water Solutions, 2010, Oli F., Kalkidan, 2020*). There is a huge gap between the potential and the level of irrigation applied in the country due to technical, physical and economic challenges (*ATA, 2016*). Irrigation is application of artificial water to the living plants for the purpose of food production and overcoming shortage of rainfall and help to stabilize agricultural production and productivity (*FAO, 2015)*. Small-scale irrigation is a policy priority in Ethiopia for rural poverty alleviation and growth but only around 5% of Ethiopia's irrigable land is irrigated, and less than 5% of total renewable water resources are withdrawn annually (AU, 2020) ,so there is considerable scope for expansion.

Small-scale irrigation has a great impact on enhancing farmers' livelihoods but this opportunity was not well used in the study area. The use of small-scale irrigation, even the traditional irrigation system was not as expected in the study area. There were traditional and few modern small scale irrigation scheme, however their exact potential and associated problems were not studied well. Thus the aim of this study was to assess the existing irrigation practices, challenges and opportunities of small-scale irrigation.

Objectives

- ✓ To assess the existing irrigation practices, challenges and opportunities

Methodology

Description of Study Area

This study was undertaken in Jimma zone and Bunno Bedelle zone, Oromia regional state. Jimma zone, which its altitude varies from 800 to 3360 m.a.s.l and the mean annual rain fall ranges from 1200mm to 2650mm. The average minimum and maximum annual temperature is 12.9°C and 26°C respectively. Bunno Bedelle is another Oromia regional state zone situated at Western of the region and located at a distance of about 500km from the Finfinnee, capital city of Oromia, Ethiopia.

Method of Data collection

To achieve the objectives of research mentioned above data were collected through primary and secondary sources. For this study both qualitative and quantitative data were collected from primary and secondary sources. To collect the required data several methods like interview schedules, focus group discussions and key informant interviews were used. The secondary data were collected from different sources such as relevant books, internet and journal articles through reviewing the secondary sources. The information collected from zonal and a district level office of irrigation authority was also taken secondary data sources.

Sample Technique and Size

The study was carried out in selected districts of Jimma and Bunno Bedelle zones to represent the irrigation potential areas to assess existing irrigation practice, challenges and opportunities. Purposive Sampling technique was used for identifying two districts that have better irrigation practices from each zone. Four districts were taken based on availability of irrigation practices and information collected from Zonal Irrigation Authority. From each district, three kebeles were purposively selected from each district.

Finally, from a total of (1284) small scale irrigation user farmers households in the four districts, 214 sample farmers were selected randomly based on probability proportional to the population size of the selected kebeles by using Taro Yamane (1967) formula; with 94 percent confidence interval.

The sample size was determined by using Yamane (1967) formula to determine sample size.

$$n = \frac{N}{1+N(e)^2} = \frac{1284}{1+1284(0.07)^2} = 214$$

Where, N= population size (irrigation user), n = is sample size and e= level of precision 6%

Method of Data Analysis

The both quantitative and qualitative data collected by the structured questionnaires were analyzed using STATA version 13.0.The sample respondents' demographic and socioeconomic conditions was computed using descriptive statistics like mean, standard deviations, frequency and percentage.

Results and Discussions

Demographic and Socioeconomic Characteristics of the Study Area

This chapter is concerned with the discussion of the results obtained from the survey data and secondary data from both qualitative and quantitative analysis. Therefore, it includes the descriptive analysis of the farm household characteristics in the study area. Major existing irrigation practices, challenges and opportunities of small-scale irrigation farming in the study area are presented.

The majority of respondents were male 196 (91.59%) and 18(8.41%) were female, which suggested that married people are more responsible to control and manage farming activities in the study areas. The high percentage of male farmers in study districts may be due to their access to farmland and their position as head of family.

About 94.85 % of the sample respondents were married and the remaining, 3.27% and 1.86% were single and divorced respectively. The other productive asset is cultivable land which is considered as the most important factor of production in rural area. In the study area, majority of residents (52.8%) owned total farmland less than of 1 hectare.

Sex and land size of respondents

Variables	**Frequency**	**%**
Sex of respondents		
male	196	91.59
female	18	8.41
Land size		
<1ha	113	52.8
1-2ha	101	47.19
>2ha	8	3.73

Source: survey of 2021/22

Age of household head was one of the variables used in the analysis of the characteristics of the farm household in the study area related with irrigation practice. The age of the household head have an influence on household decision because of experience and risk taking differences between old and young farmers. The age of respondents ranged from 22 to 73 years with a mean of 41.43. Family size is useful for formulating various development plans and for monitoring and evaluating their implementation. Average family size at the national level in Ethiopia was 4.7 (*CSA 2007; Temesgen, 2017*).The mean family size of the total sample households in the study area was about 6.23, with minimum and maximum family size of 1 and 14 respectively.

Access to market is a determinant of profitability of agricultural produce. Respondents in the study area responded that they sold their agricultural products after harvest to cover costs of farm inputs, social obligation and urgent family expenses by taking to the nearby local market. The survey result indicated that the average distance of respondents' farm from the nearest market place is found to be 6.5 km with a minimum of 2 km and a maximum of 14 km. According to their opinion the main reason for the low price of the agricultural products produced by irrigation was the nature of the product. The commodities produced by small-scale irrigation have perishable nature that is why as soon as harvested the entire farmer supplies such products to the market simultaneously since it can't be stored.

Farm animals have an important role in rural economy. They are source of draught power, food, such as, milk and meat, cash, animal dung for organic fertilizer and fuel and means of transport. Farm animals in the study area also serve as a measure of wealth in rural area. The types of livestock found in the study area were cattle, donkey, horse, sheep, goat and chicken. The mean livestock holding of respondents was 6.2 TLU, where the minimum is 0 and the maximum is 13.

Age, family size, distance from market and livestock

Variables	Observation	Mean	Minimum	Maximum
Age	214	41.4	22	73
Family size	214	6.2	1	14
Distance from market	214	6.5	2	14
Livestock TLU	214	6.2	0	13

Source: survey of 2021/22

Accessibility of irrigation Water Resources in study the area

As shown in figure, the entire major water supply systems are available in the study area. Depends on the survey accessibility of water resources, we find that, the majorities of the respondents have access to swamp, stream, springs and river within 1-2 km radius. Again, the rest have access to resources >2km radius. Besides, respondents didn't harvest rainwater which shows that they are mainly dependent on major water sources.

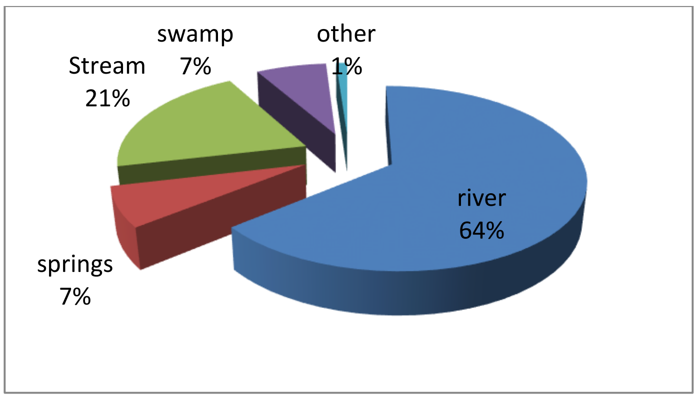
Table 4.2.1. Distance of water source from farm

Description	Frequency	Percent	Cum
<1km	62	28.97	28.97
1-2km	102	47.65	76.62
3-4km	38	17.75	94.37
>4m	12	5.63	100

Source: survey of 2021/22

Type of Water sources utilized for small scale irrigation in the study area

As presented in figure below, respondents were used water for small scale irrigation. Out of the total sampled water users for small scale irrigation, 63.08% rivers, 21% streams, 7.01 springs and the rest of 7% uses swamp. Other 1% is ponds and well. However, none of the respondents uses rain water gathered for irrigation.



Source: survey of 2021/22

Type of irrigation practice in study area

Small scale irrigations include household water harvesting, hand-dug and shallow wells, flooding, individual household-based river diversions and other traditional methods. Based on survey result, farmers used about two types of irrigations (Surface irrigation, Pressurized irrigation). While some farmers used combination of surface and pressurized irrigation. Pressurized irrigation is use of motor pump from water sources. The study revealed that surface irrigation only covers about 71.5%, 23% and 5.4% were use surface, combination of surface with pressurized and pressurized irrigation respectively.

Irrigation practice in irrigation scheme in the study area

Type of irrigation practiced	Frequency	Percent
Surface irrigation	153	71.5
Surface+ Pressurized irrigation	49	23
Pressurized	12	5.4

Source: survey of 2021/22

Type of irrigation methods used in study area

From this study, Furrow irrigation is dominant irrigation method in the study area, on areas where irrigation method practiced. From furrow irrigation accounts about 56% followed by combination of furrow and underground irrigation by 21%, combination of furrow and flood irrigation by 18.2% and 4.5% furrow + flood + pumping irrigation method were used.

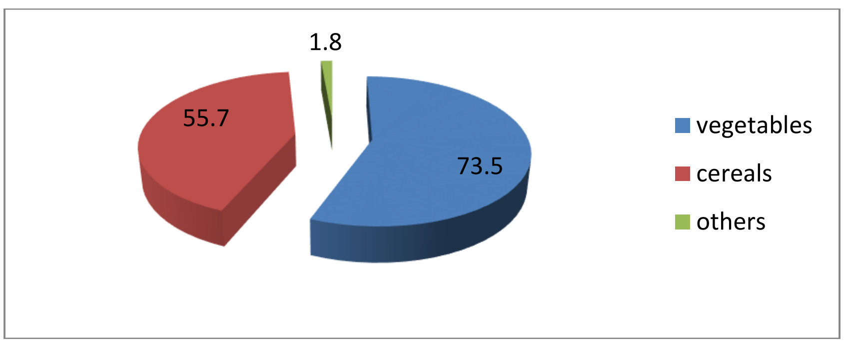
Irrigation method practiced in irrigation scheme in the study area

Irrigation methods	Frequency	Percent
Furrow irrigation	120	56
Furrow and flood irrigation	39	18.2
Furrow+ underground	45	21
Furrow + flood + pumping irrigation	10	4.5

Source: survey of 2021/22

Crops Produced by through Small-scale Irrigation in the study area

The results indicate that, 73.5 % of the respondents produce vegetables during dry season using water resources, 31 % , 24.7% and 1.8% cultivated irrigated wheat , irrigated maize and other perennial crop like khat, fruits and coffee respectively.



Source: survey of 2021/22

Cropping intensity irrigation scheme

The farmers grow crops throughout the year based on the availability of water. The irrigation schemes have increased the cropping intensity per year in study areas, especially after irrigated wheat production was introduced by government. Before farmers were dependent on rain fall and only one crop per year was grown**.** Based on the survey result majority of farmers were produce once a year (97.7%) and twice a year (65%), cereals and vegetables respectively.

Cropping intensity per year

Crop type	**Once per year**		**Twice per year**		**Three times per year**	
	No	%	No	%	No	%
vegetables	64	30	139	65	11	5
Cereals(maize and wheat)	209	97.7	5	2.3	0	0

Source: survey of 2021/22

Extension service and training

Availability of extension service plays a crucial role in terms of creating knowledge and skill in using improved agricultural inputs. It also increases awareness among farmers about new farm activities through demonstrations, trials and discussions. Unfortunately, the result from FGDs confirmed that extension agents were reportedly engaged in administrative activities rather than their real profession. Training is an important factor to enhance the knowledge and skills of farmers. The more training and technical advice is provided to the farmers, the higher is the probability that farmers adopt the technologies like small scale irrigation to improve their production system. Most rural people lack knowledge about the advantages of new technologies; hence, there is high demand for training and technical advice especially while adopting new technologies. Most of 57% irrigation users were indentified that they haven't got training and technical advice.

Extension service

Variables	Frequency	Percent
Did you get Extension service?		
Yes	101	47
No	113	53
Did you get training?		
yes	92	43
No	122	57

Source: survey of 2021/22

Market information and credit for irrigation practice

In this study, it was assumed that the respondents who owned radio had better opportunity to access market information on prices of inputs and outputs, and use of radio on current local market information is determinant factor of marketing agricultural products. As a result, owing radio helped some to get information on existing market price. Others reported that owing radio widened their knowledge on new market-oriented production activities. Farmers face low and unpredictable prices for crops because they lack up-to-date information to access high-value markets (*Eshetu et al., 2010*). Farmers' irrigation use decisions are mostly based on market price information (*Abonesh et al., 2006*). Credit service was an important institutional service to purchase agricultural inputs and water pumping motors. WALQO Microfinance Institution provides the credit services as reported. It facilitated the use of new technological innovations like improved seed varieties. In this sense, the findings of Takele (2008) also pointed out a similar result. Irrigation users who accessed credits were maintaining their output if production fails due to risks.

Market Information

Variable	Frequency	Percent
Did you get Market Information?		
Yes	73	34
No	141	66
Did you get credit service?		
Yes	75	34
No	139	65

Source: survey of 2021/22

Problems related to water distribution among the irrigation water users

Farmers undertake canal-cleaning activities, when the rainfall is low. The controlling committee was not properly handling its responsibility. These show that there were weak scheme post-maintenances for simple cleaning of grasses, silts and structural damages. There was poor resource mobilization in the irrigation scheme. Canals are not protected against livestock.

Problems related to water distribution

problems	No	%
Unfair water distribution	45	21.3
Limited technical support by experts	89	41.6
Weakness of water distributor committee(WUAs)	60	28.1
others	21	10

Source: survey of 2021/22

Conflict over irrigation water

Conflict among the members of water users association will reduce the utilization of irrigation water for cultivation purpose. The survey result indicated that majority (69.63%) of irrigation users reported as there was conflict over irrigation water utilization.

Conflict in irrigation scheme in the study area

Variable	Frequency	Percent
Is there Conflict over irrigation use?		
Yes	149	69.63
No	65	30.37

Source: survey of 2021/22

Sources of the conflict in the study irrigation system

In the study area, conflict was the frequent phenomena which demands higher attention. According to discussions that was made with the WUAs committee the types of conflicts in the irrigation scheme include the conflicts among the water users, between legal and illegal users, absence of equal labor contributions and between scheme beneficiaries . The conflict management committee was responsible to administer the conflict management activities but they have not handled them effectively. The discussion also revealed that conflict arising from water allocation and distribution between irrigation users. It was also expressed that lack of enforcement of bylaws has been one of the most important source for conflict than water scarcity. The sources for conflict were illustrated on the table below.

Sources of the conflict in irrigation scheme in the study area

Description of sources	No	%
Damage by animal	5	2
Water scarcity due to misuse of water	80	37.38
Unequal maintenance contribution	15	7
water scarcity from the source	11	5
Water theft	27	13
Lack of enforcement of by-laws	76	35.5

Source: survey of 2021/22

Challenges and Opportunities in Small-Scale Irrigation in the Study Area

There are many challenges and opportunities in the study area related to the small-scale irrigated farming. From the survey as well as key informant interview and focus group discussion it has been indicated that the farmers face many challenges in small-scale irrigation practice in the study area. Besides the challenges also there were opportunities for small-scale irrigation development. These Opportunities and challenges are discussed below.

Challenges in irrigation scheme in the study area

As per the discussions with woreda irrigation experts, about small-scale irrigation potential and its challenges and opportunity in the study area varies from one source to the other, due to different factors such as shortage of land of the farm (inappropriate location of land. The most critical challenge that was indicated in the study area by the focus group discussion as well as by the farmers interviewed was the problem of the shortage of irrigated farm land .the farmers in the study area also indicated that they were unable to irrigate larger area of land because of topography of the land difficult to bring the water from surface water source by traditional river diversion. Lack of frequent training to handle technologies and also there was lack of trained man power on the irrigation technology. Poor water and land management, poor marketing access and linkage. This problem forced the farmers to sell their product at low price and this leads the farmers to be discouraged to participate in small-scale irrigated farming and.

Shortage of fertilizer and improved seed supply and inefficient utilization of resources such as water and land and inappropriate utilization of inputs are the major challenges in the area. In addition to these challenges, as pointed out by key informants, there was no research to overcome the problems and research based extension systems are not adequate to improve the indigenous knowledge of the farmers for the development of irrigation systems and lack of strong linkage between micro finance institutions and irrigation user farmers.

As illustrated in below Table, the respondents were indicated reasons. Thus the causes for low level utilization of water resources for small-scale irrigation were, 58.4%responded problems related to land, 35.5% said Infrastructure problem, 12.6% indicated problem of market linkage, 20.1% said topography of the land problem, 7 % due to lack of input(fertilizer and improved seeds).

Challenges in irrigation scheme in the study area

Factors	Frequency	%	Ranks
Shortage of land	125	58.4	1st
Topography of the land	43	20.1	3rd
Infrastructure problem	61	28.5	2nd
Market linkage	27	12.6	5th
Lack of input	32	14.95	4th
others	3	1.4	6th

Source: survey of 2021/22

Opportunities

There are opportunities that can help the farmers to be participating in irrigated farming at smallholder level as it was indicated by different sources of information such as sample respondents, focus group discussion and key informants. One of the major opportunities is the availability of surface water in the area. The study area has many rivers and many water streams flowing throughout the year and high rainfall that can be stored and used for irrigation in the area. According to the information collected from focus group discussions and key informant interviews, the overall opportunities for the development and management of irrigation water are the availability of high surface water potential and allocated in various kebeles, good motivation and willingness from governments for the development of irrigation projects at country level and wide range of technologies are now exists in the country. These positive factors and agricultural products market competition are good reasons to utilize the available water resources in the area. The other opportunity is that there is availability of favorable climate condition and ground water in the area. It can be used as an opportunity to produce more than once a year if the farmers could be able to access the ground water by means of treadle pump, hand pump and motor pump.

Conclusion and Recommendation

Conclusion

The majority of respondents were male 196 (91.59%) and 18(8.41%) were female, which suggested that married people are more responsible to control and manage farming activities in the study areas. The age of the household head has an influence on household decision because of experience and risk taking differences between old and young farmers. The age of respondents ranged from 22 to 73 years with a mean of 41.43.The mean family size of the total sample households in the study area was about 6.23, with minimum and maximum family size of 1 and 14 respectively. The majority of respondents were male 196 (91.59%) and 18(8.41%) were female, which suggested that married people are more responsible to control and manage farming activities in the study areas.

From the total participant sample households, the majority (75.6%) uses the traditional river diversion. Based on the survey result majority of farmers were produce once a year (97.7%) and twice a year (65%), cereals and vegetables respectively.

Furthermore, there were many challenges and opportunities pointed out by the farmers and key informants in the study area. The major challenges pointed out include shortage of market demand and low market price at time of harvest, topography of land related with difficulty of bringing water to one's farm land, lack of market linkage, lack of skilled man power on irrigation issues and lack of knowhow were the major constraints figured out in the study area. The opportunities consist of the availability of surface water, favorable climate condition and availability of ground water. These opportunities can be used to the maximum possible benefits if there is a collective action by the farmers. Effective support from different institutions, governmental and any other concerned civic associations could also be key role player. Therefore, it needs calling up on these stakeholders to take part in enhancing the irrigated farming by reducing the hindrances and strengthening available enabling factors in the study area.

Recommendations

The findings of this study leads to the following specific recommendations.

During focus group discussions (FGDs) and key informant interviews, respondents were also reported that the governmental water sectors should solve the major small scale irrigation problems identified during the survey include financial constraints especially for the purchase of motor pumps, shortage of agricultural inputs like improved seed and pesticides, design and construction of high cost irrigation structures, technical supports such as maintenance of motor pumps, strengthening value chain, provision of market information and market networks, facilitating infrastructures specially roads and supply of agro-chemicals.

- ✓ Market experts of the district should disseminate market information on the input and major products prices, so that the farmers can use the information in deciding the type and timing of crop produced by irrigated farming in the study area.
- ✓ The credit system and utilization means need to be facilitated more in the study area to buy different input and the oxen for rain-fed as well as irrigated farming.
- ✓ The study also revealed that farm distance from irrigation water source and topography of the land were found to be hindrance for participation in irrigation scheme. Therefore, ground water development, water lifting technology and water harvesting should be considered and encouraged for the farmers to use it in irrigating their farm land.

References

Adugna, E., Ermias, A., Mekonnen, A. and Mihret, D., 2014. The role of small scale irrigation in poverty reduction. Journal of Development and Agricultural economics, *6*(1), pp.12-21.

Agerie, N.W., 2013. *Determinants of smallholder rural farm households' participation in small scale irrigation and its effect on income in North Gondar zone: a cross-sectional approach (evidence from Dembia Woreda)* (Doctoral dissertation, Mekelle University).

Ahmed, J., 2019. The role of small scale irrigation to household food security in Ethiopia: a review paper.

Anwar, A.W., 2014. *Impact of Small Scale Irrigation on Household Welfare: Case of Laelay Dayu Irrigation Scheme* (Doctoral dissertation, Mekelle University).

Ashine, E.T. and Bedane, M.T., 2022. Research Achievements, Challenges and Future Perspectives of Irrigation and Water Harvesting Research Program of Jimma Agricultural Research Center: A Review. *Agrotechnology*, *11*, p.251.

Assefa, M., Wesseler, J.H.H. and Hengsdijk, H., 2008. *Socio-economic assessment of two small-scale irrigation schemes in Adami Tullu Jido Kombolcha Woreda, Central Rift Valley of Ethiopia*. Environmental Economics and Natural Resources Group.

Assefa, T., Jha, M., Reyes, M., Srinivasan, R. and Worqlul, A.W., 2018. Assessment of suitable areas for home gardens for irrigation potential, water availability, and water-lifting technologies. *Water*, *10*(4), p.495.

Ayele, G.K., 2011. *The impact of selected small-scale irrigation schemes on household income and the likelihood of poverty in the Lake Tana Basin of Ethiopia* (Doctoral dissertation, Cornell University).

Casadevall, S.R., 2016. Improving the management of water multi-functionality through stakeholder involvement in decision-making processes. *Utilities Policy*, *43*, pp.71-81.

Dejene, S., Teshome, W., Makombe, G., Awulachew, S.B. and Prasad, K., 2008. *Institutions, management practices and challenges of small-scale irrigation systems in Ethiopia: a case study of two modern smallholders' irrigation systems in western Oromia, Ethiopia* (No. 614-2016-40854).

Etissa, E., Dechassa, N., Alamirew, T., Alemayehu, Y. and Desalegne, L., 2014. Irrigation water management practices in smallholder vegetable crops production: the case of the central Rift Valley of Ethiopia. *Science, Technology and Arts Research Journal*, *3*(1), pp.74-83.

Gebul, M.A., 2021. Trend, status, and challenges of irrigation development in Ethiopia—A review. *Sustainability*, *13*(10), p.5646.

Gebul, M.A., 2021. Trend, status, and challenges of irrigation development in Ethiopia—A review. *Sustainability*, *13*(10), p.5646.

Gurmessa, G.C. and Wondogenet, E., 2019. Contribution of Small Scale Irrigation to Livelihood and Adaptive Capacity to Climate Variabilty of Smallholder Farmers at Woliso District, Oromia Region, Ethiopia.

Haile, G.G. and Kasa, A.K., 2015. Irrigation in Ethiopia: A review. Academia journal of agricultural research, *3*(10), pp.264-269.

Kassie, A.E., 2019. Challenges and opportunities of irrigation practices in Ethiopia: a review. *J. Eng. Res. Rep*, *9*, pp.1-12.

Lebeta, T.H., 2017. *Participation in and Impact of Small-Scale Irrigation Practice on Household Income: The Case of Abay Chomen District of Oromia National Regional State, Ethiopia* (No. 634-2018-5524).

Mengistie, D. and Kidane, D., 2016. *Assessment of the impact of small-scale irrigation on household livelihood improvement at Gubalafto District, North Wollo, Ethiopia. Agriculture, 6(3), p.27.*

Mitiku, D.T. and Adamite, T.F., 2022. Indigenous Knowledge Assessment on Irrigation Water Management Practices in Metekel Zone, North West Ethiopian. *American Journal of Management Science and Engineering*, *7*(4), pp.40-43.

Oli, F.K. and Kalkidan, D., 2021. Indigenous knowledge assessment on irrigation water management practices at Western Showa Zone, Ethiopia. *International Journal of Water Resources and Environmental Engineering*, *13*(1), pp.49-56.

Prasad, K., 2011, July. Institutions, Management Practices and Challenges of Small-Scale Irrigation Systems in Ethiopia: A Case Study of Two Modern Smallholders Irrigation Systems in Western Oromia, Ethiopia. In *Impact of irrigation on poverty and environment in Ethiopia: draft proceedings of the symposium and exhibition, Addis Ababa, Ethiopia, 27-29 November 2007* (p. 298). IWMI.

Ricart, S., Ribas, A. and Pavon, D., 2016. Modeling the stakeholder profile in territorial management: The Segarra-Garrigues irrigation system, Spain. *The Professional Geographer*, *68*(3), pp.496-510.

Yitna, E., 2013. Utilization of Water Resources and Food Security in Seka Woreda, Jimma Zone. *Ethiopian Journal of Education and Sciences*, *9*(1), pp.39-50.

Adoption and Impact of F1 crossbred Cows on smallholder farmers' income in East Shewa and West Arsi zones, Oromia region, Ethiopia

Asfaw Negesse*, Yassin Esma'el, Beriso Bati and Shimallis Gizachew
Oromia Agricultural Research Institute (OARI) Adami Tulu Agricultural Research Center (ATARC)
P.O.Box- 35, Batu Ethiopia
*Corresponding Author: bls23asfaw@gmail.com

Abstract

This study investigated Adoption and Impact of F1 cross breed Cows distributed by ATARC in East Shewa and West Arsi Zones, Oromia Region, Ethiopia. Structured questionnaires were used to collect data from 223(105 users and 118 non-users) respondents purposively selected from designated locations in the study area. The result also revealed that about 71.43% of sample households were adopt F1 cross breed Cow. In Gender participation the participation of women high in all activities of dairy production such as milking, feeding, health management, sold milk and milk product as well as milk processing into butter. As the survey result indicated the majority of respondents about 54.3% of households was lack feed availability and high price of supplementary feeds were constraints F1 cross breed cow production. *The result of Tobit model revealed that, experience in dairy production, Number of cross breed, actual price of F1 cross breed Cow distributed, total annual cash income and extension service on livestock production positively influenced households F1 cross breed Cow decision and intensity of adoption whereas, total livestock number negatively affected sample households F1 cross breed Cow decision and intensity of adoption. Total income from milk and milk products showed that on the average, treated households (adopters) got 12, 008.68 birr per month which accounts 82% more income from milk and milk products per month than the controls (non-adopters) which is 2614.266 birr per month and this difference between adopters and non-adopters was statistically significant). The study indicated that government, stakeholders and concerned bodies need to focus on facilitating farmers to experience sharing, increase cross breed cows by improving livestock production, strengthen extension service and improve income of farmers by participating different income generating activities so as to improve adoption decision and intensity of adoption F1 cross breed Cows in the study area.*

Keywords: Adoption, Users, Non-users, Impact and double hurdle model

Introduction

Ethiopia is believed to have the largest livestock population in Africa. Ethiopia has the largest livestock population in Africa 65 million cattle, 40 million sheep, 51 million goats, 8 million camels and 49 million chickens (CSA, 2021). This livestock sector has been contributing considerable portion to the economy of the country, and still promising to rally round the economic development of the country. Livestock is a major source of animal protein, power for crop cultivation, means of transportation, export commodities, manure for farmland and household energy, security in times of crop failure, and means of wealth accumulation. The sector contributed up to 40% of agricultural Gross Domestic Product (GDP), nearly 20% of total GDP, and 20% of national foreign exchange earnings (World Bank, 2017).

The total cattle population for the country is estimated to be about 60.39 million. Out of this total cattle population, the female cattle constitute about 54.68 percent and the remaining 45.32 percent are male cattle. Regarding age groups, the majority of the cattle population (that is about 63.09 percent) is in the 3 years and less than 10 years age category, with about 28. 15 percent male and about 34.94 percent female. Moreover, about 16.9 percent are between age one and three years and those with age category 10 years and over took small portion i.e. 2.03 percent of the total estimated number of cattle population. On the other hand, the results obtained indicated that 98.24 percent of the total cattle in the country are local breeds. The remaining are hybrid and exotic breeds that accounted for about 1.54 percent and 0.22 percent, respectively (CSA, 2018).

The pathway out of poverty trap of many SSA countries depends on growth and development of the agricultural sector (Tilahun, 2018).This is possible by increasing agricultural productivity through distributing technologies in order to sustain food self-sufficient. For many years, the government of Ethiopia working with extension program diffuses agricultural technologies to improve smallholders' productivity and farmers' income.

The main factors affecting the transfer of agricultural technological packages to the end-users are knowledge level of the information users, access to information of end users, and readiness of farmers for adoption (Alemayehu, *et al.* 2013).

Agricultural researches lack effective mechanisms of transferring their technologies to the end users, most of the agricultural technology adoption was conducted focusing on a single commodity or technology, and do not consider the possible inter-relationships between the various practices, lack of responsible body to transfer technology and no attempt of impact assessment after technology is transferred to users are the major challenges. Therefore, the main purpose of this study is to assess the adoption of F1 cross breed Cow distributed by Adami Tulu Agricultural Center and their impact on the farmers' income and constraints so as to indicate the future intervention areas in the country.

Statement of the Problem

Livestock also plays an important role in providing export commodities, such as live animals, hides, and skins to earn foreign exchanges to the country. On the other hand, draught animals provide power for the cultivation of the smallholdings and for crop threshing virtually all over the country and are also essential modes of transport to take holders and their families' long distances, to convey their agricultural products to the market places and bring back their domestic necessities. Livestock as well confer a certain degree of security in times of crop failure, as they are a "near cash" capital stock. Furthermore, livestock provides farmyard manure that is commonly applied to improve soil fertility and also used as a source of energy (CSA, 2015).

Cattle production plays an important role in the economies and livelihoods of farmers and pastoralists. The share of livestock is estimated at 45% of the gross domestic product. Cattle produce a total of 3.32 billion liters of milk (CSA, 2018). From the total cattle in the country, 98.24 percent are local breeds. The remaining are hybrid and exotic breeds that accounted for about 1.54 percent and 0.22 percent, respectively (CSA, 2018). Despite the large numbers, the production and productivity per animal is very low (Aynalem 2006; Teshome, et al. 2019) .According to Fikirneh, et al. (2016), low productivity of the indigenous breeds which are owned by the smallholders and lack of access to improved breeds were the major limited factors for livestock production and productivity.

Attempts, to improve the productivity of cattle, have been made especially in the area of crossbreeding for the last five decades but with little success (Aynalem 2006). For policy design and effective management of extension programmers, information on the adoption and impact of dairy technology on the livelihoods of smallholder farmers is very important and would help to come up with workable recommendations to improve the performance of the sector. The introduction of improved dairy production system in the traditional farming system is likely to have several effects. To measure these effects of the introduction of F1 crossbred Cows as a source of milk to smallholder farmers to assess the adoption and impact of introducing crossbred Cows as source of milk. More than 100 F1 crossbred Cows were distributed for farmers by Adami Tulu Agricultural Research Center in East Shewa and West Arsi Zones last 10 years. After F1 crossbred Cows' distribution to farmers the adoption rate and their impact on farmers' income of F1 crossbred Cows better to conduct. Therefore, research studied on the adoption of F1 cross bred Cows distributed by farmers and their impact on farmers' income in the study area.

Research Questions

The study tried to answer the following research questions:

1. What is the adoption status of F1 crossbred Cows distributed?

2. What are the factors affecting adoption decision and level of adoption of F1 crossbred Cows?

3. What are impacts of F1 crossbred Cow on farmers' income in the study area?

4. How gender participation considered in F1 crossbred production?

5. What are constraints and opportunities of F1 crossbred production?

Objectives of the Study

General Objective

The purpose of this study was to assess the adoption of F1 crossbred Cows distributed and their impact on smallholder farmers' income in East Shewa and West Arsi zones of Oromia National Regional State, Ethiopia.

Specific Objectives

1. To identify the adoption status of F1 crossbred Cow distributed in the study area
2. To identify factor affecting adoption decision and level of adoption of F1 crossbred Cows
3. To analyze the impact of F1 crossbred Cow on the farmers income
4. To assess gender participation in F1 crossbred Cow production

5. To identify constraints and opportunities of F1 crossbred Cow production

Significance of the Study

The result of this study is providing valuable input to research for technology improvement. The result can also be used to make appropriate decisions by the farmers, traders, investors, and other development stakeholders, who need the information about making relevant decision. In addition the result used as guidelines on the policy makers in designing appropriate technological, organizational and institutional strategies to facilitate dairy improvement by improving smallholder farmers' incomes and, hence, improve their livelihood. Finally, the study may serve as a reference material for other similar studies.

Literature Review

In this chapter, the details of literature review on the concept of Agriculture theoretical framework and conceptual frame work cross breed dairy adoption and impact on income of household conducted abroad as well as in Ethiopia were presented.

Concepts of adoption study

Technology generation and development is an interactive process and the supply of technologies needs to be driven by demand from the users. As noted by Langyintuo and Mulugeta (2005), the importance of adoption study are: to quantify the number of technology users over time to assess impacts or determine extension requirements; to provide information for police reform and to provide a basis for measuring impact.

The rural sociological research on the diffusion of agricultural innovations originated in the United States in 1920s when the U.S Department of Agriculture decided to evaluate the process of their programme of introducing improved farming practices among farmers (Dasgupta, 1989).

The sociological research on the diffusion on agricultural innovations grew rapidly in the 1950s and 1960s in the United States, and influenced the beginnings of similar studies in other countries. Agricultural technology adoption, among development economists has attracted considerable attention as the majority of the population of less developed countries derives their livelihood from agricultural production and a new technology apparently offers opportunities to increase production and productivity (Feder *et al*., 1985)

Ban and Hawkins (1996) also state that adoption and diffusion of innovation research was high during the 1960s in less developing countries. This is because the ministries of agriculture saw the need for large numbers of farmers to use the result of scientific agriculture in order to prevent famine. The adoption of agricultural technologies during and after the Green Revolution is well documented (Gollin, *et al*., 2005).

Farmers` adoption decision

Adoption of an improved practice by a farmer is necessarily based on his/her capacity to acquire and absorb information about new techniques and on his/her capacity to convert this knowledge to practice (Aregay, 1980).

Adoption is a decision-making process, in which an individual goes through a number of mental stages before making a final decision to adopt an innovation. Decision-making is the process through which an individual passes from first knowledge of an innovation, to forming an attitude toward an innovation, to a decision to adopt or reject, to implementation of new idea, and to confirmation of the decision (Ray, 2001).

The conventional adoption framework further simplifies the analysis of the adoption decision by its implicit assumption of an individual "decision-maker." Within the farm household, the ability to make decisions regarding resource use and technology varies according to age, gender and other categories. Actual decisions can depend on a complex bargaining process among household members. Beyond the household, group processes and the ability to harness them can also play a crucial role in adoption decisions, particularly on conservation practices. Moreover, decisions about new technology are frequently prompted by an intervention in the form of a project (Cramb, 2003).

Ehui *et al.* (2004) explain that a new technology is introduced to small holders farmer by itself alone does not guarantee for a wide spread adoption and efficient use. For efficient utilization of the technology the fulfillment of specific economic, technical and institutional conditions are required. From the farmers’ perspective, the new technology should be economically more profitable than the existing alternatives. The new technology should also be technically easily manageable by small holders and adaptable to the surrounding sociocultural situations. Similarly, the availability of the new technology and all other necessary inputs to small holders at the right time and place and in the right quantity and quality should be ensured. As also noted by Yapa and Mayfeld (1978) adoption of an entrepreneurial innovation by an individual requires at least four conditions. These are: the availability of sufficient information, the existence of a favorable attitude towards the innovation, the possession of the economic means to acquire the innovation and the physical availability of the innovation. Research in the diffusion of agricultural innovations has demonstrated that knowledge/awareness of a new technology is a necessary first step in the adoption decision making process (Rogers, 1995).

The rate of adoption is influenced by the farmers` perception of the characteristics of the innovation, the changes this innovation requires in farm management and the roles of the farm family (Ban and Hawkins, 1996). The authors further stated that innovations usually are adopted rapidly when they have a high relative advantage for the farmers; compatible with the farmers’ values, experiences and needs; are not complex; can be tried first on small scale and easy to observe the results.

The decision to adopt usually takes time. People normally do not adopt a new practice or idea as soon as they hear about it (Lionberger, 1960). The author further showed people appear to go through a series of distinguishable stages. These are:-

Awareness - at the awareness stage, a person first learns about a new idea, product, or practices. He/She has only general information about it. He/She knows little or nothing about any special qualities, its potential usefulness, or how it would likely work for him/her.

Interest- at this stage the farmer develops an interest in the new thing that s/he has learned about. He/She is not satisfied with mere knowledge of its existence. He/She wants more detailed information about what it is, how it is, how it will work, and what it will do. He/She is willing to listen, read, and learn more about it, and is inclined to actively seek the information desired.

Evaluation- at this stage a person weighs the information and evidence accumulated in the previous stages in order to decide whether the new idea, product, or practice is basically good, and whether it is good for him/her. In a sense, he/she reasons through the pros and cons mentally, and applies them to his /her situation. Perhaps this stage could very well be referred to as the `mental trial stage`. To be sure, evaluation is involved at all stages of the adoption process, but it is at this stage that it is most in evidence and perhaps most needed.

Trial- at this stage the individual is confronted with a distinctly different set of problems. He/she must actually put the change into practice. The usual pattern of acceptance is to try a little at first and then to make large-scale use of it if the small scale experiment process successful.

Adoption - at this stage a person decides that the new idea, product, or practice is good enough for full scale and continued use.

According to Rogers (1981), agricultural technology has its own factors, which affect its adoption by a given society. These factors are technologies relative advantage, compatibility, complexity, triability and observability. As to Byerlee et al. (1986) cited in Getachew (1993), the adoption patterns of a particular component is a function of five characteristics namely profitability, riskiness, divisibility, or initial capital requirements, complexity and availability.
Rogers (1983) also classified innovation decision process into five functions. These are:- **Knowledge-** the function in which an individual is exposed to the innovation's existence and gains some understanding of how it performs

Persuasion - the function in which an individual forms a favorable or unfavorable attitude towards the innovation
Decision - at this function an individual engages in activities that lead to a choice to adopt or reject the innovation
Implementation - it is a function in which an individual puts the decision (adoption or rejection) into practice.
Confirmation - it is a function in which an individual seeks reinforcement for the innovation decision made, at this stage the individual may reverse his/her decision if conflicting ideas about the decision occurred.

Review of empirical studies on determinants of adoption In Ethiopia

Breed technology adoption is one of the major components that used to differentiate the adopters and non-adopter households. Cross breed cow selected because of the major implication for household food security (Mekuria *et al.*, 2017). Dairy breed technology developments of livestock project and breeding strategies have been carried out with the aim of introducing cross breed animals in terms of improving milk and milk productivity of households. Cross breeding is one of breeding strategies that increase the production and productivity of dairy products in milk production and at same time increase the profitability of the households to create market opportunity (Kebede, et al., 2018).

An improvement of feeding system is an important prerequisite for increased profitability of dairy production. The adoption of feed technology of the respondent rate was medium when compared to the recommended rate. This could be the lack of supply of industrial by product and the high price of the improved feed. In addition to this may be the inadequate practice of concentrate mixed feeds and recommended ration feed with insufficient feed quality (Hana, 2019).

Hana (2019) studied on Dairy technology adoption and its impact on household food security: the case of Basona Warena Woreda, Amhara Region, Ethiopia with objective to examine dairy production technology adoption impact on rural household food security and identify factors affecting adoption. Binary logistic regression, Tobit and propensity score matching were used to determine factors affecting the decision of farm households who participate (adopt) dairy technologies, extents of dairy technology adoption and impact of technology adoption on household food security respectively. The descriptive result indicated that dairy technology adopters were food secured as compared to non-adopter households in terms of food consumption score. The binary logit result revealed that, frequency of extension service, membership of milk collection center and input access positively affect the adoption decision. The impact of dairy technology adoption on household food security in terms of food consumption score has an effect on the household frequency of food consumption per week. The study concludes that dairy technology adoption has remarkable effect on the household food security status.

Mekuria et al., 2017 studied on Adoption of Improved Dairy Cows and Implications for Household Food Security: Evidence in Central Highland of Ethiopia with objective to analyze adoption of dairy cow technology and examining the contribution of the technology to household food security. The study is conducted in Gudo Beret watershed, North Shewa, Ethiopia. They found that nearly 26.8% of the cattle population was dairy cows that have been kept by 60.2% of households. However, adoption rate for dairy cattle technology was low and slow because 25.8% of cows were improved breeds while 26.8% of households who reared cows have adopted improved dairy breeds.

Mrinal and Baban, 2017 studied on Crossbred Cattle Adoption and Its Impact on Income and Household Milk Consumption among Dairy Farmers: Empirical Evidence from Assam. The paper examines the treatment effects of adopting crossbred cattle on household income from various sources and per capita consumption of self-produced milk. They concluded that adoption of crossbred cattle has statistically significant effect on increasing the dairy income and livestock income, but not on crop/plantation income and off-farm income. The examination of other outcome variable namely, farm milk consumption indicates that there is significant causal relationship between adoptions of crossbred cattle and increased per capita consumption of milk.

Amanuel. et al., 2018 reviewed different empirical research on Adoption, Impacts and Determinant Factors of Dairy Technology in Ethiopia. They concluded that the adoption of dairy technologies has significant impacts on livelihood indicators such as household income, nutrition, food security, health care and access to education. This implies that introducing and disseminating appropriate dairy technologies to smallholder farmers with a continuous follow up could be a means through which their livelihoods can be improved and it enables to narrow the milk demand supply gap in both rural, peri urban and urban consumers which has a good public health implication at the nation wise.

Definition and basic terms of impact

Impact evaluation: The impact of specific improved technologies on the livelihood of the farmer is measured in different indicators. Few of those indicators are impact on income and income diversity of the farmers, cash needs of the family, asset availability, new house construction and rehabilitation of the old, school fees and purchase of educational material of children, medical fees, clothing fees, seed purchase and purchase of livestock and crop for the family size. On other hands, household food diversity and food availability are the criterion for the nutritional effects of adoption (Samuel *et al*., 2016)

Theoretical review on impact assessment

To meet the increasing demand for milk and milk products, improvement of the productivity of dairy cattle through appropriate technologies such as breeding programmes, intensification of the dairy production systems and development of market infrastructures are crucial steps (Zumbach and peters, 2000). The dairy technologies available in developed countries cannot be readily adopted by smallholder farmers in developing countries due to their socio- economic and agro ecological conditions being greatly different from those in industrialized countries. Some dairy technologies may be appropriate for adoption by smallholder dairy farmers but most of these dairy technologies or dairy practices have never been transferred to smallholder farmers due to a lack of effective extension services (Chantalakhana, 1999).

Most improvements in the milk productivity of African cattle have been sought through cross breeding with high producing dairy breeds (Zumbach and Peters, 2000). High-grade cows, however, need elaborate management and maximal nutrient in take for optimal performance (Enyew *et al*., 2000). This calls for the use of more intensive technologies. Smallholders are believed to have a comparative advantage in rearing dairy cows because of the high labor requirements of the activity and the great care that dairy cows need to reach their genetic potential (Baltenweck and Staal, 2000). Farmers with grade cows are usually market oriented since the higher production levels enable them to sell the surplus milk. The introduction of crossbred cows in small-scale dairy farm in Ethiopian highlands is said to have doubled farm incomes (De leeuw *et al*., 1999).

Empirical review on impact assessment

Given considerable potential for smallholder income and employment generation from high-value dairy products, development of the dairy sector in Ethiopia can contribute significantly to poverty alleviation and nutrition in the country. Among the existing production systems, the traditional dairy production system is the one involving from smallholder dairy farms. The traditional (smallholder) milk production system, which is dominated by indigenous breeds, accounts for about 97-98% of the total annual milk production in the country (Yonad 2009).

Crossbreed cows usually are unavailable or unaffordable to rural producers, despite the high demand. Consequently, dairy producers rely on the limited genetic potential of indigenous breeds, which is a major reason for the low productivity of the rural system. Animal health is another factor that affects significantly production and productivity in the two milk sheds. Diagnostic services and treatments are not readily available to dairy producers in the rural system; one of the consequences is very high calf mortality. In addition, the price of veterinary drugs, ascaricides, etc. is constantly increasing. The limited access to adequate and affordable inputs contributes to the very low returns of dairy producers in the rural system (Filippo. *et.al*, 2019).

Opportunities to upgrade the two dairy production systems exist in terms of the product and/or the process by which the product is developed. The piloting of an Integrated Agro-Industrial Park in Central-Eastern Oromia will create market opportunities and serves as a plat form in bringing together the key value chain actors in the dairy industry. It will create strong and permanent linkages between suppliers and buyers and serves as a catalyst that would ensure a sustainable supply of milk in both quantity and quality within the Agro-Commodities Procurement Zone and will represent a means for increasing production and productivity and formalization of the market of the dairy sub-sector (Filippo. *et.al.*,2019). Unavailability of improved dairy stock and in adequate Artificial Insemination. Services, shortage of feeds and cost of concentrates, disease challenges and price fluctuation in milk and milk products are some of the bottlenecks that require systematic planning and intervention from all development practitioners (Ulfina. *et.al*. 2013).

Research Methodology

In this chapter description of study area, types and sources of data, methods of data collection, sample procedure, and sampling size, methods of data analysis and variables definition and hypothesis are presented.

Description of the Study Area

This study was conducted in East Shewa and West Arsi Zones of Oromia National Regional State, Ethiopia. West Arsi district is located at 250 km from Addis Ababa towards South direction. It shares borders with Bale Zone in the West, SNNP in the South and East Shewa Zone in the North directions (ZOA, 2019). East Shewa zone is bordered on the South by the West Arsi Zone, on the Southwest by the Southern Nations, Nationalities and Peoples Region, on the West by South west Shewa Zone, on the Northwest by North Shewa, and on the Southeast by Arsi Zone. Adama city is the capital city of East Shewa Zone. Located at 100 km from Addis Ababa/Finfinnee towards South–East direction. This zone lies between 60 00’ N to 70 35‘N and 380 00’E to 400 00’E (ZOA, 2019).

Data Types, Sources and Methods of Data Collection

Both primary and secondary data were used for this study. Semi-structured questionnaire was employed to collect primary data on the demographic, socioeconomic, institutional and physical characteristics of a representative sample of households. The questionnaire was designed and pre-tested in the field for its validity and content, and to make overall improvement of the same and in line with the objectives of the study. After necessary corrections made on the questionnaire, enumerators were given one day training to the objectives and content of the interview schedule. Primary data was collected by interviewing sample dairy producer households by preparing semi-structured questionnaire. Key informant interview and focus group discussion was also conducted to exhaustively identify production problem pertain to dairy production before conducting primary data collection. Secondary data relevant for this study was

collected from East Shewa office of agriculture, CSA, and from published and unpublished sources.
The target population of this study was the user and non-user farmers of F1 cross breed Cows distributed by Adami Tulu Agricultural Research Center (ATARC) in East Shewa and West Arsi Zones of Oromia National Regional State. Two-stage sampling techniques were employed for this study.

1st Stage: Purposive sampling method was used to select F1 cross breed cows users and randomly select non-users.
2nd Stage: Sample size termination was based on cross breed distributed by ATARC and non-users were proportional to F1 cross breed users. Accordingly a total of 223 (105 users and 118 from non-users) sample respondents were selected for the study. From the sample respondents 13.90% from west Arsi Zone while 86.10% from East Shewa Zone based on Cows distributed. The majority of respondents about 66% from Adami Tulu Jido Kombolcha districts as the distribution of F1 Cows high in order to benefit the farmers around research center.

Table 1. Sample size household heads

Zones	District	Number of respondents	Percentage of respondents
West	Kofale	20	9
Arsi	Shashamane	11	5
East	Adami Tulu Jido Kombolcha	148	66
Shewa	Dugda	16	7
	Lume	16	7
	Adama	12	5
Total		**223**	**100**

Source: Own survey result, 2022

Methods of Data Analysis

Descriptive statistics and econometric model were used for analyzing the data.

Descriptive statistics

Descriptive statistics was used for analyzing the data. The descriptive statistics like mean, frequency, standard deviation, percentage, Chi square and t-tests were used to describe and see the relationship between variables.

Econometrics model

Tobit econometric model was used to analyses the factors affecting adoption decision and level of adoption of F1 crossbred Cows by farmers.
Propensity score much (PSM) model was applied to analyze the impact of F1 cross Cows on household incomes in the study areas. STATA version 14 was used to process and analyze data. The first step in estimating the treatment effect is to estimate the propensity score. To get this propensity scores any standard probability model can be used. As the propensity to participate is unknown, the first task in matching is to estimate this propensity scores. Matching can be performed conditioning on P(X) alone rather than on X, where P(X) Prob (D=1|X) is the probability of participating in the program conditional on X. If outcomes without the intervention

are independent of participation given X, then they are also independent of participation given P(X). This reduces a multidimensional matching problem to a single dimensional problem.

In this study logit model was used to estimate propensity scores using a composite of pre-intervention characteristics of the sampled households and matching was performed using propensity scores of each observation. In estimating the logit model, the dependent variable for participation, which takes the value of 1 if a household, participated in the program and 0 otherwise. It was mathematically as follows:

$$pi = \frac{e^{zi}}{1+e^{zi}} \text{ and } qi = 1 - pi \frac{1}{1+e^{zi}} \qquad (1)$$

Where, Pi is the probability of adoption Cows,

$$\mathrm{zi} = ao + \sum_{i=1}^{n} \mathrm{aixi} + \mathrm{Ui} \qquad (2)$$

Where, i = 1, 2, 3, - - -, n a_0 = intercept a_i = regression coefficients to be estimated U_i= a disturbance term

Results and Discussion

This chapter presents the findings of the study and discusses in comparison with the results of earlier similar studies. It is organized under five sections. The first section presents results of descriptive result of household characteristics in the study area. The second section presents descriptive results of adoption decision and level of adoption F1 cross Cows. The third section presents results which deals with the impact of F1 cross Cows on households' income. The fourth section presents gender participation in F1 crossbred Cow production. The final fifth section presents constraints and opportunities of F1 crossbred Cow production.

Descriptive Statistical Results

In this sub-section, descriptive statistical results of variables such as age, family size, dependency ratio and sex are presented and discussed. The average family size of the sample households was 7 persons per household, which is greater than the national average of 4.6 persons per household (CSA, 2014b). This implies the need for strengthening family planning programs to strike the balance of population growth within the level of economic development. The average age and dependency ratio of the sample respondents were found to be about 43 years and 0.16 respectively. An independent t-test result indicates significant difference between F1 crossbreed users and non-users sample households in terms of age, family size and dependency (Table 2).

Table 2. Age, family size and dependency ratio of sample household heads

Item	F1 cross breed distribution	Statistics	Variables		
			Age(Years)	Family size(Number)	Dependency ratio
F1 cross breed Cow	Users (n=105)	Mean	46.43	7.92	0.71
		St.dev.	10.24	2.83	0.58
	Non-users (n=118)	Mean	39.85	6.75	0.87
		St.dev.	11.00	2.75	0.70
Total sample size (n=223)		Mean	42.95	7.30	0.79
		St.dev.	11.12	2.84	0.65
t-value			-4.6066***	-3.1496***	1.8405*

***,* Significant at 1% and 10% level

Source: Own survey result, 2022

Sex of the household heads: As Table 3 depicts, of the entire household heads interviewed, 63% were male-headed while the remaining 37% were female-headed (divorced or widowed) at the time of survey. The proportion of female household heads in the sample is much lower than the national level which is one fourth of the total rural household heads (CSA, 2014b). The result of Chi-square tests indicated insignificant difference in terms of sex of the household heads between sample households F1cross breed Cows users and non-users. (Table 3).

Table 3. Sex of sample household heads

Item	F1 cross breed distribution	Percent	Sex		
			Male	Female	Total
F1 cross breed Cow	Users	No.	60	45	105
		%	57	43	100
	Non-users	No.	80	38	118
		%	68	32	100
Total sample size		No.	140	83	223
		%	63	37	100
χ2-value				2.6988(NS)	

NS=Not significant

Source: Own survey result, 2022

Religion of household heads: As Table 4 depicts, of the entire household heads interviewed, majority of respondents about 67.7% were Muslim followers followed by orthodox followers. The result of Chi-square tests indicated insignificant difference in terms of religion of the household heads between sample households F1cross breed Cows users and non-users.

Table 4. Religion of sample household heads

Item	F1 cross breed distribution	Percent	Religion			
			Muslim	Orthodox	Protestant	Total
F1 cross breed Cow	Users	No.	71	23	11	105
		%	67.62	21.90	10.48	100
	Non-users	No.	80	34	4	118
		%	67.8	28.8	0.034	100
Total sample size		No.	151	57	15	223
		%	67.7	25.56	0.067	100
χ2-value						5.1857*

*, Significant at 10% level
Source: Own survey result, 2022

Land used and allocation: Owned land refers to a land which exists on a legal land certificate given by land authorities. Cultivated farmland land is land used by sample farm households to undertake agricultural production. The average cultivated land holding size of the sample households was 1.89 hectares, which is greater than national average of 0.95 hectares (CSA, 2015).

The survey results depict that, the average landholding size of 2.89 hectares. This implies that the average own land was greater than the national average of land holding which was 1.14 hectares (CSA, 2015).There was significant difference at 5% level users and non-users of F1 cross breed Cows sample household heads in terms of cultivated land and own land holding size.

In terms of grazing land, there is insignificant difference between users and non-users of F1 cross breed Cows sample household heads (Table 5).

Table 5. Land allocation system of sample households

Item	F1 cross breed distribution	Statistics	Variables		
			Cultivated land(Ha)	Grazing land(Ha)	Total land(Ha)
F1 cross breed Cows	Users (n=105)	Mean	2.22	0.27	3.35
		St.dev.	2.18	0.70	3.38
	Non-users (n=118)	Mean	1.60	0.18	2.48
		St.dev.	1.77	0.40	2.69
Total sample size **(n=223)**		Mean	1.89	0.23	2.89
		St.dev.	1.99	0.56	3.06
t-value			-2.3660**	-1.20(NS)	-2.1307**

, * Significant at 5% level; NS=Not significant
Source: Own survey results, 2022

Livestock holdings: Livestock is one of the major assets for the farmers and also indicates their level of wealth in the study area. Types of livestock owned by households are oxen, cows, calves, horses, donkey, sheep, goat and poultry. Livestock provides traction power, manure, and is a source of cash that can be used to purchase goods for household consumption and production inputs. The average livestock holdings measured in terms of tropical livestock unit (TLU) were found to be 8.39 (Appendix Table 1). This is relatively a large number in the crop-livestock mixed farming system. An independent sample t-test result shows insignificant mean difference between users and non-users F1 cross breed Cows farmer in terms of livestock holding (Table 6).

Experience in dairy production: The number of years a farmer has been involved in the dairy raring may positively influences his/her management expertise and skills, and his potential to adoption. The mean farming experiences of dairy producers was 15 years. The independent t-test was significant different between F1 cross breed Cows users and non-users farmers. The mean farming experience of F1 cross breed Cows users were greater than non-users of F1 cross breed Cows (Table 6).

Table 6. Tropical livestock unit and experience in dairy production of sample households

Item	**F1 cross breed distribution**	**Statistics**	**Variables**	
			Experience Dairy production(Years)	Tropical livestock unit
F1 cross breed Cow	Users (n=105)	Mean	16.35	8.28
		St.dev.	5.51	5.18
	Non-users (n=118)	Mean	13.64	8.53
		St.dev.	8.26	5.33
Total sample size **(n=223)**		Mean	14.91	8.39
		St.dev.	7.21	5.24
t-value			-2.8516***	-0.3567(NS)

*** Significant at 1% level; NS=Not significant
Source: Own survey result, 2022

Education Status: Out of the total sample household heads, majority about 64.14% of respondents can read and write. The formal education that attend grade from grade one also about 19.73% of respondents. This shows that farmers can easily understand agricultural instructions and advice provided by the extension workers. The Chi-square test indicated significant difference in educational status of users and non-users of F1 cross breed Cows farmers. F1 cross breed Cows users higher in attending formal education than non-users (Table 7).

Table 7. Education status of sample households

Item	F1 cross breed distribution	Percent	Education status			
			Illiterate	Read and write	Formal education	Total
F1 cross breed Cow	Users	No.	34	28	43	105
		%	32.4	26.67	40.95	100
	Non-users	No.	2	115	1	118
		%	0.17	97.46	0.085	100
Total sample size		No.	36	143	44	223
		%	16.14	64.13	19.73	100
χ2-value					121.1192***	

*** Significant at 1% level Source: Own survey result, 2022

Participation in non-farm activities: Non-farm activities refers to both self-employment 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. Out of the total households interviewed, 19.33% participated in non-farm activities. The Chi-square test result indicated that there was insignificant difference between users and non-users F1 cross breed Cows farmers in terms of participation in non-farm activities (Table 8).

Table 8. Participation in non-farm and off-farm activities of sample households

Item	F1 cross breed distribution	Percent	Non-farm activities			Off-farm activities		
			Yes	No	Total	Yes	No	Total
F1 cross breed Cow	Users	No.	17	88	105	14	91	105
		%	16.19	83.81	100	13.33	86.67	100
	Non-users	No.	25	93	118	5	113	118
		%	21.19	78.81	100	4.23	95.77	100
Total sample size		No.	42	181	223	19	204	223
		%	18.83	81.17	100	8.5	91.5	100
χ2-value				0.9072 (NS)			5.8979**	

** Significant at 5% level Source: Own survey result, 2022

Access to extension services: Agricultural extension services are expected to enhance farmers' skill and knowledge, link farmers with markets and ease liquidity and dairy management constraints. About 53.4% of sample respondents get extension service and 51.12% extension related to livestock production. This implies that the attention to livestock extension is relatively low. The extension services given to sample respondents were mostly focused on health service and AI services. The Chi-square test showed that there was significant difference between users and non-users of F1 cross breed Cows farmers in both extension service and extension service specifically for livestock production. Relatively percentage users of F1 cross breed Cows farmers who get extension service were much greater than non-users of F1 cross breed Cows who had extension service that covers 70.5% and 33.90% respectively (Table 9).

Table 9. Access to extension service of sample households

Item	F1 cross breed distribution	Percent	Extension service			Extension service for livestock		
			Yes	No	Total	Yes	No	Total
F1 cross breed Cow	Users	No.	79	26	105	66	39	105
		%	75.24	24.76	100	62.86	37.16	100
	Non-users	No.	34	84	118	40	78	118
		%	28.81	71.19	100	33.90	66.1	100
Total sample size		No.	113	110	223	106	117	223
		%	50.67	49.33	100	47.53	52.47	100
χ2-value				47.9071***			18.6830***	

*, ***Significant at 10% and 1% level
Source: Own survey result, 2022

Participation in social organizations: Participation in social organization is believed to enhance information exchange and experience sharing among farm households on adoption decision. As shown in Table 11 about 43.5% of the sample farmers participated in social organizations, of which 57.14% and 31.36% F1 cross breed Cows users and F1 cross breed Cows' non-users respectively. The Chi-square test result shows that sample farmers participate in social organization were significant difference between F1 cross breed Cows users and F1 cross breed Cows' non-users 1% significance level (Table 10)

Table 10. Participation in social organization of sample households

Commodity	F1 cross breed distribution	Percent	Participation in social organization		
			No	Yes	Total
F1 cross breed Cow	Users	No.	45	60	105
		%	42.86	57.14	100
	Non-users	No.	81	37	118
		%	68.64	31.36	100
Total sample size		No.	126	97	223
		%	56.5	43.5	100
χ2-value				15.0326***	

*** Significant at 1% level
Source: Own survey result, 2022

Access to credit: Credit service is an important institutional service which was required by the respondents in the study area. During survey season, 13% of the sample farmers had access to credit either in the form of cash or kind. However, the majority of sample respondents (about 87% of them) had not used credit because of high interest rate, shortage of credit service, religious view and inappropriate payback period of received loan. Credit and saving institutions, cooperatives, and micro finance institution are some of the credit provider institutions in the study area. The Chi-square test result showed that significant differences between F1 cross breed Cow users and non-user farmers with respect to access to credit service (Table 11).

Table 11. Access to credit services of sample households

Item	**F1 cross breed distribution**	**Percent**	**Access to credit service**		
			No	Yes	Total
F1 cross breed Cow	Users	No.	87	18	105
		%	82.86	17.14	100
	Non-users	No.	107	11	118
		%	90.7	0.93	100
Total sample size		No.	194	29	223
		%	87	13	100
χ2-value				3.0039*	

* Significant at 10% level
Source: Own survey result, 2022

Access to market information: Households with better information access (facing less fixed transaction cost) are more likely to adopt and participate in F1 cross breed production. In this study, ownership of communication equipment such as mobile phone, radio and television are used as a proxy to access to information. From total sample respondents interviewed, 60.5% of sample respondents had access to market information. The Chi-square test result showed that statistically insignificant difference between users and non-users sample households in terms of access to information for F1 cross breed Cows (Table 12).

Table 12. Access to market information of sample households

Items	**F1 cross breed distribution**	**Percent**	**Access to market information**		
			No	Yes	Total
F1 cross breed Cow	Users	No.	36	69	105
		%	34.3	65.7	100
	Non- users	No.	52	66	118
		%	44.1	55.9	100
Total sample size		No.	88	135	223
		%	39.5	60.5	100
χ2-value				2.2255 (NS)	

NS=Not significant
Source: Own survey result, 2022

Actual price of F1 cross breed Cows: The average actual price of F1 cross breed Cows during distribution was about 9306.67 ETB while Adami Tulu Agricultural research Center provided Cows by discount i.e. 2055.24 ETB. This was done to support farmers and introduce to cross breed cows to the study area.

Table 13. Actual price of F1 cross breed Cows

Item	**F1 cross breed distribution**	**Statistics**	**Variables**	
			F1 price ATARC distributed	Actual price at market
F1 cross breed Cow	Users (n=105)	Mean	2055.24	9306.67
		St.dev.	53.32	3615.09

Source: Own survey result, 2022

Dairy Production and dairy product Marketing

Dairy productions were well known in both East Shewa and West Arsi Zone of Oromia. About 86.1% of respondents have dairy cow at survey period. They have on average about three dairy cows per household that ranges from 1 to 20 cows. There is no significance difference between zones in terms of dairy owners (Table 14).

Table 14. Dairy production in the study area

Items	**Zones**	**Percent**	**Do you have Dairy cow?**		
			No	Yes	Total
Dairy cow	East Shewa	No.	26	166	192
		%	13.5	86.5	100
	West Arsi	No.	5	26	31
		%	16.1	83.9	100
Total sample size		No.	31	192	223
		%	13.9	86.1	100
χ2-value				0.1493 (NS)	

NS=Not significant
Source: Own survey result, 2022

Livestock sold: - About 75.29% of sample respondents sold livestock products while the remaining 24.71% were used household consumption. From livestock products milk was highest about 32.93% and butter followed by 14.97%. The lowest percent was household that sold the combination of Milk, butter, cheese and egg in the study area.

Table 15. Type of livestock sold by sample households

Types of livestock product sold	Number sample respondents	%
Milk	55	32.93
Butter	25	14.97
Milk and butter	11	6.59
Butter and cheese	25	14.97
Milk,butter,cheese and egg	1	0.60
Milk and egg	6	3.59
Milk, butter and egg	2	1.20
Consumed by themselves	42	25.15
Total	**167**	**100**

Source: Own survey result, 2022

Total milk supply:-The amount of milk supply to market was on average 32 liters per week per household during survey season. From total sample only 33% sold milk the remaining sold butter and consumed at home. There is significance difference between F1 cross breed Cow users and non-users in terms of volume milk sold. F1 cross breed Cow users sold more milk than non-users.

Table 16. Volume of milk sold per week of households

Item	**F1 cross breed distribution**	**Statistics**	**Variables** Amount of milk sold litter per week
F1 cross breed Cow	Users (n=40)	Mean	40.73
		St.dev.	49.56
	Non-users (n=34)	Mean	22.68
		St.dev.	30.45
Total sample size **(n=74)**		Mean	32.43
		St.dev.	42.58
t-value			-1.8468*

Source: Own survey result, 2022

Cash income from livestock: - The annual average income from livestock product sold was about 61,017.63 in Ethiopian Birr. There was significant difference between F1 cross breed Cow user and non-user in terms of livestock product sold. The average annual income F1 cross breed Cow user get was higher than non-user.

Table 17. Annual income livestock product sold of sample households

Item	F1 cross breed distribution	Statistics	Variables
			Annual income livestock product sold
F1 cross breed Cow	Users (n=61)	Mean	83487.28
		St.dev.	98093.23
	Non-users (n=64)	Mean	39601.25
		St.dev.	46030.89
Total sample size (n=125)		Mean	61017.63
		St.dev.	78851.45
t-value			-3.2262 **

Source: Own survey result, 2022

Milk yield:-The average milk yield per day of cross breed was much higher than local breed. The average milk yield of local breed in study area was about 2.22 while cross breed was 6.16 liters per day. Therefore introduction of cross breed cows better for improvement of farmer income.

Table 18. Average milk yield of local breed and cross breed Cows in the study area.

Type of breeds	Milk yield per day	
	Mean	Std.Dev
Local breed	2.22	1.78
Cross breed	6.17	3.29

Source: Own survey result, 2022

Trend of Dairy production last five years:-The majority of respondents about 61.43% suggests that dairy production trend was decreasing. This is due to expansion of urbanization and decreasing of grazing land due to expansion cultivated land.

Table 19. Trend of Dairy production last five years in the study area

Trend	Frequency	percent
Increasing	82	36.77
Decreasing	137	61.43
Constant	2	0.90
Flexible	2	0.90
Total	223	100

Source: Own survey result, 2022

F1 cross breed Cow distribution: - About 7.62% farmers get with calve while about 92.38 % farmers get pregnant Cow. Therefore about 113 Cows and calves distributed for farmers.

Table 20. Number of F1 crossbred Cow distributed in the study area

Number of F1crossbred Cows distributed per household	Frequency	percent
1	97	92.38
2	8	7.62
Total	105	100

Source: Own survey result, 2022

The Total offspring of F1 crossbred Cow and current value from such breed:-The total offspring of F1 crossbred Cow ranges from 1 to 14 cows on average about 4 cows. They get sufficient income from the Cows who adopt it. The average value of F1 crossbred Cow on average 144,272.7 Ethiopian birr with minimum 10000 ETB and maximum 800,000 Ethiopian birr.

Table 21. The total offspring of F1 crossbred Cow and current value from such breed

Variables	Mean	Std.Dev.	Minimum	Maximum
Number of F1crossbred Cows offspring up to now	4.492754	2.687789	1	14
Current value of F1crossbred Cows	144272.7	160926.6	10000	800000

Source: Own survey result, 2022

Adoption status of F1 crossbred Cow distributed in the study area

The adoption status of F1 cross breed Cows distributed by Adami Tulu Research Center was 71.43 percent. This is due to different reasons such as Cows distributed died and some respondents sold the Cows.

Table 22. Adoption status of F1 crossbred Cow distributed

Items	Percent	Have you such breed of F1 cross breed distributed by ATARC		
		No	Yes	Total
F1 cross breed Adoption status	No.	30	75	105
	%	28.57	71.43	100

Source: Own survey result, 2022

Gender participation in F1 crossbred Cow production

Gender participation on dairy production considers the management system, feeding and sold of livestock and livestock products. The participation of women high all activities of dairy production such as milking, feeding, health management, sold milk and milk product as well as milk processing into butter (Table 23)

Table 23. Gender participation in F1 crossbred Cow production

Activities	Gender									
	Men		Children		Women		Children and women		Men and women	
	No	%	No	%	No	%	No	%	No	%
Milking	1	0.95	0	0	96	91.42	5	4.76	3	2.86
Feeding	15	14.29	3	2.86	51	48.57	23	21.90	13	12.38
Watering	13	12.38	9	8.57	43	40.95	30	28.57	10	9.52
Health management	42	40	0	0	42	40	10	9.52	11	10.48
Sold milk and milk product	4	3.81	13	12.38	73	69.52	11	10.48	4	3.81
Milk processing to butter	1	0.95	2	1.9	89	84.76	11	10.48	2	1.9

Source: Own survey result, 2022

Constraints and opportunities of F1crossbred Cow production

The constraints of F1 cross breed Cow production were the combination of different constraints. As the survey result indicated the majority of respondents about 54.3% of households was lack feed availability and high price of supplementary feeds. Lack of health services, AI services, and prevalence of disease, lack of feed availability and high price of supplementary feeds were followed by 27.8% whereas lack of health services and lack of AI services were the lowest percent. Therefore the major constraints of livestock production in the study area were animal feed related problems.

Table 24. Constraints of F1 cross bred Cow production

Type of constraints	**Frequency**	**%**
lack of health service	3	1.3
lack feed availability	22	9.9
High price of supplementary feeds	14	6.3
lack of health service and lack of AI services	1	0.4
lack feed availability and high price of supplementary feeds	121	54.3
lack of health services, AI services, prevalence of disease, lack of feed availability and high price of supplementary feeds	62	27.8
Total	223	100

Source: Own survey result, 2022

The opportunities of F1 cross breed Cow production were the combination of different opportunities. As the survey result indicated the majority of respondents about 44% of households was Availability of water and availability of technical support. Availability of water was followed by 36.8% whereas Government attention to livestock were the lowest percent.

Table 25. Opportunities of F1 cross bred Cow production

Type of Opportunities	Frequency	%
Availability of AI service	17	7.6
Government attention to livestock	3	1.3
Availability of water	82	36.8
Availability of technical support	6	2.7
Availability animal health clinic	13	5.8
Availability of water and animal health clinic	4	1.8
Availability of water and availability of technical support	98	44
Total	223	100

Source: Own survey result, 2022

Results of the Econometric Model

In this section, Tobit model was used to identify factors determining sample households F1 cross breed Cows decision and level of F1 cross breed Cows adoption in the study area.

Factors affecting households' adoption decision and level of F1 cross breed Cows' adoption

The model specification was carried out using the Ramsey-reset test, and the result is insignificant (prob >F= 0.1977) indicating that there were no problem of omitted variables in the model. Variance inflation factors (VIF) was computed for all explanatory variables that are used in the Probit model and the result shows VIF values of less than 10 indicating multicollinearity was not a problem (Table Appendex2). Robust method was also employed to correct the possible problem of heteroscedasticity. Outliers were checked using the box plot graph so that there were no serious problems of outliers and no data get lost due to outliers.

The Tobit model result shows that the model being statistically significant at 1% level of significance, indicating the goodness of fit of the model to explain the effects of the hypothesized variables on the dependent variable in terms of at least one covariate. The estimation result also revealed that the adoption decision and intensity of farmers' adoption F1 cross breed Cow was influenced significantly by experience in dairy production, total livestock number, Number of cross breed, actual price of F1 cross breed Cow distributed, total annual cash income and extension service on livestock production(Table 26).

Table 26. Factor affecting adoption decision and level of adoption F1 cross breed Cow

Variables	Coefficient	Robust Std.Err	P > t	Marginal effect
Sex	0.098	0.096	0.310	0.098
Age	0.004	0.0045	0.398	0.0038
Education status	-0.025	0.052	0.633	-0.025
Family size	-0.004	0.017	0.796	-0.004
Experience in dairy production	0.0153**	0.0072	0.037	0.0153
Livestock holdings (TLU)	-0.018**	0.008	0.022	-0.018
Number of cross breed	0.151***	0.037	0.000	0.151
Actual price of F1 cross breed Cow	0.000024*	0.000013	0.068	0.000024
Access to credit service	0.042	0.113	0.713	0.042
Total Annual cash income in ETB	2.56e-07**	1.13e-07	0.026	2.56e-07
Access extension service livestock	0.362***	0.116	0.002	0.362
Constant	-0.522	0.420	0.217	

***, **,*: implies statistical significance 1%, 5% and 10% levels,
Log pseudo likelihood = -59.356 Pseudo R^2= 0.4202, F (11, 94) = 7.76, Prob > chi^2 = 0.0000 N = 105, Source: model result, 2022.

Experience of dairy rearing: Experience of the household head in dairy production had positive relationship with adoption decision and level of adoption F1cross breed Cow as prior expectation significantly at 5% significance level. The result shows that previous experience in dairy production increase by one year will be increases by 1.53% the probability of F1cross breed Cow adoption decision and level of adoption keeping all other factors constant. Farmers who had experience in dairy farming can better deal with the technical and management of F1cross breed Cow and are more prone to accept it. They are more confident that F1cross breed Cow might ultimately be beneficial. This result is in conformity with the finding of (Ward *et al*., 2016).

Livestock holdings: Livestock holding size, which is a proxy for measuring wealth status of household head, is found to have a negative and significant influenced on F1cross breed Cow adoption decision and level of adoption at 5% level of significance. This result implies that for each additional tropical livestock unit, the households would 1.8% less likely to adopt F1cross breed Cow and level of adoption; keeping all other factors constant suggesting that a farmer with large number of livestock are less likely to F1cross breed Cow adopt than others. Thus could possibly be explained farmers large livestock not care for cross breed rather more concern with large number of livestock holding. This is contradict with the findings of Yenealem (2006).

Number of crossbreed owned: The coefficient for the number of cross breed cattle had a statistically significant and positive relationship F1cross breed Cow adoption decision and level of adoption at 1% significant level. The result implies that an additional unit of cross bread cow would increase farmers' F1cross breed Cow adoption decision and level of adoption by 15.1% than others, keeping all other factors constant. Farmers who had cross breed better to know management practice and the advantage of cross breed over local than others. This is in line with the findings of (Dehinenet, 2014).

Actual price of F1 cross breed Cow: Actual price of F1 cross breed Cow was found to have a positive and significant influenced on F1cross breed Cow adoption decision and level of adoption at 10% level of significance. Higher price of F1cross breed Cow at market price makes farmers more adopt since they get with minimum price from ATARC. A unit additional price F1cross breed Cow at market of was 0.002% more probability of F1cross breed Cow adoption decision and level of adoption than others respectively, keeping all other factors constant. Farmers get F1 cross breed cow with minimum price 2004 birr from Adami Tulu Research center that on average 12000 birr at market place. So if they sold they didn't get such cow from market with minimum price why they adopt more as actual price at market increases.

Total Annual cash income: Total Annual cash income had positive relationship with F1cross breed Cow adoption decision and level of adoption as prior expectation significantly at 5% significance level. This implies the farmers who had higher cash income more adopt F1cross breed Cow because they had not sold Cow as shortage of cash income. Additional cash income increase by one ETB the F1cross breed Cow adoption decision and level of adoption increase by 0.00003% keeping all other factors constant. This is in line with the findings of (Melesse & Jemal, 2012).

Access to extension for livestock production: Access to extension for livestock production was found to have F1cross breed Cow adoption decision and level of adoption at 1% level of significance. The result implies that an access to extension on livestock would increase farmers' F1cross breed Cow adoption decision and level of adoption by 36.2% than others, keeping all other factors constant. Because it improves the technical knowhow and skill of the farmers thereby exchange of experience was improve the adoption. This is in line with the findings of (Ayantunde *et al.,* 2020).

Impact of F1 crossbred Cow on the farmers' income

The balanced propensity scores and then a best fit matching estimator to the data were used. Lastly, based on those propensity scores estimated and matching estimator selected, matching between adopters and non-adopters was done to find out the average treatment effect on the treated (ATT) for intended outcome variables.

