

**ANALYSIS OF FISH VALUE CHAIN AND POST-HARVEST LOSS:
THE CASE OF LAKE HAWASSA, SOUTHERN ETHIOPIA**

M.Sc. THESIS

TEKALIGN TULUKA TUNSISA

NOVEMBER 2019

HARAMAYA UNIVERSITY, ETHIOPIA

**Analysis of Fish Value Chain and Post-Harvest Loss: The Case of Lake
Hawassa, Southern Ethiopia**

**A Thesis Submitted to School of Agricultural Economics and
Agribusiness, Postgraduate Program Directorate**

HARAMAYA UNIVERSITY

**In Partial Fulfillments of the Requirements for the degree of MASTER
OF SCIENCE IN AGRICULTURE (AGRIBUSINESS AND VALUE
CHAIN MANAGEMENT)**

Tekalign Tuluka Tunsisa

November 2019

Haramaya university, Haramaya

HARAMAYA UNIVERSITY

POSTGRADUATE PROGRAM DIRECTORATE

As the Thesis Advisor, We hereby certify that we have read and evaluated this Thesis entitled “Analysis of Fish Value Chain and Post-harvest Loss: The Case of Lake Hawassa, Southern Ethiopia”. We recommend that it be submitted as fulfilling the Thesis requirement.

Ketema Bekele (PhD)

Major advisor

Signature

Date

Kumilachew Alamerie (Assistant Prof.)

Co- advisor

Signature

Date

As members of the board of examiners M.Sc. Thesis Open Defense Examination we certify that we have read and evaluated the Thesis prepared by Tekalign Tuluka and examined the candidate. We recommend that the Thesis be accepted as fulfilling the Thesis requirement for the Degree of Master of Science in Agriculture (Agribusiness and Value Chain Management).

Chairperson

Signature

Date

Internal Examiner

Signature

Date

External Examiner

Signature

Date

DEDICATION

I dedicated the manuscript of this Thesis to my parents Tuluka Tunsisa and Tewabech Kebede, and my brother Ashagre Tuluka for their endless support, encouragement, precious advice, partnership and lovely actuate in the success of my academic career.

STATEMENT OF THE AUTHOR

By my signature below, I declare and affirm that this Thesis is my own work. I have followed all ethical and technical principles of scholarship in the preparation, data collection, data analysis and compilation of this Thesis. Any scholarly matter that is included in the Thesis has been given recognition through citation.

This Thesis is submitted in partial fulfillment of the requirements for M.Sc. degree at the Haramaya University. The Thesis is deposited in the Haramaya University library and made available to borrowers under the rules of the library. I solemnly declare that this Thesis has not been submitted to any other institutions anywhere for the award of any academic degree, diploma or certificate.

Brief quotations from this Thesis may be made without special permission provided that accurate and complete acknowledgement of the source is made. Requests for permission for extended quotations from or reproduction from this Thesis in whole or in part may be granted by the Head of School or Department when in his or her judgment the proposed use of the material is in the interest of scholarship. In all other instances, however, permission must be obtained from the author of the Thesis.

Name: Tekalign Tuluka Signature _____

Date: August 2019

School/Department: Agricultural Economics and Agribusiness

BIOGRAPHICAL SKETCH

The author was born in South Region, Sidama Zone, Yaye town on January 10, 1996. He attended his primary education (1-8) from 2002 to 2010 in Arbegona Ku'nicha primary school, and secondary and preparatory education in Arbegona secondary and preparatory school from 2011 to 2014.

Then the author joined Haramaya University, College of Agriculture and Environmental Sciences in 2015 and graduated in June 2017 with a B.Sc. degree in Agribusiness and Value Chain Management. Soon after graduation, he was employed by Haramaya University, College of Agricultural and Environmental Science in School of Agricultural Economics and Agribusiness as graduate assistant. Finally, he joined the Postgraduate Program Directorate of Haramaya University in October 2017 to pursue his Masters study in Agribusiness and Value Chain Management.

ACKNOWLEDGEMENT

First and foremost, I extend my unique glory to Almighty God for his presence with me, giving me peace, and health, patience, and power, protecting me from any danger, leading me in a right journey.

My deepest gratitude goes to my major advisor Dr. Ketema Bekele for his unreserved effort, attention, smooth relationship, constructive comments and suggestions on the entire documents. Then I would like to extend my special thanks to Mr. Kumilachew Alamerie for his endless encouragement, kindness, conscious advice, productive comments and suggestion in all Thesis work aspects. They directed and guided me to enable to complete the Thesis task early. Their patience during editing and commenting the document was remarkable to equip me with precious paper.

My special appreciation goes to Fishers, Traders, Cooperatives, Processors and Hotels of Hawassa city and the surroundings, for their time devotion and offering necessary data during data collection period. I am also happy to thank Hawassa city, Sidama Zone and Oromia Region Fishery office for providing necessary data and facilitation.

I would like to express my appreciation to my friends specially Ayantu Arage, Kassa Kebede, Mesafint Mathews, Dereje Yonas and Shelema Refera for their assistance, unforgotten support, presence and encouragement during data collection and analysis. I am grateful to my family specially, Tuluka Tunsisa, Tewabech Kebede, Ashagre Tuluka, Mirtinesh Tuluka and Ashebir Tuluka.

The last but not the least, my deep sense of gratitude goes to Mr. Teshome Lenjisa for his facilitation of academic opportunity and encouragement. It is my great pleasure to extend my appreciation to Haramaya University which financially support me and facilitate the study process. I am also very well indebted to all who threw the stone of help upon me until completion of the Thesis work.

ACRONOMYS AND ABBREVIATIONS

BOA	Bureau of Agriculture
CSA	Central Statistical Agency
EIAR	Ethiopian Institute of Agricultural Research
FAO	Food and Agricultural Organization
FMS	Fish market supply
FPME	Fish Production and Marketing Enterprise
GAEPAS	Gap Analysis of the Ethiopian Protected Areas System
HFO	Hawassa Fishery Office
ILRS	International Livestock Research Sector
LMP	Livestock Master Plan
MEA	Millennium Ecosystem Assessment
MoA	Ministry of Agriculture
MoE	Margin of Error
NBE	National Bank of Ethiopia
N ₀	Number of Respondents
NMAR	National Meteorology Agency Records
ORFO	Oromia Region Fishery Office
PES	Pakistan Economy Survey
PHL	Post-harvest Losses
SFPSS	Shashemene Fish Production Sub-Sector
SWFA	State of World Fishery and Aquaculture
SZFO	Sidama Zone Fishery Office
UNDP	United Nation Development Programme
VC	Value Chain

TABLE OF CONTENTS

Content	Page
DEDICATION	iv
STATEMENT OF THE AUTHOR	v
BIOGRAPHICAL SKETCH	vi
ACKNOWLEDGEMENT	vii
ACRONOMYS AND ABBREVIATIONS	viii
LIST OF TABLES	xii
LIST OF FIGURES	xiii
LIST OF TABLES IN THE APPENDIX	xiv
ABSTRACT	xv
1. INTRODUCTION	1
1.1. Background of the Study	1
1.2. Statement of the Problems	3
1.3. Objectives of the Study	5
1.4. Research Questions	6
1.5. Scope and Limitations of the Study	6
1.6. Significance of the Study	6
2. LITERATURE REVIEW	7
2.1. Basic Concepts and Definitions	7
2.2. Value Chain Analysis	9

TABLE OF CONTENTS (CONTINUED)

2.2.1. Governance	9
2.3. Consumption Habit of Fish in Ethiopia	9
2.4. Post-harvest Losses of Fish	10
2.5. Challenges of Fish Value Chain in Ethiopia	15
2.6. Theoretical Review	18
2.7. Empirical Review	21
2.8. Conceptual Framework of the Study	23
3. RESEARCH METHODOLOGY	25
3.1. Description of the Study Area	25
3.2. Data Type, Sources and Methods of Data Collection	26
3.3. Sampling Procedures and Sample Size	26
3.4. Methods of Data Analysis	28
3.4.1. Descriptive Statistics	28
3.4.2. Econometric Analysis	32
3.5. Variables Definition and Hypothesis	35
3.5.1. Dependent Variable	35
3.5.2. Independent Variables	35
4. RESULTS AND DISCUSSIONS	40
4.1. Demographic and Socio-economic Characteristics of the Fishers	40
4.2. Demographic and Socio-economic Characteristics of the Traders	42
4.3. The Fish Value Chain Analysis	43

TABLE OF CONTENTS (CONTINUED)

4.4. Market Structure- Conduct and Performance of Fish	52
4.4.1. Market Structure	52
4.4.2. Fish Market Conduct	56
4.4.3. Performance of Fish Market	60
4.5. Fish Post-harvest Loss along the Value Chain	64
4.6. OLS Model Result	69
4.7. Challenges and Opportunities along the Fish Value Chain	73
5. SUMMARY, CONCLUSION AND RECOMMENDATION	78
5.1. Summary and Conclusion	78
5.2. Recommendation	80
6. REFERNCES	82
7. APPENDICES	97

LIST OF TABLES

Table	Page
1: Summary of Variables Definition, Measurement and Hypothesis for Fish Supply	39
2: Summary Statistics of Characteristics of Sample Fishers (Continuous Variables)	41
3: Summary Statistics of Characteristics of Sample Fishers (Categorical Variables)	42
4: Summary Statistics of the Characteristics of Traders (Continuous variables)	42
5: Calculation of Market Concentration Ratio	54
6: Herfindahl-Hirschman Index of the 24 Traders	55
7: Fish Harvesting, Consumption, Disposal and Selling Pattern in the Study Area	57
8: Traders Sources of Information	58
9: The Place Where the Traders sell Fish	59
10: Cost of Operating and Marketing of Fish (Birr/kg)	60
11: Marketing Costs	61
12: Fish Marketing Margin for key Actors (Birr/kg)	61
13: Response of Fishers on Post-harvest Loss Patterns	65
14: The Average Post-harvest loss per kg per day of three Sites	66
15: Causes of Fish Post-harvest Loss at Fishing Level	67
16: Causes of Post-harvest Loss at Marketing Level	68
17: The average fish post-harvest loss of traders	68
18: Determinants of Fish Market Supply (OLS result)	70
19: Constraints that hindering fishers at Lake Hawassa	74
20: The Constraints of Traders along the Value Chain	76

LIST OF FIGURES

Figure	Page
Figure 1: Conceptual Framework of the Study	24
Figure 2: Map of the Study Area	26
Figure 3: Value Chain Map in the Study Area	48
Figure 4: Marketing Channel of Fish market	51

LIST OF TABLES IN THE APPENDIX

Table	Page
1: Test for Multicollinearity	97
2: Test for Multicollinearity	97
3: Test for Omitted Variables	97
4: Test for Heteroscedasticity	97
5: Facility Owned by Fishers of Lake Hawassa	98
6: Categorization of Lake Hawassa Fish in Rank	98
7: Fish Harvested and Supply Volume of Lake Hawassa	98
8: Conversion Factor for Fish to Kilogram	99
9: Conversion Factor for Adult Equivalent	99

ABSTRACT

Fish provides nutrients that are essential to cognitive and physical development, and an important part of healthy diet. However, fish post-harvest loss, resource tragedy, overfishing, low management and traditional fish harvesting practices are discouraging fish market supply and fishers profitability. Therefore, this study was sought to analyze fish value chain and post-harvest loss of Lake Hawassa. The study used cross-sectional data from representative fishers of 166 and key informants. Additionally, data were collected from 10 traders, 5 fisher cooperatives, 4 processors, 5 hotels and 10 consumers. Both descriptive and OLS model were employed to analyze the data. Fish market of Lake Hawassa was characterized as loose oligopoly which reflects that there was concentration of resource and power. According to the result, quality, quantity and market force loss of fish were identified as influential on fish supply and actor's income. Quantity loss was more significantly affecting fish supply along the value chain. Quantitatively, 6.76, 0.93 and 1.79 kg/day of quantity, quality and market force loss were occurring, respectively. The performance of fish market was computed by using the indicators of marketing margin. Accordingly, the average cost and price of fish per kg were 7.75 and 48.1 birr, respectively. This indicates that the profit was significant to the fishers. The model indicated that market information, household education, fishing experience, owning of cold storage, credit access, fishing site and post-harvest loss affected the fish supply significantly. Accessing market information, household education, credit facility, cold storage, and experience sharing are indispensable for better fish supply.

Keywords: Value Chain Analysis, Lake Hawassa, Fish Market Supply, OLS Model, Post-harvest Loss, Southern Ethiopia

1. INTRODUCTION

1.1. Background of the Study

Fishery and aquaculture provides source of food, income generation, promote economic development as well as reducing poverty (Smith *et al.*, 2005). It also provides food and nutrition security, as food security becomes a major global concern (Aklilu, 2018; FAO, 2016b). The farming of aquatic organisms, including fish, mollusks, crustaceans and aquatic plants, is a major means of global meat production, ranked fourth after pig, poultry and beef and buffalo (FAO, 2011). According to SWFA (2008) investigation, aquaculture continues to be the fastest food-producing sector to outpace population growth.

In 2012, farmed food fish contributed 66.6 million tons, equivalent to 42.2 percent of the total 158 million tons of fish produced by capture fisheries (FAO, 2014). World food fish production rose by 5.8 percent during the period 2001–2016 (FAO, 2018). The global capture fisheries production peaked at about 171 million tonnes in 2016, with aquaculture representing 47% of the total and 53%, if non-food uses (FAO, 2018). In Pakistan out of 21.4% of GDP, fishery contributed 2.05 % (PES, 2012-13). African contribution to the total aquaculture production in 2008 was 8.1 million tons; a few countries like Egypt surpassed 1 million tons (1, 017, 738 tons) of annual aquaculture production (FAO, 2014 and Erik, 2010). In 2010, Ethiopia realized about USD 14 million from its capture fishery which were positively impacted fishery sector (Dagninet *et al.*, 2018).

Inland catches are important food sources for several countries in Africa, which accounts 25% of global inland catches (FAO, 2018). Fishery is the main source of protein supply for people to fulfill demand and minimize malnourishment (Abegaz *et al.*, 2010b, 2010c; Tesfaye and Wolff, 2014). Ethiopia is potentially endowed with inland water lakes and rivers for fish production (Tujuba *et al.*, 2016). Hence, in Ethiopia, fish production mainly captured from natural lakes and rivers, artificial reservoirs (Abebe and Sileshi, 2015).

Food security and poverty reduction have been central to national development agenda. Population growth, changes in the national economy, technology and states of the environment, changes the patterns of food demand (Grafton, 2015). Hence, fish is the matter to all these food security and poverty reduction by providing food and nutrition (protein, minerals and micronutrients) and generating income. Since lakes, rivers and reservoirs are the critical sources for fish production and harvesting. There are 180 different species of fish in Ethiopia and 30 of those are native to the country (Reyntjens and Wudneh, 1998). Though in commercial production lake namely Chamo, Ziway and Tana, the main species are Nile tilapia, Nile perch, barbus and catfish (Nigusse, 2018). In lake Hawassa, commercial fish species are Nile tilapia and catfish (Sairam, 2016).

Despite of its importance, Ethiopians per-capita consumption of fish from the capture fishery is less than 240 grams per year, which is very small in Sub-Saharan Africa (FAO, 2012). Production remains promising than an actual practice even though presence of diverse agro-ecologies, water resources and availability of fish species (Aklilu, 2018). In Ethiopia, although conducive environment facilitates fish production and supply, there are significant post-harvest losses due to spoilage, breakage, size, discarding by catch and operational losses (Brook, 2012).

Further, as the distribution chain of fresh fish is relatively short due to the nature of the product and poor storage/preservation methods, most fishers sell their catch to retailers near to harvesting area to minimize the loss of fish due to spoilage (Abebe *et al.*, 2016). To improve food security, reduction of post-harvest losses in different distribution stages and increase income generation, strategic intervention could be involved (FAO, 2010; Kumolou *et al.*, 2011). It is possible to lower post-harvest losses at all stages of fish handling hence, this can increase the tonnage of fish reaching the consumers (Yared, 2012).

1.2. Statement of the Problems

In Ethiopia, agriculture has been the basic driver of economic growth and contributor to long-term food security. Agriculture sector comprises Livestock, fishery and crop sub sectors. The sector accounts about 42 percent of the GDP, contributes around 90% of the total export earnings and 85 percent of the labor force in Ethiopia (CSA, 2017/18). However, it seems that the government of Ethiopia stipulates on livestock and crop sectors though neglecting fishery sector thus, diminishing fish production and supply sustainability.

The government of Ethiopia focuses on commodities like dairy, large and small ruminants and poultry. Even to balance red meat production-consumption gap, the government of Ethiopia designed Livestock master plan (LMP) to fulfill by poultry sector excluding fishery sector (Shapiro, 2015). With fewer policies, strategy and plan designed and implemented to fishery sectors related with low government financial support, fishery sector dramatically decreased. Therefore, fishing practice in Ethiopia remains infant (Abebe *et al.*, 2015).

Nevertheless, currently, significant fishing practice has been identified in the water bodies of Rift Valley lakes which includes Lake Chamo, Abaya, Hawassa, Langano and Ziway and the northern part of Lake Turkana, Tana, and reservoirs such as Koka and Fincha Dams (Bikila, 2016). As Abebe *et al.* (2016) found out, commercial scale fishing was dominantly practiced in Lake Ziway, Hawassa, Chamo and Tana.

More fish consumed in areas where the product is more available, in the vicinity of the lakes (FAO, 2016). Local fish productions donot satisfy demands of big cities and towns (Assefa, 2014). In order to meet this demand, the country imports significant amounts of fish from neighboring countries (Yared, 2012).

Due to poor handling practices during harvesting and transporting fish to the processing plant, tilapia fish is showed higher bacteria load (Shimelis and Mekonnen, 2010). Again, weak packaging and handling practices expose the product to the post-harvest loss. They suggested that, to upgrade the quality of the Nile tilapia, proper fish processing practices, application of modern fishing equipment, fish catching method and appropriate packaging

and storage facility has been undertaken. To reduce poverty and food insecurity, the role of inland fishery sector is indispensable (Suuronen and Bartley, 2014).

In Ethiopia, fishing is practiced in various lakes, rivers and artisanal. Lake Hawassa is one of the fishing sites of the country with surface area of 90 km² and mean value 11 m (Tadesse *et al.*, 2014). According to Aytegeb (2013), Lake Hawassa has potential of 600 tons per year to harvest fish. However, 512 tons per year was realized which is under its production potential. In Lake Hawassa, due to overfishing of large fish species, there has been gradual shift in fish capture from mature to immature (Sairam, 2014).

In spite of most population demands fish product during normal and fasting period, the consumption of product was very low due to different reason including post-harvest losses (Tujuba *et al.*, 2015). Desta *et al.* (2008) identified that in Hawassa, wastes from urban areas and referral hospitals, drain to the Lake. Those industrial wastes dropped continuously in the lake leading to water contamination and allergic which causes fish unhealthy and discourage supply.

It is also noted that parasitic diseases occur because of poor water quality (Lemma, 2017). Spoilage, therefore, is the indicative of post-harvest loss (Hui, 2006). Post-harvest losses negatively affect fish product supply, which lead to product price increment. According to FAO (2000), Ethiopia faces the most pressing problems in feeding her population. Improving the volume of fish supply to the market and livelihoods of the fishers may ensure food security (Asseffa, 2014; Abebe *et al.*, 2016; Bikila and keno, 2016 and Eshete *et al.*, 2011).

In Lake Hawassa only few studies were conducted on the issues. Shimelis and Mekonnen (2010), Desta (2008) and Abebe *et al.* (2012) conducted researches in Lake Hawassa on habitat use and trophic position to determine mercury concentration, fish biology and the composition of fish communities of nine Ethiopian lakes along a north-south gradient: threats and possible solutions, respectively. Negese *et al.* (2015) observed that, the annual total yield of tilapia during 2014 was 182.94 tons and it generates total revenue of 4,158,759.60 ETB for the fishermen who work as members of the cooperative. However, this study only focused on tilapia yield by missing other fish species annual yield. The study by Sairam (2016) of

Lake Hawassa identified only the fish production and marketing of Amoragedel villages which do not articulate the total supply volume of the Lake because of missing two other site harvesting amount such as Tikurwuha and Dorebafano.

Recently, the government of Ethiopia planned and designed intervention to improve fishery sector with good commercialization of fish across the country. Establishing fishery sector independently from other agricultural sector creates good opportunity to fish value chain. Food security to subsistence growing population need fast food production thus, fish is one of the aquatic animal with significant protein, minerals and micronutrients.

Therefore, better fish production, supply, marketing and distribution are needed to improve household livelihood, income generation, promote economic growth and ensure food security. Therefore analyzing fish value chain and post-harvest loss of Lake Hawassa was necessitated to identify how well the fish of the Lake is commercialized, the main actors, and their roles, analyze the factors that determine the volume of fish supply, identify the fish market performance and finally, identify constraints and opportunities along the fish value chain.

1.3. Objectives of the Study

The overall objective of the study is to analyze fish value chain and post-harvest losses in Lake Hawassa.

Specifically, the objectives of the study are:

1. To identify the fish value chain actors, their functions and linkages;
2. To measure fish market performance;
3. To assess the post-harvest losses of fish along the value chain; and
4. To identify the factors that affect the volume of fish supply to the market

1.4. Research Questions

This study was try to answer the following research questions

- What are the major fish value chain actors and their functions?
- What do the linkages, marketing costs and market shares in the markets look like?
- What do post-harvest losses look like along the value chain?
- What are the factors that affect the volume of fish supply in the market?

1.5. Scope and Limitations of the Study

Fish value chain comprises all activities that bring a product from conception to consumption. This study was conducted in Lake Hawassa toward fish market from input supply to consumption. The study assessed the fish value chain and post-harvest losses of Lake Hawassa. The analysis comprised of fishermen, fisher's cooperative, processors, traders, hotels/cafe and consumers. As the study intended on Hawassa city value chain entities, it does not reach other place actors to identify all value chain related aspects of fish. Secondary source of data was not fully available for time series data. During consumer information gathering, new consumers of fish might, not give accurate information.

1.6. Significance of the Study

This study will be vital to fish value chain entities to take necessary measure to reduce post-harvest losses and improve the volume of fish marketed supply. Fishery sector could also need to set measure toward fishing and marketing of fish. Policy and regulatory body may use the findings to design policy, set measure, rule and regulation to safeguard Lake, Fishermen as well as fish species. The Government used to identify the status of actual fish supply of Lake Hawassa to outface population, value chain hindering factors, set budget to implement measure and policy to improve effectiveness of value chain and build food and nutrition security in the country. Finally, the finding may help as a guideline to other researches and prepare teaching materials.

2. LITERATURE REVIEW

This chapter deals with basic terminology and their definition; consumption habit; causes and types of post-harvest losses and theoretical, conceptual and analytical framework. This section also comprehends challenges and opportunity along the fish value chain. Finally, it states previous research results on related topics.

2.1. Basic Concepts and Definitions

Fish: Fishes can be categorized into one of two groups according to their skeleton-type: cartilaginous fishes (Superclass Chondrichthyes) or bony fishes (Superclass Osteichthyes) (Nelson, 2006). Fishes are valuable laboratory animals in many aspects of medical and biological research. Reason for interest in fishes is their role as a moderate but important part of the world's food supply. Fish is an excellent source of animal protein and a wide range of essential nutrients and contributes significantly to food security (FAO, 2016).

Fishery is defined generically as a system composed of three interacting components: the aquatic biota, the aquatic habitat, and the human users of these renewable natural resources (Lackey, 2006). It is an entity engaged in raising or harvesting fish which is determined by some authority to be a fishery (Fletcher *et al.*, 2002). Fishery is typically defined in terms of the "people involved, species or type of fish, area of water or seabed, method of fishing, class of boats, purpose of the activities or a combination of the foregoing features (Madden *et al.*, 2004). Fisheries are locally important sources of food, trade and income in many developed and developing coastal nations (Karataş and Karataş, 2017).

Value Chain: The term 'Value Chain' was used by Michael Porter in his book "Competitive Advantage: Creating and Sustaining Superior Performance" (1985). It is the sequence of activities required to make a products and/or a services (Vermeulen *et al.*, 2008).

The Value Chain Analysis describes the activities the organization performs and links them to the organizations competitive position (Recklies *et al.*, 2001). Fish value chain analysis is the assessment of a portion of an economic system where upstream agents in production and

distribution processes are linked to downstream partners by technical, economic, territorial, institutional and social relationships (FAO, 2013). Value chain analysis of fish is identifying the basics of value addition, processing techniques, infrastructure tool, weakness and threats over fish and fish product outreach.

Fish Value Addition: is one aspect of marketing that deals with practices that change or transform a primary product into goods that have additional value (Addisu, 2016). The formers are cleaning, gutting, dressing, deskinning, grading, bulking and storage; these activities are conducted by the control of fishers. The latter are mixing, cooking, packaging, transporting, distribution and deliverance are undertaken by market chain actors and/or service providers (Muluken, 2014). Fish processing is a value addition process to raw fish. Fish processing involves a series of tasks such as: receiving, sorting, filleting, weighing and packaging, eco-labeling and cold storing (Ameha and Ashine, 2015).

