# Studies on Fish Market Chains and Livelihoods of Fishers for Sustainable Fish Stocks:The cases of Lake Tana and Three other Rift Valley Lakes in Ethiopia

**A Thesis Submitted to**

**The Department of Zoological Sciences**

**Presented in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy in Zoological Sciences (Aquatic Sciences, Fisheries and Aquaculture)**

**By Kidanie Misganaw Bezabih**

**Advisor: Professor Brook Lemma**

**April, 2024**

**Addis Ababa, Ethiopia**

**ADDIS ABABA UNIVERSITY**

**COLLEGE OF NATURAL SCIENCES**

**DEPARTMENT OF ZOOLOGICAL SCIENCES**

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## GRADUATE PROGRAMS

This is to certify that the dissertation prepared by Kidanie Misganaw Bezabihentitled, "**Studies on Fish Market Chains and Livelihoods of Fishers for Sustainable Fish Stocks: The case of Lake Tana and Three Other Rift Valley Lakes in Ethiopia**". Submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Zoological Sciences (Aquatic Sciences Fisheries and Aquaculture) complies with the regulations of the university and meets the accepted standards concerning originality and quality.

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Examiner: _____ Signature: _____ Date: _____

Advisor: _____ Signature: _____ Date: _____

Chairman: _____Signature: _____ Date: _____

# DEDICATION

Dedicate this work of mine to the fishers and fish traders of Lakes Tana, Ziway, Hawassa and Chamo, my loving wife, Rahel Seifu, my childeren, Eyoab and Azaria Kidanie, and my family. I thank you all for the generous support and patience that kept me going. I love you all with all my heart.

## STATEMENT OF THE AUTHOR

I first, declare that this dissertation is my work and that all sources of materials used for this dissertation have been duly acknowledged. This dissertation has been submitted for the requirements of PhD Degree at Addis Ababa University; College of Natural Sciences is deposited at the University's Library to make it available to borrowers under the rules of the Library. I declare that this dissertation is not submitted to any other institution anywhere for the award of any academic degree, diploma, or certificate. Brief quotations from this dissertation are allowable without special permission provided that accurate acknowledgment of the source is made. Requests for extended quotation from or reproduction of this manuscript in whole or in part may be granted by the head of the Department or the Dean of the School of Graduate Studies when in his 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 directly.

Name: Kidanie Misganaw Bezabih

Signature_____ Date: _____

# TABLE OF CONTENTS

## LIST OF TABLES

# LIST OF FIGURES

# LIST OF APPENDICES

# ABBREVIATIONS

| | |
|---|---|
| BEM | Bio-economic models |
| BOA | Bureau of Agriculture |
| CSA | Central Statistical Agency |
| EMEY | Effort at Maximum Economic Yield |
| EMSY | Effort at Maximum Sustainable Yield |
| ETB | Ethiopian Birr |
| FAO | Food and Agriculture Organization |
| FDRE | Federal Democratic Republic of Ethiopia |
| FGD | Focus Group Discussions |
| FPME | Fish Production and Market Enterprise |
| HLPE | High Level Panel of Experts on Food Security and Nutrition |
| IBC | Institute of Biodiversity Conservation |
| $KM^2$ | Killo meter sequere |
| LFDP | Lake Fisheries Development Project |
| LVEMP | Lake Victoria Environmental Management programme |
| m.a.s.l. | Meter above sea level |
| MEY | Maximum Economic Yield |
| MOA | Ministry of Agriculture |
| MSY | Maximum Sustainable Yield |
| NBE | National Bank of Ethiopia |
| $NH_4$ | Ammonium |
| NMA | National Meteorological Agency |
| NRC | National Research Council |
| NTU | Nephelometeric Turbidity Unit |
| OAY | Open access yeild |
| OLS | Ordinary Least Squares |
| PH | Potential Hydrogenation |
| RPs | Reference Points |
| SCP | Structure, Conduct and Performance |

| | |
|---|---|
| SLA | Sustainable Livelihoods Approach |
| SPSS | Statistical Package for Social Science |
| UN | United Nations |
| UN DESA | United Nations Department of Economic and Social Affairs |
| USD | United States Dollar |
| VIF | Variance Inflating Factor |
| WARDO | Woreda Agricultural and Rural Development Office |
| WHO | World Health Organization |
| $\chi^2$ | Chi-squaretest |

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# ABSTRACT

The fishing subsector in Ethiopia is one of the potential intervention areas to increase employment, ensure food security with quality protein supply and alternative sources of income generation to improve the livelihoods of rural communities in a sustainable way. However, the natural stocks of the fishes in Ethiopian waters are depleted by illegal and unregistered fishing practices that use undefined market chains. As a result, this project was designed to study the contemporary status of the fishing industry in Ethiopia along with the market chains and to find out how this is related to the depletion of stocks (overexploitation). For this purpose, the study areas were purposefully selected based on their high fishery productions, accessibility to market outlets (big cities like Addis Ababa and Bahir Dar) and the general fishing operations, as these systems reflect what is practiced in other minor fishing operations systems.

In the primary data collection of this study 597 individuals were involved. The study examined and analyzed the fish market value chains from 2018 to 2020. The data were gathered through fish catch analyses, field observations, structured questionnaires, focus group discussions, key informants, and other secondary data sources that examined numerous published and unpublished but official reports of regional fishery offices and those found in the archives of the fishery section of the Ministry of Agriculture. These were analyzed using both descriptive and econometric analytical methods that employed ordinary least squares (OLS) estimation method and others.

It was found out that fishing is the first major source of income accounting for 59.3%, 67%, 68.9% and 73%, of fishers in Lakes Chamo, Tana, Hawassa and Ziway, respectively. Monthly incomes from fishing fluctuated from 350 to 15,000 Birr per month, with an average income of 2,039 ETB per month (equivalent to 45 USD). The average for all the study lakes is just a little less than 5,000 ETB. However, there is a significant difference ($P<0.001$) in the level of mean monthly income from fish in the ETB. Linear OLS regression analyses showed that the number of reed boats, gillnets, land owned for crop productionand fishing trips were the determinant factors significantly influencing the volume of fish produced.

All fishers and assemblers engaged in the study did not have fishing licenses, and 65.2% of market actors were not licensed in fish trading, which probably contributed to unhealthy competition in the fish market. Transportation of fish from the collection points to registered storage sites has shown a clear association with licensed fish traders ($P<0.005$), while a considerable amount of catch entered the market using illegal and unregistered routes bypassing standard storage facilities. Fishers shared financial benefits rated 46.82%, 3.18%, and 50% from assemblers, cooperatives, and retailers, respectively. Fish retailers and assemblers obtained the highest gross profits of 1,620 and 1,572 ETB/Qt (quintal), respectively, whereas fishers and cooperatives obtained lower gross profits of 1,514 and 1,050 ETB/Qt, respectively. Fishers, assemblers, retailers, cooperatives, wholesalers, hotels, and consumers were important fish market intermediaries. Members of the fish market channel clearly indicated that the chain is predominantly traditionally split and that there are too many market networks.

Illegal fishing gear and practices are the most serious barriers constraining fish value addition among fishers. Other constraints included agricultural land expansion all the way to the shorelines in Lakes Tana between 1986 and 2018 (1954$km^2$), Ziway 1990 to 2020 (1308.42$km^2$), Hawassa 1987 to 2019 (121.7$km^2$), and Chamo 1990 to 2019 (30.65$km^2$); meanwhile in the same year, degradation of fish breeding habitats (bushes and wetlands) decreased in Lakes Tana by -1480$km^2$, Ziway by -1201$km^2$, Hawassa by -47.7$km^2$and Chamo by -247.67 $km^2$

Based on the findings, it is recommended that the policy of free-for-all should be scraped off and be replaced by agreed-upon management system, all stakeholders from fishers to administrators should take part in awareness programs, alternative fish productions technologies should be developed (e.g., aquaculture), re-structuring the market chains with the authorization of regulated and licensed operators must be put in place.

**Key words**: Ethiopian fishery, fish markets, fishers, fishery value chain, Ethiopian lakes

# CHAPTER ONE

## 1. Introduction

The global population is expected to increase from 8 billion to 9.7 billion by 2050, with sub-Saharan Africa growing at an annual rate of 2.7% (Gerland *et al*., 2022; UN DESA, 2021). This poses a serious challenge for food security, especially in regions where hunger and malnutrition are prevalent (Garcia and Rosenberg, 2010). Fish is a vital source of food and income for many poor communities, as it provides high-quality protein, micronutrients, and essential fatty acids. It is also one of the most traded food commodities in the world, with developing countries accounting for more than half of the export value (FAO, 2020). The fishery sector contributes to socioeconomic development and poverty reduction by creating livelihoods, employment, and income opportunities, as well as enabling access to other social services such as health and education (Allison and Ellis, 2001; Islam *et al*., 2011; Hendriks, 2022). Therefore, the sustainable use of fishery resources is crucial for ensuring future food security and human well-being (NRC, 2006). However, many fishery managers face the challenge of balancing the policy objectives of maximizing fish production and ensuring the conservation of fish stocks, both in developed and developing countries (Hoggarth, 2006). Promoting green growth in the fishery sector can help address this challenge and reduce poverty, by enhancing the efficiency, productivity, and resilience of the fishery systems (Tebeka, 2017). This is particularly important for fishermen in developing countries, who often suffer from low catches, lack of financial support, and increasing poverty (Platteau, 1989; Bene, 2004; Salagrama, 2006).

Ethiopia is a country where agriculture is the main backbone of the economy and the source of livelihood for a large section of economically disadvantaged population. However, as the population has grown to around 122 million by 2022 (Gerland *et al*., 2022), the demand for food has also increased, especially for animal protein sources. One of the potential ways to meet this demand is to develop the fishery subsector, which can also provide employment opportunities and alternative sources of income to improve the livelihoods of poor rural people in a sustainable manner (Global Fish Alliance, 2010; Gashaw Tesfaye and Wolff, 2014; FAO, 2020; Hendriks, 2022). Many farmers living along the shorelines of lakes and rivers have already adopted fishing

as part of their livelihoods, but they face challenges such as low productivity, poor quality, and inadequate market access. The major consumable fishery resources in Ethiopia are captured from the rift valley lakes (40%) and Lake Tana (50.2%) in the north (Lemma Abera *et al*., 2018), while the remaining percentage come from riverine fisheries.