Propensity score estimation

Prior to estimate propensity scores, the explanatory variables were checked for existence of multicollinearity and heteroscedasticity problem with appropriate technique as it is indicated in the method section. The first step in PSM was to determine the propensity score and satisfy the balancing property. Accordingly, eleven explanatory variables were identified after iteration to fulfill the criteria of "the balancing propensity is satisfied".

The first step taken to evaluate impact of F1 Cross breed cow program on HH income was estimation of propensity scores based on the selected covariates. Logistic regression model was employed to estimate propensity scores for matching F1 Cross breed cows' program households with their counterfactuals. The dependent variable in this model was a dummy variable indicating whether a given household has participated in the F1 Cross breed cow adoption taking a value of 1 or 0 otherwise.

Therefore, before matching, results of logit estimation showed that F1 Cross breed cow adoption status has been significantly influenced by five variables (Table 28). Age of household head,

Cross breed own, Actual market price of F1 Cows, Dairy cooperative members, and access to extension were found to affect the probability of adopting F1 Cross breed cow significantly. The implication could be that farm household participation was more guided by economics factors than demographic.
Estimation of logit model was followed by series of activities involving defining region of common support, matching and testing the balance for matching program and non-program households for isolating causal effects of F1 Cross breed cow program.

Defining region of common support
Identification of common support or overlap condition for program and non-program households was done in order to estimate causal treatment effects (in this case, F1 cross breed cows outcome) since violation of the common support condition is a major source of selection bias (Heckman *et al.,* 1997). We used the estimated propensity scores us to define the common support region and results of data analysis are depicted in Table. Our common support region according to Caliendo and Kopeining, (2008) would lie between 0.0243 and 1.

Matching Program and Non-program Households

Nearest neighbor, Caliper and Kernel matching estimators were used in matching the program and non-program households in the already defined common support region. The final choice of a matching estimator was guided by three criteria; namely, the equal mean test (balancing test), pseudo-*R*2 and matched sample size (Caliendo and Kopeining, 2008). In general, a matching estimator which balances all explanatory variables, bears a low pseudo-R^2 value and also results in large matched sample size is preferable. Therefore, caliper matching with tolerance level of 0.25 was found to be the best matching algorithm for the data we have 210 matched observations (table 27).

Table 27. Propensity score estimation

Variables		**Coefficient**	**Std.Err.**	**P > z**
Sex		0.2701	0.3608	0.454
Age		0.0279 **	0.0139	0.046
Education status		-0.1665	0.2047	0.416
HH Dairy experience		-0.0213	0.0211	0.313
Total Family size		0.0804	0.0552	0.145
Livestock holdings (TLU)[a]		-0.0293	0.0296	0.322
Cross breed own		0.2218***	0.0766	0.004
Actual market price of F1 Cows		-0.00027***	0.00005	0.000
Dairy cooperative member		0.6103*	0.3405	0.073
Access to Credit		0.3038	0.4043	0.452
Access to Extension		0.6134**	0.3098	0.048
Constant		2.8536***	1.6946	0.092
Number of observations	223			
LR chi^2 (11)	210.68			
Prob>chi^2	0.000			
Pseudo R^2	0.6837			
Log likelihood	-48.73			

***, **and * indicate statistical significance at 1%, 5% and 10%, respectively.

Source: model result, 2022

Choice of matching algorithm

Matching estimators were evaluated via matching the participant and non-participants households in common support region. Hence, based on the matching quality indicators, kernel matching with band width of 0.5 resulted in relatively low pseudo-R^2 with best balancing test and large matched sample size as compared to other alternative matching estimators as indicated in Table. Then it was selected as a best fit matching estimator for this study.

Estimating the average treatment effect of the treated (ATT) with the matched sample and calculating standard errors

This part indicates whether or not the F1Cross breed cow program has brought significant changes on the income of the beneficiaries. After controlling for other characteristics, the propensity score matching model using the kernel matching estimator result (band width 0.5) indicates the existence of a positive Additional value premium of birr 9,394.414 and 82.12% per month.

Here, the crossbreed cow F1 impact on the outcome variables (total income from cross breed cow per annum and total income from milk and milk products sold per month were evaluated whether there was a significant impact on adopter households or not, with the pre-intervention differences controlled.

Total income from milk and milk products showed that on the average, treated households (adopters) got 12, 008.68 birr per month which accounts 82% more income from milk and milk products per month than the controls (non-adopters) which is 2614.266 birr per month and this difference was statistically significant ($P<0.01$). Propensity score matching analysis also showed that adopter smallholder farmers, on an average, could get 82% more income from milk production than the non-adopter smallholder farmers. Positive relationship exists between the productivity of a herd and the income received by the farmer per cow. With more productive milking herds, farmers produced more milk and received more income from selling. This result is in line with the finding of Medola (2007) which stated what farmers gain from new agricultural technology has a direct influence on the poor households by raising their income while indirectly raising employment and wage rates on landless laborers.

Table 28. The average treatment effect on the treated for outcome variables of interest

Intervention	Variables	ATT on Treated	Control	Difference	S.E.	T-value
F1 cross breed Cows	Total income from milk and milk products/month	12,008.68	2,614.27	9,394.414	2512.73	8.38***
	Total income from Cows sold	18,322.37	6500	11,822.37	541	3.57***

Source: survey result, 2022.

Summary, Conclusions and Recommendations

This chapter summarizes the whole findings of the study and makes conclusions based on the results of the descriptive and econometric model. It also highlights some important policy recommendations to enhance farmers' adoption decision and level of F1 cross breed adoption.

Summary and Conclusions

Agriculture in Ethiopia is dominated by smallholder and largely subsistence farmers who are intended to meet household food consumption. The farmers in West Arsi and East Shewa zones practice mixed farming systems. Therefore livestock contributed for household income increment and sustain food security in the study area.

The overall objective of this study was to analyze status of F1 cross breed Cow distributed by ATARC, factors influencing F1 cross breed Cow adoption decision, intensity of adoption and impact of F1 cross breed Cow on household income. To conduct the study, primary data was collected from 223 household heads 105 F1 cross breed Cow user and 118 non-user through semi-structured questionnaire prepared by Cspro software. Secondary data were also collected from different sources including CSA, Zonal office of livestock agency, district office of livestock agency and from published and unpublished sources to supplement primary data. In this study both descriptive statistics and econometric analysis were employed. The primary data was analyzed using descriptive statistics and tobit model.

The descriptive and inferential analysis indicated significant difference between F1 cross breed Cow users and non-users sample households in terms of Age, education status, experience in dairy production, access to extension service, participation in social organization, access to credit and cash income from livestock products. In terms of adoption status about 71.43% of sample households were adopt F1 cross breed Cow.

The result of tobit model revealed that, out of total 11 explanatory variables included in the model. Total of six variables found significantly determined sample farmers adoption decision and intensity of adoption. To this effect, experience in dairy production, Number of cross breed, actual price of F1 cross breed Cow distributed, total annual cash income and extension service on livestock production positively influenced households F1 cross breed Cow decision and intensity of adoption whereas, total livestock number negatively affected sample households F1 cross breed Cow decision and intensity of adoption.

Logistic regression model was employed to estimate propensity scores for matching F1 Cross breed Cows' program households with their counterfactuals. Therefore, before matching, results of logit estimation showed that F1 Cross breed Cow adoption status has been significantly influenced by Age of household head, Cross breed own, Actual market price of F1 Cows, Dairy cooperative members, and access to extension service. Our common support region would lie between 0.0243 and 1. F1 cross breed cow program and non-program households had no statistically significant difference in terms of all of the covariates after matching, indicating similarities between the two groups. After controlling for other characteristics, the propensity score matching model using the kernel matching estimator result (band width 0.5) indicates the existence of a positive Additional value premium of birr 9,394.414 and 82.12% per month. Total income from milk and milk products showed that on the average, treated households (adopters) got 12, 008.68 birr per month which accounts 82% more income from milk and milk products per month than the controls (non-adopters) which is 2614.266 birr per month and this difference was statistically significant.

Recommendations

Based on the findings of this study, the following recommendations are made.

Experience in dairy production significantly and positively affect F1 cross breed cow adoption decision and level of adoption. Therefore farmers should exchange experience in dairy production and management.
Annual cash income was significantly and positively affects F1 cross breed cow adoption decision and level of adoption. Therefore farmers should participate into different income generating activities like production of cash crops and intensify the dairy production to improve income to adopt cross cows.
Extension services on livestock production were significantly and positively affect F1 cross breed cow adoption decision and level of adoption. Therefore district livestock agency experts should provide livestock extension with great attention for awareness creation on importance of cross breed cows over the local as well as dairy management and improved animal feed expansion.
Total income from milk and milk products showed that on the average, treated households (adopters) 82% more income from milk and milk products per month than the controls (non-adopters). Therefore farmers should practice to rare cross breed cow to improve their income in the study area.

Acknowledgement

First and foremost, we would like to thank our God for blessing invaluable gifts of health, strength, believe, love, hope, patience and protection to us and our families throughout our study.

Our thanks go to smallholder farmers and Development Agents in the study district who provide valuable information. Our special thanks also go to Mr. Yassin Ismael the center director of Adami Tulu Agricultural Research Center (ATARC), who provided us the required facilities for the accomplishment of this study as well as our driver Bante Curiso who gives service during data collection. We would like to thank also all partners who contribute to this work; throughout our work.

Lastly, we would like to extend our sincere gratitude to Oromia Agricultural Research Institute for the research grant to undertake this study.

References

Abreham Feyissa, 2016.Participatory Agricultural Production Constraint Analysis in Oromia: A Guiding Tool for Strategic Research and Development Interventions; Case Study in East and North Shoa, Oromia Regional State. Oromia Agricultural Research Institute, Finfinne, Ethiopia.

Alemayehu Seyoum, P. A. Dorosh, Sinafikeh Asrat, 2013. "crop production in Ethiopia: Regional patterns and trends. Food and agriculture in Ethiopia: Progress and policy challenges". 74 (2013): 53.39.

Amanuel Bekumal, Ulfina Galmessa and Lemma Fita . 2018. Review on Adoption, Impacts and Determinant Factors of Dairy Technology in Ethiopia. Food Science and Quality Management www.iiste.org. ISSN 2224-6088 (Paper) ISSN 2225-0557 (Online) Vol.74

Aregay Waketola, 1980. Assessment of the Diffusion and Adoption of Agricultural Technologies in Chilalo. Ethiopian Journal of Agricultural Systems. 1(2): 50-67.

Ayantunde AA, Oluwatosin BO, Yameogo V, van Wijk. 2020. Perceived benefits, constraints and determinants of sustainable intensification of mixed crop and livestock systems in the Sahelian zone of Burkina Faso. Int J Agric Sustain 18(1):84–98. https://doi.org/10.1080/14735903. 2019.1698494

Aynalem Haile, 2006. Genetic and economic analysis of Ethiopian Boran cattle and their crosses with Holstein Friesian in central Ethiopia. PhD thesis. National dairy research institute (I.C.A.R) karnal-132001 (Haryana), India. Pp. 197.

Baltenweck, I. A. and Staal, S. J. (2000): Determinants of Adoption of Dairy Cattle Technology in the Kenya Highlands: A SPATIAL AND dynamic Approach. International Livestock Institute. Nairobi, Kenya.

Ban, A.W, Van den and H.S Hawkins, 1996. Agricultural Extension Black well Science Ltd, UK

Becker, S. O. and Ichino, A. 2002. Estimation of Average Treatment Effects Based on Propensity Scores: The Stata Journal, 2(4); 1-19.

Brasesco, F., Asgedom, D., Sommacal, V. (2019). Strategic analysis and intervention plan for cow milk and dairy products in the Agro-Commodities Procurement Zone of the pilot Integrated Agro-Industrial Park in Central-Eastern Oromia, Ethiopia. Addis Ababa, FAO. 116 pp. Licence: CC BY-NC-SA 3.0 IGO

Chantalakhana, C. (1999): Research Priorities for Stallholder dairying in tropics. In: Smallholder dairying in the tropics: ILRI, Nairobi, Kenya.

CSA (Central Statistical Agency). 2021. Agricultural sample survey report on livestock and livestock characteristics. Federal democratic republic of Ethiopia volume II

CSA (Central Statistical Agency), (2018). Federal Democratic Republic of Ethiopia Federal Democratic Republic Of Ethiopia Central Statistical Agency Central Statistical Agency Agricultural Sample Survey Agricultural Sample Survey. Report on Livestock and Livestock Characteristics, Addis Ababa, Ethiopia

CSA (Central Statistical Agency). 2017. The Federal Democratic Republic of Ethiopia central Statistical Agency agricultural sample survey report on area and production of major crops 584 Statistical Bulletin 2016/2017 (2009 E.C.) Volume I

CSA (Central Statistical Agency, (2015). Ministry of Finance and Economic Development: Livestock Sample Survey, Study Documentation, Ethiopia

Dasgupta, S., 1989. Diffusion of Agricultural Innovations in Village India, Department of Sociology and Anthropology, University of Prince Edward Island, Canada

De Leeuw, P. N., Omore, A., Staal, S. and Thorpe, W. (1999): Dairy Production Systems in Tropics. Flavey, L. and Chantalakhana, C. (eds.). In: smallholder Dairying in the Tropics. ILRI. (International Livestock Research Institute). Nairobi, Kenya.

Dehinenet Gezie. 2014. Analyses of impact of improved dairy technology adoption on smallholder household livelihoods and milk value chain in selected zones of Oromia and Amhara national regional states, Ethiopia. A dissertation submitted to the college of veterinary medicine and agriculture, Addis Ababa University in partial fulfillment of the requirement for the degree of doctor of philosophy in Animal Production.

Ehui S.K., Lynam J. and Okike I. (eds). 2004. Adapting social science to the changing focus of international agricultural research. Proceedings of a Rockefeller Foundation. ILCA social science research fellows workshop held at ILCA, Addis Ababa, Ethiopia, 14-18 November 1994. ILCA, Addis Ababa, Ethiopia.

Enyew, N., Brannang, E. and Rottaman, O. J. (2000): Reproductive Performance and herd life of dairy cattle with different level of European inheritance in Ethiopia. ESAP 7th Conference. Addis Ababa, Ethiopia.

Gollin, D., Moris, M., and Byerlee, D., 2005. Technology adoption in intensive post Green Revolution systems. Amer. J.Agr. Eco.87 (number 5,2005):1310-1316. American agricultural economics association.

Hana Yeshitila Taddese. 2019. Dairy technology adoption and its impact on household food security: the case of Basona Warena Woreda, Amhara Region, Ethiopia. Thesis submitted to center for food security studies of the college of development studies, Addis Ababa University in partial fulfillment of the requirements for the degree of master of science in food security and development. Addis Ababa, Ethiopia

James J. Heckman, Hidehiko Ichimura and Petra E. Todd. 1997. Matching as an Econometric Evaluation Estimator: Evidence from Evaluating a Job Training Programme. The Review of Economic Studies. Vol. 64, No. 4, Special Issue: Evaluation of Training and Other Social Programmes pp. 605-654.

Kebebe, E. G. 2015. Understanding factors affecting technology adoption in smallholder livestock production systems in Ethiopia: the role of farm resources and the enabling environment. Wageningen University.

Langyintuo A. and Mulugeta Mekuria, 2005. Modelling Agricultural technology adoption using soft ware stata, International Maize and Wheat Improvement Center IMMYT).Harare, Zimbabuwe

Lionberger, H.F., 1960. Adoption of new ideas and practices. Ames, Iowa: The Iowa state university press.

M Caliendo and S Kopeinig.2008. Some Practical Guidance for the Implementation of Propensity Score Matching, DIW Discussion Papers, No. 485, Deutsches Institut für Wirtschaftsforschung (DIW), Berlin.

Mariapia Mendola .2007. Agricultural technology adoption and poverty reduction: A propensity-score matching analysis for rural Bangladesh, Food Policy, 32, (3), 372-393.

Melese Kassahun and Jemal Jeilu. 2012. Dairy Technology Impacts on Lovely hoods of Dairy Producers in Central Ethiopia: International Journal of Food and Agricultural Economics Vol. 1 No. 1 Pp. 109-118 109.

Mrinal Kanti Dutta and Baban Bayan. 2017. Crossbred Cattle Adoption and Its Impact on Income and Household Milk Consumption among Dairy Farmers: Empirical Evidence from Assam. Ind. Jn. of Agri. Econ. Vol.72, No.2.

Ray, G. L., 2001. Extension Communication and Management. Naya Prokash, Calcutta.145162pp.

Rogers, E.M, 1995. Diffusion of Innovation. New York: Free Press.

Rogers, E.M., 1981. Diffusion of Innovation. New York: Free Press

Rogers, E.M., 1983. Diffusion of Innovation. 3rd ed. New York: Free Press

Samuel, D., Chelkeba, M., Anteneh, T., Efrem, A., Gutema, B., Erko, E., and Addisu, B(2016). Adoption and Impacts of Dairy Production Technologies in Southwest Ethiopia: The Cases of Jimma and Ilu- Ababora Zones. Journal of Biology, Agriculture and Healthcare: Vol.6, No.7, 2016.

Shewaye, A. 2016. Econometric analysis of factors affecting haricot bean market outlet choices in Misrak Badawacho District, Ethiopia. International Journal of Research Studies in Agricultural Sciences 2 (9): 6–12

Simeon, k, Ehui and Nega G/silassie, 1999. The Contribution Of Livestock To The Sustainability Of Technology And Policy Issues. Proceedings Of The 3rd Conference Of The Society Of Agricultural Economics of Ethiopia, 2-3 October, 1997, AA, Ethiopia pp. 37-55

Stork, H., Bezabih Emana, Berhanu Adnew, Borowiecki, A.A. and Shimelis Woldehawariat. 1991. Farming systems and farm management practices of smallholders in the Hararghe

Highlands. Farming system and resource economics in the Tropics. 11: Wissenschafts Varlag Vauk Kiel KG, Germany.

Sultan Usman. 2016. Analysis of Wheat Value Chain: The case of Sinana district, Bale Zone, Oromia region, Ethiopia. Thesis Haramaya University, Haramaya, Ethiopia.

Takele Honja, Endrias Geta and Amsalu Mitiku. 2017. Determinants of Market Outlet Choice of the Smallholder Mango Producers: The Case of Boloso Bombe Woreda, Wolaita Zone, Southern Ethiopia: A Multivariate Probit Approach. Global Journal of Science Frontier Research, 17(2): 23-29.

Teshome Gedefa, Ajebu Nurfeta and Nega Tola, 2019.Evaluation of production performance of Arsi-Holstein Friesian crossbred dairy cattle: A case of Assela Model Agricultural Enterprise, Arsi zone, Oromia Region, Ethiopia.

Tilahun Sisay, 2018. “Agriculture –industry Linkage and Technology Adoption in Ethiopia; Challenges and Opportunities: Review”. Nutrition and Food Toxicology 3(1).

Ulfina Galmessa,, Jiregna Dessalegn, Alganesh Tola Shiv Prasad and Late Mulugeta Kebede. 2013. Dairy Production Potential and Challenges in Western Oromia Milk Value Chain, Oromia, Ethiopia. Journal of Agriculture and Sustainability, Volume 2 (1):

Ward PS, Bell AR, Parkhurst GM, Droppelmann K, Mapemba L. 2016. Heterogeneous preferences and the effects of incentives in promoting conservation agriculture in Malawi. Agr Ecosyst Environ 222:67–79. https://doi.org/ 10.1016/j.agee.2016.02.005

Wuletaw Mekuria, Workneh Negatu & Kindu Mekonnen. 2017. Adoption of Improved Dairy Cows and Implications for Household Food Security: Evidence in Central Highland of Ethiopia. Global Journal of Science Frontier Research: D Agriculture and Veterinary Volume 17 Issue 3

World Bank .2017. Annual Report. Washington, D.C. : World Bank Group.

Yapa, L. and C. Mayfeld, 1978. Non-adoption of Innovations: evidence from discriminate analysis. Economic Geography. 54(2). 145-156.

Yassin Esmael, Adam Bekele and Mengistu Ketema. 2016. Determinants of smallholder farmers’ participation decision in potato market in Kofele District, Oromia Region, Ethiopia. Journal of Agricultural Science and Research (JASR) 3(2):

Yenealem K. (006. Gender disparities in adoption of improved maize varieties between male headed and female headed households in Kuni Wereda, Western Hararghe Zone, Ethiopia. M Sc Thesis presented to the School of Graduate Studies of Alemaya University

Yonad (2009). Value chain analysis of milk and milk products in Borana pastoralist area. Zumbach, B. and Peters, K. J. (2000): Sustainable Breeding Methods for smallholder Dairy production under unfavorable conditions in the tropics Deutscher Tropentag, International Agricultural Research, A contribution to crisis prevetion.

Appendices

Appendix Table 1. Conversion factors used to compute tropical livestock units (TLU)

Livestock Categories	**Conversion factor**
Cow/Ox	1
Bull	0.75
Cow	0.75
Calf	0.2
Horse/Mule	1.1
Camel	1.25
Sheep/Goat	0.13
Donkey	0.7
Poultry	0.013

Source: Stork *et al*., 1991

Appendix Table 2. Multicollinearity test

Variables	VIF	1/VIF
Sex	1.63	0.611850
LIVESTOCKExtension	1.53	0.652386
EXPEDAIRY	1.48	0.676431
Ecucs	1.47	0.681240
Age	1.37	0.728166
CROSSBREED1	1.30	0.769445
TFZ	1.25	0.801390
ACTUALPRICE1	1.17	0.852798
TLU	1.11	0.903708
Totalincome	1.08	0.922242
Creditservice	1.08	0.929701
Mean VIF	1.32	

Impact of climate change on maize production and adaptation strategies in East Shoa zone, Oromia region, Ethiopia

Beriso Bati*, Asfaw Negesse, Shimalis Gizachew
Oromia Agricultural Research Institute (OARI), Adami Tulu Agricultural Research Center
PO Box-35, East Shoa Batu, Ethiopia
*Corresponding Author: batiberis@gmail.com, bonsahu@gmail.com, shimegiz2006@gmail.com.

Abstract

Climate change has tremendous impact on crop growth and productivity. This paper reviews effects of Climate change on maize yields, trends of maize production under the prevailing environmental condition, coping mechanisms to adapt climate change and the perception of farmers towards climate change. Semi-structured questionnaires were used to collect data from 166 sample respondents randomly selected from designated locations in East Shewa Zone. A stochastic production frontier function was fitted to the sample households. As the study result revealed that, 95.78% of farmers perceive climate change availability within the last ten years of crop production. In the meantime 98.80 % of farmers perceive climate change have impact on maize production and productivity. About 72% of smallholder farmer though decline of maize yields was due to rainfall decline and temperature increased. The sum of the partial elasticity of all inputs was 1.17 for Maize indicates an increase in all inputs at the sample mean by one percent increase by 1.17% maize. The average maize yields before ten, five and current years were 54, 31 and 24 qt/ha respectively. Percentage change in maize yield due to climate change 0.06 whereas its coefficient of variability 0.24 in East Shoa Zone. The variable included in the model have been used in their logarithmic form in order to provide convenient interpretation (elasticity) and to reduce heterogeneity of the variables. The time trend (year) has been used as a proxy for technical change in maize production technology such as development of new variety and farm management practices which general increases maize yield overtime. The main growing season rainfall has negative but statistically insignificant effect on average maize yields. As the results of research analysis indicate that, the cumulative sum of farmer's perception towards the impact of climate change were 1.9 which is below the mean suggesting farmers perceive climate change have negative impact. Adaptation to climate change requires cross-disciplinary solutions that include the development of appropriate germplasm and mechanism to facilitate to farmers access to germplasm. In addition using drought - tolerant maize varieties, early mature variety, using compost and improving agronomic management and Crops other adaptation strategies to climate change variability. So the adaptation strategies to climate change in the zones were; the development and cultivation of more drought-tolerant maize varieties; the adjustment in the planting days of maize; the use of irrigation facilities in the cultivation of maize; farmers must engage in crop diversification and Improved agronomic management and Crops.

,

Keywords: Climate Change, Maize, Drought, Impact and Adaptation, East Shoa Zone

Introduction

Background and Justification

Ethiopia is one of the fastest growing non-oil economy countries in Africa. The country is heavily reliant on agriculture as a main source of employment, income and food security for a vast majority of its population. In GTP-II period, agriculture will remain the main driver of the rapid and inclusive economic growth and development. It is also expected to be the main source of growth for the modern productive sectors. Therefore, besides promoting the productivity and quality of staple food crops production, special attention will also be given to high value crops, industrial inputs and export commodities (NPC, 2016).

The impacts of rising average temperature, rainfall variability and increase in the frequency and intensity of droughts are more severe in the tropics than temperate regions (Bekele, 2013). Agriculture is the most susceptible sector to climate change related hazards. This is due to the fact that climate change affects the two most important direct agricultural production inputs and these are precipitation and temperature (Philip et al., 2014 and Birhan, 2017). The change in rainfall distribution and pattern had contributed to the change in cropping pattern and crop yield (Kassa, et al., 2012).

The impacts of climate change are adverse in low and middle-income countries, where millions of people depend on agriculture and are vulnerable to food insecurity (FAO, 2017). The majority of the rural people in developing countries in general and in Ethiopian in particular depends rain fed subsistence agriculture and the daily exploitation of natural resources (Alebachew, 2011 and Kassa, et al., 2012). Variability of weather conditions, particularly of precipitation, is a key climatic characteristic of Ethiopia (IFAD, 2016). Because of changes in the patterns of the local climate, this region is exposed to chronic food shortages, degradation of natural resources, unstable livelihoods and distress migration (Alebachew, 2011 and Kassa, et al., 2012). The farming technology in the central rift valley of Ethiopian is basic and incomes are low, suggesting that farmers will have few options to adapt (Mendelsohn, 2000). Adaptation enhances the capacity of people and governments to reduce climate change impacts (Kassa, et al., 2012).

Agriculture is extremely vulnerable to climate change (Birhan, 2017). Higher temperatures eventually reduce yields of desirable crops while encouraging weed and pest proliferation. Changes in precipitation patterns increase the likelihood of short-run crop failures and long-run production declines. The overall impacts of climate change on agriculture are expected to be negative although there will be gains in some crops in some regions of the world (FAO, 2008).

Agriculture, and especially crop growing, is heavily dependent on weather events in SSA, where 97% of agricultural land is rain fed (Birhan, 2017). The impact of climate change on crop yields is a major concern in this region (Deressa, 2006). Ethiopia is not an exception to the adverse impacts of climate change as its economy is highly dependent upon climate sensitive rainfed agriculture. The country is among the most vulnerable nations to climate and ecological change, given that only a small proportion of its cultivated land is irrigated and food production is dependent mainly on traditional rain fed agriculture (NMA, 2007 and Birhan, 2017).

The dependence of Ethiopia on agriculture makes vulnerable to adverse impacts of climate change on crop and livestock productions. The frequent droughts and floods negatively affect agricultural production, shows agriculture's sensitivity to climate change (Yesuf, et al., 2013). Some scholars have conducted research to measure expected impacts of climate change on agriculture in developing nations (Deressa, 2006 and Birhan, 2017). For example, the studies in pastoralist and agro-pastoralist are found out impact of climate and adaptation mechanisms to reduce vulnerability to climate change, regarding crop production (Temesgen, 2008; Woldeamlak and Conway, 2009; Kassa, et al., 2012; Birhan, 2017). In different parts of Ethiopia, climate change is affecting the yield of crop production because they are exclusively dependent on rainfed agriculture with little or no adaptive strategies to cope up with climate. The magnitude of climate change related problems have been intensifying both spatial and temporally. The increase in frequency of extreme weather events such as droughts and floods accompanied by the difficulty in predicating growing seasons create a considerable endanger for the achievement of food security. This phenomenon is also the real manifestation of East Shoa Zone where this study has conducted.

Objective of the Study

- To identify the trends of maize production under the prevailing environmental condition
- To analyze the impact of climate change on maize yields
- To identify coping mechanisms to adapt climate change
- To identify the perception of farmers towards climate change

Expected Output

- Farmers coping up mechanism towards climate change identified
- Climate variability trends identified
- Impacts of climate change on maize yield quantified and
- Farmers' perception towards climate change identified

Literature Review

Climate change models and implications for maize production in Ethiopia

Climate Change is coming faster with larger impacts and bigger risk. One particular worry is the disastrous consequence to agriculture and food security sectors in many parts of the world, particularly in developing countries. Adaptation is the only option to reduce the impacts of climate change (Luhunga, 2017).

In the last few years, yields have further declined in many parts of the country (Abu, 2011; Braimoh and Vlek, 2006; Owusu-Sekyere et al., 2011a). Although other contributing factors exist, increasing temperatures and irregularity in rainfall has been cited as the primary cause of the continuous reduction in yields (EPA, 2000; Abu, 2011). Similar findings were reported by Owusu-Sekyere et al. (2011a). Maize yields across the Cape Coast metropolis within the coastal savannah zone declined over the last 16 years. This was attributed to reduction in rainfall amounts and changes in the start of the rainfall season. The decline in maize yields is also being experienced in the Mfantseman area of the Central Region. Declining rainfall amounts and rising average temperatures have been suggested as probable causes for yield decreases (Owusu-Sekyere et al., 2011b). Several other studies (e.g. Adjei-Nsiah and Kermah, 2012; Agbeve et al., 2011; FosuMensah et al., 2012) have reported similar declines in crop yields including maize across the different agro-ecological zones in the country. Although other reasons were cited, the changing climatic parameters were proposed as the main cause for the yield decline.

Climate change adaptation in maize production in Ethiopia

Current measures

Various adaptation measures have been reported in many studies in Ethiopia. Other farmers have switched to the cultivation of tree crops because they can tolerate the changes in rainfall regimes and atmospheric temperatures. Examples include cashew, teak and mangoes. Trees are also used to provide shade for the cultivation of food crops due to the increase of temperatures. Some farmers use trees for other commercial purposes due to declines in food crops incomes (Adjei-Nsiah and Kermah, 2012; Boon and Ahenkan, 2011). Educational program are run by the government for farmers to sensitize them on the need to conserve water and soils on their farms. They are encouraged to adopt practices like conservation tillage and the use of cover crops in order to conserve moisture in the soil as temperatures keep on rising (EPA, 2000).

Potential measures

Many adaptation measures have been suggested in anticipation of any further change in climatic conditions. A primary measure is the development and cultivation of more drought-tolerant maize varieties. Although some drought-resistant varieties have already been developed, future climate scenarios call for more resistant varieties than the present types (EPA, 2000; Dazé, 2007; Master et al., 2009). A second measure is adjustment in the planting days of maize. This is to accommodate the alterations in the growing season. Generally, depending on the start of the rainy season, maize is planted between May and June or earlier. Delaying this planting date for about 5-8 weeks would be essential under future climate scenario because projections suggest increased rainfall around this period compared to May-June. This should allow maize plants to grow under more favorable environmental conditions and, in addition, improve yields (Tachie-Obeng et al., 2010; Tachie-Obeng et al., 2013). The use of irrigation facilities in the cultivation of maize was recommended by many authors (Fosu-Mensah, 2012; EPA, 2000). Irrigation helps in offsetting water stress at vital stages of plant growth and ensuring efficient plant nutrition (Amikuzuno, 2013; Armah et al., 2011). Water availability for human and agricultural activities is likely to be a challenge under the future climate scenarios for Ghana (Brown and Crawford, 2008; EPA, 2000). Thus, developing effective irrigation facilities will be essential for maintaining maize production.

Lastly, farmers must engage in crop diversification. The cultivation of maize can be undertaken in association with other crops. So, if maize crops fail due to climate changes, farmers can rely on the production of alternative crops or activities adopted under the diversification scheme. This is already being practiced by many farmers in Ghana (Dazé, 2007; Masters et al., 2009). Under future climate scenarios, crops like sorghum and millet can be used in such schemes. Millet is a major staple crop in Ghana especially in the northern parts. Projections indicate that millet production may not be significantly affected under future climate scenarios for Ghana. This is due to its drought tolerant abilities and thus insensitive to temperature increase (EPA, 2000; Masters et al., 2009). A similar statement was reported by Ringler et al. (2010) who projected millet yields to increase slightly across the entire Sub-Saharan region under climate change by 2050. In Nigeria, Adejuwon (2006) projected a significant increase in yields by 2050. Beyond 2050, yields are likely to decline. Knox et al. (2012) indicated that effective adaptation measures need to be implemented if these positive yields are to be realised.

Sorghum has also been recommended as a potential substitute for maize under future climate scenarios (EPA, 2000). By 2050, yields are projected to increase slightly within the Sub-Saharan region (Ringler et al., 2010). A study by MacCarthy and Vlek (2012) revealed that for positive yields of sorghum to be realised in Ghana under climate change, significant quantities of fertilizers would have to be added during cultivation. This presents a challenge to smallholder farmers many of whom cannot afford to buy the fertilizers.

Causes of Climate Change

According to Intergovernmental Panel on Climate Change (IPCC, 2007), the causes of climate change can be linked basically to factors such as: 1. Industrial revolution; The activities of automobiles, jet-trails and other industrial acts have led to emission of several gases like carbon dioxide into the atmosphere which over time affects the composition of greenhouse gases leading to altered climate. 2. Burning of fossil fuels by oil producing companies and refineries which emit greenhouse gases directly into the atmosphere. For example, the Niger Delta region is reported to have over 123 gas flaring sites, making Nigeria one of the highest emitters of GHG in Africa (Akinro et al., 2008). Nigeria accounts for roughly one-sixth (1/6) of worldwide gas flaring: Nigeria flares about 75% of her gas (World Bank, 2008), and all take place in the Niger Delta region. Some 45.8 billion kilowatts of heat are discharged into the atmosphere of the Niger Delta, from flaring 1.8 billion cubic feet of gas every day (Olurin & Agbola, 2003). Between 1970 and 1986, about 125.5 million cubic meters of gas was produced in the Niger Delta region of which about 102.3 (81.7%) million cubic meters were flared (World Bank, 2008). The flares, due to the existence of oil industries in the region, have apparently contributed to the increase of GHG which alters climatic composition over time. 3. Land use change such as deforestation and desertification, watering of deserts, sand-filling of natural water bodies, all of which singly and/or complementarily leads to climate change,and 4. Agricultural activities such as bush burning, fertilizer application, fermentation among others, as anthropological.

Effects of Climate Change on the Environment and Agriculture

The effects of climate change on agricultural production vary from one region to another depending on the prevailing climate of the region hence affects agricultural productivity differently. Nigeria, like all other countries of sub Saharan Africa, is highly vulnerable to the impact of climate change especially the coastal low lying states. Climate change variations between 1960 and 1999 in parts of Nigeria showed visible occurrences of drought for a cumulative period of approximately 8-18yeasrs in most of Adamawa, Bauchi, Borno, Jigawa, Kano, Kastina, Sokoto, Yobe and Zamfara states of Nigeria (Obioha, 2009; Muhammed et al., 2011). Unlike the northern mentioned states, the Niger Delta states like Bayelsa, Delta, Edo and

Rivers, among others had flooding and over flowing seas. Niger Delta like most coastal low lying regions of the world is constantly faced with flooding of various degrees. Due to increased and varying extent of precipitation attributable to climate change, the occurrence of flooding has increased with rivers and oceans easily overflowing their banks. This was observed in the 2012 flooding that impacted negatively on agriculture in the region. The flood ravaged farmlands, storage buildings and farmers houses. Climate change resultant scenarios like excessive rainfall, flooding, excessive temperature, rising sea levels and water scarcity affects agricultural production and causes rises in price of agricultural productions. For example, uncertainties in the onset of the farming season, due to changes in rainfall pattern can lead to a usual sequence of crop failure which results in food shortages due to poor harvests; early rain may not be sustained, and crops planted at that instance may become smothered by heat waves. The authors explained that small rural farmers and communities no longer produce sufficient quantities of the food needed to sustain their populations. Also extreme weather events such as thunder storms, heavy winds, and floods, devastate farm lands and can lead to crop failure. Flooding could estroytheinfrastructure used to store or transport food from production areas to markets thereby acting as disincentive to farmers who could produce more food Ifeanyieze *et al*, 2016). Climate change affects livestock especially in dry weather conditions or desert-prone zones/regions where longer period of drought adversely affect the availability of fodder. Furthermore, increased temperature and accompanying decrease in water availability tend to reduce the length of growing seasons and yield potential with attendant low agricultural productivity. Admittedly, too, global warming has threatened the aquatic ecosystems with the consequential low production of sea foods and aquatic plants that may be of socio-economic importance. Climate change resultant effect of hunger and malnutrition are now adversely affecting the livelihood and well-being of a massive number of people and inhibiting the development of many poor countries (Ikehi, 2014). It is quite obvious that the most serious challenge facing agricultural production and indeed mankind, worldwide and Nigeria in particular is climate change, thus the necessity to adapt.

Mitigation and Adaptation Strategies

Developed and developing countries alike are working hard to find solutions to the effects of climate change, as the impacts vary in extent and nature. In order to address the resulting impacts, adaption practices should lay emphasis on community interest to encourage sustainable development. It is suggested that adaptation strategies will be more successful if they are identified and presented to local users for vetting to ensure their consistency with local priorities, norms, goals and institutions (Newton,Paci & Ogden, 2005). Community-based adaptation has become an important term in the climate change debate (Uyigue & Agho, 2007). It recognizes the fact that environmental knowledge and resilience to climate change lay within societies and cultures (IPCC, 2001). Furthermore, an understanding of how communities cope with environmental changes is important when developing community-based adaptation projects to mitigate the effects of climate change for the local farmers and their families. The goal of community-based adaptation is to increase climate change resilience of communities by enhancing their capacity to cope with climate related issues such as less predictable rainfall patterns, frequent droughts, stronger heat wave, invasion of diseases and weather hazards of unprecedented intensity (IPCC, 2001). Staying informed about climate change and supporting efforts to slow its progress are things necessary to be done. The climate is already changing because of the existing build-up of GHGs in the atmosphere, therefore it is important to prepared for and adapt to those changes. While actions now to reduce emissions is critical, the existing build-up of GHG concentrations means that some effects of climate change are inevitable in this and coming decades and planning must start now on adapting families, production processes, economy and the society to these changes Onu *et al* 2016.Agriculture depends largely on environment, thus any prolonged fluctuations in average weather can affect its productivity.

Methodology

Description of the Study area

The study was conducted in East Shoa Zone which found in central part of Oromia National Regional State, Ethiopia. East Shoa Zone lies between 60^{o} 00’ N to 70^{o} 35‘N and 380^{o} 00’E to 40^{0} 00’E. East Shoa Zone has different agro-ecologies which categorized as highland, midland and lowland agro-ecologies. In the Zone, 18.70% of the agro-ecology is high land, 27.50% is midland and 53.80% is lowland. The Zone received 350mm-1150 mm annual rain fall and has uni-modal nature of rain fall pattern. This Zone was received $12^{o}C$-$39^{o}C$ annual temperature per year (Farming System Report, 2018).

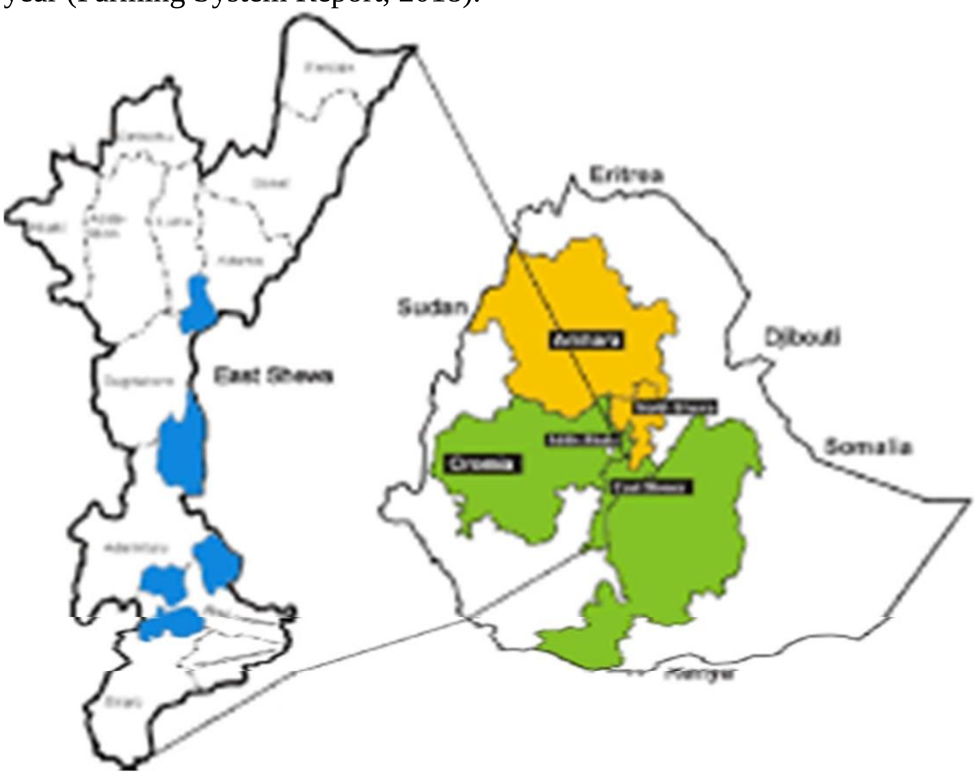


Fig: map of East Shoa zone

Sampling Procedure and Sample Size

The target population for this study was the Maize producer farmers in East Shoa Zone of Oromia National Regional State. Maize was dominantly produced in lowland areas of East Shoa Zone (Farming System Report, 2018). In order to have a representative sample in achieving the stated objectives, the sampling procedure was covered the major Maize producing Districts in the Zone. Accordingly, multi-stage sampling procedure was employed to select sample respondents.

First stage: Purposive sampling method was employed to select three major maize producing districts based on maize production volume

Second stage: Purposive sampling was applied to select two major Maize producing kebeles from three selected districts

Third stage: Simple random sampling was used to select 166 Maize producers from selected kebele by using Yamane formula, (1967)

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

Where,

n = is the sample size of sampled producer households, N= total number of maize producer households farmers, e= level of precision

Method and Type of Data Collection

Both primary and secondary data sources were used in the study. The primary data sources was semi-structure questionnaire, interview, discussion, and observation while secondary data sources was collected from government documents, Metrological data and crop production data.

To examine the impacts of climate change on crop production, agricultural product yields data with climatic parameters (i.e. Temperature and Rainfall) were employed in this research. Ten years climate data (rainfall, maximum and minimum temperature) were collected from Adama Meteorological Agency (AMA) and National Meteorological Agency (NMA) while crop yield data such as Maize, Teff, Haricot Bean, and Chick Pea were gathered from East Shoa Zone of Agricultural Development and Natural Resource Management Office.

Method of Data Analysis

Both descriptive and inferential statistical techniques were employed to analysis the collected data. Descriptive statistical techniques such as mean, standard deviation, and variance was computed whereas using inferential statistical technique such as Cobb–Douglas stochastic production frontier approach was used to estimate the production function and determinants of maize production, Auto regression, correlation analysis and analysis of variance (ANOVA) was computed to see the relationship between climatic parameters with maize yield data.

The trend analysis model is formulated as:

Ci=f(T,e),

Where:

Ci=climate variables,
T=time and

e= error term

Thus, to estimate a Cobb-Douglas production function, it needs too log all of input and output data before the data is analyzed (Coelli, 1995).

lnY=B0+B1lnLi+B2lnFi+B3lnSi+B4lnTi+B5lnPi+B6lnDi+Ui

Where:

Yi= maize yields (Quintal/ha) for farm i, Li is labor hours per hectare; Fi is fertilizer application per hectare (Kg); Si is the quantity of seed cultivated per hectare (Kg); Ti is mean summer temperature (degrees Celsius) that is experienced by farm i; Pi is mean precipitation (millimeters per month) that is experienced by farm i; Di is irrigation used of farm i ; Bk is the vector of the ki parameters to be estimated; and variables which affect maize yield, and Ui= disturbance term

The MELE and GME models were applied avoid correlation among some of the inputs, yield inconsistent and biased estimates since the application of ordinary least square may yield inconsistent and biased estimates (Golan, et al, 1996a)

Vector Auto regression Model

This model was also be used to estimate maize yield response to changes in temperature and rainfall using this model variable that fitted into model to co-integrate.

$$\mathbf{Yt = \alpha_1 Tt + \alpha_2 Rt + \alpha_3 y}$$

Where

Yt = maize yield produced at time t;
Tt = temperature at time t;
Rt = Rain fall at time t;
y = change in output of maize

The data collects from the Meteorological agency and agricultural development office was analyzed using version 15 STATA software and Microsoft Excel.

Results and Discussion

This chapter presents the findings of the study and discusses in comparison with the results of earlier similar studies. It is organized under five sections. The first section presents results of descriptive characteristics of sample respondents the study area. The second section is about the trends of maize production under the prevailing environmental condition. The third section is about the impact of climate change on maize yields. The fourth section is about coping mechanisms to adapt climate change and the last fifth section is about the perception of farmers towards climate change.

Descriptive Analysis Results

Socio-demographic characteristics of sampled households

Age of Household head (HH) has the source of good farming experience and able to participate risk involving farm activity than older farmers. The average age of the sample households during the survey period, was about 41.042 years having farming experience 17.81 years which was less than 65.97 year of average life expectancy for both sex in Ethiopia (WPP, 2017). Based on Strock et al., 1991 (as cited in Ermiyas, 2013) this average value of age included in the most economically active age group of 17-50 year.

The average education level of literate sample household heads during survey period was about 6.5 years with the minimum of zero years (illiterate) and maximum of 12 years. Family size plays an important role in crop production and most farmers depend mainly on family labor. The average family size of the sample households was 7 persons per household (Table 2) which is greater than 4.6 person per household as Ethiopia, based on household size and composition around the world in 2017.

Cultivated farmland land is land used by sample farm households to undertake agricultural production. The own average cultivated land holding size of the sample households was 2.03 hectares, which is greater than national average of 0.95 hectares (CSA, 2015). The average areas covered by maize during the year 2020 cropping season were 1.084 ha.

Livestock is one of the major assets for the farmers and also indicates their level of wealth in the study area. Types of livestock owned by households are oxen, cows, heifers, calves, horses, donkey, sheep, goat and poultry. Livestock provides traction power, manure, and is a source of cash that can be used to purchase goods for household consumption and production inputs. The average livestock holdings measured in terms of tropical livestock unit (TLU) were found to be 7.79. This is relatively a large number in the crop-livestock mixed farming system (Table 2). This indicates that the farming system in Ethiopia is mainly based on plough by animal draught power that has created complementarity between crop and livestock production. Income from crop, off-farm and non-farm income was 45,464.24; 86,766.83 and 54,625 birr respectively.

Table 2: Socio-demographic characteristics for continues variables

Demographic characteristics	**Sample respondents (n=166)**	
	Mean	**Std. Dev**
Age of HH head	41.042 years	12.34
Experience in maize production	17.81years	9.940
Family size	7.19	3.297
TLU	7.799	3.009
Grade level	6.528	2.840
Land cultivated/individual	2.03ha	1.80
Area under maize/ha	1.084ha	0.958
Income from crop	45,464.24 birr	6798.4
Off-farm income	86,766.83 birr	2454.5
Non-farm income	54,625birr	3562.5

Source: Survey result, 2020

Maize Production and its trends in East Shewa Zone

Maize production (Supply) and Demand in the zone

As survey result indicate, 55.90% of sample respondents think supply of maize within the last ten years was decreasing suggesting the production of the maize is decline due to different factors from which climate change took lion share, in the meantime its demand highly increasing due to shortage of maize production exist which accounts about 93% of sample respondents thinking (Table 3). To complement the survey result indicated under below table taken from smallholder farmers, secondary data taken from East Shewa zone agricultural office indicate that price of maize within the last ten years increased confirming the supply shortage and high demand (Fig: 1).

Table 3: Supply and demand of maize within the last ten years

	Supply of maize within ten years		**Demand of maize within ten years**	
	Freq.	Percent	Freq.	Percent
Increasing	63	39.13	150	93.17
Decreasing	90	55.90	16	6.83
No change	13	4.97	0	0
Total	166	100	166	100

Source: Survey result, 2020

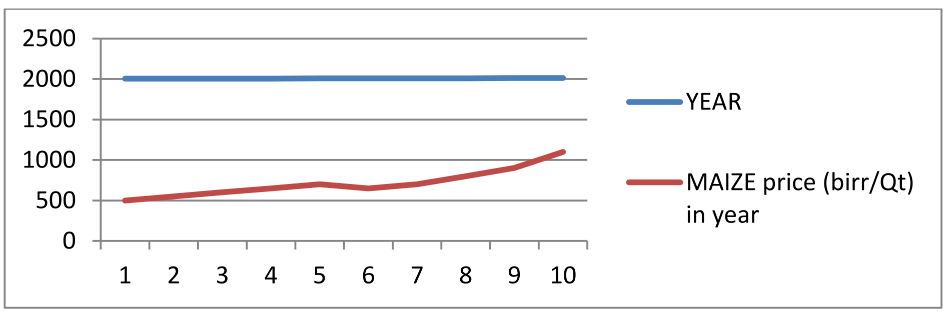


Fig 1: Price of maize within the last ten years
Source: Secondary data taken from East Shewa zone agricultural office

Cropping system in the zone

The majority of cropping system of maize production in East Shewa zone is sole cropping which accounts 98.18% suggesting the other reason of maize yield decline.

Table 4: Cropping system

Cropping system	**Freq.**	**Percent**
Inter cropping	2	1.21
Sole cropping	162	98.18
Mixed cropping	2	1.21
Total	**166**	**100**

Source: Survey result, 2020

Trends of Maize Production within the last ten years

As survey result indicate, 57.23 and 59.51% of sample respondents think trends of maize production within the last ten and five years were decreasing respectively, suggesting the production of the maize is decline due to different factors from which climate change took lion share (Table 5). To complement the survey result indicated under below table taken from smallholder farmers, secondary data taken from East Shewa zone of agricultural office indicate that productivity of maize within the last 12 years was decreased confirming the reason of production trends decline (Fig: 2 and 3). In addition to the above information gained from secondary data of zonal agricultural office, the zonal metrological office data indicate that within the last ten years rainfall was declining whereas the temperature was increasing that cause the zonal maize yield decline (Fig 3). The average annual rainfall of 30 years was 735.86 ml with SD of 262.80.

Table 5: Farmers perception on Trends of maize production within the last ten and five years

Trends of maize production	**During last ten (10) years**		**During last five (5) years**	
	Freq.	Percent	Freq.	Percent
Increasing	66	39.76	60	36.81
Decreasing	95	57.23	97	59.51
Fluctuate	5	3.01	9	3.68
Total	**166**	**100**	**166**	**100**

Source: Survey result, 2020

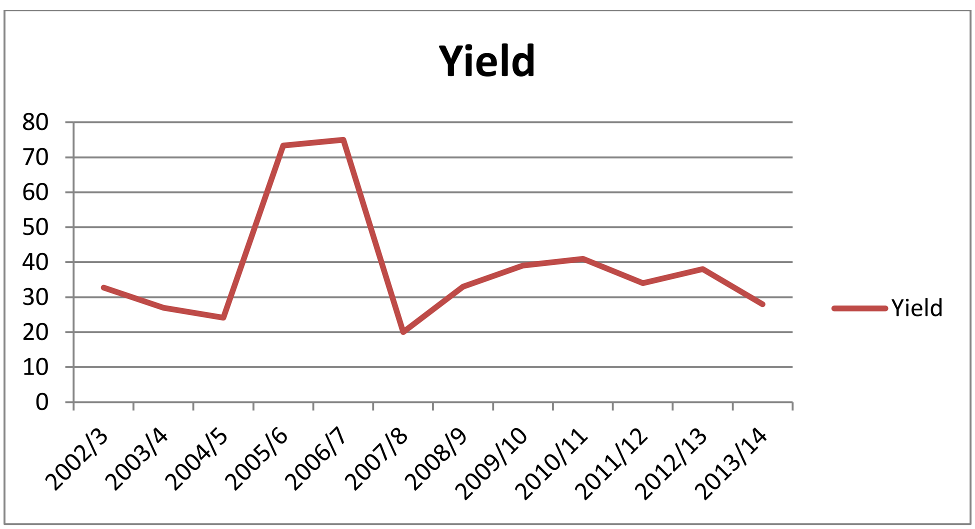


Fig 2: Productivity of maize within the last 12 years
Source: Secondary data taken from East Shewa zone agricultural office

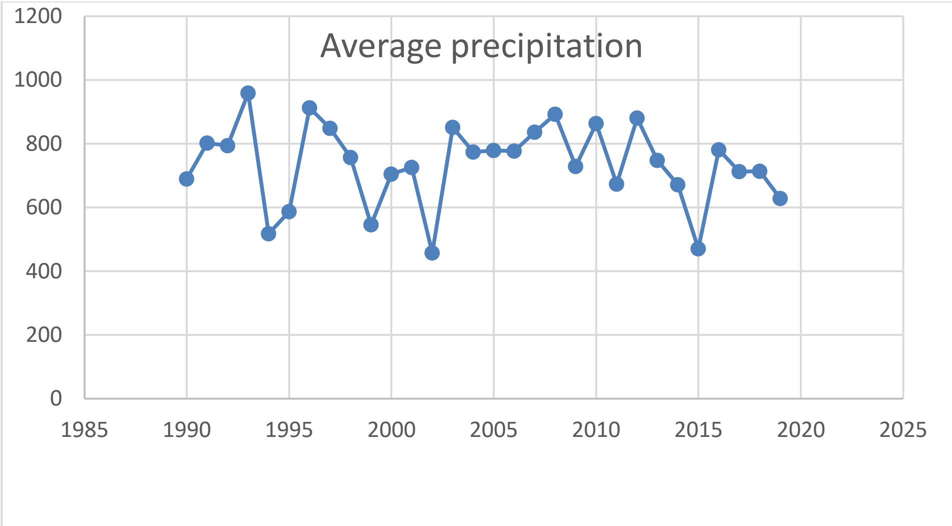


Fig 3: Productivity of maize within the last 12 years in line with RF and Temperature
Source: Secondary data taken from East Shewa zone agricultural office

Productivity/yields of Maize

There was variability in technical inputs and output among maize producing farmers (Table 6). This is economic process of producing output from these inputs or uses resources to create output that are suitable for users. The productivity of Maize per hectare was 54.159, 31.619 and 24.033 quintal before ten, five and current, respectively suggesting productivity of maize was decreasing. To complement the survey result indicated under below table taken from smallholder farmers, secondary data taken from East Shewa zone of agricultural office indicate that productivity of maize within the last 12 years was decreased confirming the reason of production trends decline (Fig: 2 and 3). In addition to the above information gained from secondary data of zonal agricultural office, the zonal metrological office data indicate that within the last ten years rainfall was declining whereas the temperature was increasing that cause the zonal maize yield decline (Fig 3).

Table 6: Productivity/yields of Maize from sample respondents and metrological office collected

Maize yields/ha across year	**Mean/quintal**	**Std. Dev.**
Current maize yield	24.03	20.06
Maize yield before 10 years	54.16	22.29
Maize yield before 5 years	31.62	20.62

Source: Survey result, 2020

Table 7: Productivity/yields of Maize from secondary data collected

YEAR	**ATJK**	**DUGDA**	**LIBAN**	**EAST SHEWA ZONE**
2010/11	21	43	40	38
2011/12	33.87	60.52	54	42.61
2012/13	35.877	60.12	50	44.27

Source: Secondary data taken from East Shewa zone agricultural office

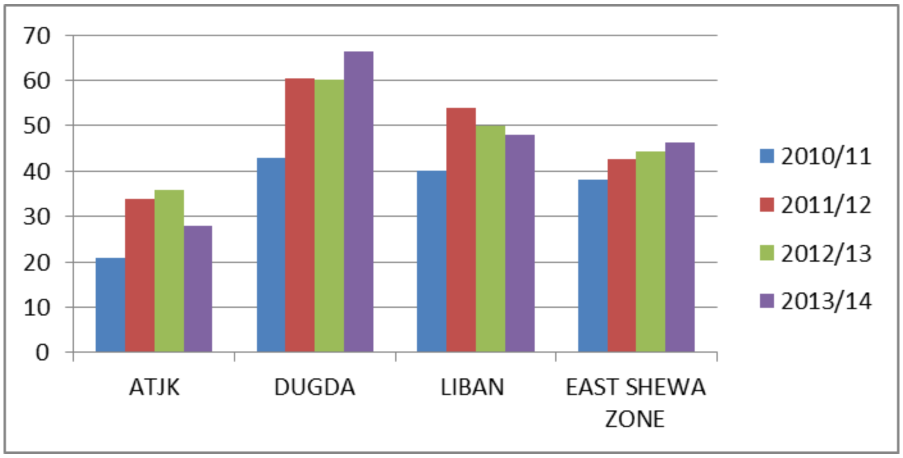


Fig 4: Productivity of maize across three selected districts
Source: Secondary data taken from East Shewa zone agricultural office

Perception of farmers towards Climate Change

As the study result revealed that, 95.78% of farmers perceive climate change availability within the last ten years of crop production from which rainfall accounts about 92%. In the meantime 98.80 % of farmers perceive climate change have impact on maize production and productivity from which about 99 and 93% perceive it have negative impact on maize yields and cost of production, respectively (Table 8). About 72% of smallholder farmer though decline of maize yields was due to rainfall decline and temperature increased. To support the above information gained from survey result of smallholder farmers secondary data of zonal metrological office data indicate that within the last ten years rainfall was declining whereas the temperature was increasing that cause the zonal maize yield decline (Fig 3).

Table 8: Perception of farmers towards climate change

Is there any climate change within the last 10 years of crop production	Freq.	Percent	If yes/climate change, which one?	Percent	Reason of maize yield change %
Yes	159	95.78	Rainfall	92.45	21.29
No	7	4.22	Temperature	7.55	6.45
Total	**166**	**100**		**100**	**Both** 72.26

Source: Survey result, 2020

Do you perceive climate change have impact on maize production and productivity?	If yes, does it have negative impact on maize yields?	Do you perceive climate change have impact on cost of maize production?
Yes 98.80	99.39	93.37
No 1.20	0.61	6.63
Total **100**	**100**	**100**

Source: Survey result, 2020

According to the survey result shown in Table 9 climate change have negative impact for all attributes of reduce maize yield, consumes a lot of labour force, demands intensive management practice, requires high overhead cost per farmer and ecological adaptability were 1.9, 1.9, 1.95, 1.92, and 1.92 respectively suggesting the mean below the average indicating negative impact of climate change.

Negative attitude towards impact of climate change is one of the factors that can speed up the change process. Positive attitude formation is also a prerequisite for behavioral change to occur. Therefore, it was hypothesized that favorable attitude towards impact of climate change negatively influences the likelihood of farmers to produce maize. This was measured using a summated rating (Likert) scale.

In this study, weighted average of individual positive (advantages) was calculated. As the results of research analysis indicate that, the cumulative sum of farmer's perception towards the impact of climate change was 1.9 which is below the mean suggesting farmers perceive climate change have negative impact.

Table 9: Distribution of respondents per perception category (%)

Farmers perception on impact of climate change	Distribution of respondents per perception category (%) (N=166)				Average score
	Strongly Agree	**Agree**	**Undecided**	**Disagree**	Mean SD
Reduce maize yield	15.06	81.93	0.60	2.41	1.9 0.5
Consumes a lot of labour	15.24	80.49	1.83	2.44	1.9 0.5
Demands intensive management practice	10.43	85.28	2.45	1.84	1.95 0.4
Requires high overhead cost per farmer	11.66	85.89	1.23	1.23	1.92 0.4
Ecological adaptability	11.04	87.12	1.23	0.61	1.9 0.38

Source: Survey result, 2020

Impact of Climate Change on Maize Yields

Model testing for appropriateness

Hypotheses stated in the model specification part and validity of the model which is used for analysis has to be tested before estimating the parameters of the model.

The appropriateness of the stochastic frontier model over the convectional production function can be tested using the statistical significance of the Stochastic Production Frontier Ordinary Least Square parameter gamma, Ý. The estimated value of gamma is equal to 99.86 for production of maize which is statistically significant at 1% level of significance. The estimated value of gamma signifies that 99.86 % of the variation in output is due to the variability of climate and technical efficiency. This indicates that climate have impact on maize production and productivity. Hence, the production function estimation using SPF analysis is more appropriate than convectional production function.

The other hypothesis testing is the test for returns to scale. The results of the estimation made under model specifications, constant and variable return to scale, show that the value of log-likelihood functions equal to -85.60 for maize production. Thus, the log likelihood ratio test is calculated to be 5.28 and when this value is compared to the critical value of $\chi 2$ at 4 degrees of freedom with 1% level of significance equals to 12.483(given by kodde and palm, 1986). Therefore the null hypothesis of climate change have no impact on maize yields was rejected. The sum of the partial elasticity of all inputs equals to 1.17. This means an increase in all inputs at the sample mean by one percent will increase maize by 1.17% in the study area. This reveals that the production function is characterized by increasing returns to scale for maize production. This shows that the elasticity of mean value of output is estimated to be an increasing function of inputs for maize production. The gamma (γ) of the MLEs of stochastic frontier production is 0.9986. This value is statistically significant implying that 99.86% of variability output from maize production is attributed to the technical efficiency of maize production technic where as 0.14% due to random shocks in production which could be climate change. As the study result suggest that, as rainfall increased by 1mm maize productivity increased by 3% whereas as temperature increased by 1^{o}c maize production/productivity declined by 1% suggesting climate change have impact on maize production and productivity.

The results of the estimated parameters revealed that all the coefficients of the physical variables confirm to a priori expectation of a positive signs whereas from coefficients of the random shocks variables rainfall have positive sign but temperature have negative sign. The positive coefficient of land, labor, seed, Fertilizer, rainfall and agro chemical implies that as each of these variables is increased, ceteris paribus, maize output increased however negative coefficient of temperature increment reduce maize output. The coefficients of the variables; land, seed, fertilizer, rainfall and temperature are significant even at 1% level of significance. Therefore these are factors explaining maize production in study the area.

The estimated value of gamma signifies that 99.76% of the variation in output is due to the variation in allocative inefficiency among the farmers and remaining 0.24% of output variation is due to due to variation output. Hence, the production function estimation using SPF analysis is more appropriate than convectional production function (Table, 10).

Table 10: Estimated Maize stochastic production and cost frontier function

Variables	**Production frontier**		**Variables**	**Cost frontier**	
	ML estimate			ML estimate	
	Coefficient	Std.Err		Coefficient	Std.Err
Intercept	1.836 ***	0.6093	**Intercept**	2.380***	0.2883
LnLand	0.601 ***	0.1158	***LnLandcost***	0.290***	0.0268
LnLabor	0.104	0.0723	***LnLaborcost***	0.163***	0.0257
LnSeed	0.196 ***	0.0663	***LnSeedcost***	0.248 ***	0.0232
LnFertilizer	0.230 ***	0.0652	***LnFertilizercost***	0.163***	0.0249
LnChemical	0.037	0.0866	***LnChemicalcost***	0.063***	0.0217
	$\sum\beta$= 1.167				
$\sigma^2=\sigma^2_u+\sigma^2_v$	124.612			12.014	
$\lambda=\sigma_u/\sigma_v$	27.062	22.708		20.420***	8.239
γ (gamma)	0.9986 ***			0.9976	
Log likelihood	-85.6014			25.5278	
LR test	5.29			9.35	

***, Significant at 1% significance level,

Source: Own computation, 2020

Returns to scale Maize production

The return to scale (RTS) analysis, which serves as a measure of total resource productivity, is given Table 11. The maximum likelihood estimates (MLE) of the Cobb-Douglas based stochastic production function parameter of 1.167 is obtained from the summation of the coefficients of the estimated inputs (Elasticities) including rainfall and temperature from random shocks. It indicates that maize production in study area is stage I of increasing returns to scale where resources and production were believed to be efficient.

Table 11: Elasticities and returns to scale of the parameters of stochastic frontier

	Maize
	Elasticities
LnLand	0.601
LnLabor	0.104
LnSeed	0.196
LnFertilizer	0.230
LnChemical	0.037
Returns to scale	**1.167**

Source: Survey data, 2020

Unit root test Result

P			
(drift, lag(1), demanded, N=30			
Maize	149.90*	Chi-square (30)	24.28

Annual Rf	SD	F	Coefficient of maize yield	Coefficient of variability
735.86	262.8	2.8	0.06	0.24

Percentage change in maize yield due to climate change 0.06 whereas its coefficient of variability 0.24 in east shoa zone. The variable included in the model has been used in their logarithmic form in order to provide convenient interpretation (elasticity) and to reduce heterogeneity of the variables.

The time trend (year) has been used as a proxy for technical change in maize production technology such as development of new variety and farm management practices which general increases maize yield overtime.

The estimated coefficient of trends (technical change in maize production) i.e. 1.167 revealed that, technical change in production has a significant effect on the variance and yield of maize.

Table 12: Estimated coefficient from mean of maize yield regression

	Mean	**se**
Kiremt	-0.0159	0.05171
Belg	0.1050*	0.06181
Trend	0.0017	0.0094
$Trend^2$	0.0005*	0.0003
Intercept	2.1258***	0.5106

Source: Secondary data

- The main growing season rainfall has negative but statistically insignificant effect on average maize yields
- The *belg* precipitation have positive and significant effect on maize average yield
- Technical change or improvement in maize production technology increases mean maize yield at increasing rate

Conclusion and Recommendations

This paper reviews effects of climate change on maize yields, trends of maize production under the prevailing environmental condition, coping mechanisms to adapt climate change and the perception of farmers towards climate change in East Shewa zone. To meet this objectives primary data was collected from 166 sample households by using semi-structured questionnaire The most dominant crop produced in East Shewa zone was Maize.

As the descriptive analysis result indicates that; the average age of the sample households during the survey period, was about 41.042 years having farming experience 17.81 years and 6.5 years of educational level. The average family size of the sample households was 7 persons per household. The own average cultivated land holding size of the sample households was 2.03 hectares, which is greater than national average of 0.95. The average areas covered by maize during the year 2020 cropping season were 1.084. The average livestock holdings measured in terms of tropical livestock unit (TLU) were found to be 7.79. Income from crop, off-farm and non-farm income was 45,464.24; 86,766.83 and 54,625 birr respectively.

55.90% of sample respondents think supply of maize within the last ten years was decreasing suggesting the production of the maize is decline due to different factors from which climate change took lion share, in the meantime its demand highly increasing due to shortage of maize production exist which accounts about 93% of sample respondents thinking. The majority of cropping system of East Shewa zone is sole cropping which accounts 98.18% suggesting the other reason of maize yield decline. About 57 and 59% of sample respondents think trends of maize production within the last ten and five years were decreasing respectively, suggesting the production of the maize is decline due to different factors from which climate change took lion share.

The productivity of Maize per hectare was 54.159, 31.619 and 24.033 before ten, five and current, respectively suggesting productivity of maize was decreasing. The gamma (γ) of the MLEs of stochastic frontier production is 0.9986. This value is statistically significant implying that 99.86% of variability output from maize production is attributed to the technical efficiency of maize production technic where as 0.14% due to random shocks in production which could be climate change. The maximum likelihood estimates (MLE) of the Cobb-Douglas based stochastic production function parameter of 1.167 is obtained from the summation of the coefficients of the estimated inputs (Elasticities) including rainfall and temperature from random shocks. It indicates that maize production in study area is stage I of increasing returns to scale where resources and production were believed to be efficient. This means an increase in all inputs at the sample mean by one percent will increase maize by 1.167 % in the study area. However, variable from random shocks i.e. rainfall and temperature; as rainfall increased by 1mm maize productivity increased by 3% whereas as temperature increased by 1^{o}c maize production/productivity declined by 1% suggesting climate change have impact on maize production and productivity.

As the study result revealed that, 95.78% of farmers perceive climate change availability within the last ten years of crop production from which rainfall accounts about 92%. In the meantime 98.80 % of farmers perceive climate change have impact on maize production and productivity from which about 99 and 93% perceive it have negative impact on maize yields and cost of production, respectively. About 72% of smallholder farmer though decline of maize yields was due to rainfall decline and temperature increased.

As the results of research analysis indicate that, the cumulative sum of farmer's perception towards the impact of climate change were 1.9 which is below the mean suggesting farmers perceive climate change have negative impact. Adaptation to climate change requires cross-disciplinary solutions that include the development of appropriate germplasm and mechanism to facilitate to farmers access to germplasm. Seed production and deployment, effective policies and management strategies at the country, regional and international levels will all be required to ensure that the technologies reach the community.

Different types and varieties with increased resilience abiotic and biotic stresses will play an important role in adaptation to climate change. While this challenge is immense, the advancement in molecular and phenol typing tools combined with the vast accumulated knowledge on mechanisms responsible for yield loss will provide a solid foundation to achieve increases in productivity within maize systems.

The main growing season rainfall has negative but statistically insignificant effect on average maize yields. The *belg* precipitation have positive and significant effect on maize average yield. Technical change or improvement in maize production technology increases mean maize yield at increasing rate.

Adaptation to climate change requires cross-disciplinary solutions that include the development of appropriate germplasm and mechanism to facilitate to farmers access to germplasm. Seed production and deployment, effective policies and management strategies at the country, regional and international levels will all be required to ensure that the technologies reach the intended beneficiaries and make the desired impacts. Smallholder and subsistence farmers will suffer more of the impacts of climate change resulting from small farm sizes, Technologies for the development of improved germplasm, however the first step in the process of reducing the impact of climate changes on Maize growth and production.

The adaptation strategies to climate change in the zones were;

- ✓ A primary measure is the development and cultivation of more drought-tolerant maize varieties
- ✓ A second measure is adjustment in the planting days of maize
- ✓ The use of irrigation facilities in the cultivation of maize
- ✓ Farmers must engage in crop diversification
- ✓ Improved agronomic management and Crops

Reference

Aklilu, A. and Alebachew, A. 2009. Assessment of climate change-induced hazards, impacts and responses in the Southern lowlands of Ethiopia. Forum for Social Studies, Addis Ababa, Ethiopia.

Alebachew, A. 2011. Climate change and rural livelihoods in Northern Ethiopia. Impacts, local adaptation strategies and implications for institutional interventions. FSS Monograph No.7. Forum for Social Studies, Addis Ababa, Ethiopia

Abd-Elmabod, S.K. 2014. Evaluation of soil degradation and land capability in Mediterranean areas, under climate and management change scenarios (Andalusia region, Spain, and El-Fayoum governorate, Egypt). PhD Thesis. University of Seville. Seville.

Abu, M. 2011. Migration as an adaptation strategy to climate change: Evidence from Buoku and Bofie-Banda in the Wenchi and Tain Districts of Ghana. Paper 110974. In: Sixth African Population Conference: Past, Present and Future. Ouagadougou, Burkina Faso. 5-9 December 2011. UAPS. Ouagadougou.

Adejuwon, J.O. 2006. Food crop production in Nigeria II: potential effects of climate change. Climate Research, 32: 229-245.

Adjei-Nsiah, S., Kermah, M. 2012. Climate change and shift in cropping system: From cocoa to maize based cropping system in Wenchi Area of Ghana. British Journal of Environment & Climate Change, 2(2): 137-152.

Agbeve. M.S., Titiati, A., Quaye. W. 2011. Emerging technologies for climate change adaptation: A case study in Dangbe East District of Ghana. African Technology Policy Studies Network. Research paper No.9. Nairobi Altieri, A. M., Koohafkan, P. 2008. Enduring farms: climate change, smallholders and traditional farming communities. Environment & Development Series 6. Third World Network. Penang.

Amaral, T.A., Andrade, C. L. T., Alves, M.E.B., Silva, D.F. 2011. Applying csm-ceres-maize to define a sowing window for irrigated maize crop - The riacho's farm case study.

Ambi-Agua, Taubaté, 6: 38-53. Amikuzuno, J. 2013. Climate change implications for smallholder agriculture and adaptation in the White Volta Basin of the Upper East region of Ghana.. In: Impacts World 2013 Conference Proceedings. Postdam. Postdam Institute for Climate Impact Research. Postdam. Pp.: 198205.

Armah, A.F., Odoi, O.J., Yengoh, G.T., Obiri, S., Yawson, D.O., Afrifa, E.K.A. 2011. Food security and climate change in drought-sensitive savanna zones of Ghana. Mitigation and Adaptation Strategies for Global Change, 16: 291306.

Araus, J. L., Slafer, G. A., Royo, C., and Serret, M. D. (2008). Breeding for yield potential and stress Paper ID: SR21821032258 DOI: 10.21275/SR21821032258 5 International Journal of Science and Research (IJSR) ISSN: 2319-7064 SJIF (2020): 7.803 Volume 10 Issue 9, September 2021 www.ijsr.net Licensed Under Creative Commons Attribution CC BY adaptation in cereals. Crit. Review Plant Sci.27, 377 - 412.

Armstrong W, Drew MC (2002) Root growth and metabolism under oxygen deficiency. In Plant roots: the hidden half (3 rdEdn), A Eshel and U Kafkafi (Eds.), Marcel Dekker, New York, USA, pp.729 - 761.

Bale JS, Masters GJ, Hodkinson ID, Awmack C, Bezemer TM, et al. (2002) Herbivory in global climate change research: direct effects of rising temperatures on insect herbivores. Global Change Biol 8: 1-16

Bänziger, M., Setimela, P. S., Hodson, D., and Vivek, B. (2006). Breeding for improved abiotic stress tolerance in Africa in maize adapted to southern Africa. Agric. Water Manag.80, 212 - -214.

Battisti DS, Naylor RL (2009) Historical warnings of future food insecurity with unprecedented seasonal heat. Science 323: 240 - 244.

Bronick, C. J., and Lal, R. (2005). Soil structure and management: a review. Geoderma 124, 3 - 22.

Burke MB, Lobell DB, Guarino L (2009) Shifts in African crop climates by 2050, and the implications for crop improvements and genetic resources conservation. Global Environ Change 19 (3): 317-325

Birhan Getachew, 2017."Impacts of Climate Change on Crop Yields in South Gonder Zone, Ethiopia." *World Journal of Agricultural Research*, vol. 5, no. 2, 102-110. doi: 10.12691/wjar-5-2-6.

Bekele Megersa, 2013. Climate change, cattle herd vulnerability and food insecurity: Adaptation through livestock diversification in the Borana pastoral system of Ethiopia.PhD Dissertation, Faculty of Agricultural Sciences at the University of Hohenheim, Germany.

Badu-Apraku, B., Hunter, R. B., Tollenaar, M. 1982. Temperature effects on maize grain filling. Canadian Journal of Plant Science, 63: 357-363.

Boon, E., Ahenkan, A. 2011. Assessing climate change impacts on ecosystem services and livelihoods in Ghana: case study of communities around Sui Forest Reserve. Journal of Ecosystem & Ecography, S3:001.

Boote, K.J., Sinclair, T.R. 2006. Crop Physiology: significant discoveries and our changing perspective on research. Crop Science Society of America, 46: 2270-2277. Braimoh, A.K., Vlek, P.L.G. 2006. Soil quality and other factors influencing maize yield in northern Ghana. Soil Use and Management, 22: 165-171

Brown, O., Crawford, A. 2008. Assessing the security implications of climate change for West Africa. Country case studies of Ghana and Burkina Faso. A report by International Institute for Sustainable Development. Manitoba. Pp.: 1-66 Dazé, A. 2007. Climate change and poverty in Ghana, CARE International. Accra.

Deressa, (2006). Measuring the Economic Impact of Climate Change on Ethiopian Agriculture: icardian Approach. CEEPA Discussion Paper No. 21. CEEPA, University Of Pretoria. South Africa.

EPA. 2000. First National Communication to UNFCCC. Environmental Protection Agency, Ghana. Accra.

Cardwell KF, Desjardins A, Henry SH, Munkvold G, Robens J (2001) Mycotoxins: the cost of achieving food security and food quality.