Value Chain Actors: It may include input suppliers, producers, collector/assembler, processor, wholesaler, retailer, and consumers (Kaplinisky and Morris, 2001). They can be those which directly involved in the chain activity (Fishers, Fishers cooperatives, processors, traders, wholeaser, hotels/cafe and consumers) or indirectly who offer financial and/or non-financial support services, such as credit and loan agencies, business service, research and extension services (KIT *et al.*, 2006). According to Gwary (2014) the main value chain actors in the fisheries activities consist of the Fishers (40%), Marketers (40%) and Processors (20%) in the study are Lake Alau, Borno State, Nigeria.

Market Supply: it refers to the amount actually taken to the markets irrespective of the needs for home consumption and other requirements (Wolday, 1994). Willingness and ability to supply goods determine the seller's actions. The suppliers will be able to maintain a profit despite the higher costs of production that may result from short-term expansion of their capacity (Whelan and Msefer, 1996).

Marketing Channel: Marketing defined as all processes involved starting from the production of a commodity until it gets to the final consumer (Crammer *et al.*, 2001). Marketing channel can be defined as an array of exchange relationships that create customer

value in the acquisition, consumption, and disposition of products and services (Pelton *et al.*, 2016). It consists of individuals and firms involved in the process of making a product or service available for use or consumption by consumers or industrial users (Berkowitz *et al.*, 2000).

2.2. Value Chain Analysis

2.2.1. Governance

Governance ensures that interaction between firms along a value chain exhibit some reflection of organization rather than being simply random (Evans and Wurster, 2000). Value chains are governed when parameters requiring product, process, and logistic qualification are set, which have consequences up or down the value chain, encompassing bundles of activities, actors, roles, and functions (Gereffi, 1994). Buyer-driven chains are characteristics of labor intensive industries and therefore highly relevant to developing countries such as footwear, clothing, furniture and toys. Whereas producer driven chains are more likely to be characterised by foreign direct investment (FDI) than are buyer-driven chains (Gereffi, 1999b). Here producers take responsibility for assisting the efficiency of both their suppliers and their customers. The final characteristic of governance concerns its depth and pervasiveness, which is its “richness” and “reach” (Evans and Wurster, 2000).

2.3. Consumption Habit of Fish in Ethiopia

Ethiopians do not consume large quantities of fish, although there is no religious prohibition for the Christian and Muslim populations. Most Christians considers fish acceptable during fasting periods, except some strict followers who not eat any animal products (Abera, 2010 and Brook 2008). Although per capita consumption of fish is generally very low in Ethiopia, there is steady growth in demand for food fish which is attributed to growing human population however; degradation of fisheries and the Lake resources usually starts with over-population followed by over-exploitation of the resources (Desta *et al.*, 2008).

Likely, the rapid growth of population and the progressive shortage of livestock products had changed the situation to a growing demand of fish and the demand for fish is higher than supply especially, in Ethiopian fasting season (Asseffa, 2014). Population rise, urbanization, agricultural development, industrialization and other water resource development ventures have contributed to the decrease in the species diversity of freshwater fish thus, reduce fish type consumed (Dereje, 2014). Fish is one of the major means of global meat production. For example, farmed fish ranked 4th in terms of global meat production after pig, poultry and beef and buffalo (FAO, 2011).

2.4. Post-harvest Losses of Fish

The term “post-harvest loss” - refers to measurable quantitative and qualitative food loss in the postharvest system (de Lucia and Assennato, 1994). Post-harvest losses have eventually resulted in farmers receiving very low prices for their produce while at the other end the consumers are compelled to pay a highly inflated price for their purchases (Hettige and Senanayake, 1992; Kodithuwakku, 2000). Despite of such nutritional importance, fish is highly perishable food, which could be rendered unfit for human consumption within twelve hours of capture at tropical temperature condition (Fellows and Hampton, 1992; Kuje *et al.*, 2011).

The quality of fish and its usefulness has affected by the capture method, handling practices, processing methods, distribution techniques and storage conditions (Davies, 2009). Consequently, Losses of quantity (weight or volume) and quality (altered physical condition or characteristics) can occur at any stage in the post-harvest chain. Quality losses include those that affect the nutrient/caloric composition, the acceptability, and the edibility of a given product. These losses are generally more common in developed countries (Kader, 2002). Quantity losses refer to those that result in the loss of the amount of a product. Loss of quantity is more common in developing countries (Kitinoja and Gorny, 2010).

In Kenya, physical and quality losses vary with the season, with high losses occurring during peak harvesting season (March to August) for sardine traders, August to October for tilapia traders, and April, May and August to October for Nile perch agents. As Teklu (2017)

investigation, Ethiopia losses one-third of its annual production and this was about 10,000 tons of fish per annum among 28,000 tons of production. This loss has often caused by biochemical and microbiological spoilage changes that occur in fish after death. Physical, quality and market force losses occur throughout the post-harvest chain from harvesting to consumption result in income lost and contribute to food insecurity.

The main type of losses encountered in fish are Physical, quality and market force loss. Physical fish loss refers to fish that, after capture or landing, is not used. It has thrown away accidentally either voluntary or authorized. Physical loss might cause by theft, insects, bird and/or animal predators (Diei-Ouadi and Mgawe, 2011). Quality loss refers to fish that has undergone changes owing to spoilage or physical damage and has suffered quality deterioration. Such fish is sold for a lower price than which would have been achieved if the fish were of “best quality” (Diei-Ouadi and Mgawe, 2011).

The quality loss incurred by fish smokers after purchase and just before smoking using the Chorkor oven in Ghana ranged between 11 and 17 percent due to long bargaining/auctioning of poorly- or non-iced fish market force loss is a loss caused by unexpected market demand and supply situations. These cause operators to sell their product at a price below expectations. The loss is the difference between the expected price and the actual price (Diei-Ouadi and Mgawe, 2011).

An economic loss refers the losses of material inevitably involve a loss in value, as the fisherman, processor, or distributor has less weight of material to sell (Ames, 1990). Consumers pay more for fish, which is in good condition. The relative value of good/fair/poor quality fish is a complicated matter and varies between countries and places. The latter are often lower income groups who may not be able to afford other protein foods richer in lysine, so this would appear to be a problem of some significance (Ames *et al.*, 1991).

The recurrent causes of losses have reported to be poor handling of fish, inadequate fish icing, processing techniques and transport conditions. Nevertheless, losses intimately linked to the upstream post-harvest practices, the socio economic context and several contributing factors. Spoilage begins as soon as the fish dies. Therefore, hygienic handling should employ to

extend its shelf life (FAO, 2004; Ghaly *et al.*, 2010). Toxic substances elaborated by molds (known as mycotoxins) cause loss in food quality and nutritional value. Currently, sardines have dried on rocks, nets and beach with limited application of new and modern technology to improve quality of products in the post-harvest chain. Consequently, current traditional sun-drying method is associated with a lot of quality problems like product spoilage through fat hydrolysis and protein proteolysis (Dampha, 1992; Venugopal, 2002). Spoilage of fish takes place within 12 hours in the high ambient temperatures of the tropics (Kabahenda *et al.*, 2009; Kuje *et al.*, 2011).

Biological causes: Different metabolic processes can render fish undesirable or unacceptable for human consumption due to changes in sensory characteristics (Burkepile *et al.*, 2006). In the fish, bacteria grow very rapidly producing undesirable odours and flavours as a result of fat oxidation and protein degradation (Johnston *et al.*, 1994; Gram and Dalgaard, 2002; Venugopal, 2002; Bataringaya, 2007; Diei-Ouadi and Mgawe, 2011). Biological causes of deterioration include respiration rate, ethylene production and action, rates of compositional changes (associated with color, texture, flavour, and nutritive value), mechanical injuries, water stress, sprouting and rooting, physiological disorders, and pathological breakdown.

Equipment and infrastructure: The use of drying racks in Uganda has resulted in a reduction in loss to negligible level as compared with the high level of losses of sardine (Gbola and Yvette, 2010). Lack of financial capital and human resources (knowledge and experience) associated with inadequate quality raw materials are the most contributing factors to deficient quality of fish and fishery products (Burkepile *et al.*, 2006). The type of fishing gears used also influences the occurrence of losses in the fishing ground. **Environmental factors:** Climatic conditions including wind, humidity, rainfall, and temperature influence both the quantity and quality of a fish harvest (Grolleaud, 2002).

The remedies include: the use of modern and improved preservation and processing methods such as smoking, drying, chilling, freezing, salting, and canning greatly minimize the spoilage of sardines (Eyabi, 1998; Kumolu and Ndimele, 2011). Cleaning of fishing boats and other gears at fishing grounds is of paramount importance to limit the rate of deterioration

of fish (Henson and Mitullah, 2004; Ponte, 2005). Obodai *et al.* (2011) based on temperature control by using ice, refrigeration or freezing; while others based on the control of water activity through drying, salting, smoking and freeze-drying (Eyoo, 1993; WHO, 2009; Abbas *et al.*, 2009).

Moreover, value addition helps to reduce post-harvest losses and bring the regional specialties over the national boundaries (De silva, 2011). Fish has gutted and filleted at the landing site and frozen quickly. The cold chain remains intact throughout transportation and retailing, which is unlike the operations of any other trader. However, there is negligible use of ice (as indicated by traders and observed with only some trucks using ice to limit thawing of frozen fish being transported overnight from production areas to Addis Ababa). Loss at this stage is primarily due to the high cost and lack of availability of pre-cooling facilities, less skill on pre-cooling technology, and place undertaken pre-cooling process (Kiaya, 2014).

Expanded Polystyrene Boxes, Solid Fibreboard boxes, Corrugated Fibreboard Boxes, Corrugated Plastic Boxes, Returnable Plastic Boxes, Bulk Modified Atmosphere Packs and Other Dry Packaging Systems (Datta, 2015). In containing of fish product by those packing materials reduce loss of quality because of limited options for conservation and time/distance from trading points. Besides, spreading fresh fish to sun leads to bad smell, quality loss, deterioration, and unhealthy, thus necessitates packaging (Gordon *et al.*, 2007). Packaging is determined according to the preference of buyers and/or consumer. As a result, all actors in value chain packing conveniently and an affordably by plastic and /or canning (Ameha and Ashine, 2015). Make shift packaging materials and practices and inappropriate transport facilities cause substantial quality as well as physical post-harvest losses. Proper packing and packaging technologies are critical in order to minimize mechanical injury during the transit of produce from rural to urban areas.

In Ethiopia, fish handling and proper care is low level and not taken instantly regarding keeping its freshness and post-harvest losses. However, in some areas, the most common forms of fish storage is the use of deep freezers of varying sizes and cold rooms in some cases

such as the FPME fish collection centers at Arbaminch, Bahirdar, Ziway and Addis Ababa (Lemma, 2010). This logistic provides a barrier to efficiency when the truck arrives at cooperative, it is unloaded and the fillets all weighed and piled on the floor before being bagged and put into a freezer container for holding purposes until transported to markets (IOC, 2014).

The score is based on the rigidity of flesh; adherence of the muscle to the back bone and color of surrounding flesh (Oyelese, 2007). Bhetki deheaded, descaled and all fins cut with knife (Dressing). After dressing, the fish has deskinned and filleted (Datta, 2013). Fillet yield of individual fishes depends on the species, sex, size, and its structural anatomy. Filleting has many merits including providing fresh product, extending product shelf life and make easy after buy preparation (Ameha and Ashine, 2015). Cooked fish meat or cooked fish mince is use for preparation of flakes. Flakes are to be fried in oil prior to use (Datta, 2013). Labelling has intended to provide information on product composition and safety, stating the origin and the means of production (farmed or wild) (De silva, 2011). Causes of PHL in the grading stages are lack of national standards and poor enforcement of standards, lack of skill, awareness, and financial resources (Kiaya, 2014).

Preservation can be taken both to short and long period of time (Eyo, 2002). By nature fish is very perishable food typically in tropical climates in less developed countries. If proper care are not taken promptly after capture of fish, it can be easily spoiled after a hour (Lemma *et al.*, 2010). Cool fish keeps longer than uncooled fish, although both will spoil in a matter of hours. Prior stage to process as well as to preserve fish is keep it cool (Tawari and Abowei, 2011). Prechecking of salt type which applied to curing fish based on composition of salt is necessary thus, one salt better than other. A distinction made between the two chief techniques of salting: wet salting and dry salting (FAO, 2005). The canned food fish prevented from contamination of pathogenic organisms by storing them in a virtually airtight package (Nwaigwe *et al.*, 2017).

2.5. Challenges of Fish Value Chain in Ethiopia

The main factors of inefficient of fish value chain with in country include poor fishing gears and vessels, poor infrastructure development - such as road, marketing centers, and shortage of electric power services in major landing sites, poor market linkages and telecommunication services (Abebe *et al.*, 2013). The distribution chain of fresh fish at Gilgel gibe area is relatively short as compared to coffee due to the nature of the product and poor storage/preservation methods (Abebe *et al.*, 2015). Gears often operated in Ethiopian fisheries include gillnets, beach seines, long-lines, hook-and-line, and cast nets. Various forms of traps, scoop nets and baskets made of plant materials and wires are used, particularly in the rivers of Ethiopia (Lemma *et al.*, 2017).

However, consumption heavily biased towards quite limited geographical (Demissie *et al.*, 2007). Habitat alteration and destruction is generally the major cause of most extinction of freshwater fishes (Thomas, 1994; L  v  que *et al.*, 2008). Recently, overfishing of tilapia was probably taking place in Lakes Chamo, Abaya, Hawassa, Langano and Ziway (Reyntjes and Wudneh, 1998). And also unemployment in other sectors thus caused the increment of the number of fishermen and a wide overexploitation in some lakes located closer to major cities (Kelil, 2002; Abegaz *et al.*, 2010c).

Some of the study (Abebe *et al.*, 2015 and Asseffa, 2014) indicated that, lack of fishing materials like refrigerator, fishing boat, fishing gear and transporting material to protect post-harvest loss in harvesting fish were major problems of fishermen. In Ethiopia, most of the fishing gears are traditional and less than the recommended size (FAO, 1995; Abegaz *et al.*, 2010a, 2010b). The minimum allowed mesh size to fisheries is 10 cm and 8 cm for gill nets and beach seines, respectively. However, these rules have not strictly followed by fishermen (Kelil, 2002).

Similarly, in Lake Chamo, Gancho net (nets made locally from fiber) has been causing the rapid depletion of Nile perch stocks (Sissay, 2003). In Lake Hawassa, use of herbicides and shore beach-seine that deplete juvenile stocks and nursery grounds are being observed (Yilma and Geheb, 2003). And also Lake Tana, commercial gillnets are set near the river mouth

during the rainy season and most of the Laboebarbus stocks (riverine spawners most which are endemic to the lake) are being overfished by this net (Gebremedhin, 2014). Fillets are collected and piled together; there is no special equipment for handling, separating and keeping them clean (IOC, 2014).

Most water for human use has drawn directly from rivers or from groundwater. Thus, exploiting of Lakes in an controllable manner and dropping industrial and environmental material waste becoming the crucial problem to fish production (FAO, 2007). At the global level, current water use represents about 13% of annual supply (MEA, 2005b) with an overall upward trend, indicating increasing pressure on freshwater resources. In addition, loading of organic and inorganic substances from the city to the lakes is affecting the fish population of Lake Hawassa (Tadesse, 2005). Likewise in lake Tana, agricultural activities are causing the over use of water resources (Anteneh *et al.*, 2010; Wondie, 2010).

Municipal and industrial effluents and human encroachment on the shoreline has given rise to historically unprecedented nutrient loadings into the Lake. Degradation of fisheries and the Lake resources usually starts with over-population followed by over-exploitation of the resource (EIAR, 2017). Waste management and disposal systems are not developed in Ethiopia and in a majority of the cases both liquid and solid waste are disposed without consideration to its impact on the physical, biological and social environment (AGP-LMD, 2013). Capture fishery is one of commodities that are highly susceptible and directly impacted by environmental degradation (EIAR, 2017).

Some stocks (Nile perch and Tilapia) on some Lakes (Chamo and Awassa) show signs of over-fishing and tilapia of Lake Ziway are probably at full exploitation (Bikila and Amanuel, 2016). Informal fisheries exploits fish stocks indirectly and isolates the information about price, amount of fish caught, income share and finally drop the performance of value chain by minimizing product supplied. Licensing a certain number of fishermen and fishing gears according to biological limits, Mesh size limitation of minimum 10cm stretched mesh for gillnets and 8cm for beach seine and Closed season (June –July) to prevent fishing during one of the tilapia breeding seasons (Asseffa, 2014).

Motorized fishery is typical for only Lake Tana while locally produced wooden boats are common in Lake Koka, Zeway, Langano, and Hawassa (FAO, 2012). Weak “forward linkages” to other economic activities generated by the supply of fish (trade, processing, transport, retail, etc.) and “backward linkages” to supporting activities (boat building, net making, engine manufacture and repair, supply of services to fishermen and fuel to fishing boats (FAO, 2006). The poor transportation, lack of post-harvest handling system, and inadequate technological know-how on fish handling are observed as common problems (Abegaz *et al.*, 2010a, 2010b, 2010c; Degebassa, 2010; Tigabu, 2010). Most of the fish catches from the Lakes reach the market by traditional means of transportation without any preservation facilities (Lemma *et al.*, 2010).

From Lake Tana the loss made during the preparation of fillet in the processing units is so high as the only part needed is the fish fillet; only 32% for Tilapia, 40% for Labeobarbus and 45% for catfish. Hence, the fish part lost during this preparation is 49% for tilapia, 55.4% for labeobarbus and 50% for catfish (Yalew, 2012). Lake Tana fisher use local made rafts, wooden made boats with low quality and illegal mesh sized net. When fishers fishing they also travelled with different materials for home, such as wood, charcoal, fuel, some agricultural materials, and local alcohol drink, which had the potential to contaminate the catch; and affect product quality (IOC, 2014).

The combination of chemical, autolytic and microbiological changes exposes fish and fishery products to the spoilage conditions. Besides, high moisture content, high fat content, high protein content, weak muscle tissue, ambient temperature and unhygienic handling are factors contribute to spoilage of fish (Abbas and Saleh, 2009). Lipid oxidation is a major cause of deterioration for many foods containing fats and oils (Shimelis and Mekonnen, 2009). However, the spoilage rate can be reduced by taking preventive measures, icing or keeping at low temperature.

During lent, Christians who abstain eating meat, milk, and eggs, consume fish since fish is the substitute of meat (Assefa, 2013). In Tigray, households operating in fishing have many constraints such as: lack of demand, finance and shortage of technology to preserve fish from

spoilage (Ejigu and Teklemariam, 2015). In Lake Zeway, during 1995 there were 1760 regular (full time) fishers (LFDP, 1996) with 2470-gill nets and 124 beach seines were used on the Lake during the same period (Kelil, 2002). Most of the small-scale fish traders were relatively young. In the four markets surveyed, 68% of the respondents were under 40 years old. The gender composition represented 95% and 5% of male and female groups, respectively. Respondents operated mostly (61%) in urban markets and 39% operate along roadside stalls on major roads leading to urban areas (Abebe *et al.*, 2015).

2.6. Theoretical Review

Fish is the primary source of food and nutrition, creating growing demand for this staple. It is a high-protein, low-fat food that provides a range of health benefits. Fish is generally a healthy food source and can be safely eaten in most cases. They possess a great economic, nutritional, medicinal, industrial, aesthetic and religious values as well as providing employment for millions of people in the world (Ordu Ticaret Borsas, 2014). Fish is an excellent source of animal protein and a wide range of essential nutrients and contributes significantly to food security. Fish provides more than one billion poor people with most of their daily animal protein.

Theory of Price: The theory of price is an economic theory whereby the price for any specific good or service is based on the relationship between supply and demand (Sautet, 2015). The optimal market price, or equilibrium, is the point at which the number of items available, the supply, can be reasonably consumed by potential customers. The market price is the price at which a good or service is bought and sold most efficiently. market price lies at the point of intersection between the available supply of the good or service and market demand for it (Warren, 1924). Any shift in the supply or demand affects an item's market price. If demand is held constant, a decline in supply results in a rise in its market price and vice versa. Likewise, if supply is held constant, a rise in the demand for an item results in a rise in its market price and vice versa (Horwitz, 2003).

Market Information can be regarded as a public good, particularly where there are numerous small farmers who are unable to pay for information. Improved information, enables fishers to plan

their production more in line with market demand, schedule their harvests at the most profitable times, decide to which markets they should send their produce and negotiate on a more even footing with traders (Shepherd, 1997). The availability of timely and accurate information to all interested parties is therefore essential, whether it be provided by the government and/or private sector. Agricultural market information systems (MIS) are designed to collect, process, and disseminate information on the situation and dynamics of agricultural markets (Galtier *et al.*, 2014). Market Information Services (MIS) as a means of increasing the efficiency of marketing systems and promoting improved price formation (Bowbrick, 1988).

Fishing Experience: Fish and fishing will remain important factors in the daily lives of many people (Cowx, 2000). Producing fish in captivity for subsequent stocking to enhance, maintain, or initiate fishing is also important. Efforts to maintain or increase the catch are likely to be tempered by society's growing interest in protecting the environment and preserving imperiled species (Jacques, 1999).

Post-harvest Value Addition: value addition is one of the possible approaches to raise the profitability of fish processing industry, which now lays greater emphasis on quality assurance (Maqsood *et al.*, 2019). It is the most talked about word in the industry, particularly in fish processing industry, mainly because of the increase opportunities the activity presents for earning (Venugopal, 2003). foreign exchange. The product mix up in the heat-processed category of seafood includes several 'convenience' ready-to-serve products such as fish curry, fish-in-rice etc. these products can conveniently be processed in retort pouches using an over pressure autoclave. The most prominent among the group of value added products is the battered and breaded products processed out of a variety of fish and shellfish (Devadasan, 2003).

Fishing Training: Training is defined generally as an enduring or semi-enduring alteration of the behaviour of the trainer. No matter how short or a long time, how simple or how complex, every set of training involves a pretraining condition, post-training condition, and an intervening set of obstacles or training phase. Training effectiveness is fundamentally an evaluation that inspects the level to which training enhanced the employee's skill,

knowledge, and behaviour inside the association (Manna and Biswas, 2018). Training effectiveness is an extremely multifaceted event. Trainees pursued as a selective and the level of picking up depends on some of the factors.

Fish Post-Harvest Loss (PHL): is defined as measurable qualitative and quantitative fish loss along the value chain, starting at the time of harvest till its consumption or other end uses (De Lucia and Assennato, 1994; Hodges, Buzby and Bennett, 2011). Fish loss can be quantitative as measured by decreased weight or volume, and/or can be qualitative, such as reduced nutrient value and unwanted changes to taste, color, texture, or cosmetic features of food (Buzby and Hyman, 2012). Fish availability and accessibility can be increased by increasing production, improving distribution, and reducing the losses. Thus, reduction of post-harvest fish losses is a critical component of ensuring future global food security and increasing the real income for all the consumers (Aulakh and Regmi, 2011; World Bank, 2011).

Membership to Cooperatives: the co-operative is a partial form of vertical integration, which means that farmers retain a relatively high degree of independence of economic action. Thus, it is possible to reduce transaction costs and uncertainty through the cooperative and maintain the entrepreneurial incentives through the market at the same time (Ollila, 1994). A cooperative is a user-owned and user-controlled business that distributes benefits on the basis of use (Barton, 1989a). Generally speaking, the main economic aim of the co-operative is to increase the income of its members. It can reduce productions costs and also decrease and internalize transaction (information) costs, with a better flow of information on consumer demand (Fertő, 2004a). The fishing and marketing co-operatives use long, medium and short term contracts to secure the raw material for themselves and to be able to govern the whole marketing chain (Hendrikse and Veerman, 2001a).

Education Status: Education is the process of facilitating learning, or the acquisition of knowledge, skills, values, beliefs, and habits. Educational methods include storytelling, discussion, teaching, training, and directed research (Bastian, 2013). Formal education is commonly divided formally into such stages as preschool or kindergarten, primary school, s

secondary school and then college, university, or apprenticeship (Johan and Harlan, 2014). The educational status of the fishers determines the speed with which he/she likely to adopt agricultural technologies. Therefore, both males and females need to be educated. However, culture, technology, and economical matters give much impact to the education system of a study area (Brown, 2013).

Fishing Boat Ownership: the bigger size boats are comparatively more efficient in fishing operation. Size of the boat and the equipment are the major factors which influence the employment potential, lake catch, and profit levels (Bose and Sarma, 2010).