Despite having an estimated annual fish production potential of 94,541 metric tons from its lakes, reservoirs, rivers, and small water bodies, Ethiopia only utilizes less than 38% of this potential (Gashaw Tesfaye and Wolff, 2014; Aytegeb Anteneh, 2013). The fishery sector remains underdeveloped and contributes only 0.3% to the national economy (NBE, 2018/19). Several factors hinder the development and sustainability of the sector, such as capital constraints, lack of infrastructure and facilities, inaccessibility of some water bodies, perishability of fish products, and high postharvest losses due to bycatch, spoilage, predation, and parasitism (Dereje Agonafer, 2002; FAO, 2010; HLPE, 2014; Hendriks, 2022; Solomon Tesfay and Mekonen Teferi, 2017; Ayalew Assefa *et al*., 2018). These challenges pose a serious threat to the food security, livelihoods, and biodiversity of the communities that depend on the fishery resources. Therefore, this study aims to address the following research problem.

### 1.1. Statement of the problem

Fish are collected from the wild from Ethiopian lakes in what is known as “open access”, or open to all who wish to fish for their own use or for marketing, although many argue that cooperatives who are organized by the government are legally entitled entities.Lakes Ziway and Langano suffer from rampant illegal fishing activities(Dawit Garoma *et al*., 2013).In contrast to the open access system,aquaculture in Ethiopia is almost non-existent and a lower level of community awareness about the wise use of resource utilization,as it has no significant contributions to the livelihoodsof the poor or the revenues of the nation (Brook Lemma, 2012;Mulugeta Wakjira *et al*., 2013 and Erkie Asmare *et al*., 2016). Moreover, fish captured with artisanal methods from the wild are not handled as per FAO standards, and the market chains are not organized in formal value-adding manners (Brook Lemma, 2012). As a result, the fish prices at the lake landing sites are low, and the fish output is declining due to overexploitation, which significantly affects the gross margin earned by fishers households (Dawit Garoma *et al*., 2013).

Ethiopian fisheries are undeveloped due to traditional methods of fishing and marketing practices that evade proper documentation of catches and their value chains. These fishing practices also affect fish breeding grounds and catch undersized fishes (FAO, 2011; Dawit Garoma *et al*., 2013; Tesfaye Wudneh, 1998; Pattnaik, 2016). Based on these facts, it can be said that the Ethiopian fisheries are not well managed, as some stocks such as tilapia and Nile perch are showing signs of overexploitation at Lakes Chamo, Hawassa, and Ziway. Most notable is the lack of legal provisions and enforcement agencies to monitor fishing activities and prevent overexploitation of fish stocks (Pattnaik, 2016). Fishing practices in Ethiopia are thus still in their infancy stages (Abebe Ejigu *et al*., 2015).The current per capita fish consumption in Ethiopia is 476 grams per person per year (Sintayehu Bedada& Seblewengel Lemma, 2015), which is extremely low compared to the world average per capita fish consumption of 20.5 kg/year in 2019. This varied from an average of 5.4 kg in low-income countries to 15.2 kg in lower-middle-income countries, 28.1 kg in upper-middle-income countries, and 26.5 kg in high-income countries (FAO, 2022), and its contribution to the national economy is the smallest (Olalea and Henson, 2012, and Aytegeb Anteneh, 2013). As a result, the fishery in Ethiopia is one of the least developed sectors of the economy (Eshete Dejen *et al*., 2017).

Maintaining sustainable utilization of fish resources requires scientific information about the diversity, socioeconomics across the value chain, accurate maximum sustainable yield (MSY) of major lakes and rivers (MOA, 2019), catch status, level of exploitation, and fish management problems (Mathewos Temesgen and Abebe Getahun, 2016). In addition, due to poor vegetation cover, the magnitude of runoff is increasing, resulting in lake turbidity and siltation, which affect the fish population and the catch level (Eshete Dejen *et al*., 2017). According to Dereje Tewabe (2014), the composition of *Labeobarbus* speciesin Lake Tana significantly declined from time to time. On the other hand, the composition of *Oreochromis niloticus* did not change, but *Clarias gariepinus* increased by 100% in catch composition. The most likely explanation for the total decline in abundance of fish species is the increased illegal commercial gillnet fishery targeting their spawning aggregation in the wetlands and river mouths and the increasing trend of the degradation of spawning and nursery habitats in both the lake and major tributary rivers of the catchment area. In addition to this, habitat degradation, which is the alteration of breeding grounds, and the separation of the river from the lake, which blocks the returning of juveniles

into the lake, can also be the cause for the decline of the *Labeobarbus* stock in Lake Tana (Shewit Gebremedihn *et al.,* 2012). Complemented with the cheap price at the lake site, the decrease in fish output significantly affects the gross margin earned by a household (Dawit Garoma *et al*., 2013).

Vijverberg *et al*. (2012), in their study of the composition of fish communities in nine Ethiopian lakes along a north-south gradient, stated that Ethiopia has a diverse range of freshwater fish species. In addition, they explained that with growing populations, there is a strong need to increase production. It is observed that the rapid growth of population and the progressive shortage of livestock products had changed the situation to a growing demand for fish (Anon., 1999; Kelil Abdurhaman, 2002). The increasing pressure on resources means that many fish stocks are now overfished. This reduces productivity, resulting in fewer fish being available and at higher prices (MOA, 2019).

According to Brook Lemma (2014) and Assefa Mitike (2014), value addition at each market chain and free access to fresh waters, as in Ethiopia, should be regulated for the sake of sustainability in fishery production, food security, and conservation of biodiversity. For instance, value addition in fisheries and aquaculture promotes improved profits by way of establishing more stable market conditions, the conversion of postharvest wastes into usable materials, creating job opportunities, and product diversification (Russell and Haanoomanjae, 2012). Mkama *et al.* (2010) stated that the possible outcomes of fisheries value chain analysis is to recommend the reduction of fishing effort so as to allow fishery resources to regenerate.Despite the fact that choice of fishing as a livelihood activity among the household can be influenced by several factors like income generation from fishing when compared to other income sources, time for earning income from fishing, land ownership, access to credit, lack of alternative livelihood activities, organization participation, education level, market access (reliability of the fish market), free access to water bodies (Lemma Abera *et al*., 2018), and household size (Khan, 2000; Be´ne´, 2003; Be´ne´ *et al.,* 2003; Pender, 2004; Smith *et al.,* 2005; Hap *et al.*,2006; Chenier et al., 2006, and Roche, 2007). The current social and economic conditions in Ethiopia, that is, high population growth rates and low job opportunities coupled with the absence of effective fisheries management, tend to lead to rapid overfishing (Vijverberg *et al*., 2012; Brook

Lemma, 2014). Therefore, conducting a well-designed study on fishery areas that lack such information is mandatory for the sustainability and maintenance of the fish stock.

Despite these facts, the socioeconomic aspects and improving the fish value chains in the Lakes Tana, Ziway, Hawassa and Chamo study areas have not been given the due attention. It does not have a well-developed standard form of marketing network. In Ethiopia, the fishery research mainly focused on biological aspects (e.g., Tesfaye Wudneh, 1998; de Graaf, 2003; Elias Dadebo *et al*., 2003; Eshetie Dejen, 2003; Abebe Getahun *et al*., 2008 and Wassie Anteneh *et al*., 2012). Consequently, the potential benefit from the current opportunities in the Ethiopian fisheries sector is hampered by the insufficiency of scientific data on fish market chain analysis. There is lack of empirical studies that focus on the sustainable use of inland fisheries resources in Ethiopia and provide a framework to guide policymakers and implementers. Hence, this study attempts to fill these research gaps and provide evidence for policymakers so that appropriate guidelines can be set to contribute to poverty alleviation efforts and improve the sustainable use of the fish stocks in the fishery sector in Ethiopia.

## 1. 2. Objectives of the Study

### General Objective

- The general objective of the study is to analyse the fish market value chains of Lakes Tana, Ziway, Hawassa, and Chamo for the purpose of value addition through sustainable use of fish stocks and improvement of livelihoods.

### Specific objectives

- To analyse contributions to the livelihoods of fishers and determinants of fish production
- To identify and analyze the existing fish market chains for each of the four studied lakes (Tana, Ziway, Hawassa, and Chamo), and to propose tailored market chain improvements that enhance efficiency and profitability specific to each lake's unique market dynamics
- To investigate the key constraints and new opportunities along the fish value chain

## 1.3. Research questions

The following analogous research questions were formulated for each specific objective;

- What are the factors that determine the level of fish production by fishers and the contributions of their fishery practices to their livelihoods?
- How are alternative fish market chains that can improve the efficiency and profitability of the fishery system?
- What are the constraints and new opportunities facing Ethiopian fishers, fish production and the value chain trends?

## 1.4. Significance of the Study

Ethiopia's thriving fish sector, with its contributions to GDP, foreign exchange earnings, and food security, is hampered by inefficiencies in the domestic and export marketing systems. Current practices lead to low incomes for fishers, middlemen, retailers, and hotel owners, hindering their livelihoods and the sector's potential. This study aims to bridge this gap by analyzing the entire fish marketing chain from lakes to domestic and export markets. By identifying bottlenecks, unsustainable practices, and missed opportunities, we will develop practical recommendations for policymakers, traders, and development stakeholders. These recommendations will focus on increasing efficiency, improving incomes for all actors, promoting sustainable resource utilization, and ultimately, enhancing the sector's contribution to national prosperity and food security.Additionally, the federal and regional governments have learned from the research that the only way out of the problem of food insecurity is to follow a market-oriented production system by giving equal emphasis to both the supply and demand sides. Therefore, based on the study results, the research will recommend to add value to fishers, traders, decision-makers, planners, and other development stakeholders involved directly or indirectly in promoting, implementing, and up-scaling fish marketing and production issues. Moreover, draw and implement practical lessons for policymakers on effective policy reform for sustainable fish resource utilization while considering the livelihood of the people. Hence, the study gives evidence-based information on how the fish marketing chain is functioning in the domestic markets, focusing on lakes. Furthermore, the

findings of the research will fill an existing gap in empirical studies that focus on the sustainable use of inland fisheries resources in Ethiopia and provide a framework to guide researchers in conducting further related studies.