CDC (Centers for Disease Control and Prevention) (2004) Outbreak of aflatoxin poisoning eastern and central provinces, Kenya, January - July, 2004. MMWR Morb Mortal Wkly Rep 53 (34): 790 - 792.

Dowd PF (1992) Insect interactions with mycotoxin-producing fungi and their hosts. In insect interactions with mycotoxin - producing fungi and their hosts (D Bhatnagar, EB Lillehoj and DK Arora, Eds.), Marcel Dekker, New York, USA, pp.137 - 155.

Dowswell CR, Paliwal RL, Cantrell RP (1996) Maize in the third world. Westview Press Inc. Boulder, Colorado, USA Ed.) Academic Press, London, UK, p.9 - 45.

Duveiller E, Singh R, Nicol J (2007) The challenges of maintaining wheat productivity: pests, diseases, and potential epidemics. Euphytica 157 (3): 417 - 430.

Duvick, D. N. (1997). What is yield in Developing Drought and Low N - -Tolerant Maize. Proceedings of a Symposium, March 25 - 29, Mickelson, and C. B. Peña - -Valdivia, Eds.) p.332 - 335. Mexico D. F., CIMMYT.

Duvick, D. N., and Cassman, K. G. (1999). Post - -green revolution trends in yield potential of temperate maize in the North - -Central United States. Crop Sci.39, 1622 - -1630.

Easterling, W. Aggarwal, P. Batima, P. Brander, K. Erda, L. Howden, M. Kirilenko, A. Morton, J. Soussana, J. F. Schmidhuber, J. and Tubiello, F. (2007). Food Fibre and Forest Products. In Climate Change 2007: Impacts, Adaptation and Vulnerability� (M. L. Oarry, O. F. Canziani, J. P. Palutikof, P. J., van der Lindin, and C. E. Hanson, Eds.). pp 273 - 313, Cambridge University Press, Cambridge, UK.

Edmeades GO, Bolaños J, Hernandez M, Bello S (1993) Causes for silk delay in lowland tropical maize population. Crop Sci 33: 889-913.

EngelenEigles G, Jones RJ, Phillips RL (2000) DNA endo - reduplication in maize endosperm cells: the effect of exposure to short - term high temperature. Plant Cell Environ 23: 657 - 663.

FAO.2013. FAO Water: Crop Water Information: Maize. Available at: http: //www.fao. org/nr/water/cropinfo_maize. html.

FAO.2019. FAOSTAT: Maize. Available at: http: //www.faostat. org

IPCC, 2001. Climate change Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press.

IPCC, 2007. New Assessment Methods and the Characterisation of Future Conditions: In Climate change 2007: Impacts, adaptation and vulnerability, pp: 976. Contribution of working group II to the fourth assessment report of the Intergovernmental panel on climate change. Cambridge university press, Cambridge, UK.

IPCC, Fourth Assessment Report: Synthesis, published online 17 November 2007.

Jones, H. G., Serraj, R., Loveys, B. R., Xiong, L., Wheaton, A., and Price, A. H. (2009). Thermal infrared imaging of crop canopies for remote diagnosis and quantification of plant responses to water stress in the field. Funct. Plant Biol.36, 978 - 989.

Katz, R. W. and B. G. Brown, 1992. Extreme events in a changing climate: variability is more important than averages. Climatic Change, 21: 289 - 302.

Kimbal, B. A., Idso, S. B., 1983. Increasing atmospheric CO_2: . Effects on crop yield, water use and climate. Agricultural Water Management, 7: 55 - 72

Krishnamachari KA, Nagarajan V, Ramesh VB, Tilak TBG (1975) Hepatitis due to aflatoxicosis: an outbreak in Western India. Lancet 305: 1061 - 1063.

Legrève A, Duveiller E (2010) Prevailing potential disease and pest epidemics under a changing climate. In climate change and crop production, CABI press, Europe, pp.263 - 283.

Le Bissonnais, Y. (1996). Aggregate stability and assessment of soil crustability and erodibility.1. Theory and methodology. Eur. J. Soil Sci.47, 425 - -437.

Lewis L, Onsong M, Njapau H, Schurz-Rogers H, Luber G, et al. (2005) And the Kenyan Aflatoxicosis Investigation Group. Aflatoxin contamination of commercial maize products during an outbreak of acute aflatoxicosis in Eastern and Central Kenya. Environ. Health Prospect 113 (12): 1763 - 1767.

Lobell DB, Burke MB, Tebaldi C, Mastrandrea MD, Falcon WP, et al. (2008) Prioritizing climate change adaptation needs for food security in 2030. Science 319 (5863): 607 - 610.

Lobell DB, Burke MB (2010) on the use of statistical models to predict crop yield responses to climate change. Agric. Forest Metero 150: 1443 - 1452.

Lobell DB, Bänziger M, Magorokosho C, Vivek B (2011) Nonlinear heat effects on African maize as evidenced by historical yield trials. Nature Climate Change 1: 42-45. Paper ID: SR21821032258 DOI: 10.21275/SR21821032258 6 International Journal of Science and Research (IJSR) ISSN: 2319-7064 SJIF (2020): 7.803 Volume 10 Issue 9, September 2021 www.ijsr.net Licensed Under Creative Commons Attribution CC BY

Farming System Report, 2018. Identification and Characterization of Farming System in West Arsi and East Shewa Zones, Oromia National Regional State, Ethiopia.

FAO, (2008). Climate Change and Food Security: A Framework Document. Food and Agricultural Organization of United Nation, Rome.

FAO. 2017. *The future of food and agriculture – Trends and challenges.* Rome, Italy. Available on the FAO website (www.fao.org/publications).

Fosu-Mensah, Y.B. 2012. Modelling maize (Zea mays L.) productivity and impact of climate change on yield and nutrient utilization in sub-humid Ghana. In: Vlek, P.L.G., Denich, M., Martius, C., Manschadi, A., Bogardi, J. (Eds), Ecology and Development Series No. 87. Cuvillier Verlag. Gottingen. Pp.: 1-171 Fosu-Mensah, B.Y., Vlek,P.L.G., MacCarthy, D.S. 2012. Farmers' perception and adaptation to climate change: a case study of Sekyedumase district in Ghana. Environment, Development and Sustainability, 14: 495 505. GAIN. 2011. Ghana 2011 Grain and Feed Annual Report. Global Agricultural Information Network. Accra.

Getachew Olana, Nuri Kedir, Raya Abagodu, Basab Dasgupta, Worku Ambelu, F. O. Okello, and M. Magut, 2018. Crop Availability and Market Analysis in Ethiopia: Analyzing Crop Production, Availability and Market Functions for 2016/2017 and Estimations for 2017/2018. Ethiopia Performance Monitoring and Evaluation Service (EPMES) for USAID/Ethiopia.

IFAD, 2016. Federal Democratic Republic of Ethiopia Country strategic opportunities programme

Knox, J., Hess, T., Daccache, A., Wheeler, T. 2012. Climate change impacts on crop productivity in Africa and South Asia. Environmental Research Letters, 7: 1-9.

Kates, R.W., 2000. Cautionary tales: adaptation and the global poor. Climate Change 45: 5 -17.

Kassa Teka, A. Van Rompaey, J. Poesen, Yemane Welday and J. Deckers, 2012. Impact of Climate Change on Small-Holder Farming: A Case of Eastern Tigray, Northern Ethiopia. *African Crop Science Journal*, Vol. 20, pp. 337 – 347.

Lobell, B.D., Banzinger, M., Magorokosho, C., Vivek, B. 2011. Nonlinear heat effects on African maize as evidenced by historical yield trials. Nature Climate Change, 1: 42-45.

Luhunga PM (2017). Assessment of the Impacts of Climate Change on Maize Production in the Southern and Western Highlands Sub-agro Ecological Zones of Tanzania. *Front. Environ. Sci.* 5:51.

Mendelsohn, R. 2000. Efficient Adaptation to Climate Change. Climatic Change 45: 583-600

MacCarthy, D.S., Vlek, P.L.G. 2012. Impact of climate change on sorghum production under different nutrient and crop residue management in semi-arid region of Ghana: a modelling perspective. African Crop Science Journal, 20: 243-259.

Masters, G., Baker, P., Flood, J. 2009. Climate change and Agricultural commodities. CAB International. Wallingford.

MEST. 2010. Ghana Goes for Green Growth. Ghanese Ministry of Environment, Science and Technology (MEST). Accra.

MiDA. 2010. Investment opportunity Ghana. Maize, Soya and Rice Production and Processing. Millenium Development Authority. Accra.

MOFA. 2009. Agriculture in Ghana: Facts and Figures 2009. Ghanese Ministry of Food and Agriculture. Accra.

Morris, M.L., Tripp, R., Dankti, A.A. 1999. Adoption and impacts of improved maize production technology: A case study of the Ghana Grains Development Project. Enconomics Program Paper 99-01. CIMMYT. Mexico DF. Osbornea, T., Rose, G., Wheeler, T. 2012. Variation in the global-scale impacts of climate change on crop productivity dueto climate model uncertainty and adaptation. Agricultural and Forest Meteorology, 30: 112.

NMA (2007). Climate Change National Adaptation program of Action (NAPA) of Ethiopia. Addis Ababa: NMA, Oxfam International.

NPC (National Plan Commission). 2016. Growth and Transformation Plan II (GTP II), National Plan Commission Volume I: Main text Addis Ababa.

Owusu-Sekyere, J.D., Alhassan,M., Nyarko, B.K. 2011a. Assessment of climate shift and crop yields in the Cape Coast area in the Central Region of Ghana. ARPN Journal of Agricultural and Biological Science, 6: 1-6.

Owusu-Sekere, J.D., Andoh, J., Nyarko, K. 2011b. Climate change and crop production in the Mfantseman area of Ghana. Journal of Applied Environmental and Biological Sciences, 1 (7): 134-141.

Ringler, C., Zhu, T., Cai, X., Koo, J., Wang, D. 2010. Climate change impacts of food security in Sub-Saharan Africa. International Food Policy Research Institute (IFPRI) Discussion Paper 01042.

Schlenker, W., Lobell, D. B. 2010. Robust negative impacts of climate change. Environmental Research Letters, 5: 1-9.

Tachie-Obeng, E., Akponikpe, P.B.I., Adiku, S. 2013.Considering effective adaptation options to impacts of climate change for maize production in Ghana. Environmental Development, 5: 131-145.

Tachie-Obeng, E., Gyasi, E., Adiku, S., Abekoe, M., Ziervogel G. 2010. Farmers' adaptation measures in scenarios of climate change for maize production in semi-arid zones of Ghana. ICID+18. 2nd International Conference: Climate, Sustainability and Development in Semi-arid Regions. August 16-20, 2010. Brazil. Fortaleza-Ceara. Pp.: 1-20

WABS Consulting. 2008. Draft Report: Maize value chain study in Ghana: Enhancing efficiency and competiveness. WABS Consulting Ltd. Accra.

Xevi E., Gilley, J., Feyen, J. 1996. Comparative study of two crop yield simulation models. Agricultural Water Management, 30: 1-19.

Pearce, D., Cline, W., Achanta, A., Fankhauser, S., Pachauri, R. and Vellinga, P. 1996. The social costs of climate change: Greenhouse damage and benefits of control. pp.179 – 224.

Philip A, Augistine Y, Abindaw B (2014). Impact of Climate Variability on Small Holder Households and Indigenous Coping Strategies in Bonga District. *Int J Develop Res* 4(3):693-699.

Rehima, M., Belay Kassa, Dawit Alemu.and Rashid S. 2013. Factors affecting farmers‟ crops diversification: evidence from SNNPR, Ethiopia. International Journal of Agricultural Sciences, 3(6): 558-565.

Temesgen Deressa (2008). Analysis of perception and adaptation to climate change in Nile basin of Ethiopia, by Post graduate Student University of Pretoria. CEEPA (Centre for Environmental Economics and Policy for Africa).

Tompkins, E.L. and Adger, W.N. 2003. Building resilience to climate change through adaptive management of natural resources. Working Paper 27. Tyndall Center for Climate Change Research, UK. 19pp.

Winkler, H. 2005. Climate change and developing countries. S Afr J Sci 101: 355 - 364.

Woldeamlak B, Conway D (2009). A note on temporal and spatial variability of rainfall in drought prone Amhara regions of Ethiopia. Int. J. Climatolo., 27: 1467-147.

Yamane, T. 1967. Statistics: An Introductory Analysis. 2nd Edition, Harper and Row, New York. p. 919.

Yesuf, M., S. Di Falco, T. Deressa, C. Ringler, and G. Kohlin, (2013). The Impact of Climate Change and Adaptation on Food Production in Low-Income Countries: Evidence from the Nile Basin, Ethiopia, IFPRI Discussion Paper No. 828 (Washington DC: International Food Policy Research Institute).

ZoARD. 2016. Report on major agricultural activities. East Shewa Zone, Zonal Office of Agriculture and Rural Development (ZoARD), un published report.

Assessments of Rural-urban Youth Movement and its Effect on Agricultural Production in Western Oromia, Ethiopia

Gemechisa Yadeta, Oromia Agricultural Research Institute, Bako Agricultural Engineering Research Centers (gemechisaya@gmail.com)

Abstract

In developing countries like Ethiopia rural-urban migration affect developments in both urban and rural areas. Therefore, the aim of the study was to identify the major causes for rural-urban movement of youth and to assess the effects of rural-urban youth's movement on the agricultural production. To achieve the objectives 185 farmers' household heads (with migrant and with non-migrant family) and 121 in-migrant youth in the town were selected randomly. Both primary and secondary data were employed, qualitative and quantitative data were utilized. The data was analyzed using descriptive statistics. The study revealed the three major reasons driving decision to migrate were associated with to search job, lack of land and dislike agricultural work have made the sampled youth to dis appointed and move to the town as migration. In addition, from the total household interviewed 143 (77%) encountered labor constraint on agricultural activity per years. The coping strategies for thus labor constraints were decreasing farm land per year for 29% of the respondents which have the direct effect on decrease of agricultural production in the study area. And the movements of youth from the rural to the town adversely affect agriculture. It was recommended that empowering the youth by giving training in how to create the job to start their own enterprises, the family early gift of land to youth may considered as promotion to stay them in rural and capacitate agricultural work, looking intensive and choosing productive agricultural enterprise for land shortage problems and the neglected/ dislike agriculture due to drudgery as cause of migration by youth may stimulated through like mechanization.

Key words; Youth migration, Agricultural production, Households and Rural urban

Introduction

Movement of people from their home to another city, state or country for a job, shelter or some other reasons is called migration. It was a common phenomenon observed in the population all across the world and especially in the developing countries (FAO, 2019). Based on the finding of UNDESA (2015) the number of young movements increased from time to time. For instance, from 23.2 million in 1990, in 2015, the number of international migrants reached 244 million. On the other hand, there were a considerably higher number of migrants moved within their countries.

According to Lee's theory there are the push and pull factors as a reasons of migration (Lee, 1966). Push factors are a negative reinforcement to leave the home land at individual level or family level. Like low productivity, land scarcity, joblessness, farming being unprofitable, poor safety and health conditions were push factors. Agriculture is associated with drudgery; hard work and low social status (FAO, 2017).Youth require substitution of labor with labor-saving modern inputs like mechanization (Bachewe *et. al*., 2015). In contrast, pull factors are the magnetizing of destinations /city /. Like relatively high and consistence wage, employment opportunities, better provision of social and economic services, availability of better infrastructures (Leavy and Smith, 2010).

In contrast determination of migration was the common challenge faced due to affected by unobservable factors (even un identified as pull and push factors) (Mora and Taylor, 2006 and Sabates. *et al.*, 2008). For instance, many youth in developing and transition countries have negative perceptions of farming and young people are usually not interested in this field of work (Michael, 2022). Kinuthia (2003), showed that African migrations especially rural to urban have not for industrialization and economic development similar as migration has done elsewhere especially in Europe and North America.

The effect of migration on agriculture were loss of households labors, negatively affect households' crop income (De Brauw and Rozelle, 2008). Especially in many developing countries delays in crop cultivation practices (Gokul *et. al*., 2019), reduces total cropped area and quality of work (Wuni , 2013) giving rise to reduced crop production.

Agriculture Development Led Industrialization have emphasis and priority to the agriculture sector by the Ethiopian government development policy. The policy aims to increase the agricultural productivity of small-scale farmers and transform them into market-oriented producers (Zemen, 2014). Despite these efforts in Ethiopia youth unemployment remains widespread in the world (Denu *et. al*., 2005). And still the youth unemployment was estimated at nearly 27 percent (USAID, 2017). 80% of households were doing their agricultural activities only with its spouse and under aged children (Gemechisa, 2018)

… I was feeling strong and initiated me to write this proposal of this paper, we asked one older farmer planting Eucalyptus tree on his a good farm land, why you plant this tree on this land? and "he replied we educated all of our children and they were not returning back to us and this may help me as my remittance when I will be too old" (field data for another work, 2019). Even though, the rural families endowed with resources, only children and aged who are not actively engaged in agriculture, call for labor shortage on agricultural production.

Empirical evidence showed that the growth of crops was researched in relation to solar radiation, temperature, day length, nutrient availability and crop characteristics and like . However, human factors contribution for the economic development including agriculture have not been considered so far (Zarko and Jovan , 2014). In addition, due to the fact that, there is no any existing literature identifying the major cause of youth migration from rural to urban in the study area. So, this paper was initiated with objective to identify the major causes for rural-urban movement of youth and to assess the effects of rural-urban youth's movement on the agricultural production

Research Methodology

Description of study area

East Wollega Zone is one of the zones of Oromia National Regional State. The East Wollega Zone comprises 17 districts with 291 rural peasant associations and capital town was Nekemte. The town is located at 331 km west of Finfinne. The total land area of the zone is about 14,102.50 km^2. The zone has 13% highland 57% midland and 30% lowland with hilly, undulating and rolling topographical features. Its altitude ranges between 1000 and 2798 meter above sea level with the mean annual rainfall ranging between 1400 mm and 2200 mm. The main rainy season runs from the months of May to September. The soil types are clay and red sandy clay. Teff, barley, wheat, faba bean, maize, sorghum, finger millet, potato, hot-pepper and noug are some of the crops grown in the area (Kifle *et. al., 2019*).

West Shewa Zone is one of the zones of the Oromia Region in Ethiopia. It has 18 woredas. West Shewa Zone is located in the central part of Ethiopia, between 9.1515°N and 37.808° E. West Shewa is bordered on the west by East Welega Zone, the capital of West Shewa was Ambo. The distance between Ambo to Finfine is 120 Km by road. This Zone has a total population of 2,058,676, of whom 1,028,501 are men and 1,030,175 women; with an area of 14,788.78 square kilometers, West Shewa has a population density of 139.21. While 242,352 or 6.10% are urban inhabitants. A total of 428,689 households were counted in this Zone, which results in an average of 4.80 persons to a household (Fufa and Fana 2021).

Data source and method of data collection

The study was based on both primary and secondary data. Primary data were collected from the sample farm households using a semi-structural schedule. Before the actual data collection qualitative data collection such as focus group discussion and key informants interview were conducted using checklist schedule. The group discussions and key informant interviews were conducted with relevant government ministries at Oromia regional state and zonal levels (East Wollaga and West Shoa) of concerned experts, namely; Agriculture and natural resource, Enterprise and industry development, Women, children and youth and Labor and social affairs bureau and like including Ambo university.

To assess the objective of the study the data were collected from youths and households head (two type surveys) (i) The migrated youth in town Ambo and Nekemt (N=121) (ii) households in rural areas in East Wollaga and West Shoa zone having migrant youth and with no migrants (N=185)

The migrated youth survey in town

Secondary data was collected from published and unpublished documents. During secondary data collection from concerning office or through preliminary survey conducted, Nekemt and Ambo town were selected purposively depending on the potential of migrated youth distributed in capital city of Western Oromiya. The data came from a longitudinal study of 121 youths migrated from the rural to search job, interviewed with structured questionnaire through personal contacts where migrants wait for their employers at the morning in the town of Ambo and Nekemt. The sample respondents' selection was conducted through simple random sampling method.

The Rural Household Head Survey

Secondly, after obtaining data from youth and identifying potential districts from each selected zone. Two districts from each zone where the maximum numbers of those youth originate were selected. This survey was conducted to compare the perspectives of migrants' and rural households' on the cause of youth migration and its effect on agricultural production in the study areas. Hence, these four districts (Ambo and Toke kutaye from West Shoa zone; Guto Gida and

Wayu Tuka districts from East Wollaga zone) were selected purposively for rural households head interview.

To select sample respondents a three-stage sampling technique was employed. In the first stage , Kebele Administrations (KAs) were selected by using purposive sampling by accessibility for data collection. In the second stage the household heads in each kebeles were stratified into household heads with one or more of youth from his/her families move to the town to search job and without categories. Lastly, primary data were gathered from 185 sample respondents (households with migrated youth from his/her families= 99 and without = 86) by systematically random sampling through semi structured interviews.

According to Singh and Masuku (2012) there are different approaches to determine the sample size of the study, from these this study used the strategy for determining sample size by imitating a sample size of similar studies and it derived from almost similar sample size of (Edith O. A., 2016) who studied the consequences of rural-urban migration on the source region in Nigeria on a total sample size of 216 respondents.

Method of Data Analysis

Data analysis involved descriptive and inferential statistics. The data was then presented as frequency distributions and percentages and presented through tables and figures

Results and Discussion

Results of the migrated youth survey in town

Birth place (Original zone) of the sample youths

Table 1, presented a detailed breakdown of origin and destination of youth migrated to search a job. Identification of the origin from where the respondents came from has used for finding of potential districts to assess the second survey rural households. 43.8%, 37%, 10.7% and 8.2% of youths have been coming from East Wollaga, West Shoa, West Wollaga and other (Horo Guduru Wollaga and Kelem Wollaga) zones respectively

Table 1: Original zone of migrated youths

No	Destination town		Youth's origin in terms of zone			Total
		East Wollaga	West Shoa	West Wollaga	Other	
1	Nekemt	50	0	12	6	68
2	Ambo	3	45	1	4	53
	Total	53(43.8%)	45(37%)	13(10.7)	10(8.2%)	121

Source: Field survey, 2021

The Socio Economic Characteristics of Migrated Youth

Distribution of Sample Youth by Age, Sex and Marital Status

As indicated table 2, age of the youth of sample respondents ranged from 18 to 35 years with mean of 23 years and standard deviation of 4.4.
The sex distributions of the respondents in this study, 77 percent were males and the rest 23 percent were females. However according to IOM (2010) the sex distributions of migrants from Ethiopia to the Middle East 68 percent were female, to South Africa the male comprised 82 percent of the total, and the majorities (75 percent) of migrants to Sudan are females. The cause for the less observation of migrated female wait for their employers on the street in the town during the survey (especially in Ambo) may be due to a culture of Ethiopia female taking care of the domestic environment and gender-based abuse (Aschalew, 2021). And those females accept domestic work were living in underpaying jobs and some, yet not all, become commercial sex workers (Ibid). So, it may have no positive effect on agricultural production with backward linkages with their families with this underpaying job.

Table 2. Distribution of sample youth by age, sex and marital status

No	Socio economic characteristics	Percent
1	Age	
1.1	Mean (23) Minimum (18) Maximum (35 years) Std.dev (4.4)	
2	Sex	
2.1	Male	77
2.2	Female	23
3	Marital Status	
3.1	Single	48
3.2	Married	52
4	From married youth (%who has children) N=63	67

Source: Field survey, 2021

According Oppenheimer (2000) marriage makes families better off by risk-sharing protection against unexpected events, sharing of economic and social resources like housing and heating. The marital status of sample respondents of the migrated youth were identified and more than half (52%) of the respondents have been married currently while the others were single. In contrary, couple with children drop in economic well-being by require high expenditures and additional income (Oppenheimer, 2000).Accordingly married category were asked as they have children or not, and 67 percent had one or more children (table 2) and those families will require additional income for life expenditure than without children

Educational and Training Status of Sampled Youth

Education is one of the factors determining rural-urban youth's migration. The educational attainment of the migrant contain illiterate up to end of degree level and the distribution of the respondents by education level showed that majority of the migrants (41.3%) are in elementary level, followed by completed degree level (15.7%), and at the third diploma graduation comprised 11.6% of the sampled respondents (table 3). The result was contradicted with finding LFS (2013) better-educated rural dwellers are more likely to migrate compared to less educate. And less educated people move from urban to rural areas tend to live with relatives. Alternatively, as a policy non-skilled migration has to be discourage to migrate (OECD, 2015).

Table 3: Distribution of sample respondents by their educational and training status (N=121)

No.	Educational levels and training status	Percentage
1	Level of Education	
1.1	Illiterate	7.4
1.2	Elementary	41.3
1.3	High school	5
1.4	Complete 10th grade	10.7
1.5	Complete 12th grade	7.4
1.6	Diploma	11.6
1.7	Degree	15.7
2	Are you studying know	
2.1	Yes	14.2
2.2	No	84.6
3	Do you receive any training for job creation	
3.1	Yes	15
3.2	No	85

Source: Field survey, 2021

Providing youth with services related to their education, health care and general wellbeing must be a policy priority to have effective future of community welfare (Dustmann and Glitz, 2011). As research showed by (Tilak, 2014) education is not only essential elements for economic development and social reform but also to operate the daily activities. According to group discussion held with different sector of government office, they consider most of the youth seeking job at the street by clustering was on education and as they do daily labor by par time to assist their education whereas, as indicated in the table 3 above, from the sampled youth in this study, only 14.2 percent have access to continue their education after they came to the town and other 84.6 percent of respondents were not on studying. The status of training for job creation for youth in the study area reviled that majority (85%) of the youths have not received any training on job creation in their life to build their capacity until the survey was conducted.

The Resource Distribution of Youth and their Families'

The average land holding of the youth families were 2.12 hectares. Whereas the national level land use survey shows that the average household farm size in Ethiopia was 1.22 hectares (CSA 2013). The youths family's land holding of majority (42.6%) of the migrants was having more than 1.22 hectares (table 4)

Table 4: Land and education status of the youth

No	Categories	Frequency	Percent
1	Land holding of youth families(average 2.12 ha)		
1.1	Null	28	23
1.2	Less than 1.22 hectares	42	34.4
1.3	Greater than 1.22 hectares	52	42.6
2	Your family have irrigation (yes)	20	17.4
3	Your family have communication media(television, radio and mobile (yes)	29	25
4	Have you resource around your families (yes)	27	23.1
5	Have you land around your families (yes)	19	16.2

Source: Field survey, 2014

Young people are extremely adept at using technology to communicate with different people in their daily lives. Without any television and radio most young people were largely ignorant of the processes of government (Patrick and David, 2009).They have no access to their parental advices timely due to lack of their parents mobile. According to table 4 above, out of the total sample youths only 25 percent of sampled youths' families have communication media; television and/or radio or mobile and other 75 percent have no any of such communication media.

Another essential resource of the family, having irrigation land was the major resources for income generation opportunities for young people during the off-season and it has fewer propensities of its members to migrate out the family having irrigation land for agriculture. Out of the total respondents interviewed only 17.4 percent his/her families has irrigation land. In addition, the resource (land and farm assets) they have around the families decrease the propensity to migrate (Kok *et. al*., 2006). For instance, only 23.1% have resource (land, livestock and other plantation like coffee) around their families in the study area (table 4).

Educational Attainment of Youth' Family

One of the factor variable used to discuss the socio-economic profile of respondents in this study is educational attainment of youths' mother or father. Father's and mother's education and subjective well-being is positively associated with children's migration decision (Habtamu , 2020).The distribution of respondents' family according to their educational level was presented in Figure 1. In this study the higher proportion (64.4 percent) respondents' mother or father were illiterate while others completed some primary**,** secondary or higher education levels

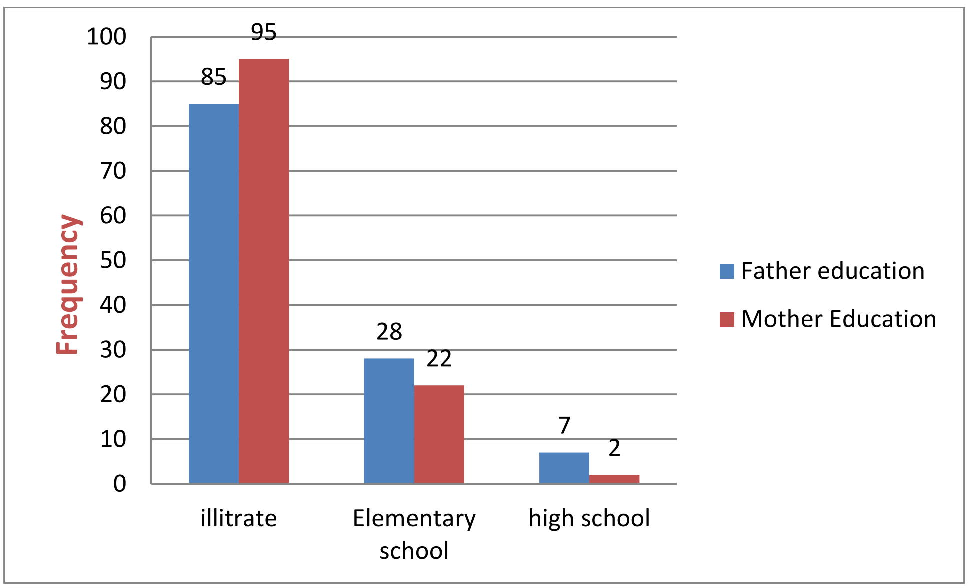


Figure 1: Respondent's family education status

According to Asrat (2013) the Ethiopia' development policy emphasizes to transform agricultural sector by cultivating a new generation of young and capable farmers who can embrace new technologies. Moreover, youth have the creativity, the potential and the capacity to make change happen – for themselves, for their communities, and for the rest of the world

(UNESCO, 2019).The low educational status of youths family require the assistance of their children, whereas the children were moving away from the family to the town may adversely affect agriculture.

Reasons for Migration of Youth

Fruitful group discussions were held on some understanding of a particular issue of youth displacement with different experts work in government office and they raised as an example “as one youth cheated simply by seeing one youth returned and come to his family by dressing a new cloth during festival and he fallows that youth by selling his oxen’’. The rural poor generally consider rural-urban migration as a coping strategy against poverty in developing countries (Tacoli, 2004). Among the seven reasons listed, the three (to search job, land shortage and to obtain education) were the majority of responses ranked first for reasons of migration from the rural to the town. Most importantly, 29.4 percent of the response cases were associated with searching job. Secondly, the other economic factors, lack of land to make a living on farming comprise 27.7 percent of a total sampled youth. 22.7 percent stated that education was mentioned as a reason to incentivize (“push”) some youth towards towns. Disagreement with families have share as a reason to migrate (7.6%). Five percent of the sampled respondents move to the town due to lack of gift of their resource from their family on time (table 5).

Table 5. Frequency of reasons in decision to migrate from rural to urban areas

No	Reasons of migration	Percent of case
1	To search job	29.4
2	Education access	22.7
3	Lack of land to make a living on farming	27.7
4	Lack of gift of resource from family on time	5
5	For un rewarded education	3.4
6	Failed of agricultural productivity always	3.4
7	Other (for business creation ,un agreement with family)	7.6

Source: Field survey, 2014

Respondents’ Perception in Improvement Standard of Life in destination area

Many researcher agree as migration has a positive impact on the rural living standards, due to migration is associated with receiving remittances from the migrant (Yousra and Julie, 2016; Adams, 2011; Beegle *et. al*., (2011). Migration has historically been a source of opportunities for people to improve their lives and those of their families. However, according to the result indicated in the figure 2, using cross-sectional data collected from youth that addresses the question “does migration improve living standards of you”? More than half of the respondents (75%) stated as there is no change in living standard after coming to the town for both category of male and female. Unless some solution required they are not on track of changing themselves.

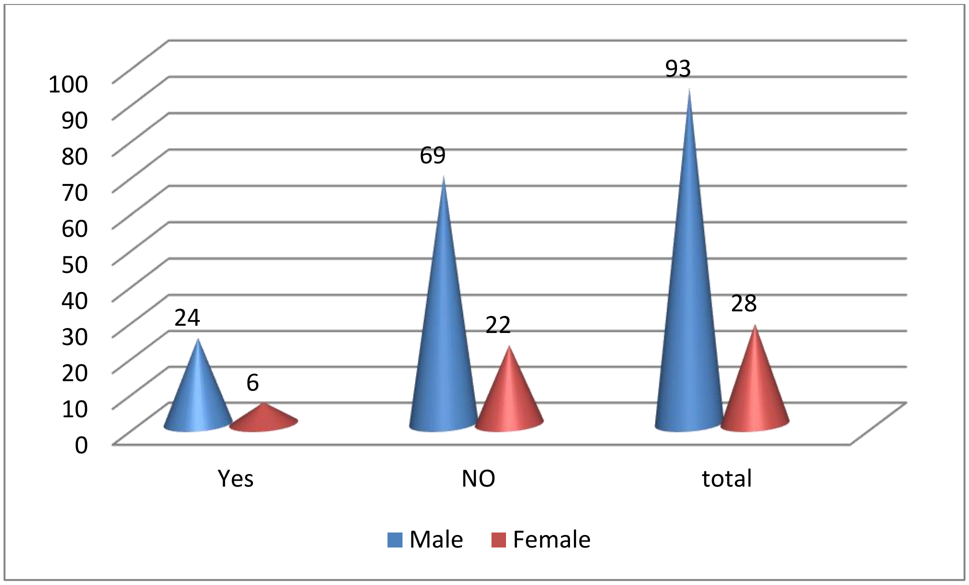


Figure 2 Respondents' perception in improvement standard of life in destination area

Major Problem Faced by Migrants at the Place of Destination

Based on data indicated in the table 5 above the reason why they were moving to the town of the 29.4 % of youth were to search job. However, according to the table 6 below, about 58.3 and 24.3 percent of the sampled youth migrants specified that there was a problem at the place of destination, not having a continues work and not having a regular income respectively. About 8.7 percent of them told that lack of shelter was the major problem encountered the migrant while the other face not feeling safe and intimacy of family were indicated as the problem. As explained by (Gazdar, 2003; Yang, 2004), rural-urban migration whom not having continues work are gonging to having a negative effect on the development of cities in many countries by increasing the crime rate.

Table 6: Major problem faced by migrants at the place of destination

No.	Problems Encountered	Frequency	Percent
1	Not having continues work	60	58.3
2	No regular income	25	24.3
3	Lack of shelter	9	8.7
4	Not feeling safe	3	2.9
5	Intimacy of family	3	2.9
6	Other	2	1.9

Source: Field survey, 2021

The Migrant Future Plan to Return to their Family

The migrant expected to capacitate the agriculture sector either by sending resources from accumulated savings or/and by returning to home by gaining knowledge from the migrated area to creating new employment opportunities (Nielsen and Riddle, 2010).whereas the migrant were asked as they have future plan to return to their place of origin and 80.8 percent of respondents agree to stay in the town where the survey conducted and only 7.1 percent have a plan to return to his/her family. Lack of income may abide the return to home. According to Black and Castaldo (2009) the return of migrants to start a new enterprise around their family more likely when they have accumulated savings

Table 7. the distribution of migrant future plan to return to their family

No	Category of migrant to return to their family	Frequency	Percent
1	To stay here	99	80.8
2	To my family	9	7.1
3	To other area	7	6.1
4	I do not know	6	5.1
	Total	121	100

Source: Field survey, 2021

Results of the Rural Household Head Survey

Household categories and its sex distribution

Table 8 showed the distribution of households by the current migrant status of their youth, as well as the classifications that was used throughout the study. In this section the households were classified into two categories; Households without migrated youth, when all his families did not move from house to search job while households migrated youth were at least one or more of his/her youth moved from their families to urban for different reasons until the time of survey conducted. Sample households were composed of both male and female household heads. Following the sample design, as indicated in the table 8, the study established that 81.6% of the respondents were males, while 18.4% were females

Table 8. Distribution of sample household heads by sex

No	By household type	Sex		Total	
		Male	Female	Frequency	%
1	Households with migrants	84	15	99	53.5
2	Households Without migrant	62	19	80	46.5
	Total	151(81.6%)	34(18.4%)	185	100

Source: Field survey, 2021

The Socio-Demographic Characteristics of Households

The socio-demographic characteristics of households include age, educational status; land owned, total livestock and number of families were examined.

As indicated in the table 9 below, the average age of the households with migrants was 50.8 years old while the average age of households without migrants were 42.2. The difference were statistically significant (($\chi 2 = 5.7$, and p value = 0.001). The average education enrolment of the respondents these send one or more of his/her children to either the town/outside of the country were 6 and household without were 6.6 grades but the difference between their education was not statistically significant. With regard to the land size of sample households, the mean farm sizes of sample respondents with migrants was 2.7 hectares and for these of household do not have migrants were 2.3 hectare and statistically significant at 5% level of probability. The average family size of the household with migrant and non-migrants was 7.8 and 6.5 and statistically significant at 1% level of probability. The average land holding of both categories of the respondents were 2.6 hectares which sustains an average household size of 7 people. Even though the land size of the households with migrant was high it may not cover the land shortage problem of their higher family size holdings.

Table 9: Socio-demographic features and resource of the youths' households

No	Variable	Households with migrants		Households Without migrant		Overall mean	t-test
		Mean	Std.er	Mean	Std.er		
1	Age	50.8	1.07	42.2	1.02	46.8	5.7***
2	Education	6.1	.39	6.6	.46	6.3	-0.91
3	Land owned(ha)	2.7	.22	2.3	.16	2.6	1.35**
4	Total family	7.8	.29	6.5	.27	7.2	3.25***
5	Total livestock (TLU)	9.1	.72	6.9	.42	8	2.46***

,* represent the significant at 5%,1% level of probability of significance respectively
Source: Field survey, 2021

Encouraging Youth's Involvements in Agricultural Sector by their Families

Globally 27.5 per cent of agricultural holders are aged over 55 years. Increased involvement of youth in agricultural activities will help to reduce the problems of the ageing farm population (Sif *et. al*., 2014). In this study out of the sampled households 66.5% have given different motivation (like land inheritance) as their youth stay in working agriculture whereas the other (33.5%) households encourage as their youth move from them elsewhere as a strategy to diversify income sources (table 10).

Sosna and Holden (2014) showed that the availability of land through inheritance was significantly increases the intention of youth to remain engaged in agriculture. For instance, a 10 percent increase in inheritance land size reduces rural-to-urban migration in Ethiopia by 4.8 percentages. As indicated in the table 10, the households time to hand down their land to their family and from sampled households in response to questions the time of land transfer to children, 20% of households were not transferring their land to children not until they alive while 16.2%, 39.5% and 11% of sample reported that they were given their farm to their children after completed education, after marriage and other respectively.

Table 10. Different motivation and time of households hand down land to children

No	Categories	Frequency	Percent
1	Have you give motivation for youth		
1.1	Yes	123	66.5
1.2	No	62	33.5
2	Time of household give land to their children		
2.1	No until alive	37	20.0
2.2	After completed education	30	16.2
2.3	After marriage	73	39.5
2.4	Both after completed education and after marriage	23	12.4
2.5	Others	22	11.9
	Total	185	100

Source: Field survey, 2021

Households Perception on the Causes of Migration Decision of their Youth

To ascertain families perception about the major causes of movement of youth to urban, the sampled households whom his at least one his child migrated to the urban (N=99) were asked the question „what was the first causes of rural-urban migration of your children? The larger percentage that accounted for 35 percent of the total sample respondents' perception was to search job. Whereas, land shortages around their families was the initial cause for about 26 percent of sampled households. 22% households blamed their youth, as they dislike agriculture as their continuous activity (table 11). However, many authors showed the household can achieve productivity gains in the land shortage problems. According to Douglas (2018) in development economics there was "inverse relationship" between farm size and land productivity. Similarly Households use family labour intensively on small plots, leading to high land productivity (Arthi *et. al*., 2018). Within African countries, non-agricultural labor is 6 times can be changed to 1.4 times when the transferring of labor from low productivity to high productivity of agricultural enterprise type in four country of Africa including Ethiopia (Ellen B. McCullough, 2016).

Table 11. Households Perception about the Causes of youth migration

No.	Reasons to decide to migrate	Frequency	Percent
1	For job creation and to earn good income	35	35
2	By dislike agriculture work	22	22
3	Land shortage	26	26
4	Lack of family assistance including dis-agreement with family	11	11
5	To seek modern urban life	5	5
	Total	99	100

Source: Field survey, 2021

Households Perception of Out-Migration on Agricultural Production

The focus of this paper has been to assess the effects of rural-urban youth's movement on the agricultural production in the study area. According to IFAD (2010) investing in youths in farming communities were the vital to improving agricultural productivity, promoting food security, and driving economic development in rural area. This was because the youth populations have great potential for modernization the lives of families in the rural communities. Similarly, out-migration have resulted in drastic decrease in the labour which in turn reduces total cropped area and quality of work (Wuni, 2013) giving rise to reduced crop production. According to Adaku (2013), in Ghana a household member engaging in migration significantly reduces household production by 55.4 percent. And the loss of labour from the origin of migration keep households held down in poverty (Abigail, 2019).

Based on the result indicated in table 12, labor shortage of households were assessed and out of the total household surveyed, only 23 % of farmers had no labor constraint on agricultural activity engaged on their farm land within each years while remaining 77% have labor constraint on agricultural activity.

The coping strategies for those labor constraints were also evaluated in this table 12, to carrying out their agricultural activities, out of the total whom face labor constraints', 29% of the respondents from the total households were able to overcome the problems by decreasing farm land per year in their farm operations. While other respondents copping strategies for their labor shortage was using dabo, and their children. The decrease of land from the farm showed as a direct effect on household crop production. In addition, the households' perception of labor shortage contribution to decrease of their agriculture production, their response and said yes for 41.6 percent of households with migrant and 34.1 percent of households without migrants.

Table 12: Household perception on agricultural productivity, labor constraint status and copping strategies

No	Variable	Category	HHs with migrant		HHs without migrant		Total HHs	
			N	%	N	%	N	%
1	Agricultural productivity decrease	No	22	11.9	15	8.1	37	20
		Yes	75	41.6	63	34.1	148	80
2	Labor constraints	No	21	11.4	22	11.9	43	23
		Yes	77	41.6	66	35.7	143	77
3	Decreasing farm land as copping strategies to labor constraints (N=77)	Yes	20	10.8	22	11.9	42	29

Source: Field survey, 2021

The Contribution of Migrated Youth for Development of Rural Agriculture

One of the effects of rural-to-urban migration is the return of money and resources to their respective home areas. Adjei, (2016) argued on the flows of resources and support from urban migrants to rural household members as backward linkages of migration. Do migrants improve living standards of their families by sending resources? Was another issue described in this study? However according to the result indicated on table 13 below only 19.2% were receiving money from their youth living in the town, it may be obtained from these households having diaspora as remittance whereas, corresponding to about 88.8% of the total households did not obtain any resource from their youth in the previous year. In contrary 32.3% of sample respondents in rural indicated as they supporting family members who are living in the town similar to (Arthi *et. al.* , 2018) finding. In conclusion, this way of supporting youth in the town may drain the resources of rural places of origin than it will capacitate the agriculture.

Table 13. Recourses transfer status between migrants and families

No	Households category	Frequency	Percent
1	Would you receive money until now		
1.1	Yes	19	19.2
1.2	No	80	88.8
2	Would you send food/ cash		
2.1	Yes	32	32.3
2.2	No	67	67.7

Source: Field survey, 2021

Conclusion and Recommendations

Conclusion

Recently the Ethiopian government development policy was "Agriculture Development Led Industrialization," gives emphasis and priority to the agriculture sector. Conversely, many youth in developing and transition countries including Ethiopia have negative perceptions of farming and young people were usually not interested in this field of agriculture. there are the push and pull factors as a reasons of migration. The effect of migration on agriculture were loss of households labors, negatively affect households' crop income, delays in crop cultivation practices, reduces total cropped area and quality of work giving rise to reduced crop production.

The objectives of this study were to identify the major causes for rural-urban movement of youth and to assess the effects on the agricultural production. Group discussions and key informant interviews had been conducted with concerned experts before the survey started. Furthermore, there were two surveys that produce the data for this analysis: (i) totally from 185 farmers' households in rural in the categories families having migrant youth and without migrant youth (ii) the survey conducted on in-migrant youth in the town of Ambo and Nekemt (from 121 youth).

The distributions of the respondents by education level showed that majority of the migrants (41.3%) were in elementary level, followed by completed degree level (15.7%). The higher proportion (64.4 percent) respondents' mother or fathers of migrants were illiterate whereas only small amounts of families attended primary school. Thus, the lower level of family education requires cultivating a new generation of young and capable farmers who can embrace new technologies for transformation of agriculture.

According to the response collected from the youth, the reasons driving the youth to migrate for 29.4 percent of the response were associated with to search job and 27.7 percent of a total sampled youth were migrated due to the other economic factors, like lack of land has been dis appointing the youth to move to the town. To cross check from the family side according to their perception about the major causes of movement of youth to urban and 35 percent approve searching job as initial cause. Whereas, land shortage around their families were the initial cause for about 26 percent of sampled respondents. 22% households blamed their youth, as they dislike agriculture as their continuous activity.

The focus of this paper has been to assess the effects of rural-urban youth's movement on the agricultural production in the study area. Out of the total household surveyed, only 43 (23 %) of farmers had no labor constraint on agricultural activity engaged on their farm land within each years. While remaining 143 (77%) have labor constraint on agricultural activity. The coping strategies for thus labor constraints were assessed to carrying out their agricultural activities, out of the total whom face labor constraints', 29% of the respondents were able to overcome the situation by decreasing farm land per year in their farm operations which have the direct effect on decrease of agricultural production in the study area. On the other side the contribution of migrated youth for development of rural agriculture was expected. In this study, only 19.2% receive money from their youth living in the town, it might be obtained from these households having diaspora as remittance.

Recommendation

The migration of youth in the study area was not only made the constraints of labor in agriculture but also it was not improve living standards youth in the town. Therefore, the policy makers should examined as it having a double edged problems affecting the rural communities as well as the urban destinations. So, based on the results of the study, the following key policy implications were listed as recommendation

- Concerning government officials should empowering the youth by giving training in how to create the job to start their own enterprises,
- The non-migrated youth should have to be awarded the challenges faced by youth in migration area
- The youth have to consider and will cover the gap of labor shortage of his families
- The family early gift of land to youth may considered as promotion to stay them in rural and capacitate agricultural work
- Looking and showing increase productivity through intensive and choosing productive agricultural enterprise for land shortage problems as the cause of migration
- The neglected/ dislike agriculture due to drudgery as cause of migration by youth may stimulated through mechanizing agriculture.
- Future research conducted in this area should focus on
- Identification and prioritization of effective agricultural enterprise for each districts of the study area for land shortage problems as cause for rural youth migration will be considered.
- Labour requirements of each crop production through its crop calendar and workability will be identified in the study area.
- Identify strategies for reducing rural-urban youth migration by changing attitude of rural youth towards agricultural work.

References

Abigail A. A. (2019).The effect of rural-urban migration on agricultural production in the northern region of Ghana.

Adaku, A.A. (2013). The effect of rural-urban migration on agricultural production in the northern region of Ghana. Journal of Agricultural Science & Applications, 2(4).

Adams, R. (2011). Evaluating the Economic Impact of International Remittances on Developing Countries Using Household Surveys: A literature review, the journal of development studies, 47:6, 809-828, DOI: 10.1080/00220388.2011.563299

Arthi, V., Beegle, K., De Weerdt, J. and Palacios L. A. (2018). Not Your Average Job: Measuring Farm Labor in Tanzania. Journal of Development Economics, 130: 160-172.

Aschalew Abeje (2021). Causes and Effects of Rural-Urban Migration in Ethiopia: A Case Study from Amhara Region, African Studies, 80(1), 77-94.

Asrat Ayalew (2013). Rural youth, education and agriculture an exploration of youth aspirations and government policy in Ethiopia. Master of philosophy in gender and development spring. Faculty of psychology department of health promotion and development.

Bachewe, F., G. Berhane, B. Minten, and A.S. Taffesse. (2015). Agricultural growth in Ethiopia (2004-2014): Evidence and drivers. IFPRI Ethiopia Strategy Support Program Working Paper 81. Addis Ababa: International Food Policy Research Institute.

Beegle, K., De Weerdt, J. and Dercon, S. (2011). Migration and Economic Mobility in Tanzania: Evidence from a Tracking Survey. Review of Economics and Statistics, 93(3), pp.1010-1033.
Black, R., & Castaldo, A. (2009). Return Migration and Entrepreneurship in Ghana and Côte Divoire: The Role of Capital Transfers. 100(1), 44–58.
Central Statistical Agency (CSA) (2013).The Federal Democratic Republic of Ethiopia Agricultural Sample Survey. Report on Area and Production of Major Crops Development Southern Africa, 24(1), 91-108.
De Brauw, A., Rozelle, S. (2008). Migration and household investment in rural China. China Economic Review 19, 320-335.
Denu, B., A. Tekeste and H. van der Dijl (2005). 'Characteristics and Determinants of Youth Unemployment, Underemployment and Inadequate Employment in Ethiopia" Employment Strategy Paper, Addis Ababa: Ministry of Labor and Social Affairs of Government of Ethiopia
Douglas Gollin (2018). Farm size and productivity Lessons from recent literature, 34 IFAD Research Series ISBN 978-92-9072-868-9.
Dustmann, C. and Glitz, A. (2011). "Migration and education," in E. A. Hanushek, S. Machin and L. Woessman (eds.), Handbook of the Economics of Education. Volume 4, pp. 327–439.
Edith O. A. (2016). consequences of rural-urban migration on the source region of Ughievwen clan Delta state Nigeria.University of Benin, Geography & Regional Planning Department, Benin City, Nigeria.
Ellen B. McCullough (2016).Labor productivity and employment gaps in Sub-Saharan Africa Department of Agricultural & Applied Economics, University of Georgia, United States
FAO (2019). Rural migration in the Near East and North Africa Cairo, Regional Trends.
FAO, I. IOM, &.W.FP.(2018). *The Linkages between Migration, Agriculture, Food Security and Rural Development. Rome.*
FAO. (2017). The future of food and agriculture – Trends and challenges. Rome.
Gazdar, H. (2003). "A review of Migration issues in Pakistan." Paper Presented at the Regional Conference on Migration, Development and Pro-poor Policy Choices in Asia.
Gemechisa Yadeta (2021).Impact of Soil Conservation on Household Income in East Wollega, H/G/ Wollaga and West Shawa Zones of Oromia Region. Addisu H., Kebret K., Mengistu J., and Diriba M. (eds.), 2020. Regional Review Workshop on Completed Research activities of Socio-economics and Agricultural Extension Research Directorate held at Adami Tulu Agricultural Research Center, Adami Tulu, Ethiopia, 23-27 December 2020. Oromia Agricultural Research Institute (IQQO), Finfinne, Ethiopia. 345 pp
Habtamu Kefelegn (2020).Determinants of youths rural to urban migration in Ethiopia (Case of Addis Ababa) academic journal of research and scientific Vol 2 ISSN: 2706-6495.
IFAD, F. (2010). Youth and agriculture: Key challenges and concrete solutions. The Food and Agriculture Organization of the United Nations (FAO) in collaboration with the Technical Centre for Agricultural and Rural Cooperation (CTA) and the International Fund for Agricultural Development (IFAD). Rome.
IOM (2010). *Assisted Voluntary Return and Reintegration Annual Report of 2010*. Addis Ababa.
Kinuthia, M. (2003). Migration in kenya and its impact on the labor market. Paper prepared for conference on African migration in comparative perspective, Johannesburg, South Africa, 4-7 June American University United States of America.
Kifle Degefa, Getachew Biru, and Galmessa Abebe 2019.Characterization and Analysis of the Farming Systems of East Wollega Zone, Oromia, Ethiopia

Leavy, J. & Smith, S. (2010). Future farmers? Exploring youth aspirations for African agriculture. Future Agricultures, Policy Brief, No. 037.
Lee, E. (1966). A Theory of Migration. Demography, 3(1), 47-57. Retrieved from http://www.jstor.org/stable/2060063.
Michael K., Shaibu B. A., Nathaniel A. B., Emile Mawutor T., K. Boadi M. & Ethel B. (2022). Changing the perceptions and attitudes of rural Ghanaian youth towards cocoa farming, Development in Practice, 32:(7), 958-967.
Mora, J. and Taylor, J.E. (2006). Determinants of migration, destination, and sector choice: Disentangling individual, household, and community effects. In: Özden Ç. and Schiff, M. (eds.). International migration, remittances and the brain drain. Washington D.C.: World Bank and Palgrave Macmillan: 21–51.
OECD (Organization for Economic Cooperation and Development) (2015). International Migration Outlook 2015, -Asset-Management/oecd/social issues migration health/international migration outlook.
Oppenheimer, V. K. (2000). The continuing importance of men's economic position in marriage formation. The perspectives on marriage and cohabitation (Vol. Chapter 14). Hawthorne: Aldine de Gruyter.
Patrick S. and David E. (2009).Effective Communication with Young People Report for: Office for Youth, DEEWR E&S Research Pty Ltd. Australian Government.
Sabates-W., R., Sabates, R., and Castaldo, A. (2008). Tackling poverty-migration linkages: Evidence from Ghana and Egypt. Social Indicators Research 87(2): 307–328.
Sif Heide-Ottosen (2014).The ageing of rural populations: evidence on older farmers in low and middle-income countries, www.helpage.org
Singh A., MB Masuku (2012): An insight statistical techniques and design in agricultural and applied research, World Jr. of Agricultural Sciences, 8(6), 568-584.
Sosina Bezu and Stein Holden (2014). Are Rural Youth in Ethiopia Abandoning Agriculture?
Tacoli, C. (2004). Rural-Urban Linkages and Pro-Poor Agricultural Growth: An Overview. Prepared for OECD DAC POVNET Agriculture and Pro-Poor Growth Task Team. Helsinki.
Tilak R. P. (2014). Socio-Economic Status of Migrants and Their Household in Ranagaun
UNDESA (United Nations Department of Economic and Social Affairs/Population Division) 2015. International Migration Report of 2015
UNESCO (United Nations Educational, Scientific and Cultural Organization) (2019). By youth, with youth, for youth
USAID (2017). Developing Ethiopia's youth
WUNI B. M. (2013). Perceived impact of rural-urban migration on agricultural productivity in Nanumba south district of northern region. Department of agricultural extension, college of agriculture and consumer sciences, university of Ghana.
Yang, L. (2004). Rural Labor Migration in China and its Impacts on Rural Households in Essays on the Determinants and Consequences of Internal Migration. Unpublished PhD thesis, Department of Economics, University of Chicago
Yousra A. and Julie L. (2016). Does Migration Improve Living Standards of Migrant-Sending Households? Evidence from Rural Ethiopia.
Zarko B. and Jovan D. (2014). The role of human factor in the development of agriculture in Montenegro. Economics of Agriculture UDC: 631.11.3:631.153(497.16).
Zemen Haddis (2014). Rural urban migration and rural development policies In Ethiopia, World Bank Conference on land and poverty. The World Bank - Washington DC, March 24-27

Assessment of Irrigated Wheat Production in Western Oromia: SWOT Analysis

Kifle Degefa*[,1], Hailu Feyisa[2], and Adisu Tadese[3]
[1]Bako Agricultural Research Center, Agricultural Economics, Bako, Ethiopia
[2]Bako Agricultural Research Center, Agronomy, Bako, Ethiopia
[3]Bako Agricultural Research Center, Irrigation Engineering, Bako, Ethiopia
*Corresponding author: kifledd3@gmail.com

Abstract

The population growth and changing food preferences in Ethiopia have resulted in an increasing demand for wheat which results in the expansion of irrigated wheat production to ensure food self-sufficiency, import substitution, and export. This expansion of irrigated wheat production for sustainability needs the identification of potential stakeholders with their roles, & constraints. Besides, Strengths, Weaknesses, Opportunities, and Threats (SWOT) analysis is also very important. The aim of this study was to assessed irrigated wheat production status, constraints, and opportunities of the irrigated wheat production. The study was conducted in East Wollega zone, Bunno Bedelle, and Jimma zones in nine districts. During the assessments, focus group discussions and key informant interviews with farmers and experts used following both purposive and simple random techniques. Descriptive statistics were employed to analyze the collected data. Further expansion constraints like unavailability of inputs with skyrocketing prices, poor irrigation schemes performance, biotic stresses, insufficient farmers' skills and knowledge of the technologies, lack of financial sources, lack of local reliable market, and shortage of modern schemes were identified as the major constraints to irrigated wheat production. The SWOT analysis has been done, showing the details of strengthen, weaknesses, opportunities, and threats of irrigated wheat production. This new initiative knowledge should be useful through developing a regular input supply system, improving farmers' skills and knowledge, credit access to farmers, developing modern schemes, developing new disease-resistant varieties, and strengthening market linkage by experts, policymakers, researchers, and seed enterprise for better orienting investments on irrigated wheat production.

Keywords: Irrigated wheat, constraints, SWOT analysis, stakeholders & Western Oromia

Introduction

The Ethiopian economy as a whole is highly correlated to the agricultural sector which contributes 34.1% to the gross domestic product (GDP), 79% of export earnings, 79% workforce for the population, 70% of raw materials for industry (Asrat et al., 2022; Endalew et al., 2022; Zegeye et al., 2022; Wordofa et al., 2021; Gebremariam & Ying, 2022). The country's agriculture is mainly dependent on rainfall (Mengistu et al., 2021) and small scale, dominated by limited access to technology, extension support, market information, and credit access which have contributed to the low agricultural productivity (Kifle et al., 2022; Nakawuka et al., 2018). Indeed, the agricultural production growth in the country is less than the population growth rate over the last four decades (Regasa et al., 2021). The food requirements of the higher population growth rate have been projected to increase over the year, with a doubling of stable crop production required (Noort et al., 2022; Krupnik et al., 2017). To ensure this food requirement expansion of agricultural growth and achieving food security through irrigation using the major stable crops is an alternative potential (Ozkan et al., 2022).

Ethiopia is the second largest wheat-produced country in Africa next to Egypt (Tadesse et al., 2019; Dessie et al., 2018). Wheat is one of the strategic crops in Ethiopia for food security, import substitution, and supply of raw materials for the agro-processing industry (Endalew et al., 2020). In Ethiopia, the crop is produced by 4.58 million smallholder farmers on 1.80 million hectares of land with an estimated annual production of 5.78 million tons and average productivity of 3.05 tha^{-1} (Abera et al., 2022; CSA, 2021). This wheat average productivity is much lower than the world average and far below research yield (Fischer et al., 2022).

The demand for wheat in the country is growing faster than any other food crop (Noort et al., 2022). This high demand gap is due to the rapidly increasing population in urban, changing preferences toward wheat-based food items, and global climate change. The increasing self-sufficiency production in Ethiopia is using horizontal and vertical expansion (Tadesse et al., 2022). Horizontal expansion is production area expansion while vertical expansion is increasing crop productivity by increasing resource use efficiency and increasing the number of crops grown per year on the same land, thus rising yield per unit area-time (Krupnik et al., 2017). Wheat production transformation and productivity increasing rapidly to enhance self-sufficiency in Ethiopia is a high national priority which expands low-land and midland areas as a double crop where water sources are available (Bentley et al., 2022).

Recently, the Government of Ethiopia has adopted a policy of irrigated wheat, focusing on radically improving production by developing best-bet wheat technologies in the major wheat-growing agroecology (Shikur, 2020). This prospect of wheat self-sufficiency can be possible with increasing wheat productivity in the rain-fed and expansion of production to the irrigable lowland and midland areas as double crop water resources are available to irrigate wheat (Jambo et al., 2021).

Irrigation is the main source to ensure food security, alleviate poverty and promote the economic growth of the country by increasing the yield of wheat (Gurmu et al., 2019). Small-scale irrigation schemes in particular make a massive contribution to the national economy which covered majority of total irrigated land (Asrat et al., 2022). This small-scale irrigation area of lower than 200 hectares (Gurmu et al., 2022; Muluneh et al., 2022). Oromia is one of the largest regional states in the country concerning arable land and practices irrigated wheat production (Alemu & Tolosa, 2022; Atinafu et al., 2022; CSA, 2021). Based on the land and water potential the government is highly given priority for lowland and midland irrigated wheat production in the region. For the success of the irrigated wheat production, identification of existing irrigation systems in the area, constraints, opportunities, and threats are critical issues. Therefore, this study was aimed at the assessment of irrigation potential stakeholders, constraints, and SWOT analysis of irrigated wheat production in western parts of Oromia.

Research Methodology

Study Area Description: The study was conducted in East Wollega, Bunno Bedelle, and Jimma Zones which are located at a distance of about 330 km, 431 km, and 359 km respectively from the center of Finfinne, the capital city of Ethiopia (Fig. 1). The East Wollega zone has seventeen rural districts and one urban district. It is found on the $8^{0}31^{'}52^{''}$-$10^{0}19^{'}44^{''}$ N latitude and

$36^{0}07^{'}51^{''}$-$37^{0}11^{'}52^{''}$ E longitude with an altitude range between 1200-2960 meters above sea level. The main agroecology classification of the zone is highland (20.50%), midland 50.90%), and lowland (28.60%). The daily temperature ranges from 14-25^{0}c with annual rainfall ranging from 1000-2400 mm. This zone's entire land area is about 14,102.50 km^2 with 1,954,369 populations (Bekuma et al., 2022).

The Bunno Bedelle zone has nine rural districts and one urban district. The zone is found on the $7^{0}27^{'}40^{''}$-$9^{0}02^{'}10^{''}$ N latitude and $34^{0}52^{'}12^{''}$-$41^{0}34^{'}55^{''}$ E longitude with an altitude range between 1600-1940 meters above sea level. The daily temperature ranges from 10.6-26^{0}c. This zone's entire land area is about 5,964 km^2 with 838,172 populations (Tsegaye et al, 2021). The majority of agroecology classification of the zone is midland and lowland with a high potential for rainfall (Sori & Adugna, 2022).

The Jimma zone has twenty rural districts and two urban districts. It is found on the $7^{0}13^{'}17^{''}$-$8^{0}53^{'}16^{''}$ N latitude and $35^{0}51^{'}07^{''}$-$37^{0}36^{'}16^{''}$ E longitude with an altitude range between 500-3500 meters above sea level. The main agroecology classification of the zone is highland (12%), midland 78%), and lowland (10%). The daily temperature ranges from 18-23^{0}c with annual rainfall ranging from 1300-2100 mm. The zone's entire land area is about 18,696.70 km^2 (Sime & Demissie, 2022).

The crop-livestock mixed farming system is the farmers' livelihood activities which are mainly dominated by crop production for family home consumption and income sources. The crop production is mainly dependent on rain-fed-subsistence agriculture like maize, tef, sorghum, wheat, barley, faba bean, field pea, nug, and sesame are the principal crops farmed in the areas. The study zones have a river potential for irrigation like Baro, Gibe, dhidhessa, etc., which are more potential for large-scale irrigation systems (Bekuma et al., 2022; Sori and Adugna, 2022; Negesso and Edae, 2018).

Data Types, Sources, and Collection Methods: In the study, the primary and secondary data types were used. The primary data was collected from irrigated wheat producers, experts, and unions through focus group discussions. This primary data includes irrigated wheat production practice and feedback, input availability and affordability, inputs used and application methods, water management, scheme status, stakeholders' role, extension services, constraints, strengths, weaknesses, opportunities, and threats that are very important for the expansion of irrigated wheat production. The secondary data was collected from districts and zonal raw data sources, published documents, and unpublished policies regarding irrigated wheat production that are vital to rational conclusions.

Sampling Techniques: The sample was drawn using purposive and simple random sampling methods. First, three zones via East Wollega, Bunno Bedelle, and Jimma were selected purposively based on the availability of irrigated wheat production. Second, three districts from each zone (Jimma Arjo, Guto Gidda & Sibu Sire districts from East Wollega zone, Bedelle, Gachi & Dhidhessa districts from Bunno Bedelle zone, and Seka Choqorsa, Qersa & Nadhi Gibe districts from Jimma zone) were selected randomly from irrigated wheat producers. From each district, three clusters from East Wollega and Jimma zones and two clusters from Bunno Bedelle zone having 10-15 farmers were selected randomly. The focus group discussion was conducted considering the numbers of farmers in the cluster, gender, and ability of farmers.

Methods of Data Analysis: The quantitative collected data was analyzed using descriptive statistics such as mean, frequency, percentage, and histogram graphs. The qualitative data like stakeholder roles, constraints, and SWOT analysis were analyzed using narrative explanation.

Results and Discussions

Irrigation Practice by Smallholder Farmers: In the study zones, irrigation practice was very important for food security since 1992 after the military regime of the Derg which is similar in the other parts of the country Degife et al. (2018) and Lavers & Boamah (2016). Traditional and modern small-scale irrigation schemes in which the total irrigable command land is less than 200 hectares. The majority of smallholder farmers were grown maize, potato, tomato, onion, and other crops (Table 1). The farmers grow these crops because of affordability, cultural practice, lack of other alternative technologies, and availability of markets in the areas. Starting in 2020 the Ethiopian government initiative irrigated wheat initiative in the zones irrigated wheat production was practiced. In the three zones, irrigated wheat production was economically better than the previously grown crops by smallholder farmers which received better production. The irrigated wheat production used full package technologies like improved varieties, recommended inorganic fertilizer, and better supervision (advice services).

Table 1. Smallholder farmers' irrigation practices from 1992-2019

Zone	FGD	%	Major crop grown
East Wollega	8	100	Maize, potato, anchote, cabbage, Hot-pepper, etc.
Bunno Bedelle	6	100	Maize, potato, tomato, onion, cabbage, coffee seedling, etc.
Jimma	7	100	Maize, potato, tomato, cabbage, soybean, etc.

Irrigated Wheat Production Practices: The irrigated wheat production practices started from September to April (Fig. 2), which is mainly the dry period in Ethiopia. This irrigated wheat production practice includes land preparation, planting, watering, fertilizer application, weeding, pesticide application, crop harvest, and storage. The field preparation for irrigated wheat was started in September in some districts and continued through November in three zones. Whereas input preparation and planting were started in October to December based on input availability. This crop management is very complex and challenges the producers for high yield Mamai et al. (2020). Seeding rate, planting depth, weeding, and pest management were other challenges in irrigated wheat production management which is in line with (Fischer et al. (2022), Li et al. (2022), Riemens et al. (2022) Dube et al. (2019) results. The harvesting and post-harvest activities were accomplished from February to April. The field management practices are very important in improving crop yield which is in line with Molla et al. (2022) result.

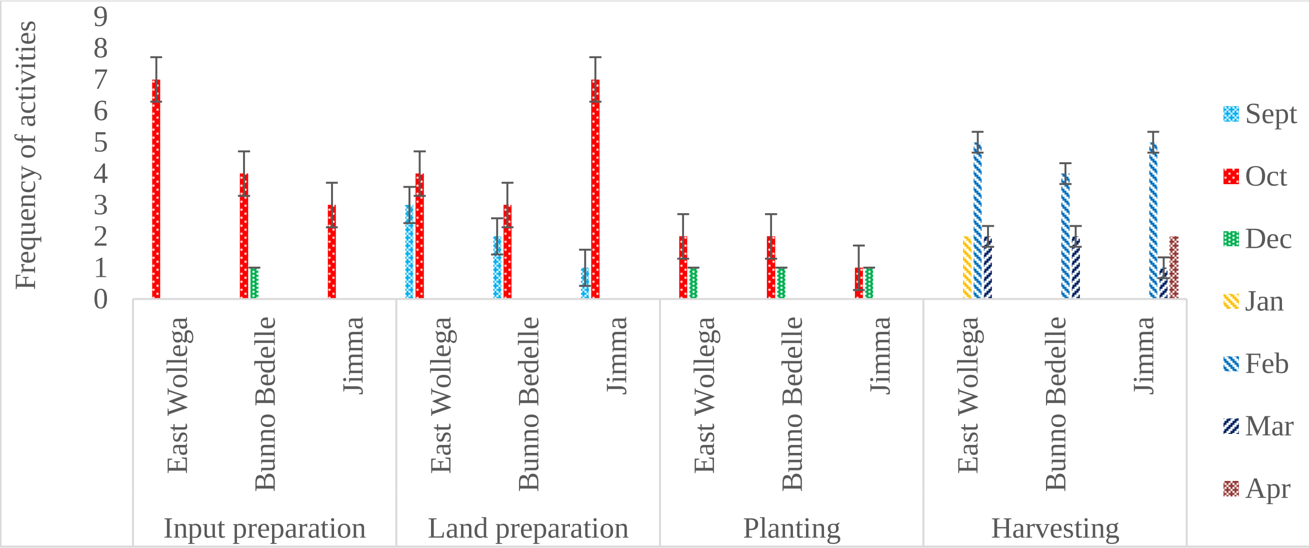


Figure 1. Irrigation wheat production calendar in the study area

Inputs used by Irrigated Wheat Production: In this study, mainly seed and inorganic fertilizer (Urea & NPSB) inputs were used by farmers (Fig. 2). These inputs were supplied by unions, research centers, and direct by the regional government. The result shows that the farmers used bread wheat seed at a rate of 150kgha^{-1}. While NPSB and Urea fertilizer was applied at the rate of 100 kgha^{-1} and 150 kgha^{-1}, respectively (Fig. 2). This result shows that the wheat yield and production responses were affected by recommended inputs and methods as well as the time of water application which are in line with Li et al. (2022) and Shikur (2022) results that stated yield and production responses are affected with policy interventions. The grain yield of irrigated wheat was affected by input rates and methods which is in line with Yuan et al. (2022) result who stated that fertilizer rate is a vital factor influencing agriculture yield.

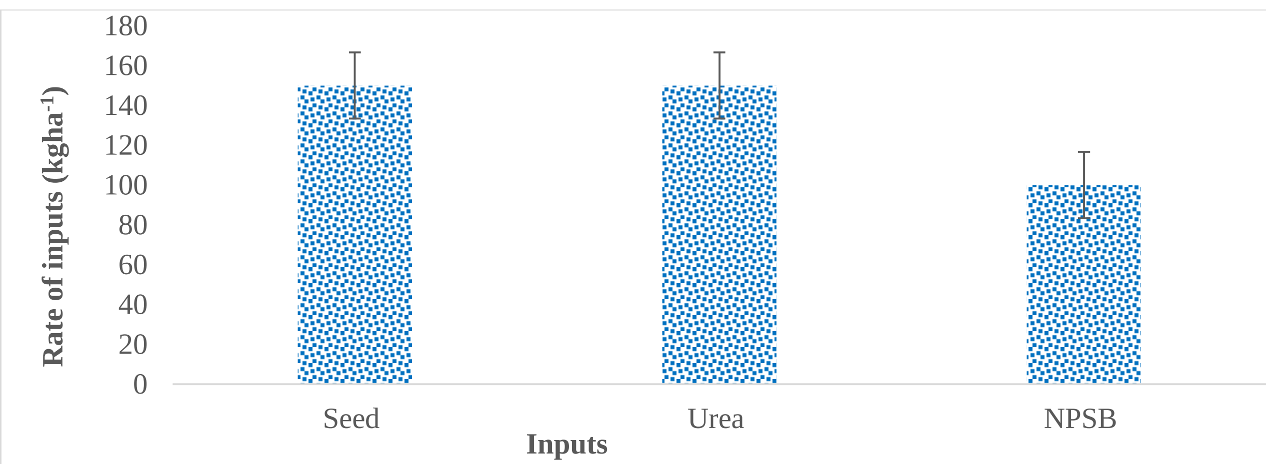


Figure 2. Rate of inputs used for irrigated wheat production

Yield obtained from irrigated Wheat: The analysis of yield was done at the zonal level with their varieties. In three zones Kingbird, Wane, Denda'a, Ogolcho, and Hulluka improved varieties were used (Fig. 3). In the East Wollega zone Wane variety was the more yielder than the kingbird variety with a mean yield of 4.81 tonha^{-1} while Kingbird variety was the highest yielding with a mean yield of 3.65 tha^{-1} than others in Jimma zone. The yield obtained from

Denda'a improved variety was the least with a mean yield of 2.67 $tonha^{-1}$. The yield varies may be due to agroecology response to variety, watering frequency, disease, soil fertility, and other management practices. Similar results were reported by Amiri et al. (2022), Shikur (2022), Zewde & Purba, (2022), Sosibo et al. (2017). The improved wheat variety yield response for irrigated and rain-fed production depends on agroecology Araya et al. (2022). In some areas, farmers minimized watering frequency due to water shortage which reduce the productivity of the crop Yohannes et al. (2019)

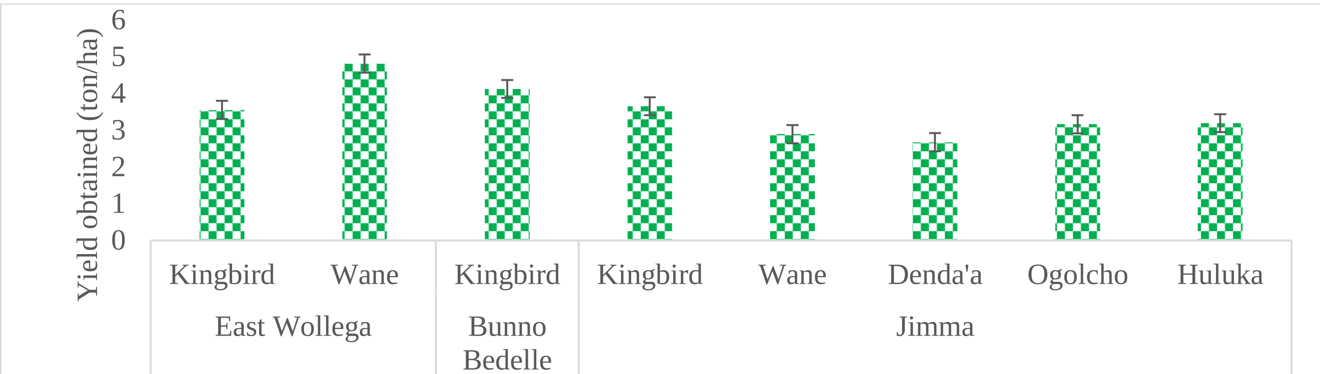


Figure 3. Irrigated yield of zones with varieties

Purpose of Irrigated Wheat Production: The farmers allocated their total wheat product to different purposes which include home consumption, market (income source), and seed (Fig. 4). This result indicates the majority of the farmers used for home consumption followed by income source. The majority of the wheat grain was consumed at home which is to ensure family food security and the left supply to the market which is in line with Atinafu et al. (2022 and Zegeye et al. (2022) results.