2.7. Empirical Review

In Africa, over 60% of fish production supplied to domestic and regional markets as well as export-oriented processing units, of which artisanal fishery accounts for the majority of fish catch (Akande and Diei-Ouadi, 2010). The FAO (2003) estimated that in 2001, fish production was 15,400 tons. However, total fish production in the Lake Tana fisheries increased from 756 tons in 2000 to 6561 tons in 2010 (MoA, 2011). A study on fish yield by Montaner *et al.* (1994) also showed that, the yield varies according to the quality of raw material, the training of the worker, size of the fish and working material and facilities. According to the Ethiopian department of fisheries and aquaculture, 1,454 tons of fish landed each year at Bahir dar, which the department estimates is 15% of its sustainable amount (IOC, 2014).

Fish supply is considerably affected by gender, access to market, lack of infrastructure to market and size of fishing gears (Bikila and Amanuel, 2016; Mathewos and Abebe, 2016). Fish produced from Lake Tana presented either as gutted whole fish, filleted or dried. The fish used as dried fish includes those that died during transport from landing sites to the processing unit and under sized ones for all commercial species (Yalew *et al.*, 2012). From Lake Tana, fish which is not presented for domestic market and kept as dried whole fish is going to be exported to Sudan (Tewabe and Goshu, 2010). The exported amount increased from time to time, 33 tons in 2007 to 64 tons in 2012 with its incremented price (Yalew, 2012).

Lake Chamo supplies three fish species namely Nile-tilapia, Nile-perch and barbus for local and central markets such as those found in Addis Ababa, the capital city of Ethiopia. In these markets, Nile Perch are in very high demand (IOC, 2014). However, there are some of the determinants that either positively or negatively affect fish supply. In Horo woreda of Oromia region, size of gear for fishing positively affects the volume of fish supply at less than 1% significance level and the possibility of using scientifically recommended size of gear increased by 20.7%. On the contrary, the survey result shows that 35.25% of the fishermen lack market information on the price of the fish market of the central market which affects fish supply negatively (Bikila and Amanuel, 2016).

In Tigray, the fishery cooperative members obtained birr 6000.00 annually on average as dividend and wage payment when they work in fishing or marketing activities. Moreover, 95.3% of the responding rural households consumed fish on average for 2.5 days per week that worth birr 33.5 (1.675 kg/week) (Ejigu and Teklemariam, 2015). The overall total cost of fishing operation per year of cooperative in Lake Hawassa estimated as 959,550.00 ETB and the cooperative fishermen earned an estimated net profit of 3,199,210 ETB (Negese *et al.*, 2015). In Gilgel Gibe dam With regard to fish marketing constraints, low prices of fish at landing sites and lack of storage facilities take the vital problems. As a result, price of filleted fish at landing site ranges from Birr 18.00 to 25.00/kg, while it commands Birr 50.00 at city markets thus, fishery cooperatives should be seen to overcome the production and marketing problem (Abebe *et al.*, 2016).

2.8. Conceptual Framework of the Study

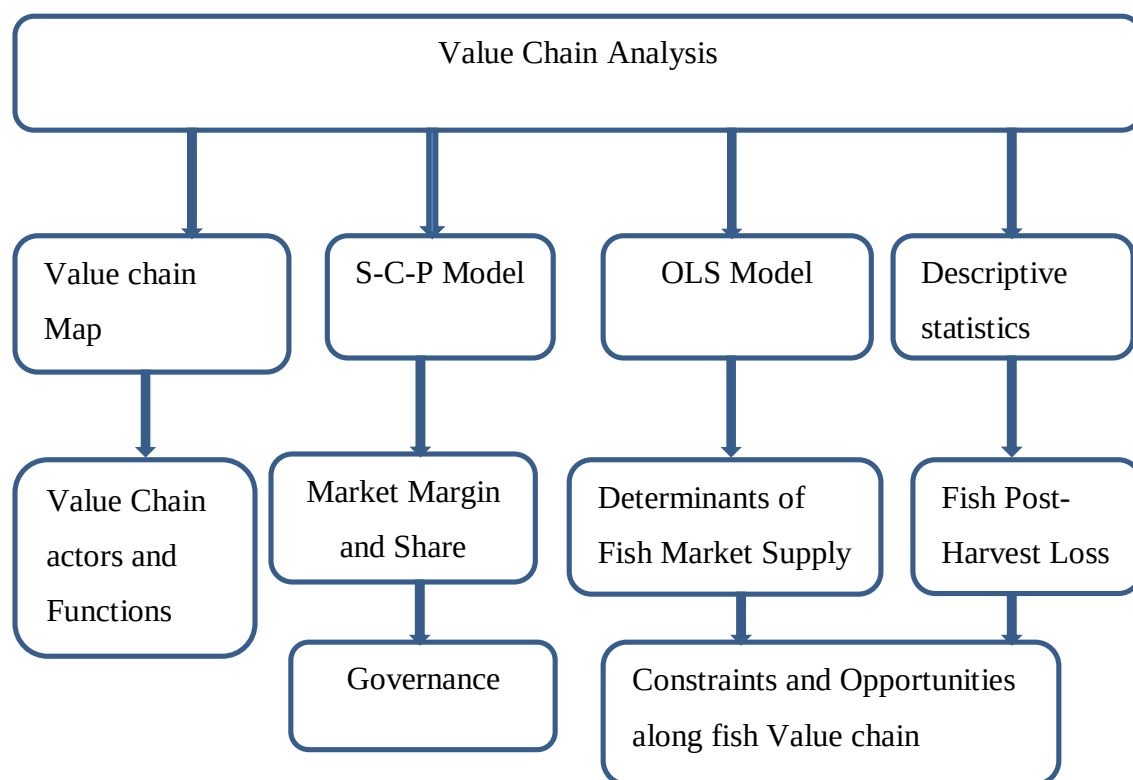
The term supply chain analysis encompasses the complete sequence of operations, which starting from the raw material, or an intermediate product, finishes downstream, after several stages of transformation or increases in value, at one or several final products at the level of the consumer (FAO, 2005). In contrary, Lundy *et al.* (2004) also clearly stated that, a market chain is used to describe the numerous links that connect all the actors and transactions involved in the movement of agricultural goods from the farm to the consumer, it means agricultural goods and products flow up the chain and money flows down the chain.

Finally, value chain can be the way in which a firm develops competitive advantages and creates shareholder value. Value chain analyses encompass issues such as organizational, coordination, power relationship between actors, linkages, and governance aspects. It refers to the full ranges of activities needed to bring a product or a service from conception, through production and delivery to final consumers. It can help to identify with whom to form partnership in the chain (Ingram, 2009).

Fish is by far the fastest-growing animal-source food, and is a critical contributor to global food and nutrition security (Beveridge *et al.*, 2013; Troell *et al.*, 2014; Béné *et al.*, 2015). The great majority of these fisheries are small-scale, operating in rivers, lakes and wetlands and in coral reefs and estuaries in coastal seas (World Bank, 2012). As opposed to the traditional exclusive focus on production, the concept stresses the importance of value addition at each stage, thereby threatening production just as one of the several value-adding components of the chain (Gereffi and Kaplinsky, 2001; Legese and Hordofa, 2011).

As Trondsen (2012) said, Lake food markets exhibit a strong demand for fresh, high quality lakefood yet empirical studies show large variations in value chains adaptation and exploitation of market opportunities. The fish fauna of Lake Hawassa consists of only six species. Moreover, the wild culture of tilapia and overproduction of eggs may inhibit the growth and reproduction of other cultivable fishes (Sairam, 2014). Lake Hawassa comprises production, marketing, distribution of fish along value chain actors. It also includes:-

Oreochromis niloticus, *Labeobarbus intermedius*, *Barbus paludinosus*, *Aplocheilichthys antinorii*, *Clarias gariepinus*, *Garra* spp (Negese *et al.*, 2015).



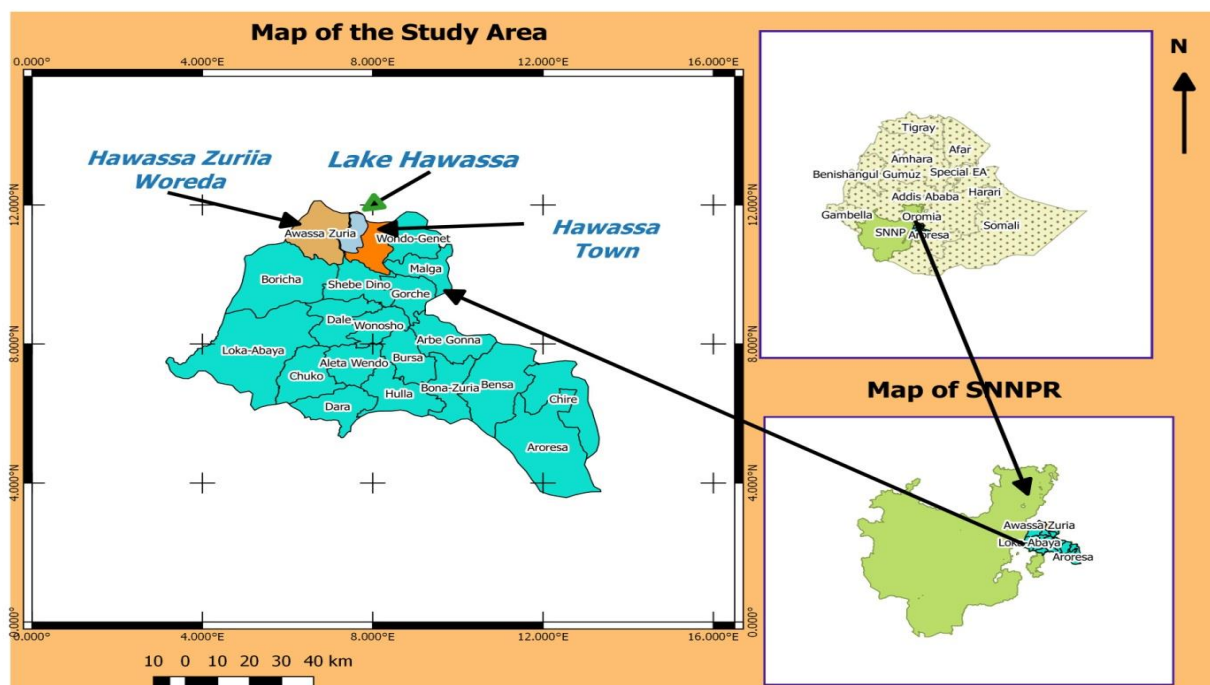
Source: adopted from (Sairam, 2014; Ingram, 2009; Negese *et al.*, 2015)

Figure 1: Conceptual framework of the Study

3. RESEARCH METHODOLOGY

3.1. Description of the Study Area

Hawassa is capital of the SNNPR. Hawassa is a city in Ethiopia, on the shores of Lake Hawassa in the Great Rift Valley. Lake Hawassa, popularly referred to as the "lake of love" is one of Ethiopia's natural wonders. Geographically, the lake lies between 6°33'–7°33' N and 38°22'–38°29' E at an altitude of 1680 m.a.s.l in the Amoragedel Villages. The lake has a surface area of 90 km², a mean depth of 11 m, a volume of 1.036x10⁹m³ and a drainage area of 1,250 km². It is a terminal lake with no surface out flow and receives surface inflow through Tikur Wuha river (Negese *et al.*, 2016). Lake Hawassa, an endorheic freshwater lake, is located between 6°59'03.91"–7°04'42.24" latitude and 38°23'017.8"–38°28'052.9" longitude in the SNNPR and Oromia Regional State, within the Central Ethiopian Rift Valley Basin (Yonas *et al.*, 2018). In Lake Hawassa three fish species were found namely tilapia, catfish and labeobarbus. Among these species, tilapia fish harvested more than other species (Sairam, 2014).



Source: Own survey result, 2018

Figure 2: Map of the Study Area

3.2. Data Type, Sources and Methods of Data Collection

In this research both qualitative and quantitative data were used. Sources of data for both qualitative and quantitative data was both primary and secondary sources. Primary sources were fishermens, fishers cooperative, processors, traders, hotels/cafe and consumers. Secondary sources were published (research thesis and dissertation, journal, books and so on) and unpublished (agricultural bureau, Hawassa city fish development office, Sidama Zone and Oromia region fish development office documents, google, and so on).

Formal survey was implemented to gather necessary information which exactly identifies and addresses preliminary problem in the area. Structured questionnaire and interview were used to obtain information from respondents. The interview schedule was prepared in English language but for the sake of better understanding, the interview schedule was translated into local languages. Before the main survey, these questionnaire and interview schedule was pre-tested to avoid errors, if any.

3.3. Sampling Procedures and Sample Size

Both purposive and random sampling techniques were used. Two-Stage-sampling procedure was applied in this study. Firstly, stratified random sampling method used and landing sites were categorized as Amorage del, Dorebafano and Tikurwuha. Then by using simple random sampling procedures, the sample fishermen were selected from the three villages on the basis of probability proportional to population size of each landing sites. According to the information obtained from Hawassa City, Sidama Zone and Oromia Region fishery development office, there were 495, 240 and 156 fishermen in Amorage del, Dorebafano and Tikurwuha landing sites, respectively (HCFDO, SZFDO and ORFDO, 2017).

Traders, fisher cooperatives, processors, hotels/café and consumers were selected randomly to estimate marketing cost and margin to assess the level of post-harvest losses and the major

constraints along fish value chain. Here also simple random sampling method was applied to obtain sample traders who properly represent the population. The population size of Hawassa city is 133,097 (NBE, 2018).

The sample size of fishermen was determined based on Yamane's formula (1967). This formula is applicable for a finite population who are homogenous. Yamane (1967) developed the following equation to yield a representative sample for proportions.

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

Where, n= sample size, N= population size, e = level of precision. The level of precision is the range in which the true value of the population is estimated to be; it is expressed in percentage points (0.07). The reason behind taking margin of error (MoE) 7% is that to obtain enough representative sample size. Addisu (2016) used 9% level of precision to obtain sample that truly represent population. Meseret (2018) also used 9% level of precision for its accuracy and true representation. If we take 5% margin of error, the sample size becomes 277, also by 10% margin of error, the sample size becomes 89, which is very less.

$$n = \frac{891}{1 + 891(0.07)^2} = 166$$

Where, 891 total fishermen from three villages

Then applying probability proportional to size to give equal chance of be selecting from each of three villages. This formula is:

$$nk = \frac{nNk}{Nt} \quad (2)$$

Where, n = population of each village; n_k = sample size of each village; Nk = sample size of total population and Nt = total fishermen from three villages. The sample size of fishermen from three villages (Amoragedel, Dorebafano and Tikurwuha) was 92, 45 and 29,

respectively. The sample size of traders, hotels/café, fisher's cooperative, processors and consumers, selected randomly are 10, 5, 5, 4 and 10, respectively. Therefore, the total size of sample that used to conduct fish value chain analysis was 200.

3.4. Methods of Data Analysis

Both descriptive statistics and econometric analysis was used to analyze both the qualitative and quantitative data collected from fishermen, fisher cooperatives, traders, processors, hotels/cafe and consumers.

3.4.1. Descriptive Statistics

Descriptive statistics were used to present socio-economic characteristics, post-harvest loss, and opportunities along fish value chain. The functions in fish value chain and the post-harvest loss of fish were analyzed using descriptive statistics namely: - mean, frequency, maximum, minimum, standard deviation and error correction test (t-test). The result was presented by table and percentage. The descriptive statistics was also used to analyse the structure- conduct and performance (s-c-p) of fish market.

Mapping Value Chain

Mapping a value chain facilitates a clear understanding of the sequence of activities and the key actors and relationships involved in the value chain. This exercise is carried out in qualitative and quantitative terms through graphs presenting the various actors of the chain, their linkages and all operations of the chain from conception to industrial processing and marketing (UNIDO, 2009). Mapping the chain means giving a visual representation of the connections between actors and tracing a product flow through an entire channel from the point of product concept to the point of consumption (Kaplinsky and Morris, 2000). The first step in a value chain study is to identify the actors and the connections between them to get the chain mapped out.

Structure-Conduct-Performance (S-C-P) Approach

Structure-Conduct-Performance (S-C-P) is an analytical approach or framework used to study how the structure of the market and the behavior of sellers of different commodities and services affect the performance of markets, and consequently the welfare of the country as a whole (USAID, 2008).

Measure of Market Structure

Market structure of fish traders was estimated by identifying market actors and their function, concentration ratio and HI index. The standard tools used to see competition and measure market concentration are the Herfindahl index (HI) and the concentration ratios (CR (n)). Thomas and Maurice (2011); Wisdom *et al.* (2014); USAID (2008) defined market structure as a set of market characteristics that determine the economic environment in which a firm operates.

Concentration ratio: It measures the percentage of traded volume accounted for by a given number of participants. It shows that whether a few large firms or many small firms dominate industry. As a rule of thumb, literatures specify a four enterprises concentration ratio of 50% or more is indicative of a strong oligopolistic industry; 33-50 percent ratio denotes a weak oligopoly, and less than that un-concentrated industry. Thus, the more the market dominated by a few large firms, the larger the concentration ratio will be (Wisdom *et al.*, 2014). For an efficient market, there should be sufficient number of firms (buyers and sellers). The methods used to identify market structure were as follow:

$$Si = 1 + \frac{Vi}{\sum Vi} \quad (3)$$

Where; Si = the percentage market share of ith firm

Vi = amount of fish handled by ith firm

$\sum Vi$ = Total amount of the product

Market concentration was given as follow:

$$C_i = \sum_i^r S_i \quad (4)$$

Where; C = Concentration ratio

S_i = the percentage market share of i^{th} firm

r = the number of relatively large firm for which the ratio was calculated

Measures of Market Conduct

Market conduct is measured using pricing strategies of market actors and terms of payment they used. In measuring market conduct, pricing role of market actors and mechanisms of pricing was evaluated. Terms of payment include payment in form of cash, credit and/or both were also assessed (Johan, 2015). Market conduct investigates the behaviors and rules that regulate the relationships between actors or how they engage with one another (WFP, 2011).

Measure of Market Performance

Market performance analyses how markets are achieving optimal or desired outcomes such as low and stable prices that are predictably transmitted (WFP, 2011). Marketing performance was evaluated by undertaking market margin analysis. Marketing margin is defined as the difference between the price paid by consumers and that obtained by producers. It is also called the 'Farm Retail Price Spread (SIFSIA, 2011). Total marketing margin is the difference between what a consumer pays and what a producer/farmer receives for the product. A wide margin usually means high prices to consumers and low prices to producers (Dirriba, 2013; Biruk, 2015). Net marketing margin of particular marketing agents defined as the residual of the gross marketing margin after paying costs. Hence, gross and net marketing margin specified as:

Gross marketing margin = Selling price – Buying price.

$$GMM_{ith} = \frac{\text{Selling price} - \text{Buyer price} * 100 \text{ (Bosena et al., 2017)}}{\text{End buyer price}} \quad (5)$$

Where; $GMM_{i^{th}}$ = gross marketing margin of i^{th} firms

The portion of end consumer price that goes to fishers calculated as:

$$GMM_f = \frac{\text{End buyer price} - \text{gross marketing margin} * 100}{\text{End buyer price}} \quad (6)$$

Where; GMM_f = the fishers share of consumers price

Net marketing margin (NMM) is the percentage of the final price earned by the intermediaries as their net income after deducting marketing costs like processing, transport, labor and non-labor cost.

$$NMM = \frac{\text{Gross Margin} - \text{Marketing Costs} * 100}{\text{End buyer price}} \quad (7)$$

Where; NMM = net marketing margin

These costs include costs of procuring the fish, labor costs and non-labor costs. Computing the total gross marketing margin (TGMM) always related to the final price paid by the end buyer and expressed as a percentage.

Total gross marketing margin calculated as deducting end buyer price from price received by fishers. This supports to determine the efficiency of market that related with low marketing margin by increasing net income.

$$TGMM = \frac{(\text{Endbuyer price} - \text{firstsell price}) * 100}{\text{Endbuyer price}}$$

Where; TGMM = total gross marketing margin

3.4.2. Econometric Analysis

3.4.2.1. Analytical Framework

Abebe *et al.* (2015) used OLS to identify the determinants of fish supply to market and stata software for data analysis, in opportunities and challenges of fish marketing at Gilgel Gibe dam in Ethiopia.

Dagninet *et al.* (2018) in his study in case of Lake Tana used OLS in fishing condition and fisher's income investigation. In this study, years of schooling and ownership of motorized boat has positively correlated while cooperative membership negatively correlated to average annual income of fishers.

Addisu (2016) used OLS to analyze factors affecting volume sales because all sampled households producing vegetable participated in marketing. Meseret (2018) used OLS to analyze factors affecting malt barley market supply at farm household level in Angolalla Tera *woreda*.

The cereals and legumes crop may be produced solely for home consumption without considering market supply. However, highly and promptly perishable product like tomato and fish not produced only for home consumption but also for market else. Thus, all producers either fully or partially involved in market orientation. Therefore, to identify the factors that affect the volume of fish supply in the market, multiple linear regression model is appropriate and relevant. Hence, all fishermen who engaged in fishing practice from Lake, expected as, supply their fish either whole or somewhat to the market.

This study used OLS model to analyze the factors that affect the volume of fish supply to the market of Lake Hawassa. OLS is a statistical model that utilize two or more quantitative and qualitative explanatory variables ($X_1, \dots, X_p$) to predict a quantitative dependent variable of Y . Hence, OLS model was appropriate in estimating factors that affect volume of fish supply. Unlike other agricultural products, almost all fish harvested supplied to market unless minimized by post-harvest loss. This OLS model has selected for its simplicity and practical applicability (Greene, 2000).

The OLS regression is specified as:

$$Y_i = \alpha + \beta X_i + U_i \quad (8)$$

Where; Y_i = market supply of fish

X_i = Explanatory variables and “i” 1,2,3...n

α = an intercept

β = coefficient of i^{th} explanatory variables

U_i = unobserved disturbance term

As a result, some of the assumptions of the Classical Linear Regression (CLR) model may be violated and the parameter estimates of the model may not be Best Linear Unbiased Estimator (BLUE). The problem of multicollinearity occur when there is relationship among explanatory variable or correlation among explanatory variables, which causes, the ordinary least squares estimators of the relevant model parameters to be biased and inconsistent (Maddala, 2001). To estimate the volume of fish supply and predict the value by the OLS, stata version 15 software was applied.

Specification Test

Model specification is one of the first step in the regression analysis which converting the theory in to a regression model (Degye, 2018). While converting into regression model, specification error caused by wrong functional form, omission of relevant variables or inclusion of irrelevant variables, measurement error and incorrect specification of stochastic error term are tested to the assumption of classical linear regression (CLR) model. Hence, it is important to check the presence of hetroscedasticity, multicollinearity and omitted variables before fitting important variables into the regression models for analysis.

Test for Heteroscedasticity

Examination of the model is a good visual diagnostic to detect heteroscedasticity. Hence, there are many tests to detect this problem namely: Breusch-pagan, Park, LM, Godfrey, White's test, Koenker Bassett (KB) tests for heteroscedasticity. These tests of heteroscedasticity tend to incorporate whether the independent variables have a significant relationship to the goodness of the fit of the model. Due to its simplicity, Breusch-Pagan test of heteroscedasticity was employed for detecting heteroscedasticity in this study. The different tests of heteroscedasticity are based on the auxiliary regressions for the OLS residuals to the squares. As usual we reject if the observed value of the test statistics exceeds an appropriate critical value. Rejection implies that heteroscedasticity is present. Therefore, this test was done to examine whether estimated variances of the residuals from a regression are dependent on the values of the explanatory variables.

Test for Multicollinearity

Multicollinearity exists when at least some of the predictor variables are correlated among themselves. Multicollinearity is considered severe and becomes a problem when this correlation is high and interferes with the estimation of the model's parameters at the desired level of statistical certainty. In this study, measure that suggested to test the existence of multicollinearity was variance inflation factor (VIF). Thus, Variance Inflation Factor (VIF) was used to check multicollinearity among independent variables. According to Maddala (2001), VIF can be defined as:

$$VIF(x_i) = \frac{1}{1 - R_i^2} \quad (9)$$

Where; R_i^2 = the squared multiple correlation coefficients between x_i and other explanatory variables. As a rule of thumb, if the VIF is greater than 10 (this will happen if R^2 is greater than 0.90), the variable is said to be highly collinear (Gujarati, 2003).

Test for omitted variables

To test omitted variables there are a number of tests such as Examination of the residuals, Durbin-Watson d, Ramsey's RESET and Lagrange Multiplier (LM). Ramsey's RESET test is not only for to test omitted variables but also for functional form correction (Ramsey's, 1969). For its simplicity in this study, Ramsey's RESET test was employed.

3.5. Variables Definition and Hypothesis

3.5.1. Dependent Variable

Volume of Fish Supply (FS): It is continuous dependent variable representing the actual quantity of fish supplied by fishermen measured in terms of kilogram per day (kg/day) which is selected for the OLS regression analysis.

3.5.2. Independent Variables

Access to market information (MKTINF): It is a dummy variable taking a value of 1 if fishermen access to market information and 0 otherwise. Farmers marketing decisions are based on updated information available on the market. Goetz (1992) noted that better market information increased the market participation decision of households. Therefore, this variable is expected to have positive relationship with fish supply.