## 1.5. Limitations of the study

The primary limitation of the study wasthat it did notinclude all Lake Tana, Ziway, Hawassa, and Chamo landing centers due to financial and logistical limitations. Lack of adequate and high-quality data was another issue, which had the impact of overestimating the number and distribution of respondents' samples that could be drawn from the local governments and cooperatives. There isno comprehensive record that can provide information about the number of people engaged in the fisheries and fish production is inconsistent and poorly documented in all study Lakes.The survey's most challenging task was gathering information from traders and fishers. Most of the time, because they associate providing accurate information with paying taxes, traders and fishers are unwilling to provide it. Additionally, they are time-constrained and busy during interviews.

# CHAPTER TWO

## 2. Literature review

### 2.1. Sustainability of Fishery Resources

Fishery resources are a renewable natural resource. However, such resources are legally liable to go extinct if the rate of harvest or exploitation is higher than the rate of regeneration (Narayanakumar, 2017). According to Hardin (1968) and Obegi *et al*. (2020), the majority of fish populations are exploited and under threat of "free for all" exploitation, making sustainable management challenging and the resources susceptible to overexploitation. The degradation and subsequent collapse of fisheries also provide an urgent economic challenge to fishers whose livelihoods depend on fishing as it is a biological and food supply disaster (Narayanakumar, 2017). The challenges of preserving or restoring fisheries sustainability and stock levels, decreasing environmental impact and degradation, and enhancing local and global food security remain enormous in the context of changing ecosystems (Garcia and Rosenberg, 2010). In addition, the challenge of achieving sustainability in fisheries requires consideration of ecological, social and economic components (MRAG, 2010). Fisheries provide both economic and food benefits to individuals and society, if not addressed, may undermine efforts to achieve biological and ecological sustainability (Ireland, 2004; MRAG, 2010).

The process of producing fish in a fishery begins with the application of labour and capital to the natural resource (Prellezo *et al*., 2012). The fish, or the biological resource, may exist on its own without the fishery but the fishery cannot exist without the fish, despite the fact that there is a clear economic benefit to utilising the biological resource (Prellezo *et al*., 2012). According to Prellezo *et al*. (2012), the fishing system consists of a dynamic interplay between the system's biological and economic (human) components. As a result, a fishery has been identified; biological and economic forces must now be taken into account. According to Clark (1985), Anderson & Seijo (2011), and Hengbin *et al*. (2020), the economics and management of fisheries combine the fish biology, ecology, and economic components of the fishery to identify sustainable production levels. There are two reference points (RPs), namely the maximum sustainable yield (MSY) and the maximum economic yield (MEY), for the purpose of fisheries management (Fig. 1).Fisheries management is far more complex than single-stock management

when it comes to achieving maximum sustainable yield (MSY) from several interacting species (Farcas & Rossberg, 2016). The maximum of the curve that emerges from estimating the yield by multiplying the input by the output is known as the maximum sustainable yield (MSY) (Fig.1). The capacity to reconstruct a time-series of total mortality from length frequency data due to the availability of long-term catch and effort data (Ricker, 1975;Farcas & Rossberg, 2016)whereas maximum economic yield (MEY) is used to maximize fishery resource rent (Guillen *et al*., 2013).Fish stocks have been exploited beyond the MSY and MEY levels, and further overfishing could result in a decline in fisheries production and rents (Hickley *et al*., 2002; Njiru *et al*., 2017; Mohsin *et al*., 2018). According to Jul-Larsen *et al*. (2003) and Kambewa (2007) stated that MSY can be achieved by controlling fishing effort and methods by restricting the number, type, and size of fishing gear; time and space (closed season and designated fishing zones); and number of fishers. Fisheries use a combination of economics and biology to explain the dynamics of stock, catch, and effort under various management regimes and to offer insights into the best ways to manage the stock (Clark, 1976; Larkin *et al*., 2011). On the other hand, the MSY fishing industry can provide more economic output and a better reference point for the whole fishing industry (Christensen, 2010) as compared to MEY. They claim that the concept of MEY belongs to individual fishing fleets and does not include the whole fishing industry (Guillen *et al*., 2013). Specifically for restocking or managing equilibrium harvesting of fish stocks, it is a crucial tool in managing fisheries for determining the sustainable levels of catch and effort and the exploitation path to achieve those levels (Clark, 1985, 1990; Hannesson, 1993; Seijo *et al*., 1998; Anderson and Seijo, 2009). A Bio-economic models (BEM) can address how rapidly a fishery can be rebuilt while maintaining a level of harvest to preserve jobs and markets while being sufficiently certain that stocks are expanding (Prellezo *et al*., 2012).

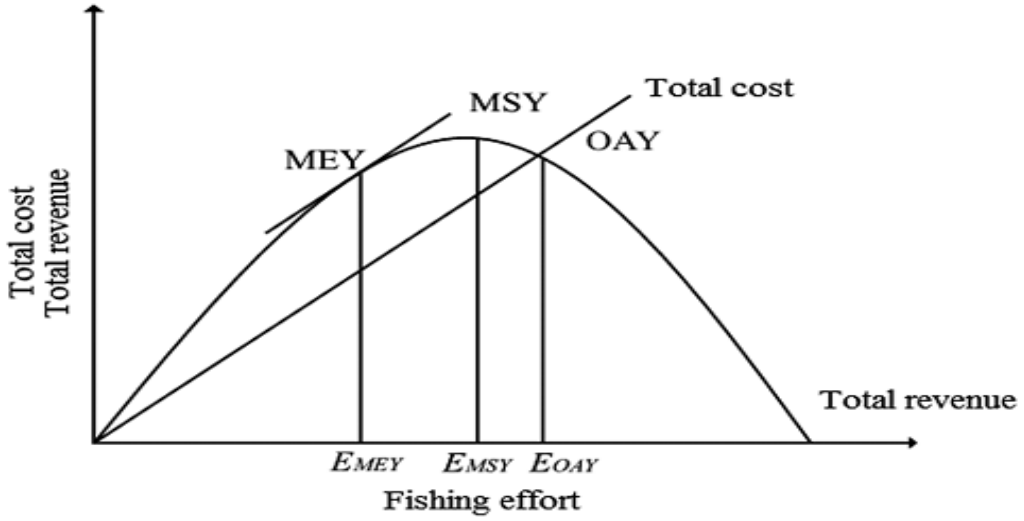


Fig. 1. Gordon-Schaefer's model on fishing efforts, bio-economic equilibrium, MEY (maximum economic yield), MSY (maximum sustainable yield) and OAY (open access yeild) **(**Hengbin *et al*., 2020)

## 2. 2. Value chain

The value chain describes the full range of activities, which are required to bring a product or service from conception, through the different phases of production (involving a combination of physical transformation and the input of various producer services), delivery to the final consumers and final disposal after use (Kaplinsky and Morris, 1999). The value chain in the fishery sector can be defined as the movements of the product (fish) from the landing centers to the final consumer taking into consideration the entire range of service providers at the various levels of the chain, the value addition done, the service provided or the subsequent value added to the product before consumption in the profit from the operations undertaken by them. Value chains can bridge the gap between the focus of mainstream economics on aggregate measures of poverty such as income and the stress of livelihoods perspectives on micro-level complexity (Kanji and Barrientos, 2002). In the context of fisheries, increased trade poses a significant risk to valuable ecosystems, but on the other hand, it has great potential as a source of desperately needed income for local fishing communities. Trade can enhance employment and income generation, both directly, and through multiplier effects, in

developing countries but of equal importance is the need to consider distributional impacts of trade to ensure that it is poor producers who actually reap the economic benefits of trade rather than a mere increase in macroeconomic indicators (Macfadyen et al., 2003). Moreover, the value chain dictates pathways based on which the policymakers, regulatory agencies and development partners can recommend future courses of action for a fair price at each tier and for further expansion of activities and markets of fishery elements through affluent outlets. The value chain provides fishery operators (fishers) and policy makers/regulatory agencies with a tool that allows them to know the costs relating to various steps in the chain. It is generally done for a potential product to identify the market actors involved in the supply chain, in order to improve access of inputs, markets and services by mobilizing the poor fishermen and policy environment towards facilitation of the chain (Rahman, 2013). They have their strength in the volume of the trade that is available to them because of the market characteristics. Exporters are another group, which are disjoint and compete for the products specific for the international market. The value chain for them is an integrated chain in which they have control over both the backward and the forward linkages of the chain. It also allows the analysis of each step in relation to preceding steps and following steps. Value chain analysis consists of two major elements (Nick, 2014 and Nowsad, 2016).

**I.** Assessment of existing market(s) to put the analysis within its proper context.

**II.** The value chain mapping which is aimed at answering six key questions are

- Who are the key customers and what are their product requirements in terms of species, volumes, quantities, packaging, delivery schedule, grades and standards?
- Who are the key players in the chain and what are their respective roles?
- What are the activities and processes along the chain?
- What is the flow of products, information and payments along the chain?
- What are the logistic issues?
- What are the external influences (e.g. ordinances, regulatory mechanisms, national policies?

## 2.3. Small scale fisheries based livelihoods

Fishery provides a range of important benefits, which sustain livelihoods: economic contribution, supply of animal protein, provision of both full-time and part-time employment. Fishing as livelihood is important especially for the poor fishermen. Small-scale fisheries are usually located in rural, remote areas, where few alternative sources of employment are available (Bene, 2003) and lack of alternative employment is one of factors determining a low living standard in small-scale fisheries (Bene, 2003). Traditionally, rural development policies and theories have not paid much attention to fishing as rural activity. Just recently, fishing has received a bit more attention and is considered as one of the most important components of rural (fishermen's) livelihood. The livelihood functions of fisheries can be complex, requiring an analytical framework, which can integrate assessment of a wide range of issues.

Ellis (2000) defines a livelihood as follows: A livelihood comprises the assets (natural, physical, human, financial and social capital), the activities, and the access to these (mediated by institutions and social relations) that together determine the living gained by the individual or household". This definition brings together the assets possessed by people, the activities in which they are engaged in order to earn their living and how they reduce threats to livelihood security and the factors that hinder or enable different people access to assets and income activities. These components are brought together in the SLF framework, which conceptualizes the interactions between them. The 'Sustainable Livelihoods Approach' (SLA) has been widely applied to inform the design of policy and development interventions aimed at reducing poverty in less developed countries (Allison, 2004). According to Kleih *et al.* (2003) the key elements of the SLA framework are:

- Capital assets: resources that help people survive and thrive (i.e. natural, social, human, physical and financial capital)
- Vulnerability context: things to which the poor are vulnerable
- Policies, institutions and processes (in earlier versions of the SLA this was referred to as 'structures and processes'): influencing their livelihoods
- Livelihood strategies: how people adapt and plan in response to threats and opportunities

- Livelihood outcomes and aspirations: people's objectives and priorities.