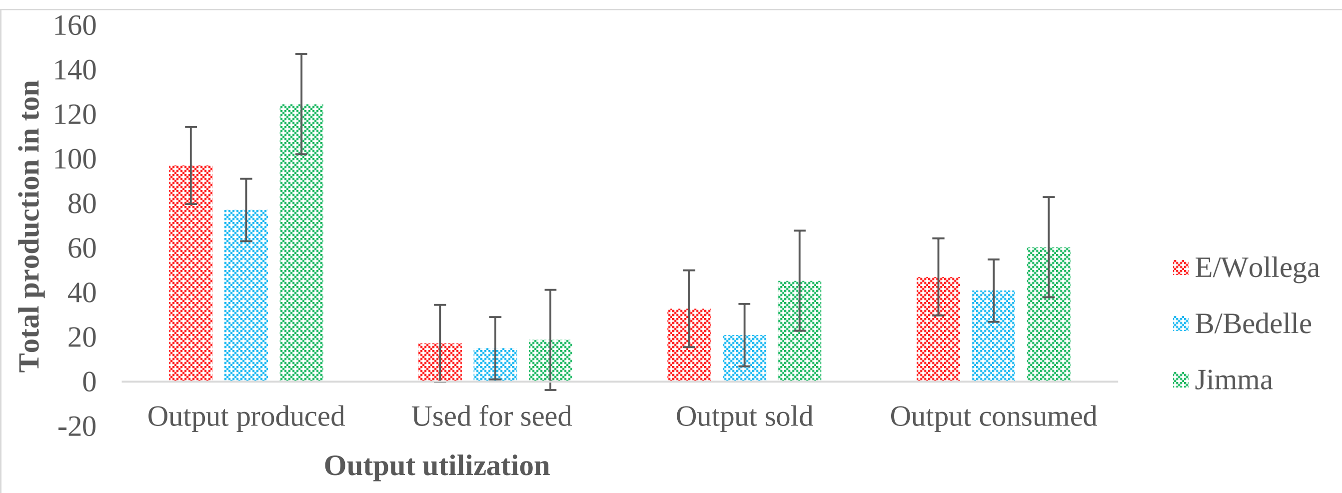


Figure 4. Utilization of produced irrigated wheat by farmers in the sampled clusters

Roles of Stakeholders in Irrigated Wheat Production: A diverse group of stakeholders like farmers, agriculture office and admiration leaders, research centers, and unions was involved in the irrigated wheat production (Table 2). The smallholder farmers serve on crop management and information sources for experts and researchers. Farmers were also involved in field day organizing and experience sharing with other farmers on the irrigated wheat production system.

In addition, they participated in the supply of wheat grain to the market and end users. Experts and leaders were responsible for providing training for the farmers, input supply, field supervising, and organizing field days. This stakeholder works with the collaboration of research centers and cooperative unions. This cooperative union was responsible for input supply and transport services to the farmers. They were also involved in grain buying from farmers and supplying to other agro-processing and end users. The public research centers work closely with district experts and farmers by driving force for innovation and technology in irrigated wheat production. They also undertake applied research and generate evidence for other stakeholders. Besides, this stakeholder was responsible for providing training for experts and farmers, input supply for the farmers, field supervising, and organizing field days with the collaboration of district experts. This result indicates that stakeholders are the central tendency for irrigated wheat production which is a critical component of setting the future direction in wheat production as sustainable Gurmu et al. (2019), Francis (2018), Santoso & Delima (2017).

Table 2. Roles of stakeholders in irrigated wheat production

Stakeholders	**Roles**	**Members**
Farmers	Land preparation, sowing, crop production management and information sources	Smallholder farmers
Public sectors	Training providers, inputs supply, advisory service, organize field days and field supervision and conflict resolution	Regional BoA, zonal and district agricultural offices, and administration leaders
Unions	Storage and transportation facilities and fertilizer supply	Unions and primary cooperatives
Researches	Training providers, inputs supply, Organize field day and supervision	Bako, Nekemte, Bedelle, Jimma Agricultural Research Centers

Extension Services for Irrigated Wheat Production: Agricultural extension services for irrigated wheat production were reported as the most important through providing training, availability of inputs on time, advising farmers on technology, and giving different information on marketing (Table 3). This shows that agricultural extension services were basic for the development of irrigated wheat production and marketing linkage sustainability Tadesse et al. (2021) and Anteneh &Asrat (2020). Among these services training at least three times, field supervision and advising more than two times per week during the production season, and two to three times organizing field days were conducted during the production season. As the farmers reported the services focused on the current production situation. The result shows that different agents including BoA experts, research centers, and leaders have participated in this extension service.

Table 3. Extension service provides for irrigated wheat production

Type of services	Zone	Mean	Sources
Training	East Wollega	3.33	BoA (regional SMSs, zonal SMSs, woreda SMSs, DAs) & Research centers
	Bunno Bedelle	3.33	
	Jimma	3.88	
Supervision and advancing per week	East Wollega	3.22	BoA (leaders, SMSs & DAs), Research centers & political leaders
	Bunno Bedelle	2.67	
	Jimma	2.63	
Field days	East Wollega	1.78	Collaboration of BoA & Research Centers
	Bunno Bedelle	2.17	
	Jimma	3.00	

Irrigated Wheat Production Constraints: The irrigated wheat production constraints of the smallholder farmers were summarized in Table 4. According to the farmers' report, these constraints were presented across the three zones. This result shows that farmers in the area have been facing these different constraints.

Limited agricultural inputs with high prices: Irrigated wheat production was constrained by the unavailability, accessibility, affordability of inputs including fertilizers, improved wheat seed, and the high price of pumps. The cost of fertilizer and seed are increasing over time which is in line with Tadesse et al. (2019) result. The study also shows that there is no regular input supply system for irrigation which results in untimely deliveries and a shortage of input supply for the farmers. This access to improved agricultural inputs including fertilizer, seed, chemicals, and motor pumps advances subsistence farmers' shift to marketable farmers.

Poor performance of irrigation: The majority of the modern-small scale schemes were reported as performing under their capacity performance. The majority of farmers reported sedimentation of canal head work, shortage of the main canal, and lack of canal up to their field problems which cause water scarcity Gurmu et al. (2022). This constraint was directly related to the water use system adjusted by the farmers. The majority of these problems occurred due to a lack of timely scheme management (maintenance and repairs). The majority of the irrigation beneficiaries reported that there was no financial saving system for scheme maintenance, weak linkage with relevant stakeholders, poor coordination, and inefficient control system. This increases the water shortage due to sediment deposits or large volumes of sand in the canal system Mesfin et al. (2020) and Gurmu et al. (2019). Due to these poor schemes management land productivity is declining from year-to-year Gurmu et al. (2022). In addition, there was inadequate community involvement in scheme planning and implementation which is a very important aspect of scheme sustainability Abesha et al. (2022). Besides, the modern irrigation schemes were constructed with very short-lined canals huge amount of water is lost in the form of seepage as a result earthen canals have more seepage loss. This shows that the lined canal should be expanded over the command area of the scheme to use water and land effectively.

Biotic stresses: The most biotic stress constraints which affect irrigated wheat production include disease and weeds. Common diseases like rust and smut were reported and the grass family weed was the most important in irrigated wheat production. These biotic stresses may be causing high-yield losses Zewde and Purba (2022) and Dube et al. (2020). The majority of varieties including Ogolcho and Hulluka were susceptible to disease (rust and smut) which loss of crop yield Araya et al. (2022).

Lack of local reliable market: The other constraint reported by farmers was the lack of a local reliable market and transport. In the study areas, local market access, price instability, and market facilities like transportation systems were reported as the major constraints in irrigated wheat production. The lack of access to market information on price has greatly reduced the farmers' income gained from irrigated wheat production Atinafu et al. (2022). The majority of the farmers reported that market network (linkage) and transportation due to lack of road facilities as the main constraints in irrigated wheat production. The market linkage constraints with the lack of road facilities the market price was dropping during harvesting season resulting in farmers often selling at a low price which does not the cover costs of production.

Lack of financial sources for irrigation: Regarding financial sources for irrigated wheat production, there was no credit provided for purchasing inputs like fertilizer, seed, and chemicals required financially. For the sustainability of irrigated wheat production credit access by microfinance and banks are more crucial for input purchasing Fischer et al. (2022). This helps farmers as operation cost to purchasing inputs and pumps for more irrigated wheat commercialization which is in line with Nakawuka et al. (2022) result who stated that credit access to the farmers significantly affects the use of agricultural inputs. As the majority of farmers reported this access to credit is also used to purchase a motor pump and other spare parts which are in line with Alemu & Dessale (2022) result.

Inadequate farmers' knowledge & skill in irrigation technologies: The irrigated wheat production practice was a new initiative in the study areas. This new initiative was constrained by water need, application water without calculation, irrigation interval, and input application methods. The agricultural extension services in the areas focused on the current performance of the crop rather than sustainability. As farmers reported there was no awareness of crop rotation to improve soil fertility and water use efficiency. The farmers reported that there was a variation in soil fertility within each scheme command area. To improve and sustain soil fertility crop rotation and other soil management are important in sustainable crop production Sosibo et al. (2017). The majority of the farmers have complained about the input supply system which was forced to buy the input rather than change the farmers' attitude toward irrigated wheat production through training and advice. The majority of the farmers need attention for sustainable irrigated wheat production. The farmers were reported to need government support on inputs, pumps, tractors, and combiner services. This expectation was coming from a first-year government organization that gives free seeds and tractor and combiner services. This shows that the agricultural extension service pays less attention to the sustainability of irrigated wheat production. The farmers have complained about the market failure of irrigated wheat. This shows that there is no network linkage between extension services and unions. In the study areas, farmers had no awareness of routine mump maintenance. This result shows that farmers need training on routine pump maintenance to effectively use a pump and reduce maintenance costs Nakawuka et al. (2018).

Shortage of modern schemes: The shortage of modern schemes was reported as another constraint. The majority of the farmers used traditional water diversion structures to divert water from the rivers for irrigated wheat production and this river water used water pumps Asrat et al. (2022). The traditional schemes were constructed from local materials which need yearly construction of diversion structures and ha low diverting efficiency. The majority of water pumps used by farmers were not readily available nearest to the communities which incurred another cost for farmers Nakawuka et al. (2022).

Table 4. Irrigated wheat production constraints

#	Constraints (n = 24)	Frequency	Rank
1	Limited agricultural inputs with high price	24	1
2	Poor irrigation schemes performance	19	3
3	Biotic stresses (diseases & weeds)	13	6
4	Lack of local reliable market	21	2
5	Lack financial source for irrigation	17	4
6	Inadequate farmers knowledge & skill on irrigation technologies	11	7
7	Shortage of modern scheme	15	5

SWOT Analysis: The strengths, weaknesses, opportunities, and threats (SWOT) analysis was conducted to understand the situations for a potential irrigated wheat production, market, and extension policy. This result shows that the internal factors (strength and weakness) and external factors (opportunity and threat) were taken into attention to developing strategic planning for sustainable irrigated wheat production in the areas (Fig. 5).

Strength: The farmers and experts reported farmers' early accepting new initiatives, experience sharing with other farmers, good teamwork, and strong commitment of the cluster farmers as internal strengths which can use effectively to achieve their objectives. These vital aspects of irrigated wheat production in the areas are an asset for the expansion of irrigated wheat production.

Weakness: During the production, management limited farmers' poor managed their fields, hesitation, water conflict due to poor water management and shortage, and lack of community scheme maintenance reported as weaknesses. Compared to rain-fed production, the irrigated wheat production in the areas is new and needs more extension services.

Opportunities: Irrigation potentials for the study zones as reported by the farmers and other stakeholders for expansion of irrigated wheat production government attention on improving agricultural production and productivity. They reported the recognition of the government and others on irrigated wheat production was different from rain-fed production. The government of Ethiopia gave special attention to the expansion of irrigated wheat production for food self-sufficiency and export through developing new schemes and making the availability of funds for irrigation research and development interventions. Expansion of urbanization and food insecurity was reported as another opportunity for expansion of irrigated wheat production. The increasing population and urbanization in the country increase the demand for a diversity of food and higher value-added product which is again a market opportunity for agricultural products Nakawka et al. (2018). This needs infrastructure and a market network to improve irrigated wheat productivity and reduce the market complex. Irrigation potential includes land and river water availability and suitability reported as an opportunity. The area under irrigation is lower than the potential this implies that there is a lot of potential for the expansion of irrigated wheat production. The farmers and experts reported in the three zones there are ample water resources that are unexploited. Besides, the three zones have high rain which needs attention to optimize rainwater harvesting for expansion of irrigated wheat production where water resources are scarce to support irrigated wheat production. The result shows that the weather condition with the richest natural opportunities is the main opportunity for the expansion of irrigated wheat and increasing productivity.

Threats: In the study areas, climate change (untimely rainfall), disease (rust), fluctuation of water, and termite infestation from time to time were reported as threats. The farmers reported that these threats like fluctuation of water & termite infestation were increased which decreased crop productivity.

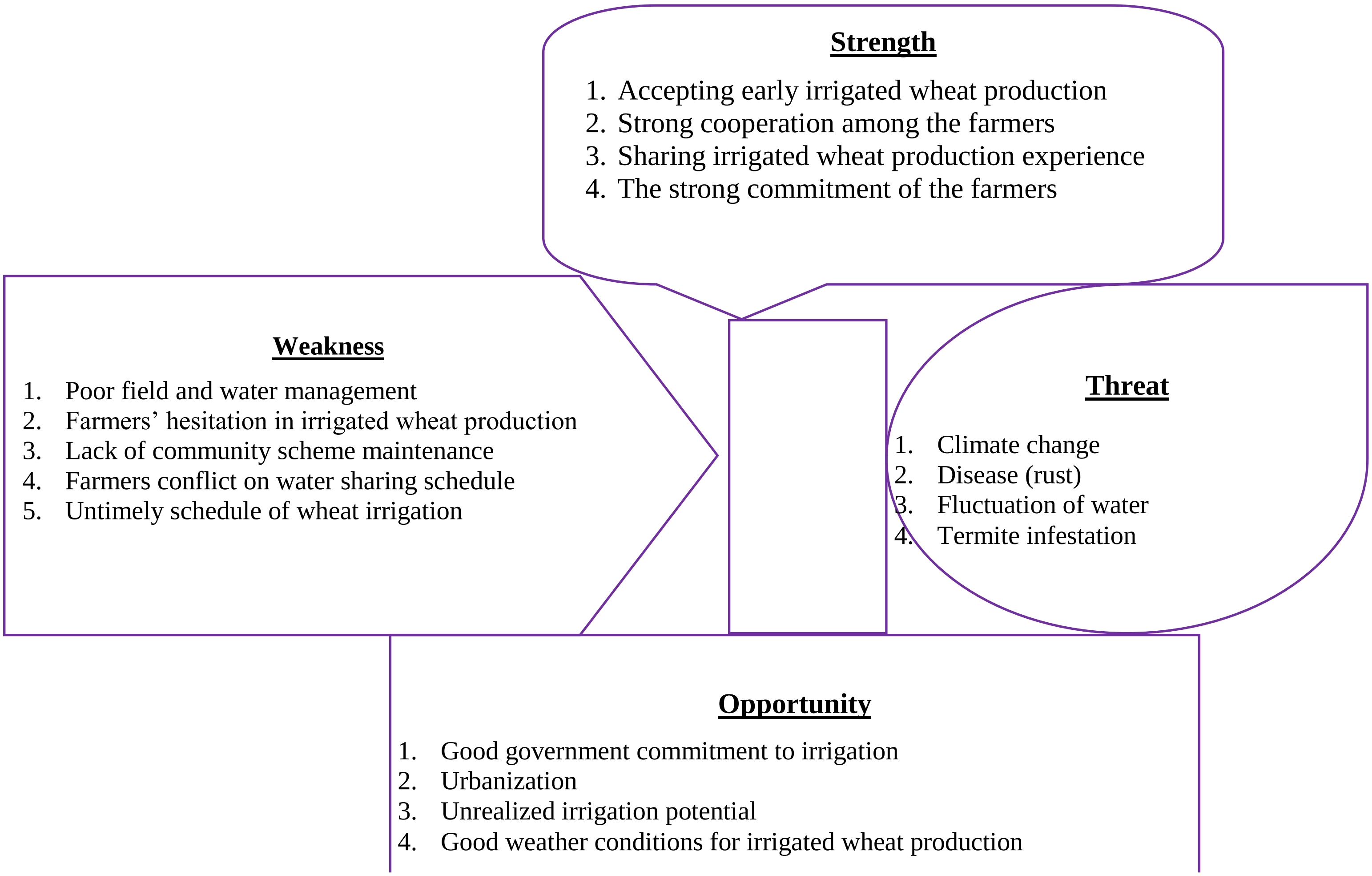


Figure 5: Strength, weakness, opportunity, and threat in irrigated wheat production

Conclusions and Recommendations

The three zones (East Wollega, Bunno Bedelle, and Jimma) have resources for irrigated wheat production which has not yet been fully utilized. In the study areas, the majority of the farmers accepted irrigated wheat production as an opportunity for ensuring their food security. The improved bread wheat varieties including Kingbird, Wane, Hulluka, Denda'a, and Ogolcho were used by the farmers. The yield of the varieties varies from zone to zone which indicates the potential of varieties depends on agroecology, management, water availability, soil fertility, and other aspects. The farmers in all zones used inputs: 150 kg/ha of seed and Urea and 100 kg/ha of NPS based on the recommendation given by experts and obtained yields from 2.67 to 4.81 tons per hectare which were used for home consumption and income source.

Various stakeholders like farmers, agriculture offices and admiration leaders, research centers, and unions, were involved in irrigated wheat production in different aspects. The smallholder farmers serve on crop management and information sources for experts and researchers. The other experts of agriculture offices and leaders, researchers, and unions participated in input supply, training and advising services, field day organizing, close field supervision, and giving different market information to the farmers. These stakeholder roles are critical components for the expansion of irrigated wheat production.

The limited agricultural inputs and high prices in the areas were reported as major constraints. There are no regular input supply systems for irrigated wheat production. Poor performance of irrigation schemes including sedimentation and canal shortage was reported as constraints Biotic stresses, poor market linkage, lack of financial sources for irrigated wheat production, and insufficient farmers' skill and knowledge on irrigated wheat production were also reported as main constraints for irrigated wheat producing farmers. The majority of the farmers used traditional irrigation systems which indicate a shortage of modern schemes.

The positive aspects (strengths & opportunities) and negative aspects (weaknesses and threats) of the irrigated wheat production SWOT analysis were identified and summarized. The strengths like early accepting technology, experience sharing, good coordination, and strong commitments of the farmers were reported. Poor field & water management, farmers' conflict, and lack of community scheme maintenance system in the cluster were reported as weaknesses. The ample opportunities include government commitment, increasing urban population, unused land & water sources, and good weather condition for irrigated wheat production reported as a potential for more irrigated wheat expansion. Climate change, rust disease, water fluctuation, and termite infestation were reported as major threats to irrigated wheat production.

Based on the above constraints and opportunities the following recommendation should be identified:

- Regular input supply systems are the first required to enhance irrigated wheat production. Thus, inputs especially seed production and delivery system should be tackled to ensure their availability on time, affordability, and sustainability.
- Strengthening the capacity of the farmers in the production system, business attitude, soil fertility, termite control, proper water use, and routine pump maintenance.
- Modern irrigation schemes and maintenance of the old schemes to improve the capacity of water to enhance sustainable intensification.

- Establish a market system for inputs and outputs to the farmers along the wheat value chain in the areas.
- Access to credit for input and pump purchasing through providing technical support is vitally crucial for sustainable irrigated wheat production.
- Strengthening the interventions on promotion and dissemination of available improved wheat technology include seeds, machinery, pumps, and other inputs for sustainability.
- New wheat rust-resistant varieties and the availability of regular rust chemicals also need attention from researchers, unions, and experts.

Acknowledgment: The authors rise their appreciation to farmers in the study areas of agriculture experts in three zones and nine districts. We express gratitude to Oromia Agricultural Research Institute and Bako Agricultural Research Center for logistic services for data collection.

References

Abera, W., Tamene, L., Tesfaye, K., Jiménez, D., Dorado, H., Erkossa, T., . . . Ramirez-Villegas, J. (2022). A data-mining approach for developing site-specific fertilizer response functions across the wheat-growing environments in Ethiopia. *Experimental Agriculture, 58.*

Abesha N, Assefa E, Petrova MA. 2022. Large-scale agricultural investment in Ethiopia: Development, challenges and policy responses. Land use policy, 117:106091.

Alemu M, Dessale M. 2022. Impacts of small-scale irrigation on rural households' income in north eastern Ethiopia. Sustainable Water Resources Management, 8(1): 15.

Alemu Y, Tolossa D. 2022. Livelihood Impacts of Large-Scale Agricultural Investments Using Empirical Evidence from Shashamane Rural District of Oromia Region, Ethiopia. Sustainability, 14(15): 9082.

Amiri E, Bahrani A, Irmak S, Mohammadiyan Roshan N. 2022. Evaluation of irrigation scheduling and yield response for wheat cultivars using the AquaCrop model in an arid climate. Water Supply, 22(1):602-614.

Anteneh A, Asrat D. 2020. Wheat production and marketing in Ethiopia: Review study.Tejada Moral M, editor. Cogent Food Agriculture, 6(1):1778893.

Araya A, Vara Prasad P V., Ciampitti IA, Rice CW, Gowda PH. 2022. Using Crop Simulation Models as Tools to Quantify Effects of Crop Management Practices and Climate Change Scenarios on Wheat Yields in Northern Ethiopia. In: Enhancing Agricultural Research and Precision Management for Subsistence Farming by Integrating System Models with Experiments: Wiley, p. 29-47.

Asrat D, Anteneh A, Adem M, Berhanie Z. 2022. Impact of Awash irrigation on the welfare of smallholder farmers in Eastern Ethiopia. Cogent Economics and Finance, 10(1). 2024722.

Atinafu A, Lejebo M, Alemu A. 2022. Adoption of improved wheat production technology in Gorche district, Ethiopia. Agriculture and Food Security, 11(1):3.

Bentley AR, Donovan J, Sonder K, Baudron F, Lewis JM, Voss R., et al. 2022. Near to long-term measures to stabilize global wheat supplies and food security. Nat Food, 3(7): 483-486.

CSA (Central Statistical Agency). 2021. The Federal Democratic Republic of Ethiopia Central Statistical Agency Agricultural Sample Survey 2020/21 (2013 E.C.) Volume I Report on Area and Production of Major Crops (Private Peasant Holdings, Meher Season).

Degife AW, Zabel F, Mauser W. 2018. Assessing land use and land cover changes and agricultural farmland expansions in Gambella Region, Ethiopia, using Landsat 5 and Sentinel 2a multispectral data. Heliyon, 4(11): e00919.

Dessie AB, Abate TM, Mekie TM. 2018. Factors affecting market outlet choice of wheat producers in North Gondar Zone, Ethiopia. Agriculture & Food Security, 7(1):91.

Dube E, Tsilo TJ, Sosibo NZ, Fanadzo M. 2020. Irrigation wheat production constraints and opportunities in South Africa. *South African Journal of Science, 116(1/2)*: 1-6.

Endalew B, Anteneh A, Tasie K. 2022. Technical Efficiency of Teff Production Among Smallholder Farmers: Beta Regression Approach. Eur J Dev Res., 34(2):1076-1096.

Endalew B, Aynalem M, Assefa F, Ayalew Z. 2020. Determinants of Wheat Commercialization among Smallholder Farmers in Debre Elias Woreda, Ethiopia. Adv Agric., 2020:1-12.

Fischer T, Ammar K, Monasterio IO, Monjardino M, Singh R, Verhulst N. 2022. Sixty years of irrigated wheat yield increase in the Yaqui Valley of Mexico: Past drivers, prospects and sustainability. F Crop Res., 283:108528.

Francis M. 2018. Stakeholders engagement at Magozi Rice Irrigation Scheme: Case study of moving from food-aid dependency to food self-sufficiency in Tanzania. Journal of African Studies and Development, 10(8):115-123.

Gebremariam, T. K., & Ying, S. (2022). The foreign direct investment-Export performance nexus: An ARDL based empirical evidence from Ethiopia. *Cogent Economics & Finance*, *10*(1), 2009089.

Gurmu ZA, Ritzema H, de Fraiture C, Ayana M. 2019. Stakeholder Roles and Perspectives on Sedimentation Management in Small-Scale Irrigation Schemes in Ethiopia. Sustainability, 11(21): 6121.

Gurmu ZA, Ritzema H, de Fraiture C, Ayana M. 2022. Sedimentation in small-scale irrigation schemes in Ethiopia: Its sources and management. International Journal of Sediment Research, 37(5):576-588.

Jambo Y, Alemu A, Tasew W. 2021. Impact of small-scale irrigation on household food security: evidence from Ethiopia. Agriculture and Food Security, 10(1):21.

Kifle T, Ayal DY, Mulugeta M. 2022. Factors influencing farmers adoption of climate smart agriculture to respond climate variability in Siyadebrina Wayu District, Central highland of Ethiopia. Climate Services, 26:100290.

Krupnik TJ, Schulthess U, Ahmed ZU, McDonald AJ. 2017. Sustainable crop intensification through surface water irrigation in Bangladesh? A geospatial assessment of landscape-scale production potential. Land use policy, 60(2017):206–222.

Lavers T, Boamah F. 2016. The impact of agricultural investments on state capacity: A comparative analysis of Ethiopia and Ghana. Geoforum, 72:94-103.

Li Y, Huang G, Chen Z, Xiong Y, Huang Q, Xu X, Huo Z. 2022. Effects of irrigation and fertilization on grain yield, water and nitrogen dynamics and their use efficiency of spring wheat farmland in an arid agricultural watershed of Northwest China. Agric Water Manag, 260:107277.

Li Z, Cui S, Zhang Q, Xu G, Feng Q, Chen C, Li Y. 2022. Optimizing Wheat Yield, Water, and Nitrogen Use Efficiency with Water and Nitrogen Inputs in China: A Synthesis and Life Cycle Assessment. Frontiers in Plant Science, 13.930484.

Mamai O, Parsova V, Lipatova N, Gazizyanova J, Mamai I. 2020. The system of effective management of crop production in modern conditions.Fayzrakhmanov D, Ziganshin B, Nezhmetdinova F, Shaydullin R, editors. BIO Web of Conferences, 17:00027.

Mendes, Diogo Machado; Paglietti L. 2015. Irrigation market brief. In: Food Agricultural Organizations. Rome: Food Agricultural Organizations; p. 57.

Mengistu DD, Degaga DT, Tsehay AS. 2021. Analyzing the contribution of crop diversification in improving household food security among wheat dominated rural households in Sinana District, Bale Zone, Ethiopia. Agriculture & Food Security, 10(1):7.

Mesfin M, Matusala B, Teketel M. 2020. Assessing the Challenges of Irrigation Development in Ethiopia: A Review. International Journal of Engineering Research, 9(01). 010114.

Molla E, Hailekirstos E, Mengstie M, Zenebe T. 2022. Determinants of wheat value chain in case of North Shewa Zone of Amhara region, Ethiopia. Cogent Economics & Finance, 10(1): 2014639.

Muluneh A, Tadesse T, Girma R. 2022. Assessing potential land suitable for surface irrigation using GIS and AHP techniques in the Rift Valley Lakes Basin, Ethiopia. Sustainable Water Resources Management, 8(2):46.

Nakawuka P, Langan S, Schmitter P, Barron J. 2018. A review of trends, constraints and opportunities of smallholder irrigation in East Africa. Global Food Security, 17(11):196-212.

Negesso H, Edae M. 2018. Environmental implications of Universal Rural Road Access Program (URRAP) roads in Southwestern Ethiopia: The case of Jimma and Buno Bedelle zones. Multidisciplinary Journal for Education, Social and Technological Sciences, 5(1): 86.

Noort MWJ, Renzetti S, Linderhof V, du Rand GE, Marx-Pienaar NJMM, de Kock HL, Magano N, Taylor JRN. 2022. Towards Sustainable Shifts to Healthy Diets and Food Security in Sub-Saharan Africa with Climate-Resilient Crops in Bread-Type Products: A Food System Analysis. Foods, 11(2):135.

Ozkan B, Dube AK, Reed MR. 2022. Role of Agricultural Extension in Building Climate Resilience of Food Security in Ethiopia. In: Food Security & Climate-Smart Food System, Cham: Springer International Publishing: 219-239.

Regasa MS, Nones M, Adeba D. 2021. A Review on Land Use and Land Cover Change in Ethiopian Basins. Land, 10(6):585.

Riemens M, Sønderskov M, Moonen A-C, Storkey J, Kudsk P. 2022. An Integrated Weed Management framework: A pan-European perspective. Eur J Agron, 133:126443.

Santoso HB, Delima R. 2017. Stakeholder Definition for Indonesian Integrated Agriculture Information System (IAIS). IOP Conf Ser Mater Sci Eng, 185(2017):012014.

Shikur ZH. 2020. Agricultural policies, agricultural production and rural households’ welfare in Ethiopia. Journal of Economics Structure, 9(1):50.

Shikur ZH. 2022. Wheat policy, wheat yield and production in Ethiopia. Cogent Economics and Finance, 10(1). 2079586.

Sime CH, Demissie TA. 2022. Assessment and prediction of the climate change impact on crop yield, in Jimma Zone Upper Gilgel Gibe Districts, Ethiopia. Arabian Journal of Geosciences, 15(3): 313.

Sori O, Adugna M. 2022. Determinants of groundnut producers’ market channel choice in Western Oromia region, Ethiopia. Journal of Agriculture and Food Research, 7: 100277.

Sosibo NZ, Muchaonyerwa P, Visser L, Barnard A, Dube E, Tsilo TJ. 2017. Soil fertility constraints and yield gaps of irrigation wheat in South Africa. S Afr J Sci 113(1/2). 20160141.

Tadesse W, Zegeye H, Debele T, Kassa D, Shiferaw W, Solomon T, Negash T, Geleta N, Bishaw Z, Assefa S. 2022. Wheat Production and Breeding in Ethiopia: Retrospect and Prospects. Crop Breeding, Genet Genomics, 4(3): e220003.

Tadesse B, Tilahun Y, Bekele T, Mekonen G. 2021. Assessment of challenges of crop production and marketing in Bench-Sheko, Kaffa, Sheka, and West-Omo zones of southwest Ethiopia. Heliyon, 7(6): e07319.

Tadesse W, Bishaw Z, Assefa S. 2019. Wheat production and breeding in Sub-Saharan Africa. International Journal of Climate Change Strategies & Management, 11(5): 696-715.

Wordofa MG, Hassen JY, Endris GS, Aweke CS, Moges DK, Rorisa DT. 2021. Adoption of improved agricultural technology and its impact on household income: a propensity score matching estimation in eastern Ethiopia. Agriculture & Food Security, 10(1):5.

Yohannes DF, Ritsema CJ, Eyasu Y, Solomon H, van Dam JC, Froebrich J, Ritzema HP, Meressa A. 2019. A participatory and practical irrigation scheduling in semiarid areas: the case of Gumselassa irrigation scheme in Northern Ethiopia. Agricultural Water Management, 218:102-114.

Yuan Y, Lin F, Maucieri C, Zhang Y. 2022. Efficient Irrigation Methods and Optimal Nitrogen Dose to Enhance Wheat Yield, Inputs Efficiency and Economic Benefits in the North China Plain. Agronomy, 12(2):273.

Zegeye MB, Fikrie AH, Asefa AB. 2022. Impact of agricultural technology adoption on wheat productivity: Evidence from North Shewa Zone, Amhara Region, Ethiopia. Cogent Economics & Finance, 10(1). 2101223.

Zewde AA, Purba JH. 2022. Rate of stripe rust (Puccinia striiformis) on wheat in the highland and lowland area. J Agriculture & Applied Biology, 3(1): 62-69.

Analysis of Head Cabbage Value Chain in Guji Zone, Southern Oromia, Ethiopia

Tesfu Nega Bedada [2] Tekle Bobo Tolassa [1]

[1] Oromia Agricultural Research Institute Bore Agricultural Research Center, P. O. Box 21, Bore, Ethiopia

[2] Oromia Agricultural Research Institute Bore Agricultural Research Center, P. O. Box 21, Bore, Ethiopia

Corresponding author: Tekle Bobo Tolassa, E-mail: bobotekle@gmail.com, Phone: +251931665168/+251921829854

Abstract

Cabbage is highly nutritious, and it is an economically important vegetable in Ethiopia which is widely cultivated in Guji zone especially at highland districts. The study was aimed to analysis head cabbage value chain with the specific objectives of identifying actors, estimate marketing c ost and margins identify determinants of market outlets choice decisions and head cabbage market supply in the study area. Data were collected from 128 farmers, 25 traders and 15 consumers and analyzed. Identified actors include input suppliers, producers, rural collectors, brokers/dealers, wholesalers, retailers, and consumers by which 94.63 % of product pass through. The highest total gross margins 48.1% and highest producer gross marketing margin of 68.2% was recorded in channel V and II respectively. Total livestock unit, area allocated to head cabbage, market information and market distance as important factors affecting head cabbage market supply in the study area. Family size, land total, total livestock unit, transport facility, production experience, area allocated to head cabbage, extension service, training, credit access, off farm income and selling price determine market outlet choice decision of head cabbage producers in the study area. This study suggests improving farmers' knowledge and experience on head cabbage production and marketing, encouraging producers through extension service, land allocation for head cabbage, improving productivity and volume sales, improving market information access, expanding accessibility of market infrastructure and strengthening supportive institutions like credit access. In addition to this, it shall be better to improve the farmers' market margins by strengthening farmers-traders linkage through reducing brokers' exploitation and solving related production and marketing problems there by establishing centers for wholesalers and retailers and linking producers with institution like university make producer more profitable in the study area.

Key words: Guji**,** Actors, Head Cabbage, producer, value chain, analysis, channel choice, multivariate probit

Introduction

Background and Justification

Head cabbage is leafy vegetables and highly nutritious with so many health reimbursements. It is rich in photo-nutrient anti-oxidants that are powerful oxidants and known to help protect against breast, colon, and prostate cancers blood. Additionally, fresh cabbage is an outstanding source of natural antioxidant, vitamin C that develops resistance against infectious agents and scavenges harmful, pro-inflammatory free radicals (Umesh, 2014). Its production is increasingly important activity in the agricultural sector of the country 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). It is economically important vegetables in the country which grows best under cool conditions. According to CSA (2019), annual head cabbage production (in quintal) and area under production (in hectare) has increased by about 16 and 30 percent, respectively, from 2020/21 to 2021/22.

In Ethiopia, Head Cabbage is mostly produced for consumption and market through informal market (Anonymous, 2012). It grows best under cool conditions. During the 2018/2019 cropping season in Ethiopia, the total area under head cabbage production was estimated to be 5,170.52 hectares with an average yield of about 60.89 quintal per hectare where Oromia region shared 2474.91 hectares (CSA, 2019).

Guji Zone is one of the head cabbage producing Zones in the region. Head Cabbage is widely produced in highland of Guji Zone due to its suitable environmental condition. It is one of the cash crop vegetable produced and marketed by farmers.

However the development of horticulture production and marketing in Ethiopia is constrained factors like 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).

As 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 like 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.

In the study area, head cabbage is one of the cash crop vegetable produced. Farmers produce head cabbage especially for market purpose for cash income. However, there are problems related to head cabbage in the country in general and in the study area in particular; Input supply shortage, low productivity, product perishability, poor post-harvest management, price drop after harvest, limited recipes at consumption level (Bezabih and Mengistu, 2011; kassa, 2014; Bazie, 2009), limited infrastructural development, transportation pr oblem and low negotiation of producers who can be cheated by marketing agents.

The development and upgrading of the value chains is an important agenda for the government, companies and other institutions. Entry into higher value markets requires an understanding of the requirements and dynamic forces within the value chain (Baker, 2006). Understanding of the existing inputs supply systems, production, marketing systems and consumption of head cabbage is important for developing/upgrading value chain in the study areas. Despite the production potentials and importance of head cabbage crop for 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 producers and supply to the markets. 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 (Beriso *et al*., 2019). Therefore understanding of the existing head cabbage inputs supply systems, production and marketing systems is crucial for developing well organized value chain development in the study area.

Objectives of the Study

General objective

The general objective of this study was to analysis of head cabbage value chain in Guji Zone, Southern Oromia.

Specific objectives

The specific objectives of the study were to:

- ✓ Identify head cabbage value chain actors and draw value chain map;
- ✓ Analyze the market performance in the head cabbage value chain
- ✓ Identify the determinants of market outlets choice decisions of head cabbage producers and
- ✓ Identify the determinants of head cabbage market supply by farmers in the study areas**.**

Methodology

Research Design

A cross sectional survey research design was employed for this study. Quantitative and qualitative research data were collected from primary and secondary data sources. Quantitative data was collected from district agricultural offices whereas both quantitative and qualitative data were collected from farmers, traders and consumers using questionnaires and analyzed.

Sampling Technique and Sample size

The study was undertaken in two districts of the highland area of the zone in which Head cabbage is potentially produced. The districts used for the study were Bore and Ana Sora where three PA of Bore Bidika, Ano keransa and Alayo Diba were selected from Bore and Yirba Buliyo, Gosa Ilu, Raya Boda and Homa shela were purposively selected from Ana Sora district respectively. Based on the completed enumeration or sampling frame of the household in each selected PAs, household farmers were selected based systematic sampling where the total sample size is the summation of sample household selected from each PAs as described in table1.

Table 1 sampling producers of head cabbage producers

No	PA	Total Number of head cabbage producers (N = 862)	Number of sampled households
1	Bore Bidika	140 (k = 140/20 =7), j =2	20
2	Anno Keransa	120(k = 120/20 =6), j =3	20
3	Alayo Diba	160(k = 120/20 =8),j=5	20
4	Gosa Ilu	180(k = 180/30 =6), j= 6	20
5	Homa Shela	124(k = 124/15 = 8), j=3	15
6	Yirba Buliyo	132(k = 120/16 =7), j=2	16
7	Raya Boda	106(k = 106/17 =6), j=1	17
Total		862	128

Sample traders were collected using a purposive sampling method where the actors, wholesalers (7), rural collectors (2) and retailers (16) from the markets that head cabbage passed through. Accordingly, a total of 25 traders were selected. Furthermore, 15 consumers were interviewed.

Methods of Data analysis

Descriptive statistics was used to analyze the data collected, employed maps, percentages, frequencies, means and standard deviations. To evaluate the market performance in the value chain net returns and estimated costs of value chain actors along the value chain were calculated. For describing market chain actors of producing and transacting Head cabbage from farmers to final consumer were identified and mapped .this actors include head cabbage producing farmers, input suppliers, wholesalers, retailers, collectors, brokers and final consumers. The value chain was visualized the chain of actors, identify roles and linkage among the actors. The data of production, cost of production and marketing were obtained from survey result.

Head cabbage market performance of the area was examined by analyzing market cost and price margins among different head cabbage marketing actors in order to measures the degree of head cabbage marketing efficiency where marketing margin is the difference between prices at different levels in marketing system and total marketing margin is different between what a consumer pays for head cabbage per quintal and what producers or farmers receives for the produce (Mendoza, 1995).

$$TGMM = \frac{\text{Final consumer price} - \text{Farmer price}}{\text{Final Consumer price}} \quad (1)$$

Where, TGMM is Total Gross Marketing Margin which is useful to introduce here the idea of producer participation, farmer's portion or producer's gross margin (GMM) which is the portion of the price paid by the end consumer that belongs to the farmer as a producer. The producer's margin or share in the consumer price (GMMp) is calculated as:

$$\text{GMMp} = \frac{\text{Consumer price} - \text{TGMM}}{\text{Consumer price}} = 1 - \text{TGMM} \quad (2)$$

The consumer price share or portion of market intermediate is calculated as:-

$$\text{MM} = \frac{\text{Selling price} - \text{Buying price}}{\text{Consumer price}} * 100 \quad (3)$$

Where MM is Marketing Margin in percentage

Net marketing margin (NMM**)** which is the percentage over 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:

$$\text{NMM} = \frac{\text{GMM} - \text{Marketing cost}}{\text{Consumer price}} * 100 \quad (4)$$

Econometric Model

In this study, multiple linear regression models was used to analyze data to generate information about determinants of head cabbage market supply and Multivariate probit model was used to analyze the producers channel choice.

Multiple linear regression models are employed to estimate the determinants continuous dependent variables and two or more continuous or categorical independent variables. This model is also selected for its simplicity and practical applicability (Woodridge, 2002). Based on literatures, the head cabbage supply model to be estimated in this study was taking the following form.

$Y_i = f(x_1, \dots, x_n)$ Where sample size and n is number of explanatory variables used for building model.

Where Econometric model specification of supply function defined as:

$$y_i = \alpha + x_i\beta_i + \varepsilon_i \quad (5)$$

Where is ε_i distributed as $\varepsilon_i \sim N(0, 1)$

X_i is a vector of explanatory variables hypothesized to affect farmers' head cabbage market supply, β_i is a vectors of parameters to be estimated which measures the effects of explanatory variables on the farmers decision of potato market supply. ε_i is random error normally distributed with mean zero and constant variance.

It is known that, the selection decision is inherently multivariate and attempting univariate modeling excludes useful economic information contained in interdependent and simultaneous choice decisions. Based on this argument, the study adopted multivariate probit (MVP) econometric model to simultaneously model the influence of the set of explanatory variables on each of the different market channel choices, while allowing the unobserved or unmeasured factors (error terms) to be freely correlated (Belderbos *et al*., 2004).

In multivariate probit model, where the choice of several market channel choice 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 $(\mu y_1, \mu y_2, \mu y_3, \ldots) MVN \sim (0, \Omega)$, the symmetric covariance matrix is given by:

$$\begin{bmatrix} 1 & \cdots & \rho yiyj \\ \vdots & \ddots & \vdots \\ \rho yjyi & \cdots & 1 \end{bmatrix} \quad (6)$$

Similarly, since the decision to select market channel or channels might be affected by some dependent variables the multivariate model will be specified of all actors across each channel. Where the model is described as follow.

$$\begin{cases} Wholesales = x_1'\beta_1\varepsilon^W \\ Retailers = x_2'\beta_2\varepsilon^R \\ Consumers = x_3'\beta_3\varepsilon^C \\ . \\ . \\ . \end{cases} \quad (7)$$

Result and Discussions

Descriptive Statistics

Demographics and Socioeconomics Characteristics of Households

The variables used to describe demographic characteristics of sample farmers were sex, , marital status, transport facility, extension service, training, off farm income and credit from categorical variables and family size, total land owned, total livestock unit, production experience of head cabbage, area allocated to head cabbage, selling price, market supply and distance to nearest market of continuous variables were contributed influence on the head cabbage and head cabbage channel choice of the producers respectively. The results are presented in Table 2 depicts that, about 85.16% of the producers were male and the remaining 14.84 % were female headed households revealing that females participation is low in determining family livelihood among assessed respondents.

The average head cabbage harvested which was taken to the market for sale by the respondents in rural area was 5787.3 quintal 2013. The average household size is about 6.6 hectare, with family size of 8.4 persons per household, which is larger than the national average 4.6 persons per household (CSA, 2014b). Livestock owned TLU of 13.3 in average. A household on average allocated 0.5 ha of land for head cabbage production, which is very small, perhaps due to the unavailability seed for the crop. The extension services reached out 53.13% of the farm households, while the credit service extended only credit about 11.81%.

Though all the respondents in this survey are primarily engaged in crop production and livestock rearing, 69.29% of them are also participated in off/non-farm activities to generate additional income. Off/non-farm activities refer both to self-employments in non-farm sectors such as petty trade, mining and off-farm employment such as government, daily labor, and guard non-government organizations.

Access to agricultural markets and marketing information are essential factors in promoting competitive markets and improving agricultural sector development. A well-organized market intelligence information system helps all the producers and traders freely interact with one another in arriving at prices (Wubet *et al.*, 2022). Access to reliable market information help farmers sell their surpluses of head cabbage and choose modes of transaction, each of which yields a different benefit. It has been postulated that farmers will choose a profitable mode of transaction if they can receive reliable market information on the prevailing market conditions. The result revealed that about 79.53 % the producer obtain market information.

Table 2 Demographic and Socio-economic characteristics of Respondents

Variables	Descriptions	Frequency	Percent
Sex	Female	19	14.84
	Male	109	85.16
Marital status	Unmarried	1	0.78
	Married	127	99.22
Transport facility	No	32	25
	Yes	96	75
Extension Service	No	60	46.88
	Yes	68	53.13
Training	No	97	75.78
	Yes	31	24.22
credit access	No	112	88.19
	Yes	15	11.81
Off farm income	No	39	30.71
	Yes	88	69.29
Market information	No	26	20.47
	Yes	101	79.53
Family size	Mean	8.4 (3.5)	-
Land Total	Mean	6.6 (4.8)	-
Total Livestock Unit	Mean	13.3 (7.3)	-
Production Experience	Mean	4.9 (4.1)	-
Area allocated	Mean	0.5 (0.4)	-
Selling price	Mean	383.9 (163.4)	-
Market supply	Mean	45.8 (37.8)	-
Market Distance	Mean	34.9 (25.5)	-

Input utilization

Inputs used by farmers of the study area are seed, fertilizer, herbicides and pesticides. These inputs are supplied to farmers either by District Agricultural office, union, private traders or local markets.

The value chain map of head cabbage in both district was similar and presented in Figure 1, the two head cabbage value chain actors were identified namely direct actors those are input suppliers, producers, traders, consumers and indirect actors were those that provide financial or non-financial support services, such as government offices, credit agencies, business service providers and union.

The survey result indicated that around 93.75 of sample respondents applied fertilizers for production of head cabbage in the study area (Table 3).

Table 3 Input usage of sample Respondents

Input	Measurement	Total (N=128)	
		Frequency	Percentage (%)
	Yes	128	100
Improved Seed	No	0	0
Fertilizer	Yes	120	93.75
	No	8	6.25
Chemicals	Yes	18	14.06
	No	110	85.59

Input Suppliers: Primary multipurpose farmers' cooperatives, Union, district agricultural office and local market were major suppliers' of seed, fertilizer and chemical input to producers in both districts (Table 4). Head cabbage farmers also participated in preparing their own inputs and they also supply to fellow farmers. Over all, these actors supplied seeds, fertilizers, chemicals and trainings. In the study area, farmers use inorganic fertilizer of DAP and UREA fertilizers supplied from cooperatives and agricultural office (Table 5).

Table 4 Major input Suppliers

Input	Source	Total(N = 141)	
		Frequency	Percentage (%)
Improved Seed	Agriculture Office	0	0
	Local Market	125	97.66
	Union	0	0
	NGOs	3	2.34
Fertilizer	Agriculture Office	120	93.75
	Local Market	8	6.25
Chemicals (Pesticides and Herbicides)	Agriculture Office	3	2.34
	Local Market	25	19.53
Labor	Family labor	83	64.84
	Hired labor	15	11.72
	Labor Exchange	15	11.72
	Cooperation	15	11.72

A larger proportion of farmers (97.66%) were purchased seed from local market (Table 5). This contradicts with the finding of Kassa (2014) the most common seed sources were producers themselves.

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 (Beriso, 2019). Head cabbage sole cropping is the most popularly practiced cropping pattern in the study area. Sample farmers sold their head cabbage produce at the available market options which were at farm gate and nearest village market or urban (town) market to different value chain actors like collectors, wholesalers, retailers and consumers (including individual households, hotels and restaurants).

Collectors: Rural collectors are independent operators at primary markets who assemble and transport head cabbage from smallholder 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 horse 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/dealers: Brokers/dealers in the districts have regular and temporary customers from major towns and cities across the country. They facilitate transaction by convincing farmers to sale his product and facilitating the process of searching good quality and quantity head cabbage to wholesalers. The share of profit that goes to brokers/dealer varies from farmer to farmer and from trader to trader. The brokers/dealers 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/dealers to purchase the head cabbage products from the farmers where they negotiate prices. Brokers/dealers 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/dealer, they forced to sell at the lower price because of perishability of the product. The broker/dealers 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/dealers.

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 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, local collectors and using brokers/dealers. They buy head cabbage from producers, collectors and by using brokers/dealers from Bore and Ana sora districts and sell to retailers and consumers at Bore, Sora, Adola, Shakkiso, Negele and Hawassa markets.

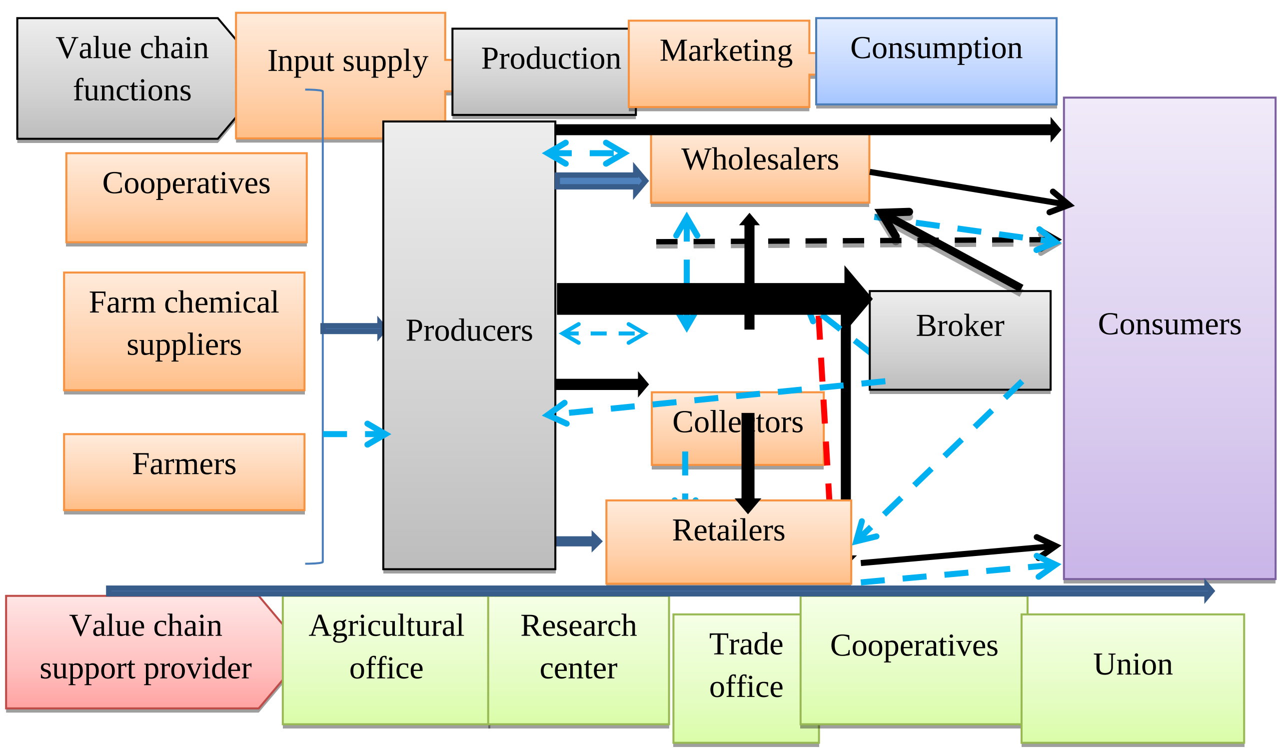
Retailers: Retailers are key actors in head cabbage value chain within and outside the study area. These are known for their limited capacity of purchasing and handling products and low financial capacity. They are the last link between producers and consumers. There are two types of retailers in the study area districts retailers and central retailers. Districts retailers are buying head cabbage either from farmers or wholesale traders. While district or zonal or regional market retailers in major cities mostly buy from wholesalers and sell to town consumers. The 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) and hotels. 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 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 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 like 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 (Beriso, 2019).

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 Agriculture Office, District Trade and Market Development Office, Research and Private transporters. Some service providers extend services beyond one function and others are limited to a specific function.

Private Transporters and NGOs are value chain supporters identified in the study area. Some service providers extend their supportive functions along the value chain and also have multiple functions. Agricultural offices provided agricultural extension services, follow closely the head cabbage farmers, they advise on head cabbage cultivation, management of agronomic practices and organizing and providing trainings.



Produce and input flow two way flow of information one way flow of information.

Fig 1 production, Input and Information flown of head cabbage value chain

Value chains, marketing margins and Marketing Channels of Head cabbage

Value chain Analysis

Five marketing channels were identified for head cabbage value chain in the study area. The total product passed through the channel was 5857.30 quintals of head cabbage. The channel comparison was made based on volume passed through. Accordingly, a channel of Farmers → Wholesalers → Retailers→ consumers is the largest in which was about 59%(3432.8 quintal) of the product passed through (channel I) and followed by a channel of Farmers →Retailers → Consumers in which 19.55% (1145 Quintal) of the product passed through it (channel II) in the study area (figure 1)

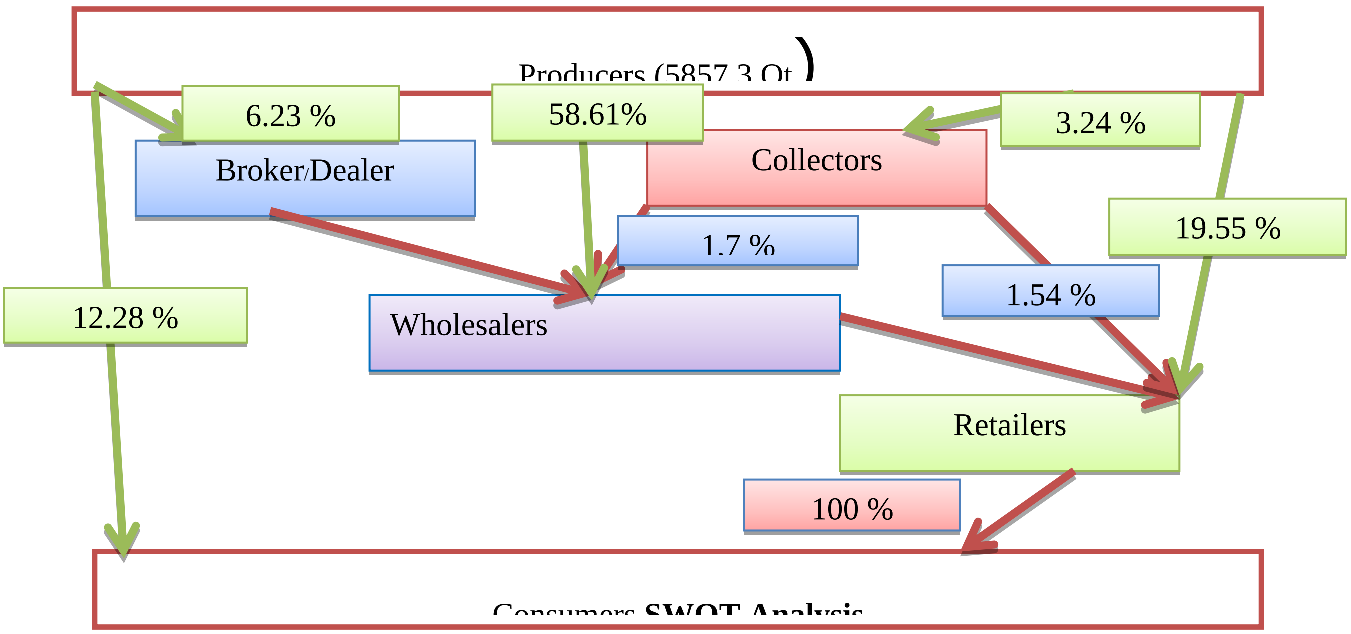


Fig 2 Head cabbage value chain map of study area

Channel I. Producer → Consumers (12.28%)
Chanel II. Producer → Broker → Wholesalers → Retailers → Consumers (6.23%)
Channel III. Producer → Wholesalers → Retailers → Consumers (58.61%)
Channel IV. Producer → Collectors → Wholesalers → Retailers → Consumers (1.7%)
Channel V. Producer → Collectors → Retailers → Consumers (1.54%)
Channel VI. Producer → Retailers → Consumers (19.55%)
Farmers sold about 58.61% of their head cabbage produce to wholesalers, 19.55% Retailers, 6.23% to brokers/dealers and 12.28% to consumers.

Marketing margin

Marketing margin is one of the commonly used measures of the performance of a marketing system. It is defined as the difference between the price the consumers pay and the price the producers receive. Computing the total gross marketing margin (TGMM) is always related to the final price or the price paid by the end consumer, expressed in percentage (Mendoza, 1995).
Gross marketing margin (GMM) is the gap between prices at consecutive levels in the marketing channel. Therefore for this study the marketing margins were computed based on the data collected of value chain actors.
In Table 5 GMMp, GMMbr, GMMr, GMMc and GMMw means gross marketing margins for producers, retailers, collectors and wholesalers agents respectively were computed.

Table 5 Marketing margin (Birr/Quintal)

Channels	GMMP	GMMbr	GMMr	GMMc	GMMw	TGMM
I	100	-	-	-	-	0.00
II	51.9	0.0064	0.481	-	0.015	0.481
III	60.2	-	0.174	-	0.398	0.398
IV	56.6	-	0.431	0.15	0.021	0.431
V	56.9	-	0.015	0.431	-	0.431
VI	68.6	-	0.314	-	-	0.314

Total gross marketing margin is the highest in channel II which is 48.1%. Without considering channel I, which farmers sell directly to consumers, producers gross marketing margin is the highest in channel VI which is 68.2%.

Profitability of head cabbage production in the study areas

In conducting profitability analysis of head cabbage production, market prices for purchased inputs and output were considered. For inputs like family labor, exchange labor, own animal draft power, own land and other inputs which the households use in head cabbage production without paying direct cost, its opportunity costs were used. Sampled farmers sold head cabbage product in fresh form so the reference product was taken in fresh head cabbage form. Prices differ per marketing channel, per quantity sold, change over the season, and even prices can vary during one single day. Therefore, weighted average price was used in analyzing profitability of head cabbage production and marketing for the value chain actors.

Table 6. Profitability analysis of head producer sample farm households

Input cost Items	Average Cost	
	Birr/Qt	Production cost (%)
Seed cost	41.03	40.6
Labor cost	27	26.71
Land rent	8.30	8.21
Fertilizer cost	20.17	19.95
Oxen cost	2.10	2.08
Pesticide cost	2.5	2.06
Total cost	**101.10**	
Marketing cost		
Packing material	12.5	
Loading and unloading	10	
Transportation	19.50	
Broker	10.20	
Sell tax	0.2	
Other cost	15.40	
Loss	0	
Total marking cost	**67.8**	
Overall total cost	**168.9**	
Selling price	393.5	
Net return	**292.4**	

Qt = quintal, % = percentage, other cost implies opportunity costs
Source: Own survey result, 2021

As observed in Table 7, the average production cost of head cabbage was 168.80 Birr/ Qt. Out of the total costs of production, seed accounts 40.6% of the total production cost which was major cost component in head cabbage production in the study area. The average selling price was 393.5 Birr/Qt and net return of farmers from head cabbage production was estimated at 292.4 Birr/Qt, which is 56% their selling price and 127.4% of total cost of the area in the year 2021/22. The study result was high as compared with the study of head cabbage value chain in West Arsi of Kofole and Kore of Beriso (2019). As Masuku and Xaba (2013) this variation could be arise from types of market agency where farmers were selling and land allocation affected vegetables production profitability.

Table 7, depicts the total cost and net return of different actors from a quintal of head cabbage. Retailers in general get highest net return of 120 Birr per quintal than other value chain actors followed by wholesalers and collector where the least earner was broker. Among actors, retailers earn highest percentage of net profit that was a net return about 22.41% of the purchase price. But this does not mean that retailers are generating more profit in total than other actors. Even if they get highest net profit per unit, they handle small quantity of head cabbage than wholesaler of low profit. This finding in line with Dawit and Fitsum (2016), retailers earn the highest marketing margin from all other vegetable traders in East Shoa, Ethiopia. Wholesaler’s total benefit is greater than the others because they handle large volume.

Table 7. Cost, Marketing margin and profit margin of value chain actors

Cost items	Producers	Broker	Collectors	Wholesalers	Retailers	Total
Production cost	**101.10**	-	-	-	-	-
Purchasing price	-	393.5	383.91	400	440	1208.91
Labor for packing	-	-	0	1.5	2	3.5
Loading and unloading	-	-	20	25	28.25	73.25
Transport	-	-	0	40	30	70
Packing material	-	-	15	17	17.5	49.5
Sorting	-		20	0	5	25
Telephone	-	58.25	15	57.25	26	98.25
Storage	-	-	0	0	-	0
Marketing cost	67.80	-	70	75	90	302.8
Total cost	168.9	58.25	140	215.75	198.75	781.9
Total cost (%)	21.6	7.45	17.91	27.6	25.42	100
Sale price	393.5	480	623.91	716.25	758.75	2960.82
Marketing Margin	215.01	86.5	240	316.25	318.75	1220.01
Share (%)	17.62	-	19.67	25.92	26.13	100
Profit margin	**292.40**	**71.75**	**100**	**100.5**	**120**	535.51
Share (%)	40.15	13.4	18.67	18.77	22.41	100

Source: Own computation from survey result, 2022

Marketing Channels

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 58.61% sold head cabbage to wholesalers, 19.55% to retailers and 12.28% to consumers.

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. Six marketing channels of head cabbage are exhibited in the study areas. It was estimated that 5857.3 quintals of head cabbage were supplied to market by sampled farmers. Wholesalers and retailers were the main receivers of head cabbage with percentage shares of 58.61% and 19.55%, respectively (Figure 1).

Econometrics Model Results

Determinants of head cabbage market supply

Several variables were hypothesized to influence the volume of head cabbage market supply by sampled farmers. The results for all VIF values were ranges between 1.1 and 1.74. Hence, multicollinearity was not a serious problem among the variables used for constructing the model. The regression model has also no problem of heteroscedasticity which proves that all the explanatory variables were included for the model can be used to analysis determinants of market supply of head cabbage. Similarly, the model has no the problem of endogeneity Generally, the overall goodness of fit of the regression model was measured by the coefficient of determination, R^2. R^2 Values of the model were 0.90 which shows that what proportion of the variation in the dependent variable is explained by the explanatory variable. Hence this result indicates that about 90% of the variation in marketed supply of head was attributed to the hypothesized variables in the study area. There are 7 continuous and 8 dummy independent variables of which 5 variables significantly affect the market supply of head Cabbage (table 8).

Total Livestock unit: The model result showed that total livestock owned of the household was positively associated with the quantity of head cabbage market supply indicating a one unit increase in livestock likely to increase head cabbage market supply by 0.66 quintal in average. The positive relationship indicates that farmers having large total livestock are able to purchase more input for head cabbage production intern produce more quintal of head cabbage and supplied a large quantity of head cabbage to the market outlet. In the other cases, farmers with more livestock assets have better animal manure for input production which helps to increase productivity and production and finally farmers would supply more head cabbage to market where livestock also used as transport facility in transporting head cabbage produce. This indicates that the number of livestock increases; farmers can increase their production and promote market participation. In line with this finding, Habtamu (2015) and Shewaye (2015), in their studies, found that the number of livestock owned had positive and significantly associated with the likelihood of farmers' participation in potatoes and haricot bean market respectively.

Land allocation: The result also revealed farmers who allocated more land for head cabbage production significantly and positively affect the quantity of head cabbage market supply. It revealed that as the land allocation is increased in 1 hectare the quantity supply of head cabbage is increased by 57.11 in average. Corresponding to this finding, (Kuma *et al*., 2013) who reported that large land size allocated for banana has significant and positive affect to the farmers' market participation.

Market information: market information access was positively affected the head cabbage market supply at 10% significance level. This shows head cabbage producers who mostly accessed to true market information of selling price from different sources had supplied large amount of their product to the appropriate market channel where they can get expected profit. The result is in line with Mmabando *et al*., (2016). Who identified that access to market price information is directly related to households' choice of wholesaler market channel.

Market Distance: Distance from the nearest market positively influenced the household's market supply at 10% significance level. This indicates that as the distance from the nearest market (walking minute) increases the head cabbage market supply decreased by 0.16. The result agrees with the findings of Oliyad and Megersa (2022) who identified market distance has positively affected the probability of selling at farm gate and to collector market channel. This might be due to that the type of product where to be mostly supplied regardless of the distance like sesame being produced for export while horticultural crops cannot be stored for a longer time due to their perishability.

Table 8. Head cabbage market supply factors result

Market Supply	Coef.	SE	P>|t|
Sex	-2.46	8.66	0.777
Age	0.12	0.42	0.777
Family size	-0.22	1.23	0.86
Education level	-12.3	9.68	0.207
Land Total	0.49	1.26	0.7
Total Livestock Unit	0.66*	0.36	0.071
Transport facility	-0.62	6.88	0.928
Production Experience	0.02	0.77	0.982
Area allocated to Head cabbage	57.11***	14.01	0.00
Extension Service	7.96	5.82	0.174
Training	-3.02	8.55	0.725
Credit access	-4.88	7.80	0.533
Cooperative member	2.31	7.11	0.746
Market information	9.85*	5.80	0.092
Market distance	-0.16*	0.10	0.103
Constant	-27.3	23.73	0.252
Number of observation	128	-	-
F(16, 110)	4.9	-	-
Prob >F	0.000	-	-
R- squared	0.912	-	-
Root MSE	30.249	-	-
Breusch Pagan test		-	-
Chi-square (1)	13.98	-	-
Prob > chi-square	0.0002	-	-

Determinants of market channel choice

Three binary dependent variables, wholesaler, retailer and consumer were used to jointly estimate the multivariate Probit model (Table). The Wald test was used to test the model fits, the data is statistically significant at 1% significance level, which implied that the subsets of coefficient are jointly significant and the independent variable include in the model is acceptable. Moreover the likelihood ratio test in the model (ρ21 = ρ31 = ρ32 = 0) is significant at 1%. Therefore, the null hypothesis that all the ρ (Rho) values are jointly equal to 0 is rejected, indicating that the decisions to choose these market channels are interdependent.

Hence, the use of multivariate probit model is justified to determine factors influencing choice of market channels. Further, there are ρ values (ρij) indicate the degree of correlation between market channel choices. The ρ21 (correlation between the choice for retailer and wholesaler market outlet) and ρ32 (correlation between the choice for consumer and retailer market outlet) are both negative and statistically significant at the 1% and 10% significance level respectively

(Table 9). The study revealed that farmers delivering to the wholesalers are less likely to deliver to retailer (ρ21). Equally, farmers who involved in retailer market outlet are less likely to send their head cabbage to the wholesaler (ρ21). Moreover the Simulated maximum likelihood estimation results suggested that there was positive and significant interdependence between farmers selection of market outlet of retailer and consumers which implied that the ρ31 (correlation between choice for consumers and retailer) are positively and statistically significant at 1% level.

The marginal success probability for each equation (market channel decision) is reported below. The likelihood of choosing retailer is relatively low (41.7%) as compared to the probability of selecting consumer market channel (59.5 %) and selecting wholesaler market channel (54.9%). This is good evidence because farmers were not interested in selling their products to retailer market channel even if they get good price than other market channel due to marketing cost.

If head cabbage farmers choose all three market channels, their joint probabilities of choosing these market channels would be only 6.14%. It was unlikely for farmers to choose all three market channels simultaneously. This was justified either by the fact that simultaneous chose of all market channels was unaffordable for the smallholders head cabbage farmers, or that all three market channels were not simultaneously accessible in the study areas. However, their joint probability of not choosing all three market channels was 5.13%, implying that the households were more unlikely to fail. This evidence suggests that choosing the right mix of market channels is determined by different factors for each market channels. The finding was also consistent with Degye *et al*. (2013) in their study on food security and agricultural technologies interaction study in Ethiopia.

Total livestock unit: The model result showed that total livestock owned of the household was positively associated with the wholesaler market outlet at 5% significant level. The positive relationship indicates that farmers having large total livestock are able to purchase more input for head cabbage production intern produce more quintal of head cabbage and supplied a large quantity of head cabbage to the retailer market outlet. In the other cases, farmers with more livestock assets have better animal manure for input production which helps to increase productivity and production and finally farmers would supply more head cabbage to wholesaler market outlet. This study in line with (Kuma *et al*., 2013; Habtamu *et al*, 2020) confirmed that livestock hold had positively and significantly affected the access of milk and onion market outlet respectively.

Land allocation: The result also revealed farmers who allocated more land for head cabbage production significantly and negatively associated with the choice of retailers outlet chose at 5%, level of significant. This is in line with the study of (Woldie and Nuppenau, 2009) and (Kuma *et al*., 2013) who reported that large land size allocated for banana and potato positively and significantly affects the proportion sold to wholesaler traders and cooperative milk market outlets, respectively.

Quantity of head cabbage supplied: It affected the probability of selecting wholesaler market channels positively and significantly at 1% significance level. This implies that farmers who produce and supplied larger quantities of head cabbage sell to markets that purchase a large quantity of groundnut for sale. The result agrees with the findings of Habtamu *et al*, (2020) who revealed a quantity of onion product supplied to market had a positive influence on the probability of selecting wholesalers market channel.

Access to transport facility: access to transport services has positively influenced the likelihood of head cabbage producers to select wholesaler market channels at a 5% significance level. Transport facilities increase the likelihood of farmers to select wholesaler channels than other market channels. Having transport services minimize transportation cost, the problem related with it and supplies the product where the market channel they want locating timely. The result is consistent with the findings of (Kassaw *et al*., 2016; Sori *et al*., 2017) access to transport facilities has a positive effect on the probability of selecting a wholesaler market channel of tomato and groundnut, respectively.

Off-farm income: The likelihood of households to select retailer market channels were positively affected by access to off/ non-farm income at a 5% significance level. It implies that farmers who have access to off/non-farm income choose retailer channels over others. This is due to farmers who have non-farm income wanting to sell head cabbage smaller quantities and want to practice retail business by using their income from other businesses. The result is in contrast with the finding of Habtamu *et al*. (2020 who identified a direct relationship between groundnut producers' non-farm income and retailer's market channel choices.

Family size: family size influences positively the likelihood of choosing wholesalers outlet at 5% significance level and influenced negatively the likelihood of choosing retailer outlet at 5% level of significance. This result indicated that those households with large number of family size were more likely to sell to whole sellers. This is because the wholesalers has the capacity to purchase large quantity of head cabbage expectations of future benefits like share dividend for those households who supply more product where the farmers having large number of family size produce ore and supply more by using family labor. The implication is that if the family have enough family labor, it is possible to produce large quantity of head cabbage to be sold is large, farmers search market outlets that buy large volume with reasonable price and incentive.

Production experience: Head cabbage producing experience has a negative relationship with likelihood of choosing retailer outlet at 5% levels of significance. The result showed that those households with a more number of year engagement in cabbage production and marketing are more likely to choose other outlet. This may be due to that experienced producers had better knowledge of cost and benefits associated with various cabbage marketing outlets that give the producers desire to adjust their market links, trying alternative marketing outlets to increase sales volume so as to increase the profits. The finding of Kifle *et al*. (2015) showed that the number of years a household spent in beekeeping positively and significantly affected using cooperative market outlet. Additionally selling price of head cabbage has positive relationship with the likelihood of choosing retailers outlet at 5%level of significance implying that since retailers buy small quantity in relation to wholesalers at market place they had owe to pay good price.

Extension service: extension service has a positive and significant influence on both wholesalers and retailer and retailer's outlet choice decision at 1% and 5% significance level respectively. Extension services increase the ability of farmers to acquire important market information as well as enable the head cabbage producers to improve production methods, hence leading to more output which in turn increases producers' ability to choose the best market outlet for their product. Thus, households who were visited more by extension agents were more likely to deliver head cabbage via wholesalers and retailers outlets. This result is similar to a study by Bardhan *et al*. (2012) that confirms regular contact with extension functionaries had a positive influence on the likelihood choice of cooperative outlet by milk producer in Uttarakhand. Tarekegn *et al*. (2017) also reported that extension service positive influence on likelihood choice of retailers and cooperatives by beekeepers.

Table 9. Determinants of head cabbage market channel choice

Variables	Market Channels											
	Wholesaler				Retailer				Consumer			
	Coef.	SE	Z	P>|z|	Coef.	SE	Z	P>|z|	Coef.	SE	z	P>|z|
Household sex	0.67	0.44	1.5	0.133	0.11	0.39	0.28	0.779	-0.99	0.42	-2.33	0.2
Household age	0.02	0.02	0.73	0.464	0.01	0.02	0.76	0.445	0.02	0.02	0.95	0.34
Family size	0.12**	0.06	2.22	0.026	-0.07**	0.04	-1.86	0.062	0.05	0.05	1.03	0.305
Land total	0.14****	0.04	3.24	0.001	0.04	0.04	1.04	0.3	-0.01	0.04	-0.18	0.858
Total livestock nit	0.05**	0.02	2.24	0.025	0.02	0.02	1.17	0.242	0.01	0.02	0.26	0.792
Transport facility	0.82**	0.38	2.15	0.031	0.29	0.34	0.85	0.394	0.10	0.33	0.31	0.759
Production Experience	0.03	0.03	0.78	0.434	-0.06**	0.03	-1.67	0.095	-0.01	0.03	-0.26	0.792
Area allocated	0.27	0.49	0.54	0.587	-1.05**	0.45	-2.34	0.019	-0.12	0.44	-0.28	0.777
Extension service	1.42***	0.36	3.93	0.000	0.57**	0.32	1.76	0.078	-0.32	0.29	-1.09	0.274
Training	1.08***	0.39	2.81	0.005	0.55**	0.33	1.69	0.091	0.45	0.33	1.35	0.176
Credit access	0.16	0.41	0.41	0.685	-0.02	0.39	-0.06	0.953	0.68*	0.43	1.59	0.112
Cooperative	-0.25	0.31	-0.82	0.415	0.16	0.28	0.55	0.584	0.22	0.28	0.78	0.435
Off farm income	-0.35	0.34	-1.04	0.298	0.61**	0.32	1.9	0.058	-0.25	0.30	-0.81	0.415
Selling price	0. 35	0. 86	0.4	0.686	0. 18**	0. 791	2.23	0.026	0.0005	0.001	0.57	0.569
Market information	0.54	0.35	1.54	0.125	0.04	0.34	0.13	0.897	-0.18	0.33	-0.54	0.592
Education level	-0.27	0.4	-	0.538	-0.11	0.36	-0.3	0.76	0.34	0.40	0.8	0.39

		4	0.62					5			5	4
Market supply	0.02***	0.01	3.53	0.000	0.00	0.01	0.87	0.386	0.00	0.00	-0.74	0.458
Market distance	-0.002	0.01	-0.26	0.8	-0.002	0.005	-0.36	0.72	-0.001	0.005	-0.25	0.803
Constant	-1.32	0.89	-1.48	0.14	-1.28**	0.73	-1.74	0.081	0.07	0.78	0.09	0.924
Predicted Probability	0.55				0.417				0.595			
ρ_{21}	-0.86	0.09	-9.96	0.00***								
ρ_{31}	-0.30	0.17	-1.76	0.078*								
ρ_{32}	0.28	0.14	1.97	0.049**								
Number of Observation	122											
LRT (16)	61.46***											
LRT of correlations	31.99***											
Joint probability of success	0.064											
Joint probability of failure	0.051											

Additionally Even though head cabbage is widely grown and marketed for a long time in the study area, farmers face many constraints such as availability of improved seed, disease, , pesticides, shortage of fertilizer, insect, pests, low linkage with lower value chain actors, lower price, low and consumer demand in cabbage production and marketing.

Moreover, poor product handling absence of storage facility, lack of credit availability, price fluctuation, poor sectorial support and inadequate market information were the common problems which have been raised by traders. Traders reported absence of proper standardization facility and product perishability as the main problems in head cabbage trading which cause price fluctuation and lower price. About 36 % of the traders reported that in availability of credit access is their main problem trading the product in the area. They also reported, Even if suitable agro-ecology, presence of experienced and interested farmers, the existence of non-governmental and governmental support to the crop is very low in improving farmer’s livelihoods regarding head cabbage production and marketing.

Table 9. Head cabbage marketing constraints of traders

Constraints	Number of respondents	Percentage
Credit	9	36
Price	2	8
Lack of demand	7	28
Inadequate information	2	8
Quality problem	5	20

Source: Own survey result, 2021

Conclusions and Recommendations

Conclusion

The study analyzed value chain analysis of head cabbage in southern Oromia. Data collected from 128 head cabbage producers through systematic sampling techniques where data collected was analyzed by using both descriptive and econometric methods (linear regression and multivariate probit models). The result from the analysis showed that head cabbage producers market supply and decision to select channel is determined by many factors where different market channels like collectors, wholesalers, retailers, and consumers were identified. Among these market channels wholesalers were the largest channel in terms of quantity of head cabbage supplied. However, the quantity of head cabbage supplied to broker market channels was relatively low when compared with other channels.