Education level of the household head (EDUC): It is a continuous variable measured in formal years of school. Education increases fisherman's ability to get and use information, expands fisherman's intelligence and enables them to perform the fishing activities critically, accurately and efficiently. Moreover, better educated fishermen tend to be more innovative, market orienter and are therefore more likely to adopt the marketing systems. fishermen who have better knowledge are expected to be early adopters. The number of years spent in formal education enhances the knowledge ability to adopt modern technology in improving their fishing activities, method of processing and efficient marketing strategies. The need to encourage the respondents to embrace formal education cannot therefore be overemphasized (Gwary *et al.*, 2014). Study by Woldemichael (2008) conducted on dairy marketing showed

that education level showed a positive effect on milk market participation. Education level of household enhance fishers' willingness to catch more and increase volume of sales (Abebe, 2013). Therefore, this variable is expected to have positive relation with fish supply.

Access to Credit Services (CRDT): This is a dummy variable with the value 1, if a fisher has access to credit, 0 otherwise. Access to credit services may be enhancing the financial capacity of the fishermen to purchase the appropriate fishing gears, and cover operational expenses. Muhammed (2011) found that, access to credit increasing the amount of wheat supplied to market. Further, Gebremedhin *et al.* (2015) found that, use of credit services increases the probability of small ruminant market participation. If the fishermen get opportunity to access credit services, he may be potential to buy equipment and fishing gears. Therefore, access to credit services is expected to have positive relation with volume of fish supply.

Experience of the household head in fish harvesting (EXPR): It is a continuous variable and measured in the number of years' experience in fish harvesting of the household head. Abay (2007) illustrated as farmer's experience increases, the decision to participate in the production and marketing as well as volume of tomato supplied to the market increases. Therefore, this variable is expected to have positive effect to fish supply.

Average output Price of fish (APQ): It is a continuous variable measured in Birr per unit of fish. As a given household sells the different types of fish for the same buyer with different price, it is taken as average. According to Birhanu *et al.* (2013) price offered by milk market outlet per liter of milk significantly and negatively affected accessing cooperative milk market outlet as compared with accessing individual consumer milk market outlet. The variable is expected to influence level of supply positively. When the price of the product is increasing, fishemans are motivated to participate in the market.

Access to Fishing Training Service (ATRSR): It is a dummy variable with value of 1 if a household head has access to training and 0 otherwise. Kindie (2007) showed that, contact with fishing expert and development agents has positive effect on marketable supply of sesame. Training is assumed to have positive contribution to more market supply as it has a

stimulation of fishing, and also it is a proxy for better access to information and can adopt better technology that will increase their supply of fish.

Post-harvest Value Addition (PHVAdd): It is a dummy variable measured in terms of whether the household adding value to his activities or not. It takes a value 1 if a household practice value adding activities and 0 otherwise. Households who practice better post-harvest handling practices (cleaning, drying, separating quality product, storing in quality material and place) have high probability to supply more to market (Ababulgu, 2016). Post-harvesting and marketing activities are critical factors for the supply of fish (Abebe *et al.*, 2015). Therefore, Packaging, storing, using preservative spice, processing etc add value to fish which encourage fish supply and affecting positively.

Ownership of Cold Storage (OWCST): It is a dummy variable measured interms of whether the household owning cold storage or not. It takes value 1 if a household own cold storage, 0 otherwise. Fishermen who own cold storage preserves his product from post-harvest loss and extend its shelf life which increases fish supply. Market participants indicate that, capital like large cold storage facilities and transport constrains fish market (Dereje, 2002). Post-harvest loss also increases as the catch increases due to low storing capacity of the freezer availability (Yared, 2012). However, fishermen who own cold storage supply more fish. Therefore, this variable positively affects fish supply.

Membership to cooperative (MCPR): It is a dummy variable measured in terms of whether the fishermen is membership to cooperative or not. It takes value 1 if fishermen are member to cooperative, 0 otherwise. The best possible supplies of fish for the market could be guaranteed when all those involved in fisheries work together to conserve and manage fish resources and habitats (Negese *et al.*, 2015). When the fishermen are joining together they can pool resource jointly to overcome fishing constraints which increases fish supply level. Therefore, this variable positively affects fish supply.

Boat ownership (BOWN): It is a dummy variable measured in terms of whether the fishermen owning boat or not. It takes the value 1 if fishermen own boat, 0 otherwise. According to Dagninet *et al.* (2017) said that owning boat increases the fish harvest because

of power available to go distant places for better catch volumes. Also to stock together the harvested fish to minimize the time that burned by travelling to landing site if there is no fish pooling material (boat). Therefore, this variable affects fish harvesting and supply volume positively.

Landing Site (LS): It is a categorical variable measured in terms of where does/in which site the fishermen exist. It takes the value 1 if the fishermen in Amorage del; 2 if the fishermen in Tikurwuha and 3 if the fishermen in Dorebafano villages. Some of the causes of fish post-harvest losses are natural, such as high temperature, distance and geographic problem (Solomon and Mekonen, 2017). One landing site might be different from other site, by species stock, infrastructure (electric power, road), transporting vehicles, proximity to market, information access, convenience of area, and near to city/town. The sites, which gifted with those issues supply more fish to the market unless and otherwise supply less. Therefore, the site with less infrastructure, facility and processing equipment's supply less fish to the market.

Post-harvest loss (PHL): It is a continuous variable measured in terms of kilogram, how much fish discarded after harvest at fishing level. It expresses the magnitude of loss of participants in kilogram per day thus fish is harvested day to day. Fish loss grouped in to physical, quality and market oriented loss (Tsehay and Teferi, 2017). Fishes are perishable product they spoil very quickly by intrinsic and extrinsic factors (Agumassie, 2018). For instance, temperature speeds up spoilage hence it increases the activities of bacteria and enzymes which leads to fish post-harvest losses. Abebe (2015) supported that, the spoiling rate of fish is very high due to warm weather and lack of cold storage in Koka reservoir. Fish loss occurs at harvest and post-harvest along value chains. Harvest loss occurs between beginning and completion of harvesting whereas post-harvest loss occurs between harvest and consumption. At harvesting level, fish might be lost by inappropriate harvesting techniques, net type and size, weak handling practices and so on whereas at post-harvest level loss might occur during storage, processing and transporting to deficit area. Therefore, this variable affects fish market supply negatively.

Table 1: Summary of Variables Definition, Measurement and Hypothesis for Fish Supply

No	Variables	Types of variables	Measurement	Actual effect
1	Access to market information	Dummy	1, if has access, 0 otherwise	+
2	Education of household	Continuous	Years of school	+
3	Access to credit services	Dummy	1, if has access, 0 otherwise	+
4	Household fishing experience	Continuous	Years of experience	+
5	Fish market price	Continuous	Birr per kg	+
6	Access to fishing training services	Dummy	1, if has access, 0 otherwise	+
7	Fish post-harvest value addition	Dummy	1, if adding value, 0 otherwise	+
8	Ownership of cold storage	Dummy	1, if fishermen own cold storage, 0 otherwise	+
9	Membership to cooperatives	Dummy	1, if a cooperative member, 0 otherwise	+
10	Boat ownership	Dummy	1, if fishermen own boat, 0 otherwise	+
11	Landing site	Categorical	1, if Amoragedel, 2, If Tikurwuha, 3, if Dorebafano	—
12	Post-harvest loss	Continuous	Kilogram	—

4. RESULTS AND DISCUSSIONS

This chapter deals with the analysis of the findings from the descriptive statistics and econometric model. Different descriptive and inferential statistics were employed to analyze the demographic and socio-economic characteristics of value chain actors. To map value chain function and actors' role, value chain analysis approach was employed. S-C-P model was used to analyze structure, conduct and performance of fish market. Multiple linear regression model was employed to examine the factors that affect the volume of fish market supply of Lake Hawassa. Finally, opportunities in fish value chain were identified.

4.1. Demographic and Socio-economic Characteristics of the Fishers

The demographic and socio-economic characteristics are conceived to have influence on fish harvesting and supply to the market in various aspects. This is in line with Temesgen and Getahun (2016) reported that, the exploitation and utilization of fish mostly depends on socio-economic factors, resource accessibility and religious characteristics.

The mean age of fishers was 32 years with the minimum and maximum age of 17 and 56 years, respectively. Moreover, fishers were well experienced about fish abundances areas and harvesting techniques. The mean experience of fishers was 7 years with minimum 1 and maximum 40 years. Concerning their educational background, the mean education level was 7 with minimum and maximum value of 0 and 13, respectively. The mean value of fishers' family size was 2 with the minimum and maximum 1 and 7 values, respectively. The mean value of fish post-harvest loss was 9.48 kilogram with the minimum and maximum value of 1 and 20 kilograms, respectively. The mean value of market price was 48.1 birr per kilogram with the minimum and maximum value of 25 and 75 birr per kilogram, respectively.

Table 2: Summary Statistics of Characteristics of Sample Fishers (Continuous Variables)

Variables	No of respondents	Mean value	Minimum	Maximum	Variance
Age	166	31.94	17	56	57.676
Experience	166	7.02	1	40	30.657
Education	166	7	0	13	9.886
Post-harvest loss	166	9.48	1	20	32.93
Market price	166	48.1	25	75	53.05
Family size	166	2.35	1	7	1.51

Source: Own survey result, 2018

As Table 3 indicated, all observed fishers in study area were men. Refrigerator is one of the most pieces of equipment for keeping fish food safe. From 166 sampled fishers, only 28.3% of them owned refrigerator. Access to fish training services is one of the indispensable activities in fish harvesting and supply function. This training provides information and knowledge about fish harvesting techniques, appropriate fishing gears and vessels, and the most demanded and healthy fish species. Therefore, the fishers who get fish training services properly, can harvest and supply appropriate fish size and amount which simultaneously increases fish supply. About 48% fishers get training services (Table 3).

Credit increases the financial ability of fishers who are investing in buying fishing gears, adopting new technology and covering fixed and operational costs. Likely, the fishers who obtain credit from any source invest their money in productive activity in Lake Hawassa. About 20.5% of fishers used credit in various extents (Table 3).

Access to extension services: diversify other agricultural activities other than fishing. Rather than expanding fishing practices, extension services influence fishers to shift to raising crop and rearing cattle. So that fishers who get the extension services have the probability of supplying less fish to the market. About 18% fishers got extension services (Table 3).

Table 3: Summary Statistics of Characteristics of Sample Fishers (Categorical Variables)

Variables	No of respondents	Percent
Male	166	100
Refrigerator	47	28.3
Access to fishing training services	80	48
Access to credit services	34	20.5
Access to extension services	29	18

Source: Own survey result, 2018

4.2. Demographic and Socio-economic Characteristics of the Traders

The result indicated that, the mean age of the respondents was 29 years with 17 and 38 minimum and maximum years, respectively. The education level ranges from grade 3 to 17 and with the mean grade of 10. Education improves traders' capacity by improving their way of involvement. More educated traders participating actively in fish supply activity. The mean family size of traders was 3 (Table 4).

Table 4: Summary Statistics of the Characteristics of Traders (Continuous variables)

Variables	No of respondents	Minimum	Maximum	Mean	Variance
Age of Actors	24	17	38	29	42.6
Status of Education	24	3	17	10	14.8
Family Size	24	1	8	3	3.5

Source: Own survey result, 2018

Note: S.E = standard error

4.3. The Fish Value Chain Analysis

Value chain analysis is a complementary to a subsector analysis. It can provide other analytical elements that can improve entity activity. Fishery subsector analysis identifies the range of activities that can bring fish to the final consumers. Elements of subsector analysis understand fish market and market trend, relationships between participants, and constraints and opportunities and subsector mapping. It also includes actors who are either directly involved in activities or indirectly support the operation of activities. Finally, value chain influencers who might have impression in fish related operation are identified. These elements are described sequentially. Here, actors and their roles are explained as follows:

4.3.1. Value Chain Actors

Input Suppliers: Agriculture value chain generally started with supplying inputs to various productive activities. Fish value chain is one of the agricultural subsector value chains which encompass both of direct and indirect actors. Typically, Lake Hawassa fishers only have direct suppliers. Specially, private entity/traders of timber and nets, hooks and long line are the main input suppliers. As fishers order, these suppliers are conscious to provide inputs as fishers' capacity.

Fishers: Fishers are indispensable entities which directly participate in fish harvesting activities. They also functioning the basic activities which can maintain other fish actors. However, in this study, fishers operate at household level. Most likely, some of the fishers perform more than one activity at landing site. Fishers expend a lot of power and time in harvesting fish. They start spreading their nets at the midst of the lake about 1:00 pm at noon. The net spread out over the lake for about 14:00 hours from day to night till 3:00 am until fish caught. They also safeguard spread out nets over night from theft. Even they sometimes invest their time and labor for least fish harvested during shortage period.

Fishers who harvest fish by using hooks and long line supply food to fish to caught it easily. Rarely some fishers sell their fish below their operational cost particularly in least harvesting season. The most experienced fishers know the place where the fish abundantly existed.

Hence, there is horizontal relationship among fishers to share information, build bargaining power and collaboratively harvesting fish. They are also able to strengthen vertical relationship with their trusted buyers. Fishers grade fish by size as large, medium and small. They sell their fish through different channels to different actors around the lake. Fishers who not sell fish to cooperatives pay money to cooperatives per fish per day as a tax.

Net Arrangers: are the person who ties nets in serially and putting slight stone and/or plastic can on those nets then spreading it on lake. These actors combine many nets together which ranges in number from 20 up to 40 per boat. The activity of tying nets starts after fish catch dropped from nets. The exact time of tying nets is from 2:00 up to 6:00 am at day time before spreading/leaving nets in the lake. The actors involved in this activity are young who cannot able to harvest fish from lake and have not legal fishing license. But after reaching to fishing capacity level and grasp experience of fishing, these actors can be able to harvest fish.

Fisher's cooperative: Cooperatives are established cyclically by small scale enterprise office to generate job opportunity to young generation. The cooperatives have their own criteria within to make an individual as a member besides concerned office regulation. To be a member of cooperatives, an individual has to pay birr 5000, 2000 and 3000, respectively in Amoragedel, Dorebafano and Tikurwuha sites as a prior rule. The main task of cooperatives is supporting the members in different aspects. The activity is regulating member fishers from illegal fisher's competition, providing fish price and demand information easily, facilitating supply of input, and buying fish from fishers and create bargaining power to fishers. Cooperatives buy fish from fishers in discounted price and get priority. Cooperatives buy fish by counting in number and selling it by weighing in kilogram. Then they distribute fish to hotels, restaurants and traders within Hawassa city and some other cities and towns. However, the turnover of the fishers and/or traders who comprised in the cooperatives either voluntarily and/or as law of concerned office after five years' operation might force to change existing cooperatives rule.

Processors: These entities change the shape and size of fish partially at the landing sites before sending it to any further value chain activity. The processor sometimes buys fish either

himself from fishers and/or cooperatives or processing as a paid for cooperatives and/or traders. The processors, who are the root actors to process fish conveniently, reduce post-harvest loss, maintain quality and extend fish shelf life.

In Amoragedel and Tikurwuha sites, a processing house so called an abattoir is available, which is one of the places where fish is processed and sent to fish preparation place. At this level, fish is processed for three purposes. Firstly, prepare the fillet to the consumers who consume fillet at landing site. Secondly, process conveniently to hotels for Hawassa city and other cities and towns. Thirdly, after processing and filleting, the bone is deboned gently to café to prepare soup at landing sites.

Wholesalers: wholesalers are small in number but large power holder actors within fish value chain. Next to cooperatives, wholesalers are focal firm by having highest fish holding and marketing capacity. Unlike retailers, wholesalers could transport their product to long distance with in a country. Generally, wholesalers distribute fish to hotels but particularly, to retailers. Usually, wholesalers distribute fish to Hawassa, Addis Ababa, Zeway, Shashemene, Arsinegelle, Dilla, Wondogenet, Tuula, Yirgalem, Adama and etc.

Retailers: retailers are the part of actors who are directly involved in fish marketing activity. Retailers buy fish from either fishers or wholesalers at landing site or fish market. The major function of retailers is filling fish supply and demand gap within the country. After demand identification process, retailers sell their product either fresh or processed. Consumers who want to consume fillet at landing site might buy fresh fish from retailers and consume with spicy sauce which is available around the landing site. While fish is delivered to hotels, restaurants and cafes either at Hawassa city or other cities and/or towns, only shifting utility is created by retailers. However, most of retailers deliver fish with in Hawassa city and its surrounds. While distributing fish to near towns, the retailers used container/tank to handle fish. As its immediate spoilage nature, either water or ice is used in containers/tanks to cool fish while transporting fish by vehicles. Some retailers who might handle small volume of fish could use jerry can fill with water during moving product from place to place.

Consumers: The final actor in fish value chain is the consumer. The key activities in the fish value chain including: harvesting, processing, marketing and distributing is performed by targeting final purchaser (consumer). A consumer in fish value chain is the key point concerning fish value addition patterns and product deliverance. The demand and preference of final consumers can shape fish value chain. In Lake Hawassa, the fish value chain actors can process and supply partially according to consumer demand. The consumers in Hawassa city prefer mostly tilapia fish following by catfish.

4.3.2. Value Chain Enablers and Facilitators

Agricultural value chain becomes essential and successful while the enabling environment available. As porters (1998) said, creating the right enabling environment to agricultural value chain could help to meet customer satisfaction and differentiation between value chains. Here, Governments, NGOs (UNDP), MFI, Zonal and Regional fish production and development office, Cooperatives, Hawassa city Research and development center, water minerals and energy office and soon might provide support to fishers.

The functions of all supporters have tangible importance in different aspects. Lake management has a positive correlation towards fish harvesting, quality, and/or supply of fish. Collaborating with Hawassa city, NGOs aim to fund environmental management of the lake which indirectly influences fish harvesting positively. Likely, credit accessibility improves fish supply potential through covering fixed equipment cost and operational expenses. Training and advices on fish harvesting methods and price setting strategy provided by extension services can extend fish value chain by increasing harvested amount and demand seeking strategy. Therefore, fish value chain effectiveness might be ensured when sustainable enabling environment exists.

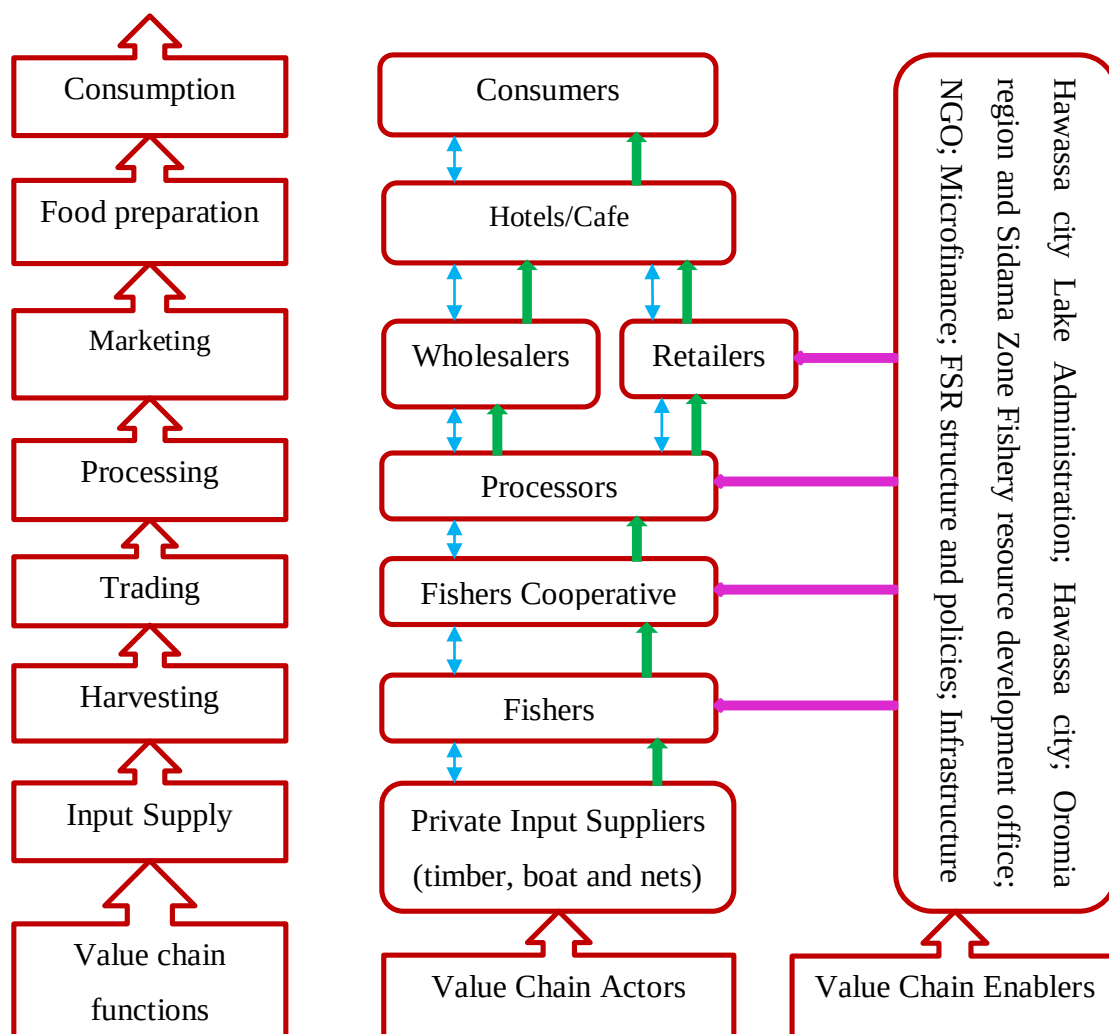
Value chain influencers were policies, infrastructure and structure of fishery resource development office toward fish operation. Structure of the sector influences the department and operation which determine the method of harvesting, the fish species being harvested and duration of harvesting. Road of Dorebafano site is not comfortable to move product from fishing site to near market. This situation exposes fish to quality reduction by cracking fish,

extending market area reaching time and decrease profit by increasing transportation cost. Electric power unavailability also restricts this site from owning cold storage (refrigerator) resulting in high post-harvest loss.

4.3.4. Value Chain Map in the Study Area

The map of the fish value chain depicts the key actors, sequences of activities, governance involved and other influencing aspects. Map also visually displays all issues in fish value chain. Mapping of a value chain actors and functions facilitates the sequences of activities and linkages along fish value chain and integration of backward and forward activities.

Performing of each value chain activities involving the key actors is to address targeted product distribution. The most important functions in the fish value chain were input supply, harvesting, processing, trading, distribution and consumption. The actors involved were input suppliers, fishers, net adjusters, processors, fisher's cooperative, wholesalers, retailers and consumers.



Source: Own sketch from survey result, 2018

Note: ↑ Product flow

↕ Money and Information flow

Figure 3: Value Chain Map in the Study Area

4.3.5. Value Chain Governance

The governance implies the power to control, influence, set the modes and rules of interaction. According to Kaplinsky and Morris (2000), governance means the relationship between buyers, sellers, service providers and regulatory institutions that operate within and/or influence the range of activities that bring the product and/or services from conception to consumption and disposal after its usage. Moreover, the relationship along fish value chain actors of Lake Hawassa was harmonized and smoothed. The fish buying and selling process was basically based on agreement and negotiation between actors. In addition, trust and pre-contract have a great influence along buyers and sellers of fish. However, wholesalers hold tight power than any other actors along the value chain due to their high purchasing power. There were also some rules that are enforced by fishers' cooperatives which force fishers sell their fish to them.

4.3.6. Fish Marketing Channels

Marketing channel was first used to describe the existence of trade channels or paths bridging fishers and users (Pelton *et al.*, 2016). According to Kohls and Uhl (1990), market channel refers to the routes that the product moves from one actor to another and/or one place to another place. Here, it refers to the fish that is flowing after deducting home consumption and Lake Gate loss. From the total 350.1 tonnes of fish harvested by sample fishers in the study area, about 251 tonnes of fish was supplied by the fishers to consumers through different actors in 2018.

The following Fish market channels were identified:

Channel I $\Rightarrow$ Fishers $\Rightarrow$ Consumers (Landing site)

Channel II $\Rightarrow$ Fishers $\Rightarrow$ Cooperative $\Rightarrow$ Hotels $\Rightarrow$ Consume

Channel III $\Rightarrow$ Fishers $\Rightarrow$ Cooperative $\Rightarrow$ Processors $\Rightarrow$ Hotels $\Rightarrow$ Consumers

Channel IV $\Rightarrow$ Fishers $\Rightarrow$ Wholesalers $\Rightarrow$ Retailers $\Rightarrow$ Hotels $\Rightarrow$ Consume

Channel V $\Rightarrow$ Fishers V $\Rightarrow$ Wholesalers $\Rightarrow$ Retailers $\Rightarrow$ Consumers

Channel IV $\Rightarrow$ Fishers VI $\Rightarrow$ Retailers $\Rightarrow$ Consumer

Channel I: Fishers- Consumers: Consumers are directly buying fish from fishers. In this channel about 13.26% of fish, which means 33.28 tonnes was marketed during the survey period.