## 2.4. Fish marketing and distribution

Marketing plays a very critical role in meeting the goals of food security, poverty alleviation and sustainable agriculture, particularly among smallholder farmers in developing countries (Altshul, 1998). Fish marketing and distribution are integral aspects of fish production but they are not the only activities in the business; because fishery can only be called complete only when the fish gets to the final destination (consumers). Marketing has been defined as all processes involved starting from the production of a commodity until it gets to the final consumer (Crammer *et al*., 2001). These processes ascertain that the right product is available at the right place, at the right price and at the right time to fully satisfy the consumer (Beierlein and Woolverton, 1991). The market chain of fresh fish is relatively short as compared to coffee due to the nature of the product and poor storage/preservation methods (Abebe Cheffo *et al*., 2015). There are several actors in fish market chains who engage in various activities in fisheries. These actors have defined roles specific to the activities they perform and/or services they provide within the chains. Based on their roles and responsibilities the actors present in the chains. However, many different actors are involved in the traditional fish market characterized by no licensing requirements and by under developed and inefficient type of operations in Ethiopia.Fish consumption presents a complex pattern, ranging greatly between countries and within different areas in the same country or region. Fish consumption varies greatly depending on the quantities of fish supply available for consumption produced from capture and/or culture or imported. In addition to the normal supply, demand and location factors that influence prices, fish prices vary depending on quality, size of fish (different size fish may have different per kg prices), how it has been prepared (filleted, gutted, headed, skinned, etc.) and time of sale (fresh fish usually trades at a discount later in the day) (Meberat Alem, 2001)..

By tradition Ethiopians do not consume large quantities of fish, based on religious grounds of the Coptic Orthodox Christians (see Fetha Negest: book of Christian Conduct). In due course, this country has become a country with a strong tradition of livestock rearing and

meat consumers. The Ethiopian Orthodox Church observes several fasting periods as well as fasting days every week, when animal products are not consumed. Most Christians consider fish acceptable during those periods, though some strict followers of the religion will not eat any animal products (Brook Lemma, 2012). The choice of fish species depends on taste and cultural view. Most people have preferred to eat tilapia due to its presumed better taste. It has lesserintramuscular bones than other species (Berihun Tefera *et al*., 2009). There is less preference of consuming catfish in general due to religious and cultural reasons. Some people do not consider catfish as fish. Even though this is a general picture, there is also less preference of tilapia and high preference of *Labeobarbus* in the Northern part of Lake Tana and some significant preference of catfish around Delgie and Kunzila, western Lake Tana (Berihun Tefera *et al*., 2009).

## 2.5. Fisheries policy

As mentioned in the previous section, Ethiopia's fishery subsector has been facing several challenges, such as overexploitation, illegal fishing, habitat degradation, and lack of value addition. To address these issues, the Federal Parliament approved the National Fisheries Proclamation in 2003 (FDRE, 2003). The proclamation provides the general framework for the development and utilization of fish resources in Ethiopia. It aims to increase fish supply in the country, ensure food safety, promote aquaculture development, and conserve biodiversity. The proclamation also regulates the fishing activities, fishing vessels, boats, processing of fish products, water bodies, introducing exotic species, and controlling the fishery market. However, the proclamation does not specify the roles and responsibilities of the different stakeholders or the mechanisms for implementation and enforcement. Moreover, the proclamation does not adequately address the issues of fish quality, grading, processing, and marketing, which are crucial for value addition and income generation.

Legal authority is granted to the Ministry of Livestock and Fisheries to issue the directives required for the full implementation of the proclamation. The depletion of the fish stocks is a major issue for the regional administrations, and the fishermen have been pleading with the government to take action. In the context of constrained human, financial, and logistical resources, it provides clear indications of the priority actions that the government and its partners must carry out in order to make the greatest use of what they have at their disposal. Additionally, it places a lot of emphasis on rules, authorization, and the function of fishery inspectors (Hussen Abegaz *et al*., 2010). Perhaps the sector is underdeveloped due to the low level of the economy, ineffective administration setup, and lack of expertise (Assefa Mitike, 2014). Accordingly, a team of experts should be assigned to develop the Lakes fisheries management plan, including the enforcement of the proclamations to add the fish value chain to Ethiopia.

## 2.6. Fish production potentials of Ethiopia

The country is believed to have promising potentials for different fish stocks and it has a number of lakes, rivers, reservoirs, and small water bodies with substantial quantities of fish stocks. The total area of the lakes and reservoirs(including Grand Ethiopian Renaissance Dam and Gelgel Gibe III) stands at about 7,740 $km^2$ and3531 $km^2$, respectively (Gashaw Tesfay and Wolf, 2014) (Table 1). The country has 12 river basins with a mean annual flow (runoff) estimated at 122 billion $m^3$ of water (Seleshi Bekele*et al*., 2007), a total length of all rivers estimated at 8,065 km, and small water bodies make up about 4,450 $km^2$ of the country with substantial quantities of fish stocks, but so far it has not benefited from these resources (Gashaw Tesfay and Wolf, 2014).

Acording to Gashaw Tesfaye and Wolff (2014), due to the higher total area of water bodies and growing number of man-made water bodies (dams and reservoirs) excludingGrand Ethiopian Renaissance Dam and Gelgel Gibe III, estimated potential fish yield (EPY) estimates are evaluated for the overall possible yield range of 89,577 to 99,504 tyr-1 on average (94,500 t yr-1 + 5.2%). The EPY estimates are derived from empirical models that relate the physical and biological characteristics of the water bodies to their fish production potential. However, EPY estimates are not equivalent to MSY estimates, as they do not account for the ecological, economic, and social factors that affect the actual fishery performance. Therefore, it is recommended that MSY estimates are obtained for each stock, whenever possible, using data-rich methods such as stock assessment models, multispecies models, or ecosystem models. MSY estimates can provide more accurate and robust reference points for fisheries management and can help to avoid overfishing and ensure the long-term viability of the fish stocks.A straight forward method of assessing the fishery production potential of lakes, rivers, reservoirs, and small water bodies is needed to guide management decisions in planning, evaluating, and managing fisheries resources. Besides, fishing sustains the livelihoods of most rural communities with access to water shores, contributes to household food security source of supplementary incomes, employment and act as a natural safety net (Rahman *et al*., 2002; FAO, 2005; Omwenga, 2006; Navy and Bhattarai, 2009).

The Ethiopian Rift Valley Lakes are the most northern of the African Rift Valley Lakes. Most of these are located close to major cities and hence they are easily accessible by road, such as Lakes Koka, Ziway, Langano, and Hawassa (Gordon *et al*., 2007; Redeat Habteselassie, 2012; and

Gashaw Tesfaye and Wolff, 2014). Besides these lakes, the Ethiopian Rift Valley contains a chain of small to medium-sized lakes, a few of which are saline and the most highly productive lakes where regular fishing is conducted. The inland water bodies that supported by numerous crater lakes such as Hora, Arsade, Kilole,Bishoftu, Arenguadie, Pawlo and Chitu. There is fishing on all these water bodies, but commercial production (i.e. serving markets other than the local communities) is concentrated on the lakes (Chamo, Ziway and Tana) particularly dominant (Gordon *et al*., 2007). In addition, fishing is highly practiced in two large reservoirs, namely, Fincha and Koka. Riverine fishing activities, mostly for local consumption, are performed in Baro River and its tributaries (located in Gambela and Benishangul Gumuz, south western Ethiopia) and the Omo River systems, going as far as the Kenyan border (Brook Lemma, 2012).

Table 1.Estimation of production potential for the major water bodies developed from different researches (t $yr^{-1}$)(Estimates [a] Hussien Abegaze (2010); [b]FAO (2003); [c] Gashaw and Wolf (2014) and [d] Breuil (1995)
EPY

| **Major water bodies** | **Area ($km^2$)** | **Length (km)** | **Potential yield estimates (t $yr^{-1}$)** | | | **Lowest Estimate[C]** | **Highest estimate[C]** | **Per unit area ($tkm^{-2}$) or length (t $km^{-1}$)[C]** |
|---|---|---|---|---|---|---|---|---|
| | | | **EPY[b]** | **EPY[d]** | **EPY[C]** | | | |
| **Major lakes** | 7740 | | 23,342 | 47,400 | 39,262 | 37,346 | 41,177 | 5.8 ± 0.6 |
| **Major reservoirs (area >10 $km^2$)** | 3531 | | 4399 | 4100 | 7879 | 7698 | 8059 | 6 ±0.6 |
| **Rivers** | - | 8065 | 21,788 | | 21,405 | 18,855 | 23,954 | 4.1 ± 0.4 |
| **Small water bodies (area <10 $km^2$)** | 4450 | | 1952 | | 25,996 | 25,678 | 26,314 | 2.4 ± 0.9 |
| **Total** | **15,721** | **8065** | **51,481** | **51,500** | **94,541** | **89,577** | **99,504** | |

## 2.7. Trends of fisheries production in Ethiopia

Fig. 2 shows the trends in the average volume of inland fish production and its annual growth rate from 2007 to 2019. Moreover, fish production trends in the country indicate an increasing trend from 24,278 tons in 2012 to 57,399 tons in 2019 (MOA, 2020). According to the most recent catch figures, however, the nation's fish production is inconsistent and poorly documented, and in some cases it even runs counter to reports of the Ministry of Agriculture (MOA), literature, Bureau of Agriculture of the Regional States (BOA), and fishermen's perspectives (Table 2). Most of the estimates did not include the production of small water bodies, and in some cases even the rivers were not considered (Gashaw Tesfaye and Wolff, 2014). Contrary to Ministry of Agriculture (MOA) reports, fish production in Ethiopia has increased over time (Fig. 2) as a result of increased man-made water bodies (dams and reservoirs).In other words, between these years, there was an increase of 42% in fish landings by fishermen (MOA, 2019). Likewise, the value of fish Br/kg increased from 2006 to 2018 (MOA, 2019), which is a production growth rate of 1-27% (Fig. 2**)**. This indicates that there is still to the possibility of increasing fish production from the capture fisheries.