Multiple linear regression result revealed that head cabbage market supply affected by variables such as marital status, total livestock unit, land allocated to head cabbage, market information and market distance. Multivariate probit model result indicated that variables like

Producer's different alternative market outlets such as wholesalers, retailers and consumers are confirmation that the dependency of household level marketing decisions is empirically estimated by multivariate probit where variables like family size, total land, total livestock unit, transport access, extension service, training and market supply had significantly affected the probability of head cabbage producers to choose wholesalers market channel and the likelihood to select retailers market channel was also affected by the family size, production experience, land allocation, extension service, training, off farm income, and selling price. Farmers' choice of consumer's market channel is significantly affected by the sex of household and access to credit services.

The producers select multiple marketing outlets as a strategy to safeguard their savings and to maximize their incomes in the long term. Head cabbage producers involved in wholesalers marketing are less likely to send their head cabbage to the retailers and consumers. Significant negative correlations between some choices of market outlets support assumption that sellers can select two or more market outlets' simultaneously. The head cabbage producers who sell their produce to retailer and consumer are characterized small in volume as a result of poor access to road and market information (about quality and prices), low extension packages know how, and their weak capacity to comply with cooperative market requirements.

Recommendations

Therefore, to increase production, market supply, select preferable market channels and supply the required amount of head cabbage to appropriate market channels at right time farmers need aware direction of the effects which could improve their production, marketing of head cabbage produce and market channel choices, developing production skills, willing to be cooperated with macro consumers, innovate new methods of head cabbage production and engage in other income-generating non-farm activities that improve their market channel choice likelihoods.

Expanding equal infrastructures like road and transportation facilities needs government intervention to promote the effective marketing of head cabbage through all outlets and establishing head cabbage collection centers in potential production areas that encourage better price for producer. Additionally, expanding rural micro finances to tackle shortage of credit provision and advising farmers to use credit for head cabbage production create conditions for larger production of head cabbage, market supply and head cabbage market channel choices. Farmers should search market information and identify their choice of market information sources to supply for appropriate market channels. Minimizing transportation problems through shifting from local transport to vehicles for supplying for appropriate market channel could bring expected income of head cabbage selling for farmers.

References

Bazie, M., 2016. Potato value chain analysis in Banja District, Awi Zone of Amhara *Region, Ethiopia* (Doctoral dissertation, Haramaya University).

Belderbos, Heterogeneity in R and D cooperation strategies, Int. J. Ind. Organ. 22 (8–9) (2004) 1237–1263.

Beriso Bati, Esmael, Y., Negassa, A. and Gizachew, S., 2018. Value Chain Analysis of Head Cabbage: The Case of Kofele and Kore Districts in West Arsi Zone, Oromia National Regional State, Ethiopia. In *Regional Review Workshop on Completed Research Activities* (p. 1).

Bezabih E, Mengistu K, Jeffreyson KM, Jemal Y (2015) Factors Affecting Market Outlet Choice of Potato Producers in Eastern Hararghe Zone, Ethiopia. J Econ Sustainable Development 6: 159-172

Bezabih Emana and Mengistu Nigussie. 2011. Potato value chain analysis and development in Ethiopia: Case of Tigray and SNNP regions. International potato center (CIP-Ethiopia), Addis Ababa.

Bezabih Emana, Amsalu Ayana, Tesfaye Balemi and Milkessa Temesgen. 2014. Scoping Study on Vegetables Seed Systems and Policy in Ethiopia. Addis Ababa, Ethiopia.

Bezabih Emana. 2010. Market Assessment and Value Chain Analysis in Benishangul Gumuz Regional State, Ethiopia. *SID-Consult-Support Integrated Development*, Addis Ababa, Ethiopia.

Central Statistical Agency of Ethiopia, (CSA, 2019).

CSA (Central Statistical Agency). 2014a. Agricultural sample survey 2013/2014: Report on area and production

CSA (Central Statistical Agency). 2014b. Agricultural sample survey 2013/2014: Volume IV– Report on land utilization (Private peasant holdings meher season). Statistical Bulletin number 446, Addis Ababa, Ethiopia.

Habtamu Mossie,., Berhanie, Z. and Alemayehu, G., 2020. Factor affecting outlet choice of onion producers Northwest Ethiopia in multivariate probit approach. *Cogent Food & Agriculture*, *6*(1), p.1722351.

Hailegiorgis, D.S. and Hagos, F. 2016. Structure and performance of vegetable marketing in East Shoa zone, Oromia Region, Ethiopia. Journal of Marketing and Consumer Research. 26:7-16.

Kassa T. Alemu. 2014. Potato value chain in Ethiopia: Cases of Sinan and Bibugn districts in East Gojjam. *Time Journals of Agriculture and Veterinary Sciences*, 2(6):114-124.

Kohls, R.L., and J.N. Uhl. 1990. Marketing of agricultural products. 5th edition, McMillan Publishing, New York.

Kuma, D. Baker, K. Getnet, B. Kassa, Factors affecting milk market channel choices in wolaita zone, Ethiopia, African Journal of Agricultural Marketing 8 (21) (2013) 2493–2501.

Masuku, M. B. and Xaba, B. G., (2013). Factors affecting the choice of marketing channel by vegetable farmers in Swaziland. Sustainable Agriculture Research, 2(526– 2016–37887)

Megersa Adugn and Sori, O. and., 2022. Determinants of groundnut producers' market channel choice in Western Oromia region, Ethiopia. *Journal of Agriculture and Food Research*, *7*, p.100277.

Mendoza, G. 1995. A Primer on Marketing Channels and Margins. Lyme Rimer Publishers Inc., USA. 425p.

Mmbando, E. Wale, J.S.L. Baiyegunhi, The welfare impacts of market channel choice by smallholder farmers in Tanzania, Dev. Pract. 27 (7) (2017) 981–993.

Sori, M. Ketema, M. Aman, Factors affecting market channel choice of groundnut producers in Digga district of Oromia state, Ethiopia, J. Econ. Sustain. Dev. 8 (17) (2017) 61–68.

Tarekegn, K., Haji, J. and Tegegne, B., 2017. Determinants of honey producer market outlet choice in Chena District, southern Ethiopia: a multivariate probit regression analysis. *Agricultural and food economics*, *5*(1), pp.1-14.

Woldie, G. A., & Nuppenau, E. (2009). Channel choice decision in the Ethiopian banana markets: A transaction cost economics perspective. Journal of Economic Theory, 3(4), 80–90.

Woodridge Greene, Econometric Analysis, seventh ed., Prentice Hall, Pearson, NJ, 2012.

Analysis of Smallholder farmers' Vegetable Crops Commercialization in East Hararghe Zone, Oromia Regional State, Ethiopia: Crops output market

Solomon Ayele[*1], Kibret Ketema and Hussein Abro
[1]Socio-economics Research Team, Fedis Agricultural Research Center, P. O. Box 904, Harar, Ethiopia
*Corresponding authors email-address**:** solomon4ayele@gmail.com, kebret2012@gmail.com, hhnn2004@gmail.com

Abstract

Transforming the subsistence-oriented production system into a market-oriented production system as a way to increase the smallholder farmer's income and reduce rural poverty has been in the policy spotlight of many developing countries, including Ethiopia particularly in the East Hararghe Zone. The objective of this study was to identify factors that determine household level output side commercialization of vegetable crops in East Hararghe zone. A multi-stage or two stage random sampling procedure was used to select 230 sample vegetable producers from the zone using probability proportional to size. Descriptive statistics and econometric model were used to analyze data. The findings further revealed that the mean household vegetable commercialization index (HCI) was 89.21%. The results from the Tobit regression model revealed that commercialization of vegetable crops was determined by the distances to nearest market center, access to market information, livestock ownership, cooperative membership and area allocated under vegetable production. This study recommended that improving market access, organizing farmers into groups in order to have better access to agricultural inputs, providing market information through networking and institutions, and clustering and intensification of vegetable crops production are therefore crucial in enhancing the commercialization and level of vegetable commercialization.
Key words: Commercialization, East Hararghe, Smallholder farmers, Tobit model, Vegetable crops

Introduction

Agriculture continues to dominate the national economy of Ethiopia, accounting for 36.7% of overall GDP and 70% of foreign exchange earnings. The sector provides employment for 72.7% of the population and is a means of generating livelihood for about 83% of the rural population (ATA, 2017; FAO, 2015). In Ethiopia 95% of the total area under agriculture is cultivated by smallholder farmers and contributes to 90% of the total agricultural output indicating the dominant contribution of smallholder farmers to the overall agricultural production (MoARD, 2012; Gebreslassie and Bekele, 2012). However, in agriculture-based economies the smallholder agricultural production is characterized by low output, poor access to land, and poor access to inputs, poor irrigation system, little access to know-how (risk management, technology, and skill), low level of market orientation, poor infrastructure and institutional factors (Bezabih and Hadera, 2007; Moti, 2007; Tilaye, 2010).

Commercialization in agriculture refers to the progressive shift from household production for auto-consumption to production for sale in the market. This shift entails that production and input decisions are based on profit maximization, reinforcing vertical linkages between input and output markets (Olwande *et al*., 2015). Historically, this has typically been a lengthy process of transformation from subsistence to semi-commercial farming, and then to fully commercialized agriculture (Pingali and Rosegrant, 1995). Increasing the extent of commercialization among Sub-Saharan Africa's generally semi-subsistence, low-input, low-productivity smallholder famers is seen as playing a crucial role in poverty alleviation (Olwande *et al*., 2015).

Recently, the governments of developing countries have sought to promote diversification of production and exports away from the traditional commodities in order to accelerate economic growth, expand employment opportunities, and reduce rural poverty (Solomon *et al.*, 2010). Market oriented production can allow households to increase their income by producing output with higher returns to land and labor and using the income generated from sales to purchase goods for consumption (Schneider and Gugerty, 2010). Similarly, Ethiopian government, in its two-consecutive five-years Growth and Transformation Plan (GTP-I and GTP-II), has given much emphasis on agricultural commercialization, among which the second pillar intends to achieve growth and thereby improve people's livelihoods and reduce poverty. Commercialization of the smallholder farmers has been viewed by the government as the major source of agricultural growth in Ethiopia. The government of Ethiopia implemented agricultural commercialization clusters with the primary goal of commercialization of smallholders' agriculture and agro-industrial development, offering a strategic entry point for private sector engagement (MoFED, 2015).

Vegetable production plays important role in poverty alleviation through employment generation, improving the feeding behavior of the people, and creating new opportunities for poor farmers. Since the labor to land ratio of vegetable cultivation is high, vegetable products are bulky and perishable, and vegetable has continuous demand in the market, its production and marketing allows high productive employment. Increasing horticultural production and marketing thus contribute to commercialization of the rural economy and create many off-farm jobs (Weignberger and Lumpkin, 2005). Most of the vegetables and fruit produced in the eastern region are exported to Djibouti and small amounts of fruit and vegetables are also exported to Europe, Pakistan, Saudi Arabia and Yemen (Emana, 2007). Small scale production is concentrated in Harerghe (eastern high land parts) and the central high lands, whilst large commercialized cultivations are widely spread in the low land zones, mainly following the Awash and Gibe/Omo rivers (Wiersinga and Jager, 2007). According to Ethiopian Export Promotion Agency, the eastern part of the country like Haramaya, Kombolcha, Dire Dawa and Harari region are well known in production and supply of vegetable crops.

Although there is a wealth of literature on smallholder commercialization in Ethiopia, it is mainly on grain crops and livestock and livestock product however market participation of the smallholder vegetable crops producers in the country is still limited. Accordingly, various empirical studies pointed out that, in Ethiopia, smallholder commercialization determined by institutional factors, infrastructural and market related factors, household resource endowments, and household specific characteristics (Pender and Dawit, 2007; Berhanu *et al.*, 2009; Goitom, 2009; Adam *et al.*, 2010; Berhanu and Moti, 2010; Aman *et al.*, 2014; Abafita *et al.*, 2016). Eastern Hararghe zones have good potential in vegetable crops production for which smallholder farming have diversified from staple food subsistence production into more market oriented and higher value commodities. However, there is apparent knowledge gap as regards to factors influencing the degree of commercialization of vegetable crops in Ethiopia general and in particular to East Hararghe zone because most of the literature on Ethiopia has been largely crop-specific (focusing on a single crop in most cases) and based on narrow samples drawn from one or two districts that do not allow generalization. Moreover, there are issues related to how commercialization is conceptually defined and measured. Chanyalew *et al.,* 2011; Kumelachew, 2013) conducted factors determined the degree of commercialization of potato production at Kombolcha district which was focused on a single crop.

Despite the fact that, in the study areas, the extent to which farmers have commercialized major vegetable crops production was not known. There was no research conducted on the commercialization of major vegetable crops in the study areas. In addition, in the study area, the purpose of vegetable production (family consumption and/or for sale) varies from situation to situation and person to person. As such, there are tremendous factors, which influence the level of commercialization in vegetables production. Therefore, this study was mainly devise to find the level of major vegetables (potato, onion, tomato and cabbage) commercialization (measured from the output side-a more prevalent way than that of the input side) and identification of factors determining proportion of vegetable marketed at the household level in the selected districts of the study area.

Objectives of the Study

The general objective of this study was to describe the characteristics of smallholder farmers' commercialization in vegetable crops and explore policies to promote smallholder farmers' participation in market-oriented vegetable crops in East Hararghe Zone of Oromia National Regional State, Ethiopia with the following specific objectives.

Specific Objectives

1) To measure level of smallholder farmers' commercialization in the major vegetable crops in the study area;
2) To identify determinants of smallholder farmers' commercialization of vegetable crops in the study areas;
3) To identify major vegetable crops production and market constraints in the study areas

Methodology

Descriptions of the study areas

This study was conducted vegetable producing districts of East Hararghe Zone namely Kombolcha, Haramaya and Kersa because of their medium for both export and domestic vegetable marketing centers.

Kombolcha District: Kombolcha district is one of the nineteen districts of East Hararghe Zone of Oromia Regional State. It is located at about 17 km north of Harar town and 542 km east of Addis Ababa, the nation's capital city. The altitude of the district ranges from 1200-2460 meters above sea level. Agro climatically, the district ranges from *Woina-dega (mid-altitude)* to Kola (low lands). The annual rainfall ranges from 600mm to 900mm with a bimodal and erratic pattern. The mean annual temperature of the area ranges between 16-25°C.

Different types of vegetables and cereals are grown in the district. The most commonly grown vegetables are potato, cabbage, onion, carrot and among the cereals sorghum and maize are dominant. Chat is also one of the intensively grown crops in the area. The district is also one of the potato trading centers in the country from which potato is sold for export and domestic market.

Haramaya District: Haramaya district is one of the nineteen districts of East Hararghe Zone of Oromia Regional State. It is located at about 12 km west of Harar town and 524 km east of Addis Ababa, the nation's capital city. The altitude of the district ranges from 1214-2066 meters above sea level. Agro climatically, the district ranges from *Woina-dega (mid-altitude)* to Kola (low lands). The annual rainfall ranges from 600mm to 900mm with a bimodal and erratic pattern. The mean annual temperature of the area ranges between 16-25°C.

Farming practices of the district is under rain-fed, and irrigation for crop production. The major crops cultivated under rain fed was sorghum, maize, some pulse crop and, dual season crop production practiced i.e. both under rain-fed, and irrigation were some vegetables (potato, lettuce, onion and khat dominantly cultivated in the area. The common cash crop produced under irrigation in the area, were potatoes, head cabbage, leaf cabbage, lettuce, small pod, hot pepper, carrot, beat root, shallot (baro) are important crop following khat.

Kersa District: Kersa district is one of the nineteen districts of East Hararghe Zone of Oromia Regional State. It is located at about 51 km west of Harar town and 475 km east of Addis Ababa, the nation's capital city. The altitude of the district ranges from 1400 -3200 meters above sea level. The agro climatic of the district is Highland, midland and lowland. The mean annual rainfall of the district is 1500mm with a bimodal and erratic pattern. The mean annual temperature of the area ranges between 18-22°C.

Farming practices of the district is under rain-fed, and irrigation for crop production. The major crops grown in the area are wheat, maize, sorghum, haricot beans, Feba beans, chick peans, lentils, linseed, potato, cabbage, onion and beetroot.

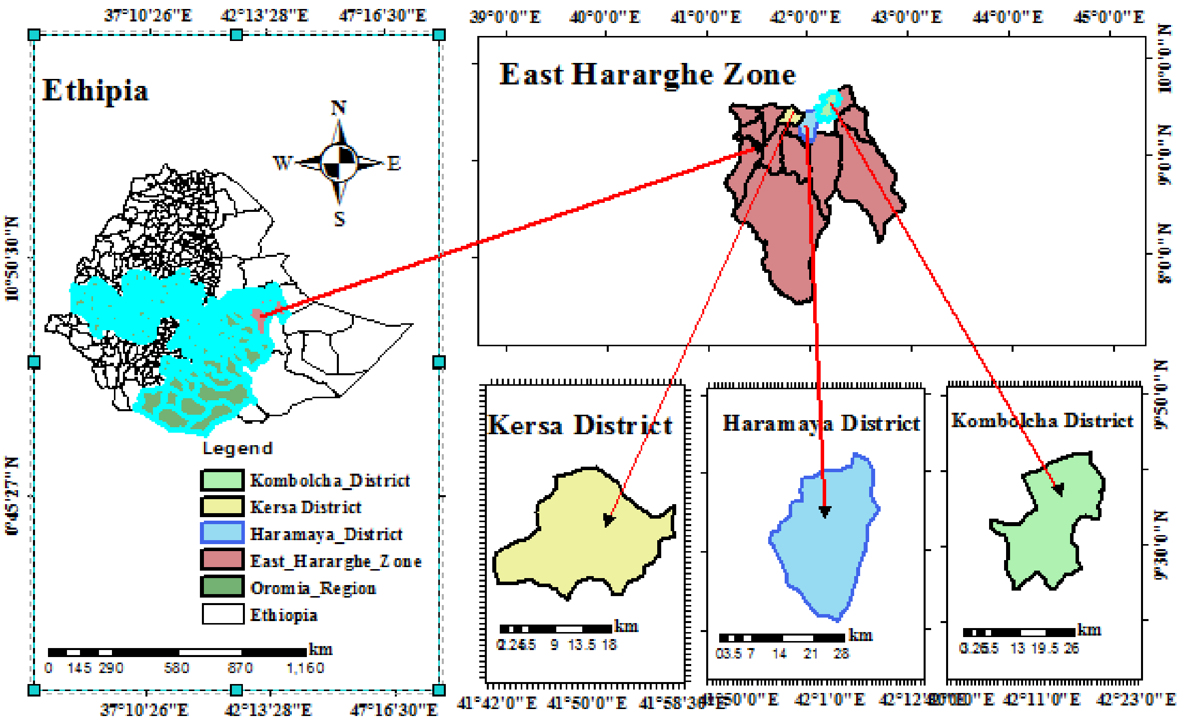


Figure 6. Map of study areas

Types, Sources of data and Methods of data collection

Both qualitative and quantitative data were collected from secondary and primary sources. Primary data were collected from sampled household heads interviews who were randomly selected from the selected *kebeles* using structured and semi-structured questionnaire. Secondary data were collected from secondary sources (published and unpublished materials), Districts Office of Agriculture and other sources.

Sampling procedure and Sample size determination

A multi-stage sampling procedure was employed to select sample households. In the first stage, vegetable crops growing potential districts were identified in collaboration with zonal office of agriculture and accordingly four districts were selected purposively. In second stage, vegetable crops growing *kebeles* were listed based on their production potential and accessible road with districts agricultural office experts. Accordingly, three *kebeles* were randomly selected in each district. In the third stage, households growing vegetable crops were randomly selected from the sampled *kebeles.* The sample size in each kebeles was determined using Probability Proportional to sample size of vegetable producers' households.

Table 5. Distribution of sample vegetable producers included in the survey

Kebele	**District**			**Total**
	Haramaya	**Kersa**	**Kombolcha**	
Ifa Jalala	-	25	-	25
Bal'a lange	-	27	-	27
Wacaro	-	20	-	20
Tuji Gabisa	34	-	-	34
Kurro	30	-	-	30
Tinike	25	-	-	25
Qeeransa	-	-	20	20
Bilisuma	-	-	24	24
Qaqalli	-	-	25	25
Total	**89**	**72**	**69**	**230**

Methods of data analysis

Both descriptive statistics and econometric model was used in this study to address the stated objectives. The statistical value of mean, standard deviation, percentages and ratios was used to examine and understand the socio-economic characteristics of sampled households. Commercial Index (HCI) was used to analyze level of vegetable crops commercialization. Tobit econometric model was used to analysis the determinants of commercialization of smallholder farmers' vegetable crops in the study areas.

Analysis of level of major vegetables commercialization

Different approaches and indicators have been used for measuring the level of agriculture commercialization (Randolph, 1992) and Von Braun *et al.,* (1994) specified three types of indices for measuring commercialization at household level. These are the (i) output and input side commercialization type indices which measure the proportion of agricultural output sold to the market and input acquired from market to the total value of agricultural production, (ii) commercialization of the rural economy index is defined as the ratio of the value of goods and services acquired through market transactions to total household income. Here, there is an assumption that some transactions may take place in-kind such as payments with food commodities for land use, and (iii) degree of a household's integration into the cash economy which is measured as the ratio of the value of goods and services acquired by cash transaction to the total household income (von Braun *et al.*, 1994).

Govereh et al., (1999) and Strasberg et al., (1999) on the other hand used a household commercialization index (HCI) to measure the extent of commercialization at household level. The HCI is a ratio of the gross value of all crop sales per household per year to the gross value of all crop production. It thus measures the degree to which a household sells its output to market. The advantage the HCI is that it provides the level of commercialization for every household separately. Gabre-Madhin *et al.*, (2007) used four approaches to measure the level of household commercialization which are:

(i) The sales-to-output ratio which measures the gross value of all agricultural sales by a household as a percentage of the total gross value of its agricultural production. This ratio is similar to the percentage of agricultural output sold to total agricultural production.

(ii) The sales-to-income ratios which measures the ratio of the gross value of total sales to total income from crop production. In this index, income from crop production is assumed as a proxy to total household income, ignoring income from livestock, and off- and non-farm sources.

(iii) The net and absolute market positions (either as a net buyer, net seller or autarkic/self-sufficient household) which is evaluated using the ratio of volume of sales and volume of purchases to the total volume of stock: the sum of storage from the previous production year and production in the current year.

(iv) The income diversification or level of specialization in agricultural production. The specialization index tries to capture to what extent farm households are specialized in their production to capture the benefits from comparative advantages: producing what they can efficiently produce and buying what they cannot. This index measures the proportion of the value of purchased agricultural products not produced by households to the gross value of agricultural production.

A majority of studies measure the level of smallholder commercialization in terms of the proportion of output sold in markets (Randolph 1992; von Braun et al. 1994). This study was used to measured agricultural commercialization in terms of scale adapted from von Braun (1994) and Strasberg *et al*, (1999) and Bekele *et al*, (2010). It is an index measured as proportion of total amount sold to total output produced at farm level as given in equation (2):

$$\boldsymbol{HCI_i = \frac{Gross\ value\ of\ vegetable\ sales}{Gross\ value\ of\ all\ vegetable\ produced} * 100} \quad \textbf{(2)}$$

Gross value of vegetable sold = $\boldsymbol{S_{Ki}}$, Gross value of all vegetable produced = $\boldsymbol{Q_{ki}}$**,** Then

$$\boldsymbol{HCIi = \frac{\sum_{i=1}^{n} S_{ki}}{\sum_{i=1}^{n} Q_{ki}} \times 100} \quad \textbf{(3)}$$

Where, $\mathbf{HCI_i}$, refers to the level of households' commercialization index growing vegetable crop *"k"* which is ($\boldsymbol{0 \leq HCI_i \leq 100}$)**,** $\boldsymbol{S_{Ki}}$ is value of vegetable crop sold in monetary terms of crop *k, and* $\boldsymbol{Q_{ki}}$ is the monetary value of total vegetable crop *k* where *k* ranges from 1,2…*k.* The vegetable crops considered will be potato, onion, tomato and cabbage which are produced for home consumption as well as for market purpose. The larger the index the higher the degree of commercialization and a value of zero showing a totally subsistence-oriented household. Following the works by Strasberg et al., (1999) and Bekele et al., (2010) the farm households involved in greater sales of crop output with index value of fifty or more(HCI ≥50) are commercial oriented while those with lesser or no sales (HCI <50) are subsistence oriented.

Econometric Analysis

Determinants of smallholder farmers' vegetable commercialization

The dependent variable used to measure commercialization of vegetable producing sample households was commercialization index. HCI is the ratio of the gross value of all vegetable sales to gross value of all vegetable production by a household. The commercialization index is censored because some of its values cluster at the limit (i.e., 0 for subsistence producers and 1 for fully commercialized). Hence, censored regression model is the option for handling this limited dependent variable. Therefore, this study was used a Tobit regression model. The Tobit regression model was chosen because it allows for the estimation of linear relationships between variables when there is either left- or right-censoring in the dependent variable (also known as censoring from below and above, respectively (Maddala, 1983; Gujarati, 2004). The structural equation of the Tobit model is given as:

$$\boldsymbol{Y_i^*} = \boldsymbol{X_{i\beta'}} + \varepsilon_i \qquad \textbf{(7)}$$

Denoting Yi as the observed dependent (censored) variable

$$\boldsymbol{Y_{i=}} \begin{cases} & \mathbf{0} \quad \boldsymbol{if\ y*\leq 0} \\ \boldsymbol{y*_{i\,=}} & \boldsymbol{y*} \quad \boldsymbol{if\ 0<y*<1} \\ & \mathbf{1} \quad \boldsymbol{if\ y*\geq 1} \end{cases} \qquad \textbf{(8)}$$

Where:
Y_i = the observed dependent variable, in this case commercialization
y_i^* = the latent variable (unobserved for values smaller than 0 and greater than 1)
X_i= is a vector of independent variables hypothesized to influence commercialization.
β_i = are parameters associated with the independent variables to be estimated.
ε_i= Residuals that are independently and identically normally distributed with mean zero and a common variance.
i= 1, 2…, n, (n is the number of observations).

β = a vector of parameters to be estimated

U = disturbance term

Hypothesis, Variable Selection and Definition

In the course of identifying factors influencing vegetable household commercialization index the main task is exploring which factors potentially influence and how (the direction of the relationship) these factors are related with the dependent variables.

Dependent variables

Household Commercialization Index (HCI): It is a dummy dependent variable used in the Tobit model equation. It is measured in the proportion of gross value of vegetable sales to gross value of vegetable produced in the survey year.

Independent variables

Age of Household Head: It is a continuous variable and measured in years. Aged households are believed to be wise in resource use, on the other hand young household heads have long investment horizon and it is expected to have either positive or negative effect on volume of vegetable sales. Adugna (2009) who found that age of the household head have negative effect on the elasticity of onion supply to the market. This variable is also expected to have positive/negative relationship with household commercialization index. In their study of smallholder cassava commercialization in Ghana, Martey *et al.,* (2012) found that increasing age had a positive effect on the commercial index of a farm household. Older farmers tend to be more commercialized because they are able to make better production decisions and have greater contacts which allow trading opportunities to be discovered at a lower cost than younger ones. Alternatively, it is possible that younger heads are more dynamic with regards to adoption of innovations both in terms of those that would enhance their productivity and enhance their marketing at a reduced cost (Enete and Igbokwe, 2009).

Gender of household head: A dummy variable taking zero if female and one if male for variable to be considered. Sign could not be attached with the variable. Tshiunza *et al.*, (2001) determined that male farmers tended to produce cooking banana for market and therefore participated in banana market more than female farmers participate. This study expects to that being the male household headed was positively related with the household commercialization.

Education status of household head: It is measured in continuous variable in years of education level of household head. According to Gebremedhin and Tegegne, (2012), literate farmers have better skills, better access to information and better ability to process information and are thus positively associated with commercial orientation. Education enhances farmers' understanding of production and marketing dynamics (Martey *et al.*, 2012). It positively influences the farmer's perceptions towards credit, new technologies, and information which all aid in commercialization (Kabiti *et al.*, 2016). Astewel (2010) found that if paddy producer gets educated, the amount of paddy supplied to the market increases, which suggests that education improves level of sales that affects the marketable surplus and commercialization.

Farming experience of household head: It is the total number of years a farmer stays in production of vegetables. A household with better experience in vegetable farming is expected to produce more amounts of vegetables and, as a result, he is expected to supply more amounts of vegetables to market. Farmers with longer farming experience are expected to be more knowledgeable and skillful (Ayelech, 2011). Therefore, this variable was hypothesized to positively influence vegetable marketable surplus. A number of studies have found the farming experience to positively influence the household's commercial orientation (Pender and Alemu, 2007; Kabiti *et al.*, 2016).

Family size: Family size of a respondent is a continuous variable measured in terms of number of family members in the household. As vegetable production is labour intensive activity, vegetable production in general and market supply of vegetable products in particular is a function of labour. Accordingly, families with more household members tend to have more labor which in turn increase vegetable production and then increase vegetable market supply. On the other hand, family size also decreases market supply because high proportion of the product would be used for consumption. But for this study family size was expected to influence positively the volume of vegetable supply to the market. Gezahagn (2010) who found that family size have positive effect on the households' gross income from groundnut production. Household size represents the productive and consumption unit of the household (Randela, *et al.*, 2017). It is, therefore, logical to expect a large household to produce more marketable output or store it for household consumption. According to Kirui and Njiraini (2013), increasing household size, results in an increase in productivity which in turn results in increased output commercialization.

Total livestock owned (TLU): This is a continuous variable measured in tropical livestock unit. The effect of livestock ownership on smallholder commercialization is varied. Income obtained from livestock can be used to acquire crop production resources to boost productivity, hence, commercialization. Also, access to assets such as ownership of livestock provides households with leverage to invest in market-oriented production (Randela, *et al.*, 2017). Alternatively, livestock ownership can be negatively associated with commercialization through offering alternative cash income sources (Gebremedhin and Tegegne, 2012). Study by Rehima (2006) on pepper marketing showed that TLU showed a negative sign on quantity of pepper sales.

Farm Size: This refers to the total area of land that a farm household owned in hectares. In agriculture, land is one of the major factors of production. The availability of land enables the owner to earn more agricultural output which in turn increases the marketable supply (Desta, 2004). In their study of market participation by smallholder cotton farmers in Nigeria, Randela *et al.*, (2008) found that farmers with relatively large land size had low levels of commercialization. Therefore, land holding have positive impact on vegetable marketable supply and level of vegetable commercialization.

Access to Market Information: This variable expected to influence market supply and level of vegetable commercialization positively. The variable will be considered dummy. Assign one if a farmer got information and zero if not. Farmers marketing decisions are based on market price information, and poorly integrated markets may convey inaccurate price information, leading to inefficient product movement. Therefore, it is hypothesized that market information is positively related to market supply of vegetables. Again, business decisions are based on dynamic information such as consumer needs and market trends (CIAT, 2004). Therefore those who have access to dynamic information will produce more vegetables for market. Muhammed (2011) who found that if wheat producer gets market information, the amount of wheat supplied to the market increases.

Credit Access: This is a dummy variable taking the value one if the household takes loan and zero otherwise, which indicates credit taken for vegetables production. Access to credit would enhance the financial capacity of the farmer to purchase the inputs, thereby increasing vegetable 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) who found that if pepper and teff producer gets credit, the amount of pepper and teff supplied to the market increased.

Distance to Nearest Market: It is the distance of the vegetables producer households from the nearest market and it is measured in hours of walking time. The closer the market, the lesser would be the transportation charges, reduced walking time, and reduced other marketing costs, better access to market information and facilities. In this study distance to nearest market is hypothesized to affect volume of vegetables sales and negatively. Similar issue was studied by Ayelech (2011) on fruit market in Goma woreda identified that poor market access has significant and negative effect on quantity of avocado and mango supplied. Siziba *et al*., (2011) found the distance to market to be negatively related to cereal market participation thus underscoring the adverse impact of increased transportation costs on output commercialization.

Table 6. Summary of dependent and independent variables used in econometric model

Variables	Definition	Measurement	Expected sign
Dependent variable			
HCI	Household Commercialization Index	Gross value of crop sold to Gross value of crop produced	
Independent variables			
AgeHH	Age of household head	Year of household head	+/-
EduHH	Education level of household head	Level of education	+
GenderHH	Gender of household head	1= male, 0= female	+/-
FamSize	Total active labor force in the household	Man equivalent	+
FarmExper	Farming experience of household head	Number of years since started farm activity	+
TLU	Total livestock owned by household	Tropical Livestock Unit	+/-
AccMktInf	Access to market information	1= if access to information, 0= otherwise	+
AccCredt	Access to credit	1= if access to loan, 0= otherwise	+
AccIrrig	Access to Irrigation	1 if the access to irrigation and 0 otherwise	+
DistMkt	Distance to nearest market	Kilometers/walking hours	-
Off/NonFam	Off/non-farm activities	Birr/year	-
ExtCont	Extension contact	Frequent visit of development Agents	+
FarmSize	Total land allocated for vegetable production	Hector	+

Results and Discussion

Descriptive Statistics Results

Socio-Economic Characteristics of the Sample households

The descriptive statistics results of the socioeconomic characteristics of the sample households in the selected districts are presented in Table 3 and 4. As shown in Table 3, the majority (about 92%) of the respondents were male-headed households. While Table 4 shows that, the average age of the sample household heads is about 34 years and the household heads have about 9 years of vegetable production experience. The survey results show that 36.5% of the vegetable producers were illiterate while the remaining sample respondents were literate.

Table 7. Summary statistics of sample households (dummy variables)

Variable	Category	Freq.	Percentage
Sex of household head	Male	213	92.61
	Female	17	7.39
Education of household head	Literate	146	63.48
	Illiterate	84	36.52
Access to use irrigation	Yes	163	70.87
	No	67	29.13
Access to market information	Yes	190	82.61
	No	40	17.39
Access to credit	Yes	22	9.57
	No	208	90.43
Extension contact by developmental agent during the last 12 months?	Yes	104	45.22
	No	126	54.78
Membership to cooperatives	Yes	51	22.17
	No	179	77.83
Access to improved seed/s	Yes	117	50.87
	No	113	49.13

Source: Computed from survey data result, 2022

The survey indicated that 70.82% of those respondents use irrigation for vegetables production. Most of the farmers rely on boreholes and pond for irrigation. In the study areas, water-pumping motor (owned or exchanging with labor service for fieldwork or just mutual assistance of the neighbors) plays a great role to undertake the irrigation. According to the survey result, 9.57% of the sample vegetable producing households had access to credit.

Access to timely and accurate vegetables market information is the basic element for producers to decide how much to produce and supply to market at what possible prices. (Table 3) revealed that 82.61% of the total sample households had access to vegetables market information.

Table 8. Summary statistics of sample households (continuous variables)

Variable	Mean	Std. Dev	Min	Max
Age of household head (year)	34.88	10.129	20	70
Household size (no.)	7	2.71	1	13
Total own landholding (ha)	0.331	0.196	0	1
Livestock owned (TLU)	2.23	1.56	0	8.02
Farm experience in vegetables production (year)	9.42	6.28	1	30
Distance to the nearest market place (Minutes)	54.76	24.92	10	120
Annual non/off-farm income (Birr)	1094.35	310.85	0	40000

Source: Computed from survey data result, 2022

Despite the huge and extensive investment in promoting extension services in the country, the survey shows that only 45.22% of the total sample respondents had contacted or visited by developmental agents on vegetables production (Table 2). Concerning the distance to the nearest market, according to the survey, the respondent farmers are expected to travel an average distance of about 54. 76 minutes to access to the nearest market. The mean total land holding for the sample vegetables producers is 0.331 hectares. Average number of livestock for the sample households is 2.23 tropical livestock units (Table 4).

Types of Vegetables Produced in the Study Areas

Different types of vegetables are grown in the study area with different intensities in terms of land and other input allocation, purpose of production, and marketability. The most commonly grown vegetables in terms of the number of growers are Irish potato, onion, beetroot, cabbage and carrot (Table 5).

Table 9. Proportion of households producing vegetables (2013/14 production year)

SNo.	Crops	Frequency	Percentage
1	Irish potato	225	97.82
2	Cabbage	37	16.08
3	Beetroot	42	18.26
4	Carrot	22	9.57
5	Onion	43	18.69

Source: Computed from survey data result, 2022

Inputs used for vegetables Production in the Study Areas

Land allocated for vegetables production

The smallholder farmers' livelihood in the study areas relied on small and fragmented plots. According to the survey, the average own landholdings of the respondents in the study areas is less than a hectare (0.331 ha on average). The average total cultivated land was 0.353 ha in the study areas. Since land is shortage in the study areas most of the sample households are using their own land. In addition very few sample households are producing their vegetables by rent in and share-in land from other farmers. Of these, an average of above 0.158 ha (45%) of the land is suitable for irrigation (is irrigable area). Overall, the survey results indicate that the proportion of land that is allocated to vegetables production was about 0.16 ha (45.32%). This indicates that vegetable production is potential crop in these study areas. Although vegetables are produced using rainwater, high income is earned from the production of vegetables produced under irrigation since the harvesting time can be scheduled for the period of high price i.e. the dry seasons. Thus, the irrigable area and availability of irrigation water determine the area allocated to vegetables and thereby determine the extent of income generated from vegetable production.

Table 10. Landholding, crop land, irrigable land and area allocated for different crops in hectors

Variable	**Mean**	**Std. Dev**	**Min**	**Max**
Own cultivated land (ha)	0.331	0.196	0	1
Rent-in land (ha)	0.009	0.047	0	0.375
Share-in land (ha)	0.0127	0.075	0	0.75
Total cultivated land (ha)	0.353	0.214	0.0625	1.25
Rain fed area (ha)	0.188	0.143	0	0.75
Irrigable area (ha)	0.158	0 .147	0	1
Area allocated to cereal (ha)	0.135	0.107	0	0.625
Area allocated to vegetables (ha)	0.190	0.094	0	0.5
Area allocated khat (ha)	0.076	0.066	0	0.375

Source: Computed from survey data result, 2022

Labor

Labor is an important factor of agricultural production. Smallholder farmers rely on family labor for land preparation, planting, cultivation, weeding, irrigation, fertilizer application, pesticides application, harvesting and transporting of the product. The assessment of the different sources of labor used in vegetables production shows that 62% of the respondents rely on family labor while 38% work on reciprocate labor exchange system, hired labor and cooperation (Table 7).

Table 11. Sources of labor for vegetables production

Sources of labor	Frequency	Percentage
Family labor	144	62.61
Hired labor	29	12.61
Labor exchange	28	12.17
Cooperation	29	12.61

Seeds

Adequacy and quality of vegetable seeds are crucial for increased production. This means that the seed of needed traits should be timely acquired from reliable sources to ensure high determination and increased yield. About 51% of sample households had access to improved vegetable seeds in the study districts. From the sample producers who identified the sources of the vegetable seeds, 60% used both improved and local varieties while 40% used improved vegetable varieties from different sources (Table 8). The sample households underscored the problem of lack or shortage of appropriate type of improved seeds of vegetables which are needed by the market.

Table 12. Access to vegetable seeds and sources of vegetable seeds

Variable	Item	Frequency	Percent
Access to seeds	Yes	117	51
	No	113	49
Sources of seeds	Local market and own	138	60
	Fellow farmers	39	17
	Farmers' Cooperative	4	1.74
	BoA	9	3.91
	University	37	16
	NGOs/Projects	2	0.87

Source: Computed from survey data result, 2022

Commercialization of vegetables Producers

Vegetable is the most commonly grown crop in the study areas in three production cycles. In Cycle I (February to April) and Cycle III (November to January) produced using irrigation while in Cycle II (May to October) produced using rainfall. The production may primarily means for consumption or for market. Some farmers usually produce certain crops for home consumption and some specific crops for sale (Bekele *et al*., 2011). In this case, the commercial orientation of farmers should be measured with reference to a specific crop rather than the farmer, in general. Thus, this study judged the commercialization behavior of smallholder farmers in vegetable production using commercialization index. The index was constructed based on production at the household level.

The overall findings of this study showed that commercialization index for sample vegetable producers were 89.21%. This implies that, on average, 89.21% of all vegetables produce were sold. While the remaining output was either consumed or stored as seed tubers for the next season. According to Bekele *et al*. (2011) and Strasberg *et al*. (1999), a crop commercialization index greater than 50% signifies a commercial oriented farmer for a crop under consideration. Therefore, vegetables crops produced in the study areas were market oriented and highly commercialized.

Table 9 showed the mean production and cash income from sales of vegetables by sample households. From the total production of vegetables, 89% were sold while the remaining 10% was consumed. For certain vegetables, the seeds needed for the next production cycle are provided from the own production. In the case of potato, for example 85% was sold, 4% consumed and 11% used for seed whereas 97% of the onions were sold and 3% was used for consumption.

Table 13. Household Commercialization Index (HCI) of vegetable crops

Vegetables	Area allocated (ha)	Amount produced (qt)	Amount sold (qt)	Commercialization Index (HCI)
Onion	0.02	3.8	3.7	97.80
Irish Potato	0.13	25.94	22.6	85.37
Cabbage	0.014	6.85	6.52	97.55
Beetroot	0.016	2.39	2.2	92.24
Carrot	0.01	1.86	1.8	96.77
All vegetables	0.19	40.89	36.82	89.21

Source: Computed from survey data result, 2022

Results of econometric model analysis

In a survey data set a researcher should expect to encounter many problems. The problems of multicollinearity and heteroscedasticity are very common in cross-sectional data. Data should be cleared before it is used for purposes of analysis. While fitting important variables in the models a test for multicollinearity problem among variables was performed using VIF and there was no serious problem as indicated in appendix Table 1. In estimating the preferred model, robust method was employed in order to correct the possible problem of heteroscedasticity. Chi-square test was used to test the fitness of the model.

Determinants of smallholder farmers' vegetable commercialization

The commercial behavior of vegetable producers was measured by commercialization index, which is the ratio of the value of vegetable sold to the value of all vegetable produced in the study areas in the given production year. There are different determinants that determine the commercialization behavior of smallholder farmers in vegetable production. These determinants were analyzed using the Tobit regression model. The results of the regression are given in (Table 10).

Distance to nearest market: Distance to market was seen to be significant at 10 percent probability level with contrary to expectation positive sign. By implication, it means that the nearest the distance to the market center, the more likely to the farmer's orientation towards vegetable commercialization and level of commercialization. Households further away from market places have lower market participation and thus market orientation. This result is in line with previous studies like (Barrett, 2007; 2008; Omiti *et al*., 2009).

Access to market information: Information access is also another factor, which positively affects the proportion of vegetable sold at 5% significance level. This result suggested that the proportion of vegetable marketed increases in response to access to vegetable market information. Access to information are expected to enhance skills and knowledge of farmers, link farmers with modern technology, and ease liquidity and input supply constraints (Lerman, 2004), thus are expected to induce market orientation(Berhanu, Moti, 2010). Therefore, this study shows that as the smallholder vegetable farmers had access to market information the more likely to the farmer's orientation towards vegetable commercialization and level of commercialization.

Livestock ownership: As expected livestock ownership was found to be positively and significantly affect at less than 5 percent of significance level of vegetable commercialization and level of commercialization in the study areas. Income obtained from livestock can be used to acquire crop production resources to boost productivity, hence, commercialization. Also, access to assets such as ownership of livestock provides households with leverage to invest in market-oriented production (Randela, *et al.*, 2017).

Cooperative membership: The coefficient of farmer's membership to cooperative was positive and significantly related to vegetable commercialization and level of commercialization at 10 percent probability level. This means that farmer's membership to cooperative increases vegetable commercialization. Membership of cooperative and groups possess the potentials of increased access to information important to production and marketing decisions. Given this, the result is plausible. It is also in line with previous findings of (Olwande, 2010).

Land allocated under vegetable crops: land allocated under vegetable crops was positively and significantly associated with the commercialization and level of commercialization at 1% significance level. This is expected since land is a critical production asset having a direct bearing on production of surplus due to economies of scale. An additional *timad* (0.125 ha) of the household allocate vegetable crops would increase the proportion of output sold by 135 quintals. Consistent with the findings of Aman (2014), increase in cultivated land size may have boosted production of horticultural crops and also consistent with the government's massive push to promote and deliver technology packages to smallholders.

Table 14. Tobit estimation results for vegetable commercialization

Explanatory variables	**Coef.**	**Robust Std.Err**	**P-value**
Sex of household head	-1.3001	8.856	0.883
Age of household head	-0.0038	0.00356	0.274
Education level of household head	7.1014	5.1182	0.167
Family size of household head	-0.07966	0.8201	0.923
Distance to nearest market	0.2061*	0.1236	0.097
Access to market information	9.683**	4.5081	0.033
Access to credit services	-11.708	7.7942	0.135
Access to extension services	0.20645	0.8673	0.812
Farm experience in vegetable production	0.36701	0.3658	0.317
Livestock ownership (TLU)	3.1082***	1.1617	0.008
Non/off- farm activities	-5e-05	2.7e04	0.852
Access to irrigation	4.2801	4.0837	0.296
Access to improved seed	6.496	4.668	0.166
Cooperative membership	12.565*	7.126	0.079
Area allocated to vegetable	135.3518***	32.8001	0.000
Constant	-20.54186	16.4654	0.214
/sigma	31.05665	3.5755	

Number of observation =130, F (15, 215) = 5.21, Prob> chi_2 =0.0000 Log likelihood= -1105.8719, Pseudo R_2 = 0.9112, Note: ***, ** and * indicate significance at 1%, 5% and 10% levels, respectively. Source: model output based on survey data, 2022

Major Vegetable Production and Marketing Constraints

Major vegetable production constraints

There are factors that hinder the production of vegetable products in the study areas. The majority of the sample producers indicate shortage of fertilizer, shortage of improved vegetable seeds, diseases, shortage of pesticide and high price of fuel for pumping water for irrigation as major constraints of vegetable production. Institutional and natural factors are the major vegetable production constraints identified in the study areas (Table 11).

Institutional factors: The most important physical inputs for vegetable production are improved seeds, fertilizers, and pesticide/insecticide and irrigation water. Among the total sample of respondents, 49% replied limited access and supply of improved vegetable seeds as their production problem. This was directly related to agricultural input access problem. Unavailability of pesticides/insecticides mainly creates 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 are expensive. The expensiveness, shortage of fertilizer and untimely supply should be an alert issue for the vegetable producer farmers in the study areas.

Natural factors: Natural factors such as drought, frosts, rainfall and flood are often beyond the control of farmers and institutions. Despite the availability of irrigation water for some respondents, the utilization is traditional leading to inefficient water use which in turn consumes high fuel.

Table 15. Major vegetable production constraints (Yes)

Constraints	**Frequency**	**Percentage (%)**	**Rank**
Oxen shortage	97	42.17	9
Insects	142	61.74	6
Diseases	201	87.39	**3**
Drought	124	53.91	7
Weeds	69	30.00	10
Frost	102	44.35	8
Shortage of improved seeds	206	89.57	**2**
Shortage of fertilizers	216	93.91	**1**
Shortage of pesticides	182	79.13	4
High price of fuel for irrigation	163	70.87	5

Source: Computed from survey data result, 2022

Major vegetable marketing constraints

Almost all vegetable producer farmers responded that there were market constraints in their area (Table 12). The major vegetable marketing constraints are related with non-availability of market/limited access to market, low price of product, lack of storage, lack of transport, low quality product that cannot meet consumers demand and perishability. The results show that low prices of the products, brokers/middlemen's hindrances to getting a better price for the products and perishability are the top three constraints in the marketing system of vegetable crops in the study areas.

Table 16. Major vegetable marketing constraints (Yes)

Constraints	Frequency	Percentage (%)	Rank
Lack of market	133	57.83	4
Low product price	221	**96.09**	**1**
Lack of storage	97	42.17	6
Lack of transportation	111	48.26	5
Lack of market information	48	20.87	8
Broker interfering	194	**84.35**	**2**
Perishability	172	**74.78**	**3**
Lack of market access (road)	86	37.39	7

Source: Computed from survey data result, 2022

Conclusion and Recommendations

Conclusion

Transforming the subsistence-oriented production system into a market-oriented production system as a way to increase the smallholder farmer's income and reduce rural poverty has been in the policy spotlight of many developing countries, including Ethiopia. There is need to deliberately improve the smallholder commercialization decision as well as the level of commercialization in order to facilitate stable incomes and sustainable livelihoods. This study was aimed at analyzing smallholder vegetable commercialization in Haramaya, Kersa and Kombolcha districts of East Hararghe Zone, Oromia National Regional State, Ethiopia with the specific objectives to estimate household level of output side vegetable crops commercialization, determinants of commercialization and the level of commercialization, and major vegetable production and marketing constraints in Haramaya, Kersa and Kombolcha districts of East Hararghe Zone, Oromia National Regional State, Ethiopia.

The average household commercialization index for smallholder farmers engaged in vegetable enterprise was 89.21%, which shows that households producing vegetables sell most of their farm produce to the market which indicates the vegetable commercialization is highly commercialized crop in the study districts. However, it was noted that the commercialization of vegetable crops was determined by access to market, resources ownership and institutional factors. The study found that commercialization was significantly influenced by the distances to nearest market center, access to market information, livestock ownership, cooperative membership and area allocated under vegetable production.

This study finding indicates that shortage of fertilizer, shortage of improved vegetable seeds, diseases, shortage of pesticide and high price of fuel for pumping water for irrigation as major constraints of vegetable production in the study districts. The results also shows that low prices of the products, brokers/middlemen's hindrances to getting a better price for the products and perishability are the major constraints to vegetable marketing in the study areas.

Recommendations

The recommendations or policy implications to be drawn from this study are based on the significant variables from the analysis of empirical study. Thus, some relevant policy implications can be drawn from the findings of this study that can help to design appropriate intervention mechanisms to improve the smallholder commercialization of vegetable crops at the farm level in the study districts.

The fact that distance to the market places has become important determinant of commercialization of vegetable crops suggests the role of policies geared towards improving physical access to market places could yield positive results towards improving commercialization of smallholder farmers of vegetable 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 vegetable crops.

The size of land allocated for vegetable crops affected the smallholders' commercialization of vegetable crops positively and significantly. It will be difficult for policy makers to increase the land holding of the household; but the policies need to strengthen more in intensifying the farm practices through provision of sustainable and timely availability of inputs, increasing the farmers' awareness on production packages like agronomic practices and proper application of inputs. This will enable the farmer to produce more from the same plot of land so that increased smallholder farmers commercialization and level of commercialization of vegetable crops will be achieved.

Livestock possession is also an important determinant of commercialization of vegetable crops which calls for enhancing the livestock assets of the household as it provides manures for the farm, means of transportation of their products to the market, and provide financial liquidity for the farmers. Therefore, the study suggested strengthening the existing crop-livestock production system is crucial.

Cooperative membership is also an important determinant of the vegetable commercialization. However, most of the vegetable farmers are unorganized or not cooperative member in the study districts. This clearly needs strong government intervention and the effort should also be made to strengthen farmers' cooperative and encourage collective action of farmers to lower transaction costs and access to inputs. It is important to promote the formation of farmer's organization or cooperatives in pre-urban and urban areas.

Additionally the concerned organizations like districts office of agriculture/extension services experts should provide market information about prices, market places information, time of production, consumers' preference and other related information which serve as a base for planned production.

References

Abafita, J., Atkinson, J. and Kim, C.S. 2016. Smallholder Commercialization in Ethiopia: Market Orientation and Participation International Food Research Journal 23(4): 1797-1807.

Adam B, Belay K, Belaineh L, Tesfaye L. 2010. Effect of crop commercial orientation on productivity of smallholder farmers in drought-prone areas of the Central Rift Valley of Ethiopia. J. Rural Dev. 33(4):105-128.

Adugna Gessesse. 2009. Analysis of fruit and vegetable market chains in Alamata, Southern Zone of Tigray: The case of onion, tomato and papaya. M.Sc thesis presented to the school of graduate studies, Haramaya University. pp98

Alemnewu Abay. 2010. Market chain analysis of red pepper: the case of Bure woreda, west Gojjam zone, Amhara National Regional State, Ethiopia. M.Sc thesis submitted to the school of graduate studies, Haramaya University. 91p.

Aman Tufa, Adam Bekele and Lemma Zemedu. 2014. Determinants of smallholder commercialization of horticultural crops in Gemechis district, West Hararghe Zone, Ethiopia. African Journal of Agricultural Research, 9(3): 310-319.

Astewel Takele. 2010. Analysis of rice profitability and marketing chain: The case of Fogera Woreda, South Gondar Zone, Amhara National Regional State, Ethiopia. M.Sc thesis presented to School of Graduate Studies, Haramaya University. 76p.

ATA (Agricultural Transformation Agency). 2017. Agricultural Transformation Agenda. Annual Report of 2016/17. Addis Ababa, Ethiopia

Ayelech Tadesse. 2011. Market chain analysis of fruits for Gomma woreda, Jimma zone, Oromia National Regional State. M.Sc thesis presented to School of Graduate Studies, Haramaya University.p110.

Barrett, C. 2007. "Smallholder Market Participation: Concepts and Evidence from Eastern and Southern Africa," Food Policy, volume 33, number 4 (August 2008) pp. 299-317.

Bekele, A., Belay, K., Legesse, B., Lemma, T. 2011. Effects of Crop Commercial Orientation on Productivity of Smallholder Farmers in Drought-Prone Areas of the Central Rift Valley of Ethiopia. Journal of Rural Development Vol. 33, No. 4, pp. 105- 128.

Berhanu, G., Moti, J. 2010. Commercialization of Smallholders: Is Market Participation Enough? Contributed Paper presented at the Joint 3rd African Association of Agricultural Economists (AAAE) and 48th Agricultural Economists Association of South Africa (AEASA) Conference, Cape Town, South Africa, September p. 19-23.

Bezabih, E., Hadera, G. 2007. Constraints and Opportunities of Horticulture Production and Marketing in Eastern Ethiopia. Drylands Coordination Group Report No. 46.

Chanyalew Seyoum, Tesfaye Lemma, Ranjan S. Karippai, 2011. Factors Determining the Degree of Commercialization of Smallholder Agriculture: The Case of Potato Growers in Kombolcha District, East Hararghe, Ethiopia

CIAT (Centro International de Agricultural Tropical). 2004. Increasing the competitiveness of market chains of smallholder's producers. Manual, 3: Territorial Approach to Rural Agro Enterprise Development Project.

Desta Beyera, 2004. Impact of community managed irrigation on farm production efficiency and household income. The case of Weliso and Wenchi districts of Oromiya Regional State. M.Sc. Thesis Presented to the School of Graduate Studies, Haramaya University. 46p.

Enete, A. A. and Igbokwe, E. M. 2009. 'Cassava Market Participation Decisions of Producing Households in Africa', Tropicultura, (11), pp. 129–136.

FAO (Food and Agricultural Organization of the United Nations). 2015. Ethiopia Country Highlights on Irrigation Market Brief. FAO, Rome, Italy.
Gebremedhin, B., M. Jaleta, and D. Hoekstra. 2009. Smallholders, Institutional Services, and Commercial Transformation in Ethiopia.Agricultural Economics 40 (S1):773–787.
Gebremedhin, B. and Tegegne, A. 2012. 'Market Orientation and Market Participation of Smallholders in Ethiopia: Implications for Commercial Transformation', in 2012 Conference August Foz do Iguacu Brazil. Available at: http://ideas.repec.org/p/ags/iaae12/125847.html
Gebreslassie Atsbaha and Bekele Tessema. 2012. A Review of Ethiopian Agriculture: Roles, policy and small-scale farming systems. Country analysis: Ethiopia and D.R. Congo
Gezahagn Kudama. 2010. Value chain analysis of groundnut in Easter Ethiopia. M.Sc thesis submitted to the School of Graduate Studies, Haramaya University. 80p.
Goitom A. 2009. Commercialization of smallholder farming in Tigrai, Ethiopia: Determinants and welfare outcomes. MSc. Thesis, the University of Agder, Kristiansand, Norway.
Govereh, J., Jayne, T.S., Nyoro, J. (1999): Smallholder commercialization, interlinked markets and food crop productivity: Cross-country evidence in eastern and southern Africa, available at: http://www.aec.msu.edu/fs2/ag_transformation/atw_govereh.PDF
Kabiti, H. M., Raidimi, N. E., Pfumayaramba, T. K. and Chauke, P. K. 2016. 'Determinants of Agricultural Commercialization among Smallholder Farmers in Munyati Resettlement Area, Chikomba District, Zimbabwe', J Hum Ecol, 53(1), pp. 10–19.
Kirui, O. K., and Njiraini, G. W. 2013. Determinants of Agricultural Commercialization among the Rural Poor: Role of ICT and Collective Action Initiatives and Gender Perspective in Kenya. Paper prepared for the 4th Conference of AAAE. DiarLemdina Hotel – Hammamet, Tunisia September 22-25, 2013.
Kumilachew Alamerie. 2016. Commercial behaviour of smallholder potato producers: the case of Kombolcha woreda, Eastern part of Ethiopia: Economics of Agriculture Review article
Lerman, Z., 2004. Policies and Institutions for Commercialization of Subsistence Farms in Transition Countries. Journal of Asian Economics 15, pp 461-479, ELSEVIER.
Maddala, G.S. 1992. Introduction to Econometrics Second Edition. Macmillan Publishing Company, New York.
Martey, E., Al-hassan, R. M. and Kuwornu, J. K. M. 2012. 'Commercialization of smallholder agriculture in Ghana: A Tobit regression analyses, African Journal of Agricultural Research 7(14), pp. 2131-2141
MoARD (Ministry of Agriculture and Rural Development). 2010. Ethiopia's Agricultural and Sector Policy and Investment Framework (PIF): 2010-2020, Addis Ababa, Ethiopia.
MoFED (Ministry of Finance and Economic Development). 2015. Growth and Transformational Plan (GTP 2015-2020). Addis Ababa, Ethiopia.
Mohammed, A., Baze, M. and Ahmed, M. 2016. 'Smallholder Commercialization and Commercial Farming in Coffee-Spice Based Farming System of South West Ethiopia', International Journal of Research Studies in Agricultural Sciences, 2(5), pp. 13–26.
Moti J. 2007. Econometric analysis of horticultural production and marketing in Central and Eastern Ethiopia. PhD Thesis, Wageningen University.
Olwande, J., Smale, M., Mathenge, M. K., Place, F. and Mithofer, D. 2015. Agricultural marketing by smallholders in Kenya: A comparison of maize, kale and dairy. Food Policy.
Omiti, J. M., Otieno, D. J., Nyanamba, T. O., McCullough, E. 2009. Factors Influencing the Intensity of Market Participation by Smallholder Farmers: A Case Study of Rural and Peri-Urban Areas of Kenya, African Journal of Agricultural and Rural Economics, vol. 3, pp. 57-82.

Pender, J. and Dawit Alemu. 2007. Determinants of Smallholder Commercialization of Food Crops: Theory and evidence from Ethiopia. Discussion Paper No. 745. Washington D.C., International Food Policy Research Institute (IFPRI).
Pingali, L.P. and Rosegrant, M.W. 1995. Agricultural commercialization and diversification: Process and policies. Food Policy.
Randela R., ZG Alemu & JA Groenewald, 2008. Factors enhancing market participation by small-scale cotton farmers. Agrekon, 47(4):451-469.

Randela, R., Alemu, Z. G. and Groenewald, J. A. 2017. 'Factors enhancing market participation by small- scale cotton farmers', Agrekon, 47(4), pp. 451–469.
Rehima Mussema. 2006. Analysis of red pepper marketing: The case of Alaba and Siltie in SNNPRS of Ethiopia. M.Sc thesis presented to the School of Graduate Studies, Haramaya University. 105p.
Schneider K, Gugerty MK. 2010. The impact of export-driven cash crops on smallholder households. Evans School of Public Affairs, University of Washington. August 17, 2010, EPAR Brief P. 94.
Siziba, S., Nyikahadzoi, K., Diagne, A., Fatunbi A. O., Adekunle, A. A. 2011. Determinants of cereal market participation by sub-Saharan Africa smallholder farmer, Journal of Agriculture and Environmental Studies, vol. 2, no. 1, pp. 180-193.
Solomon A, Bekele S, Franklin S. 2010. Does technology adoption promote commercialization? Evidence from Chickpea Technologies in Ethiopia.
Strasberg, P.J., Jayne, T.S., Yamano, T., Nyoro, J., Karanja, D., Strauss, J. (1999): Effects of Agricultural Commercialization on Food Crop Input Use and Productivity in Kenya. Office of Sustainable Development; Policy Synthesis for USAID-Africa Bureau, pp. 41.
Tilaye B. 2010. How to involve smallholder farmers in commercial agriculture/horticulture. Ethiopian horticulture producers and exporters association, Ethiopia, Addis Ababa.
Tshiunza, M., J. Lemchi, A.Tenkouano. 2001. Determinants of market production of cooking banana in Nigeria. African Crop Science Journal, 9 (3): 537-547.
Von Braun, J., and E. Kennedy, 1994. Conclusions for agricultural commercialization Policy. In Agricultural commercialization, economic development, and nutrition.
Weignberger, K. and A. Lumpkin, 2005. Horticulture for poverty alleviation: The unfunded revolution: The World Vegetable Centre, AVRDC Publication No. 05-613, Shanhua, Taiwan.

Value chain analysis of Beef cattle in East Hararghe Zone, Oromia Regional State, Ethiopia

Solomon Ayele*[1], Kibret Ketema and Hussein Abro

[1]Socio-economics Research Team, Fedis Agricultural Research Center, P. O. Box 904, Harar, Ethiopia

Corresponding author's email-address: solomon4ayele@gmail.com, kebret2012@gmail.com, hhnn2004@gmail.com

Abstract

The study was initiated to identify beef cattle value chain actors and their roles, and investigate the determinants of market channel choices. To achieve this, primary data were collected from randomly selected 236 cattle fatteners, input suppliers and traders at various levels using pre-tested semi-structured questionnaire. Besides, data were collected through Focused Group Discussions and key Informant interviews to substantiate the survey data. And secondary data was collected from published and unpublished sources. Descriptive result indicated that, input suppliers, cattle fatteners, brokers, traders, hotel and restaurant owners, and consumers are principal value chain actors. High broker interference, weak linkage and information flows were observed within and among beef cattle value chain actors. Multinomial logit (MNL) results revealed that, experience in cattle fattening, sex of household head, Age of household head, education level of household head, herd size, access to market information, access to credit and membership to cooperative had significantly affect beef cattle market channel choices by small-scale beef cattle fatteners in the study areas. The results suggest that relevant policy interventions in the directions of the aforementioned factors are central to stimulating smallholder beef cattle producers to better market outlets.

Key words: Beef cattle, Market channel, Value chain, Multinomial Logit (MNL), East Hararghe

Introduction

Agriculture is an important sector and it is taken as the government priority so as to stimulate the overall economic development, reducing poverty and achieving food security in Ethiopia (Shapiro *et al.,* 2017). Livestock subsector as one component of agriculture provides an opportunity for further development of the country. The total size of Ethiopian livestock herd, one of the largest in Africa, makes it a potential resource to contribute significantly to national development, including poverty reduction (Shapiro *et al.*, 2017). According to Ethiopian Central Statistics Agency (2017), the compositions of livestock production in Ethiopia are cattle, sheep, goats, horses, mules, donkeys, camels, poultry and beehives among which the cattle production is the largest composition of the Ethiopian livestock herd size. The total size of cattle population in Ethiopia is estimated to be about 59.5 million (CSA, 2017).

As to the research work of Gebreselassie (2018), the economic contribution of the livestock sub sector in Ethiopian economy is about 12% of the total gross domestic product (GDP) and 33% of agricultural GDP and it also provides livelihood for 65% of the population in general. In many circumstances livestock are also central component of small holder risk management strategies in adverse situations (Gebreselassie, 2018). While specifically discussing about cattle production in Ethiopia it is an integral part of all farming categories in the country mixed farming, agro-pastoral and pastoral production systems (Idnekachew et al., 2016).This reality holds true in the context of East Hararghe Zone where the study is intended to be done in.

Hararghe farmers have also their own indigenous fattening practice which is one of the fattening systems in Ethiopia and known as Hararge fattening system. Hararghe fattening system is manifested by cut and carry type of feeding young cattle. This practice has a locational trade mark of Harar beef production and fattened cattle for Harar fetches a premium price of up to 50% over other condition cattle in the Addis Ababa market (Gebreselassie, 2018). However, because of various socioeconomic, institutional, natural and technological factors farmers in Ethiopia in general and fattening farmers in Hararghe in particular are not getting fair market access for their beef cattle. According to Sisay (2015), the major cattle fattening constraints for smallholder farmers in Somali Regional State were diseases, lack of grazing lands, lack of management, poor market information, unavailability of veterinary service and lack of road for transportation. Moreover, Addis (2017) figure outs that absence of market information system, inadequate infrastructure, absences of veterinary services, contraband and clan conflict are the constraints of livestock marketing in the lowland area of Ethiopia. To address those constraints/challenges analysis of beef cattle value chain is an important strategy in such a way that the current characteristics of the chain will be identified. From this study alternative market channels and areas of intervention in the chain will be suggested for better functioning of beef cattle value chain in the study area.

Objectives of the study

1) To identify the major beef cattle value chain actors and draw up beef cattle value chain map in the study areas;
2) To identify the current market outlets in the study areas;
3) To identify the determinants of market channel choices by smallholder beef cattle keeper in the study areas;
4) To assess constraints and opportunities in beef value chain in the study areas

Methodology

Description of the study areas

This study was undertaken in the eastern part of Ethiopia specifically in East Hararghe zone of Oromia National Regional State, Ethiopia. From the zone four districts namely Babile, Fedis, Kurfachalle and Meta districts were selected based on their extent of beef cattle production.

Babile District: It is located in the eastern part of East Hararghe Zone. Babile district is geographically located between $8^0$9' and $9^0$23'N latitude and $42^0$09' and $42^0$55'E longitude to the south east of Harar town. The district is bordered by Gursum district to the north and north east, Harari Regional state to the north and north west, Fedis district to the west and Somali Regional state to the south, south west and south east directions. Babile district is classified into woina dega and kola agro-climatic zones, covering about 10% and 90% of the total area of the district respectively. Weina-dega agro-climatic zone (1500-2007.08m.a.s.l) is characterized by average annual rainfall and temperature ranging between 600 and 1200 mm and 15^0c and 20^0c, While Kolla agro-climatic zones (900-1500m.a.s.l) is explained by average annual rainfall and temperature varying between 410 and 820mm and 20^0c and 25^0c ((ZBoA, 2017).

There are different types of crops such as cereals, oil seeds, vegetables, fruits and cash crops are that produced in Babile district. Cereals types of crops that are highly produced in the district are maize and sorghum. Ground nut is the major type of oil seeds which highly known and produced by farmers of the district. Tomatoes, mangoes and chat are well known and produced types of vegetable, fruit & cash crop respectively in the district. Babile district is one of the well-known districts of east Hararghe zone with livestock resources. As rural population of the district is semi pastoralist, livestock plays major role in their life economically and socially. The livestock reared in the district are cattle, goat, sheep, donkey, camel and poultry (ZBoA, 2017).

Fedis District: It is one of the administrative districts of East Hararghe zone of Oromia Regional State with a total area of 720,791 km^2. The district is located in the Eastern part of Oromia within the range of 8052' - 9^0 24'N latitude and 42^0 02'-$42^0$19'E longitude. The district is bounded by Harari Regional State from north, Haromaya and Kurfachale woredas from north west, Girewa woreda from west, Midhaga Tola from south and Babile administrative woreda from north east side. It estimated to have a total length of 125 km boundary with the region and administrative woredas. In general the districts is divided in to two urban and 19 rural sub administrative *kebeles*, and divide in to two climatic zones, namely, semi-temperate (Woyna Dega) and semi-arid (Kola) covering 28.2 % and 71.8 % of the total area of the administrative district respectively. The altitude ranges from 1437 – 2118m.a.s.l while the topography of the woreda comprises 70 % flat 15 % plateau and the remaining 15 % is running in to gullies and bush land.
The major crops produced in the woreda are stalk crops such as sorghum and maize. Cereal Crops like wheat, barley and oat are also produced to some level. In addition to cereal crops produced, pulses and oil seeds such as groundnut, chicken pea, haricot bean, field peas, lentils, are produced as cash crops. Besides chat is the widely cultivated permanent cash crop in the woreda. Regarding fruits and vegetables sweet potato, potato, onion, tomato, carrot, beetroot etc. and Banana, papaya, guavas, Mango are the major ones that are produced in the woreda.

The district has a significant Livestock population & potential. It constitutes a significant amount of house hold income of farmers in the woreda. Despite traditional animal fattening practice, the woreda is well known for its good quality oxen it supplies for national and abroad markets. Farmers of the woreda have a good reputation in the animal fattening practice.

Kurfachele District: Kurfachele district located between 9^0 07' and $9^0$20'N latitude and $41^0$43' and 42^0 02' E longitude in the south east Harar town. The study district is bordered by Bedeno district to the west, Kersa district to the North West and north, Haromaya district to the East and northeast, Fedis district to the southeast and Girawa district to the south and southwest directions. It is the smallest district among the districts of east Hararghe Zone (ZBoA, 2017).

The district is classified in to dega (Temperate rainy climate), Woina-dega (Tropical rainy climate) and Kolla (Tropical arid climate) agro-climatic zones, covering about 93.55%, % 57.34 and 19% respectively. The total area kurfachale district is 268km^2. Average annual rainfall and temperature ranging between 1200 and 700 mm and 10^{0}and 15^{0}c characterize degas agro-climatic Zone (2300-3405m.a.s.l). Similarly, weina-dega agro-climatic zone (1500-2300 m.a.s.l.) is characterized by average annual rainfall and temperature varying between 500 and 1200mm and 15^{0}c and 20^{0}c. While kola agro - climatic (1400-1500 m.a.s.1.) is explained by average annual rainfall and temperature ranging between 410 and 8820 mm and 20^{0}c and 25^{0}c (ZBoA, 2017).

The cereal crops produced in the district are sorghum, maize, wheat, barley, oat and Teff. In addition to cereal crops produced, pulses and oil seeds such as faba bean, field peas, lentils, ground nut and linseeds are produced as cash crops. Besides chat and coffee are the two permanent cash crops in the district. The district has a significant Livestock population & potential. It constitutes a significant amount of house hold income of farmers in the woreda. Despite traditional animal fattening practice, the woreda is well known for its good quality oxen it supplies for national and abroad markets. Farmers of the woreda have a good reputation in the cattle fattening practice. The livestock reared in the district are cattle, goat, sheep, donkey, horse, mule, camel and poultry (ZBoA, 2017).

Meta District: Meta District is one of the administrative districts of East Hararghe Zone of Oromia Regional State. Meta district lies between 9^0 07' and 9^0 32' N latitude and 41^0 29' and 41^0 44' E longitude to the west of Harar town. The study District is bordered by Gorogutu & Deder district to the West, Kersa district to the East, Bedeno & Melkabelo district to the South & Somali regional state to North Dire Dewa Administrative council to the North East. Climatically Meta district is classified in to *Dega* (temperate rainy climate) *weina-dega* (tropical rainy climate) & *kolla* (tropical arid climate) agro climatic zones, covering about 31%, 38% & 31% of the total area of the district respectively. Average annual rain fall & temperature ranging between 1200 &2015/16 mm & 10^{0}C &15^0 C explain highland agro climatic zone (2201-3200m.a.s.l). Similarly, weina-dega agro climatic zone (1901-2200 m.a.s.l) is characterized by average annual rainfall 200 -600mm and Temperature Varying b/n 15^{0}Cto 20^{0}C while lowland agro climatic zone(1400-1900 m.a.s.l) is explained by average annual rainfall b/n 410-820mm temperature varying between 20^{0}C - 25^{0}C (ZBoA, 2017).

The cereal crops produced in the district are sorghum, maize, wheat, barley, oat and Teff. In addition to cereal crops produced, pulses and oil seeds such as faba bean, field peas, lentils, ground nut and linseeds are produced as cash crops. Besides chat and coffee are the two permanent cash crops in the district. The district has a significant Livestock population & potential. It constitutes a significant amount of house hold income of farmers in the woreda. Despite traditional animal fattening practice, the woreda is well known for its good quality oxen it supplies for national and abroad markets. Farmers of the woreda have a good reputation in the cattle fattening practice. The livestock reared in the district are cattle, goat, sheep, donkey, horse, mule, camel and poultry (ZBoA, 2017).

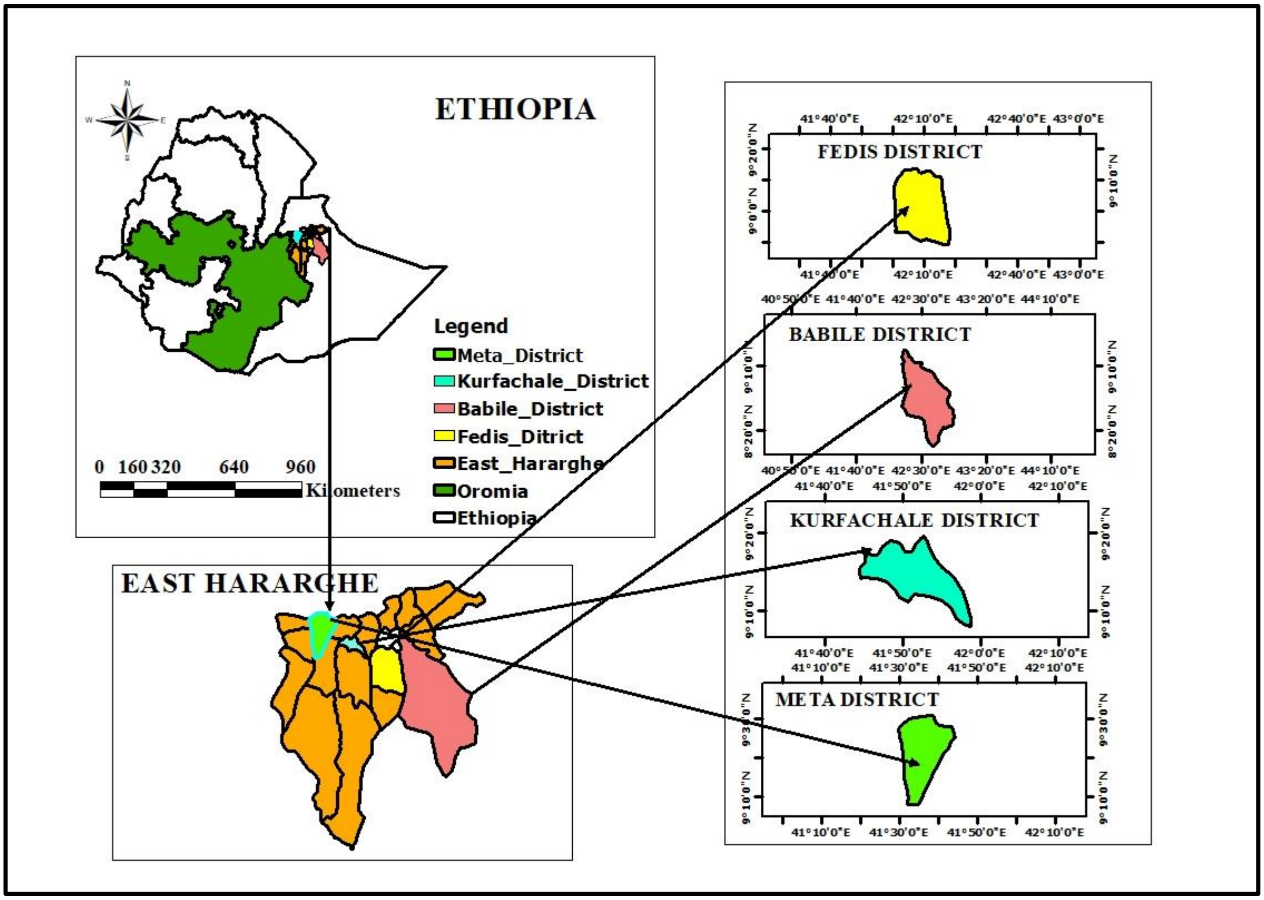


Figure 7. Map of the study areas

Sources of data and methods of data collection

The study was used both primary and secondary data sources. Primary data were collected from sample farm households, traders, and respective experts. Survey method was applied to the sample farm households using semi-structured questionnaires. And, case study was used in the case of traders, cooperatives (if available), and experts where checklists were developed for the purpose of data collection. Secondary data were also gathered from secondary sources (published and unpublished materials), Districts Office of Agriculture and Natural Resource Development, and Office of Trade and Industry.