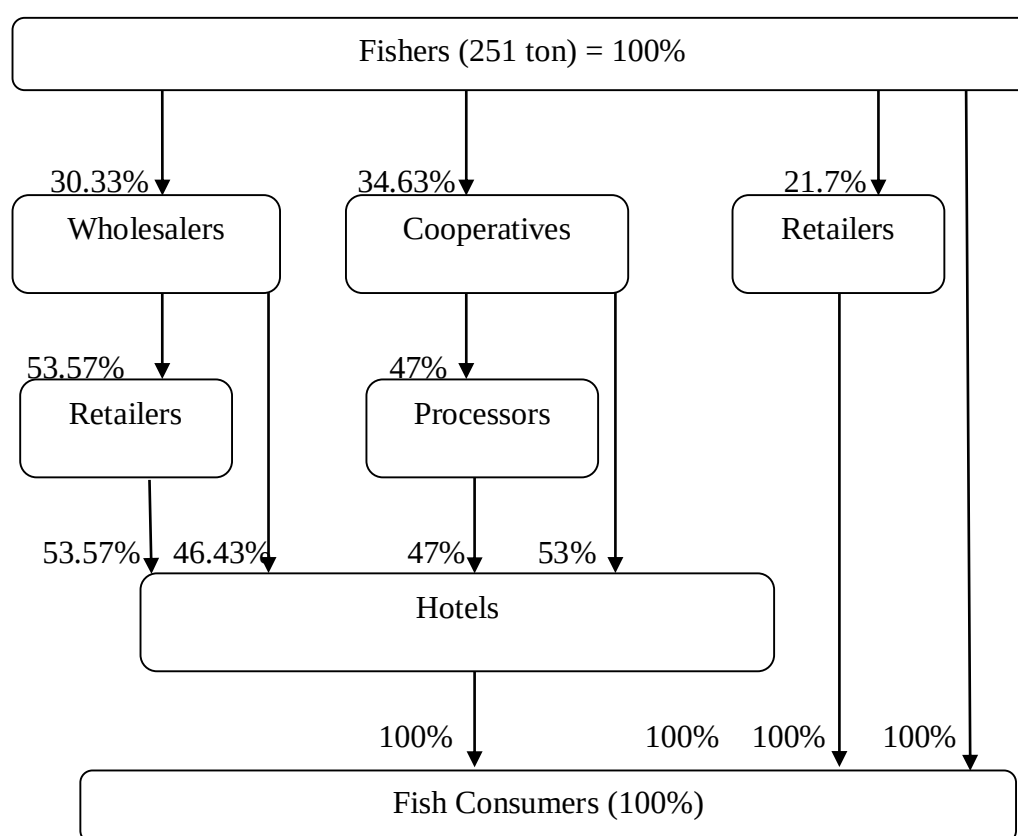
Channel II: Fishers- Fishers Cooperatives-Hotels-Consumers: Fishers Cooperatives are buying fish directly from Fishers and sell to Hotels. Hotels preparing fish food then sell to consumers. It accounted for 53% of total 46.23 tonnes of fish marketed during the survey period.

Channel III: Fishers-Fisher's Cooperatives-Processors-Hotels-Consumers: Fishers cooperatives sell to processors to Hotels. Hotels then directly sell to consumers after preparing fish food. In this channel about 47% of 40.88 tonnes of fish marketed during the survey period.

Channel IV: Fishers-Wholesalers-Retailers-Hotels-Consumers: Wholesalers are buying fish directly from Fishers and then they sell to Retailers to Hotels. Hotels then sell to Consumers by preparing fish food. It accounted for 53.57% of total 40.78 tonnes of fish marketed during the survey period.

Channel V: Fishers-Wholesalers-Hotels-Consumers: Wholesalers are buying fish directly from Fishers and then sell to Hotels. Hotels then sell to Consumers by preparing fish food. It accounted for 46.43% of the total 35.34 tonnes of fish marketed during the survey period.

Channel VI: Fishers-Retailers-Consumers: Retailers are directly buying fish from Fishers and then sell to Consumers. It accounted for 21.7% of total 54.47 tonnes of fish marketed during the survey period.



Source: Own sketch of Survey result, 2018

Figure 4: Marketing channel of Fish market

4.4. Market Structure- Conduct and Performance of Fish

4.4.1. Market Structure

To evaluate the structure of fish market the following characteristics were used:

Entry Barriers to the Fish Market

In the study area, there were some limiting factors that prohibit person from involving in fish marketing activities. Such barriers include:

Capital: fish marketing activities basically need financial capital to mobilize product from place to place and/or person to person. As traders said, to start fish trading, initial financial capacity was indispensable. In study area, finance was not available easily as traders need to run fish marketing functions. Even if financial capital accessed easily, its interest rate was not affordable. Working capital was also challenging fish traders. Traders tell that working capital was obtained from daily fish transaction but not initial capital. Therefore, these factors restricted the traders from involvement in the market.

Market Price Information: recently, market demand and price information are the key factors which enable traders to be effective. Seeking accurate and valid price information encourages traders to marketing his/her fish easily and making his/her marketing activities sustained. But in study area, some traders do not get accurate and up dated fish price and demand information. Hence, they faced huge fish post-harvest loss and get in bankruptcy. Unavailability of the media and/or stakeholders which provide valid information also prohibits traders from entering in the markets.

Education Level: fish marketing activity involvement from this lake was determined mainly by fishery sector entities. These entities organize traders' cooperative membership style to establish competent fish traders who can distribute product as needed to fulfill population demand as much as possible. While establishing traders' membership, education level or evidence could be required. Therefore, the person who could not fulfill educational

requirement might not get license and/or permission to enter in to fish harvesting and/or marketing.

Market Transparency

Refers to the reliability of market information and explicitly imply the perfect condition of the market. Transparency focuses more on situational market information rather than trends. Information about fish demand, prices, needs and preferences exchanged among participants might be relevant and necessary. Both backward and forward activities information might be clearly displayed to traders in a transparent market. Some traders might not trust other traders regarding market information. The competition made between fish traders to become more profitable, might force traders sometimes to hide real information and makes market imperfect. Therefore, some traders offer fish to the market on the basis of previous fish market demand and price information.

Concentration Ratio of Fish Markets

Here, the analysis of the degree of the market concentration was calculated for the lake fish markets. The calculation was made for traders in sampled market places. The calculation took the daily total purchased volume because of the fish market was performed generally from daily harvesting of fish. Unlike the fish harvesting, fish marketing operated by few small traders. According to Kohls and Uhl (1985) the four firms (CR_4) concentration ratio is the important concentration ratio level to determine the market structure.

Accordingly, a CR_4 over 50% is considered as tight oligopoly; a CR_4 between 25 and 50% is recognized as loose oligopoly market structure and a CR_4 less than 25% is no oligopoly at all. Nevertheless, the traders of fish at each sample site market were few in number. Therefore, the computation of the concentration ratio was undertaken for all traders for the sake of its accuracy. Under here, concentration ratio for four traders of fish serially summed to decide the structure of market to all traders across the sample site.

Table 5: Calculation of Market Concentration Ratio

No of traders (A)	Cumulative frequency of traders (B)	% of traders (C)	Cumulative % of traders (D)	Quantity purchased in kg per day (E)	Total quantity purchased (F)= E*A	% share of purchase (G)	% cumulative purchased (H)
1	1	4.17	4.17	330	330	13.47	13.47
1	2	4.17	8.34	300	300	12.24	25.71
1	3	4.17	12.51	200	200	8.16	33.87
1	4	4.17	16.68	185	185	7.55	41.42
3	7	12.5	29.18	120	360	14.7	56.11
5	12	20.83	50.01	100	500	20.40	76.51
1	13	4.17	54.18	90	90	3.67	80.18
1	14	4.17	58.35	80	80	3.26	83.44
1	15	4.17	62.52	70	70	2.85	86.29
2	17	8.33	70.85	60	120	4.9	91.19
1	18	4.17	75.02	50	50	2.04	93.23
1	19	4.17	79.19	40	40	1.63	94.86
3	22	12.5	91.69	30	90	3.67	98.53
1	23	4.17	95.86	20	20	0.81	99.34
1	24	4.17	100	15	15	0.66	100
					2450		

Source: Own survey result, 2018

As depicted in Table 5, the result of sample fish traders' concentration ratio was 41.42% CR₄. This showed that loose oligopoly existed in fish market. This means that the top four series traders were less likely controlling the fish market at Lake Hawassa. Therefore, there was market imperfection, large buyers and few sellers, and less competition.

Calculation of Herfindahl- Hirschman Index to Market Concentration

HHI is commonly accepted measure of market concentration. The HHI takes in to consideration the relative size distribution of the firms in market. When the HHI approaches to zero, the market is occupied by a large number of firms of relatively equal sizes whereas when the HHI reaches its maximum 10000 points the market is controlled by a single firm. The HHI increases both a number of firms in the market and the disparity in size between those firms. As UNDOJ (2018) supported, if the HHI is in excess of 2500 points, the market is said to be highly concentrated. When HHI lies between 1500 and 2500 points, it is said to

be moderately concentrated and finally, if the HHI lies below 1500, the market concentration is considered as lower concentration. The HHI is calculated by squaring the market share of each firm competing in the market and then summing the resulting numbers.

Table 6: Herfandahl-Hirschman Index of the 24 Traders

Participant	Market share	Square
A	13.47%	181.44
B	12.24%	149.82
C	8.16%	66.59
D	7.55%	57
E	14.7%	216.09
F	20.40%	416.16
G	3.67%	13.47
H	3.26%	10.63
I	2.85%	8.12
J	4.9%	24.01
K	2.04%	4.16
L	1.63%	2.66
M	3.67%	13.47
N	0.81%	0.56
O	0.66%	0.43
	100%	1164.61

Source: Own computation of survey result, 2018

As result showed, the fish market concentration was 1164.61. According to (Herfandahl, 1945 and Hirschman, 1950) if the HHI becomes less than 1500, the market is recognized as lower concentration. Therefore, the fish market at Lake Hawassa was weak oligopoly which means, a few sellers control the fish market.

4.4.2. Fish Market Conduct

4.4.2.1. Fishers' Market Conduct of Lake Hawassa

All sample fishers of Lake Hawassa supplied their fish to the market. However, the amount of fish supplied to the market varies as fishers' type, home consumption requirement and harvesting techniques. Besides to this, season of harvesting determine supply volume. Generally, fish is harvested all year round but particularly two seasons namely autumn and spring are peak harvesting seasons in Lake Hawassa. Specially, in August, September, February, March and July, more fish are harvested. Except some, the fishers harvest fish for only the market. From the per day total harvested amount, some amount retained for home consumption and some lost after harvesting at landing site level but the rest will be sold in the market.

Fishers harvesting amount varies with different factors which directly and/or indirectly affects fish marketing conduct. Volume of fish market supply varies in all three sites accordingly. The absence of processing house or abattoirs and weak infrastructural development forced Dorebafano site to more home consumption and exposed to post-harvest loss. In Dorebafano site, the fishers sell about 80% of the total fish harvest per day. Amorage del and Tikurwuha sites offer about 88 and 90% of total fish harvest per day, respectively.

This figure is in line with the result by Abebe *et al.* (2013) on market chain analysis of Koka reservoir fish in Ethiopia in which, out of the total fish harvest per day, 90% supplied to the market and the remaining 10% retained to home consumption. However, in this case post-harvest loss was incorporated to identify exact fish market supply. The fish harvesting, consumption, disposal and selling behavior determine fish market performance.

Table 7: Fish Harvesting, Consumption, Disposal and Selling Pattern in the Study Area

Variables	Sample landing sites					
	Amoragedel (%)		Tikurwuha (%)		Dorebafano (%)	
Fish Harvested	100		100		100	
Fish Consumed	4		5		8	
Fish Lost	8		5		12	
Fish Sold	88		90		80	
The average fish price received by fishermen per kg in birr	Tilapia	Catfish	Tilapia	Catfish	Tilapia	Catfish
	50	40	55	45	40	34

Source: Own survey result, 2018

The result showed that, the market supply volume varies according to landing site. For market supply volume variation, the main factors were less market information availability, post-harvest loss, processing materials and methods and storage condition. These variations lead to different price setting and marketing strategy.

Fishers Price Information: Usually the price of fish was determined by the negotiation between fishers and buyers. Before setting fish price, fishers communicate jointly taking the harvested amount and market demand in to account. During low harvesting period, fishers have the power to fix the price of fish accordingly. Price varies according to fish type and size. Due to homogeneity of fish harvested from the Lake, fishers' fish price was almost similar. Fish traders and hotels were major market price providers based on preference and demand of fish by the market.

Selling Strategy: A formal weighing materials was not used by fishers. Fishers sell fish by simple judgment. Counting the fish number was the major buying and selling method. There were two selling strategies used by fishers namely, wholesaling and retailing. To reduce post-harvest loss and sell early, fishers at landing site mostly prefer wholesaling strategy.

4.4.2.2. Traders Fish Market Conduct

Market concentration of fish market participants was determined by CR (n) and HHI thereby directly influencing market conduct and performance. Price information and, buying and selling strategy were the marketing behaviors that might be determined by market concentration.

Price Information: Validity of market information influences traders. Information determine the volume to be purchased, price to be set, type of fish, demand level and places fish shipped. Getting false and invalid information leads traders to high post-harvest loss, extending selling times, variation in purchasing volume and price setting strategy. Co-traders and hotels/cafes were market information providers to traders. Telephone and proximity were also the major information exchanging ways. As indicated in Table 8, 33.33% of information source were from each of other traders, hotels and cafes, and consumers, respectively.

Table 8: Traders Sources of Information

Sources of information	Number of traders	of sample	Proportion	Ways of getting	
				Telephone	Proximity
Other traders	8		33.33	5	3
Hotels and cafes	8		33.33	4	5
Consumers	8		33.33	-	7
Total	24		100	9	15

Source: Survey Result, 2018

As a survey result indicated, 37.5% of the traders who sell their product out of landing sites used telephone rather than proximity. Mostly, traders who shift their fish to Addis Ababa, Zeway, Shashemene, Wondo, Arsinegelle, Dilla, Yirgalem and other towns used telephone frequently. About 62.5% of the traders sell their fish near towns.

The trader price setting strategy during buying period depends on negotiation between traders and fishers. Traders sometimes set price and fishers were price takers. While selling fish, traders set price considering its cost, demand level and holding amount.

Buying and Selling Strategy: Sample traders buy and sell fish day to day as their need and holding capacity. Traders mostly prefer Amoragedel and Tikurwuha sites with their conveniences and proximity. To save time and fish quality traders frequently buy from sites near to the market and having good road. But some traders prefer Dorebafano site with its low fish price and affordability. Traders built loyalty and trust with fishers with strong relationship. These behaviors of traders favor them to buy fish early during less harvesting and supply volume situation. In addition to this, high purchasing power and amount prioritize traders to buy fish as availability.

However, some traders' fraud fishers by minimizing weight and choosing the best fish, retaining the small size fish to fishers. The traders who come early to landing site bought the appropriate size and best fish with affordable price. Sometimes, a trader who buys fish firstly from fishers be informant to other traders about fish price. A trader who comes late buy the remaining fish which might be spoiled and likely lack buyer during resell. Even if almost all traders buy fish from the landing sites at similar price, their selling price may vary due to different factors. The traders at landing site sell at low price. Specially, the price of fish at Addis Ababa, Zeway, and Dilla was high compared with other cities and towns due to high transportation and storage costs. As indicated in Table 9, 20.33% of traders prefer to sell their fish to Addis Ababa due to high price and demand.

Table 9: The Place Where the Traders sell Fish

Towns and cities	Number of sample traders	Proportion
Hawassa	8	33.33
Addis Ababa	5	20.83
Zeway	3	12.5
Dilla	2	8.33
Wondo	2	8.33
Arsi negelle	2	8.33
Shashemene	2	8.33
Total	24	100

Source: Own survey result, 2018

4.4.3. Performance of Fish Market

Performance of the fish market is the heart of the agricultural economic growth in the organization. Market performance can be measured by identifying the total cost, purchase price, selling price added cost and marketing margin (chuong, 2011). Generally, fish market performance was evaluated towards transaction cost, returns, profit and marketing margin. Fishers from the lake incur different costs to harvest and supply fish to the market. They faced transactional, operational and fishing gears costs. These costs were categorized as fixed and variable costs.

Boat, refrigerator and net cost are fixed costs whereas transaction, transportation and operational costs are variable costs. Operational costs include labor, processing and transportation costs. Labor costs were estimated as wages that were paid to net arrangers at landing sites. Here, fisher labor was not considered in the wage estimation process because of fishers are benefit share stakeholders. As a Table 10 showed, total average cost of a fisher was 352.63 birr per day. The average cost of fish per kilogram was 7.75 birr. The average fish harvest per day was 45.5 kilogram. The price of fish at landing sites was determined by farm gate price level. The average price valued at landing site was 48.1 birr per kilogram. Hence, a fresh fish weighted as one kilogram was approximately equivalent to five and three fresh fish of Nile tilapia and African cat fish, respectively. However, processed fifteen Nile tilapia and nine Catfish were quantified to be one kilogram, respectively.

Table 10: Cost of Operating and Marketing of Fish (Birr/kg)

Items	Cost per kg (Birr) (A)	Cost per day (Birr) (B)	Total cost (166*B)
Wage	1	45.5	7553
Processing	1	45.5	7553
Storage	0.75	34.13	5665.58
Other asset cost	5	227.5	37765
Total	7.75	352.63	58536.58

Source: Own survey result, 2018

Note: Number of observation (Fishers) = 166

The marketing cost and margin of fish was calculated along each value chain stage to estimate the benefit of fish marketing for the actors. A Table 11 depicted that, key players incur costs namely transaction, processing, storage, transportation and other related costs. The average cost incurred by wholesalers was 6.5 birr/kg per day. The other actors such as fishers' cooperatives, processors, retailers, and hotels expended 3.75 birr, 2.5 birr, 3.4 birr, and 3 birr per kilogram per day, respectively. This is in line with the study of Abebe (2015) that, a retailer who involved in formally established market incur cost in storing unsold fish.

Table 11: Marketing Costs

Marketing costs	Fishers' Cooperative	Processors	Wholesalers	Retailers	Hotels	Consumers
Transaction cost	1	0.5	1	0.5		
Processing cost	1		1			
Storage cost	0.75		1	0.4	1	
Transporting cost	1	1	3.5	1.5		
Other cost		1		1	2	

Source: Own survey computation, 2018

Table 12: Fish Marketing Margin for key Actors (Birr/kg)

Players	Cost/profit item	Fish marketing channels					
		I	II	III	IV	V	VI
Fishers	Purchase price						
	Harvesting cost	6	6	6	6	6	6
	Marketing cost	1.75	1.75			1.75	1.75

Fishers' cooperative	Selling price	50	48	48	35	35	45
	Market profit	42.25	40.25	42	29	27.25	37.25
	GMM _F (%)	100	73.85	73.85	42.17	42.17	81.82
	Purchase price		48	48			
	transport cost		1	1			
	Marketing cost		2.75	2.75			
	Selling price		55	55			
	Market profit		3.25	3.25			
	GMM _{FC} (%)		10.77	10.77			
	Purchase price			55			
Processors	transport cost			1			
	Marketing cost			1.5			
	Selling price			60			
	Market profit			2.25			
	GMM _P (%)			7.7			
	Purchase price				35	35	
	transport cost				3.5	3.5	
Wholesalers	Marketing cost				3	3	
	Selling price				75	75	
	Market profit				33.5	33.5	
	GMM _W (%)				48.2	48.2	
	Purchase price				75		45
	transport cost						
	Marketing cost				3		3.4
Retailers	Selling price				79		55
	Market profit				1		6.6
	GMM _R (%)				4.82		21.05
	Purchase price		55	60	79	75	
	transaction cost						
	Marketing cost		3	3	3	3	
Hotels							

Selling price	65	65	83	83	
Market profit	7	2	1	5	
GMM _H (%)	15.38	7.7	4.82	9.64	
TGMM (%)	26.15	26.15	57.83	57.83	18.18

Source: Own survey result, 2018

GMM: Gross marketing margin of key players as percentage of final consumers' price

TGMM: total gross marketing margin of marketing channel

Table 12 shows, not only purchase and selling price but also costs associated with marketing and adding value to a product. Except channels IV and V, fishers profit was high compared to traders' income after deducting any costs related to fish. Fishers received full market share (100%) when they sell fish directly to consumers in channel I. Profit margin of fishers in channel I, II, III, IV, V, VI was 42.25, 40.25, 42, 29, 27.25, and 37.25 birr/kg/day, respectively.

The actors who got the next market share were wholesalers in channel VI and V with a share of 48.2%. Profit margin of wholesalers in channel IV and V was 33.5 birr/kg/day for each. This indicated that, the market share of fishers was 42.17 for each channel IV and V. Thus, when the channel become long, the fishers get lower market share and largest market share goes to wholesalers at different levels. This is in line with Abebe *et al.* (2013) supported that, when the marketing channel become long, the higher share goes to traders at various levels than fishers. Retailers received 21.05% market share in channel VI. Profit margin of retailers in channel VI was 6.6 birr/kg/day. Market share of fishers' cooperative in channel II and III was 10.77% for each. Processors received 7.7% market share in channel III.

Similarly, hotels shared 15.38% of the market when they purchased from fishers' cooperative in channel II. Moreover, channel I brought more profit to fishers and benefit consumers with high market share and low purchasing price, respectively. Accordingly, total gross marketing margin (TGMM) of all channel were identified. As Table 13 indicated, TGMM was

comparably high in channel IV and V, and low in VI with 57.83 and 18.18 %, respectively. The less the TGMM the higher the profit goes to the fishers. The longer the marketing agents in the channel the lower the share goes to fishers and the higher the purchasing price to the consumers. For instance, the wholesalers in channel VI and V shared 42.2% GMM in each, which was added to the final consumers' price. This implies that the existence of middlemen was influential to consumers' prices.

The less the GMM indicates that, the channel is efficient and favors consumers. The more the costs associated with the fish, forces actors to add their selling price. Market share depicted more about the market performance of actors in the channel. Delivering fish to long distances away from the Lake might push the price up because of high transportation and transaction costs.

4.5. Fish Post-Harvest Loss along the Value Chain

As urbanization and population grows rapidly, the demand for fish rises to feed the growing. Increased number of population need more fish food to production as well as survival. However, fish intake varies from place to place due to production, post-harvest handling practices and consumption patterns. Fish post-harvest loss reduces market supply and food security.

In study area, three types of fish post-harvest loss were identified namely: quantity, quality and market force loss. Kitnoja and Gorny (2010) suggested that, quantity loss refers to those that result in the loss of the amount of a product. According to Kader (2002), quality loss includes those that affect nutrient composition, reduce acceptability and edibility of a given product. According to Agumassie (2018), market force loss, caused by limited access to the market and price fluctuation. Reduction in quality and/or quantity affects both traders and consumers. Quality loss is challenging during weighing and measuring. The amount and pattern of loss varies across the three sites. Similarly, the loss was different across actors along the value chain.

Fish post-harvest Loss Accounted by Fishers: fish harvested from the Lake by licensed fishers. Fishing is a daily activity and post-harvest loss is encountered by fishers. Solomon and Mekonen (2017) investigated that, a significant amount of fish wasted annually because of post-harvest loss. Fishers in Amoragedel, Dorebafano and Tikurwuha faced quantity, quality and market loss. The quantity loss was 69.6, 84.4 and 79.9% of fishers in Amoragedel, Dorebafano and Tikurwuha sites, respectively (Table 13).

The quality loss was 13.6, 27.2 and 20.7% of Amoragedel, Dorebafano and Tikurwuha sites, respectively. The market force loss was 35.9, 44.4 and 41.4% of Amoragedel, Dorebafano and Tikurwuha sites, respectively. Accordingly, the quantity loss was high in Dorebafano which was 84.4%. The quality loss was high in Amoragedel which was 27.2%. Market loss was high in Dorebafano which was 44.4% (Table 13).

Table 13: Response of Fishers on Post-harvest Loss Patterns

Landing site	Sample fishers	Post-harvest loss encountered	No of respondents (%)
Amoragedel	92	Quantity loss	69.6
		Quality loss	13.6
		Market force loss	35.9
Dorebafano	45	Quantity loss	84.4
		Quality loss	27.2
		Market force loss	44.4
Tikurwuha	29	Quantity loss	79.9
		Quality loss	20.7
		Market force loss	41.4
Total	166		

Source: Own computation of survey result, 2018

The average fish harvest per day was 45.5 kg of Lake Hawassa. However, those total harvested amount of fish do not go directly to consumers. At farm gate level, average post-harvest loss per day accounted for 9.48 kg. Almost 1/4 of fish harvested per day was lost

after harvest (Table 14). A fisher has a probability of losing 4,274 kg per year. In monetary terms, a fisher might loss 205, 159 birr per year from the total sale. Quantity loss was the major kind of loss encountered in the study area. Along the fish value chain, each actor faced loss.