Open access characteristic of the fishery in the area increases the number of fisherme n and fishing gears, which in turn leads to stock depletion and decrease in catch trend (Felegeselam Yohanes, 2003; de Graaf *et al*., 2006; Lemma Abera *et al*., 2018). Benson (2012) and Lemma Abera *et al*. (2018) also confirmed that the decline in fish catch has been attributed to destruction of vegetation, agricultural and industrial pollution, hydrologic alterations and use small mesh sizes nets. Since excessive water abstraction for horticulture development and irrigation developments Lake Ziway has shown reduction its water level (Deribessa, 2006; Ayenew and Legesse, 2007, Girum Tamire and Seyoum Mengistou, 2012). In addition, Prellezo *et al*. (2012) stated that an increase in the input (vessels, fishing days at Lakes) leads to an increase in the output (harvest). However, detailed knowledge of the biology shows that the biological productivity of a fish resource is limited, and increases in input do not necessarily lead to long-term increases in output (harvest). Besides, complicated density dependant connections in the biology of a species, or the fishery, may lead to a system with non-linear relationships between input and

output (Gillis, 2003; Poos *et al*., 2010; Prellezo *et al*., 2012).

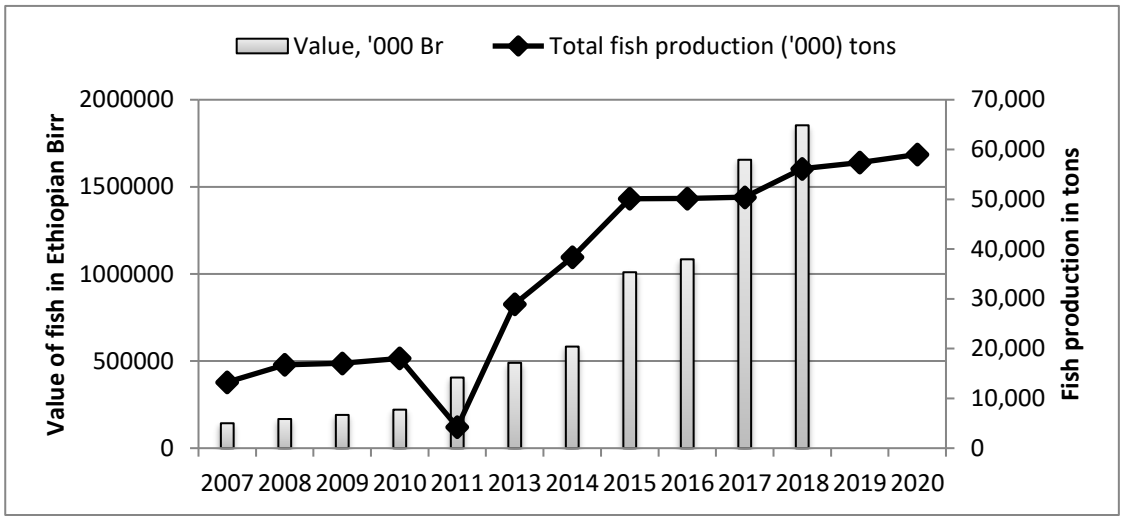


Fig 2. Trends in total supply of fisheries and value of fish in Ethiopia (MOA, 2020)

Table 2.Trends in total fish production in tons the year 2010-2019

| Lakes | FISH PRODUCTION IN TONS | | | | | | | | | | Sources |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** | **2019** | |
| **Tana** | 4432 | 4432 | 7,338.00 | 9,369 | 16,652 | 22,463 | 17,000 | | | 12,216.72 | MOA, 2019 |
| | 1413 | 846 | 975 | 1001 | 2703 | 2744 | 4735 | 4112 | 6561 | | BOA,2019 |
| | | 466 | 495 | 569 | 978.5 | 684 | 1085 | 1100 | 1055.6 | 863 | Bahir Dar Ketema Geberna, 2019 |
| **Ziway** | 2155 | 1261 | 3,823 | 4,969 | 4,056 | 3,927 | 2,582 | | | 1313 | MOA, 2019 |
| | | 1156.7 | 1555.7 | 1333.8 | 1157.14 | | 1120 | 800 | 860 | | Batu Zonal Agricultural Office, 2019 |
| **Hawassa** | 574 | 789 | 703 | 670 | 810 | 720 | 800 | | | 526.4 | MOA, 2019 |
| **Chamo** | 2300 | 3479 | 3,126 | 2,849 | 2,491 | 3,986 | 5,457 | | | 6,533.98 | MOA, 2019 |
| | | | | 1766.1 | 2352.175 | 3149 | | 2773.6 | 3430.2 | | Arba Minch Zonal Agricultural Office, 2019 |

## 2.8. Diversity of Fish species in the study lakes

Ethiopian water bodies support a diverse aquatic life including more than 200 fish species of 70 genera and 29 families(Redeat Habteselassiie, 2012). 200 valued species of which 41 species are endemic to Ethiopia(Abebe Getahun, 2007).Lake Tana alone contains natural stocks of 28 fish species, of which 21 are endemic (Eshete Dejen, 2008 and Vijverberg *et al*., 2009). It is also the home of diverse species of the genus *Labeobarbus* (Abebe Getahun, 2007; deGraaf, 2003) (Table 3). Moreover, there are between 20 and 30 fish species overall in the Rift Valley lake basins (Golubtsov and Mina, 2003), with the most common species of commercial value being *O. niloticus, C. gariepinus,* and *Lates niloticus, Bagrus docmac, and Labeobarbus* (Golubtsov & Mina, 2003; Vijverberg et al., 2012; Brook Lemma and Hayal Desta, 2016) (Table 3). There are somecommercially important fish species in Lakes Chamo, Ziway, and Tana (Table 3) that are harvested in the most traditional fishing methods and yet they are dominating the fish market (Gordon et al., 2007).Besides, the main preferred species in the market in the fishing grounds are Nile tilapia (*O. niloticus*), which represents 60% of the catch (Brueil, 1995; Reyntjens and Tesfaye Wudneh, 1998), Nile perch (*L. niloticus*) (favored but increasingly scarce), various species of *Labeobarbus* spp., and the African catfish (*C. gariepinus*) (Table 3). The story is however different when the fisheries of Gambella, Benshangul Gumuz, and Wollega are considered, where almost all types of fish species are marketable, including the world-renowned Nile perch.

Table 3.Llist of fish species caught in the Lakes Tana, Ziway, Hawassa and Chamo(Abebe Getahun and Eshetie Dejen, 2012; Redeat Habteselassie, 2012; Golubtsov & Redeat Habteselassie, 2010 and Vijverberg *et al*., 2012). **Note**: ✓indicates that species is present in the listed lake while X for absence.

| **Family** | **Species** | **Lakes** | | | |
|---|---|---|---|---|---|
| | | **Tana** | **Ziway** | **Hawassa** | **Chamo** |
| Clariidae | *Clarias gariepinus* | ✓ | ✓ | ✓ | ✓ |
| Cichilidae | *Oreochromis niloticus* | ✓ | ✓ | ✓ | ✓ |
| | *Coptodonzillii* | X | ✓ | X | X |
| Balitoridae | *Afronemacheilus abyssinicus* | ✓ | X | X | X |
| Centropomidae | *Lates niloticus* | X | X | X | ✓ |
| Mormyridae | *Mormyrus caschive* | X | X | X | ✓ |

| Family | Species | Lakes | | | |
|---|---|---|---|---|---|
| | | Tana | Ziway | Hawassa | Chamo |
| Characidae | *Hydrocynus forskahlii* | X | X | X | ✓ |
| Bagridae | *Bagrus docmak* | X | X | X | ✓ |
| Mochokidae | *Synodontis schall* | X | X | X | ✓ |
| Poeciliidae | *Aplocheilichthys antinorii* | X | X | ✓ | ✓ |
| Cyprinidae | *Carassiuscarassius* | X | ✓ | X | X |
| | *Cyprinus carpio* | X | ✓ | X | X |
| | *Enteromiushumilis* | ✓ | X | ✓ | X |
| | *Enteromiuspaludinosus* | ✓ | ✓ | ✓ | X |
| | *Enteromiustanapelagius* | ✓ | X | X | X |
| | *Garra dembecha* | ✓ | ✓ | ✓ | X |
| | *Garra dembeensis* | ✓ | X | X | X |
| | *Garra regressus* | ✓ | X | X | X |
| | *Garra tana* | ✓ | X | X | X |
| | *Garra makiensis* | X | ✓ | X | X |
| | *Labeobarbus ethiopicus* | X | ✓ | X | X |
| | *Labeobarbus acutirostris* | ✓ | X | X | X |
| | *Labeobarbus brevicephalus* | ✓ | X | X | X |
| | *Labeobarbus crassibarbis* | ✓ | X | X | X |
| | *Labeobarbus dainellii* | ✓ | X | X | X |
| | *Labeobarbus degeni* | ✓ | X | X | X |
| | *Labeobarbus gorgorensis* | ✓ | X | X | X |
| | *Labeobarbus gorguari* | ✓ | X | X | X |
| | *Labeobarbus intermedius* | ✓ | ✓ | ✓ | ✓ |
| | *Labeobarbus longissimus* | ✓ | X | X | X |
| | *Labeobarbus macrophthalmus* | ✓ | X | X | X |
| | *Labeobarbus megastoma* | ✓ | X | X | X |
| | *Labeobarbus nedgia* | ✓ | X | X | X |
| | *Labeobarbus ossensis* | ✓ | X | X | X |
| | *Labeobarbus platydorsus* | ✓ | X | X | X |
| | *Labeobarbus surkis* | ✓ | X | X | X |
| | *Labeobarbus truttiformis* | ✓ | X | X | X |
| | *Labeobarbus tsanensis* | ✓ | X | X | X |
| | *Labeobarbus beso* | ✓ | X | X | X |
| | *Enteromiuskerstenii Peters* | X | X | X | ✓ |
| | *Enteromiussp* | X | X | X | ✓ |
| | *Enteromiuscf.* | X | X | X | ✓ |

| Family | Species | Lakes | | | |
|---|---|---|---|---|---|
| | | Tana | Ziway | Hawassa | Chamo |
| | *stigmatopygus Boulenger* | | | | |
| | *Garra cf. hirticeps* | X | X | X | ✓ |
| | *Garra cf. quadrimaculata* | X | X | X | ✓ |
| | *Labeo cylindricus* | X | X | X | ✓ |
| | *Labeo horie* | X | X | X | ✓ |
| | *Labeo niloticus* | X | X | X | ✓ |
| | *Labeobarbus bynni* | X | X | X | ✓ |
| | *Enteromiusamphigramma* | X | X | X | ✓ |

## 2.9. Economically important fish species

The African catfish (*C. gariepinus*), Labeobarbus species, and Barbus species are the most significant ones that contributed to the yield in that order, respectively (Fig. 3). The Nile tilapia (*O. niloticus*) dominated the fish catch at the Ethiopian Lakes. The Nile tilapia is the most popular fish, accounting for around 50% (Gashaw Tesfaye and Wolff, 2014) and 46.29 percent (MOA, 2019) of the total fish catch over the previous two or more decades (Fig.3).