Sampling procedure and sample size

For survey part of this research, a multi-stage sampling technique was used to select sample farm households in the study areas. In the first stage four districts were selected purposely based on their potential in beef cattle production. This was done in collaboration with zonal agricultural experts. In the second stage, out of total kebeles, three potential kebeles were selected randomly from each district. Lastly, 236 sample farm households were selected randomly using probability proportional sampling technique (PPS). In addition key informant interview (KII) at district offices/experts level and Focused Group Discussion (FGD) was conducted to collect the primary data on the constraints and opportunities existed along the beef cattle value chain in the study areas. A purposive sampling technique was used to select respondents among traders, experts, and other relevant stakeholders in the beef cattle value chain for this study.

Method of data analysis

As to the methods of data analysis in order to address the research objectives, value chain mapping, narrative explanations and content analysis for qualitative data, descriptive, and econometric analysis were used. Based on the nature of the data Multinomial logit (MNL) econometric model was used to analysis determinants the farm households' market channel choices for beef cattle producers.

Results and Discussion

Socio-economic characteristics of beef cattle producers

Table 1 below summarizes the dummy variables that were used in the analysis. The data revealed that high percentage of respondents study areas were male headed (93.22%) when compare to female's (6.78%). The education level of sampled household heads' indicates that about 64.83% were literate while illiterate (35.17%). The survey result showed that 97.888% of the respondents were married, and 1.69% of them were single and the remaining was widowed.

According to the survey result, about 50.42% of smallholder beef cattle producers had access to extension services in the study areas. Access to credit service is an important input in beef cattle value chain. The study showed that about 67.80% of household respondents were not used or no access to credit services that affects cattle production and marketing in the study areas.

The study result revealed that, about 77% of beef cattle producers had access to market information. Large percentage of respondents reported to depend on actual market day information/through personal observation, market information obtained from fellow/other farmers in the neighbors' betrothed on the same activities, and friends for prices and selling decisions. Results revealed that about 92% and 8% smallholder beef cattle producer farmers are non-participant and participant on non/off-farm income generating activities, respectively. Majorities (86%) of household respondents had accessed to animal health services in the study areas.

The study result showed the majorities (90%) of the smallholder beef cattle producers were not the member of any cooperative or not organized in beef cattle production and marketing. About 76% of the respondents' household heads had mobile phone which is play crucial role in beef cattle value chain as means of market information.

Table 1. Summary statistics of sample respondent households (dummy variables)

Variable	Categories	Frequency	Percentage
Sex of household head	Male	220	93.22
	Female	16	6.78
Education of household head	Literate	153	64.83
	Illiterate	83	35.17
Marital status of household head	Married	231	97.88
	Single	4	1.69
	Widowed	1	0.42
Access to extension services	No	117	49.58
	Yes	119	50.42
Access to credit services	No	160	67.80
	Yes	76	32.20
Animal health services	No	33	13.98
	Yes	203	86.02
Access to market information service	No	54	22.88
	Yes	182	77.12
Membership to cooperatives	No	212	89.83
	Yes	24	10.17
Mobile ownership	No	56	23.73
	Yes	180	76.27
Participation in no/off-farm activities	No	217	91.95
	Yes	19	8.05

Source: Computed from survey data result, 2022

The survey on age provided a clue on working ages of households. The survey result indicated that, the average age of cattle fatteners were 35.1 years with the minimum and maximum age of 19 and 71 years (Table 2). The result indicates that productive aged was involved in the beef cattle value chain in the study areas.

The study result showed that the average available labor forces (labor supply) estimated by adult equivalent scale was about 6.56 persons per household. This implies that most households had enough family labor and might not hire labor for their cattle fattening operation, which might assist them for a better participation in the cattle fattening business (Table 2).

The average landholding respondents' households were 0.43 hectare on average which includes both cultivated and grazing land. About 62.2% households' holds less than 0.5 hectare. The minimum and maximum land holding size was 0.125 and 1.5 hectare respectively which indicates scarcity of this resource in the study areas (Table 2). This has implication of livestock feed shortage due to limited land size per household

The study result indicated that, beef cattle keepers had on average 12.36 years of general experience in practicing cattle keeping with the minimum and maximum experience of 1 and 45 years respectively (Table 2). In addition the beef cattle keepers had on average 6.56 years' experience in beef cattle fattening with the minimum and maximum experience of 1 and 30 years respectively in the study areas (Table 3).This indicates that the sub-sector is very old as compared to other parts of the country where cattle fattening are practiced and important income source in the study areas.

The study result indicated that the total livestock owned by the respondent households was on average 4.19 TLU with the minimum and maximum livestock owned of 0 and 13 tropical livestock unit (TLU) respectively in the study areas. Moreover, the mean total number of cattle owned by the respondents' households was 3.24 tropical livestock unit (TLU) with the minimum and maximum livestock owned of 0 and 11 tropical livestock unit (TLU) respectively in the study areas.

Table 2. Summary statistics of sample households (continuous variables)

Variable	**Mean**	**Std. Dev**	**Min**	**Max**
Age of household head in years	35.097	9.727	19	71
Household size in numbers	6.56	2.36	1	14
Total landholding owned in hectares	0.421	0.254	0.125	1.5
Grazing land owned in hectares	0.021	0.059	0	0.5
Cultivating land owned in hectares	0.404	0.248	0	1.5
Number of total livestock owned in tropical livestock unit	4.18	2.86	0	13
Number of cattle owned in tropical livestock unit	3.24	2.42	0	11
Farm experience in cattle keeping in years	12.36	9.63	1	45
Farm experience in beef cattle fattening in years	6.57	4.92	1	30
Distance to the nearest market place in minutes	97.62	54.29	15	360
Distance to the main road in minutes	18.37	10.86	5	60
Beef cattle supply to market in numbers (heads)	1.84	1.14	1	9
Male cattle sold in numbers (heads)	1.63	0 .890	1	6
Female cattle sold in numbers (heads)	1.203	0.65	0	5
Animal mean age for fattening (years)	4.23	1.12	2	10

Source: Computed from survey data result, 2022

Producers' characteristics by market outlets

In this study four major beef cattle market outlets were identified as alternatives to smallholder farmers to sell their beef cattle. These were traders (both small and larger traders) which accounts for 71 percent of total sells followed by consumers (13 percent), collectors (9%) cooperative (7 percent). The study result indicated that most of the respondents (53 percent) were selling at the local/primary markets followed by woreda and zonal markets sales with 44% and 3% respectively in the study areas (Table 3).

Table 3. Producers' characteristics by market outlets

Variables	**Categories**	**Frequency**	**Percentage**
To who did you sold Beef cattle?	Collectors	21	9
	Cooperatives	17	7
	Traders	167	71
	Consumers (hotel owners, institutions, individuals)	31	13
Where did you sell Beef cattle?	Primary local market	127	53.81
	District market	103	43.64
	Zonal market	6	2.54

Source: Computed from survey data result, 2022

Socio-economic characteristics of beef cattle traders

The study result indicated that 100% of the sample traders were male. Average traders age was 36.5 years. The average family size of the sample traders was found 6 persons in the study areas. With regards to business experience, 9 average years of business experience in beef cattle trading in the study areas. Table 3 summarizes the demographic characteristics of sample traders in the study areas.

Table 4. Summary statistics of socio-economic characteristics of sample traders (Continuous variables)

Variable	**Mean**	**Std. Dev**	**Min**	**Max**
Age of traders in years	36.5	9.96	20	60
Sex of trader	1	0	1	1
Household size in numbers	6.3	2.33	1	11
Education level of traders in year of schooling	8.06	2.44	2	12
Business experience in years	9.56	7.089	1	25

Source: Computed from survey data result, 2022

The results (Table 5) showed that about 93% of the respondents operate trading using their own capital sources and others (7%) receives a loan from friends, micro-finance institution, family and private money lenders.

Most of the time traders purchase cattle by themselves, and sometimes they use a broker/commission agent who facilitates simply buying and selling activities. Since there is no pricing system for livestock in the market, selling and buying price of the cattle mostly set by supply and demand and sometimes traders have more bargaining power due to access of market information than farmers in the study areas.

The majority (76%) of the trader respondents use truck as a means of cattle transportation and others (24%) use trekking during trading. The survey result showed that almost all the sample beef cattle traders had business license since the beef cattle trading the study areas needs business license. Most of the time the buying and selling activities of beef cattle trading is undertaking at the districts livestock market center. The study result indicates that the majority the beef cattle supplied by the smallholder producers were exported to the outside of the study areas like the central market (Addis Ababa), West Hararghe Zone (Hirna, Chiro) and Jigjiga as the market outlets. Here, attention should be given by the concerned bodies about illegal traders and border cross trading of beef cattle in the study areas.

Table 5. Description of beef cattle traders and their activities

Variables	Categories	Frequency	Percentage
Participated in beef cattle trading year round	Yes	17	56.67
	No	13	43.33
Sources of capital	Own	28	93.33
	Loan	2	6.67
Traders having trade license	Yes	30	100
Cattle trading need a trading license?	Yes	30	100
Purchasing market place	Woreda market	30	100
Selling market place	Woreda	11	36.67
	Zonal	8	26.67
	Outside of the districts	11	36.67
Mode of cattle transportation in trading	Truck	23	76.67
	Trek	7	23.33
Who set purchase price	Self (Buyer)	5	16.67
	Demand and supply	9	30.00
	Negotiation	11	36.67
	Broker	5	16.67
Who set selling price	Self (Seller)	13	43.33
	Demand and supply	17	56.67

Source: Computed from survey data result, 2022

Beef cattle value chain actors and value chain mapping

The value chain analysis starts with the process of mapping out the existed value chain which allows one to visualize the flow of the products from the commencement to the final users (McCormick D, Schmitz H (2001)). In Ethiopian meat and live animal value chains have developed over the years into a series of complex constituents involving various actors. The main actors in meat and live animals include producers, collectors, small private and cooperative fatteners/feedlots, brokers/middlemen, and livestock trading cooperatives, individual traders and exporters (AGP-LMD, 2013). Thus, the current value chain map the potential well-known beef cattle actors, relationships, marketing and associated support service providers; their roles and functions was developed and portrayed in Figure 3.

Primary actors in the beef cattle value chain

The primary actors are those directly involved in beef cattle value chain starting from input suppliers, producers, local collectors, traders, cooperatives, butchers, hotels and restaurants to end users. Each of these actors adds value in the process of changing product title. With these components, beef cattle pass through different channels before it reaches the end users in the study areas.

Input Suppliers: Value chain function starts from inputs use to produce beef cattle and beef products (meat). Veterinary services/drugs, feeds and improved breeds are the major inputs used in beef cattle keeping practices (Table 6). The major suppliers of breeding stock in the study areas are farmers and government. Majorities (97.46%) of the cattle used by sampled household producers are the local breeds, 2.12% exotic breeds and the remaining was cross-breeds that issued for fattening purpose The study result indicated that about 65.25% of the respondents households responded that crop residue was used to feed their beef cattle from different feed sources in the study areas. About 86.02% of the respondent households had accessed to veterinary services for their beef cattle in the study areas. The survey result indicated that most of the animal healthy veterinary services/drugs (88.68%) were rendered by the districts office of livestock and fishery development in the study areas.

Table 6. Descriptions of inputs supply for beef cattle production

Inputs/variables	Categories	Frequency	Percentage
Type of feed resources used	Crop residues	154	65.25
	Hay (local plus improved forages)	7	2.97
	Concentrates (factory by-product)	11	4.66
	Pasture	4	1.69
	Crop residues, hay & concentrates	37	15.68
	Crop residues & concentrates	23	9.75
Sources of feed resources	Own farm	115	48.73
	Feed suppliers (traders)	10	4.24
	Purchasing from neighbor farmers	30	12.71
	Both own & feed suppliers	81	34.32
Animal health services	No	33	13.98
	Yes	203	86.02
Sources of veterinary services/drug	Public clinic center (government)	188	88.68
	Private veterinary drug shop	16	7.55
	Free service from NGOs	2	0.94
Type of cattle breeds used	Local breed	230	97.46
	Exotic breed	5	2.12
	Cross breed	1	0.42

Source: Computed from survey data result, 2022

Producers: Is one among value chain actors who are involved in fattening of different age categories of cattle for a limited period of time usually 3-6 months and finally supply for sell when the cattle conditioned. They fatten the cattle by traditional fattening system through utilizing available feed resources mostly in semi-intensive type of feeding system. The sources of cattle for fattening might be from own herd or could be purchased from local cattle market based on different selection criteria's such as breed, frame size, age, body condition, horn size, initial price, health, adaptation, and physical appearance among others. Accordingly, about 32% and 43% of the small-scale cattle keepers were used from their own herd and purchased from local market for fattening in the study areas respectively (Table 7).Thus, in the study areas, the core functions of producers in the beef cattle value chain include the husbandry practices to produce the cattle for traction purpose, milk purpose and fattening and asset building (Table 4). Thus, their function includes feeding the animal, watering, provision of veterinary services and housing the animal for production. This study indicates that about 77% of the sample respondents were not castrates their bull/ox for the fattening purpose. About 60% of the sample respondent households were use young with no or relatively low service bull or ox for fattening purposes. The mean age of beef cattle used for fattening was about 4.2 years in the study areas (Table 2). This indicates young or relatively low service bulls or oxen were used for fattening purposes.

Table 7. Descriptions of beef cattle producers and their activities

Variables	Categories	Frequency	Percentage
Primary purpose of keeping cattle	Milk	92	38.98
	Fattening	66	27.97
	Asset building	7	2.97
	Traction	12	5.08
	Both milk and fattening	59	25
Sources of beef cattle used for fattening	Born at home (own herd)	76	32.20
	Purchased for fattening purpose	102	43.22
	Both	58	24.57
Male cattle kept for fattening	Castrated	41	17.45
	Uncastrated	181	77.02
	Both	12	5.11
Status of beef cattle you kept for fattening	Young with no/low services	142	60.68
	Old with relatively low services	72	30.77
	Old with relatively high services	20	8.55

Source: Computed from survey data result, 2022

Brokers: Brokers are mediators between sellers and buyers in beef cattle value chain. They are usually expected to link buyers with sellers and facilitate the terms of exchange. They are often criticized for creating a communication gap between buyer and seller and then mediate them in the way they like. Farmers are usually price takers and loss negotiation power while brokers are act as price setters in the beef cattle markets in the study areas. The problem is very serious especially for those who do not have much information on market price and experience of such markets. And also, the brokers can charge as they like the amount of money from both sellers and buyers. Usually they get more benefit than the producers and traders per head of beef cattle sold at a time.

Collectors: These important market agents collect animals, usually from remote locations and gather animals to the producer areas where watering points are founds. They become an important source for big and small-scale traders and livestock trading cooperatives, which lack the local knowledge and relationships. They are usually constrained by a financial capacity that limits their operations and keeps them within a narrow geographic range. The collectors are not always good sources of market information, however, and they may take advantage of a producers' limited knowledge of the markets. This can lead to distortional pricing, almost always benefiting the collector. Designing and implementing dependable information dissemination mechanisms is essential in order to develop significant levels of trust and cooperation among producers and other market actors in remote areas. Collectors may also operate as agents for exporters and traders usually on a fixed-fee or commission basis.

Traders: Beef cattle traders are categorized to small and large traders based on their weekly purchasing capacity, capital and resources ownership. Accordingly small traders are who purchase beef cattle from producers and farmer traders at local markets through broker interferences. After they purchase mostly they sell to butchers, hotels and restaurant owners, and large traders who transport to other large cities outside of the study areas. Most of the purchasing power of the small traders is up to a maximum of five to ten beef cattle. Large traders are those traders purchasing mostly the beef cattle from farmer trader, small traders, and sometimes from the producers at local markets through high broker interferences. They sometimes give capital to other traders to buy on their behalf. Large traders usually use trucks for transporting beef cattle. In the beef cattle market other actors believe them as the ultimate source of market information.

Hotel and restaurant owners: Are those who invest and control the hotel or restaurant business which belongs to the sole proprietor or partnership. They sometimes buy beef cattle from producers, farmer traders and small traders through broker interference. They slaughter the beef cattle at abattoirs, cook them and serve them as meals to their customers. Sometimes they are directly purchase beef from butcher shops to serve the consumers in different forms.

Cooperative/union: Livestock cooperatives are located throughout the livestock production areas in Ethiopia, however, very few exist in the study areas. *Afran Kello* union has been participating in the beef cattle value chain in the study areas. They purchased beef cattle from the farmers at districts market center. Before resold they are add value (fattening) in their feedlot operation and sold the fattened cattle to the existed market outlets in the study areas. In addition they are directly purchase Borana beef cattle for their feedlot operation.

Consumers: These are the final actors in the beef cattle value chain. They are domestic consumers who buy either processed meat from butchers and hotels or who, as a group buy beef cattle to slaughter and then share the meat particularly during holidays and other social occasions in the study areas.

Value chain support actors or service providers

These value actors were identified as those who provide supportive services at micro-level actors rather than supplying physical inputs which are including veterinary services, financial services, training and extension services, Inspection services, and business licensing services in the study areas. According to Key Informant Interview (KII) at zonal and districts levels indicates that zonal livestock and fishery office, District Agriculture Offices, District and Zonal Trade and Market Development Offices, Oromia Micro Finance Institutions, Districts municipality, Private transporters, Private clinic services and Non-Governmental Organizations (NGOs) are the most common supportive service providers in beef cattle value chain among others in the study areas.

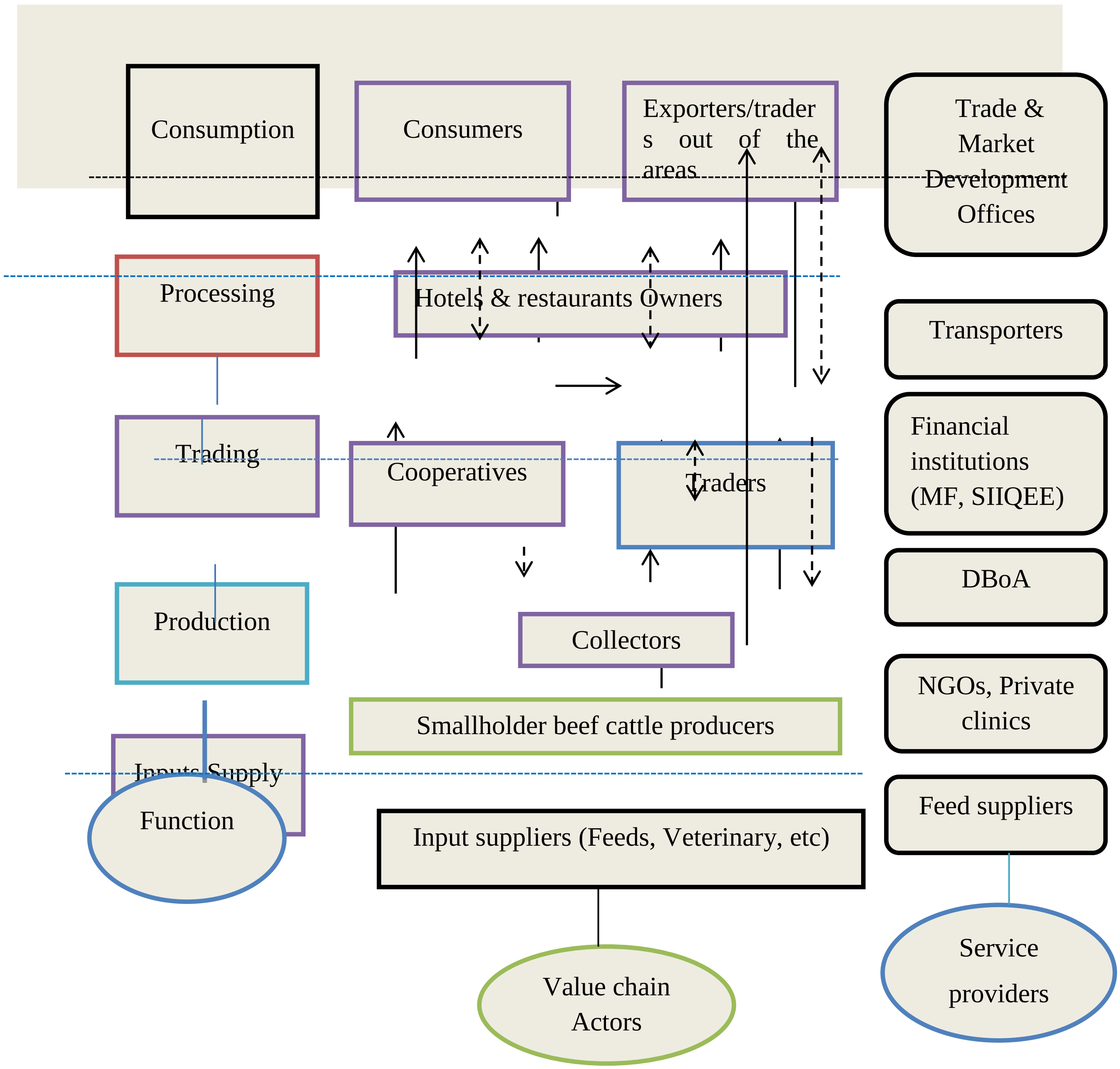


Figure 2: Map of beef cattle value chain in the study areas

Source: Own sketch based on survey result, 2022

<------> Information flow ——> Product flow

Beef cattle market channels in the study areas

The analysis of beef cattle marketing channels provides a systematic knowledge of the flow of livestock from their production areas to their final end-users. Marketing of beef in the study areas starts with the collection of beef cattle from production areas moving on to the districts market places (Figure 3). In such marketing chains, the beef cattle passes successively through a number of market actors, implying a series of links in the value chain before it reaches the end-users. As mentioned above, the main actors in the beef cattle markets include producers, collectors, traders, and hotel owners, cooperative and domestic consumers. These different channels represent the full range of available outlets through which the animals move from the different collection points in production areas and finally to the terminal markets to meet end-users needs. There are six major market channels for beef cattle produced in the study areas and moving to the different market outlets.

It was estimated that totally about 436 heads of beef cattle were supplied to the market by the sample smallholder beef cattle producers in the study areas for the year 2021. From the total beef cattle heads supplied to the market about 357 were male cattle heads and 79 were female cattle heads respectively in the study areas. From the total beef cattle supplied to the market by the sample beef cattle producers, traders had the largest share where about 71% followed by collectors and hotels owners whom share about 9%.

Channel 1: Producers Consumers (18 heads)
Channel 2: Producers → Collectors → Traders → Consumers (39 heads)
Channel 3: Producers → Traders → Hotel owners → Consumers (87)
Channel 4: Producers → Traders → Exporters/Larger traders (223 heads)
Channel 5: Producers → Hotels owners → Consumers (39 heads)
Channel 6: Producers → Cooperative → Hotels owners → Consumers (13 heads)
Channel 7: Producers → Cooperative → Traders → Consumers (17 heads)

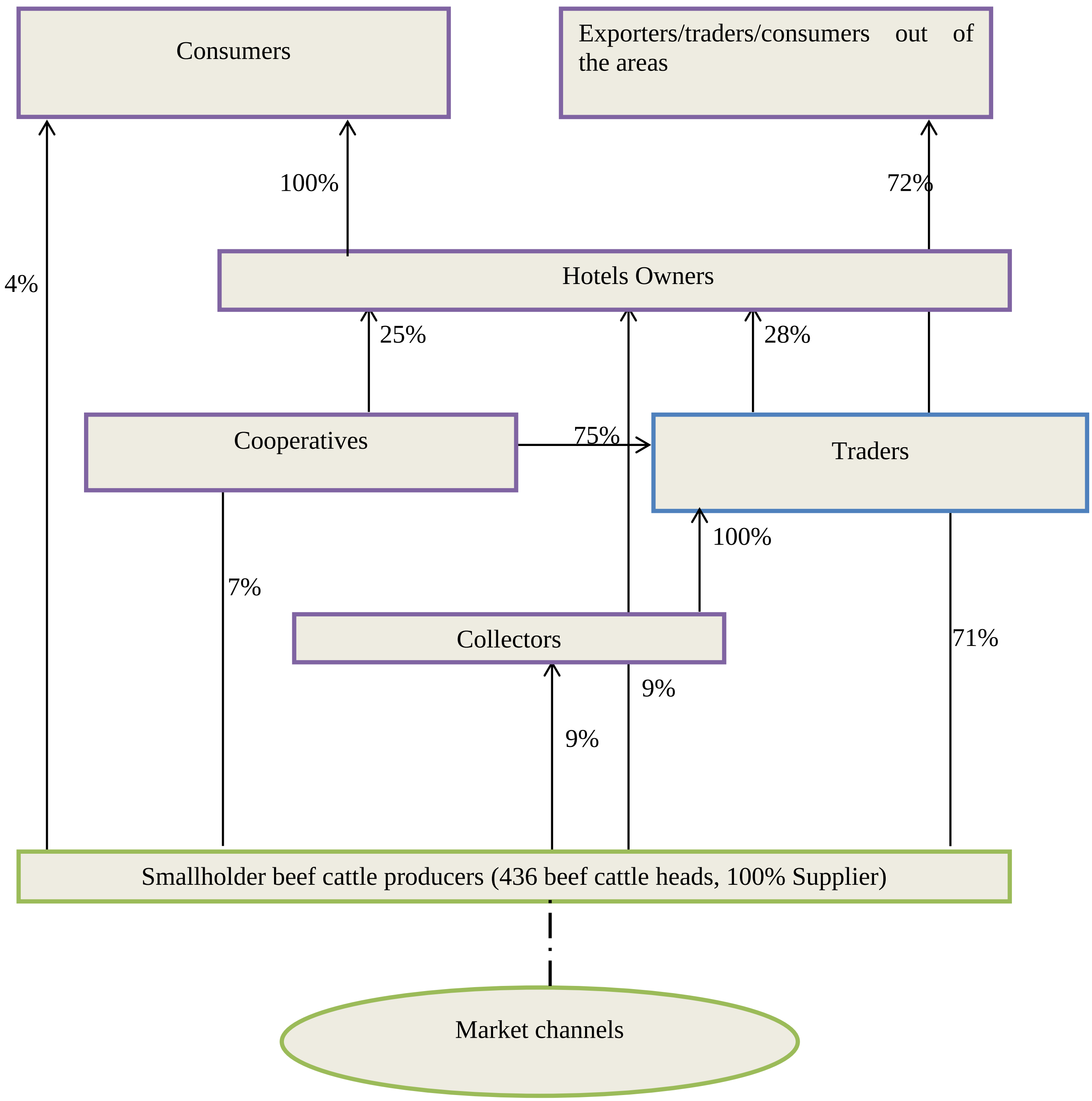


Figure 3. Map of beef cattle market channels

Source: Own sketch based on survey result, 2022

Econometric estimation results

Determinants of beef cattle market channel choices

Table 8 presents the model significance and goodness of fit values for the equations. The model explained 24.4 percent of the variation in market choice among smallholder beef cattle farmers in the study areas. The hypothesis that all the coefficients except the constant are zero is rejected at the 1 percent level based on the Wald test. The author also corrected the model for possible heteroscedasticity and multicollinearity problems. The command *robust* in (Stata version 14) was used to correct for heteroscedasticity. The multicollinearity problem was corrected using VIF (Variable Inflation Factor) (Appendix 1).

Table 8 below presents the coefficients from multinomial logit regression on the existing alternative marketing channels in the sample. The result showed that some of the variables were significant at alternative market outlets while some others were significant in one marketing channel but not in the other channel and each significant variables were discussed underneath.

Sex of household head: The study result indicated that as compared to the base category (traders), sex of household head had determined the selection of cooperatives and consumers as market channel preferences among alternative channels existed in the study areas keeping other variable constant. The result shows that male household heads tend to prefer cooperatives and consumers market channels over traders as compared to female household heads. This implies that being male household head increases the probability of selecting cooperatives and consumers market channels in the study areas. This study finding was consistent with Mamo and Degnet (2012).

Age of household head: The study result indicated that as compared to the base category (traders), age of household head had determined the selection consumers as market channel preferences among alternative channels existed in the study areas keeping other variable constant. The result shows that as the age of household head increases the household be likely to prefer consumers market channel compared to traders market channel. This implies that aged household had choices the end consumers' market channel in the study areas. This study finding was similar with the Nodro *et al.,* (2014) who indicates that older and experienced farmers are not likely to sell at farm gate when they can sell at the auction.

Education level of household head: As education level increases, beef cattle farmers choose the final consumers' market channel as their market destination compared to traders. Educations increase the ability of farmers to gather and analysis relevant market information for their products and choose the end market for better price. This study finding was consistent with Mamo and Degnet (2012).

Fattening experience: Farmers' experience in beef cattle fattening has a negative and significant influence on choosing collectors and consumers' market channels as compared to the base outcome (traders) and selecting cooperative market channel positively and significantly over selecting the traders' market channel. This result shows that experienced farmers are not likely to prefer collectors and consumers market outlet when they are capable of selling at the secondary market outlet (traders). Similar to the hypothetical probability, this result deduces that when beef cattle producers add more managerial and marketing skills through experience, they get the capability to bargain and manage sales transactions at negligible cost. The result agrees with the finding of Ndoro *et al.,* (2014) and Dinku *et al.,* (2021) who argued that as cattle farmers accumulate managerial and marketing skills through experience, they gain an ability to coordinate market transactions at a much-reduced cost.

Livestock owned (Herd size): Herd size had negatively and significantly influence on the preference of collectors and cooperatives market channels as compared to traders' market channels. An increase in the number of herd size decreases the likelihood to prefer collectors and cooperatives market channels over traders' market channels. The result agrees with the finding of Sarma *et al.,* (2014) and Dinku *et al.,* (2021) who found that herd size had positive influence to selling at secondary market outlets than primary market outlets.

Access to credit services: Access to credit services for sampled beef cattle farmers decreases the probability of choosing cooperatives market outlets by 17.44 percent as compared to the base category or traders' market outlets. This indicates that as the smallholder beef cattle producers accessed to credit services they were preferred traders market outlets than cooperatives market outlets.

Access to market information: Access to market information for sampled beef cattle farmers decreases the probability of choosing cooperatives market outlets as compared to the base category or traders' market outlets. This indicates that as the smallholder beef cattle producers had accessed to market information services they were preferred traders market outlets than cooperatives market outlets. An increase in price information by one unit increases the probability of selling the beef cattle production in the secondary market (Sarma *et al*., 2014).

Membership to cooperative: Farmers' membership to cooperatives had a negative and significant influence on choosing collectors and cooperatives' market channels as compared to the base outcome (traders). This result shows that the farmers who are the membership to cooperatives not likely to prefer collectors and cooperatives market outlet than traders market outlets. The implication is that households are dependent on traders (middle men) as sources of beef cattle market information since they are not able to get effective market information services from their cooperatives. The result agrees with the finding of Sarma *et al.,* (2014) who found that group membership had a significant influence on the preference of primary market and terminal market. The farmer who belongs to group membership had a lower chance of selling their beef cattle at farm primary market than selling at terminal market. This finding was also in contrary to Mamo and Degnet (2012) who found that farmer's agricultural cooperative membership and the availability of market information reduce the probability of traders as market destination and increase the probability to sell to other farmers.

Non/off-farm income: The study result indicated that as compared to the base category (traders), household heads participation in non/off farm activities was determined the selection of collectors cooperatives and consumers market channel preferences among alternative channels existed in the study areas keeping other variable constant. The result shows that those households who earned income from the non/off-farm activities were less prefers to collectors and cooperatives, and more tend to prefer consumers market channels over traders as compared to who were not earned income for non/off farm activities. Income earned from off-farm activities can benefit farm activities through financing farm activities and investment in increasing farm productivity (Dorward et al., 2004)

Table 8. Multinomial logit estimation results

Variables	Collectors		Cooperatives		Consumers	
	Coef.	P-value	Coef.	P-value	Coef.	P-value
Sex of household head	-0.5912	0.584	17.698***	000	17.848***	0.000
Age of household head	0.0674	0.252	-0.1240	0.188	0.0954*	0.055
Education level of household head	0.4945	0.596	-1.1661	0.336	1.213*	0.096
Household size of household head	0.31903	0.217	-0.1943	0.441	-0.0135	0.926
Farm size	-0.6884	0.814	2.115	0.407	1.2893	0.335
Fattening experience	-0.4141**	0.022	0.3148***	0.004	-0.2181***	0.004
Livestock owned (TLU)	-0.3911*	0.088	-0.3886*	0.075	-0.1142	0.408
Access to extension services	-0.9562	0.249	0.78002	0.506	-0.3150	0.708
Access to credit services	1.5451	0.171	-17.4405***	0.000	-0.1567	0.863
Access to market information	-1.1048	0.307	-2.438*	0.055	0.4657	0.609
Membership to cooperative	-17.226***	0.000	-13.486***	0.000	0.3061	0.798
Distance to market place	-0.0064	0.397	-0.0098	0.143	-0.00256	0.725
Non/off-farm income	-17.705***	0.000	-15.257***	0.000	1.9452**	0.026
_Cons	-3.018	0.514	-14.574***	0.000	-24.398***	0.000

Log likelihood = -78.294724, Number of observation = 236, LR chi2 (36) = 50.55, Prob > chi2 = 0.0000, Pseudo R2 = 0.2440, and *, **, *** significant at 10 percent, 5 percent and 1percent significance level respectively, (Choice == Traders as base outcome).

Constraints and opportunities across beef cattle value chain

This section provides an analysis of constraints and opportunities along the beef cattle chain with a view to suggesting value chain interventions. The following table 6 summarizes constraints and opportunities in beef cattle value chain in the study areas.

Table 9. Constraints and opportunities in beef cattle value chain

Value chain function	Constraints	Opportunities
Inputs supply	❖ Shortage of feed supply in terms of quantity and quality ❖ Shortage of veterinary drugs supply ❖ Shortage of water in dry season	❖ Farmers are willing to pay for medicine ❖ Existence of concentrated feeds and crop residues ❖ Availability of veterinary services and experts
Production	▪ Feed shortage/grazing land ▪ Feed price increment ▪ Shortage of veterinary drugs ▪ Shortage of availability of water	▪ Government is committed to developing the sector ▪ Agriculture University, agriculture degree and animal health diploma course exist ▪ Existing cattle farm cooperatives / groups ▪ Availability of labor ▪ Farmers experience in fattening
Marketing	▪ Shortage of beef cattle supply ▪ High transportation costs ▪ Lack of capital ▪ Lack of business knowledge ▪ Broker ▪ Illegal traders ▪ Price is based on the appearance of the animal not the weight ▪ Lack of cattle market/collection point in the districts	▪ Availability of experienced traders ▪ Availability of transporters ▪ Demand for beef cattle ▪ Price increments for beef cattle
Processing	▪ Lack of capital ▪ Beef cattle price increment ▪ Lack of modern technologies ▪ Lack of modern slaughtering and butchering techniques, knowledge and skills ▪ Lack of proper slaughter houses	▪ Government inspection ▪ Government commitment to establish abattoirs ▪ High potential for profitable slaughter and processing business ▪ High demand for meat

Conclusion and Recommendations

This study was conducted in the selected districts of East Hararghe Zone which is highly known for beef cattle producing areas and known by locally called Harar Sanga in Ethiopia. However, because of various socioeconomic, institutional, natural and technological factors farmers in Ethiopia in general and fattening farmers in Hararghe in particular are not getting fair market access for their beef cattle. Therefore, to address those constraints/challenges analysis of beef cattle value chain is an important strategy in such a way that the current characteristics of the chain were identified. From this study alternative market channels and areas of intervention in the chain was suggested for better functioning of beef cattle value chain in the study areas.

The study results revealed that inputs suppliers, beef cattle producers/fatteners, collectors, cooperatives, traders, brokers, butchers, hotel and restaurant owners, consumers are the main primary actors in beef cattle value chain in the study areas. The study also identified enablers of beef cattle value chain such as macro finance institutions, veterinary and government extension service providers and business license providers among others. The study also identified inaccessibility of credit service and beef cattle market, weak linkage among chain actors, low information flow, and high illegal broker interference in beef cattle value chain.

The findings of this study also confirm that the role of intermediaries has been still dominant in beef cattle value chain in the study areas. Large proportion of beef cattle sales was made by traders (71 percent) and only small volumes were sold directly to final consumers (13 percent), to collectors (9 percent) and to cooperative (7 percent) in the study areas. Most of the transactions were conducted in the local/rural markets in the study areas due to transaction costs.

The multinomial logit (MNL) econometric results revealed that socio-economics and institutional factors were found to be significant in determining in beef cattle marketing channel choices in the study areas. Constraints hindering the success of beef cattle value chain are found in all the stages of the value chain functions which are important to intervene in the beef cattle value chain development in the study areas. In contrast, opportunities that enable the development of beef cattle value chain were suitable climate to develop forage and cattle production, farmers' experiences in beef cattle fattening, high demand for the fattened animal, and increasing demand for live animal and meat export, urbanization, high population and vicinity to the export market. Based on the study findings, the following recommendations are recommended:

At all stages of the beef cattle value chain only the butcher men graded and sold meat in the study areas, even if the laws and regulations governing livestock state clearly all cattle should be sold upon use of weighing machines. Thus, the study recommends strict enforcement of existing laws and regulation governing beef cattle marketing through weighing machines in the areas.

Improving financial services, market price information, and implementation legal action on illegal broker interference in beef cattle value chain in the study areas is vital since it has multiple effects in all actors engaged on beef cattle business.

Since age of the household heads was positively affect market channel choices young farmers should be encouraged to participate in beef cattle marketing activities as job creation opportunities. Beef cattle marketing are male-dominated. Therefore, policies that encourage women to participate actively in the beef cattle value chain are important.

Besides, the zonal Livestock and Fishery Office should augment cattle fatteners bargaining power through launching marketing cooperatives which is believed to be the best measure to reduce long beef cattle value chain and increase producers' income from sell of their beef cattle.
There is a need to train the actors at various levels to create a harmoniously operating system along the entire value chain from primary production to consumption. Particularly at the farm level, there is need for training in management of beef cattle producers as business enterprises.
This will enable farmers take farming seriously in order to be able to reap more from the enterprise. The training must be hands-on-training on techniques of preparing good quality rations that contribute for maximum body weight gain and at the same time are economically feasible.
Employ more effort in scaling-up of packages of improved forage production technologies are important since shortage of feed is critical constraint in the study areas.

References

Addis B. 2017. Major constraints of livestock marketing in lowland part of Ethiopia

AGP-LMD (Agricultural Growth Project-Livestock Market Development). 2013. Value Chain Analysis for Ethiopia: Meat and Live Animals, Hides, Skins and Leather and Dairy; AID-663-C-12-00009. Link: http://bit.ly/2DbNgk5

CSA (Central Statistical Agency). 2017. Report on Livestock and Livestock Characteristics (Private Peasant Holdings). Federal Democratic Republic Of Ethiopia

Dinku, A., Abebe, B., Lemma, A. and Shako, M. 2021. Analysis of beef cattle marketing channels under transaction costs in rural Ethiopia. *Int. J. Agril. Res. Innov. Tech.* 11(1): 37-48. https://doi.org/10.3329/ijarit.v11i1.54465

Gebresellassei N. 2018. Review on Beef cattle production and marketing system in Ethiopia. J Fisheries Livestock Production

McCormick D, Schmitz H. 2001. Manual for Value Chain Research on Home workers in the Garment Industry. Brighton, Institute of Development Studies. Link: http://bit.ly/2O4OB2j

Mamo Girma and Degnet Abebaw. 2012. Patterns and determinants of livestock farmers' choice of marketing channels: micro-level evidence. Ethiopian Economics Association, Addis Ababa, Ethiopia.

Ndoro, J.T., Mudhara, M. & Chimonyo, M. 2014. Farmers' choice of cattle marketing channels under transaction cost in rural South Africa: A multinomial logit model. *African Journal of Range & Forage Science (in press)*.

Sarma, J U Ahmed A K M A Al-Amin, M M Islam and K Fatema. 2014. Determinants of market participation in small scale beef cattle Entrepreneurs: evidence from pabna and sirajganj districts of Bangladesh.

Shapiro B, Gebru G, Desta S, Negassa A, Nigussie K, 2017. Ethiopia livestock sector analysis: A 15 year livestock sector strategy. Link: http://bit.ly/35h95KN

Sisay. 2015. Major cattle fattening constraints for smallholder farmers in Somali Regional State.

Appendix Table 1. Multicollinearity test (VIF)

Variable	**VIF**
Mkt_Info	1.59
logHSIZE	1.41
Access_Credt	1.39
logAge_HH	1.39
Ext_serv	1.35
Coop	1.22
logTLH	1.20
logLiveTLU	1.18
Edu_HH	1.15
Sex_HH	1.09
NonFII	1.06
logDist_mkt	1.06
Mean VIF	1.26

Assessment of Major Fruit Crops Production and Marketing Systems in East Hararghe Zone of Oromia Region, Ethiopia

Kibret Ketema, Husein Abro and Solomon Ayele
Oromia Agricultural Research Institute, Fedis Agricultural Research Center,
P.O. Box: 904, Harar, Ethiopia.
Corresponding Author's E-mail: kebret2012@gmail.com

Abstract

The study was conducted in selected districts of East Hararghe Zone of Oromia Region, with objectives to assess fruit production and marketing systems, and identify fruit production and marketing constraints and opportunities in the study area, and three-stage sampling procedures was used to select a total of 160 fruit producer farmers in the study area. Primary data were collected from sampled fruit producer households through household survey and the collected data analyzed using descriptive statistics. The survey result showed that fruit ***production*** *is a major source of income for fruit producer households in the area, and fruits such as mango, papaya, banana, avocado, orange, guava and lemon are grown in the area, and mango tree was the dominant one grown by 68.13% of sampled farmers followed by papaya, banana, and avocado that account for 48.75%, 36.88%, and 26.87%, respectively. The result showed that the average number of bearing trees of papaya, mango, orange, banana and avocado owned by the farmers was 22.70, 14.53, 12.82, 11.98 and 9.21, respectively in the area. The survey results showed that lack of access to improved variety, diseases and insects, lack of improved agronomic practice, low price, and lack of postharvest technologies were the major constraints for fruit crops in the study area. Hence, improving access to improved fruit varieties and postharvest handling technologies, capacity building on diseases management, introducing improved agronomic practice for fruit crops, improving fruit extension services, strengthening producer cooperatives and improve access to irrigation water are some of the recommendations forwarded to alleviate fruit crops production and marketing constraints in the study area.*

Key words: Fruit crops, Production, fruit marketing, East Hararghe Zone

Introduction

In Ethiopia, production of fruit crops plays an important role in improving the living conditions and food security of the nations. Fruit crops are generally delicious and highly nutritious, mainly of vitamins and minerals that can balance cereal-based diets (Griesbach, 2003). Ethiopia's fruit productions and exports play a significant role in the local economy as a means of earning livelihoods for nearly five millions farmers, creating jobs and generating foreign exchange revenues and supply raw materials for local industries. Besides, fruit crops are friendly to nature and provide shade, and can easily be incorporated in agro-forestry practices (MoARD, 2009, EHDA, 2012). The country has great potential for production of fruit for domestic and export markets (Awole, *et al*., 2011). The fruit crops sub-sector is one of the priority strategic sectors recognized by the GOE for its potential sector for investments and exports (Mohammed and Aferwork, 2016).

Owing to the importance of fruits in Ethiopia, the GOE has encouraging policy to expand fruit production for domestic and export markets. The major fruit crops produced are bananas, mangos, avocados, papaya, guava, grape, citrus, pineapples and strawberry (Edossa, *et al*., 2021). Among fruits, avocado, banana, orange, papaya and guava are common, and about 99% of the fruit crop production is cultivated by small scale farmers. According to CSA (2020/2021), about 161,470.82 hectares of land is under fruit crops in Ethiopia. Out of the total crop land area under fruit crops, about 59.43% and 18.94% of the total fruit area took up by Banana and Avocado, respectively, and more than 14,192,409.18 quintals of fruits was produced, and Banana, Avocado, Mango, Papaya, and Orange took up 63.30%, 17.29%, 10.66%, 5.07% and 2.81% of the fruit production, respectively (CSA, 2021).

Eastern Ethiopia is well-known for production and supply of both fruits and vegetables and about 35% of the total acreage allotted for fruit production is covered by Mango (Unpublished Haramaya University Horticulture Department Survey, 1996). Fruit crops is the major sources of livelihood for a large number of farmers in the area; and it contributes a major source of cash income for the farmers, and the crops also gives the opportunity of the farmers to participate in the fruit market in the area (Bezabih and Hadera, 2007, Mohammed and Afework, 2016).
In East Hararghe Zone, fruit crops are grown by smallholder farmers, and in 2021 production year, about 2,682.92 hectares covered by different fruit crops and more than 228,131.58 quintals of fruits was produced by smallholder farmers in the Zone. The major fruit crops grown in the area includes Mangoes, Oranges, Avocados, Bananas, Papayas, Guavas, Lemons and Pineapples (CSA, 2021). Even if the farmer's livelihood is highly supplemented by the income from their fruit crops, there is a declining of fruit crops production. Some of the factors contributing to the declining of fruit crops include foliar fruit diseases, old age fruit trees and poor management practices. Despite the importance the crops, the production of the fruits are low as compared to potential, this mainly due to foliar fruit diseases, limited technical training, and research and extension services, foliar diseases and pests, postharvest loss and lack of market development (Tekle *et al*., 2014, Melkamu *et al*., 2015, Alemayehu and Abatneh, 2019, Yeshitela and Nessel, 2003). Despite the importance of the fruit crops, and potential of the East Harerghe Zone, there is inadequate information on the fruit crops production status, technologies such as improved fruit varieties and management practices used by smallholder farmers in the Zone. Hence, this study was initiated with the objective to assess fruit crops production and marketing systems in the study area.

Objectives of the Study

The general objective of the study was to assess major fruit crops production and marketing system in the selected districts of East Hararghe Zone, Oromia National Regional State, Ethiopia with the following specific objectives.

Specific objectives

1. To describe the **fruit production and marketing status** in the area, and
2. To identify and prioritize major fruit production and market constraints in the areas.

3. To identify and prioritize major fruit production and market opportunities in the study areas.

Methodology

Description of the Study Area

The study was undertaken in Meta, Babile and Gursum districts of East Hararghe Zone of Oromia Region. The East Hararghe Zone is located at the eastern part of Oromia regional state and it is found about 525 km away from Finfine capital of the country. The zone lies between $7^{0}32^{'}$N to $9^{0}44^{1}$Nand 41^{0} $10^{'}$E to $43^{0}16^{'}$E and is demarcated by West Hararge Zone from the west, Bale Zone from the south, Somali regional state from the East and Southeast, and Dire Dawa administrative council from the North. East Hararge Zone has three major agro-ecologies namely lowland, midland and high land. The lowland accounts (67.76%) followed by midland (24.57%) and highland (7.67%) agro-ecologies. East Hararghe zone lies within an altitude of 500 to 3405 meters above sea level. The annual rainfall of the zone ranges between 400 to 1010 mm, and the annual temperature also ranges between $14\,^{o}$c to 25^{o}c. The Zone has a total of 26,308.60 km^{2} of land. Agricultural production is the main means of livelihood of the residents of the zone, and it is characterized by a smallholder mixed farming system where crop production and livestock rearing are simultaneously practiced. The main crops produced in the area include sorghum, maize, wheat, barley, haricot bean, groundnut, and vegetables, fruits, coffee and chat are produced in the zone (EHZFEC, 2020).

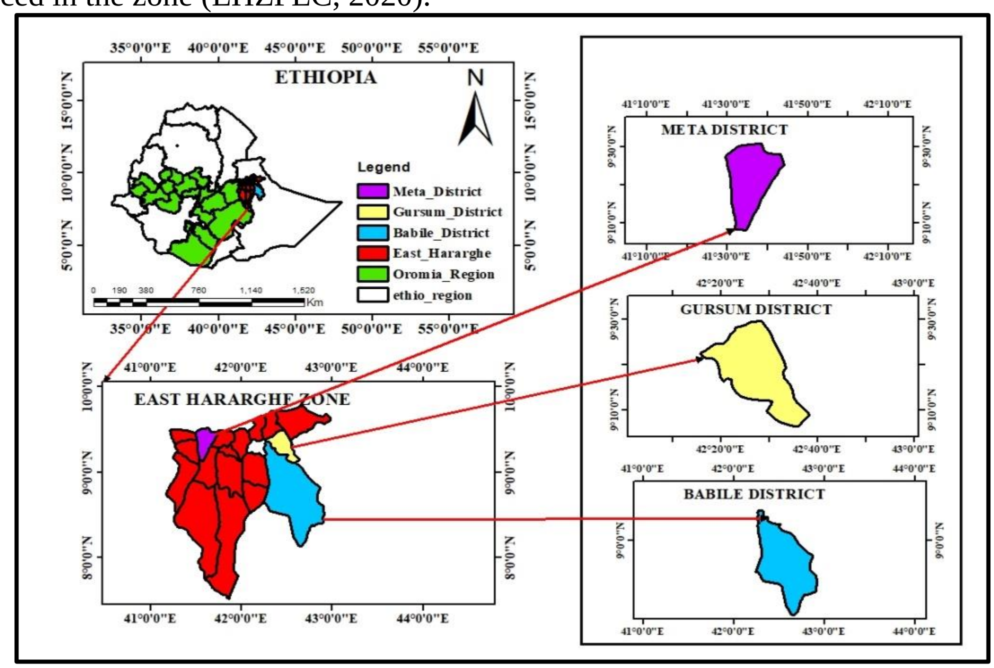


Figure 1. Map of the study areas

Sampling Me

Three stages sampling procedure was used to select districts, Kebeles and sample households. In the first stage, three districts (Babile, Gursum and Metta) were purposively selected based on fruit production potential in study area. In the second stage, fruit growing kebeles in each district were listed and identified. Once fruit growing kebeles identified, three kebeles from each district were selected, and a total of nine fruit growing kebeles were selected from three districts using simple random sampling technique for this study. In the third stage, a total of 160 fruit producer farmers were randomly selected using probability proportional to the population size sampling technique and interviewed. In addition, 36 fruit producer farmers were purposely selected also involved in this study through FGDs and key informants in the study area.

Sources of Data and Methods of Collection

The study used both primary and secondary data sources to collect data. Primary data were collected from fruit producer farmers using household survey, focus group discussions, discussions with key informants and field observations. Primary data were collected through individual interviews using semi-structured questionnaires from fruit producer farmers in the area. The primary data collected from farmers include demographic and socio-economic characteristics, fruit production, production system, sources of inputs, type of varieties used and constraints and opportunities in the area. In addition, key informant interviews and focus group discussions were held with the farmers, development agents and experts by using checklists to support primary data collected. Secondary data required for the study were taken from Central Statistical Agency's website, and district agricultural and natural resource offices.

Method of Data Analysis

Descriptive statistics such as frequencies, percentages, means and standard deviations were used to examine the socioeconomic characteristics of fruit grower farmers, and fruit production and marketing systems of the study area. In addition, trend analysis and ranking were used to analyze fruit production status, and fruit production and marketing constraints in the study area. The collected data were analyzed by using SPSS statistical software package version 26.

Results and Discussion

Socioeconomic of characteristics fruit producers

The average age of the sample fruit producer households was 40.28 years, with a range of 20 to 71 years old in the study area (Table 1). Regarding to **experience in fruit production, the result of the survey indicates that t**he average **fruit production** experience of the farmers was 19.63 years (Table 1). This shows that farmers in the study area have good experience in production of **fruit crops** in the study area. The survey result also indicated that, sample fruit producer farmers walk on average 89.60 minutes to get market to sell their fruit products in the study area.

The family size of the fruit producer respondents ranges from 2 to 14 with an average of 7.14 in the study area, which was higher than the national average family size (Table 1). The family members provide a major source of labor for crop production in general and fruit crop production in particular. Hence, the existence of high family size has a positive contribution to the supply of large volume of fruits production in the study area. With respect crop land holding of the respondents, average crop land holding of the respondents was 0.55 hectare ranging from 0.125 to 1.88 hectares in the study area (Table 1). The survey result indicated that the average annual income of the households was 36830 birr with ranging from 17910 to 59400 birr, and they obtained more income from sale of fruit crops which the average was 20740 birr (Table 1).

Table 1. Socioeconomics and demographic characteristics of fruit producers (cont. variables)

Variables	Mean	SD	Max	Min
Age of household head (years)	40.28	18.07	71	20
Family size	7.14	2.92	14	2
Land holding in ha	0.55	0.31	1.88	0.125
Experience in fruit production (years)	19.63	9.10	55	3
Distance to nearest market (minutes)	89.60	35.50	120	30
Annual gross income (“000” birr)	36.83	15.30	59.40	17.91
Annual fruit crops income (“000” birr)	20.74	**10.12**	31.05	9.26

Source: Own survey result, 2022

The result of the study indicated that, about 87.5% of sample fruit producer households were males and the remaining 12.5% of fruit producer households were females, and the majority (95.63%) of the respondents were married. Regarding literacy of fruit producer households, out of the total fruit producer households included in the survey, about 56.25% of the sample fruit producer households were illiterate while about 43.75% of fruit producer households were literate in the study area.

Fruit producers’ access to institutional services

Institutions play a vital role in providing agricultural production and marketing services like access to training and advices, agricultural inputs such as seeds (seedlings) and fertilizer supply, access market information and extension services provided by experts, development agents, cooperative/Union, agricultural research centers, Universities and NGOs. In line with this, access to different institutional services might contribute market participation and commercialization of smallholder fruit producer farmers.

As indicated in the table 2 below, regarding to **access to extension services**, the survey result shows that about 53.75% of the respondents reported that they had totally no extension services and visit in relation to fruit production and marketing while about 46.25% of the respondents are entitled to get extension access on fruit production in the study area (Table 2). This finding implies that the majority of households had low in access to extension services on fruit production in the study area. The result of the study has therefore indicated the extension service is largely in favor of other crops. This is in line with Carlson *et al.* (2005) and Sonko *et al.* (2005) who explained the current extension approach was in favor of cereals but not fruit crops.

The survey result also showed that that about 42.5% of the fruit farmers received training on fruit production and marketing, while majority, 57.5% of the sample fruit producer farmers not received any training on fruit production and marketing in the area (Table 2). This revealed that majority of fruit producer farmers learnt fruit cultivation practices from their family and neighboring farmers, and technical training and advice provided by experts and development agents on fruits production was limited in the study area.

Concerning access to fruit market information, as indicated in the table 3, about 60.63% of sample households have access to fruit market information while about 39.37% of the sample households have no access to market information in the study area. Regarding membership to cooperatives and unions, the result of the study indicated that about 38.1% % and 61.9%% of the sample households have membership in farmer cooperative in their area, respectively (Table 2). This is to mean that there is no fruit marketing cooperatives and fruit processing groups the study area.

Table 2. Proportion of fruit producer farmers' access to services in the study area

Variables	**n=160**	**Category**	**Frequency**	**%**
Access to fruit crop based extension services		Yes	76	46.25
		No	84	53.75
Access to training on fruit production/marketing		Yes	68	42.5
		No	92	57.5
Access to fruit market information		Yes	97	60.63
		No	63	39.37
Membership to cooperatives and unions		Yes	61	38.10
		No	99	61.90

Source: Own survey result, 2022

Means of income sources for fruit producer households

The respondents depend on different means of income generation activities where fruit and vegetable production is a major source of income for the majority of fruit producer households in the study area. For this reason, about 100 % of the fruit producer households earn their income from fruit and vegetable production as a primary source. Grain and legume crops production is also considered as the second major means of income (88.75%) while Khat/Coffee production takes the third (51.25%) in the study area (Table 3). In the study area, sorghum, maize and groundnut are grain and legume crops that support the livelihood of farming households commonly. Livestock production takes the fourth rank in terms of the number of households that depend on them as a means of livelihood in the study area.

The findings indicate that crops in general and fruit crops in particular are the dominant income/livelihood source farming households in study area. This shows that the study sites are appropriate for the assessment of fruit production system in the study areas.

Table 3. Major means of income generation of the fruit producers

Income/livelihoods sources	**Frequency**	**%**	**Rank**
Fruit and vegetable production	160	100	1
Grain and pulse production	142	88.75	2
Livestock production	73	45.63	4
Khat/Coffee production	82	51.25	3
Fruit and vegetable trading	32	20.0	5
Khat trading	19	11.88	6
Livestock trading	4	2.50	7
Total	160	100	

Source: Survey result, 2022

Fruit crops production system

Major fruit crops grown

Different types of fruit crops planted by the farmers in the study area with different intensities in terms of number fruit trees planted and managed on their farm fields. The study showed that the farmers are cultivated mostly mango, papaya, banana, avocado, orange and lemon together with vegetables, cereals and pulse crops in the study area. Mango is relatively widely grown followed by papaya, banana, orange and guava in terms of number of farmers grown in the zone. The survey results indicated that, mango was the dominant grown by 68.13% of sampled fruit grown farmers followed by papaya, banana, and avocado that account for 48.75%, 36.88%, and 26.87%, respectively. In addition to these fruits, **lemon, orange,** guava and other fruit crops were cultivated by 21.25%, 15.63%, 12.50% and7.50% of the fruit producer farmers, respectively in the area (Table 4). This imply that most of the fruit producer farmers growing different types of fruit trees on their fields; and they noted that the reasons for growing different types of fruit crops were for diversifying the source of income.

The productivity of fruit crops depends on number of fruit trees that are productive (fruit bearing trees) managed in the farmers' fields. The result showed that the average number of bearing trees of papaya, mango, orange, banana and avocado owned by sample fruit producer farmers was 22.70, 14.53, 12.82, 11.98 and 9.21, respectively. The survey result shows that, average number of 6.75, 2.06 and 5.30 guava, lemon and other fruits trees grown by sampled farmers in the study area (Table 4). This implies that the farmers have productive fruit trees and serving as the main source of income for the farmers in the study areas. The result showed that on average a farmer has **4.5**, **2.61**, 1.76, 6.98 and mango**, papaya, banana, avocado and orange** nonbearing trees in number, respectively in the study area. This finding is in line with the findings of Bezabih and Hadera (2007) and Efrem *et al*., (2020). Bezabih and Hadera (2007) reported that that on average a farmer has 4, 7, 10, 38 and 39 for guava, mango, banana, orange and papaya trees in number, respectively in Eastern Ethiopia. Similarly, Efrem *et al*., (2020) also reported that on average a farmer has 10.67 and 8.24 avocado and mango trees in number, respectively in Jimma Zone, South West Ethiopia.

Table 4. Type of fruit, the number of farmers owning fruit trees and the number of trees owned

Fruit type	Proportion of fruit producers		Number of fruit trees		
	Frequency	%	Average	Minimum	Maximum
Mango	109	68.13	14.53	1	30
Papaya	78	48.75	22.70	2	140
Banana	59	36.88	11.98	1	60
Orange	43	26.87	9.21	1	20
Guava	34	21.25	6.75	4	36
Avocado	25	15.63	12.82	1	70
Lemon	20	12.50	2.06	1	7
Others fruit crops	12	7.50	5.30	1	10

Source: Survey result, 2022

The farmers in the study area grow fruit trees for variety of purpose such as for sale of fruit, consumption and for shade in the farm fields. The survey result indicates that the main purpose of fruit production by the majority of the farmers (89.55%) is for sale and income generation whereas a small proportion of the sampled households (10.45%) said that they produce fruit for both sale and home consumption in the study area.

Land coverage, production, and productivity of fruit crops

The survey results show that different types of fruit crops were produced by smallholder farmers in the study area. Mango and papaya were highly produced in zone (Table 5). The survey results indicate that almost all farmers in the study area are engaged in the production of fruit crops, and the area allocated by fruit producer households for the production of these crops is very small, and the average area of land allocated for production ranges from 0.12 to 0.16 hectares in the study area. The survey result also shows that the farmers produced on average a total 2344.92 quintals of produced, and mango, papaya, banana and orange took up 41.84%, 26.61%, 15.09% and 6.06% of the total production, respectively (Table 5). The result showed that there was high production percentage, 41.84%, 26.61 and15.09% for mango, papaya and banana fruits than any other fruits in the area.

Table 5. Total fruit production and share of the crops in the study area

Types of fruits	Production in qt	%
Mango	981	41.84
Papaya	624	26.61
Banana	354	15.09
Avocado	105	4.48
Lemon	42	1.79
Orange	142	6.06
Guava	69.5	2.96
Others fruit crops	27.42	1.17
Total	2344.92	100

Source: Survey result, 2021

The productivity level of fruits was presented in Table 6. The average productivity of mango in the zone was 64.87 quintals per hectare which is by far lower than the potential of the crop and the national average i.e. 72.81 quintals per hectare for mango. Similarly, the average productivity of 66.77and 70.80 quintals per hectare for banana and lemon in the study area which is lower than the national average i.e. 93.62 and 80.21quintals per hectare respectively (CSA, 2021). The average productivity of orange and guava in the zone was 81.94 and 82.89 quintals per hectare (Table 6). The low productivity of the crops can be attributed to low use of inputs, and managing old fruit trees in the area.

Table 6. Area allocation and productivity of major fruit crops in the Zone

Types of fruits	Area (ha)	Productivity (qt/ha)
Mango	1048.43	64.87

Banana	556.85	66.77
Lemon	**121.40**	70.80
Orange	**838.11**	81.94
Guava	**1352.30**	82.89

Source: Computed from CSA, 2020

Trend of production of fruit crops

According to CSA, the area under fruit crops grown by smallholder farmers increased from **1,557.78** hectare in 2015 to about **2,690.36** hectare in 2016 in the Zone, representing an increase of about 72.70%. Total production also increased by 50.98%, from about **56,659.45 quintals** in 2015 to about **85,545.83 quintals** in 2016 (Table 8). The Zonal level CSA production data were not available for the years 2017 to 2018. Similarly in 2019 and 2020**,** the area under fruit crops and total production showed an increasing trend. The result shows that fruit production trends at zonal level were increasing from year to year in the area.

Table 7. Trends of fruit crops production over the last four years in East Hararghe Zone

Years	Area and production	
	Area (ha)	Production (qt)
2015	**1557.78**	**56,659.45**
2016	**2690.36**	**85,545.83**
2017	NA	NA
2018	NA	NA
2019	**2257.64**	**126,868.16**
2020	**2682.92**	**228,131.58**

Source*:* derived from CSA data of the respective years NA= Not Available

The survey result further showed that majority of fruit producers, 53% of the sample respondents were replied that, the trend of fruit production is apparently increasing over the years, while about 38.5% of the sample respondents were replied that, the trend of fruit production is decreasing over the years in the study area (Figure 1).

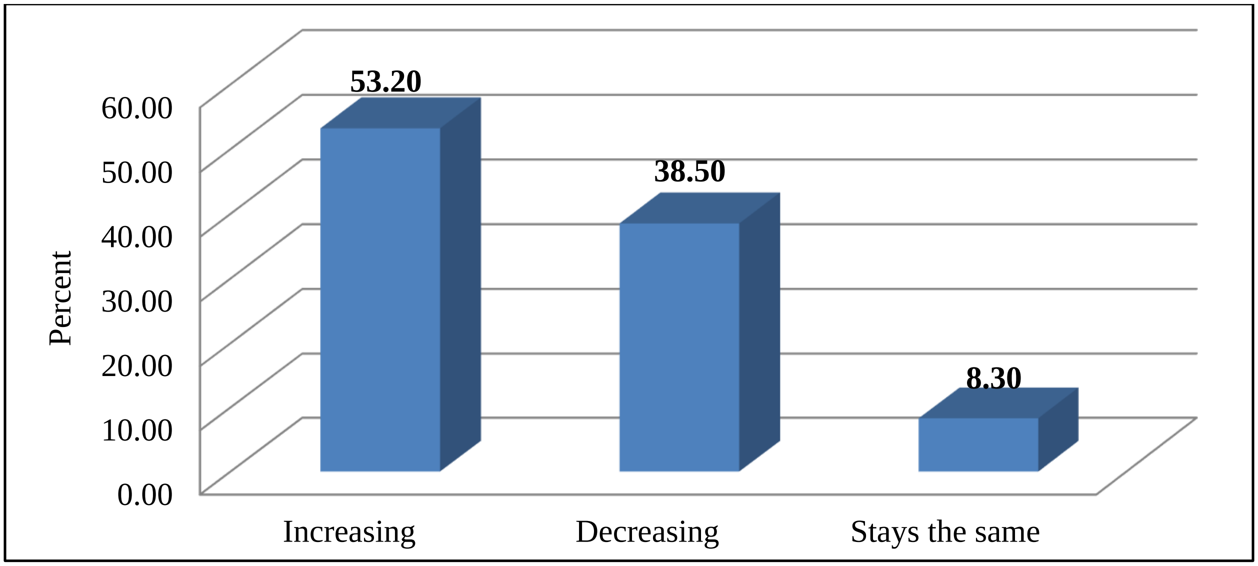


Figure 1. Farmers' perception on trend of fruit crops production

Fruit crops production and utilization by sample farmers

The result in Table 9 indicates about the percentage of fruit production in the study area as well as the household's consumption and amount sold to market. Analysis of fruit production in the study area shows that the total fruit production in the study area was estimated to be 2344.92 quintals in 2021 production year. With regard to the amount of fruits sold to market, the result showed that, about 94.52%, 90.74% and 91.60% of mango, papaya and banana products were sold to the market (Table 9). Similarly, about 86.50%, 98.75%, 93.82% and 94.28% of the total products of avocado, lemon, orange and guava was sold to market in the study area. The farmers in the study area supplied the largest proportion of fruits produced to the market and sold it, and this showed that fruit crops were produced mainly for the market in order to generate income in the zone (Table 9).

Whereas regarding consumption of fruit products, the consumption percentage of fruit products by the farm households is also listed in Table 9 for different fruits, and the result showed that small proportion of the fruits was consumed by farm households in the study area. Accordingly the results showed that, the farm household consumption percentage of mango, guava, orange, papaya, banana and avocado was 5.48%, 5.72%, 6.18%, 8.40%, 9.26% and13.50 %, respectively in the study area. The consumption of fruits by the farm households was low as compared to the amount of fruits sold to market in the zone, and this might be due to fruit crops produced mainly to generate income and limited awareness on the nutritional benefit of fruit consumption by the farm households in the study area.

Table 8. Percentage of fruit crops sold and consumption by sample farm households

Fruit type	Amount produced (qt)	Amount Sold (%)	Amount consumed (%)
Mango	981	94.52	5.48
Papaya	624	90.74	9.26
Banana	354	91.60	8.40

Avocado	105	86.50	13.50
Lemon	42	98.75	1.25
Orange	142	93.82	6.18
Guava	69.5	94.28	5.72
Other fruit crops	27.42	87.40	12.60
Total	2344.92		

Source: Survey results, 2021

Fruit crops management practice and input use

Fruit cropping systems

The farmers are cultivating fruit crops either as intercropped with other crops or sole in farm fields and backyards/garden in the study area. The survey result revealed that, about 85.63% of the fruit producer respondents reported that they intercropped fruits with cereal, legumes, vegetable, coffee and chat whereas about 6.25% of fruit producers reported that they practice sole cropping in the study area (Table 9). The rest 8.13% of respondents reported that they use both sole and intercropping systems in the study area (Table 10). The intercropping of fruits with others crops is the most popular cropping practice in the study area. This might be due to land shortage and the farmers need to diversify their income source by intercropping fruits with other crops in the study area. The result of this study is line with **Ayelech** (2011) who reported intercropping of mango and avocado with short cycled crops in Gomma Woreda, Jimma Zone, Oromia National Regional State.

Table 9. Fruit cropping systems in the study area

Fruit production practices	Frequency	%
Intercropping	137	85.63
Sole planting	10	6.25
Sole and intercropping	13	8.13

Source: Survey results, 2021

Fertilizer use

The survey result showed that, the majority, majority, 78.75% of the fruit producer farmers used organic fertilizers such as farm yard manure for their fruit crops, and all of the farmers reported that they did not apply inorganic fertilizer for fruit production in the study area (Table 10). The reason indicated for not using inorganic fertilizer to fruit crops was shortage of fertilizer and give priority for other crops in use fertilizer.

Pesticide use

Key informants and fruit producer farmers reported that the most prevailing insects were fruit fly, termite and aphid, and diseases like fruit decay, powdery mildew, white mold, dieback and anthracnose are the most prevailing on fruit crops in study area. The survey result revealed that from the about 73.12% of fruit producer farmers did not use pesticides to control fruit diseases and insects, and only 26.88% of fruit producer farmers used pesticides to control fruit diseases and insects in the study area (Table 10). During focus group discussion the farmers reported that the farmers used cultural practices like smoking in order to manage their fruit trees from diseases and insects in the study area. The focus group discussions and key informants also noted that lack of knowledge, lack of access to pesticides and high price are mainly affect farmers' fruit production and productivity in the study area. Irrigation water use, about 58.75% of the producers use irrigation water for fruit production in the study area (Table 10).

Table 10. Management practices used by fruit producer farmers in the study area

Management practices	Frequency		%	
	Yes	No	Yes	No
Organic fertilizers application (manure/compost)	126	34	78.75	21.25
Inorganic fertilizers use (NPS, Urea)	0	120	0	100
Pesticides use (fungicide, insecticide)	43	117	26.88	73.12
Irrigation water use	94	66	58.75	41.25

Source: Survey results, 2021

Fruit seed/seedlings used

Fruit producers used improved and local varieties of seedlings for their fruit production in the study area. According to the survey result, out of the total respondents in the study area, about 59.30%, 60%, 46.38%, 65.73% and 80.25% of fruit producing households used local varieties for mango, banana, avocado, lemon, and orange respectively whereas about 36.20%, 47%, 53.62% and 68.40% of fruit producing households used improved varieties for mango, guava, avocado and papaya, respectively. Only 5.50%, 15.25% and 21% of fruit producer farmers used both improved and local varieties for mango, banana and guava in the area (Table 11). The result is consistent with work of Diriba *et al.*, (2020) that shows, majority (55.63%) of horticultural crops producer households used local varieties in Arsi Zone of Oromia Region, Ethiopia.

Improved varieties for mango, papaya, banana and avocado were introduced to the area through agricultural office and development partners in the study area. However, agricultural office and development partners are providing limited number of seedlings of improved varieties accessed for a limited number of fruit producers in the study area. The focus group discussions and key informants noted that lack of access to seedlings of improved varieties for major fruit crops is reported that as main constraint for fruit producer farmers in the study area.

Table 11. Type of fruit seedlings used by fruit producer farmers in the study area

Types of fruits	seedlings types used		
	Local	Improved	Both
Mango	59.30	36.20	5.50
Papaya	31.60	68.40	-
Banana	60.0	24.75	15.25

Avocado	46.38	53.62	-
Lemon	65.73	34.27	
Orange	80.25	20.75	-
Guava	32.0	47.0	21.0

Source: Survey results, 2021

Sources of improved seedlings/seeds

In the study area, fruit producer farmers use both improved and local fruit seedlings/seeds from different sources. The result of the survey showed that out of the total fruit producer farmers, about 66.25 % and 32.50% of fruit producer farmers accessed fruit seedlings from Agricultural office and non-governmental organizations (NGOs), respectively in the study area. The remaining, 6.85%, 13.75% and 16.875% fruit producer farmers obtained fruit seedlings from market, other farmers and from their own fruit plant, respectively and only 12.50% of fruit producer farmers obtained fruit seedlings from research centers and Universities (Table 12). Therefore, the findings infer that the majority of the fruit farmers obtain seedlings from agricultural office, non-governmental organizations (NGO) and from their own plant in the area.

Table 12. Sources of fruit seedlings for fruit producer farmers in the study area

Source	Frequency	%
Agricultural office	106	66.25
Research centers/Universities	20	12.50
NGOs	52	32.50
Own plants	27	16.875
Other farmers	22	13.75
Market	11	6.85

Source: Survey results, 2021

Fruit marketing system

Main market of fruit crops

The major markets identified for collection and distribution of fruit products are farm gate and district markets, Harar and Dire Dawa in the study area. Farm gate market is the main market where farmers sale their fruit products in the zone. The results for households who did sell fruits in different market places are indicated in Table 13. The survey result showed that, from the total fruit producer farmers, 62.25% and 32.5% of them sold their products at farm gate and district markets, respectively, and the remaining, 6.25% they sold in other market places in the study area. Similarly, during focus group discussions, the participants reported that the farmers sold their fruits at farm gate at low price due to transportation problem, traders, and weak market linkage among all actors in the study area.

Table 13. Main market place of fruit products in the study area

Market place	(n=160)	
	Frequency	%

Farm gate/Village market	98	62.25
District market	52	32.50
Other market places (Dire Dawa, Harar)	10	6.25

Source: Survey results, 2021

Major buyers of fruit products

The market actors namely producers, collectors, brokers, traders and consumers were identified for collection and distribution of fruit products in the study area. Producers sold their fruit produces harvest to collectors, retailers and consumers. The result of the survey showed that out of the total fruit producer farmers, majority 63% of them sold their fruit produce to collectors at farm gate in the study area, while 18.75% and 12.5% of fruit producer farmers sold their fruit produces to retailers and consumers, respectively (Table 14). This could be due to perishable in nature of fruit produces; the producer sold their fruit produces at farm gate in the study area.