Table 14: The Average Post-harvest loss per kg per day of three Sites

landing site	Quantity loss/Kg	Quality loss /Birr	Market loss/Birr
Amoragedel	1.77	0.26	0.57
Dorebafano	2.98	0.38	0.75
Tikurwuha	2.01	0.29	0.47
Total	6.76	0.93	1.79

Source: Own computation from survey result, 2018

Causes of Post-harvest Loss at Fishing Phase: Due to its prompt perishable character, fish is easily exposed to post-harvest loss. Post mortem shelf life of fish is low which is easily affected by bacteria and other contaminants which reduces its quality and creates health problems. Hence, the causes of fish post-harvest loss are enormous. Both human and natural factors have significant impacts. Harvesting immature fishes, employing improper fishing gears and poison dropped in the lake from different industries and referral hospital were identified.

As Table 15 indicated, thrown away and storage time contributed 60.24% and 54.21% of the post-harvest loss, respectively. Storing long without usage of cold facility exposed fish to spoilage and forced to discard. Moreover, the main reasons for fish thrown away include inappropriate net size, damage, poor harvesting method, temperature and spoilage. About 6.24% of the fishers lost fish due to theft. About 24.09% and 17.47% of fishers' faced poor handling and inappropriate harvesting method, respectively. Besides, about 9.03% of the respondents suggested that they lost fish because of insects and birds. About 36.14% of the fishers lost fish due to ambient temperature resulting in quality deterioration and spoilage (Table 15).

Table 15: Causes of Fish Post-harvest Loss at Fishing Level

No	Variables	Frequency (N=166)	Proportion (%)
1	Thrown away	100	60.24
2	Theft	10	6.24
3	Insect and birds	15	9.03
4	Damage	40	24.09
5	Net size	45	27.1
6	Harvesting method	29	17.47
7	Storage time	90	54.21
8	Temperature	60	36.14
9	Spoilage	47	28.31

Source: Own survey result, 2018

Fish Post-harvest Loss accounted by Traders: Table 16 depicted that, thrown away mostly constrain the traders from being effective in marketing activities. About 45.8% of respondents thrown away their fish are due to spoilage. Price decline was the next major factor that forced 37.5% of the traders to discard their fish. Spoilage and quality degradation because of high temperature was another factor which exposed about 29.2% of the traders to loss their fish. This is in line with Agumassie (2018) investigated that; about 46.5% of the respondents reported the high proportion of catch damaged because of ambient temperature while moving to market place.

While selling if fish is exposed to sun, it will lose its quality and perish easily. Traders who lost fish due to infrastructure, storage facility, processing equipment and transportation were 12.5%, 20.8%, 12.5% and 25%, respectively (Table 16).

Table 16: Causes of Post-harvest Loss at Marketing Level

No	Variables	No of respondents (N=24)	Proportion (%)
1	Thrown away	11	45.8
2	Poor Transportation	6	25
3	Poor Infrastructure	3	12.5
4	Poor Processing equipment	3	12.5
5	Lack of market information	2	8.3
6	Price decline	9	37.5
7	Lack of storage facility	5	20.8
8	Temperature	7	29.2

Source: Own survey result, 2018

Fish Post-harvest Loss along Traders: As Table 17 indicated that, fish traders faced with three type of loss namely: - quantity, quality and market force loss. Traders mostly exposed to quantity loss rather than other type of loss. Quantitatively, quantity, quality and market force loss was, 3.79, 0.54 and 1.17 kg/person per day, respectively.

Table 17: The average fish post-harvest loss of traders

Types of loss	Sum	Mean	Proportion
Quantity loss	91	3.79	58.33
Quality loss	13	0.54	20.83
Market force loss	28	1.17	33.33

Source: Own survey result computation, 2018

4.6. OLS Model Result

Econometric analysis emphasize that endogenous variables could be determined by both quantitative and qualitative exogenous variables. Likewise, data obtained from 166 fishers were used to run OLS analysis. Before fitting OLS regression, the basic problems related to OLS model was tested. The critical assumption such as multicollinearity, hetroscedasticity and specification error that ignore statistical properties OLS were tested. Breusch-pagan/cook Weisberg test was applied to identify the existence of and/or to detect hetroscedasticity. In a sense, there was hetroscedasticity problem that ignore BLUE properties of OLS with inconsistency problem. Therefore, Robust OLS result detects different covariate character to bring constant variance through overcoming hetroscedasticity problems.

Besides to test the presence of multicollinearity in the data set, VIF was used. The result of VIF was less than 10 for each included variables with mean value of 1.91. Again to identify specification error due to omitted relevant variables and for its detection Ramsey reset test using the power of fitted value was applied. The result of MLR showed that there was no omitted relevant variable for the fish market supply ($F = 2.03$ ($P = 0.11$)).

The estimates of parameter of the variables are believed to determine the marketed supply volume of fish. Basically, 12 explanatory variables (4 continuous 7 dummy and 1 categorical) were used to identify the determinants of volume of fish supply by fishers. Out of these, market information, household education, fishing experience, ownership of cold storage, credit access, site of fishing and post-harvest loss affecting the volume of fish supply statistically and significantly. Results depicted that, market information, household education, credit access, experience of fishers and ownership of cold storage affected positively and statistically; whereas Dorebafano site and post-harvest loss negatively and significantly affect.

Table 18: Determinants of Fish Market Supply (OLS result)

Variables	Coefficient	Robust Std. Error	P-value
Access to market information	14.000	2.565	0.000**
Household education level	0.836	0.438	0.058*
Access to credit services	7.935	4.056	0.052*
Fishing experience	0.652	0.231	0.005**
market price	0.093	0.192	0.630
Access to fishing training	-0.992	2.781	0.722
Value addition	-0.618	2.390	0.796
Owning cold storage	14.562	3.105	0.000**
Cooperative membership	0.592	2.221	0.790
Boat ownership	2.407	2.650	0.365
Landing site (cf. Amoragedel)			
Tikurwuha	-1.686	2.859	0.556
Dorebafano	-5.578	3.155	0.079*
Post-harvest loss	-0.381	0.198	0.056*
Number of Observation		166	
CONSTANT	19.718	9.553	0.041
F (13, 152)		36.17	
R- SQUARE		0.756	

Source: Survey outcome in 2018

Note: ** and * indicates significance at 1% and 10% probability levels respectively.

As depicted in Table 18, the model was statistically significant at 1% significance level implies that the goodness of fit of the model to explain the relationships of the hypothesized variables. The coefficient of multiple determination (R^2) was used to check goodness of fit for the regression model. Hence, R^2 indicates that 76 percent of the variation in the quantity of fish supplied to market was explained by the variables included in the model. The explanation of the effects of the significant explanatory variables on the dependent variable is discussed below.

Market information (MKT_INF) – As a survey result showed that, market information positively and significantly affected the volume of fish supply a significance level at 1%. If fishers get market information, fish market supply increases by 14 kilograms. Updated and valid market information could help fishers to design best fish selling and cost minimization strategy, and choose which fish should be harvested and shipping places. Therefore, fishers harvest fish daily and marketing with no delay. Similarly, Assefa (2013) has found that, having market information increases the probability of entering in market and supply of haricot bean. A fisher who gets current information might apply modern technology to his daily operation. This information was accessed through various sources like telephone services, radio program; others fish traders and fish training extension agents.

Household Education Level (EDUC) – Education has showed positive effect on fish supplied to market with significance level less than 10%. The survey result showed that, if fishermen gets educated, the fish volume supplied to the market increases by 0.836 Kilogram. Pursuing formal education may improve skills and knowledge of fishers about adopting harvesting technology and technical advice which encourage them to gather valid and updated fish market information. This is in line with Ayelech (2011) who found that, if avocado producer gets educated, the amount of avocado supplied to the market increases. Also Abebe *et al.* (2013) reported that, literacy reduces the risk of depletion of fish genetic resources by abstaining from using small sized mesh. The fishers, who educated more, can supply the more fish to the market by diversifying their harvesting techniques by coordinating with fishing training.

Access to Credit services (CRDT) - It affected fish market supply positively and significantly at less than 10% level of significance. If fishers accessing credit, increase their supply by 7.935 kilograms. Meseret (2018) found that, the amount of credit used increased the malt barley market supply and ensure market stability of farmers. The fishers who obtain credit and invested on fish harvesting and market operation supplied more fish to the market. The credit obtained by fishers, expensed in buying fishing gears and boat. This is in line with Abebe *et al.* (2013) the household who get opportunity to receive credit build his capacity to buy and use mesh and boat. According to Assefa (2013) the households accessed credit

services in a better way might be involved in producing much haricot bean and can potentially supply to the market.

Fishing experience (EXP_OFF) – The result of the model showed that experience of fishers in fish harvesting affected market supply positively and significantly at 1% level of significance. Thus, the result reveals that, if fishers experience increases by 1 year, the fish supplied to the market increase by 0.652 kilograms. Likely, Kabtamu (2012) supported that farm experience of household head affected positively and significantly in mango supply in Babile district. Experienced fishers supply more fish to the market than new entrants do. Because, experienced fishers know the time of fish abundances, location of fish, demand dynamics, and techniques applied in fishing.

Ownership of Cold storage (OW_CST) – This implies that, ownership of cold storage positively and significantly affected fish supplied to the market at 1% significance level. If fishers own cold storage, the supply of fish to the market increases by 14.562 kilogram. Refrigerator was the most influential storage facility in fishing area with its cooling and shelf life extending ability. With the help of cooling facility, the fishers save their resource from unnecessary market failure which leads to market force fish loss and cheap selling price. Even if the price of refrigerator was expensive, some of the fishers own it to reduce post-harvest loss and extend fish shelf life.

Landing Site (LS) – The outcome of the model reveal that, site Dorebafano was negatively and significantly affected fish supplied to the market at the significance level of less than 10%. If the fishers are from Dorebafano, the supply of fish to the market decreases by 5.578 kilogram than two sites namely Amoragedel and Tikurwuha do. Due to inconvenient of site toward poor infrastructure like road, electricity and transport vehicles this site more likely restricted from supply more fish to the market. In addition to this during transporting to the market, inconvenient road leads to cracking fish and exposed to temperature and spoilage. This site incurs more likely high cost while move fish and buying inputs since it is far away from the town. Meseret (2018) suggested that, distance affected malt barley market supply negatively and significantly at 5% significance level. When the distance from the nearest

market increases by one km, the quantity of malt barley supplied to the market decreased by 0.0998 quintal, holding all other variables constant. Therefore, this is because of, when the landing site far from the market center, increases transportation cost and expose fish to post harvest loss due to ambient temperature, poor storage and so on which in turn decreases the fish market supply.

Post-harvest loss (PHL) – Post-harvest loss negatively and significantly affected the fish market supply at the significance level of less than 10%. If fishers are exposed to fish post-harvest loss, the supply of fish to the market decreases by 0.381 kilogram. Post-harvest loss affects fishers' income and food security. Quality loss is the difference between the potential value of fish or fish product that would be received if no deterioration had taken places and the actual value of fish after it had undergone change due to spoilage and was sold for a low price (Alemu, 2016). From 176 kg of Bagrus harvested per day, 60 kg (34.09%) of quality deteriorated fish was discarded (Alemu, 2016). Market force loss is the difference between expected value and actual value (Shafiur, 2007). Assefa (2014) said that, quality loss is the loss after harvesting the fish totally not use whether thrown away suddenly either voluntarily or authorized. According to Teklu (2015) Ethiopia loses one-third of its annual production and this was about 10,000 tons of fish per annum among 28,000 tons of production. Due to its natural characteristics, fish spoil instantly after harvest as not put as in cold storage. Factors contributing to fish discard along fish value chain of Lake Hawassa minimizing fish supply which decreases consumers' affordability of fish price.

4.7. Challenges and Opportunities along the Fish Value Chain

The system of Fish value chain of Lake Hawassa was constrained by various factors starting from input supply to consumption. Primary activities of actors hindered typically by complex problems related to supplying fish at national scale. Bottlenecks that particularly lower actor efficiency are so many. The convenience of analysis necessitates categorizing the value chain functions at four phases to articulate constraints along the chain. These categorizes are the fishing phase, marketing phase, food preparing phase and consumption phase.

Fishing phase: at the fishing level, the problems faced were fishing gears and vessels, weak forward and backward linkages, low knowledge and skills, other competitor force, market linkages, market information access, theft, water billow, water quality and management, infrastructure, lack of post-harvest handling facility, lack of cold storage and post-harvest losses. As Table 19 shows, 38.2% of the fishers' encountered the problems toward fishing gears and vessels which was highly affecting fishers next to post harvest loss.

The costs of nets and boats set by producers and traders were high around the Lake. Lack of accessibility to boats according to fishers' preference restrained them from effective fishing. Thin and inconvenience behavior of nets were challenging fishers during harvesting time. Easily spoilage character of nets when spreading in the lake was also the other problem during fishing period. Post-harvest loss was the most important problem of fishing during harvesting, at landing site and transporting period. According to the survey result, 67.5% fishers' faced post-harvest loss.

Table 19: Constraints that hindering fishers at Lake Hawassa

No	Variables	No of respondents (N=166)	Percent
1	Fishing gears and vessels	63	38.2
2	Knowledge and Skill	19	11.4
3	Other competitor force	32	19.3
4	Market Linkage	44	26.5
5	Market Information Access	29	17.5
6	Theft	29	17.5
7	Water Billow	19	11.4
8	Water Quality and Management	6	3.6
9	Infrastructure	32	19.3
10	Lack of Post-harvest Handling Facility	28	16.9
11	Lack of Cold Storage	29	17.5
12	Postharvest Loss	112	67.5

Source: Own survey result, 2018

The result depicted above in Table 19 shows that, constraints might affect fishers either directly or indirectly along the value chain. The direct constraints were fishing gears, water billow, water quality and management and post-harvest loss. Whereas backward and forward linkages, knowledge and skill, market information, infrastructure, lack of post-harvest handling facility and lack of cold storage are indirect constraints.

This result is in line with the study of Addisu (2016) who stated that, those farmers do not have storage facility forced to sell immediately after harvest. About 26.5% of the fishers were influenced by weak market linkages. Shortage of organized market linkages exposes fishers to significant post-harvest loss. In addition, fishers who do not have enough storage facility are forced to sell their fish immediately after harvest. Thus, the perishable characteristic of fish limits their negotiation.

To minimize such problems, corrective actions such as providing incentives, enforcing rule and regulation, prohibiting illegal fishers and hook harvest, securing lake hygiene, and establish horizontal relationship between fishers should be undertaken. Fishers can also take action as systematically resisting water billow, receiving credit from potential creditors to facilitate fish harvesting and marketing, applying appropriate harvesting methods and marketing activities to reduce post-harvest loss.

Traders and hotels: Traders and hotels faced marketing constraints along the value chain concerning fish products trading and preparing fish food. The main constraints include poor roads, lack of enough cold storage, high cost of processing and transportation, low access to credit, unstandardization of weights and measures during buying and selling period, disappearance of safety and inspection organ and less extension of market information delivering media. According to the table below, the traders and hotels most importantly, constrained by market and financial constraints.

The result showed that, shortage of fund and price and competitor affects traders significantly of 53.33% and 33.33% respectively. Majority of the respondents were unable to adopt new technology and processing methods due to fund shortage. Due to price fluctuation, traders

might be exposed to bankruptcy that leads to abandon of fish trading activity. The problems of intermediaries accounted for 10% of the traders.

Table 20: The Constraints of Traders along the Value Chain

No	Variables	No. of respondents (N= 24)	Proportion (%)
1	Equipment constraints	6	25
2	Market constraints	10	41.67
3	Infrastructure	3	12.5
4	Financial constraints	15	62.5
5	Transportation constraints	8	33.33
6	Resource constraints	9	37.5
7	Intermediaries	3	12.5

Source: Own survey result, 2018

At Table 20 indicated, about 30% of the traders faced transportation constraints regarding moving fish from high harvesting to low/no production area to fulfill fish demand. Shortage and/or inconvenience of vehicles and lack of and/or high cost of fuel limit the movement of the product. About 13.33% of the traders in Dorebafano site were affected by poor road and lack of electric power. This site is critically affected by infrastructure and transportation constraints than other sites. About 23.33% of respondents were affected by equipment constraints. Unfavorable chopping and gutting facility cause fish loss while processing.

Enhancing fishers' technical and financial capacities helps to withstand risks and uncertainties toward fish harvesting and supply. As a table indicated, accessing and using enough credit to purchase good nets and boats increases fishers' potential to supply more. Processors also need to improve processing methods to increase fish supply and maintain its quality. Applying appropriate processing facility maintains quality and safeguard hygiene.

In addition, traders, seek market information to provide according to buyer's requirement and reduce loss. Cold storage safeguards traders from loss when they lack market demand. Hotels

keep hygiene and seek preference and tastes to prepare fish food accordingly and save food disposal before use. Finally, promotion of fish consumption could be one solution to create demand.

One of the benefits of value chain analysis is articulating the opportunities that can be exploited along the value chain. Various opportunities might be available to improve performance of the value chain. As the Lake is so around the city, there were a number of opportunities for each actor along the value chain. The major opportunities include the road being under construction from Hawassa city to Hawassa airport created good demand and fast delivery, highly increasing demand by consumers' overtime, opportunity to move fish to near market from landing site. As single fish is cheap and can substitute ruminant and beef cattle meat, fish was demanded highly by consumers across the areas. The strategy and policies designed by a government to establish equipped fishery sector and sustainable fish resource availability.

The financial support provided from GO and NGO also encourages fishers to harvest well and substantially supply fish to the market. Favorable fish price, good awareness of consumers about fish importance and its impacts in human health, availability of cooling facility are some of the opportunities available along the value chain. These opportunities were identified in various levels namely: at fishing, processing, marketing, fish food preparing and consumption level. These indispensable opportunities might encourage actors and consumers to participate in the value chain.

At fishing level: no land crowdedness like other agricultural activities, accessing fishing harvesting chance easily, no need of more feed to fish, demand availability to fish all year round, support of fund from GO and NGO, and credit facility accessibility.

At processing level: having demand for processed fish, having abattoir, having fish resource immediately as harvested. At marketing level: fish demand availability with appropriate price, government investment on infrastructure development, availability of potential creditors, at consumption level: availability of diversified fish sellers, fish species preference, having various fish food preparing hotels and/or café.

5. SUMMARY, CONCLUSION AND RECOMMENDATION

5.1. Summary and Conclusion

Lake Hawassa is a source of income and livelihoods to inhabitants in and around Hawassa city. Hence, this study aimed to analyzing fish value chain and post-harvest loss of Lake Hawassa. The specific objectives of the study are identifying value chain actors, their role and linkages, draw up value chain map; analyze S-C-P of fish market; assess post-harvest loss along the value chain and identify the factors that affect the volume of fish supply.

Primary and secondary data were generated. The primary data were collected from 200 respondents (166 fishers and 24 traders, cooperatives, processors and hotels, and 10 consumers). This data was collected through semi-structured interview schedule, focus group discussion, observation and key informants' interviews. Secondary data were collected from published and unpublished sources. Published document used for data collection were journal articles, review papers, proceedings and so on. Similarly, unpublished data were obtained from Agricultural office, Hawassa city, and Tikurwuha and Sidama Zone Fishery sector documents. Two-stage technique was employed to select sample respondents. Firstly, stratified sampling method was employed to categorize the sites. Secondly, simple random sampling method was applied to select sample respondents from each site.

Both qualitative and quantitative methods were used to data analysis. To enter, organize and analyze data, STATA version 15 and SPSS version 25 software were employed. Descriptive statistics were employed to analyse, demographic and socio-economic characteristics and post-harvest loss analysis. Value chain analysis was adopted to map fish value chain activities and their roles and linkages. S-C-P model were employed to measure harvesting and marketing costs of actors, market share, and to profitability of actors along the value chain. Finally, OLS econometric model were applied to identify the factors that affect fish supply volume.

As the study indicated, all fishers of Lake Hawassa were men. Along the fish value chain, there were direct and indirect actors who are involved in moving product from conception to

consumption. The actors who are directly involved were fishers, fisher's cooperative, processors, wholesalers, retailers, hotels/café and consumers. Whereas the supporters of value chain were Hawassa, Sidama zone and Oromia region fishery sector, training agents, Sidama and Omo credit and saving institutions, Hawassa university research agents, Hawassa trade and industry office and potential creditors.

From Lake Hawassa six main fish marketing channels were identified. The fish traders' market concentration was 41.42% and some entry barriers were identified and the market was a kind of weak oligopoly and imperfect. As indicators of market conduct of buying, selling and pricing strategies, the market is less likely deviated from competitive market. Marketing cost was high to wholesalers (6.75 birr/kg) followed by fishers' cooperatives (3.75 birr/kg). Except channel IV and V, fishers shared high marketing margin and profit.

Highest market share of fishers were 100% and 81.82% of channel I and II, VI, respectively whereas low market share was 42.17% of channel V. The next high marketing margin was shared by wholesaler 48.2% and retailer 21.05% channel VI, V, and VI, respectively. High market share received by wholesalers were 33.25 birr/kg and retailers 6.6 birr/kg in channel IV, V and V, respectively. Three kinds of post-harvest loss were identified; quantity, quality and market force loss. Post-harvest loss was high in Dorebafano site due to inconvenient of site.

Poor infrastructure, processing equipment's and transportation; lack of storage facility and market information; price fluctuation, net size and temperature were identified as causes of fish loss. The measures to reduce post-harvest loss include employ appropriate harvesting and processing methods, keep hygiene and ensure quality, adopt cold storage and appropriate transporting vehicles and employing relevant value addition techniques and facility.

The opportunities that favors value chain actors were having demand for fish all year round, support gained from GO and NGO, training from concerning body, accessing credit and government investment on infrastructural development. As the OLS result revealed, market information, household education, fishing experience, ownership of cold storage, credit access, site of fishing and post-harvest loss statistically and significantly affected the volume

of fish supply. Market information, household education, fishing experience, access to credit services and ownership of cold storage positively and significantly affected fish market supply. Whereas post-harvest loss and fishing site (Dorebafano) negatively and significantly affected fish market supply.

The Lake Hawassa created enabling environment for fish harvesting and marketing activities. The Lake open job opportunities, contributes to GDP, economic development and food security. The highly consumed fish types in Lake Hawassa are two namely, Nile Tilapia and African Cat fish. The main market destination of fish from Lake Hawassa were Hawassa city, Addis Ababa, Zeway, Shashemene, Dilla, Wondogenet, Alettawondo, Arsinegelle, Yirgalem, Lakko, Tula and So on.

5.2. Recommendation

The fishing and processing activities in the fishing site were male dominated. Hence, empowering female in those activities should be necessary. Illegal fishers have been harvesting immature fish and creating resource tragedy. Therefore, establishing strong fishers' cooperatives should take place to sustain fish harvesting and supply. Further, improving fishers bargaining power through establishing interaction and fisher's cooperatives is the best measure that should be taken to reduce oligopolistic nature of the fish market. When Compared to other Lakes, the price of fish from Lake Hawassa was high. Therefore, establishing good interaction and market linkage among value chain actors are required to charge affordable competitive price by fishers and traders.

Similarly, the fish market was characterized by weak oligopoly. Hence, increasing the bargaining power of the fishers is relevant measure to lower harvesting and marketing costs and price of fish. Post-harvest loss along the fish value chain reduces food security and income generation. So, integration and appropriate measures should be undertaken to minimize the loss. The main challenges in fish value chain were lack of latest and appropriate post-harvest handling facility and lack of cold storage. Hence, interventions are important to sustain fish value chain and improve fishers' livelihood. Providing basic inputs namely; nets,

boats, refrigerators and motorized boat to fishers and fishers' cooperatives should increase supply of fish to the markets.

Access to market information affected the supply of fish positively. So, fishers' access to updated market information should be strengthened. Government of Ethiopia should implement an advanced information distribution system to favor all fish value chain actors.

Household education level affected the fish supply positively. Therefore, fisher gets educated should be encouraged. Fishers by themselves should be voluntary and desire to follow education to improve fishing skills. Government of Ethiopia should diversify academic center and favor fishers to pursue education.

Credit use affected the supply of fish positively. Thus, provision of credit facilities to fishers should be encouraged by microfinance institution and potential private creditors.

Owning of cold storage was found to be determining the supply of fish positively since it maintains fish quality and elongates shelf life. Hence, accessing refrigerator to minimize fish post-harvest loss should be given attention by fishers, trade and industry office, and fishery office.

Experience of fishing was found to increase fish supply. Therefore, experience sharing among fishers should be considered.

Site of fishing was found to be negatively affecting fish supply. Dorebafano landing site was limited by factors like far distance, lack of infrastructure and good market. Therefore, to use refrigerator and other value adding equipment, developing infrastructure and facility should be considered by road and transportation office, Ethiopia electric power corporation.

Post-harvest loss was found to be reducing fish supply significantly. Therefore, each actor along the value chain should undertake appropriate post-harvest handling practices. Processing and Packing fish with advanced packaging materials should extend shelf life and minimize post-harvest loss. The chain actors should engage in an integrated way build trust, and loyalty among them to improve harvest and reduce fish post-harvest loss.