Between 2007 and 2019, the annual supply of African catfish and Nile tilapia increased. From 2013 to 2019 (Fig. 3) with a dramatic fall in Barbus and Labeo species ensued. The Nile tilapia (*O. niloticus*), the African catfish (*C. gariepinus*), the Nile perch (*L. niloticus*), and the Barbus species are the most significant species that make up significant amounts of the commercial catches. The common carp (*C. carpio*) and the crucian carp (*C. carassius*), two introduced carp species, are also included in a report from the Ministry of Agriculture (MoA). However, due to their accessibility in the closest water bodies, infrastructure (such as roads), and transportation facilities, the spatial distribution of these commercially significant fish species varies across the nation.

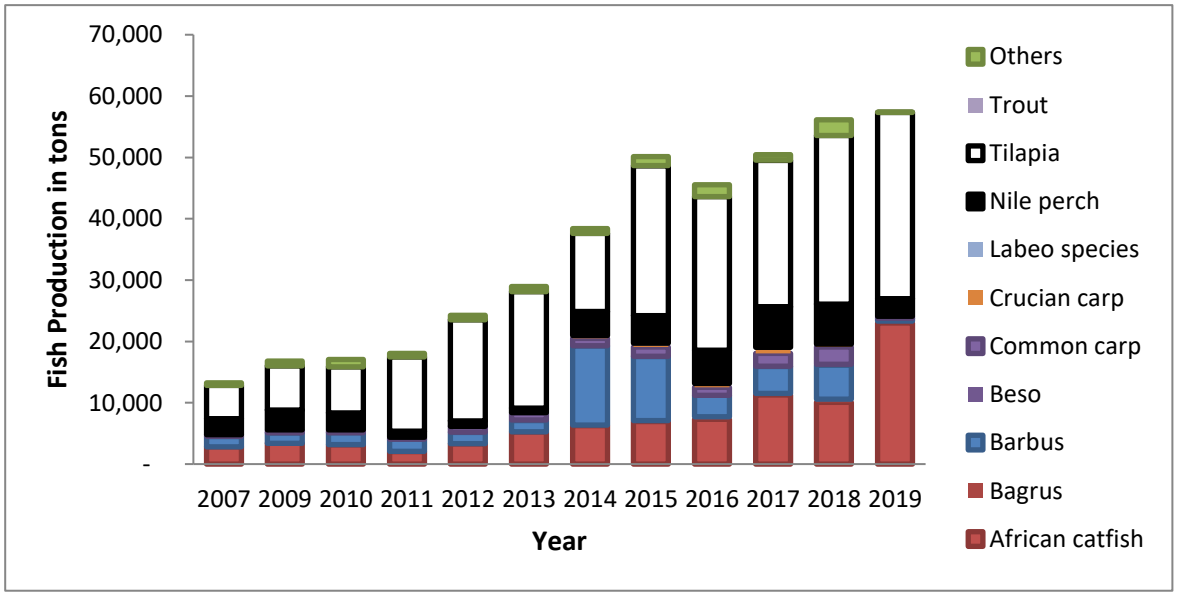


Fig 3. Trends in share and overall supply of fish species in Ethiopia (MOA, 2019)

# CHAPTER THREE

## 3. Materials and Methods

### 3.1. Description of Study Lakes (location, area, topography, and climate)

The study was conducted at Lake Tana located in the highlands of Northern Ethiopia, the Ethiopian Central Rift Valley lakes Ziway and Hawassa, and the southern Rift Valley Lake (Chamo) (Fig.4). Among these lakes, Tana, Ziway, and Chamo are contributing more than 65% of the total annual fish catches in Ethiopia (Assefa Mitike, 2014; Gashaw Tesfaye and Wolff, 2014; Mathewos Temesgen and Abebe Getahun, 2016).Moreover, people consume large amounts of fish on fasting days in big cities and around production areas and towns, especially in Ziway, Arbaminch, and Bahir Dar. Outside these areas, the domestic market for fish is small due to the fact that fish has not been integrated into the diet of most of the population; due to religious influences on consumption patterns. As a result, the demand for fish has become seasonal and during lent times (Assefa Mitike, 2014). The details below provide baseline information of the study lakes.

The above four lakes were selected purposively on the basis of their accessibility to market outlets from their respective landing sites, number of fishermen operating in the area, availability of marketable fish, the volume of trade generated, opportunity of market and number of forward and backward linkages in the market chain and providing considerable catches and fishery that supply resources for the local and urban communities of the major cities including the capital, Addis Ababa.

Table 4. Baseline information on the study lakes (LFDP,1997; Elias Dadebo *et al*.,2003; Ayalew Wondie *et al*., 2007; Vijverberg *et al*., 2009;Vijverberg*et al*., 2012; Wassie Anteneh *et al*., 2012; Taddesse Fetahi et al., 2014 Begashaw Abate *et al*., 2015; Brook Lemma and Hayal Desta, 2016; Negese Kebtieneh *et al*., 2016; Eshete Dejen *et al*., 2017; Fassil Teffera *et al*., 2017;Teklu *et al*., 2018; MOA,2019;WondimuTadiwos and Tenalem Ayenew, 2019 and Zigide *et al*., 2019).

| No. | Parameters | Lakes | | | |
|---|---|---|---|---|---|
| | | **Tana** | **Ziway** | **Hawassa** | **Chamo** |
| 1. | Location | 12°N, 37°15'E | $7^0$54'N, $38^0$45'E | $7^0$03'N, $38^0$27'E | 5°42′N, 37°39′E |
| 2. | Elevation (m.a.s.l) | 1830 | 1636 | 1680 | 1233 |
| 3 | Dissolved oxygen (DO) $mgL^{-1}$ | 6·4-7·2 | 3.46- 6.01 | 6.27-16.7 | 5-9 |
| 4 | Conductivity, $\mu Scm^{-1}$ | 142-184 | 361.50-484.51 | 846-1673.5 | 1100-1910 |
| 5 | pH | 6.98 - 9.97 | 8.03 - 8.37 | 8.66-9.17 | 8.10-8.9 |
| 6 | Total Dissolved solid (TDS) (mg/l) | 63-135 | 107.7-433.5 | 472.5 | 608-1100 |
| 7 | Phosphate (mg/l) | 0.07-3.50 | 0. 21- 0.64 | 0.42-1.36 | 1.39 -2.09 |
| 8 | Chlorophyll-*a*(µg/l) | 3.34-12.0 | 37 -54.50 | 25.45 | 44 |
| 9 | Watershed area ($km^2$) | 16500 | 7025 | 1250 | 2210 |
| 10 | Surface area ($km^2$) | 3200 | 440 | 91 | 551 |
| 11 | Max. depth (m) | 14 | 7 | 22 | 13 |
| 12 | Mean depth (m) | 8 | 2.5 | 11 | 6 |
| 13 | Potential yield t/year | 15000 | 3010 | 611 | 4500 |
| 14 | Per unit area ($t/km^2$) | 4.3 | 5.1 | 5.8 | 5 |
| 15. | Major inflows | Gilgel Abbay, Megech, Rib, Gumara, Dirma,Arno-Garnoand Gelda rivers | Meki and Katar rivers | Swampy area, Tikur-Wuha | Sile, Argoba, Elgo Wezeka, Sego and Kulfo Rivers |
| 16. | Major outflows | Blue Nile river | Bulbula river | no | Sagan River |
| 17. | Offshore cities | BahirDar, Goregoa, Delgie | Batu | Hawassa | Arbaminch |

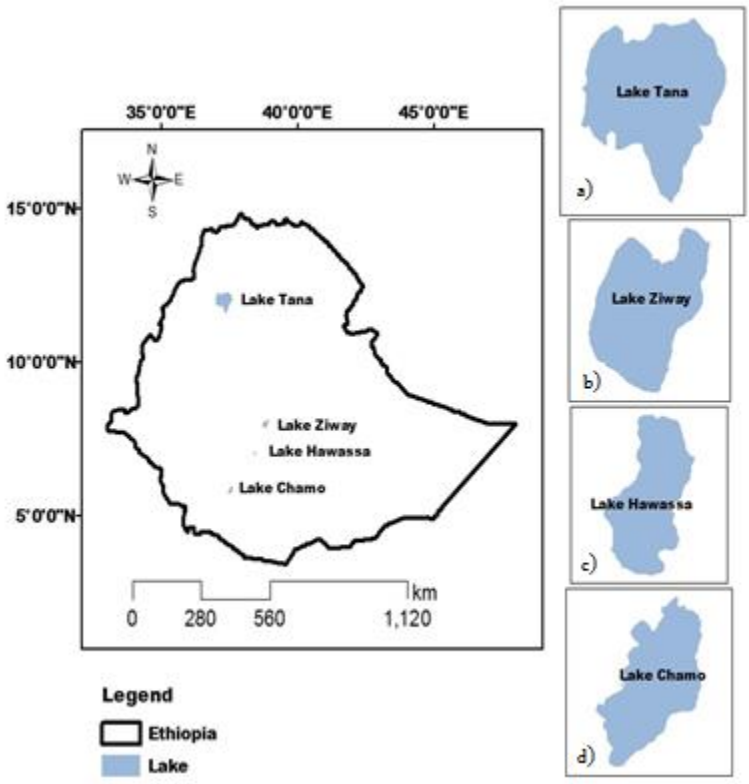


Fig 4. Geographical locations of Lakes:a)Tana, b)Ziway, c)Hawassa and d)Chamo

**Lake Tana:** This is the largest lake in Ethiopia, coveringhalf of the country's natural lake area, and is the third largest lake in the Nile Basin (Vijverberg *et al*., 2009). It is situated in the north-western highlands of Ethiopia (12°N, 37°150E) on a basaltic plateau at an altitude of 1830 m above sea level and can be characterized as an oligo-mesotrophic lake (Chlorophyll-*a* at ranged from 2.6 to 8.5 mg $m^{-3}$ (mean: 4.5 mg $m^{-3}$) (Ayalew Wondie *et al*., 2007; Eshete Dejen *et al*., 2017). The lake has a maximum length of 78 km and a width of 68 km (Eshete Dejen, 2003) (Table 4). It is the source of the Blue Nile River (Great Abbay), which forms 40-meter-high water falls 30 km downstream from the Blue Nile outflow with a catchment area of 16,500 $km^2$ and a volume of 28 $km^3$ (Ligdi *et al*., 2010) (Table 4). It is boarded by 3 zones (North Gondar, South Gondar, and West Gojjam). Alefa, Denbia, and Gondar Zuria are the districts in north Gondar bordering the lake. Libokemkem, Fogera, and Dera are found in the South Gondar zone, whereas Bahir Dar, Zuria, and Achefer are found in the West Gojjam. In Lake Tana fisheries,