Table 14. Proportion of fruit producer farmers who sold fruits to different buyers

Market actors	(n=160)	
	Frequency	%
Collectors	101	63.13
Retailers	30	18.75
Consumers	20	12.50
Processors (juice houses/restaurants)	9	5.63

Source: Survey results, 2021

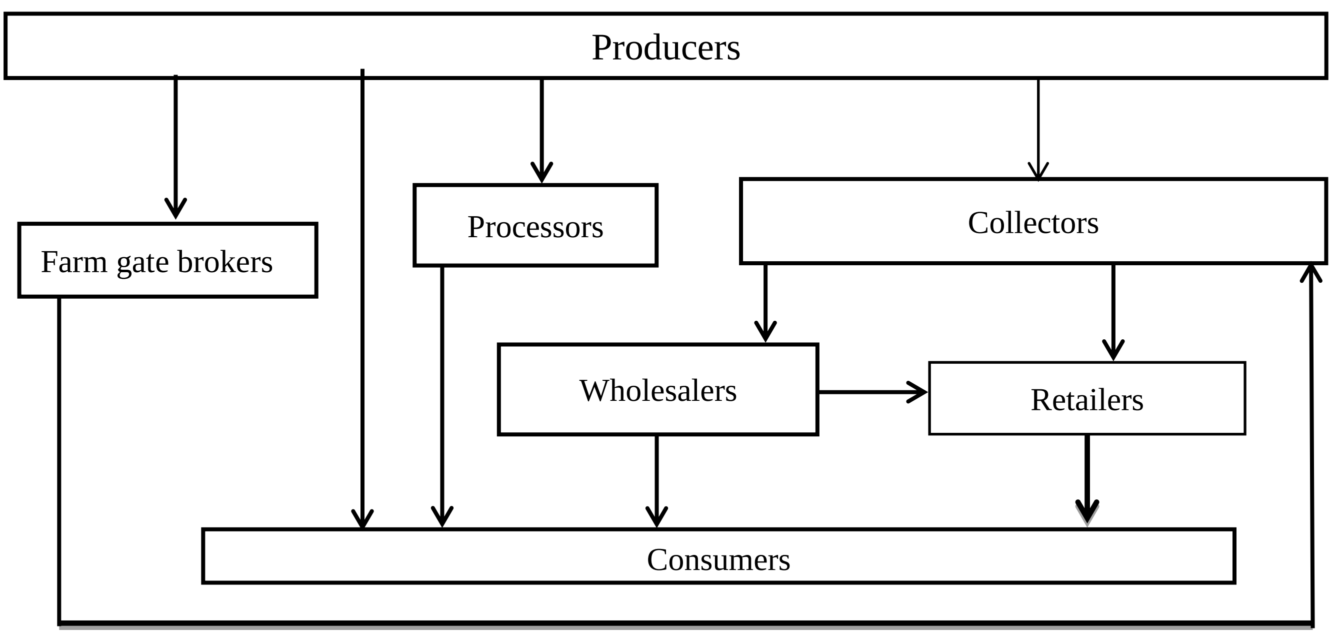


Figure 2. Fruit producers market and the major actors in the study area

Pr

Production constraints

There are constraints that hinder the production and productivity of fruit crops in the study area. The majority of the sample fruit producer farmers reported that lack of improved fruit seedlings, diseases and insects, rainfall shortage/drought, lack of improved agronomic practices, limited of extension services, low irrigation facility, limited skill of the farmers and lack of improved agronomic practices as major constraints of fruit production in the study area (Table 15). The result obtained from the survey showed that, among the total sample fruit producer farmers, about 98% of them responded that lack of access to improved fruit seedlings/varieties which are adaptable to local conditions as their production constraint and it ranked first in the study area (Table 15). This indicates that there was a problem of access to improved fruits seedlings in the study area. During the focus group discussion, the participant farmers indicated that the farmers used local and unidentified fruit seedlings as planting materials due to lack of access to improved planting materials, and this is mainly due to absence of seedlings multiplying and distributing organizations in the area.

Concerning diseases and insects, out of the total of sample fruit producers, about 84.38% of them reported that diseases and insects as the major constraint to fruit production in the study area and it ranked second in the study area (Table 15). This is related to access to improved fruit seedlings and pesticides problem. Unavailability of pesticides and resistance improved seedlings of fruit va were aggravated the problem of diseases in the study area.

The result of the survey also showed that erratic rainfall distribution/drought, about 68.75% of fruit producer farmers identified as the third most important constraint to fruit production followed by irrigation water shortage and lack of improved agronomic practices in the study area (Table 15). The majority of the fruit producers in the study area were replied that they depend on by rain fall due to lack of sufficient irrigation water. This indicated that utilization of irrigation scheme by farmers in the study areas were limited and this resulted in low production of the fruit produces in the study area. Furthermore, the survey result revealed that limited extension services and limited knowhow and skill were also regarded as major constraints of fruit production by 55% and 46.25% of the fruit farmers respectively, in the study area (Table 15).

Table 15 Major production constraints of fruit producers in the study area

Constraints	Sample household (160)		
	Frequency	%	Rank
Lack of fruit seedlings of improved varieties	157	98.13	1
Diseases and insects	135	84.38	2
Erratic rainfall/drought	110	68.75	3
Limited extension services and supports	88	55.0	6
Shortage of irrigation water	109	68.13	4
Knowledge and skills gap of farmers	74	46.25	7
Lack of improved agronomic practices	105	65.63	5

Source: Survey results, 2021

Marketing constraints

During the survey, different constraints related with the fruit marketing in the study area were identified with farmers and key informants. The major market constraints noted by fruit producer farmers are low price of fruit produces, lack of proper postharvest handling technologies, high prices of inputs (seedlings, agrochemicals), lack of fruit market linkage, lack of strong fruit cooperatives, inadequacy of transport facilities and lack of market extension support services in the study area (Table 16).

Low price for fruit produces was identified as the first most important constraint to the fruit marketing system in the surveyed area (Table 16). The participant farmers noted that the farmers sold the fruit product in the village markets at a low price which is determined by brokers in the study area. Due to perishable nature of fruit products and interference of brokers/collectors, the fruit producers are forced to accept low price offered by brokers/collectors at village/farm gate market in the study area. The study result showed that, about 88.13% of sampled fruit producer farmers mentioned that lack of access to postharvest handling technologies considered as the most important constraint followed by high prices of inputs such as fruit seedlings and pesticides in the area (Table 16).

Regarding postharvest handling technologies, focus group discussion and key informants noted that lack of proper postharvest handling technologies such as lack of storage and preservation technologies as the major constraint in the area. The key informants also mentioned that fruit lose is high, mainly due to small scale agro processing enterprise particularly for mango as the major constraint in the area. During the focus group discussion, the participant farmers mentioned that fruits losses occurred before harvesting, mainly due to diseases and pests and rainfall shortage occurred during fruit growing stage, while fruits lost occur at harvesting, mainly due to harvesting methods, and most of the participant farmers reported that fruit products lost after harvesting occurred mainly due to packing, transporting and marketing in the study area.

The survey has further revealed that, about 83.75%, 67.5%, 53.75% and 46.87% of sample fruit producer farmers replied that lack of fruit market linkage, lack of strong fruit cooperatives, inadequacy of transport facilities and lack of market extension support services, respectively, are the major constraints of fruit marketing in the study area (Table 16). The result of focus group discussion also revealed that lack of market linkage among all actors in the fruit production and marketing and weak performance of existing farmer cooperatives on fruit marketing in the area, and due to this reasons, local collectors controlled all the fruit marketing activities in the area. The focus group discussion and key informants also indicated that high cost of transport was raised as constraint to fruit marketing system in the study area.

Table 16. Major constraints of fruit marketing in the study area

Constraints	(n=160)		
	Frequency	%	Rank
Low price of fruit produces	148	92.5	1
Lack of proper postharvest handling technologies	141	88.13	2
High prices of inputs (seedlings, agrochemicals)	136	85.0	3
Lack of fruit market linkage	134	83.75	4
Lack of strong fruit cooperatives	108	67.50	5
Inadequacy of transport facilities	86	53.75	6
Lack of market extension support services	75	46.87	7

Source: Survey results, 2021

Fruit production and marketing opportunities

The survey result of producers' group discussion and key informants showed that potential opportunities perceived based on key informants and fruit producers views in the study area include availability of suitable climatic conditions for growing different fruit types, growing demand for improved fruit technologies and market by fruit producer farmers, government policy dimension on fruit crops stimulates the involvement of farmers, expansion of irrigation schemes and farmers' indigenous knowledge in fruit production are some of the major opportunities available for improving fruit production and productivity in the area. The Urbanization and rapidly growing population is also perceived as a potential opportunity for improving fruit production in the area. Moreover, availability of arable land particularly in lowland areas and surface and underground water, and availability of various organizations such as Research Centers and Universities that are engaging in research and development work, and provide inputs and technical services to the fruit producer farmers are some of the major opportunities available for improving fruit production in the eastern part of the country. The survey result further showed that availability of domestic and export market demand, proximity to export market such as Somalia and Djibouti, increasing number of buyers, expansion of agro processing, and small scale business centers are the most important market opportunities that enhance commercialization of fruit sector in the study area.

Conclusion and recommendations

The study was conducted in fruit production potential districts of East Hararghe Zone of Oromia Region, with objectives to assess and describe fruit production and marketing systems, identify fruit production and marketing constraints and opportunities in the study area, and three-stage sampling procedures were used to select a total of 16o sample fruit producer farmers in the study area. Primary data were collected from sampled fruit producer households through a household survey using questioners, focused group discussions and key informant interviews and the collected data analyzed using descriptive statistics. Fruit crops production is one of the major sources of livelihood for a large number of farm households in the eastern part of Ethiopia; it contributes a major source of cash income for the small scale farmers.

The survey result showed that fruit **production** is a major source of income for the majority of fruit producer households, and all sampled fruit producer households (100%) earn their income from fruit production as a primary source in the study area. However, lack of improved fruit seedlings, diseases and insects, rainfall shortage/drought, lack of improved agronomic practices, limited of extension services, limited knowhow and skill on agronomic practices and lack of sufficient irrigation water were the major production constraints of fruit crops production in the study area.

Fruit marketing is also constrained by low price of fruit produces, lack of proper postharvest handling technologies, high prices of inputs (seedlings, agrochemicals), lack of fruit market linkage, lack of strong fruit cooperatives, lack of market extension support services and the producers are forced to become price takers and accept low prices offered by brokers and collectors in the study area. Thus, from the findings it is possible to conclude that, even though there were potential opportunities for increasing fruit crops production and production in the study area, the fruit sub sector was constrained by different production and marketing related constraints in the study area.

Based on the above finding and conclusion, the following recommendations are drawn that should be taken in to consideration by concerned bodies in the study area. Generation and promotion improved fruit planting materials/varieties (high yielding, disease resistant and adaptable to the area), improve access to inputs and provision of improved seedlings through demonstration and multiplication of quality seedlings should be done by development organizations and institutions in the area. In addition, development and promotion of affordable postharvest technology is a priority to minimize fruit postharvest losses, and that can facilitate the production and marketing of fruits in the area.

Farmer's awareness and knowledge on the improved fruit production and marketing practices should be improved through strengthening extension and training services, and successive follow to enhance the competitiveness of smallholder fruit farmers in the area. Establishment of market places, and re-establishment of farmers' organizations for input and output marketing and creating linkages with fruit value chain actors should be facilitated to enhance fruit market in the area. Finally, it is better to suggest that establishment and promotion of small scale fruit processing industries that can enhance utilization of glut production of fruits, and this will help smallholder fruit producers to enhance their competitiveness in fruit production and marketing systems in the study area.

References

Ayelech T., 2011. **Market Chain Analysis of Fruits for Gomma Woreda, Jimma Zone, Oromia National Regional State.** M.Sc. Thesis presented to School of Graduate Studies, Haramaya University, Ethiopia

Awole, S., Woldetsadik K., and Workneh, T., 2011. Yield and storability of green fruits from hot pepper cultivars (*Capsicum* spp.), *African Journal of Biotechnology*, vol. 10, 2011

Bezabih E. and Hadera G., 2007. Constraints and Opportunities of Horticulture Production and Marketing in Eastern Ethiopia, DCG Report No. 46.

Carlsson, F., Köhlin, Alemu Mekonnen and Mahmud Yesuf. 2005. Are Agricultural Extension Packages What Ethiopian Farmers Want? A Stated Preference Analysis, Working Papers in Economics no. 172, Göteborg University.

Central Statistical Agency (CSA), 2021. Agricultural Sample Survey 2016/2017 (2009 E.C.) Statistical Bulletin, Report on Area and Production of Major Crops (private Peasant Holdings) Meher Season 1:58

Diriba S., Hailu D., Mebrat T., 2020. Horticultural Crops Production Potentials and Challenges Assessment in Arsi Zone, Oromia-Ethiopia. *Volume 6, Issue 4, 2020, PP 24-41*

Duressa, T., 2018. Newly Emerging Insect Pests and Diseases as a Challenge for Growth and Development of Ethiopia: The Case of Western Oromiya. *J Agri Sci Food Res*, *9*(201), p.2.

Efrem A., Beza E., Megdalawit T. and Kumelachew., 2020. Production and Marketing Constraints of Major Sub-Tropical Fruits in Jimma Zone, South West Ethiopia Vol. 7, Issue 1, pp: (1-7), Month: January - March 2020.

EHDA (Ethiopian Horticulture Development Agency). 2012. Exporting fruit and vegetable from Ethiopia. Assessment of development potentials and investment options in the export-oriented fruit and vegetable sector, Addis Ababa, Ethiopia.

Griesbach, J. 2003. Mango growing in Kenya. World Agroforestry Center (ICRAF). Nairobi, Kenya

Mohammed K., and Afework B., 2016. Post-harvest loss and quality deterioration of horticultural crops in Dire Dawa Region, Ethiopia, Journal of the Saudi Society of Agricultural Sciences

MoARD (Ministry of Agriculture and Rural Development). 2009. Ethiopia's Agricultural and Sector Policy and Investment Framework (PIF), Addis Ababa, Ethiopia

Selamawit M., Dubale A., Chigign A., Aklok Z., and Yonnas A., 2019. Value chain analysis of fruits: The case of mango and avocado producing smallholder farmers in Gurage Zone, Ethiopia. *Journal of Development and Agricultural Economics*

Sonko, S., Njue E., James M. and A. Jager, 2005. Pro-Poor Horticulture in East Africa and South East Asia, the Horticultural Sector in Uganda, EAST AFRICA, January 2005.

Tekle Y., Wondewosen S., Zemach S., Tibebu S., Abraham S., Woineshet S., 2014. Adaptability Study of banana (Musa paradisiacal var. sapiertum) varieties at Jinka, Southern Ethiopia. Vol.2

Yeshitela, T. and Nessel, T. 2004.Characterization and Classification of Mango Ecotypes Grown in Eastern Hararghe (Ethiopia). *Sarhad Journal of Agriculture*, 19 (2):179-180

Analysis of Dairy Value Chain in Jidda and Abichuf Gnea Districts of North Shewa Zone, Oromia Regional State

Mengistu Jifara[1*] and Badho Hora
[1] Oromia Agricultural Research Institute (OARI), Fitche Agricultural Research Center
P.O. Box 109, North Shewa, Ethiopia
*Corresponding author: jifaramenge@gmail.com.

Abstract

The study was initiated on analysis of dairy value chain with the objectives of examining the dairy marketing channels and efficiency. Data came from the separate survey of dairy producing households and marketing middlemen. Maximum Likelihood Estimation procedure such as logit model was employed in identifying factors affecting decision to sell dairy products, Tobit model was used in investigating factors affecting decision on volume of dairy sales. Concentration ratios and marketing margin analysis were conducted in examining efficiency. Market participation decision is affected by household demographic and socio-economic characteristics represented by distance to market and urban centers. Volume sale of dairy is affected by intellectual capital represented by distance to district capital. Un concentrated suppliers characterize dairy market; market at the next level is also un concentrated for butter and cheese but concentrated for liquid milk. The dairy processing industries enjoy the highest return while the dairy cooperative gets the lowest margin. The results suggest that production and marketable surplus should be improved and adequate marketing infrastructure like roads and transport facilities should be established between districts and rural areas in the district to support enhanced market participation. With the aim of reducing transactions cost adequate marketing link should be established between the rural producer and urban consumer through institutional arrangements, such as dairy cooperatives. Relaxing the criteria required in obtaining bank and micro credit and forming a well-functioning urban and rural financial system would enable resource poor farm households to participate in dairy market and improve its supply.

Key words: *North Shewa, Econometric model, Value chain and Market channel*

Introduction

Agriculture is the mainstay of the Ethiopian economy and its contributions to the economy of the country accounts 72.7% employment and 36.2% to the country's GDP (CSA, 2017). From the agricultural sector, livestock is an integral part of the agriculture and the contribution of live animals and their products to the agricultural economy accounts 40%, excluding the values of draught power, manure and transportation. In other sources according to (Behanke and Metaferia, 2011) the sub-sector accounts nearly 47% of total agricultural GDP.

Ethiopia is believed to have the largest Livestock population in Africa. The total livestock population estimated to be about 59.9 million cattle, 30.20 million goats, 30.70 million sheep, 2.16 million horses, 8.44 million donkeys, 0.41 million mules and 1.21 million camels. Out of the total population about 11.83 million are milking cows, 1.26 million goats are kept for milk and 23.15 percent of camels are kept for milk production (CSA, 2017). From the same source in the given year the total milk production from cow and camel is about 3.1 billion, 179.66 million liters respectively.

According to (CSA, 2017) about 11.4 million households are involved in livestock production in Ethiopia. Livestock plays a significant role in generating income for 80 % of rural smallholder households, and livestock products and by-products meeting domestic consumption meat, milk, eggs, cheese, and butter are animal protein that contributes to the improvement of the nutritional status of the people. Livestock productions has key role in providing export commodities, such as live animals, hides and skins to earn foreign exchanges to the country (LMP, 2015).

Dairy has been identified as a priority area for the Ethiopian government, which aims to increase Ethiopian milk production at an average annual growth rate of 15.5% during the GTP II period (2015 to 2020), from 5,304 million litters to 9,418 million litters. The government is actively encouraging the private sector to produce milk and is making supporting investments in supply-chain infrastructure, training, improved breeds, and dairy-focused agricultural commercialization clusters. Agricultural commercialization clusters that support commercialization of smallholder farmers in dairy have been identified in all four major regions (Tigray, Amhara, Oromia, and SNNP), and the government is particularly prioritizing genetic improvement through selecting premium indigenous breeds and introduction of exotic breeds (GTP, 2016).

Oromia region is characterized by diversified Agro-climatic zones, topography, agricultural potential and natural resources endowment. The region is contributing for 63% of the national volume of export of agriculture and share about 54% of grain production and 44.62% of livestock production from the country (CSA, 2017). In North Shewa zone livestock play important role in the economic and social well-being of the population. In spite of the greater ecological and economic value of livestock milk production is low compared to the number of milking cows (CSA,2015). The potential for production and growing demand for dairy, marketing is characterized by weak institutional support, inadequate infrastructure and dairy commodity value chain development not significantly contributing to benefits smallholder farmer.

Value chain is essential for those commodities to coordinate and effective transactions, allow small producers to access to the quality services, information, value addition and increase long term benefits from participation in market. In the study area different traders/actors are involved in marketing of produced milk and milk product along different value chain. Therefore, analysis of value chain of milk and milk product of the study area is found to be important and aimed do the value chain analysis.

The other problems are the actors along dairy value chain have weak collaboration, inadequate milk value addition, and information on price, weaken bargaining power and the major dairy processing system traditional. Milk and butter marketing system is traditional and under developed, fragmented and inefficient (ADPLAC, 2019).

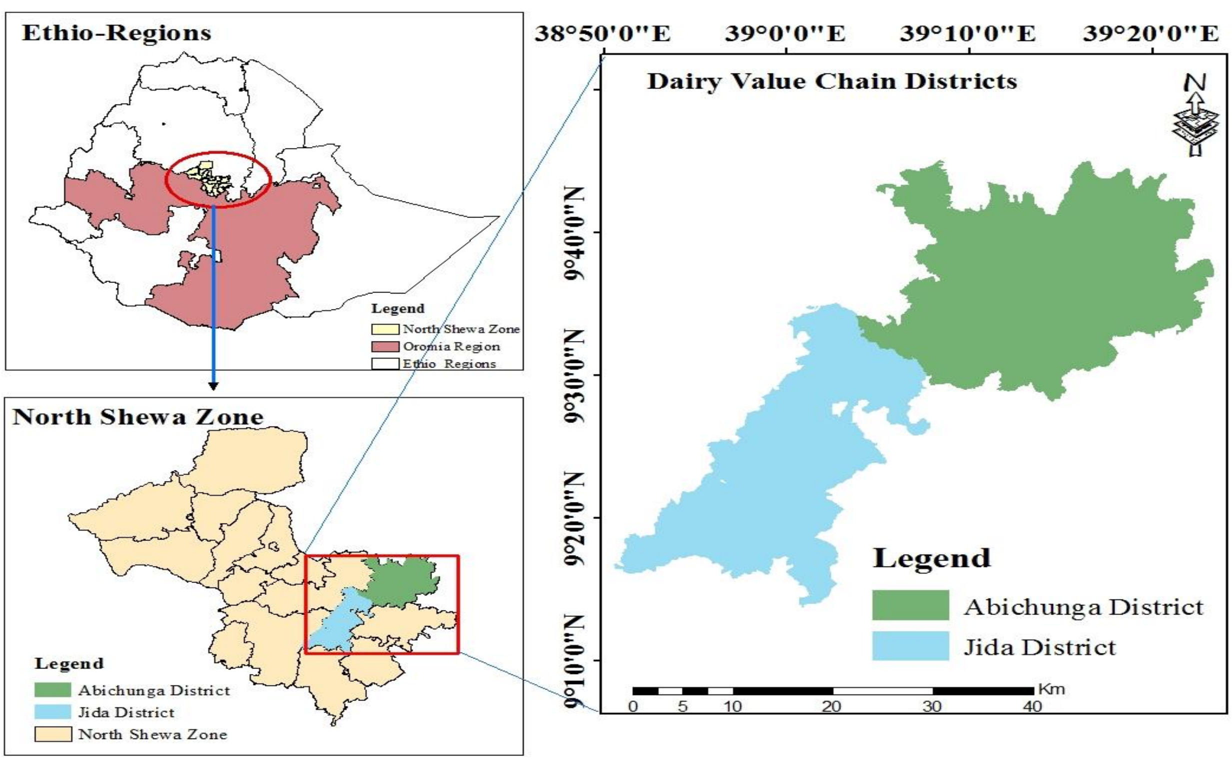
There were no studies specifically examining the value chain of dairy for farmers/ producers to identify the actors participate in dairy value chain, the factors which determine from participation and volume supply, profit margin and their constraints and opportunities in North Shewa zone.

Therefore, in the study area, there was a gap of information and knowledge on dairy value chain. The existing information and knowledge gap in the study area were not well known, the actors participate in the chain, market participation, volume of supply, beneficiary from the participant in the chain and how it will develop the dairy value chain in the study area. In line with this how smallholder dairy producer households can reach to market and sells its product.

So that, this study was proposed to fill the information and knowledge gap as to how the dairy products were reached to the end market/consumers and identify the actors, beneficiary, constraints and opportunities and how the producers market share. The main objective of the study was to estimate the potential production and marketing volume of cow milk in the study area with interrelated sub objectives to identify the major value chain actors participated on the production and marketing of cow milk and to identify the constraints on production and marketing of milk.

Methodology

Description of the study areas



Sampling technique and Sample size determination

The sample dairy producing households were drawn randomly from four kebeles, i.e., Adare Ejersa (56 household) and Mendida Zuria (56 household) (Abichuf Gnea) and Arrabsa Chifara/kolfe (45 household) and Siba Sirti (45 household) (Jidda). Both districts have the potential for both crop and livestock production, which is mainly undertaken by smallholder farmers. Through proportional probability 202 dairy producing households from two districts were selected.

Two-stage random sampling technique was employed to select sample households. The districts were selected purposively. In the first stage, five kebeles were selected randomly and in the second stage, a total of 202 small holder farmers and 36 other value chain actors of sample respondents were randomly selected from the sampling frame of milk producers by using simple random sampling technique. The sample size of respondents was allocated based on probability of proportional to size. Data Collection and Analysis Both primary and secondary data were used. Primary data were collected form dairy producer farmers and different value chain actors. Secondary data were obtained from different sources of reports of Agricultural offices at different levels and Dairy Cooperative in the study districts. Other sources of secondary data were previous research findings, journals, books, websites and other published and unpublished materials, which were relevant to the study. Questionnaire was developed, pretested and modified accordingly and then interview was conducted and the data were collected the study used for this research was both quantitative and qualitative especially on field interview methods both producers and intermediate value chain practitioners. Data were analyzed using descriptive statistics such as means, frequency, test statistics and percentages in tabular and graphical forms by using Statistical Package for Social Sciences (SPSS). Value chain analysis of milk was done using different chain diagrams/value chain maps

Methods of Data Analysis

The concentration of dairy product in the market, as an indicator of the structure, was estimated using the common measure of concentration ratio. Marketing margins were analyzed for the most marketable dairy products such as milk, butter and cheese. The market participation of the smallholder dairy farmers with dairy products (milk, butter and cheese) was analyzed using logit model. A Tobit model was used to analyze the relative importance of different determinants of volume of butter sale.

Concentration ratio

Concentration ratio has been widely used as numerical index of industrial organizations for measuring the size of firms in market (Shugart, 1990). It is calculated as:

$$C = \sum_{i=1} r\,S_i\,, i = 1,2,3 \ldots\ldots\ldots\ldots\ldots\ldots. r.$$

Where Si is the percentage market share of i^{th} firm and r is the number of largest firms for which the ratio is going to be calculated. There are a number of measures of market concentration, but the most commonly used is the concentration ratio, which measures the percent of traded volume accounted for by a given number of participants.

Marketing margin

Total gross marketing margin (TGMM) is the final price of the produce paid by the end consumer minus farmers' price divided by consumers' price and expressed as a percentage (Mendoza and Rose grant, 1995).

$$TGMM = \frac{\text{Consumers' price} - \text{Farmers' price}}{\text{Price paid by the consumer}} X100$$

The Net Marketing Margin (NMM) is the percentage over the final price earned by the marketing middleman as his net income once his marketing and transaction costs are deducted. From this measure, it is possible to see the allocative efficiency of markets. Higher NMM or profit of the marketing intermediaries reflects reduced downward and unfair income distribution, which depresses market participation of the smallholder. An efficient marketing system is where the marketing costs are expected to be closer to transfer costs and the net margin is near to normal or reasonable profit.

$$NMM = \frac{\text{Gross Margin} - \text{Marketing cost}}{\text{Price paid by the consumer}} X100$$

Where: TGMM = Total Gross Marketing Margin
NMM = Net Marketing Margin

Market participation and sales volume decision of smallholders

It was assumed that smallholder farmers who produced milk and other dairy products for various reasons may or may not participate in marketing (may sale or not sale). This dependent variable is discrete consisting of two outcomes, yes or no, so the use of Ordinary Least Square technique for such variables poses inference problems, and thus not appropriate for investigating dichotomous or otherwise limited dependent variables. In such circumstances, maximum likelihood estimation procedures such as logit/probit models are generally more efficient (Gujarati, 1988). A Tobit procedure was employed in identifying factors affecting volume sales decision of dairy products. The logic behind the use of the Tobit model was covariates affecting participation decision might be different from covariates affecting sales decision, and the magnitudes of the effects of parameter estimates is also different.

Market participation

Models, that include a yes/no type dependent variable, are called dichotomous or dummy variable regression models in which determinants of an event happening or not happening are identified. These include the linear probability function, linear discriminant function, logistic distribution function (logit), and normal distribution function (probit). These functions are used to approximate the mathematical relationship between explanatory variables and dependent dummy variable, which is always, assigned qualitative values (Gujarati, 1988; Maddala, 1992; Feder et al., 1985; Pindyck and Rubinfeld, 1981)

$$\rho_i(y = 1) = \frac{1}{(1 + e^{zi})}$$

Where ρi = is the probability of participating in the market for the ith dairy producer and ranges from 0 – 1.
e^{zi}: Stands for irrational number e for the power zi
Zi: Is a function of a number of explanatory variables, which is also expressed as;

$$Z_i = \mathrm{Zi} = \beta o + \beta 1X1i + \beta 2X2i + \ldots + \beta nXni$$

Where X1, X2, Xn are explanatory variables and βo is the intercept, β1, β2, …, βn are parameters (slopes) to be estimated.

The interpretation of logistic regression coefficients (Bi) is considered by using odds ratio and the natural log of the odds ratio (Liao, 1994). The odds value gives the expected change in the odds ratio of being increase versus non-increase in market participation per unit change in an explanatory variable. The logistic regression slope, the coefficient, is interpreted as the change in the natural log of the odds ratio associated with a unit change in the independent variable (Xi).

$$\rho i = \frac{1}{1 + e^{(\beta o + \beta 1\, X\, 1i + \beta 2\, X\, 2i + \ldots + \beta n\, X\, ni)}}$$

If ρi is the probability of market participation decision then (1- ρi) is otherwise.
Now $\frac{\rho i}{(1-\rho i)}$ simply the odds ratio in favour of market participation.
It is the ratio of the probability that dairy producer would participate in the market to the ratio producers would not.

Factors affecting sales volume of dairy sale

A Tobit model was used in analyzing factors affecting sales volume of dairy. The key aspect of using the Tobit model is the use of latent quantities of marketable surplus of non-participating households. The dependent variable takes on positive and zero values. When a zero value is observed, it is assumed that the household in question, rather than possessing an excess of the marketable product, actually has the demand for the commodity (that is, a negative supply) (Lapar et al., 2002). Hence, sales quantities are left censored at 0 and Tobit model is also known as censored regression model. Following Tobin (1958), which is expressed as:

$$Y_i^* = \beta^{'}0 + \sum \beta^{'}i\, Xi + e_i = \text{ and } e_i i \text{ is N } (0, \sigma)$$

Where Y= Y*, if Y* > 0, Y=0 if Y* < 0 and Y= max (Y*,0)

Yi * represents dependent variable and quantities of dairy supplied to the market by farm households which contains observed and censored data, Xi represents a set of covariates and the reduced form equation of sales depends on explanatory variables, which are categorized into resources, the household socio-economic characteristics, and travel time or distance to dairy product market or district capital.

X1 = Number of household members
X2 = Experience in dairy production
X3 = Educational level of household head,
X4 = Educational level of spouse
X5 = Number of extension visits,
X6 = Number of local bred dairy cows
X7 = Number of cross bred dairy cows
X8 = Return time from the market
X9 = Return time from the district capital
X10 = Amount of loan received last year
X11 = Financial income from non-dairy sources
X12 = Grain production
X13= Sex

β_0 represents the constant term

β_1, β_2, β_3 …, β_{13}represents parameters to be estimated, and e_i represents the disturbance term

The model parameters are estimated by maximizing the Tobit likelihood function of the following form;

$$L = \prod_{y*>0} \frac{1}{\delta} f \ \frac{(Y - \beta_i Xi)}{\delta} \prod_{y*<0} F\left(\frac{\beta_i Xi}{\delta}\right)$$

Where F(z) is the cumulative standard normal distribution function and f(z) is the value of the derivative of the normal curve at a given point, z is the Z-score for the area under normal curve, β is a vector of Tobit Maximum Likelihood estimate and δ is the standard error of the error term. ∏y*>0 means the product over those i for which y* > 0 and ∏y*≤0 means the product over those i for which yi* ≤ 0.

The marginal effect of an explanatory variable on the expected value of the dependent variable among the whole sample was expressed by the following formula;

$$\frac{\partial \mathrm{E}(Yi)}{\partial \boldsymbol{Xi}} = F(Z)\beta_i$$

Where, Yi is dependent variable and Xi is a vector of independent variable β is a vector of Tobit Maximum Likelihood estimate and F(z) is the cumulative standard normal distribution function.

The change in the volume sale of dairy with respect to change in explanatory variables among the participating households under Ceterus Paribus assumption was given by;

$$\partial \mathrm{E} \frac{\left(\frac{Y}{Y^*} > 0\right)}{\partial \boldsymbol{Xi}} = \beta \left[1 - Z\frac{f(z)}{F(Z)} - \left[\frac{f(z)}{F(Z)}\right]2\right]$$

Definition of explanatory variables

Distance to market: The closer the market the lesser would be the transportation charges, reduced transaction costs, reduced trekking time, reduced loss due to spoilage, and reduced other marketing costs, better access to market information and facilities. This improves return to labour and capital and increase farm gate price and the incentives to participate in economic transaction (Admasu 1998).

Dairy production: The variable is expected to have a positive contribution in market participation of smallholder farmers. A marginal increase in dairy production has obvious and significant effect in motivating market participation. Production beyond consumption has two fates based on various reasons; either sold as fluid milk or processed into different dairy derivatives. The processed part of the product may be used for home consumption or sales. Production in turn varies directly with the number of crossbred and other lactating dairy cows. As the number of cows increases production, also increases and the percentage share of consumption declines and sales increases. Adoption of technology, such as crossbred dairy cows, improves the milk yield, through increased milk yield per lactation, increased lactation length, yield per day and short dry period. Some field studies have shown that the policy relevant variables having the greatest impact on farmer participation in liquid milk markets are cow numbers, the number of cows kept affects marketable surplus through both total production and the marginal costs of production (Holloway et al., 2000).

Education of the household head: Intellectual capital or education, measured in terms of formal schooling of the household head, is assumed to have positive effect on the market participation and sales decision. Sometimes, however, because of cultural and socio-economic characteristics education has opportunity costs in alternative enterprises (Lapar et al., 2002). So, it is not possible to have a definite expectation of the effect of education on market participation and sales volume.

Distance to district capital: Most of dairy production is found in rural areas while the demand and profitable market is found in the district capital. The closer the urban center the lesser would-be transaction and marketing costs. Distance to urban centers is a proxy to transactions cost which negatively affect participation and sales volume decision of dairy products. Small-scale dairy producers face many hidden costs that make it difficult for them to gain access to markets and among the barriers are transactions cost (CSA,2015).

Age of the household head: Is measured in terms of number of years of the household head, aged households are believed to be wise in resource allocation and use, and it is expected to have a positive effect on participation decision and sales volume of dairy products (EIAR,2012).

Sex of the household head: In mixed farming system, both men and women take part in livestock management. Generally, women contribute more labour input in areas of feeding, cleaning of barns, milking, butter and cheese making and sale of milk and other products. However, obstacles, such as lack of capital and access to institutional credit, competing use of time, and access to extension service, may affect women's participation and efficiency in ruminant livestock production (Tanga et al., 2000). Therefore, it is not possible to talk a priori about the likely sign of the coefficient of sex, in market participation and sales volume.

Experience in dairy: This variable is measured in terms of the number of years of dairying of the household head; it is expected to have a positive effect on market participation and sales volume (Birhanu, 2012).

Number of household members: Family size measured in terms of adult equivalent was included in the model as a variable explaining variation in market participation. Families with more household members tend to have more labour. Production in general and marketable surplus in particular is a function of labour. Thus, family size is expected to have positive impact on market participation but larger family size requires larger amounts for consumption, reducing marketable surplus.

Number of extension visits: The number of visits made by extension agent in the year measures the variable. Number of extension visits improves the household's intellectual capitals, which improves dairy production and divert product resources to market such as different forms of dairy products. These dairy products would otherwise be consumed by the household or wasted. Therefore, number of extension visits has direct influence on market participation and sales volume. Studies have shown that visits by extension agent improve participation and volume decision of dairy sale (Holloway et al., 2000).

Crop production: In subsistence smallholder farming, production of crop is mostly meant for household consumption. crop is sold when it is only surplus or beyond the consumption need of the household. On the other hand, when the household is deficit in crop production, it must either borrow or buy through money secured from different sources. Families who are deficit in crop production should likely participate in the dairy market and allocate much of the income for the purchase of crop. High protein dairy products are often sold to buy high-energy crop at favorable terms of trade. Livestock keepers also exchange high value commodities like meat and milk for cheaper and larger quantities of food, such as cereals (Bouis and Haddad, 1990).

Estimation procedure

The model used for the study of market participation was logit model and the model adopted for analyzing factors affecting dairy sales volume was Tobit model. In short, the coefficient of the interaction of the variables indicates whether one of the two associated variables need to be eliminated from the model analysis (Kothari, 1990).

Results and Discussions

Socio-economic characteristics of dairy product producers

Table 1 below summarizes the dummy variables that were used in the analysis. The data revealed that high percentage of respondent's study areas were male headed (81.68%) when compare to female's (18.32%). The education level of sampled household head indicates that about 64.85% were literate while illiterate (35.15%). The survey result showed that 97.52% of the respondents were married, and 2.48% of them were single and the remaining was widowed.

According to the survey result, about 12.38% of smallholder dairy producers had access to extension services in the study areas. Access to credit service is an important input in dairy product value chain. The study showed that about 70.30% of household respondents were not used or no access to credit services that affects dairy production and marketing in the study areas.

The study result revealed that, about 80% of dairy producers had access to market information. Large percentage of respondents reported to depend on actual market day information/through personal observation, market information obtained from fellow/other farmers in the neighbors'

betrothed on the same activities, and friends for prices and selling decisions. Majorities (90.59%) of household respondents had accessed to animal health services in the study areas.
The study result showed the majorities (63.86%) of the smallholder dairy producers were the member of any cooperative. About 76% of the respondents' household heads had mobile phone which is play crucial role in beef cattle value chain as means of market information.

Table 1. Summary statistics of sample respondent households (dummy variables)

Variable	Categories	Frequency	Percentage
Sex of household head	Male	165	81.68
	Female	37	18.32
Education of household head	Literate	131	64.85
	Illiterate	71	35.15
Marital status of household head	Married	197	97.52
	Single	5	2.48
Access to extension services	No	177	87.62
	Yes	25	12.38
Access to credit services	No	142	70.30
	Yes	60	29.70
Animal health services	No	15	7.43
	Yes	187	92.57
Access to market information service	No	39	19.31
	Yes	163	80.69
Membership to cooperatives	No	73	36.14
	Yes	129	63.86
Mobile ownership	No	19	9.41
	Yes	183	90.59

Source: Computed from survey data, 2022

The study result showed that the average available labor forces (labor supply) estimated by adult equivalent scale was about 6.56 persons per household. The average landholding respondents' households were 0.43 hectare on average which includes both cultivated and grazing land. About 62.2% households' holds less than 0.5 hectare. The minimum and maximum land holding size was 0.125 and 1.5 hectare respectively which indicates scarcity of this resource in the study areas (Table 2). This has implication of livestock feed shortage due to limited land size per household.

The study result indicated that, cow milk had on average 12.36 years of general experience in practicing cattle keeping with the minimum and maximum experience of 1 and 45 years respectively.

The study result indicated that the total livestock owned by the respondent households was on average 4.19 TLU with the minimum and maximum livestock owned of 0 and 13 tropical livestock unit (TLU) respectively in the study areas. Moreover, the mean total number of cattle owned by the respondents' households was 3.24 tropical livestock unit (TLU) with the minimum and maximum livestock owned of 0 and 11 tropical livestock unit (TLU) respectively in the study areas.

Table 2. Summary statistics of sample households (continuous variables)

Variable	Mean	Std. Dev	Min	Max
Age of household head in years	34.08	8.71	18	70
Household size in numbers	6.56	2.36	1	14
Total landholding owned in hectares	0.421	0.254	0.125	1.5
Grazing land owned in hectares	0.021	0.059	0	0.5
Cultivating land owned in hectares	0.404	0.248	0	1.5
Number of total livestock owned in TLU	4.18	2.86	0	13
Number of cattle owned in tropical livestock unit	3.24	2.42	0	11
Farm experience in cow milk in years	12.36	9.63	1	45
Distance to the nearest market place in minutes	97.62	54.29	15	360
Distance to the main road in minutes	18.37	10.86	5	60
Dairy product supply to market in numbers (heads)	1.84	1.14	1	9
Male cattle sold in numbers (heads)	1.63	0 .890	1	6
Female cattle sold in numbers (heads)	1.203	0.65	0	5
Animal mean age for fattening (years)	4.23	1.12	2	10

Source: Computed from survey data 2022

Forms of dairy sale by households

The most marketable product representative in the areas is butter. From the total 45.54% participated in butter sale and 27.72% participated in selling milk, spatially the sale of the former is restricted to urban and peri urban areas while the sale of the later is undertaken elsewhere in the districts. As depicted in Table 3 households have a tendency of selling one dairy product at a time. Many households participate in selling butter and market participating farm households tend to sell one type of dairy product at a time. Better combination was observed between butter and cheese. The combination of milk with other dairy products was weak and this shows that milk-selling households try to specialize in selling milk.

Table 3. Households selling different forms of dairy products

Market participating households	Number	Percentage
Households selling butter	92	45.54
Households selling milk	56	27.72
Households selling cheese	2	0.99
Households selling butter and cheese	33	16.34
Households selling butter and milk	11	5.45
Households selling milk and cheese	5	2.48
Households selling butter, cheese and milk	3	1.49

Source: Survey results,2012/13

Uses of income from dairy

Many households in the study area are not market oriented and much of dairy product is used for household consumption. Large number of dairy products especially butter is used during cultural and religious festivals as cosmetics and preparation of varieties of cultural foods. Dairy income is used to cover expenditures on students' school material and purchase of grain and food items, farm inputs and replacement stock Table 4. More than 30% of the sample households allocate their income to cover student expenses as their first priority. There were better terms of trade right after crop harvest which had been continuously reducing till the next crop harvest. Terms of trade declines in summer when prices of crops escalating and opposite movement of prices of dairy products. Therefore, trading dairy products for grain far more support poor people in the district. Again, selling dairy products for grain during periods of food shortage improves food security of the poor because of its favorable terms of trade and continuous income.

Crossbred dairy cows require better management, inputs and conditions as compared to local cows. Few households who keep crossbred dairy cows spent relatively much of the income for the purchase of feed, different forms of roughages and concentrates, and for other management expenses

Table 4 Percentage expenditure of income from dairy by sample households

Type of expense	**1st**	**2nd**	**3rd**
Soap and cloth	12.3	19.5	2
Buy grain	18.3	9.2	8
Loan repayment	4.6	4.3	11
Other and coffee	25	49	58
Student material	30	14	18
Cow feed	9.8	4	3

Source: Computed from survey data, 2012/13

Dairy Product Utilization

Table 5 Utilization of milk among sample farm households

Dairy products	**Liters**	**Percent**
Milk for human consumption in the household	9,174	21
Milk sold	16,035	37
Milk processed into butter	16,314	38
Milk processed into yoghurt	1,675	4
Total milk produced	43,198	100

Sample households produced 43,200 liters of milk per week. Most of the milk produced, 16,314 liters (38%), was processed into butter and 16,035 liters (37%) was sold in liquid form (figure 1). The remaining 9,174 liters (21%) was consumed in the household in milk form, and 1,675 liters (4%) was processed into yoghurt.

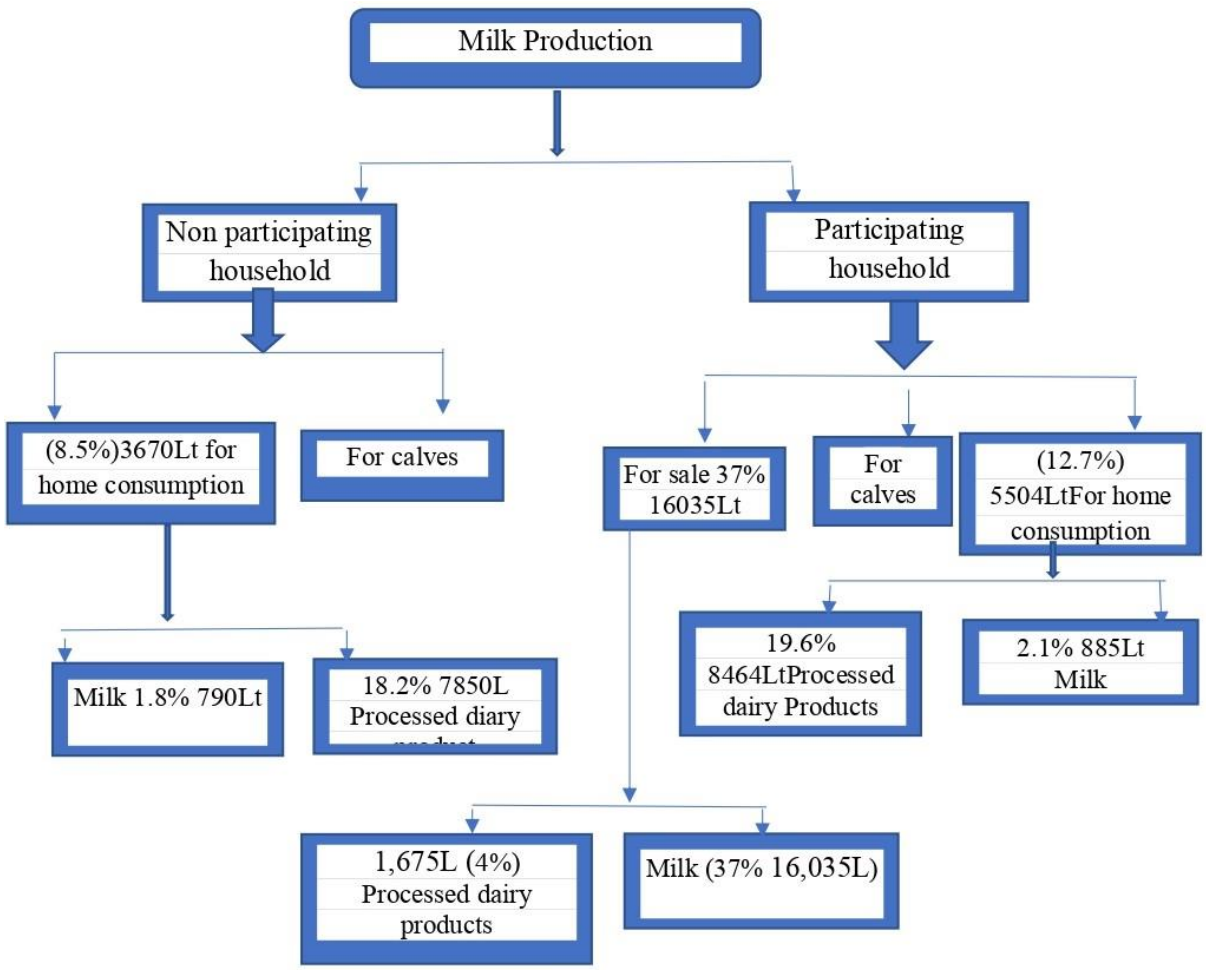


Figure 1 Milk

Problems of smallholders in dairy marketing

Subsequently of inherent physical and chemical properties of different dairy products related to sale and other external problems these products have different sales problems. Generally, as explained by respondents, the major constraints in dairy marketing in the district were low marketable surplus, remoteness from markets and urban centers, low prices and lack of tradition in dairy marketing.

Table 6 problems of dairy marketing of smallholders by commodity type

Marketing Problem	Milk	Butter	Cheese
Low price	121	56	75
Distance from market or town	40	28	25
Low production	31	99	58
No tradition of selling dairy	3	-	42
No problem	7	19	2
N	202	202	202

Source: Survey results 2012/13

As indicated in Table 6 121 (59.9%), 56(27.7%) and 37.1%) of the respondents prioritized low price of production as a major constraint in milk, butter and cheese marketing, respectively. Low price itself seems to be the result of the lack of market chain and price information. Consequently, processed dairy products, which have lower volume and perishable nature, such as butter and cheese, were sold within the villages where market outlets and producers bargaining power were limited.

Distance has relatively minimum effect on butter and cheese sales because of reduced volume and perishability. Remoteness coupled with high perishability and bulky natures of liquid milk have important effects on market participation decision and its volume of sales. Some respondents, 40(19.8%), indicated that because of their long distance from markets and major urban centers, they were unable to participate in the milk markets. This has restricted their participation in spatial arbitrage and profitable transaction. This reduced market involvement in turn is expected to lead into reduced dairy production and low farm income.

Small number of respondents about 3(1.5%) and no have- pointed out that lack of tradition and said no problem, respectively in milk and butter sale inhibited them from involving in dairy markets (Table). Sample farmers inherently know the resource allocative power of price and tend to allocate resources according to relative returns expected to be realized from producing for the market.

Econometric Analysis

Factors affecting dairy market participation

Meaningfully household physical wealth affecting market participation decision is local breed and crossbred dairy cows. As it was expected, they are posited to affect market participation decision significantly. However, investment in high yielding exotic breeds or crossbred dairy cattle would also seem a difficult option because of high initial cost, limitation of feed and fodder and with the increasing population and demand to allocate more land for crop production small and marginal areas are left for pasture. This has resulted into an ever-decreasing pasture both in quality and quantity. Therefore, only few urban and peri urban market-oriented farmers possess crossbred dairy cows.

Financial capital includes income from different sources such as off-farm activities of household head and spouse, remittances and income by other household members other than the household head and spouse. Financial capital from different sources has positive coefficient, indicating that such resources strengthen the ability of smallholder dairy producers for coping with different risks of production and consumption and enter to economic transactions

Household members represent labour resources and, hence, are posited to be directly related to engagement in production and marketing activities. In agricultural studies, it was shown that household members represent labour resources and directly influence market participation. In this particular case number of household members have positive coefficient and large households with greater members tend to participate in the market.

Transaction costs are hypothesized to impede market participation because they impose added cost burdens to the dairy marketing activities. Distance to market is considered as a proxy for transaction costs and is hypothesized to negatively affect market participation; that is, the farther away is a household from the market, the more difficult and costly it would be to get involved in the market. Consistent result was found in this study. Distance to district capital has negative coefficients affecting market participation level. However, distance to the market and district capital has indirect effect on household output and also affect market participation position of the household.

Table 7 factors influencing dairy market participation

Variables	**Coefficient SE**	**Odds ratio**	**Wald statistic (Z-test)**
Family size	0.06 (0.17)	1.05	0.15
Crop production	-0.02 (0.01)	0.87	1.65
Education	0.40* (0.24)	1.45	2.56
Extension Visit	0.30* (0.20)	1.22	3.12
Education of household head	0.41** (0.211)	0.55	3.53
Return time from the district capital	-1.90** (0.80)	0.11	5.43
FINANCE income from different source	0.001** (0.00)	1.00	5.49
Return time from the nearest main market	0.30 (0.41)	1.50	0.53
Number of crossbred dairy cows	1.02 (0.83)	2.42	1.31
Constant	1.20 (1.52)	2.48	0.54

*** Significant at 0.1 and 0.05 probability level, respectively

Loglikelihood ratio index (Mc Fadden R^2) 0.53

Number of observations = 202

Households who have sufficient per capita grain production avoid the idea of market participation altogether. Relatively wealthy households consume a high portion of milk extracted from cows with surplus turned to butter, which partly indicates that that dairy consumption exhibits higher income elasticity of demand in the rural households. The dietary habits and cultural significance of milk and dairy products in the diet of the rural people in the district suggests that the demand for milk and dairy products increase with increase in income. It is not unusual to see these households waste substantial amount not being able to sell because of distance as well as cultural taboos. In such a situation, producers lose income and consumers are denied these products.

In this particular study, negative coefficient of crop production indicates inverse relationship with dairy market participation decision. Relatively rich households, when they find crop production to be more profitable less likely to engage in dairy marketing and other off-farm activities. This shows that under such undeveloped situations, specialization of relatively wealthy households in crop production may be a custom. On the other hand, poor households with limited per capita crop production try to diversify income source from farm and non-farm activities. The poor with limited per capita crop production is observed to participate in the dairy market and negative coefficients of crop production corroborate this fact. The sales of dairy products mainly by smallholders in rural areas, therefore, may be regarded as a symptom of increasing poverty.

As it was expected most participating households in the sample have more than one dairy cow and as the number of dairy cows increases households are likely to participate in dairy market. The increasing number of quality local and crossbred dairy cows is an important policy relevant variable in stimulating the smallholder to market entry and benefit from economic transaction.

Factors influencing volume of dairy sales

The appropriate model for estimation under this condition is Tobit model. Households first make discrete decision to sell or not to sell. Then they decide how much to sell. The dependent variable in the Tobit equation was volume of dairy sales, such as butter and milk. Observed samples of farm household selling milk were few. Volume of milk sold, therefore, converted into butter equivalent. The set of covariates used were household demographic characteristics, transactions cost represented by distance to market and district capital, physical and financial wealth and intellectual capital represented by education of household head and spouse and number of extension visits received by farm households during the year.

Demographic characteristic believed to affect volume decision of dairy was number of household members. Farm households with better number of household members believed to have more labor to participate in economic transactions. The effect of number of household members on volume sale of dairy was positive but insignificant. Sex of the household head has important influence on household volume sale of dairy. From the study the female-headed households have better predisposition to entry into dairy market and volume supply. The volume of dairy sales is expected to be affected by various continuous and discrete independent variables.

Explanatory power of the model is given by pseudo R^2 that is 70%. This is low but reasonable given the small sample size. However, it also indicates possible non-inclusion of other relevant variables. Intellectual capital hypothesized to affect the volume decision of dairy sale is educational level of household head and spouse and number of extension visits. This stock level may be related in a contradictory way when other employment opportunities are available and was no prior belief about the likely sign of education. Intellectual capital of the household expressed as educational level of the household head and spouse had negative and positive coefficients, respectively.

Education of household head was significant at 5% level while education of spouse was insignificant. Extension visit on the other hand was consistent with a priori expectation and exhibited a positive coefficient and significant effect at 5% level (Table 8).

The priori expectation was that transaction costs are likely to play a major role impeding volume of dairy sale and it was assumed that transactions cost increase with greater distance to market and district capital and which causes surplus to decline. In the absence of precise information concerning the values of these costs, two proxies were used instead-return time from the market and the district capital. Return time from the market had positive and insignificant effect on the volume of dairy sale while return time from the district capital had negative and significant at 5% level.

Physical capital variables expected to exert a positive impact on volume decision of dairy were number of dairy cows and type of dairy breed, such as local and crossbred dairy cows. The effect of number of dairy cows was insignificant, as households were keeping poor performing dairy cows. The effect of crossbred dairy cows was positive and significant at 5% level. Households who keep crossbred dairy cows are market oriented and because of higher productivity marketable surplus also increases with crossbred dairy cows. Financial capital such as loan (credit) and income from different sources other than dairy were expected to exert a positive impact on volume sales of dairy. Thus, the effect of these covariates was positive and significant at 1% and 5% level, respectively.

The priori expectation was that households with surplus and sufficient crop production tend to participate less in dairy market, and poor households with less per capita grain production sell dairy products and allocate much of the income for the purchase of grain at favorable terms of trade.

Crop production per household exhibited negative coefficient as expected and was significant at 10% level. Households with surplus grains production use grains as cash crops to cover expenses for household needs, and consume larger volume of dairy products, this partly explains income elasticity of dairy consumption. Their opportunity cost of labor of those households in participating dairy market is also low because of reduced land and subsequent reduced farm activity.

Table 8 factors influencing farm households' volume of dairy sales

Variables	**Coefficients (SE)**	**t- value**
FAMSIZE	0.090 (0.0610)	1.50
EDUCATIONH	-0.189 (0.087) **	-2.15
EDUCATIONHS	0.067 (0.054)	0.84
EXPDAIRY	-0.009 (0.009)	-1.05
EXTENSIONV	0.162 (0.064) **	2.01
RETRNTMMRT	0.047 (0.138)	0.20
RETRNTMDISCAP	-0.271 (0.119) **	-2.35
FINANCE	0.00027 (.00013) **	2.05
LOAN	.00063 (.000091) ***	6.60
CROPPRO	-0.015 (.009) *	-1.64
SEX	-0.640 (0.33)	-1.54
DAIRYCOWS	0.191 (0.334)	-0.64
BREED (1)	2.94 (1.393) **	2.10
(Constant)	0.216 (0.725)	0.25
R^2 =0.70	δ = 1.27	
Chi-square = 79	f(z) = 0.110	
Log likelihood = -34	F(z) = 0.328	
N = 202		

*** Significant at 0.01 probability level, ** Significant at 0.05 probability level, * Significant at 0.1 probability level

Marketing

The analysis of dairy marketing is expected to provide a systematic knowledge of the flow of dairy and its products (butter and cheese) from production areas in Abichuf Gnea and Jidda districts to final consumers (end users) in different parts of the country. Marketing also describes the actors who play roles and how they function in the market.

Raw milk and milk products marketing routes

There are several marketing routes for raw and skimmed milk produced in the study area. From the FGD, the proportion of milk marketed by dairy producers was only 15%. The rest 85% of the produced milk will remain within the households either for household consumptions or for processing purposes (butter and cheese). The dominant market rout for raw milk is the local Market of Mendida Zuria cooperative, hotels, cafeteria and individual urban and pre-urban consumers of the town of Debre Brian). The evening milk will be used for home processing into butter and cheese and for household consumption.

Butter and cheese market routes

The main market routes for butter are consumers of Mendida and Sirti towns. Debre Brian and Shano also serve as market outlets for retailers to the Finfinnee. Traders are responsible for directly purchasing butter from farmers and distribute to the wholesalers of Addis Ababa markets. In some instances, wholesalers directly purchase the butter and sell to Debre Brian and Addis Ababa markets.

The primary market outlet for cheese is the Debre Brian market. Large traders collect cheese using their own collectors on major market days and transport it to the Debre Brian market. Likewise, traders from different area purchase cheese from the producers in Mendida, Jimate and Sirti market and sell it to wholesalers of Addis Ababa.

Characteristics of Dairy Traders

Traders to be successful require a pool of friends, families and suppliers in a trade. The number and capacity of families and friends in the dairy trade who supported in the past and at present and the number of languages or dialects spoken by traders would enhance their social capital position. The social capital helps in terms of exchange of market information, on credit purchase and sale, and number of local and distant trade contracts.

Dairy producers

Smallholder dairy farmers are the major players in the dairy value chain in Abichuf nyea and Jidda districts. The proportion of milk marketed by farmers is lower. According to the information from FGD, the proportion of milk marketed by dairy producers is only small amount of the total production. The large amount of the produced milk will remain within the household either for household consumption or for processing purposes (butter and cheese). The main reason given for not selling milk was low-level of milk production, which was not sufficiently larger than home consumption.

Collectors

Collectors are one of the important actors in the dairy value chain. Some of collectors undertake their regular duties for private processor by collecting milk in their rented collection shops in Mendida, Mendida Zuria, Adare Ejersa (Abichuf nyea) and Kofale, Siba Sirti (Jidda) villages. They usually use plastic can to transport the milk to collectors. In order to detect the milk quality, they mainly use lacto- meter tests and visual observations for their regular customers.

Private processors

one private dairy milk-processing firm (cheese trader private milk processing) was involved in milk marketing in Debre bran town. this private processor has other milk collection centers in Abichuf nyea district. According to the information obtained from FGD and key informants, cheese trader private milk processing commands small amount of the fresh milk market. The main market outlet for this firm was the urban consumers of Debre bran and Addis Ababa, where it has a mini shop that sell the milk products (cheese and butter) and sour milk to the consumers of this town.

Hotels/cafeterias

Hotels and cafeterias directly purchase fluid milk (morning and evening milk) from the producers based on contractual agreements. They purchase butter from local butter traders at a price of 550 ETB/kg. The average daily intake for raw milk reaches up to 12 liters/day/hotel or cafeteria. According to the information obtained from FGD and key informants, hotels/cafeterias command large amount of the fresh milk market of the study site. They consider quality parameters such as freshness, adulteration with water, taste, hygiene and price in their decision to buy liquid milk.

Individual consumers

There are three main dairy products consumed by individual consumers in the area: raw milk, edible butter and cheese. Smallholder dairy producers are still very important sources of milk for individual consumers of the study area. Smallholder dairy producers sell fresh milk to their neighbor and other individual consumers on monthly contractual basis. In this case, the consumer collects milk from the producer’s gate. Either the children or women are usually collecting milk from the producer. Collection could be in the morning, afternoon or both depending on their agreement. In this case too, there is no formal written agreement.

Since the two parties meet every day, they easily communicate the quality problems so that producers can correct them as much as possible. If not, the consumer looks for better quality milk from other producers usually after finishing the contract.

On the other hand, for other dairy products like cheese and butter the major points of purchase are town markets and the main sellers are traders and individual producers

More than 98% of traders started up their trading business themselves, which is small and personalized. Only 10% of traders indicated that their mothers were involved in dairy trade and none of them suggested that their father was in dairy trade thus insignificant social capital was derived from family dairy trade. Traders didn't appear to switch businesses very often; the total number of years the traders surveyed had worked in dairy trading was only slightly higher than the number of years they had been in their current business, and the average number of years in dairy trade of those in the sample was 9.17 years. There appears to have been relatively little variation within the sample in terms of years of schooling or experience in dairy trade; traders received 4.33 years of schooling on average.

Table 9 Trader's experience, financial and social capital (N=20)

Variables	Mean values (SE)
Amount of capital currently used	50,193.90 (933.46)
Years in dairy trade	9.17 (1.91)
Years of schooling of trader	4.33 (0.92)
Trade alone or in partnership	0.03 (0.31)
Number of markets visited/week	3.7 (0.39)
From how many people buy on credit	3.47 (2.22)
To how many people sell on credit/week	4.24 (1.03)
Number of friends in dairy trade	1.25 (0.290
Number of local trade contracts/week	3.42 (0.41)
Number of distance trade contracts/week	0.43 (0.10)
Number of partners through telephone order only/week	0.30 (0.15)
Parents in dairy trade	0.10 (0.06)

Source: Survey results, 2012/13

Marketing Channels

The persistence of this section is to review the structures adopted by marketers to deliver dairy products, mainly milk and butter, from producers to consumers. Roads, communication facilities and market institutions are often poorly developed in the rural areas and this limit the range of marketing functions and services and confine sales to the nearby consumers. Poor infrastructure coupled with perishability of dairy products form a major obstacle to the marketing functions and limits the involvement of market intermediaries, which resulted into poor development of marketing channel for dairy products. Dairy products reach the consumer in a variety of ways: by means of direct sales to rural and urban consumers, direct sales to rural traders or retailers, through farmer trader, direct sales to shops, direct sales to the cooperative and dairy processing industries. More often, smallholder farmers transport dairy products to the rural and urban markets themselves, either carrying or using donkeys, and sometimes sell directly to farmer trader (retailers) at the farm gate or in the market, or directly to wholesalers. Urban and peri urban producers sell dairy products to consumers, dairy cooperative, shops and kiosks, and processing industries.

Through the network of marketing channel as the dairy product moves from producer to consumer either sold as liquid milk or transformed to butter, cottage cheese and yoghurt. The bulk of dairy products in rural areas is sold in the form of butter and cheese, and milk is more transacted around urban and peri urban areas.

Urban consumers have high quality considerations of dairy products such as hygiene and standards. Few and poorly developed dairy market institutions are not able to satisfy these growing needs. This indicates unsophisticated dairy market structure. Marketing in the form of liquid milk is restricted to major urban centers while transaction in the form of butter and cheese is dominating and undertaken all in rural and urban areas in the district.

However, because of limited production of dairy especially butter, the district is not able to satisfy the increasing demand both in urban and rural areas. Therefore, the district is deficit in butter product and there is wide supply-demand gap.

Summary transaction of liquid milk in the rural areas is mainly because of small dispersed production, problem of collecting and transporting milk to market, bulky and high perishability nature of milk and lack of cooling facilities and reduced demand because of income and inhibiting traditional and cultural taboos in the rural areas. Farm households were using farm gate and milk collection centers owned by the cooperative and milk processing industries as an outlet for liquid milk. No sale of liquid milk was observed in physical market place, which was the case for butter and cheese.

Marketing channels for milk

As depicted on the Figure 2 about 71% the product, passes from the producer to the consumer. Milk is bulky and highly perishable and its spatial transaction is very much limited as compared to butter and cheese. This characteristic of milk and increasing demand for milk in major urban centers has resulted in institutional arrangement to establish reliable outlet. Milk marketing channel in milk market is changing rapidly with the increasing milk marketing outlets in urban and peri urban areas. This is because of the coming into scene of some new actors to the marketing channel, which were hitherto unknown until very recently in the district i.e., private processing industries and dairy producers cooperative and who stood between producers and consumers. This is the second most important channel through which the product reaches the consumer.

Fresh milk for consumption without changes of form must flow in the marketing channel very quickly from producers to consumers. The flow of milk through the channel starts with the fresh product produced early in the morning, being sold either to consumers or processors before noon. Vertical integration by forming producers' dairy cooperative is extremely important in marketing of high quality and highly perishable dairy product such as milk, which ensures greater efficiency and effectiveness in the milk market

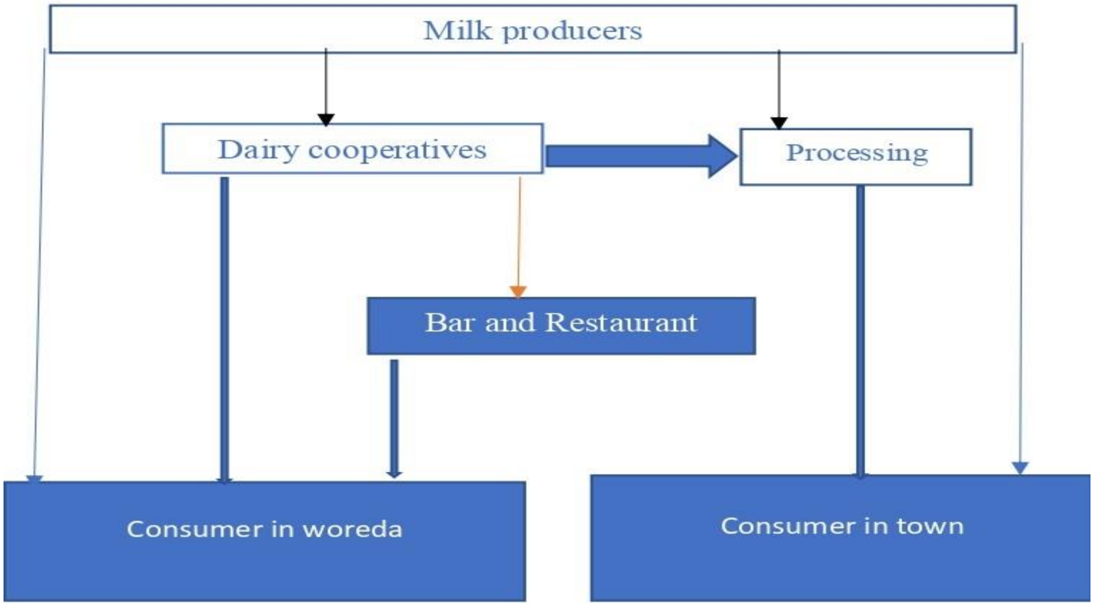


Figure 2 milk market channel

The analysis of dairy marketing channels is assumed to provide a systematic knowledge of the flow of dairy and its products from their production areas to their final end-users. In due course, it allows simplifying the complex nature of the subsector, helps to identify all key actors and the main leverage points for the sub-sector where targeted interventions could affect the entire value chain.

Analysis of information obtained from different sources during the study depicts that there are four main market channels for fresh milk produced in Mendida and Jidda districts with which it reaches to final consumers. The final consumers of dairy products in the study area are individual consumers and hotels/cafeterias of the main route road of Debre brain and Addis Ababa city.

Marketing channels for butter

Fresh butter produced by the smallholder farmer in the districts is expensive and has dual functions; used for cooking as well as cosmetics. Usually, urban consumers who are concerned with quality and food safety prefer such a product for household consumption.

Most farmers sell butter in markets within their vicinity. This can be attributed to the small amount of butter produced and offered for sale, long distances, and to the high demand urban and peri urban markets is rare because of reduced output levels and consequently the increasing transactions cost. However, most of the product, around 85%, passes from producer to consumer. Small quantities of butter produced and offered for sale restrict most farmers to take advantage of spatial arbitrage. This is mainly because of the transaction costs and opportunity cost of time for farmers to mediate exchange is high since output levels are low. Therefore, mobile butter traders are involved in accumulating supplies for resale to consumers in rural and urban markets.

Mobile butter traders purchase butter from wholesalers in Addis Ababa and Debra baran, purchase fresh butter and cheese from producers in the district for resale in urban and rural market. They buy dairy products of better shelf life from producers at farm gate or at market place after transported to the market. About 4.9% of butter reaches the final consumer through this line of system

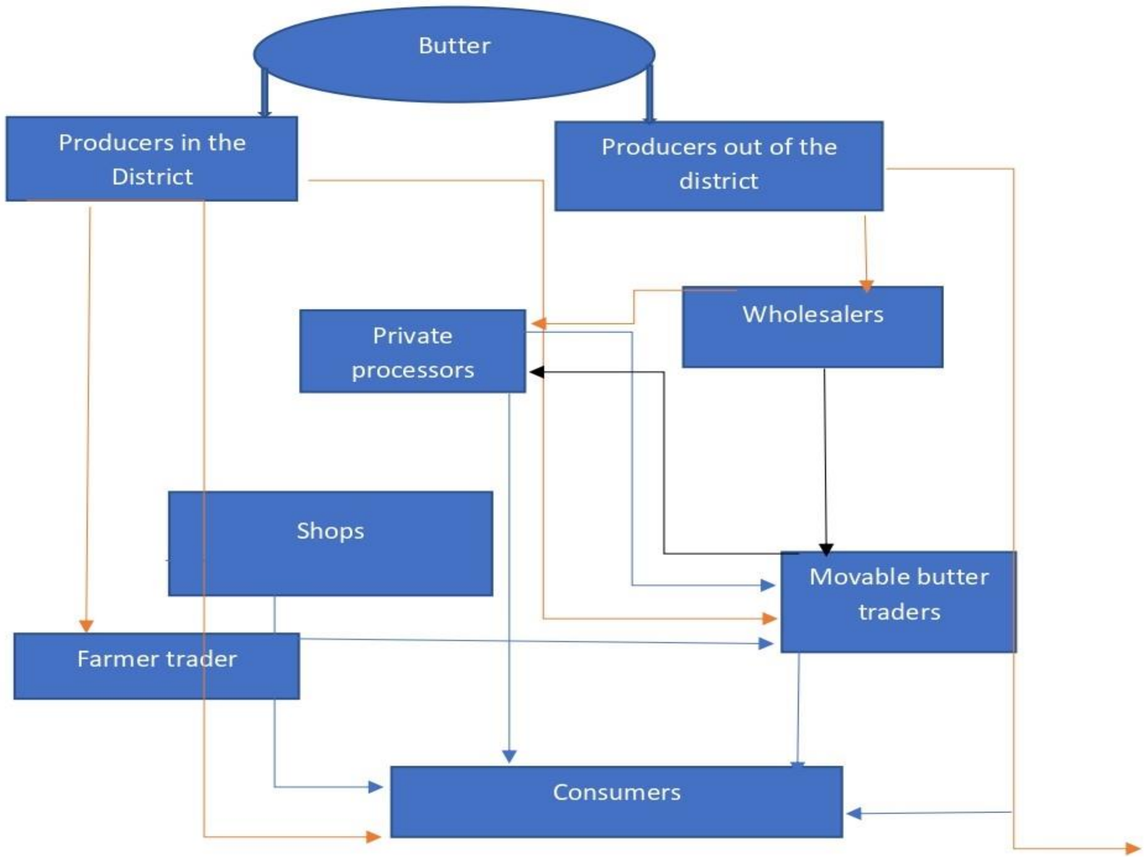


Figure 3 Marketing channels of butter

Concentration of firms

Dairy market of milk, butter and cheese in the district is characterized by the prevalence of un concentrated supplies. Dairy products are supplied by a very large number of producers from different areas, whereby no producer affects the function of other producers. Market in the next level, at buyers' level, is also un concentrated for butter and cheese. So, this market resembles the characteristic of a competitive market. Milk market on the other hand exhibits relatively concentrated buyers. Concentration ratio for milk market is calculated by taking the annually purchased volume of milk by market participants in liters.

However, there are reasons why high concentration levels may be reasonable in light of small potential volume traded and where much of the product passes directly from producer to consumer. Moreover, dairy products especially milk is bulky, perishable and lower volume of production per household and per unit area and the associated higher transaction cost.

Marketing margins

The overall marketing margin is simply the difference between the farm gate price and the price received at retail sale. It is important to sort out the producers' share in the consumers Birr and also to know the shares of different actors. Market prices reflect two elements; marketing and transaction cost on one hand and normal profit on the other. Normally, at each successive stage, the price per unit is higher because of adding value by all or some of the marketing functions of transport, storage and processing. In marketing margin analysis, the purchase price and selling price of dairy products of different marketing middlemen was considered.

In an efficiently operating market, the competitive environment should keep the marketing margin to the minimum. Efficiency in performance of marketing is not in all cases equated with small marketing margins. Small marketing margin, however, is not always equated with efficient performance in marketing functions. Similarly, large margins are not necessarily a firm indication of inefficiency or excess profit. Marketing margin and costs can be meaningfully discussed in relation to the services and functions provided. Sometimes widening margin overtime may reflect an increasing demand by consumers for additional services.

Small-scale dairy traders comprise those who trade in butter and milk as a main business, farmer trader, milk bars, processors and those who trade in dairy as part of other retail activity mainly involving sale of other household consumer items like shops and kiosks. Here the dairy trade comprises of less than one fourth of the total turnover.

Table 10 Costs and margins of dairy products (milk/L butter/kg and cheese/kg) in Birr

No	Costs/margins	Movable Traders (N= 12)		Bars & Shops (N= 5)	Processing Plants (N= 1)	Dairy coopera.
		butter	cheese	milk	milk	milk
1	Marketing cost					
	Purchase cost	27	4.6	2	1.85	1.90
	Processing cost	-	0.75	0.05	0.4	-
	Transport cost	1.16	0.13	0.06	0.13	0.0578
	Other cost	0.17	0.3	0.12	0.1	0.0032
2	Transaction cost					
	Opportunity cost of capital	0.036	0.18	0.01	1.65	0.012
	Opportunity cost	0.07	0.58	0.84	0.15	0.077

	of labor					
3	Total cost	28.23	5.49	3.19	2.46	2.0889
4	Sales	31.40	6.80	3	3.34	2.1111
5	Margins					
	Total gross marketing margin	14.12%	32.34%	33.3%	44.6%	10%
	Net marketing margin	7.8%	19.26%	-6.25%	19.7%	1.05%

Source: Survey results, 2012/13

As shown in Table 10, the net marketing margin is one of the lowest and is only 1.05% as compared with other traders. However, member dairy producers contribute 100gms/kg of milk sold with the aim of strengthening the financial position of the cooperative and yet many dairy producing households in urban and peri urban areas prefer to sell the produce to the cooperative. This is mainly because they feel the sense of ownership and consider the cooperative as their own and it is also a reliable year-round outlet for their produce. The provision of inputs and veterinary services keep members loyalty and maintain milk yield and giving the cooperative economies of scale.

Market actors

In marketing chains, the product passes through different market stages in the value chain before it reaches to final consumers. The main actors in dairy and its products markets include a network of private processor, cooperatives (available at kolfe but its channel through Muka Turi), hotels/cafeteria, individual consumers and farmers.

Challenges of Dairy Value Chain

Constraints at Input Supply

Information gap on credit services: With regard to credit, farmers and dairy producers have limited awareness about the terms and conditions of credit providers. Currently most farmers do not have good knowledge of how to get credit services, amount of credit and loan repayment periods for dairy farming activities. Farmers abstain from using this credit mainly due to lack of understanding of its terms.

Low quality and untimeliness of AI and animal health service provision: Based on famers' response during FGD, the service rendered by the AI technicians was inadequate and offering low quality services. Due to this problem, nowadays farmers tend to use bull service for breeding, which is more attractive from the point of view of its timely accessibility when service is required.

Additionally, the situations become even worse for those farmers who live in far distance areas within the peasant association where provision of animal health and AI services were either unavailable or inadequate. It was learnt that those farmers in distant areas travel more than 5 hours to arrive at the service provider station. In some cases, they reach the service station after the heat period is over. This leads to failure of conception which perpetuates farmers to lose their confidences on AI services and leads to the use of the alternative bull services.

Unavailability of budget for demonstration sites on improved forage production in Farmers Training Centers (FTC): Utilization of FTC as training ground for demonstration of improved forage development was not observed in the study area. The major problem behind this was budget shortage. Due to lack of awareness and emphasis regarding the importance of improved forage deployment in enhancing dairy productivity, the allocated budget for the district went for development of major cash crops like carrot, onion, bread wheat and pulse crops. As a result, farmers were following the practice of producing only natural grazing pasture, fodder beet and oats using the knowledge obtained from their neighborhood.

Shortage of government and private farms and multiplication centers for the supply of improved dairy heifers and bulls: Farmers stated that there was shortage of ranches that multiply and distribute improved heifers and bulls in the area.

Opportunities

The major opportunities available to stimulate the transformation of the dairy sector of two districts are include:

- Favorable climate and weather conditions
- The availability of some progressive farmers who have adopted the practice of keeping improved dairy cows provides clear evidence that there is an opportunity to bring about the positive changes.
- Change of lifestyles in urban centers joined with urbanization and rapid population growth.