6. REFERNCES

- Abbas, K.A., Saleh, A. M., Mohamed Abd and Lasekan, O. 2009. The Relationship between Water Activity and Fish Spoilage During Cold Storage. *Article in Journal of Food and Agricultural Environment*, 7: 86-90.
- Abebe Ameha and Sileshi Ashine. 2015. Tilapia Aquaculture Business Model for Ethiopia: Feasibility Study: Addis Ababa Chamber of Commerce and Sectoral Associations.
- Abebe Cheffo, Lemma Zemedu and Endrias Geta. 2013. Market Chain Analysis of Koka Reservoir Fish in Ethiopia. *American Journal of Scientific Research and Essays*, 1(1): 0042-0053.
- Abebe Cheffo, Hiwot Teshome and Genanaw Tesfaye. 2015. Opportunities and Challenges of Fish Marketing at Gelgel Gibe Dam in Ethiopia.
- Abebe Ejigu and Tekle Mariam. 2015. Livelihood Effects of Fishing and Constraints Affecting Participation in Fishing in Tigray.
- Abegaz Hussien, Alayu Yalew and Ermias Mengistu. 2010a. Fishery Resource Development Program: Survey on Fish Resource Potential and Socio-Economics of Tendaho Reservoir, Afar National Regional State, Addis Ababa, Ethiopia. Agricultural Extension Directorate, Ministry of Agriculture.
- Abegaz Hussien, Alayu Yalew and Ermias Mengistu. 2010b. Fishery Resource Development Program: Fish Resource Survey in Benishangul Gumuz Regional State. Addis Ababa, Ethiopia.
- Abegaz Hussien, Alayu Yalew and Ermias Mengistu. 2010c. Riverine Fishery Assessment in Gambella Peoples' Regional State, Addis Ababa, Ethiopia.
- Abera Degebassa. 2010. Technical and Socio-economic Characteristics of Fishing Activities: Fish Handling and Processing in Ethiopia in Management of Shallow Water Bodies for Improved Productivity and Peoples' livelihoods in Ethiopia. EFASA, Addis Ababa.
- AGP (Agricultural Growth Program). 2013. Value Chain Analysis for Ethiopia: Expanding Livestock Markets for the Small-holder Producers.
- Agumassie Tesfahun. 2018. Review in Current Problems of Ethiopian Fishery: In Case of Human and Natural Associated Impacts on Water Bodies, Reproductive Biology and

Feeding Habits of Commercially Important Fish Species in Ethiopian Rift Valley Lakes.

- Akande, G.R., Diei-Ouadi. Y. Post-harvest losses in small-scale fisheries. Case studies in five sub-Saharan African countries. FAO Fisheries and Aquaculture Technical Paper No. 550. Rome: FAO; 2010.
- Aklilu Nigussie. 2018. Livestock and Fisheries Research Strategies. EIAR (Livestock and Fisheries Research) Strategies 2016 – 2030.
- Alemu Lema Abelti. 2016. Postharvest and Nutritional Loss Assessment of Fish at Different Handling Stage from Genale River, Southeastern Oromia.
- Ames B.N, Magaw, R. and Gold L.S. 1990. The Kinds and Levels of Post-harvest Losses in African Inland Fisheries. *Proceedings of the Symposium on Post-Harvest Fish Technology*, FAO, Italy, pp: 1-10.
- Ames, G.R, Clucas, I. and Paul. S.S. 1991. Post-harvest Losses of Fish in the Tropics. Natural Resources Institute, London.
- Anteneh Wassie., Getahun Abebe and Eshete Dejen. 2010. Assessment of Downstream Dispersal of Juveniles of the Migratory Riverine Spawning Labeobarbus species of Lake Tana, pp:161–172. Addis Ababa University ,Addis Ababa, Ethiopia.
- Arrignon, Jacques. 1999. Management of Freshwater Fisheries. Science Publishers, Inc., Enfield, New Hampshire, 582 pp.
- Assefa Mitike. 2013. Assessment of Fish Products Demand in Some Water Bodies of Oromia, Ethiopia: *International Journal of Agricultural Sciences*, 3(9): 460-466.
- Assefa Mitike. 2014. Fish Production, Consumption and Management in Ethiopia. *Research Journal of Agriculture and Environmental Management*, 3: 460–466.
- Aulakh,J And Regmi, 2011. A Post-Harvest Food Losses Estimation- Development of Consistent Methodology.
- Ayalew Wondie. 2010. Current Land use Practices and Possible Management Strategies in Shore area Wetland Ecosystem of Lake Tana: Towards Improving livelihoods, Productivity and Biodiversity Conservation, pp: 7–9.
- Aytegeb Anteneh. 2013. Management and Livelihood Opportunity of Lake Tana Fishery, Ethiopia. Norway: Norwegian College of Fisheries Science.

- Barry Shapiro (ILRI). 2015. Livestock Master Plan (LMP): Roadmaps for the Ethiopia Growth and Transformation Plan (GTP II - 2015-2020): The Livestock State Ministry, MOA and ILRI.
- Barton, D. G. 1989a. Cooperatives in Agriculture. New Jersey: Prentice-Hall, Inc., 1-20.
- Bataringaya, A. 2007. Analysis of Quality Deterioration at Critical Steps/Points in Fish Handling in Uganda and Iceland and Suggestions for Improvement.
- Bastian, A. Q. 2013. Indonesian Education System Fails Students. Retrieved from Jakarta Globe March.
- Bene, C., Lawton, R and Allison, E.H. 2010. "Trade Matters in the Fight Against Poverty": Narratives, Perceptions, and Lack of Evidence in the Case of Fish Trade in Africa. *World Development*, 38(7): 933–954.
- Berhanu Kuma, Derek Baker, Kindie Getnet and Belay Kassa. 2013. Factors Affecting Milk Market Outlet Choices in Wolaita Zone, Ethiopia. Holota Agricultural Research Center, EIAR, Addis Ababa, Ethiopia. *African Journal of Agricultural Marketing*, 1 (2): 024-031.
- Berkowitz, E. N., Kerin, Roger. A and Rudelius, W.1989. "Marketing", 2th edition, Irwin, Boston.
- Beveridge, M. C., Thilsted, S. H., Phillips, M. J., Metian, M., Troell, M and Hall, S. J. 2013. Meeting the food and nutrition needs of the poor: The role of fish and the opportunities and challenges emerging from the rise of aquaculture. *Journal of Fish Biology*, (83): 1067–1084.
- Bikila Keno and Amanuel Zewdie. 2016. Fish Market Supply Analysis the Case of Fincha Amarti Nashe Reservoir in Horo Woreda, Oromia, Ethiopia.
- Bose, K.S. and Sarma, P.V. 2010. Analysis of Costs and Returns of Mechanized Fishing Boat Operations in India. *EJBE*, 1(2): 129-161.
- Bowbrick, P. 1988. "Are Price Reporting Systems of Any Use?" *British Food Journal*, 90:2, pp 65-69.
- Brook Lemma. 2008. Introduction to Lake Ecology, Aquaculture and Fisheries in Ethiopia. Haramaya University, Haramaya, Addis Ababa University Printing Press, Addis Ababa, Ethiopia, 416.

- Brook Lemma. 2012. Report on the Value Chain Assessment of the Fishery Sector in Ethiopia, FAO Sub-regional Office of East Africa, Addis Ababa, Ethiopia.
- Brown, M. A and White, J. 2013. An Introduction to Comparative Education, 0-11: Childhood in Context. New York: Routledge Chapman and Hall.
- Burkepile, D. E., Parker, J. D., Woodson, C. B., Mills, H. J., Kubarek, J., Sobecky, P. A. and Hay, M. E. 2006. Chemically Mediated Competition between Microbes and Animals: Microbes as Consumers in Food Webs. *Journal of Ecology*, 87: 2821 – 2831.
- Buzby, J. C., and Hyman. J. 2012. “Total and per capita value of food loss in the United States.” *Food Policy*, 37(5), 561-570.
- Crammer, G.L. Jensen, C.W and Southgate, D. D. 2001. *Agricultural Economics and Agribusiness* (Eight Editions) John Wiley and Sons, Inc., New York, U.S.
- Central Statistical Agency (CSA). 2017/18. The Federal Democratic Republic of Ethiopia Central Statistical Agency, Agricultural Sample Surveys.
- Cowx, I. G. 2000. Management and Ecology of River Fisheries. Fishing News Books, Ltd., Osney Mead, Oxford, United Kingdom, 444 pp.
- Dagninet Amare., Mihret Endalew., Tegegne Deba., Ayalew Demissew., Kiber Temesgen., Ayenewu Meresa and Amare Getnet. 2018. Fishing Condition and Fishery Income: The Case of Lake Tana, Ethiopia. *International Journal of Aquaculture and Fishery Sciences*, ISSN: 2455-8400.
- Dampha, N.J. 1992. Fish processing in the Kagera Region of Lake Victoria. *A Review-UNDP/FAO Regional Project for Inland Fisheries Planning*.
- Davies, R.M. 2009. Traditional and Improved Fish Processing Technologies in Bayelsa State, Nigeria. *European Journal of Scientific Research* 26(4): 539 - 548.
- Dereje Abebe. 2002. Traditional Fishing in Gambella Region, Gambella Bureau of Agriculture (Unpublished).
- Dereje Tewabe. 2014. Spatial and Temporal Distributions and Some Biological Aspects of Commercially Important Fish Species of Lake Tana, Ethiopia: *Journal of Coastal Life Medicine*, 2(8): 589-595.

- DE Silva. 2011. Value Chain of Fish and Fishery products: Origin, Functions and Application in Developed and Developing Country Markets Value Chain Project, Food and Agriculture Organization.
- Desta Zerihun, Borgstrom. R and Gebremariam Zinabu. 2008. Habitat use and Trophic Position Determine Mercury Concentration in the Straight fin Barbus Paludinosus, a small Fish species in Lake Awassa, Ethiopia, 73: 477-497.
- Devadasan.K. 2003. Value Added Fish and Fishery Products. *Fishing Chimes*, 23(1): 131-136.
- Diei-Ouadi, Y. and Mgawe, Y.I. 2011. Post-harvest Fish Loss Assessment in Small-Scale Fisheries: A Guide for the Extension Officer. FAO Fisheries and Aquaculture Technical Paper No. 559. FAO, Rome. 93pp.
- Dirriba Idahe. 2013. Sheno Butter Market Chain Analysis: The Case of Kimbibit District in North Shewa Zone of Oromia National Regional State, Ethiopia. M.Sc. Thesis, Haramaya University, Ethiopia.
- Ethiopian Institute of Agricultural Research (EIAR). 2017. Livestock and Fisheries Research Strategies; Poultry, Fisheries, Apiculture and Sericulture (2016 – 2030).
- Evans, P. and T. Wurster. 2000. Blown to Bits: How the New Economies of Information Transform Strategy. Harvard Business School Press, Cambridge, Massachusetts, USA.
- Eyabi, E. 1998. Technology for Fish Preservation and Processing in Cameroon. In: *Proceedings of FAO Expert Consultation on Fish Technology in Africa*, Kisumu, Kenya. pp. 88 – 102.
- Eyoo, A. A. 1993. Comparatives Study of the Quality of Smoked Fish from Four Different Smoking Kilns. *Proceeding of FAO expert Consultation on Fish Technology in Africa, Accra, Ghana*, 217 - 227.
- Eyo, E.E. 2002. Fish Processing and Utilisation. *Paper Presented at the National Workshop on Fish Processing, Preservation, Marketing and Utilization*, New Bussa, pp.4-5.
- FAO.1995. Review of the Fisheries and Aquaculture Sector: Ethiopia. FAO Fisheries Circular No. 890, Rome, Italy.
- FAO. 2000. Use of Property Rights in Fisheries Management. Food and Agriculture Organization of United Nations Fisheries Department. Rome, Italy, 2000.

- FAO. Fishery Country Profile, Ethiopia. 2003.
- FAO. 2005. Fishery Country Profile: Food and Agriculture Organization of the United Nations.
- FAO. 2005. World Inventory of Fisheries. Food Utilization and Value-adding. Issues Fact Sheets. Text by Lahsen Ababouch. *FAO Fisheries and Aquaculture Department*.
- FAO. 2005. Addressing Marketing and Processing Constraints that Inhibit Agri-food Experts: A Guide for policy analysts and planners. *FAO Agricultural Service Bulletin* 160. Rome, Italy.
- FAO. 2006. The State of World Fisheries and Aquaculture. Rome, Italy. 198pp.
- FAO. 2007. Real time evaluation of the FAO emergency and rehabilitation operations in response to the Indian Ocean earthquake and tsunami
- FAO. 2010. Post-harvest Losses in Small-scale Fisheries: Case Studies in Five Sub-Saharan African Countries.
- FAO. 2010. The State of World Fisheries and Aquaculture. Vialledelle Terme di Caracalla, 00153, Rome, Italy.
- FAO. 2011. The State of Food and Agriculture: Women in Agriculture Closing the Gender Gap for Development; Food and Agriculture Organization of the United Nations, Rome, Italy.
- FAO. 2012. The State of World Fisheries and Aquaculture. *FAO Fisheries and Aquaculture Department*.
- FAO. 2013. Fish Farming Value Chain Analysis: Policy Implication for Transformation and Robust Growth in Tanzania.
- FAO. 2014. Fishery and Aquaculture Country Profiles, Ethiopia. *FAO Fisheries and Aquaculture Department*.
- FAO. 2018. The State of World Fisheries and Aquaculture in 2016: Contributing to Food Security and Nutrition for All.
- Fellows, A. and Hampton, A. 1992. Small-scale Food Processing. A Guide for Appropriate Equipment.
- Fertő, I. 2004b. Transaction cost economics and agricultural co-operatives: a Hungarian case study.

- Fletcher, W.J., Chesson, J., Fisher, M., Sainsbury K.J., Hundloe, T., Smith, AD.M and Whitworth, B. 2002. *"How To" Guide for Wild Capture Fisheries*. National ESD Reporting Framework for Australian Fisheries: FRDC Project 2000/145. Page 119–120.
- Flores, B. E., Olson, D. L and Dorai, V. K. 1992. Management of Multi-Criteria Inventory Classification. *Mathematical and Computer Modelling*, 16(12): 71-82.
- Galtire, F., David, H., Subervie, J and Egg, J. 2014. Agricultural market information systems in developing countries: New models, new impacts. *Article in Cahiers Agricultures*.
- Gereffi, G. 1994. “The Organization of Buyer-Driven Global Commodity Chains: How U.S. Retailers Shape Overseas Production Networks”, in G. Gereffi and M. Korzeniewicz (eds), *Commodity Chains and Global Capitalism*, Westport, CT: Praeger: 95–122.
- Gereffi, G. 1999. A Commodity Chains Framework for Analyzing Global Industries.
- Gbola, A. and Yvette, D. 2010. Post-harvest Losses in Small-scale Fisheries: Case Studies in Five Sub-Saharan African Countries. ISSN: 2070-7010.
- Gebremedhin Gebremeskel. 2014. “Determining Factors for Fishers’ Income: The Case of Lake Tana, Ethiopia”. *International Journal of Current Research*, Pp: 1182-1186.
- Ghaly, A.E., Dave, D., Budge, S. and Brooks, M.S. 2010. Fish Spoilage Mechanisms and Preservation Techniques. *American Journal of Applied Sciences* 7(7): 859 – 877.
- Gordon A, Sewmehon. D.T, and Melaku, T. 2007. Marketing Systems for Fish From Lake Tana, Ethiopia: Opportunities for Improved Marketing and Livelihoods. IPMS (Improving Productivity and Market Success) of Ethiopian Farmers Project Working Paper 2. ILRI (International Livestock Research Institute), Nairobi, Kenya. 49 pp.
- Greene, W. 2003. *Econometric Analysis. Fifth edition*. Prentice Hall, New Jersey.
- Goetz, S. 1992. A Selective Model of Household Food Marketing Behavior in Sub Saharan-Africa. *America Journal of Agricultural Economics*, 74(2): 444-452.
- Gram, L. and Dalgaard, P. 2002. Fish Spoilage Bacteria. Problems and Solutions. *Current Opinion in Biotechnology* 13: 262 – 266.
- Grolleaud, M. 2002. Post-harvest Losses: Discovering the Full Story. Overview of the Phenomenon of Losses during the Post-harvest Handling Practices. Rome, Italy: FAO, Agro Industries and Post-Harvest Management Service (AGSI).

- Gujarati, D. 2003. *Basic Econometrics*, 4th edition. Tata Mc Graw-Hill Publishing Company Limited, New Delhi, India.
- Gwary, M.M., Yekini, I.B, and Diyaware, M.Y. 2014. Value Chain Analysis of Fish Caught in Lake Alau, Borno State, Nigeria. *Nigerian Journal of Fisheries and Aquaculture* 2(1): 15-23.
- Hendrikse, G.W.J. and Veerman, C.P. (2001a). Marketing Co-operatives: An Incomplete Contracting Perspective. *Journal of Agricultural Economics*, 52: 53-64.
- Henson, S. and W. Mitullah (2004) Kenyan Exports of Nile Perch: Impact of Food Safety Standards on an Export-Oriented Supply Chain. Case study for World Bank program on the Challenges and Opportunities Associated with International Agro-Food Standards, Washington, D.C.
- Hettige, S.T., and Senanayake, S. M. P. 1992. Highland Vegetable Production and Marketing Systems. A Report Prepared for Agriculture Cooperative Development International/ USAID.
- Hodges, R.J., Buzby, J.C and Bennett. B. 2011 “Postharvest losses and waste in developed and less developed countries: opportunities to improve resource use.” *Journal of Agricultural Science* 149:37-45.
- Horwitz, S. 2003. “Say’s Law of Markets: An Austrian Appreciation.” In *Two Hundred Years of Say’s Law: Essays on Economic Theory’s Most Controversial Principle*, edited by Steven Kates, 82–98. Cheltenham: Edward Elgar.
- Hui, Y.H. 2006. *Handbook of Food Science, Technology and Engineering*. CRC Press, Boca Raton, FL, Pp. 32-36.
- IOC. 2014. Value Chain Assessments and Targeted Training for Improved Trade Performance: Lake Tana, Chamo, and Zeway, Ethiopia Pp 3-1.
- Johan, R and Harlan, J. 2014. Education Nowadays. Gunadarma University, J Margonda Raya 100, Depok, Indonesia. *International Journal of Educational Science and Research (IJESR)*, 4(5): 51-56.
- Johnston, W.A., Nicholson, F.J. and Roger, A. 1994. Freezing and Refrigerated Storage in Fisheries. Stround Series FAO Fisheries Technical Paper No: 340. Rome, Italy. 143pp.

- Kabahenda, M.K., Omary, P and Husken, S. M. 2009. Post-harvest Handling of Low-value Fish Products and Threats to Nutritional Quality: A Review of Practices in the Lake Victoria region.
- Kader, A.A. 2002. Post-harvest Technology of Horticultural Crops. 3rd edition. University of California, Agricultural Natural Resources, Oakland, Publication. 3311.
- Kaplinsky, R and Morris, M. 2000. A Handbook for Value Chain Research, International Development Research Center (IDRC), Canada.
- Kaplinsky, R., and Morris, M. 2001. A Handbook for Value Chain Research. Working Paper Prepared for the IDRC. Institute for Development Studies, Brighton, UK.
- Kelil, A. 2002. Users' Attitudes Toward Fisheries Management on Lake Zeway, Ethiopia. MSc Thesis, University of Tromsø, Norway.
- Kindie Aysheshm. 2007. Sesame Market Chain Analysis: The Case of Metema Woreda, North Gondar Zone, Amhara National Regional State. M.Sc. Thesis, Haramaya University, Haramaya, Ethiopia.
- Kitinoja, L. and Gorny, J.R. 1999. Postharvest Technology for Small-scale Produce Marketers: Economic Opportunities, Quality and Food Safety, University of California.
- Kiaya. V. 2014. Post-harvest Losses and Strategies to Reduce Them. Technical paper, Scientific and Technical Department.
- KIT, Faida MaLi and IIRR. 2006. Chain Empowerment: Supporting African Farmers to Develop Markets. Amsterdam: Royal Tropical Institute, Arusha; Faida Market Link, and Nairobi: International Institute of Rural Reconstruction.
- Kodithuwakku, K.A.S.S. 2000. Analysis of Tomato Supply Chains in the Kandy District. An Unpublished Report Prepared for University of Peradeniya.
- Kohls, R.L. and Uhl, J.N. 1985. Marketing of Agricultural Product. Fifth Edition. McMillian Publishing Company, New York, USA.
- Kumolu-Johnson, C.A. and Jimoh. A.A. 1997. Quality Assessment of Fresh and Frozen *Oreochromis Niloticus* (Trewavas) in Some Markets in Niger State, Nigeria. *Journal of Prospects Science*, 1: 145-148.

- Kumolu, J. C. and Ndimele, P. E. 2011. A Review on Post-harvest losses in Artisanal Fisheries of Some African Countries. *Journal of Fisheries and Aquatic Sciences* 6(4): 365 – 378.
- Kuje, Y.J., Usman, F.A and Aka'ama, W. 2011. Prospects for Adaptable Technological Innovations in Fresh Fish Processing and Storage in Rural Areas of Doma, L of Nasarawa State. *Journal of Agricultural Science* 3(3): 1-5.
- Legese, G. and Hordofa, D. 2011. Value Chain Analysis of Small Ruminant Sub-sector in Oromia and South Region, Addis Ababa, Ethiopia: Berhan and Associates Consultancy PLC.
- Lemma Abera. 2017. Fisheries Production System Scenario in Ethiopia. *International Journal of Fisheries and Aquatic Studies*, 5(1): 79-84.
- Lévêque, C., Oberdorff, T., Paugy, D., Stiassny, M.L.J. and Tedesco, P.A. 2008. Global Diversity of Fish (Pisces) in freshwater. *Journal of Fish Biology*, Pp: 545-567.
- Maddala, G.S. 2001. Introduction to Econometrics. Third Edition, John Will.
- Madden, C.J and Grossman, D.H .2004. *A Framework for a Coastal/Marine Ecological Classification Standard*.
- Maqsood, S., Singh, P., Hassan, M., Samoon and Bilal, W. 2019. Various Fish and Fish Products Being Produced In Fish Processing Industries and Their Value Addition. Faculty of Fisheries, Sher-e-Kashmir University of Agricultural Science and Technology-Kashmir.
- Mathewos Temesgen and Abebe Getahun. 2016. Fishery Management Problems in Ethiopia: Natural and Human Induced Impacts and the Conservation Challenges. *Reviews in Fisheries Science and Aquaculture*, 24(4): 305-313.
- Millennium Ecosystem Assessment (MEA). 2005b. Ecosystems and Human Well-Being: Wetlands and Water Synthesis. Washington, DC, World Resources Institute (WRI).
- Meseret Alef. 2018. Analysis of Malt Barley Value Chain: The Case of Angolalla Tera Woreda of North Shewa Zone, Amhara Region, Ethiopia. M.Sc. Thesis in Haramaya University, Haramaya, Ethiopia.

- Ministry of Finance and Economic Development (MoFED). 2010. Growth and Transformation Plan (GTP) Working Paper. Addis Ababa: Federal Democratic Republic of Ethiopia.
- Ministry of Agriculture (MoA). 2006. Fishery Resource Development, Guide Plan Ministry of Agriculture, Addis Ababa, Ethiopia.
- Mohammed, B., de Graaf, M., Nagelkerke, L.A., Mingist, M and Anteneh, W. 2011. Lake Tana, Ethiopia Endemic Labeobarbus Species Flock; a Uncertain Future Threatened by Exploitation, Land use and Water Resource Developments. In: Proceedings of the Ethiopian Fisheries and Aquatic Sciences Association (EFASA) Meeting, University of Haramaya, Harar, Ethiopia.
- Montaner, M.I., Parin, M.A., Zugarramudi, A.Y and Lupm, H.M. 1994. Requerimien to in Sumosen Industria Pesquera. Alirn., Espana, (253):19-24.
- Muluken Marye. 2014. Value Chain Analysis of Fruits for Debub Bench Woreda, Bench Maji Zone, SNNPR. MSc Thesis, Mekelle University, Mekelle, Ethiopia.
- Negese, K. 2016. Stock Assessment and Estimation of Optimum Yield for Tilapia Stock (*Oreochromis niloticus*) in Lake Hawassa, Ethiopia. Department of Wildlife, Wetland and Fishery Management, Wondo Genet College of Forestry and Natural Resources, Hawassa University, Ethiopia.
- Nelson J.S. 2006. Fishes of the World, 4th Edition (Hoboken, NJ: John Wiley and Sons, p. 39, 41).
- Nwaigwe. N.N., Anyanwu. E.E., Ononogbo. C and Eneweremadu, C.C. 2017. Comparative Analysis of Chemical Oxygen Demand Removal Rates of Continuous and Sludge Bed Biogas Processes Applied to Organic Waste. *Journal of International Agricultural Engineering CIGR*, 12(2): 86-90.
- Ollila, P. 1994. Farmers' Cooperatives as Market Coordinating Institutions. *Annals of Public and Cooperative Economics*, 65(1): 81-102.
- Ordu Ticaret Borsas. 2014. Karadeniz'de Balıkçılık ve Sorunları.
- Oyelese O.A .2007. Utilization of Compounded Ration and Maggot in the Diet of *Clarias Gariepinus*. *Research Journal Applied Sciences*, 2(3):301–306.
- Pauly, D., Christensen, V., Dalsgaards, J., Froese, R. & Torres Jr., F. 1998. Fishing down marine webs. *Journal of Science*, (279): 860-863.