there are 51 and 54 *kebeles* (the lowest administrative unit in Ethiopia) and landing sites, respectively (Sewmhon Demessie, 2003), that have potential for fishing. Fishers have been engaged in fishing on a seasonal, part-time, and full-time basis. It supports a diverse and huge number of livelihoods and development activities. Seven permanent rivers as well as more than 40 small seasonal rivers and streams feed into the lake (Eshete Dejen *et al*., 2017). The main tributaries to the lake are the Gilgel Abbay (Little Blue Nile), Megech, Ribb, Gumara, Dirma, Arno-Garno, and Gelda rivers. Together, they contribute >95% of the total annual inflow (Lamb *et al*., 2007; BOA, 2011;Wassie Anteneh *et al*., 2012).

The north-eastern and southern ends of the lake are relatively stagnant gulf areas, where the cities of Gorgora, Delegie, Infranze, and Libo Kemkem are located, respectively. There has been a settlement at or around North Eastern and Bahir Dar for many centuries; however, the economic growth of Bahir Dar began in the 1990s, when its status was raised to that of a regional capital. Bahir Dar city is presently expanding rapidly, with much new construction and the main city on the lake concentrated in the south gulf. It has good services as both a regional (administrative) capital and a commercial center, drawing immigrants from the surrounding rural areas. It attracts both Ethiopian and foreign tourists because of its attractive location nearthe lake and because the area has many famous monasteries. It has many hotels and restaurants (including new developments) and is an important market for goods produced locally and items shipped in from Addis Ababa.

The climate is typical of semi-arid regions close to the equator, with a high diurnal temperature variation between daytime extremes of 30◦C and nighttime lows of $6^0$C. Lake Tana is characterized by four seasons: a main rainy season with heavy rains during July-September, a post-rainy season during October-November, a dry season during December-April, and a pre-rainy season during May-June. It has relatively low water temperatures (Eshete Dejen *et al*., 2004), varying between 20 and 27 °C). The mean monthly air temperature of the Lake area varies between 10.6ºC and 30.2°C. Average monthly maximum temperature occurs in February to May and the minimum in December and January (Fig. 5(NMA, 2020)). The total monthly rainfall pattern of Lake Tana is lower in the months of November to April and with peak rainfall from June to September (Fig. 5 **(**NMA, 2020)). Alemayehu Taddesse *et al*. (2010) and Wassie Anteneh *et al*., (2012) stated that water levels are highest at the end of the rainy season and

during the post-rainy period, slowly decreasing to a minimum around the end of the dry season. During October to June, evaporation exceeds in put via rainfall and during this time many of the inflowing streams dry up completely.

**Lake Ziway** is the fourth-largest lake in Ethiopia, with an area of 434 $km^2$ and a shoreline length of 137 km. It has a maximum length of 32 km and a maximum width of 20 km (LFDP, 1997). It is located at an altitude of 1636 masl (Von Damm & Edmond, 1984) (Table 4). It provides a wide range of ecosystem services to the local community and the country at large. For instance, it is the second annual fish potential and supplier of fish catch in the Rift Valley Lakes, next to Lake Chamo, and accounts for about 19% of the national fish catch (Gashaw Tesfaye and Wolff, 2014).

It is a moderately shallow lake compared with other Ethiopian Rift Valley lakes, with a maximum and mean depth of 8.95m and 2.5m, respectively (Von Damm and Edmond, 1984). The lake is fed by two major rivers, Meki from the north-west and Katar from the east, and has one outflow in the south, i.e., the Bulbula River, which flows into Lake Abijata (Megerssa Endebu et al., 2015). Lake Ziway, home to five main islands including Tullu Guddo, Tedecha, Debresina, Funduro, and Gelila, serves multifunctions such as irrigation, fishing, and drinking water supply for the residents of Ziway town. Additionally, it supportstransportation, recreation, and a source of fresh water forLake Abijata through the outflowing Bulbula River.Recently, indoor flower farming has been introduced (Lemma Abera *et al*., 2018, Spliethoff *et al*., 2009). However, extensive human activities in the lake's catchment, such as daily water withdrawal for irrigation (approximately612,000 $m^3$) and land use changes, includingconversion of woodlands into agricultural lands and settlement areas have led to environmental changes (Hayal Desta *et al*., 2015). Despite these challenges, Lake Ziway boasts a diverse array of bird species and hippopotamus populations. Additionally, it islands are adorned with historical churches, drawing in tourists. Nevertheless, the lake's ecosystem confronts notable threatsincludingcatchment degradation, siltation, imbalance between water inflow and outflow, and uncontrolled fishing practices (IBC, 2005).

The climate in the Lake Ziway catchment ranges from dry to humid. The lowlands around the lake are semi-arid, while the highlands are humid sub-dry, and humid (Araba Jemal, 2021). The catchment has a tropical climate, with a minimum and maximum monthly total rainfall of 0mm

and 258.3 mm, respectively (Fig. 5(NMA, 2020)). The total monthly rainfall pattern of Lake Ziway is lower in the months of November to February and higher from June to August with peak rainfall (Fig. 5). Hayal Desta *et al*. (2017) declared that the rainy season, which lasts from June to August, accounts for around 55% of the yearly precipitation, while the other seasons account for the remaining 45%. Adamneh Dagne (2010) also stated that the rainfall pattern is largely influenced by the annual fluctuation of the intertropical convergence zone, which results in the rainy season (with most of the rainfall occurring from June to September) and the dry season (from October to March). The temperature in the Lake Ziway catchment is relatively constant throughout the year. The daily maximum temperature is 27.6 $^{o}$C to 29.5 $^{o}$C, while the daily minimum temperature varies between 10.9 $^{o}$C and 16.9 $^{o}$C (Fig. 5(NMA, 2020)). The meteorological data also show comparable trends to those documented by Lemma Abera *et al*. (2017) and Adamneh Dagne (2010).

**Lake Hawassa** is located in the central north-east of the Ethiopian Rift Valley basin, bordering two regional states, namely the Southern Nations, Nationalities, and People's Regional State and the Oromiya Regional State in Ethiopia, and the eastern side of Hawassa city, which is 275 km south of Addis Ababa. It is the smallest and highest in altitude among the Great Ethiopian Rift Valley lakes and is located between the Ziway-Shalla lakes to the north and Lakes Chamo and Abaya to the south (Lamb *et al*., 2002). The maximum depth of the lake is 22 m, with a mean depth of 11 m (Elias Dadebo, 2000), a volume of 1.036 x 109 m3, and a drainage (catchment) area of 1,250 km$^2$ (LFDP, 1997) (Table 4). It is productive and one of the most fished lakes in the country. The topographical characteristics include, flat plains, gentle slopes to dissected escarpments, mountainous regions, and hilly surfaces. The altitudes average 1680 m above sea level. It is a terminal lake with no surface outflow and receives surface inflow through the Tikur Wuha River (LFDP, 1997; Negese Kebtieneh *et al*., 2016). It provides a habitat for different fish species, waterbird sanctuaries, and aquatic organisms. It also provides fundamental sources of income through fisheries and tourism, both at the local and national level. Dorebafena-Shamena, Wedesa-Kerama, Tikur Wuha, Lalima-Wendo Kosha, and Shashemene-Toga its main inflow comes from the swampy area, which was once part of Lake Shallo and drains through the river Tikur Weha (Makin *et al*., 1975).

Agriculture is the major land use at subsistence level and the mainstay of the farming community (Arega Degife *et al*., 2019). The land-use system was dominated by rain-fed agriculture. Common grazing lands are changed into agricultural lands and plantations due to the high population density (Arega Degife *et al*., 2019; Kuma *et al*., 2022). The western part of the area near Lake Hawassa is highly degraded due to repeated cultivation and exposure to gully erosion. While the eastern and north-eastern parts of the area are more stable and covered with forests and woodlands (Garedew *et al*., 2009).

The catchment area has a tropical climate with pronounced aridity in the southern part and a warm-temperate rainy climate in the central and northern highlands. Moreover, the rainfall regime is unimodal for the northern and central parts of the basin and bimodal for the south. It receives a total monthly rainfall of about 4mm to 236 mm. The mean monthly maximum and minimum temperatures are between 24.9 and 30.30 ℃ and 11.3 and 15.60 ℃, respectively(Fig.5; NMA, 2020).

**Lake Chamo**: Lake Chamo is one of the rift valley lakes in southern Ethiopia's Gamo Zone.Lake Abaya to the south, the Guge Mountains to the east, and nearby the town of Arba Minch.Many streams from the mountain chains join to form the Kulfo and Hara rivers, which eventually connect the western part of the Central Rift Valley to the lakes (Chamo and Abaya). The floodplains and the deltas of the lake are fertile, and hence they have been under extensive agricultural cultivation for the last three decades (Fassil Teffera*et al*., 2018). The fish species are more diverse than those in the other rift valley lakes of the country, possibly due to the free passage of the Soudanian species from the Nile system via the interconnections of Lakes Turkana and Chew Bahir (Beadle, 1981; Elias Dadebo *et al*., 2003). Kulfo River is the main affluent of the lake, which flows in at the north end. The less important feeders are the Sile and Sago Rivers from the west (Elias Dadebo *et al*., 2003) (Table 4).