Conclusions and Recommendations

Conclusions

Market participation and sales volume decisions are found to be important elements in the study of marketing patterns. Participation in dairy sale is a dichotomous dependent variable the Maximum Likelihood Estimation procedure of logit model was thus used in the study. Participation decision of the smallholder was affected by education of household head, experience in dairy production, and return time from the district capital and financial income from different sources. The sales volume decision of dairy was analyzed using Tobit model. Education of the household head, extension visit, return time from the district capital, financial income from different sources, credit, grain production and crossbred dairy cows were important determinants affecting volume of dairy sales.

Marketing costs and margin were also analyzed in this study. Milk marketing is changing rapidly with increasing market oriented small scale dairy producers and milk marketing outlets, such as milk processing industries and dairy producer's cooperative which stood between producers and consumers.

Recommendations

Policies that are of significant importance which are also policy relevant are provision of improve breed both local and crossbred, which improve total production and subsequently marketable surplus. Dairy production especially in rural area is small to support an elaborated marketing system. The low marketable output generates limitations to explore distant but rewarding markets due to high transaction costs arising from transportation and high opportunity cost of labor involved.

Inaccessibility from district capital and demand areas is one of the constraints to dairy marketing in the district, which resulted into inadequate marketing link between the rural producer and the urban consumer. This missing link can be forged through institutional arrangement such as cooperative structures. Cooperatives can be very successful in dealing with both information asymmetries and easily attain competitive edge.

They do this through collective action, pooling resources and lowering the unit cost of transactions. Members should widely understand the cooperative and its aims to established voluntarily without any form of external imposition. Once decision to adopt cooperative structure as a means of dairy development is taken, government policies may be used to support dairy cooperatives. Extension and training programs in dairy market should be designed primarily in such a way to target and inform these sectors of the society.

For the improvement and development of marketing structure, a coordinate approach aiming at removing all the weak links of the marketing channel is essential. A package of improved marketing services in the form of regulated markets, grading, weighing, storing, transporting and handling services need to be made available to ensure the producer a fair return from his production efforts and a better share in the price paid by the consumer. On the other hand, ensure the consumer to get quality product in relation to the money expenditure.

Financial income from different sources and credit found to stimulate dairy market participation and volume decision. However, extension of bank credit is conditioned by the availability of collateral. Land ownership issues, traditional farming practices and lack of market access often prevent smallholder farmer from obtaining loan from banks.

Therefore, increasing the dimension of access to credit and forming well-functioning formal rural and urban financial systems are critical in influencing entry to the dairy market.

References

Andargachew Kebede, 1990. Sheep marketing in central high lands. Unpublished M Sc Thesis presented to the School of Graduate Studies of Alemaya University of Agriculture. 116p.

Azage Tegegne, A. Lahlou-Kassie and E. Mukasa-Mugerwa, 1993. Biotechnology in Animal Production. pp. 49-80. In: Proceeding of 2nd Annual Conference of Ethiopian Society of Animal Production (ESAP), Addis Ababa, Ethiopia, 26-27April 1993.

Behanke, R. and Fitaweke Metaferia, 2011.The contribution of livestock to the Ethiopian economy Part II IGAD LPI working paper 02-11 Addis Ababa: Ethiopia.
Berhanu Kuma, 2012. Market access and value chain analysis of dairy industry in Ethiopia: The Case of Wolaita Zone. PhD Dissertation, Haramaya University, Ethiopia
Bouis, H. and L. Haddad, 1990. Agricultural Commercialization, Nutrition, and the Rural Poor: A Case Study of Phillippines Farm Households. Lynne Reinner Publishers. Bouler, Colorado, USA.191p.
Central statical agency (CSA), 2016. Ethiopia Sample survey Enumeration. Addis Ababa. Ethiopia Cleaver, K.M. and A.S. Gotz, 1994. Reversing the spiral: The population, agricultural and environment nexus in sub-Saharan Africa. The World Bank, Washington, D.C. 43p
CSA (Central Statistical Agency), 2015. Agricultural sample survey 2014/15. Volume II Report on livestock and livestock characteristics (private peasant holdings), Addis Ababa, Ethiopia.
CSA (Central Statistical Agency), 2015. Agricultural sample survey 2014/15. Volume II Report on livestock and livestock characteristics (private peasant holdings), Addis Ababa, Ethiopia
EARO (Ethiopian Agricultural Research Organization). 2000. A kid looking after a kid our loved ones. Next generations! What do they need! EARO, Addis Ababa, Ethiopia. 63p.
EIAR, (Ethiopian Institute of Agricultural Research) and ILRI (International Livestock Research Institute), 2012. Liquid milk and feed value chain analysis in Wolmera District, Addis Ababa, Ethiopia.
Staal S. J., A. P. Nin, and J. Mohammad, 2008. Dairy development for the resource poor part 2: Kenya and Ethiopia dairy development case studies PPLPI working paper No. 44-2.

The Role of Apiculture in diversifying bee keepers' income in Oromia, Ethiopia

Sinbone Tefera[1] and Diriba Mengistu[1]*
Holeta Bee Research Center, P.O. Box 22, Holeta, Ethiopia
*Email of the correspondent author: *sinbonetefera@gmail.com*

Abstract

In Ethiopia agriculture play great role.Nonetheless, climate change, recurrent droughts, and floods are having hemorrhaging effects on the performance of the sector thereby hurting rural households who depend on agricultural activities. Against this backdrop, responsible stakeholders are in the process of finding alternative livelihood strategies for rural households in the country. Among the potential and most neglected sources of livelihood is apiculture which defines as the rearing of honey bees in order to get economic benefits. Bee keeping requires little land and therefore is an ideal activity for small scale resource-poor farmers.The study was conducted in Oromia national regional state, Ethiopia with objective determine the contribution of beekeeping to household income of the bee farmers.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 180 respondents and analyzed by using SPSS.The finding of this study show that the average numbers of hives owned by house holders was 1.23; 5.31 and 0.58 traditional, transitional and frame hive, respectively. On average The beekeepers earned about 25461.7 ETB per annual income from honey.The main income source of households were crop production having higher share (77.7%) and followed by beekeeping having proportion of 22.89%. Beekeeping generally contributed to the annual household income of households and 52.6% to their annual share of livestock income.This indicates that a reasonable alternative income can be earned from beekeeping in the study area.Therefore, focuses are needed to promote modern beehive and transitional beekeeping technology for improvement of households income.
Keywords: *Beekeeping, contribution, income,technology*

Introduction

Eradication of extreme poverty and hunger is currently one of the policy goals of the Ethiopia government. Within the arsenal of strategies used in developing to eradicate poverty, agricultural production plays a central role. Nonetheless, climate change, recurrent droughts, and floods are having hemorrhaging effects on the performance of the sector thereby hurting rural households who depend on agricultural activities. Against this backdrop, responsible stakeholders are in the process of finding alternative livelihood strategies for rural households in the country. Among the potential and most neglected sources of livelihood is apiculture which defines as the rearing of honey bees in order to get economic benefits. Bee farming requires little land and therefore is an ideal activity for small scale resource-poor farmers (Jinanus and Tamiru, 2016).

Beekeeping as a livelihood strategy: Apart from enhancing food security, beekeeping provides employment especially in areas where there is population pressure on the land. This helps households manage economic shocks hence reducing vulnerability among these households (Gebreyohannes, 2010). Apiculture also accelerates the accumulation of savings as a result of increased income. Beekeeping increases cash flows because it supplements the household income especially during off seasons when on-farm income is low. Hive products may be harvested one to two times a year especially at consumption peak times, for instance, when school fees have to be paid (Kidd, 2001). Some bee products such as beeswax and propolis have long shelf lives which enable them to be stored for a long period as a form of saving and sold when need arises. Additionally, the ease of asset recovery and accumulation among beekeepers in case of insecurity was reported by Enzama (2008). This makes beekeeping a very important safety and cargo net.

Ethiopia is a leading country in Africa and ninth in the world in honey production by having bee hive 6.9 million and 0.14 million ton/year of honey production (CSA,2020/21). In respect of the country's agricultural GDP, beekeeping contributes 1.3% (Akessa, 2016).

Among Ethiopian regional states oromia region were leading by having beehive 3.8 million and 0.069 million ton/year of honey production (CSA,2020/21) which mean about 54 % and 49 % of total bee hive and honey production share respectively. Attaining such production quantities, however, will require several successful interventions at all levels by identifying factors that affects beekeeping contribution to farm smallholders income and acting on the bottlenecks.

In addition the potentiality of beekeeping activity to diversify farmers' income is not well recognized in the study area. Therefore, the research investigates contribution of beekeeping to household income and the factors that contributed beekeeping activities to be low at the study area. Along with, recommends solution to enhance the beekeeping activities to increase its role in the livelihood of the local community in particular and for the national economy in general. Governmental and non-governmental organizations which want intervention in beekeeping activities in the study area and in other neighbor districts can also utilize the research findings and recommendations.

Objectives

- Determine the contribution of beekeeping to household income of the bee farmer
- To identify challenges of honey production and market of bee products.

Methodology

The study areas

The study was conducted in four zones (Ilu Abba Bor, Jimma, East shewa and Arsi) of Oromia Regional State, Ethiopia. From these, nine districts were selected based on the potential for beekeeping and honey production. from secondary data, about 3603 beekeepers with 5990 traditional hives, 4149 transitional hive and 2416 modern hives and also 318 tone of honey were found at survey time in East shoa zone (livestock office East shoa zone, 2022). As the same information, 2843 of beekeepers with 7449 traditional hives, 2150 transitional hive and 1671 modern hives were found in Arsi zone and The corresponding zone expert also reports that about 75788 traditional hives, 19466 transitional hives and 10668 modern hives had been addressed in Jimma.

Sampling techniques and Sample size determination

Arsi ,East shawa,Jimma and I/A/Bor zone were selected. Multi stage or Three stage sampling procedures were used to select sample from community. In the first stage form four zone at list two district weer selected from each. Then, PA were select randomly. In the last stage, sample of household heads was selected randomly, using probability proportionate to size.

There are number of factors determine the correct sample size that appropriately represents the population. these factors are: homogeneity of the population, analytical methods to be employed, and available resource such as time, finance and management (Alan, 2004). The decision on the selection of the method of sampling techniques depend on the objective of the study, information available about the target population before survey, the size of the target population and the natural order of the individuals in the study (Rengaswamy, 2007). accordingly, To determine the required sample size, in this study was used a simplified formula developed by Yamane (1967) to minimize availability of error and bias during sample determination selection for the study at 92% confidence level.the total sample size (n=180) was determined following a simplified formula provided by Yamane (1967).

n = N/ 1+N(e) 2 (1)

Where: n = sample size, N = population size (sampling frame) and e = level of precision.

Method of data collection and Method of data analysis

The primary data were collected using structured interview scheduled administer to households from Districts; Bora and Dugda , Xiyoo and Munessa,Yayyo and Alle and Gera, Seka and Gummay from East Shao, Arsi, Ilu Abba Bor and Jimma respectively.

Accordingly data were collected from 180 beekeepers households. Secondary data were collected from previous research findings, Internets, reports of Agriculture and Rural Development Offices at different levels, reports of NGOs, and other published and unpublished materials.

Formal survey were 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 honey, constraints in beekeeping production and input market and bee products. The descriptive statistics used were minimum, mean and maximum values, standard deviations, frequencies and percentages.

Results and Discussions

Households' socio - demographic Characteristics

The demographic features of sampled farmers are shown in Tables 1 and 2. Accordingly the age of household head was range with minimum of 18 years old and maximum of 78 years old (table 1). Household size is an important source of labor supply to agricultural activity as general and it could initiate a farmer to participate on farm and off farm activity. The farmer who has large family size would manage agricultural production on time and can handle other income generating activity and the same for beekeeping activities. The sampled farm households' have 2 minimum and 15 family size (table1). And also the experience of sample households on beekeeping activity was minimum 1 year and maximum 50 years (table1). The experience can be traditional experience or that can be obtained from professionals.

Table 17. Socioeconomic characteristics of samples household (continues variables)

Variables	N	Min	Max	Std. Deviation	Mean
Age of the household head(year)	180	18	78	13.228	39.82
Total Family size (number)	180	2	15	2.893	5.49
Household experience in beekeeping (year)	180	1	50	9.76	10.57

Source, (own result, 2022)

Most of the farmers had attended education which is highest percent (32.3%) grade 5 to 8, 28.3% above grade 8, 15.6% grade 1 to 4,11.1 % read and write and 10.6 % illiterate.(Table 2). Educational level of the farming households may have significant importance and determining the type of development and extension service approaches (Taye and Marco, 2014).

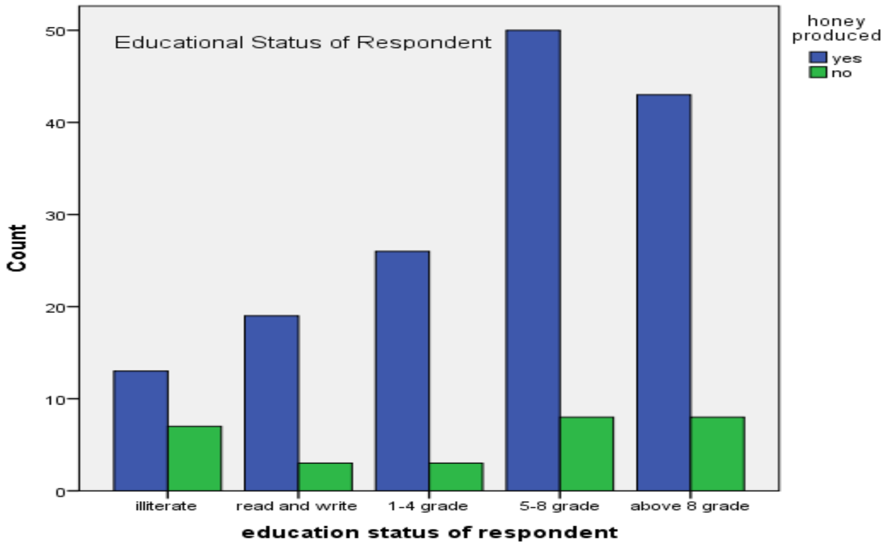


Figure 1: Education status and beekeeping practices of households

Table 18. Socioeconomic characteristics of samples household (dummy variables)

	Frequency	Percentages
Sex of respondent		
Male	17	9.4
Female	163	90.6
Marital status of respondent		
single	17	9.6
married	161	89.5

Source: (own result, 2022)

As indicated in Table 2, 90.6% of sample households are male participated in beekeeping activity while 9.4 % are female. This implies that male headed constitute a higher percentage in the participating the activity even though the activity is also affordable and can be participated by no differentiating age and sex. About 89.5% of the sampled households were married and 9.4 % were single(Table 2). This may implies that youth participation in the beekeeping is low, and need more attention.

Economic contribution of beekeeping to the households

This section intends to describe the contribution of beekeeping to livelihood outcomes of the beekeepers. The main products and their incomes are presented first, followed by beekeeping equipment and beekeepers' skills. Beekeeping was found to economically contribute to the well-being of rural households as direct income generation. Bee products also facilitated beekeepers to meet their consumption needs.

The main Bee products and their incomes

Table 19.beekeeping practice, honey produced and wax produced

		Frequency	Percent
Beekeeping practice	yes	147	81.2
	no	33	18.2
Do you produces honey	yes	151	83.4
	no	29	16.0
Do you produce wax	yes	12	6.6
	no	168	92.8
Do you sell honey	yes	134	74.0
	no	16	8.8

Source, (own result, 2022)

As Table 3 show that, 81.2% of respondent were involved in beekeeping activities. Honey (83.4%), and beeswax (6.6%) were the bee products harvested by beekeepers in the area. About 82.8% of the honey produced was used for both sale and home consumption, while 74% was produced for sale and only 8.8% for home consumption and other purpose.

The mean of income obtained from honey product were 25461.78 ETB with standard deviation of 21257.21 with maximum income gain of 128250 ETB (Table 4). The mean of income obtained from other bee product (Wax) were 2352.0 ETB with standard deviation of 1265.11 per household with maximum income gain of 2202.2 ETB (Table 4).

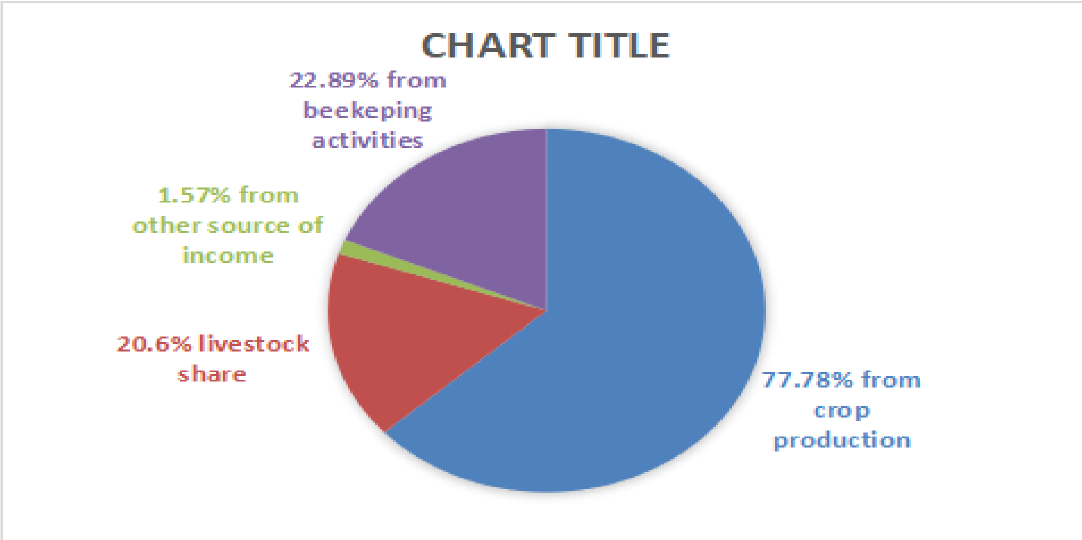
Table 20.The main Bee products and their incomes

Variable	**Mean**	**Standard deviation**	**Maximum**
Quantity of honey harvested/year (kg)	255.4	200.4	10048
Average price of honey (birr/kg)	194.7	130	600
Total income from honey	25461.78	21257.21	128250
Quantity of beeswax harvested /year (kg)	0.8	0.7	30
Average price of bee wax (birr/kg)	180	110.6	300
Total income from wax	2352.0	1265.11	2202.2

Source, (own result, 2022)

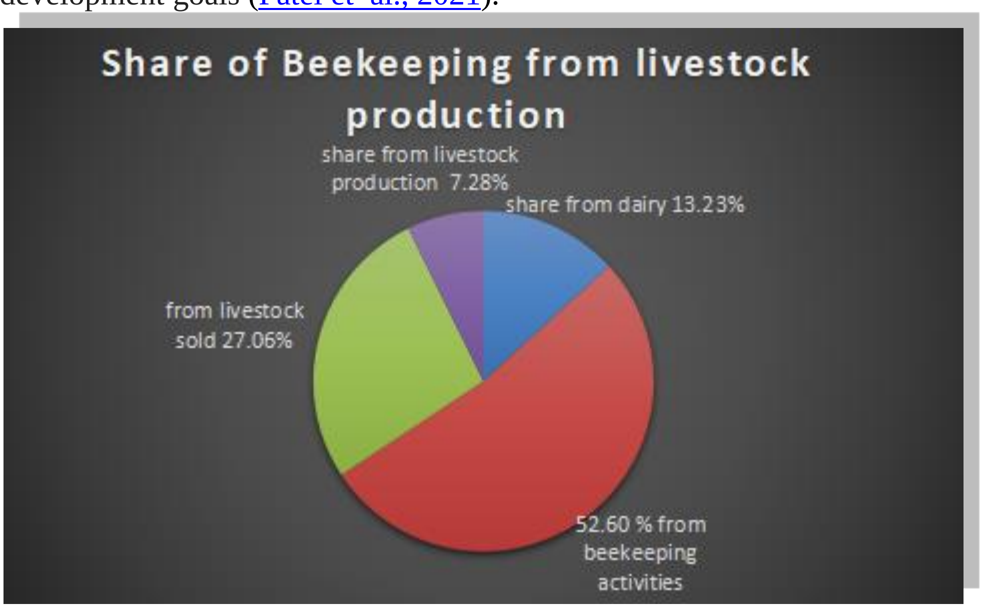
Income contribution of Beekeeping activities to Household

The main income source of households were crop production having higher share (77.7%) and followed by beekeeping having proportion of 22.89% (figure 2).



Source, (own result, 2022)
Figure 8 The share of beekeeping to total households income

Beekeeping generally contributed to the annual household income of households and 52.6% to their annual livestock income (figure 3).This indicates that a reasonable alternative income can be earned from beekeeping in the study area. The promotion of sustainable beekeeping is needed to address these emerging problems as well as contribute, in turn, to achieving the sustainable development goals (Patel et al., 2021).



Source, (own result, 2022)

Figure 9: the share of beekeeping to households' income from livestock production

Beekeeping Equipment

Table 21: colonies owned by beekeepers

		Frequency	Percent
Traditional colonies owned	yes	123	68
	no	33	18.2
Modern colonies owned	yes	63	34.8
	no	95	52.5
Transitional colonies owned	yes	38	21
	no	132	72.9

Source, (own result, 2022)

Beekeepers owned a number of equipment used in production and processing of honey. Beehives were the major production equipment. From below table 4 Among beekeepers who practice beekeeping 68%, 34.8%, 21% of beekeepers were own traditional, modern and transitional colonies (Table 22). 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.

Table 23. Summary bee hive owned by beekeeping and frequency of honey harvest households

Variables	**Mean**	**Standard Deviation**	**Maximum**
Traditional bee hive	11.4	17.9	100
Transitional bee hive	1.3	9.2	35
Modern bee hive	3.1	10.9	120
Frequency of harvesting of traditional bee hive	1.1	0.9	4
Frequency of harvesting of modern bee hive	0.6	0.9	3
Frequency of harvesting of transitional bee hive	0.4	0.8	3

Source, (own result, 2022)

As table 6 show that on average beekeeper bee hive were 11.4, 1.3 and 3.1 traditional, transitional and modern beehives respectively. With having maximum and standard deviation of 100 (17.9) ,35(9.2) and 120 (10.9) traditional, transitional and modern bee hives. While the frequency of honey harvesting among bee hive were varies. as table 7 show that average and maximum of harvesting honey from traditional, modern and transitional hive were 1.1(4), 0.6(3) and 0.4(3) respectively.

The Beekeepers obtained their bee hive from different sources: namely through either own purchase, co-funding, making them locally or through donation from NGOs and government programs that were promoting beekeeping in the area. None of the equipment was found to be obtained on credit in this study. The major sources were donation and own purchase. The results on beekeeping equipment implied that beekeeping in the area of study was dominated by the use of traditional beehives that were majorly locally made by the beekeepers. It was also found that a few of the beekeepers owned processing equipment and those who did mostly acquired them through donations rather than own purchase.

The major challenges of beekeeping production

The major beekeeping production problems in the study area were 30.9 % lack of material skill and training, 15% Agro chemical and toxic problem and 16.5% Birds, spiders, lizards, small hive battle and ants (table7)

Table 24: The major beekeeping production challenges

Major beekeeping Productions	frequency	Percentage
Lack of material , skill and training	56	30.9
Agro chemical and toxic problem	27	15
Birds,spiders , lizards, small hive battle and ants	30	16.5

Source, (own result, 2022)

The main beekeeping inputs and bee products market problems

As table 8 show, that the main beekeeping inputs and products market problems low price of honey and unreliable of honey buyers, Market problem form beekeeping equipment and market problem for bee wax 16%, 8.8% and 2.8% , respectively.

Table 25.The major beekeeping inputs and product marketing problems

Major beekeeping Productions	frequency	Percentage
Low price and dis honest honey buyers	29	16
Market problem form beekeeping equipment	16	8.8
Market problem for bee wax	5	2.8

Source, (own result, 2022)

Conclusion and Recommendations

Conclusion

The study was conducted in Oromia national regional state, Ethiopia with objective determine the contribution of beekeeping to household income of the bee farmers.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 180 respondents and analyzed by using SPSS.The finding of this study show that the average numbers of hives owned by house holders was 1.23; 5.31 and 0.58 traditional, transitional and frame hive, respectively. The mean of income obtained from honey product were 255.4 kg. On average The beekeepers earned about 25461.7 ETB per annual income from honey. The main income sources of households were crop production having higher share (77.7%) and followed by beekeeping having proportion of 22.89%. Beekeeping generally contributed to the annual household income of households and 52.6% to their annual share of livestock income. This indicates that a reasonable alternative income can be earned from beekeeping in the study area.

Recommendations

Based on the findings from field survey, the following recommendations have been proposed for beekeepers increasing production and productivity in order to improve the livelihood of local beekeepers.

- ✓ Lack of material and awareness and training, Agro chemical and toxic problem and Birds, spiders, lizards, small hive battle and ants were the major challenge beekeeping production in the study areas. From this finding lack of awareness and training and material are the main problems East shawa even though different intervention were made by different organizations, but not enough further work will be important by input suppliers and extension workers As well as issue of Agro chemical and toxic problem and Birds, spiders, lizards, small hive battle and ants were need attention by research institute and agricultural extension.
- ✓ According to survey results traditional beekeeping practices were leading which need attention for adoption of modern technology by research institute and agricultural extension.

References

D.W. Akessa 2016. Beekeeping in Ethiopia: country situation paper,Un published Paper presented at the Fifth Api Expo Africa 2016 Held in Kigali, Rwanda, 21–26 September

CSA (2020/21), Agricultural sample survey 2020/2021 on livestock and livestock characteristics. Central Statistics Authority. Addis Ababa, Ethiopia

Enzama W, 2008. Quest for economic development in agrarian localities: lessons from West Nile, Uganda. ISS Working Papers-General Series, (0921-0210).

Gebreyohannes. M, 2010. Socio-economic analysis of market oriented beekeeping in Atsbi Wemberta district of Eastern zone, Tigray Region. Unpublished: Makelle University; Ethiopia

Haftu K. 2015. Analysis is of honeybee production opportunities and challenges in central zone of Tigray, Northern Ethiopia. Int J Sci Res Publ 5

Kidd AD, Christoplos I, Farrington J, Beckman. M, 2001. Extension, poverty and vulnerability in Uganda: country study for the Neuchatel initiative: Overseas Development Institute;

Scoones I., 1998. Sustainable rural livelihoods: A framework for analysis, IDS working paper 72, Brighton.

Tamiru. K., and Jinanus.D, 2016. Challenges and Practices of HoneyProduction in Ambo District, West Shoa Zone, Oromia Regional State, Ethiopia. *International Journal of Economics and Business Management, 2016, 2(2), 148156*

V. Patel, N. Pauli, E. Biggs, L. Barbour, B. Boruff, 2021. Why bees are critical for achieving sustainable developmentAmbio, 50 (1), 49-59

Yamane, T. (1967). Statistics: An Introductory Analysis, 2nd Edition. Harper & Row, Publisher, New York.pp. 919.

Determinants Of Smallholder Farmers Adoption For Improved Finger Millet Varieties In West Hararghe Zone, Oromia National Regional State, Ethiopia

Birhanu Angasu[1*], Gosa Alemu and Nimona Sime
Oromia Agricultural Research Institute, Mechara Agricultural Research Center, Mechara, Ethiopia.
*Corresponding Author E-mail: birhanu.angasu@gmail.com

Abstract

Finger millet is one of among the important crop produced in Ethiopia. It has been grown for many years for its nutritive and food security values. For this different improved finger millet varieties with its packages were promoted and disseminated. However, factors that limit adoption decision and intensity of improved finger millet varieties were not conducted in study area. Thus, the purposes of this study were to examine determinants of adoption of improved finger millet in West Hararghe zone, Oromia region. For this study both primary and secondary data were used. Primary data were collected from 143 households (87 adopters and 56 non-adopters) and supported by secondary data. To address the aforementioned objectives descriptive statistics and econometric models (Double hurdle) were employed. The probit results of Double hurdle (DH) model indicated that the likelihood of adopting decision of improved finger millet was positively and significantly affected by land size owned, fear of risk on improved varieties, participation on demonstration, access to extension service and participation on demonstration. The second stage of the double hurdle model revealed that household size, access to extension service and fertilizer application for finger millet were positively and significantly affects the adoption intensity of improved finger millet technologies. While, access to credit negatively and significantly affects the adoption intensity of improved finger millet technologies. The findings generally suggest the need to create a chance of participation on demonstration and field day for farmers; access for extension service and strength application of fertilizer for finger millet production.

Key words: Adoption, Double hurdle model, Finger millet

Introductions

The adoption of agricultural innovations is crucial to increase incomes and food output in developing countries to meet the needs of the continuing growing population (Pingali, 2012). Adoption is degree of use of new technology in long run equilibrium when the farmer has full information about new technology and its potential (Feder *et al*., 1985). They further divided adoption into individual (farm level) adoption and aggregate adoption. Final adoption at the individual farmer's level can be defined as the degree of use of new technology in long run equilibrium when the farmer has full information about new technology and it's potential. Aggregate adoption is a process of spread of new technology within a region. Aggregate adoptions are measured by aggregate level of use of specific new technology within a given geographical area or within a given population. The rate of adoption is defined as the percentage of farmers who have adopted a given technology and intensity of adoption is the number of hectares planted with improved seed or the amount of input applied per hectare (Ibid).

Millets are the most important cereals of the semi-arid zones of the world. For millions of people in Africa and Asia they are staple crops. Among millet crops, finger millet figures prominently; it ranks fourth in importance after sorghum, pearl millet and foxtail millet (GCDT, 2012). In recent years, a strand of literature and strategies has emerged that promote particularly underutilized cereal crops including finger millet. It is argued that these could make an important contribution to food and nutritional security as well as to income generation to resource-poor farmers living in low productivity areas like the semi-arid climates of Sub Saharan Africa for several reasons (Padulosi *et al*., 2013). Besides, they tend to be more resilient to poor or unpredictable agro-ecological conditions than commonly produced cereals such as maize, wheat, and rice (Tadele and Assefa, 2012).

In Ethiopia, finger millet is the 6^{th} important crop after teff, wheat, maize, sorghum and barley. It comprises about 5 percent of the total land devoted to cereals (Molla, 2012). The crop is mainly grown in the northern, north western and western parts of the country, especially during the main rainy season. The national annual production area of finger millet in 2017/18 cropping season is estimated at around 456,057.31 hectares, with a total production of 10.3 million quintals (CSA, 2018). In Oromia national regional state, finger millet is produced in different zones but it is widely grown in West Wollega. The annual finger millet production area coverage in 2017/18 cropping season is estimated at 93,831.88 hectares, with a total production of 2.1 million quintals in this region.

In West Hararghe zone, finger millet has been grown for many years for its nutritive and food security values. It is produced by smallholder farmers who have continuously grown low yielding unimproved finger millet varieties. It has consequently food insecurity persistently experienced in the zone and contributed significantly to the low food production. For this, Mechara Agricultural Research Center was introduced, promoted and scaled up improved finger millet varieties (Boneya, Tadesse, Tessema and Meba) and improved agronomic practices in the zone since 2004 E.C. Besides, different stakeholders like Melkassa Agricultural Research Center; and zone and districts Agricultural Offices also have been disseminated improved finger millet varieties in the study area. Despite the efforts made so far, the dissemination and adoption of this technology among the smallholder farmers, similar study was not conducted in the study area which was forming the basis for this study.

It is due to various technical and socio-economic constraints including limited supply of improved seeds varieties, less adoption of modern agricultural technology, high prices of fertilizers and inadequate credit facilities for purchase of agricultural inputs are the major socio-economic constraints (Fatima *et al.*, 2015; Farooq *et al.,* 2007) and Chandio *et al.,* 2016). Additionally, there is no empirical evidence on the determinants of adoption decisions for these improved finger millet varieties. Therefore, this study aimed at investigating factors that influence the farmers' decisions to affect these improved varieties in the study area.

Objectives

- To assess the adoption status of improved finger millet varieties in West Hararghe zone,
- To identify factors affecting smallholder farmers' decision and intensity of adoption of improved finger millet varieties in the study area.

Methodology

This section outlines the research procedure used in the study. It covers description of study area, sampling procedure and sample size, data collection and data analysis used in the study.

Description of study area

This study was conducted in three districts (Daro Lebu, Habro and Gemechis) of West Hararghe Zone of Oromia National Regional State, Ethiopia. Daro Lebu district is one of the 15th districts of West Hararghe zone. It is located at 434 km South-east of Addis Ababa and 115 km from Chiro, the zonal capital town of West Hararghe Zone. The district is found from 1350 to 2450 meters above sea level. The district has three agro-ecological zones. These are 10% high land, 34% midland, and the rest 56% lowland. The minimum and maximum annual rainfalls are 900 and 1000 mm with an average of 963 mm. The minimum and maximum temperature of 14°C and 26°C with the average temperature is 16°C (DLAO, 2021).

Habro district is one of the 15 districts of West Hararghe Zone of Oromia National Regional State, Ethiopia. It is located at 404 km South-east of Addis Ababa and 75 km from Chiro, the zonal capital town of West Hararghe Zone. The district is found from 1600 to 2400 meters above sea level. The district has three agro-ecological zones. These are 15% high land, 80% midland, and the rest 5% lowland. The district received mean annual rainfalls of 966.7 mm. The minimum and maximum temperature of 13.4°C and 26.8°C with the average temperature is 19.97°C (HAO, 2021).

Gemechis district is one of the 15 districts of West Hararghe Zone of Oromia National Regional State, Ethiopia. It is located at 343 km South-east of Addis Ababa and 17km from Chiro, the zonal capital town of West Hararghe Zone. The district is found from1300 to 3400 meters above sea level. The district has three agro-ecological zones. These are 26.9% high land, 35.5% midland, and the rest 37.6% lowland. The minimum and maximum annual rainfalls are 650 and 1200 mm with an average of 850 mm. The minimum and maximum temperature of 15°C and 30°C with the average temperature is 22°C (GAO, 2021).

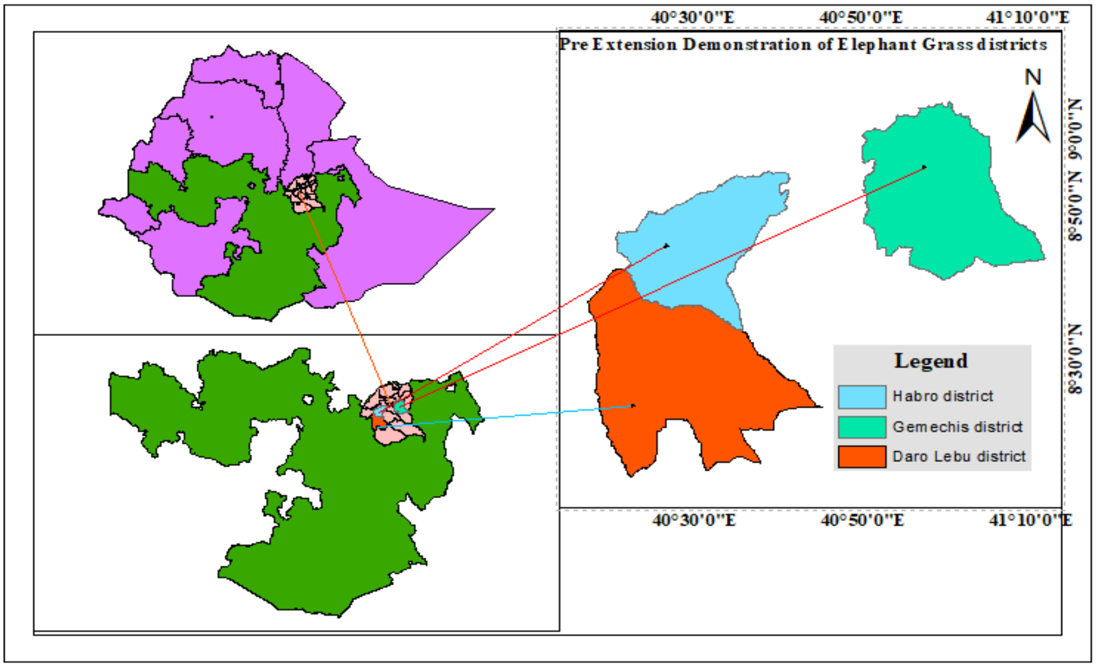


Figure 1: Map of the study areas
Source: Own design from ArcGIS data, 2022

Sampling frame and sample size

In this study a multi-stage sampling techniques were employed. Firstly, three districts (Daro Lebu, Habro and Gemechis) were selected purposively based on the intervention of improved finger millet varieties. Secondly, two kebeles from each district were selected randomly among the kebeles in which the intervention of improved finger millet varieties was undertaken. Finally, appropriate sample size of representative households producing those improved finger millet varieties were selected randomly by considering probability proportional to population size. For the drawn sample respondents, the simplified formula provided by Yamane, (1967) was employed in determining the required sample size at 91.65% confidence level and level of precision (e) = 8.35%.

$$n = \frac{N}{1+N(e^2)} = \frac{112{,}887}{1+112{,}887(0.0835^2)} = 143 \qquad (1)$$

Where n is the sample size, N is the population size (total agricultural households of the three districts), and e-is the level of precision.

Table 1. Summary of sample respondents across districts

District	Kebele	Sample size taken	
		Frequency	Percent
Daro Lebu	Kotora	20	13.99

	Gelma Jeju	25	17.48
Habro	G/Goba	30	20.98
	Gadisa	31	21.68
Gemechis	K/Segariya	26	18.18
	W/Defo	11	7.69
Total		**143**	**100**

Data Types, Sources and Method of Data Collection

This study used the two data types: qualitative and quantitative data. It was employed from both primary and secondary data sources. Secondary data source was collected from published and unpublished documents of district Agricultural Office to support the primary data. The primary data was collected from the selected representative sample households through direct interview. Data collected from primary sources were collected using structured questionnaire administered through personal interviews.

Method of Data Analysis

Descriptive statistics

The collected data was analyzed with STATA 16. Both descriptive statistics (such as mean, standard deviation, frequency and percentage) and econometric model (Double hurdle model) were employed to meet the specific objectives of the study. Furthermore, test statistics such as t-test for continuous and discrete variables to compare means; and chi-square ($\chi 2$) test for dummy variables were employed among adopters and non-adopters of improved finger millet technologies.

Econometric Analysis

A smallholder farmer faces two hurdles while deciding on improved finger millet varieties. The first is to decide whether to cultivate improved finger millet varieties. The second hurdle is related to the intensity of adoption. The most important underlying assumption of the model is that these two decisions are made in two different stages. Therefore, the first dependent variable in this model was dichotomous consisting of two outcomes, yes or no. The second dependent variable of this model was the adoption index which was continuous variable ranges 0 to 1.

The different econometric model could be used to identify factors that affect producers‟ decision to participate in cultivating improved finger millet varieties (yes/no); and also identify the determinants of the adoption intensity. Those include Tobit, Heckman's two stage models, and Double hurdle models.

According to Negussie *et al*. (2021), the double hurdle (DH) model is a useful and proper approach to analyze technology adoption in assumption of many Ethiopian farmers' faces constraints of accessing inputs. Hence, double-hurdle model was used instead of Tobit and Heckman's model.

In addition, the specifications of the empirical model used to identify these factors the Double-hurdle models widely discussed in different adoption studies (Negussie et al., 2021; Yonas *et al*., 2020; Galmesa, 2018; Nigus, 2018; Achandi and Mujawamariya, 2016). The double-hurdle model was used to analyze factors influencing smallholder farmers' adoption decision, and the adoption intensity. Based on the specification by Cragg (1971), the two hurdles for a farmer can be written as:

$$d_i = \alpha Z_i + v_i \tag{2}$$

$$y_i^* = \beta x_i + \varepsilon_i \tag{3}$$

Where,

$$d_i = 1 \ if \ d_i^* > 0, \ and \ is \ 0 \ if \ d_i^* \le 0$$

d_i is the observable variable describing a farm's decision to adopt, y_i* is the latent variable describing intensity of adoption, and d_i and y_i are their observed counterparts, respectively. Also, z_i is the vector of variables explaining whether farmer participants in producing improved finger millet, x_i is a vector of variables explaining intensity of adoption, and v_i and ε_i are the error terms. The two error terms of the model were jointly normal and correlated,

$$(v_i, \quad e_i) \sim N(0, \Sigma) \tag{4}$$

The likelihood function for the double hurdle model is:

$$L = \prod_0 \left[1 - F_2\left(Z_i\alpha, \frac{X_i\beta}{\alpha}, \rho\right)\right] \prod_+ \Phi\left(\frac{Z_i\alpha + \rho/\sigma(y - X_i\beta)}{\sqrt{1-\rho^2}}\right)\frac{1}{\sigma}\phi\left(\frac{y - x_i\beta}{\sigma}\right) \tag{5}$$

Where, Φ and ϕ are the standard normal cumulative distribution function and density function, respectively.

Before running the specified model, the explanatory variables were checked for the existence of severe multicollinearity problems using the Variance Inflation Factor (VIF). According to Greene (1997), the threshold value of the VIF is 10 and that a highly positive value of the VIF indicates existence of severe multicollinearity. However, in this study there was no serious multicollinearity problem (VIF = 1.22) among explanatory variables (Appendedix Table 1). However, the tests of the Breusch-Pagan/Cook-Weisberg test showed the existence of heteroscedasticity problems in the dependent variable (Prob > chi2 = 0.0028).

Besides, to check as the double hurdle model was fit (appropriate) than Heckman two stages, specification tests were done. Heckman two-step procedure was tested against the Double hurdle model using inverse mills ratio (IMR). The study result revealed IMR was insignificant at 5% probability level. Therefore, Double hurdle model was appropriate and employed for the study.

Estimation of the adoption index

Before analyzing the determinants of adoption decision, it is important to assess the level of the adoption for each farm household. Accordingly, farmers who were not growing an improved finger millet variety were considered as non-adopters, while farmers who were growing at least one improved finger millet variety focusing on 2020/21 production season were considered as adopters. Among improved agronomic practices only four practices (improved variety, seed rate, portion of land allocated for improved finger millet and fertilizer application) are currently practiced by finger millet producer in the study area. The other practices (spacing, number of plough, chemical application and harvesting time) were excluded because of absence and difficulty in getting reliable information from farmers. In this study, adoption index was used to measure the extent of adoption at the time of the survey for multiple practices (package). Accordingly, the adoption index for each respondent farmer, which shows to what extent the respondent household, has adopted the technology packages were calculated using the following formula:

$$AI_i = \frac{\frac{AH_i}{AT_i} + \frac{FA_i}{RFA_i} + \frac{SR_i}{RSR_i}}{NP} \quad (6)$$

Where, AI_i= Adoption index; AH_i = Area under improved variety of finger millet of the i^{th} farmer; AT_i = Total area allocated for finger millet production of the i^{th} farmer; FA_i = fertilizer application for finger millet production of i^{th} farmer; RFA_i = fertilizer application for finger millet production; SR_i = Seed rate of finger millet i^{th} farmer used and RSR_i = Recommended seed rate of finger millet.

Thus, the adoption index is a continuous dependent variable calculated using the formula presented above with a value ranging from 0 – 1. Zero indicates no adoption and 1 indicates full adoption; an adoption index score between 0 and 1 indicates partial adoption. Improved finger millet production involves the use of different package practices. These include use of improved variety, seeding rate, fertilizer application and land allocated. Significant improvement in production and productivity depends on the extent to which a household has practiced the recommended improved agronomic practices. The level of adoption of improved finger millet production practices by farmers may vary depending on demographic and socioeconomic variables, institutional and environmental factors in which the household operates. The sample households' index scores were categorized into four adopter groupings namely non-adopter (0), low (0.01 – 0.33), medium (0.34 – 0.66) and high (0.67 – 1) adopter.

Table 2. Summary and description of explanatory variables

Variables	**Measurement**	**Expected sign**
Dependent variable		
Adoption decision	Dummy	
Adoption index	Continuous variable	
Explanatory variables		
Age of Household head	Years	+
Household size	Number	+
Land size owned	Timad	+
Livestock owned	Tropical livestock unit	+
Sex	Dummy	$\pm$
Education status	Categorical	+
Fertilizer application	Dummy	+
Fear of risk on improved varieties	Dummy	_
Access to market information	Dummy	+
Access to extension services	Dummy	+

Participation on demonstration and field day	Dummy	+
Access to credit	Dummy	+

Results and Discussions

This section presents descriptive and econometrics results of the study.

Socio Economics Characteristics of Finger Millet Producer Farmers

In this study adopters were referred as those farmers cropped improved finger millet varieties for at least one year. While, non-adopters were referred as those farmers never used improved finger millet varieties forever. According to Figure (1) below, from the total sample respondents 60% were adopters of improved finger millet technologies; while the rests were non adopters.

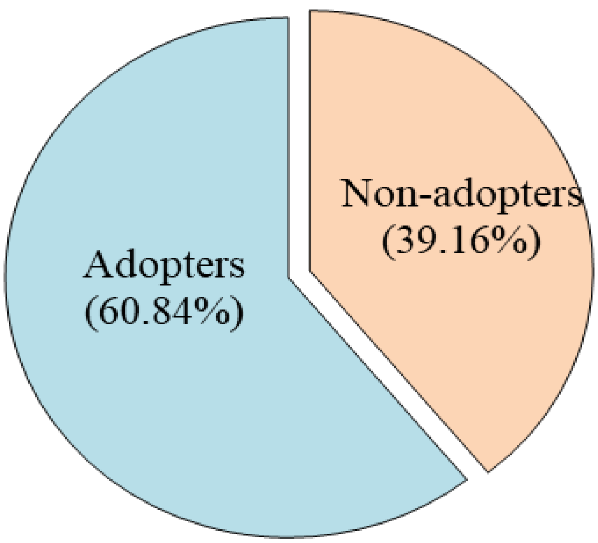


Figure 2: Status of sampled finger millet producer farmers

In study area, household size was on average 6. As indicated on Table (2) below, F-value indicated that there is no statistical difference between the two groups (adopters and non-adopters). It implied that there was no household size difference in between adopters and non-adopters (Table 2).

Table 3. Socio-economic characteristics of respondents (Continuous variables)

Items	**Adopter**		**Non-adopter**		**Overall**		**F**
	Mean	SD	Mean	SD	Mean	SD	
Household size (No)	5.8	2.4	5.9	2.1	5.9	2.3	0.36
Age (year)	39	10	41	11	40	10	1.16
Land size (ha)	0.75	0.46	0.48	0.28	0.65	0.42	1.78**
Livestock (tlu)	2.56	2.05	2.02	1.43	2.35	1.85	1.08

Source: Survey result, 2022

Land size had a great role in agricultural production and productivity. Households in the study area had on average 0.65 hectare with standard deviation of 0.42 hectares of farm size. There is a statistical significance difference in between adopters and non-adopters at 5% significance level. Adopter farmers had larger farm size (0.75ha) than non-adopter farmers (0.48ha).

Livestock is assets that guard farm household against shocks and agricultural related risks such as crop failure. In study area, on average households had 2.35 tropical livestock unit. Even if livestock owned is no statistical difference between adopter and non-adopter; there is numerical difference that means adopter had 2.56 tlu and non-adopter had 2.02 tlu.

Demographic and Institutional Service Characteristics of Respondents

According to the study result of Table (3) below, majority of the sampled households were male household heads which was around 97% while the rest were female headed households. Among adopter and non-adopter 96% and 98% were male headed households, respectively. However, there was no statistical difference among adopter and non-adopter in sex of households.

Education may directly affect application of new agricultural technologies and its adoption. In study areas in education status, most of the interviewed farmers (74.83%) were followed at least 1 year school formal education, 6.29% were not followed formal education but they could read and write; while 18.88% were illiterate. Among adopter 18.18%, 7.95% and 73.86% were illiterate, read and write and formal education, respectively (Table 3). While, non-adopter 20%, 3.64% and 76.36% were illiterate, read and write and formal education, respectively.

In finger millet production, both organic (manure, compost) and inorganic fertilizer is recommended as it should be applied. Out of the total respondents, three fourth (75.52%) were applied inorganic fertilizer (Urea and/ NPS) for finger millet production. But, one fourth (24.48%) of respondents were not used inorganic fertilizer for finger millet production. There are different reasons why farmers did not applied inorganic fertilizer for finger millet production. The main reason why households did not applied fertilizer was lack of capital, expensiveness and farmers perception of not applied for finger millet.

Table 4: Demographic and institutional service characteristics of respondents

Items		Adopter (%)	Non-adopter (%)	Overall (%)	ch^2
Sex of household head	Male	96.59	98.18	97.20	0.315
	Female	3.41	1.82	2.80	
Education status	Illiterate	18.18	20.00	18.88	
	Read and write	7.95	3.64	6.29	1.090
	Formal education	73.86	76.36	74.83	
Fertilizer application for finger millet	Yes	86.36	58.18	75.52	14.542***
	no	13.64	41.82	24.48	
Access to extension service	Yes	61.36	38.18	52.45	7.293***
	no	38.64	61.82	47.55	
Access to market information	Yes	56.82	47.27	53.15	5.51
	no	43.18	52.73	46.85	

Fear of risk on improved varieties	Yes	55.17	21.43	41.96	15.929***
	no	44.83	78.57	58.04	
Participation on demo & field days	Yes	40.91	14.55	30.77	11.043***
	no	59.09	85.45	69.23	
Access to credit	Yes	10.23	16.36	12.59	1.158
	no	89.77	83.64	87.41	

Source: Survey result, 2022

According to the survey result, out of the total sample respondents 52.45% were get extension service access and the rest were not get access to extension services. From adopter farmers 61.36% were got extension service access and the rest were not got. Out of the non-adopter farmers only 38.18% were got extension service access. There were statistical significant differences in access to extension services among the two groups at 1% significance level.

Market information is important for enhancing finger millet producers to adopt packages of improved finger millet technologies. However, only 53.15% of sample households were access to finger millet market information and 46.85 percent of sample households did not have access to market information. According to the survey result 56.82% of adopter households and 47.27% of non-adopter households get market information. They were getting market information from different sources, mainly from market observations, neighbors and radio. The chi-square result revealed that there is no significant statistical difference between adopters and non-adopters in access to market information.

Among finger millet producers in study area, 41.96% were fear risks to cultivate improved finger millet varieties. This is a reason of wilting problems except Tesema variety, pests' occurrence (birds attach) and untimely availability of its improved seeds. Among adopter categories 55.17% had fearing of risks within land shortage owned during cultivating even if they are adopters. While among non-adopters 21.43% were did not fear to cultivate improved finger millet varieties. However, due to untimely availability of improved seed, expensiveness and no need have improved variety. The chi square test showed that there is a statistical significant difference between the two groups at 1% significance level (Table 3).

Farmers who participated in on demonstration & field days are believed to have to access more information on improved technology packages as compared to other farmers. Accordingly, survey result shows that overall only about 30% of the respondents were participated on demonstration and/ field day. There is a statistical significance difference in between adopters and non-adopters at 1% significance level. Adopter farmers were more participated (40.91%) than non-adopter farmers (14.55%) on demonstration & field days. In study area, few of the sampled respondents (12.59%) get credit access, while the remaining 87.41% did not get. Available credit itself is mainly for only for fattening and trades rather for crop production. On credit access there is no significant differences between adopters and non-adopters.

Finger Millet Technologies

Agronomic Practices

The agronomic practice of improved finger millet production technology package contains improved seed, sowing method, seed rate, fertilizer application, land preparation, sowing date, weeding, pest prevention, threshing method, storage system and others. However, all the packages were not included in this study to calculate the adoption index because it is difficult to get reliable data for some packages (i.e., sowing date and harvesting).

In study area, all producers were conducted weeding managements of finger millet production. Majority of households (on average 90%) were weeding more than one times; while only 10% were weeding only one time.

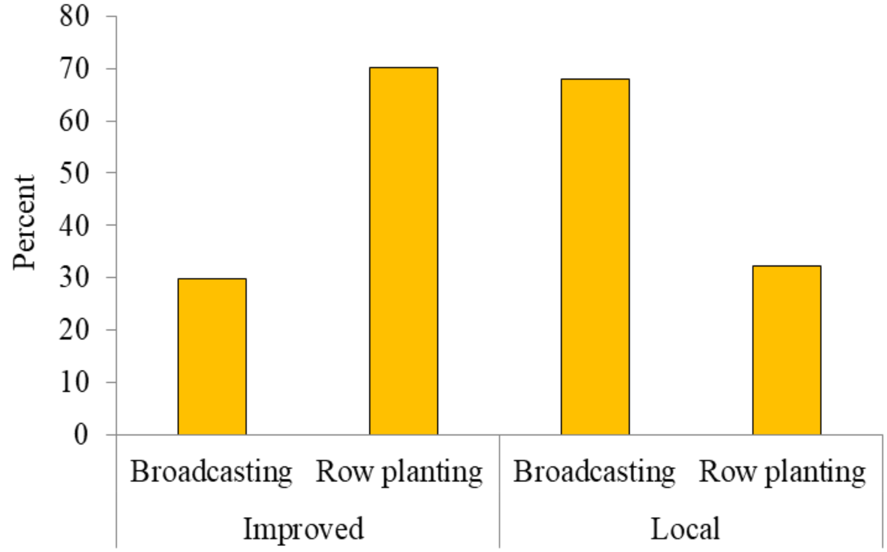


Figure 3. Sowing methods of finger millet in study area

According to figure (3) above, majority of farmers used improved finger millet varieties were sowing in row planting method. However, majority of farmers not used improved finger millet varieties (local) were sowing in broadcasting.

Being the crop is drought tolerant it is popular crops for both home consumption and market sales. In study area smallholder farmers primarily they produce finger millet for home consumption. Besides, the surpluses from home consumption were applied for market by some farmers. Among interviewed farmers some farmers were increasing area allocated for finger millet from year to year. As a reason of finger millet were productive crops, long store ability and drought tolerance of crop. But, few farmers in reverse decreasing area allocating for finger millet due to maize cluster, giving priority for other crops and small amounts is sufficient for home consumption.

Table 5. Cropping system of finger millet in study area

Cropping system	**Frequency**	**Intercropped With**	**Frequency**
Sole	102		
Both	2	Maize	36
Intercropping	39	Sorghum	3
		Chat	2
Total	**143**		**41**

Source: Survey result, 2022

In study area, majority of farmers (71.33%) were sowed finger millet in sole cropping system. The rest percent were intercropped with other crops mainly with maize, sorghum and in chat (Table 5).

Improved finger millet varieties

Table 6. Mean yield and traits of farmers used varieties

No	Varieties	N	**Mean** (qt/timad)	Traits
1	Boneya	12	4	Red seed color & flower
2	Tadese	29	7.88	White seed color & flower
3	Tesema	36	6.2	Red seed color & white flower
4	Meba	2	8.25	Red flower
5	Tesema & Tadese	8	9.71	-

Source: Survey result, 2022

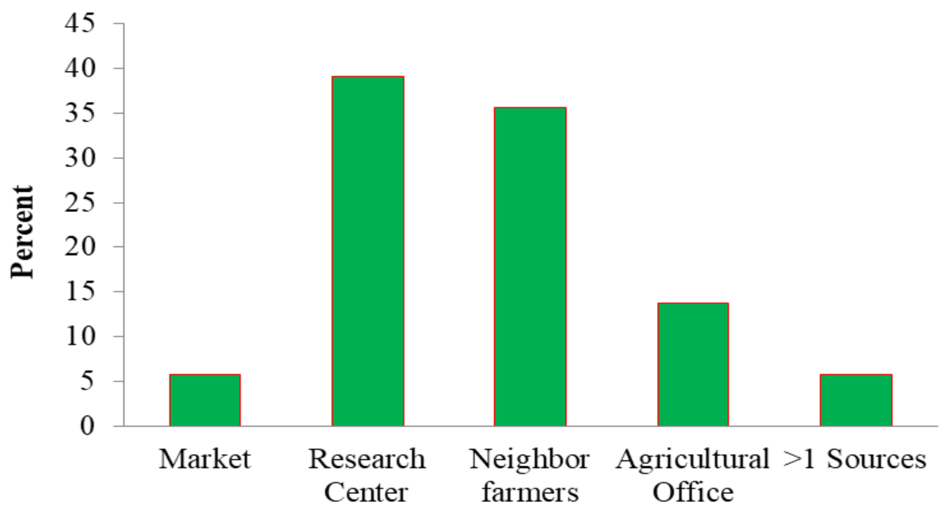


Figure 4. Sources of improved finger millet varieties

Research center and neighbor farmers (who transfer the received improved seed for other farmers) were the two major sources of improved finger millet varieties in study area. In this case research center played a lion share in provision of improved finger millet varieties for farmers. While, it followed by agricultural office and purchase from the market.

Adoption intensity of finger millet packages of technologies

Table 7. Categories of adopter farmers on finger millet packages of technologies

No	Technologies	Category (Yes)	
		Frequency	Percent
1	Using improved varieties	87	100
2	Recommended seed rate used (10-15kg/ha)	19	21.84
3	Fertilizer application	74	85.06
4	Sowing method (row planting)	61	70.11

Source: Survey result, 2022

According to Yayeh and Fekremariam (2014), planting finger millet at the lowest seed rate (10kg/ha) at 30 cm row spacing gave the optimum grain yield of finger millet. Other studies indicated that planting finger millet at 15kg/ha seed rate at 40 cm row spacing gave the optimum finger millet grain yield (Getahun *et al*., 2016). Therefore, 10-15kg/ha seed rate is taken as a standard in calculation of adoption index.

Table 8. Status of adoption categories of smallholder farmers

No	**Adoption categories**	**Index score Categories**	**Frequency**	**Percent**
1	Non-adopters	0	56	39.16
2	Low adopters	0.01–0.33	8	5.60
3	Medium adopters	0.34–0.66	24	16.78
4	High adopters	0.67–1.00	55	38.46
Total			**143**	**100**

Source: Survey result, 2022

The actual adoption categories were categorized into four groups such as non-adopter, low adopter, medium adopter, and high adopter based on the adoption index. The index score is 0.00, 0.01–0.33, 0.34–0.66, and 0.67–1.00, which represents none, low, medium, and high adopters, respectively. Similar studies, Atrsaw *et al*. (2022), Jima *et al*. (2020), Bosena and Susie (2020), and others), used similar techniques. Therefore, more than half of the interviewed farmers were found under categories of medium and high adopters.

The main reasons for not adopting of improved finger millet varieties indicated in table above is due to expensiveness of seed, no need and fear of risks in 60.53%, 16.89% and 22.58% of respondents, respectively. Besides, disease, pests and shattering of the improved varieties issues caused farmers mistrusts on the technology and leads to not adopting it.

Table 9. Adoption categories of smallholder farmers across district

No	**Adoption categories**	**Daro Lebu**		**Habro**		**Gemechis**	
		Freq	%	Freq	%	Freq	%
1	Non-adopters	21	46.67	13	21.31	22	59.46
2	Low adopters	1	2.22	1	1.64	7	18.92
3	Medium adopters	5	11.11	13	21.31	5	13.51
4	High adopters	18	40	34	55.74	3	8.11
Total		**45**	**100**	**61**	**100**	**37**	**100**

Source: Survey result, 2022

Among the study districts, large numbers of high adopters were found in Habro district. The reason is that Habro is firstly ranked district in finger millet production potential and there are large numbers of finger millet producers. That is also the reason the proportion of sample size taken among the district is differ. While Gemechis district less potential in finger millet production than Habro and Daro Lebu districts.

Econometric Results

In this section factors affecting adoption decision of improved finger millet varieties and adoption intensity are presented and discussed.

Factors affecting adoption decision of finger millet Varieties

The first stage of the double hurdle model shows that land size owned, fear of risk on improved varieties, participation on demonstration, access to extension service and participation on demonstration were positively and significantly affects the probability of adoption decision of improved finger millet varieties.

As expected, land size households owned was statistically significant at 10% probability level and had a positive effect on the household adoption decision on packages of improved finger millet varieties. As one hectare increment of land sizes the probability of the decision to adopt improved finger millet varieties increase by 25.65% keeping all other variables constant. The study result is coinciding with Akwalu *et al*. (2020). This result also agrees with the findings of Degefu *et al*. (2017) which reported that production of crops like wheat is better relatively on large size of land than on small plots of land in economic gain.

Fear of risk on improved varieties was positively and significantly affects the probability of adoption of improved finger millet varieties at 1% probability of significance level. The probability of adopting improved finger millet varieties is 36.67% greater for farmers those do not fear risks to produce improved finger millet varieties than those fear its risks to produce keeping other variables constant. The study results agree with the study results of Sussie and Bosena (2020) which revealed that farmers' perception of a new specific technology on its future benefit and cost influences their adoption decisions.

Table 10. Results of Double hurdle model estimation of adoption decision and level of adoption in improved finger millet technologies

Variables	Probability of adoption			Adoption intensity		
	Coefficient	Std. Err.	Dy/dx	Coefficient	Std. Err.	Dy/dx
Age of household head	-0.0208	0.0133	-.0077	-0.0028	0.0019	-.0028
Education status	-0.2242	0.1781	-.0827	-0.0073	0.0241	-.0073
Household size	-0.0870	0.0754	-.0321	0.0257***	0.0089	.0257
Land size owned	0.6958*	0.4018	.2565	-0.0308	0.0429	-.0308
Livestock owned (TLU)	-0.0041	0.0796	-.0015	-0.0136	0.0087	-.0136
Fear of risk on improved varieties	1.0714***	0.2795	.3667	-0.0087	0.0358	-.0087
Access to credit	-0.4355	0.3733	-.1678	-0.0976*	0.0557	-.0976
Participation on demonstration	0.6741**	0.3077	.2309	0.0281	0.0397	.0281
Access to extension service	0.4390*	0.2594	.1614	0.1218***	0.0393	.1218
Fertilizer application for finger millet	0.9669***	0.3485	.3673	0.3024***	0.0569	.3024
Access to market information	-0.3447	0.2847	-.1260	0.0171	0.0395	.0171
Sex of household head	0.1207	0.7388	.0454	0.0831	0.0954	.0831
Constant	0.3733	1.0904		0.2854*	0.1423	
Sigma	0.1515***	0.0117	Number of obs	143	Log likelihood	-69.507019
Pseudo R2	0.2739		LR chi2(12)	52.45 (0.0000)	Truncated obs.	56

*, ** & *** represents significance at 10%, 5% and 1% respectively.
Source: Survey result, 2022

Finger millet responds well to fertilizer application to give good yield. Fertilizer application for finger millet was positively and significantly affects the probability of adoption of improved finger millet varieties at 1% probability of significance level. The study results indicate that the probability to adopting decision of improved finger millet varieties is 36.73% greater for farmers applying inorganic fertilizer for finger millet production than those not applying inorganic fertilizer holding all other variables at their means. This is in line with the result of Bedilu *et al*. (2021), who reported that fertilizer application decision was concurrent in decision to adopt improved bread wheat varieties.

Access to extension service was positively and significantly affects the probability of adoption decision of improved finger millet varieties at 10% probability of significance level. The study results revealed that the probability of adopting improved finger millet varieties is 16.14% greater for farmers get access of extension service than do not get access keeping other variables constant. The results are similar with Nigussie *et al*. (2022) findings indicated that farmers who had frequent extension visit are more likely to adopt improved bread wheat technologies. The results also agree with Sussie and Bosena (2020).

Technological change was the basis for increasing agricultural productivity and promoting agricultural development. Participation on demonstration was positively and significantly affects the probability of adoption decision of improved finger millet varieties at 5% probability of significance level. As farmer participate on demonstration and/ field day they would aware of the technologies and get knowledge of how to use which leads to technology adoption. The study result showed that the probability of adopting improved finger millet varieties is 23.09% greater for farmers get chances of participation on demonstration and/ field day than do not get chance keeping other variables constant. The results are coincides with the results of Susie and Bosena (2020).

Determinants of adoption intensity of improved finger technologies

The second stage of the double hurdle model shows that household size, access to credit, access to extension service and fertilizer application for finger millet were significantly affects the adoption intensity of improved finger millet technologies.

Household size was positively and significantly affects adoption intensity of improved finger millet technologies at a 1% level of significance. The result of truncated part of Double hurdle indicates that an increase of household size in a number increases intensity of adoption by 2.57% keeping the effect of the other variables constant. That is a reason of in study area most farmers produced finger millet for home consumption and the crop is high demand for food. In labor labor-intensive activity like teff production a household with high working labor force are allocate more hectares of land in a position to manage the activity (Susie and Bosena, 2020). The current findings also concur with past findings of Nigusu *et al*. (2022).

Access to credit was negatively and significantly affects adoption intensity of improved finger millet technologies at a 10% level of significance. The marginal effect implied that households whose access to credit can reduce adoption intensity of improved finger millet technologies by 9.76% than those who do not have access to credit, other things remaining constant. A reason majority of finger millet producer farmers in study area did not search/ need credit because of religions case and fear of interest. While the left were lacks its access. This result is agreed with the study result conducted by Nigusu *et al*. (2022) and Girma *et al*. (2019).

Access to extension service was positively and significantly affects adoption intensity of improved finger millet technologies at a 1% level of significance. This implied that keeping other explanatory variables at their mean level, as a farmer being access to extension service the adoption intensity of improved finger millet technologies increases by 12.18% (Table 8). This result is consistence with other adoption studies by Atrsaw *et al*. (2022) and Jerop *et al*. (2018).

Fertilizer application for finger millet was positively and significantly affects adoption intensity of improved finger millet technologies at a 1% level of significance. The marginal effect result indicated that when all other variables are at constant, as farmers applied fertilizer for finger millet their adoption intensity of improved finger millet technologies increases by 30.24% than those not applied fertilizer for finger millet. This result is agreed with the study result conducted by Demelash *et al*. (2020) which reported as organic fertilizer as positively affected the productivity of Teff.

Conclusions and Recommendations

The study was initiated to identify adoption status and factors affecting the probability of adoption and intensity use of improved finger millet varieties. Finger millet is one of the important cereal crops which are staple crops for millions of people. It was conducted in three districts of West Hararghe zone. Descriptive and econometric (Double hurdle) model were used to analyze the collected data.

Descriptive results of the study revealed that, there exists a significant variation among adopters and non-adopters in relation to fear of risks on improved varieties, household size, participation on demonstration and field days, access to extension services and fertilizer application for finger millet. Improved finger millet varieties such as Tesema, Tedesa, Boneya and Meba predominantly grown in the study area. About more than three fifth of finger millet producer farmers were adopter of improved finger millet varieties in study area.

The first hurdle result indicated that land size owned, fear of risk on improved varieties, participation on demonstration, access to extension service and fertilizer application on finger millet significantly affects the adoption decision of improved finger millet varieties producer farmers. The second hurdle result indicated that household size, access to credit, access to extension service and fertilizer application for finger millet were significantly affects the intensity of adoption of farmers those produced improved finger millet varieties.
Based on the findings of this study the following recommendations were forwarded:

- It is crucial to give special attention of fertilizer application for finger millet production by farmers because around half of non-adopters were not applied fertilizer for finger millets. Farmers ought to be used fertilizer (either organic or in organic) for finger millet productions.
- Participation on demonstration and field days were an important factor in finger millet technology adoption. Therefore, research centers, universities and agricultural office should have to be creates and strengthens experience sharing program for farmers to enhance the adoption of improved finger millet varieties.
- Access to extension positively and significantly affects the adoption decision and intensity of finger millet technologies. Thus, development agents and extension experts of agricultural office need to give attention on awareness creation for farmers on recommended seed rates of finger millet, avoiding farmers' risks fearing on improved varieties and existence of interest free credits.
- Land size household owned had the greatest impact on increasing adoption decisions of finger millet technologies. However, there is no possibility of expansion of cultivation land to increase adoption decision of smallholder farmers in the study area. Therefore, further research required to see the crop compatibility for intercrops on the available cultivated land.

References

Achandi, E.L. and Mujawamariya, G. 2016. Market Participation by Smallholder Rice Farmers in Tanzania: A Double Hurdle Analysis. Studies in Agricultural Economics, 118(1): 112-115.

Akwalu, V.M., Mbogori, S.N., Obare, G.A. and Njehia, B.K., 2020. Factors Influencing Farmer's Willingness to Adopt Pearl Millet Production in Tigania West District, Kenya. International journal of innovative research and development; 9(1):201-206.

Atrsaw Anteneh, Girmachew Siraw, and Negussie Siyum. 2022. Adoption Status and Perception of Farmers on Improved Tef Technology Packages: Evidence from East Gojjam Zone, Ethiopia. Hindawi Advances in Agriculture; https://doi.org/10.1155/2022/6121071

Bedilu Demissie, Adem Kedir, Hussien H. Komicha, Sisay Asefa, 2021. Determinants of adopting improved bread wheat varieties in Arsi Highland, Oromia Region, Ethiopia: A Double-Hurdle Approach. *Cogent Economics & Finance*; 9:1-23.

Chandio AA, Jiang Y. and Magsi H. 2016. Agricultural sub-sectors performance: An analysis of sector-wise share in agriculture GDP of Pakistan. *Int J Econ Finance* 8: 156.

Cragg, J. 1971. Some Statistical Models for Limited Dependent Variables with Application to the Demand for Durable Goods, Econometrica, 39(1): 829 – 844.

CSA (Central Statistical Authority). 2018. Central Statistical Authority: Report on Area and Production of Major Crops. Volume I.

Daro Lebu Agricultural Office (DLAO). 2021. Annual Report of 2020 of Daro Lebu Agriculture District Office. Daro Lebu district, West Hararghe Zone.

Degefu Kebede, Mengistu Ketema, Nigussie Dechassa and Feyisa Hundessa, 2017. Determinants of Adoption of Wheat Production Technology Package by Smallholder Farmers: Evidences from Eastern Ethiopia. *Turkish Journal of Agriculture - Food Science and Technology*.

Demelash Abewa, Hayimero Edmealem and Mulusew Kassa. 2020. Prevalence and Associated Factors of Agricultural Technology Adoption and Teff Productivity in Basso Liben District, East Gojjame Zone, North west Ethiopia. https://doi.org/10.1101/2020.10.28.358770

Farooq A, Ishaq M, Yaqoob S. 2007. Varietal adoption effect on wheat crop production in irrigated areas of NWFP. Sarhad J Agric 23: 481–485.

Fatima, H, Khan, MA. 2015. Influence of wheat varieties on technical efficiency and production of wheat crop in Pakistan (in selected area of Punjab). Sarhad J Agric 31: 114–122.

Feder, L., Just, R.E. and Zilberman, O. 1985. Adoption of Agricultural Innovation in Developing Countries:" A Survey" Economic Development and Cultural Change, 32(2): 255- 297

Galmesa Abebe. 2018. Adoption of Improved Soya Bean Varieties: The Case of Buno Bedele and East Wollega Zones of Oromia Region, Ethiopia. MSc. Thesis, Haramaya University, Haramaya, Ethiopia.

GCDT (Global Crop Diversity Trust). 2012. Global strategy for the ex situ conservation of finger millet and its wild relatives. Global Crop Diversity Trust, Rome, Italy.

Gemechis Agricultural Office (GAO). 2021. Annual Report of 2020 of Gemechis Agriculture District Office. Gemechis district, West Hararghe Zone.

Getahun Dereje, Tigist Adisu and Bekele Anbessa, 2016. nfluence of Row Spacing and Seed Rate on Yield and Yield Components of Finger Millet at Assosa Zone in Benshagul Gumuze Region of Ethiopia. *Journal of Biology, Agriculture and Healthcare*; 6(5):42-45.

Girma Gezimu, Hiroshi Isodab, Dil Bahadur Rahutc, Yuichiro Amekawad and Hisako Nomura. 2019. Gender differences in the adoption of agricultural technology: The case of improved maize varieties in southern Ethiopia. Women's Studies International Forum; 76:1-11.

Greene, J.C. 1997. Evaluation as Advocacy, Evaluation Practice. 18: 25-35.

Habro Agricultural Office (HAO). 2021. Annual Report of 2020 of Habro Agriculture District Office. Habro district, West Hararghe Zone.

Jerop, R., Dannenberg, P., Owuor, G., Mshenga, P., Kimurto, P., Willkomm, M. and Hartmann, G. 2018. Factors affecting the adoption of agricultural innovations on underutilized cereals: The case of finger millet among smallholder farmers in Kenya. *African Journal of Agricultural Research*; 13(36): 1888-1900.

Jima Degaga, Gosa Alemu and Birhanu Angasu. 2020. Factors affecting adoption of improved haricot bean (Phaseolus Vulagris L) technology in West Hararghe zone of Oromia region, Ethiopia: A Heckman two-step approach. *TropicalAgriculture*; 97(4):253-267.

Molla F. 2012. Participatory evaluation and selection of improved finger millet varieties in North Western Ethiopia. *International Research Journal of Plant Science*, 3(7): 141-146.

Negussie Siyum, Almaz Giziew and Azanaw Abebe. 2021. Factors influencing Adoption of improved bread wheat technologies: a double hurdle approach in Northern Ethiopia. : https://doi.org/10.21203/rs.3.rs-275768/v1

Negussie Siyum, Almaz Giziew and Azanaw Abebe. 2022. Factors influencing adoption of improved bread wheat technologies in Ethiopia: empirical evidence from Meket district. Heliyo, 1-11.

Nigus Gurmis. 2018. Market Chain Analysis of Teff: The Case of Merhabete District, North Shewa Zone, Amhara National Regional State of Ethiopia. MSc. Thesis, Haramaya University, Haramaya, Ethiopia.

Padulosi S, Thompson J, Rudebjer P. 2013. Fighting poverty, hunger and malnutrition with neglected and underutilized species: Needs, challenges and the way forward. Biodiversity International https://cgspace.cgiarorg/bitstream/handle/10568/68927.

Pingali PL. 2012. Green Revolution: Impacts, limits, and the path ahead. Proceedings of the National Academy of Sciences 109(31):12302-12308.

Susie Teshome and Bosena Tegegne, 2020. Determinants of Adoption of Improved Teff Varieties by Smallholder Farmers: The Case of Kobo District, North Wollo Zone, Amhara Region, Ethiopia. *International Journal of Agricultural Economics*; 5(4): 114-122

Susie Teshome and Bosena Tegegne. 2020. Determinants of Adoption of Improved Teff Varieties by Smallholder Farmers: The Case of Kobo District, North Wollo Zone, Amhara Region, Ethiopia, International Journal of Agricultural Economics, 5(4): 114-122.

Tadele Z. and Assefa K. 2012. Increasing food production in Africa by boosting the productivity of understudied crops. Agronomy 2(4):240-283.

Yamane, T. 1967. Statistics, An Introductory Analysis 2nd Edition. New York.

Yayeh Bitew and Fekremariam Asargew, 2014. Determination of Seed Rate and Inter Row Spacing for Finger Millet Production (Eleusine Coracana Gaertn.) in North Western Ethiopia. *International Journal of Research & Review*; 1(4):1-7.

Yonas Kassahun, Mengistu Ketema and Zekarias Shumeta. 2020. Determinants of Participation Decision and Levels of Participation in Small Ruminants Market. Sustainable Agriculture Research, 9(1):56-66.

Appendice

Appendix table 1: VIF of independent variables

Variable	VIF	1/VIF
Hhsize	1.42	0.702975
Landsize	1.38	0.723514
Fertilizer_n	1.35	0.739187
Age	1.33	0.752243
Mktinfo_n	1.26	0.792336
Demopart_n	1.25	0.798647
Educstat	1.19	0.841702
Extenacces~n	1.14	0.879155
TLU	1.12	0.894902
Riskimprov	1.11	0.902925
Sex_n	1.09	0.913877
Creditacce~n	1.03	0.971081
Mean VIF	1.22	