- Pelton. L.E., Strutton.D and Lumpkin. J.R. 2016. Marketing Channels, a Relationship Management Approach.
- PES. 2013. Overview of the economy.
- PES. 2018. An Economic Analysis of the Fisheries Sector of Pakistan: Challenges, Opportunities and Development Strategies. *International Journal of Fisheries and Aquatic Studies*, 6(2): 515-524.
- Ponte, S. 2005. Bans, Tests and Alchemy: Food Safety Standards and the Ugandan Fish Export Industry, Copenhagen, Denmark. 184pp.
- Recklies, D. 2001. The Value Chain. Recklies Management Project GmbH and www.themanager.organization.
- Reyntjens, D. and Tesfaye, Wudneh 1998. Fisheries Management: A Review of the Current Status and Research Needs in Ethiopia. SINET; *Ethiopian Journal of Sciences*, 21: 231-266.
- Sairam, P. 2014. Impact of Overfishing on Ecology of Lake Hawassa at Amoragedel, Ethiopia; *Article in International Journal of Scientific Research*. Pp 34.
- Sairam, P. 2016. Species Diversity of Lake Hawassa, Ethiopia. *International Journal of Scientific Research*, 3(11):33-35.
- Sautet, F. 2015. Market Theory and the Price System. The Catholic University of America.
- Shafiur R. 2007. Hand book of food preservation. (2nd ed.). CRC press Taylor and Francis Group, LLC.
- Sheperd, W.A. 1988. Market Information Services. Theory and Practice, FAO Agricultural Services Bulletin.
- Shimelis Admassu and Mekonnen Melaku. 2010. Influence of frozen period on the proximate composition and microbiological quality of Nile Tilapia (*Oreochromis niloticus*). *Article in Journal of Food Processing and Preservation*.
- Sissay, L. 2003. Biodiversity Potentials and Threats to the Southern Rift Valley Lakes of Ethiopia, pp. 18–25. In: Wetlands of Ethiopia. *Proceedings of a Seminar on the Resources and Status of Ethiopia's Wetlands*, IUCN, Switzerland.

- Smith, W.L., Charlock, T.P and Kahn, R. 2004. EOS Terra Aerosol and Radiative Flux Validation: An Overview of the Chesapeake Lighthouse and Aircraft Measurements for Satellites (CLAMS) Experiment; *Journal of the Atmospheric Sciences*, 62: 903-918.
- Solomon Tesfaye and Mekonen Teferi. 2017. Assessment of Fish Post-harvest Losses in Tekeze Dam and Lake Hashenge Fishery Associations: Northern Ethiopia.
- Suuronen, P and Bartley.D.M. 2014. Challenges in Managing Inland Fisheries- Using the Ecosystem Approach. *Article in Boreal Environment Research*, 19(3): 245-255.
- SWFA. 2008. World Review of Fisheries and Aquaculture, Fisheries Resources: Trends in Production, Utilization and Trade.
- Tadesse Fetahi. 2005. Trophic Analysis of Lake Awasa, Ethiopia using Mass-Balance Ecopath Model. M.Sc. Thesis. Addis Ababa University, Ethiopia.
- Tadesse Fetahi and Seyoum Mengistu. 2014. *Ethiopian Journal of Biological Sciences Indexed and Abstracted by Cabi Ajol Long-Term Changes in Phyto-and Zooplankton Communities of Lake Hawassa, Ethiopia*, ISSN: 1819-8678.
- Tawari, C.C. and Abowei, J.F.N. 2011. “Traditional Fish Handling and Preservation in Nigeria”. *Asian Journal of Agricultural Sciences*, 3 (6): 437-452.
- Teklu Desta. 2015. Determinant factors for wasted fish during harvesting at Amerti and Fichawa Reservoirs Oromia/Ethiopia. *Journal of Fisheries sciences*, 9(4):012–5.
- Tesfaye, G., and Wolff. M. 2014. The State of Inland Fisheries in Ethiopia: A Synopsis with Updated Estimates of Potential Yield. *Ecohydrology and Hydrobiology*, 14: 200–219.
- The Monthly Publication from the Ethiopian Embassy in London Ethiopian News, January, 2012.
- Thomas, C.D. 1994. Extinction, Colonisation and Metapopulations: Environmental Tracking by Rare Species Conservation. *Journal of Biology*, 8: 373-378.
- Troell, M., Naylor, R. L., Metian, M., Beveridge, M., Tyedmers, P. H., Folke, C., de Zeeuw, A. 2014. Does aquaculture add resilience to the global food system? *PNAS*, 111(37): 13257–13263.

- Tujuba Ayele., Simagegnew Melaku and Tsegaye Dobamo. Assessing Fishing Activity, Fish Production and Demand Outlook in Ilu Abba Bora Zone, Oromia Regional State, South West Ethiopia. *Greener Journal of Agricultural Sciences*, 7 (1): 009-018.
- Tys, D and Pieters, M. 2009. Understanding a Medieval Fishing Settlement along the Southern North Sea: Walraversijde, C. 1200–1630. *Fisheries of the North Atlantic*, Pp: 91–122.
- UNIDO (United Nations Industrial Development Organization). 2009. Agro-Value Chain Analysis and Development. Working paper 3:34. Vienna International Centre, Vienna, Austria.
- USAID. 2008. Structure-Conduct Performance and Food Security: FEWS Net Markets Guidance No 2.
- Venugopal, V. 2002. Biosensors in Fish Production and Quality Control. *Biosensors and Bioelectronics* 17: 147 - 157.
- Venugopal.V. 2003. Value addition to Aquacultured Fishery Products. *Fishing Chimes*. 23 (1): 82-84.
- Vijverberg. J., Eshete Dejen., Abebe Getahun., and Leopold A.J. 2012. The Composition of Fish Communities of Nine Ethiopian Lakes along a North-South Gradient: Threats and Possible Solutions. *Animal Biology* 62: 315–335.
- Warren, C. 1924. *American Journal of Agricultural Economics*, 6 (4): 351-359.
- Whelan, J and Msefer, K. 1996. Economic Supply and Demand. Permission granted to copy for non-commercial educational purposes.
- Wondie, A. Current Land Use Practices and Possible Management Strategies in Shore Area Wetland Ecosystem of Lake Tana: Towards Improving Livelihoods, Productivity and Biodiversity Conservation, pp. 7–9.
- World Bank. 2009. Minding the Stock: Bringing Public Policy to Bear on Livestock Sector Development. Report No. 44010-GLB. The World Bank, Washington D.C, USA.
- Yamane, Taro. 1967. *Statistics: An Introductory Analysis*, 2nd Edition., New York: Harper and Row.
- Yared Tigabu. 2012. Fish Post-harvest Losses and Intervention Measure to Reduce Losses in Lake Hashengie, *Journal of Agricultural Development* 2(2): 52.

- Yilma D. Abebe and Geheb, K. 2003. Wetlands of Ethiopia. *Proceedings of a seminar on the resources and status of Ethiopia's wetlands*.
- Yonas Abebe, Menberu Bitew, Tenalem Ayenew, Clement Alo, Assegid Cherinet and Mulugeta Dadi. 2018. Morphometric Change Detection of Lake Hawassa in the Ethiopian Rift Valley.
- Zemeda Desta. 2016. Value Chain Analysis of Small Ruminant: The Case of Tahtay Adyabo District, Tigray, Ethiopia: M.Sc. Thesis, Haramaya University, Haramaya, Ethiopia.
- Zerihun Desta, Borgstrøm, R., Zinabu Gebremariam and Rosseland, B.O. 2008. Habitat Use and Trophic Position Determine Mercury Concentration in the Straight Fin Barbus Paludinosus, A Small Fish Species in Lake Hawassa, Ethiopia. *Journal of Fish Biology*, 73: 477–497.

7. APPENDICES:

Table in the appendix

1: Test for Multicollinearity

Variable	VIF	1/VIF
Education of Fishers	2.27	0.440
Credit used	2.24	0.447
Tikurwuha Site	1.75	0.571
Dorebafano	2.67	0.374
Value Addition	1.91	0.524
Fishing Experience	2.01	0.498
Owning Cold Storage	2.03	0.493
Boat Ownership	1.84	0.544
Member to Cooperatives	1.73	0.579
Training Access	1.60	0.624
Market Information	1.70	0.587
Market Price	1.41	0.709
Post-harvest Loss	1.74	0.575
Mean VIF	1.91	

2: Test for Multicollinearity

Source: Own survey result, 2018

3: Test for Omitted Variables

Ramsey RESET test using powers of the fitted values of Quantity Supplied
Ho: model has no omitted variables
F(3, 150) = 2.03
Prob > F = 0.11

Table 1 4: Test for Heteroscedasticity

 Breusch-Pagan / Cook-Weisberg test for heteroscedasticity

Ho: Constant variance

Variables: fitted values of Quantity Supplied

chi2(1) = 19.09

Prob > chi2 = 0.0000

5: Facility owned by fishers of Lake Hawassa

Nets	300	1100
Un motorized boat	20	40
Motorized boat	1	2
Hooks and line	3	10

6: Categorization of Lake Hawassa Fish in Rank

Based on Taste/Preference	Based on Size	Based on Availability
Nile Tilapia	African Cat Fish	Nile Tilapia
African Cat Fish	Nile Tilapia	African Cat Fish
Labeo Barbus	Labeo Barbus	Labeo Barbus

7: Fish Harvested and supply volume of Lake Hawassa

Year	Harvested Volume (Tonne)	Market Supply (Tonne)
2009	412.22	408
2010	386.4	381.5
2011	294.3	287.6
2012	322	320.5
2013	265.8	260
2014	234.41	230
2015	261.2	256
2016	249.6	243
2017	310.5	298
2018	350.1	340

Source: Own survey result, 2018

8: Conversion Factor for Fish to Kilogram

Fish Category	Conversion Factor
Nile Tilapia	5
African Cat Fish	3
Labeo Barbus	7

9: Conversion Factor for Adult Equivalent

Age group (years)	Adult Equipment	
	Male	Female
11-13	0.9	0.8
14-16	1	0.75
17-50	1	0.75
>50	1	0.7

Appendix II: Survey Questionnaire

This Questionnaire is for the Survey on “Fish Value Chain and Post-harvest Losses Analysis”: The Case of Lake Hawassa. The purpose of the survey is only to identify value chain actors, their role, linkages, marketing cost and share; identify the volume of fish supply to the

market; assess post-harvest loss along value chain, and identify the opportunities along the value chain. Therefore, you kindly requested to respond the response honestly and accurately as much as possible.

- 1.1. Name: _____ Age: _____
- 1.2. Sex: M___ F ___; Village: _____ Id/No _____
- 1.3. Marital status: 1=single, 2= married, 3=divorced,4=widowed
- 1.4. Household Size: M___ F ___ Total: _____
- 1.5. Household Head: M ___ F ____: Age:_____
- 1.6. Status of education: _____
- 1.7. Religion group:1=Protestant,2=Orthodox, 3=Muslim, 4=Catholic, 5= others

Part I: General question on fish harvesting

2. Do you involved in fishing practice?1=Yes, 0=No
 - 2.1. If yes, do you have legal license? 1=Yes, 0=No
 - 2.2. If you involved in fishing practice, for which purpose you will harvest fish?
 - i) For home consumption ii) for market iii)for both home consumption and marketiv)for charity
 - 2.3. If for market, for whom you sell the fish?
 - (a) wholesaler(b) hotel (c) restuarant/cafe (d) processor (e) final consumer(f) retailer (g) other/specify_____
 - 2.4. How often per week you harvest fish
 - (a) 2 (b) 3 (c) >3 (d) all day)(e) othe/specify_____
 - 2.5. Do you use weighing scale?1=Yes, 0=No
 - 2.6. If yes, in what unit you measure your product? In:
 - a) number/unit b) kg c) gram d) other/specify_____
 - 2.7. What amount you could harvest in kg, per?
 - Day_____ week _____ month_____ season_____ year_____

Part II: Preharvest activity

3. What type of fish species belongs to lake?
 - i) Tilapia ii) perch iii) garra iv) labeobarbus v) catfish vi) others/specify_____.
4. Are you selective during harvesting time? 1=Yes, 0=Not
 - 4.1.If yes, which one you could harvest? (a) nile tilapia (b) nile perch (c) labeobarbus (d) all e) others/specify_____
5. What type of net you could use, local or modernized?_____
 - 5.1.If local, what type_____,_____,_____
 - 5.2. If modernized, what type_____,_____,_____
6. How can you determine the size of net? depends on:
 - (a) Size of fish (b) fish type (c) legal recommendation (d) others/specify_____
7. What size of net could you use_____,_____
8. Do you buy feed to fish? 1=Yes, 0=No
 - 8.1.If yes, what amount and at what cost in birr respectively? _____and_____
9. Do you know before harvest your trusted customer who will buy immediately your product after harvest? 1=Yes, 0=No
 - 9.1. If yes, do you determine the price of product before selling and buying process? 1=Yes, 0=No
 - 9.2. If not, who determine the fish price:
 - (a) Wholesaler (b) Retailer(c) Hotels/café (d) Consumer e) Cooperatives (f) Demand and Supply
10. Do you have training of fishing from authorized body for better harvesting practices and legal business form? 1=Yes, 0=No
 - 10.1. If yes, how often/how many times in year do you get training?
 - (a) 1 (b) 2 (c) 3(d) 4 (e) out of these_____

Part III: post-harvest activity

- 11.1. Which season is the peak harvesting season of lake Hawassa?
 - (a) Summer (b) autumn(c) winter (d) spring
- 11.2. Is there seasonal variation in price of product? 1=Yes, 0=No

11.3. If yes, what is the reason behind variation?

(a) Peak harvesting (b) shortage (c) demand(d) others/specify_____

11.4. Is price vary according to fish species? 1=Yes, 0=No

11.5. If yes, based on what? (a) size (b) taste (c) contents (d) quality (e) others/specify

11.6. What is the current price of fish species in Birr

No	Fish species	Wholesalers		Retailers		Hotels/cafes		Consumers	
		Per kg	Per ton	Per kg	Per ton	Per kg	Per/ton	Per kg	Per ton
1	Nile Tilapia								
2	African cat fish								
3	Labeo barbus								

11.7. What time is assumed to be best for fish harvesting?

(a) Morning 12:00 am to 4:00 am (b) noon (c) afternoon 8:00pm to 12:00 pm(d) other time/specify_____

11.8. Does price of unit vary according to buyer types? 1=Yes, 0=No

11.9. If yes, why and based on what? _____,

a) Purchasing amount (b) buying power(c) relation ship (d) trust(e)others/specify_____

11.10. During fishing time what type of moving gear you could use to fishing?

(a) Wooden box (float) (b) unmotorized boat (c) motorized boat (d) others/specify_____

11.10.1. If your answer is motorized boat, what is its daily benzene cost in ETB?_____

11.11. After harvesting fish,as prompt spoilage nature of fish,do you take any immediate preservation practicesat landing site,. 1=Yes, 0=No

11.12. If yes, what is that activity?

(a) Pre-cooling (b) salting (c) smoking (d) drying (e) chilling (f) other specify____

(b) If pre-cooling, do you own cold stoarge? 1=Yes, 0=No

11.13. If you take any of one preservation activity, does it has money cost? 1=Yes, 0=No

11.14. If yes, what amount it consume in ETB_____

- 11.15. Do you take post-harvest handling practices other than preservation process? 1=Yes, 0=No
- 11.16. What is that (a) curing (b) filleting (c) flaking (d) packaging (e) labeling (f) drying (g) other/specify____
- 11.17. What type of vehicles do you use during moving your product from landing to your receiver.
(a) Cart (b) handcart (c) carry/ride (d) isuzu (e) bus (f) others/specify_____
- 11.18. If your answer is other than carry/ride, does it has money cost? 1=Yes, 0=No__
- 11.19. If yes, what is moving equipment cost_____
- 11.20. Do you assume the activity other than fishing? 1=Yes, 0=No
- 11.21. If yes, what is that activity (a) processing (b) transporting (c) packaging (d) retailing (e) wholesaling(g) other/ specify____
- 11.21.1. If transporting, where_____

Part V

12. Who participate more in fishing: female ____, male__
13. Do you think that having information about fish harvesting, marketing, processing and demand is useful? 1=Yes, 0=No
- 13.1.If yes, where do you get it and how? _____,_____
14. Does fish market far from your fishing site? 1=Yes, 0=No
- 14.1. How long it be in hour_____
- 14.2. Does it affect your fish price? 1=Yes, 0=No
- 14.3. How? (a) rise transporting cost (b) limit information access (c) other/specify_____
- 14.4. If transport cost, how much in birr_____
15. Are you educating? 1=Yes, 0=No
- 15.1. If yes, what about grade_____
- 15.2. Do you think that, education increasing your fishing and fish supply ability? 1=Yes, 0=No_____
- 15.3. If yes, how? (a) enhancing adoption of modern technology (b) improving methods of fishing and processing (c) adopt efficient market strategies(d) other/specify

- 15.4. If no, why? _____,
16. Have you get a credit access? 1=Yes, 0=No
- 16.1. If yes, from where and how much in birr _____,
- 16.2. Does it increase your fishing and supply level ability? 1=Yes, 0=No
- 16.3. If yes, how _____,
17. How many years you counted in fishing activity? _____
- 17.1. Do you think that experience increase fishing ability? 1=Yes, 0=No
- 17.2. Do you harvest more than new fishermen? 1=Yes, 0=No
- 17.3. If yes, how much in kg? _____
18. What is the today's average price of fish in birr _____
19. Do you incur cost in fish harvesting and supplying activity? 1=Yes, 0=No
- 19.1. If yes, for what purpose?
- (a) Fish transporting (b) buying fishing equipments (c) storage (d) wage
- 19.2. How much is daily total cost of fish operation in birr _____
20. Have you own storage material? 1=Yes, 0=No
- 20.1. Has it monetary cost? 1=Yes, 0=No
- 20.2. How much incurred in birr _____
21. Are you member in cooperative? 1=Yes, 0=No
- 21.1. If yes, what are the benefits of being member in cooperative?
- (a) getting input (b) pooling resource together to better market (c) avoid resource competition
- (d) getting fishing gear (e) getting fish delivering vehicles
22. Do you own boat? 1=Yes, 0=No
- 22.1. If yes, does it has monetary cost? 1=Yes, 0=No
- 22.2. If yes, how much incurred in birr _____
- 22.3. Does it increase fish harvested? 1=Yes, 0=No
- 22.4. If yes, how? (a) it helps to go to distant area to better catch (b) pool harvested resource together rather than travelling many times to landing site (c) other/specify _____

1	Nets										
2	Storage facility										
3	Boat/Canoe										
4	Benzene										
6	Floats										
7	Hook										
8	Feed										

28. What are the prices of fish for past five years in birr?

No	Fish species	2013		2014		2015		2016		2017	
1	Nile Tilapia										
3	African cat fish										
4	Labeo barbus										
8	Total income										

Part I: Marketing

A. Role of traders on buying activities

29. What are your major roles or activities performed in fish marketing

_____, _____

30. From where/which market area do you buy fish? _____, _____, _____

31. Is trader's trusted and/or permanent supplier? 1=Yes, 0=No

31.1. If not, how you could run your business daily? Do you have another fish supplier?

1=Yes, 0=Not

31.2. If yes, who is? _____

32. Do you scaling/weighing fish when you purchase it? 1=Yes, 0=No

32.1. If yes, when you buy what is the average fish price in birr in kg____, gram____, per/unit____

33. How do you attract your supplier?

(a) by better price (b) by fair scaling/weighing (c) by giving credit (d)
other/specify_____

34. Do you have a trusted/honest seller? 1=Yes, 0=No

34.1. If yes, cooperative/individual?,_____

34.2. Does he always supply fish for you? 1=Yes, 0=No

35. Does price of fish vary as fish species variation? 1=Yes, 0=No

36. If yes, at what price you could buy currently in birr?

No	Type	Total bought amount in kg	Bought price per kg	Bought price per Unit	Per tones
1	Nile Tilapia				
2	Labeo barbus				
3	African cat fish				

B. Role of traders on selling activities

37. Does price of fish varying as purchaser variation? 1=Yes, 0=No

37.1. If yes, why and how_____,_____

38. Do you sell your product through brokers/commission agent? 1=Yes, 0=No

39. Who purchase fish from you in 2017?

No	Type of purchaser	Price per kg	Price per gram	Price per unit	Price per tone
1	Wholesaler				
2	Retailer				
3	Cooperative				
4	Processor				
5	Consumer				
6	Hotels/Cafes				

40. Where do you sell your product?

No	Selling place	Total amount sold in kg	Price per gram	Price per unit	Price per tone
1	Hawassa city				
2	Shashemene				
3	Dilla				
4	Addis Ababa				
5	Wondo				
6	Other/specify				

41. Why your prices vary from place to place? Depends on:

- (a) Transporting cost (b) storage cost (c) time cost (d) convenience (e) other/specify_____

42. How could you attract your buyer?

- (a) By discounting price (b) by quality fish (c) by fair scaling/weighing (d) by giving credit (e) other/specify_____

43. Do you own storage facility? 1=Yes, 0=No

43.1. If yes, does it has operational cost? 1=Yes, 0=No

43.2. How much it incur in birr? _____

43.3. If not, what do you do if you lost buyer/market price falls_____

Part II: Post-harvest handling practices

Preservation and processing activity

44. Do you take preservation techniques to extend fish shelf life and to maintain/retain its quality? 1=Yes, 0=No

44.1. If yes, which methods you could apply? If you undertaken more than one methods, rank it

No	Methods	Rank
1	Smoking	
2	Drying	
3	Chilling	
4	Freezing	
5	Canning	
6	Packaging	
7	Other/specify	

45. Do you prepare fish food? 1=Yes, 0=No

46. What is average cost per fish food/product preparing in birr? _____

C) Post-harvest loss

47. Do you sell your whole fish to market? 1=Yes, 0=No

47.1. If not, do you count some loss? 1=Yes, 0=No

47.2. If yes, which one?

No	Types of PH loss	Amount/quantity lost in kg	In monetary value	Years
1	Quantity loss			2013
				2014
				2015
				2016
				2017
	Total			
2	Quality loss			2013

				2014
				2015
				2016
				2017
	Total			
3	Market force loss			2013
				2014
				2015
				2016
				2017
	Total			

48. What are causes of post-harvest loss?

	Causes of loss	Quantity loss	Quality loss	Market force loss	Ranking
1	Thrown away				
2	Insect				
3	Birds/predator				
4	Theft				
5	Net size				
6	Transport vehicle				
7	Infrastructure				
8	Temperature				
9	Storage facility				
10	Processing equipment				
11	Packaging material				
12	Price decreasing				
13	Market information				

14	Processing methods				
----	--------------------	--	--	--	--

49. What are your measures to minimize loss?

No	Measure taken	Rank
1	Improving post-harvest handling practices	
2	Getting fishing training	
3	Using preservative	
4	Accessing adequate market information	
5	Owning cooling material	
6	Strengthening value chain	
7	Building trust	
8	Building integration with upward and downward streams	

50. What are constraints in value chain that hindering you from achieving your goal?

No	Constraints	Rank	Measure undertaken
1	Policy constraints		
2	People constraints		
3	Equipment constraints		
4	Market constraints		
5	Infrastructure		
6	Financial constraints		
7	Transporting constraints		
8	Resource constraints		
9	Structure constraints		
10	Intermediaries		
11	Others/specify		

Part I: Consumption behavior

51. Do you want to consume fish? Yes/not_____
52. If yes, from whom you did buy fish? _____
53. Who determine fish price? a) wholesaler b) retailer c) hotels/café d) fishermen's e) yourself f) others/specify_____
54. Do you prefer fish species? Yes/no_____
55. If yes, which fish you prefer mostly and at what price you buy it?

No	Fish type	Rank	Price in birr				
			2013	2014	2015	2016	2017
1	Tilapia						
3	Cat fish						
4	Labeobarbus						

56. Do you want to buy/consume imported fish product? Yes/no_____
57. If yes, what is the reason that leads to buy/consume imported fish product?

1	High quality
2	Low price
3	Availability of fish product
4	Demand for imported fish
5	Taste

58. If you buy imported fish product which one you buy/prefer mostly?

No	Fish product type	Rank	Price in birr in 2018
1	Sardine		
2	Salmon		
3	Pilchards		
4	Tuna chunks		
5	Other/specify		