The catchment of the lake is characterized by a humid to hot semi-arid tropical climate with a bimodal rainfall pattern including two wet seasons (the first from end-March to mid-June, and the second from mid-September to late November) and two dry seasons (the first from December to mid-March, the second from end-June to mid-September) with peaks in April/May and August/September, a high rate of evaporation (about 2300 mm per year on average), and dominated by warm temperatures throughout the year (Makin *et al*., 1975;

Wagesho, 2014; Dagnachew *et al*., 2020). It receives about 0-229.5 mm total monthly rainfall. The mean annual maximum and minimum temperatures are 27.6-34.5 °C and 16.2-18.3 °C (Fig. 5; NMA, 2020). Depending upon the topography, diverse types of indigenous and non-indigenous vegetation exist in the catchment (Hailu Gisha Kuma *et al*., 2022). The high lands and middle areas are known for cultivation and intensive home gardens close to their homes.

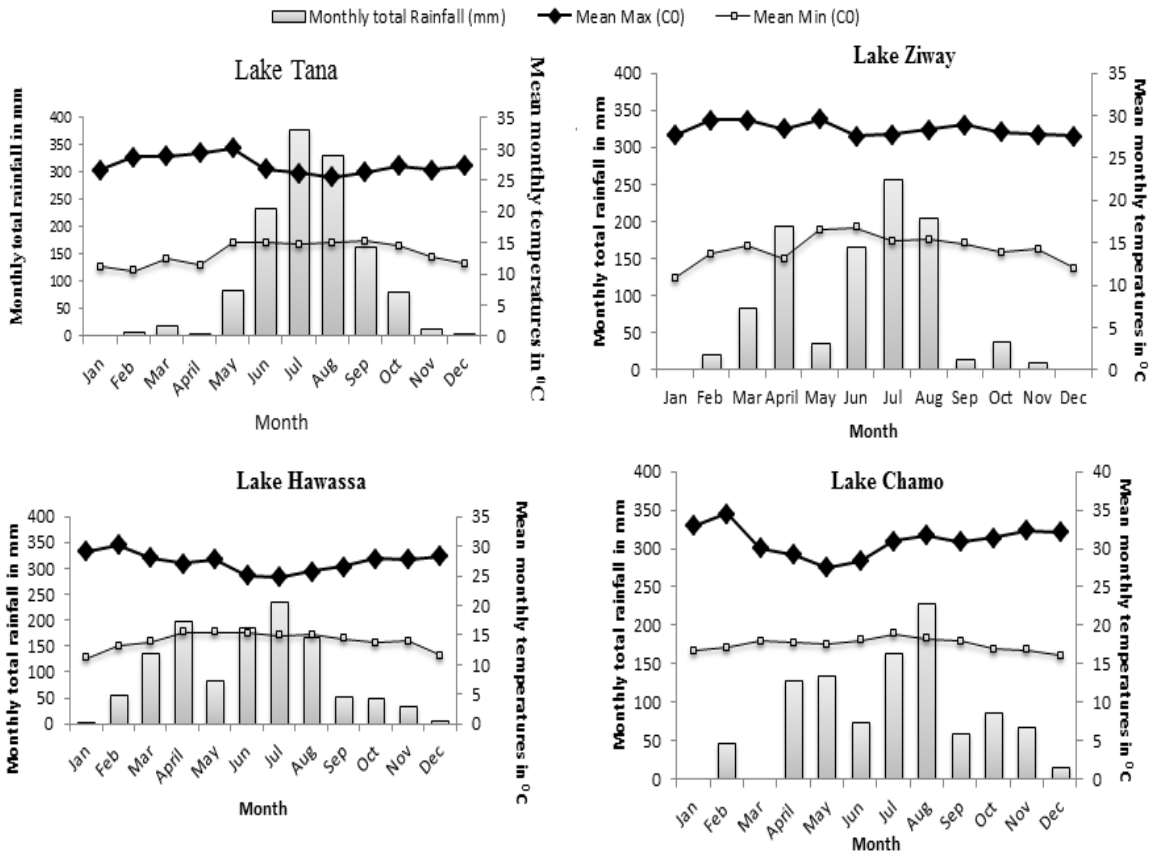


Fig. 5. Monthly total rainfall; mean minimum and maximum temperature of the Lakes Tana,Ziway,Hawassa and Chamo (From January 2019 to December 2019)(Source: National Meteorological Agency, 2020).

## 3.2. Data sources, sampling procedure and data collection methods

This study was conducted from October 2018 to July 2020. Observations, primary and secondary data sources were used in Lake Tana and the Rift Valley lakes Ziway, Hawassa and Chamo. Both qualitative and quantitative data were collected from primary and secondary sources.

### 3. 2.1. Observations

Throughout the study first hand observations were made on the existing, postharvest handling, gutting, filleting, packaging, transporting and marketing processes of fish.

### 3.2.2. Primary data collection tools

Primary data collection was conducted using questionnaires to find out the responses of the involved parties in the market chain. According to field research, the standards for ethical clearance were not mentioned in any of the fish and livestock markets. Accordingly, a questionnaire was developed and validated on a small scale to ensure consistency and cover all possible areas of investigation. Before starting the actual data collection, the objectives of the research were clearly explained to each respondent, group, and office-holding expert. Cascading from the main questionnaire, an itemized checklist was prepared to ensure that all comments for fishers, fish traders, and government and non-government institutions at different levels were captured (see appendix 1). The main data collection was focused on socioeconomic characteristics, fishing and trading experiences, collected socioeconomic variable such as age, gender, education status, marital status, credit access, fish-fish product prices, income sources, fishing trips, gillnet size and number, family size, fishing ground distance, reed boat number, wooden boat number, distance to market center, and credit service to answer the question related to the determinants of fish production, determinants of fish production by fishersand problems associated with fish production. Besides buying and selling, pricing by species type, mode of transportation, types of preservation, postharvest handling techniques, characterization of fish marketing actors, problems associated with fish marketing, and sanitary conditions at all levels of the market chain.

### 3. 2.3. Sampling fishers and traders

Sampling and selecting the personnel to be interviewed were done based on random, and purposive sampling methods. The structured questionnaires were pre-tested to determine the consistency of the questions and their validity before the actual interviews were held. Some adjustments were made to the questionnaire, and the final data used in the research were collected. Purposive sampling or a judgement technique was therefore employed to select a number of fishermen who are thought to be reliable representatives. In the process, approaches for purposeful sampling were used to collect a wide range of data about their experiences with fishing activities. The population's ability to appropriately select and look at eligible participants who fit a specific profile determined the sample size for each lake. These were Lake Tana at 4539, Lake Ziway at 1766, Lake Hawassa at 1495, and Lake Chamo at 1104. Thus, with a total sample size of 450 fishers, random selections of 150, 125, 90, and 85 were selected.With respect to the sampling of fish traders, a purposive sampling technique was used depending on the volume of fish they were handling and their proximity to the market place at Lakes Tana, Ziway, Hawassa, and Chamo.

### 3.2.4. Sampling for focus group discussions, key informants and leaders of cooperatives

This survey was also supplemented with additional general and specific information collecting methods. Focus group discussions (FGD) with responsible persons of both sexes and diverse age groups were formed. We interviewed key informants (regional fisheries experts), knowledgeable fishers, cooperative leaders, fisheries experts from the Ministry of Agriculture, and members of the private Fish Production and Marketing Enterprise management group (Table 5).

Finally, fish market channels were drawn based on the collected data to help the authors produce a complete picture of the fishery market chain from the Lakes Tana, Ziway, Hawassa, and Chamo. After this whole exercise, the overall sample size came to 597 individuals who were involved in the primary data collection (see the breakdown in Table 5below).

Table 5. Summary of the number of individual of data sources

| Categories of subjects involved in the study | Study areas (lakes) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Tana | | Ziway | | Hawassa | | Chamo | | Total | | Total |
| | M | F | M | F | M | F | M | F | M | F | |
| **Fishers** | 150 | 0 | 122 | 3 | 89 | 1 | 84 | 1 | 445 | 5 | 450 |
| **Fish traders** | 25 | 5 | 22 | 1 | 19 | 0 | 17 | 0 | 83 | 6 | 89 |
| **Focus groups** | 8 | 2 | 7 | 0 | 6 | 1 | 6 | 0 | 27 | 3 | 30 |
| **Regional Bureau of Agriculture and Zonal experts** | 5 | 1 | 2 | 0 | 2 | 1 | 3 | 1 | 12 | 3 | 15 |
| **Leaders of fishery cooperatives** | 2 | 0 | 2 | 0 | 2 | 0 | 2 | 0 | 8 | 0 | 8 |
| **Experts from the Federal Ministry of Agriculture** | | | | | | | | | 2 | 2 | 4 |
| **Technical persons from a private Fish Production and Marketing Enterprise** | | | | | | | | | 1 | 0 | 1 |
| **Total** | **190** | **8** | **155** | **4** | **118** | **3** | **112** | **2** | **578** | **19** | **597** |

### 3.2.5. Secondary data collection tools

The information provided in the review is from both published and unpublished sources. The collection of fish production (catch) statistics from Ethiopian fishery resources data for the period of 2008-2018 was obtained by reviewing secondary data from the Ministry of Agriculture (MoA), FAO, Bureaus of Agriculture (BoA), *Woreda* (district) Agricultural and Rural Development Office (WARDO), and fisheries research institute records from fish production cooperatives. Moreover, various relevant policy papers and catch records from cooperatives and the Fish Production and Market Enterprise (FPME) were examined. Additional secondary data collection was conducted by examining catch statistics from fish stock assessment studies done by academic and research institutes and changes in fish prices from user hotels and traders.

### 3.3. Data Analysis

The collected data were analyzed using descriptive statistics and econometric analysis. In this study, the collected data were tabulated and organized in graphs, charts, and tables and analyzed using descriptive statistics such as frequency, average, percentage, and other appropriate statistical methods with SPSS version 20.0 Statistical Software. The data collected from the focus group discussions and the interviews made with key informants were analyzed using qualitative methods and included in the discussion accordingly.

To test whether there were significant differences in age, education level, and fishing experience among the groups of fishers, a chi-squared test ($\chi 2$) was performed using cross-tabulation. The groups of fishers were defined by the fish production systems, which were the different types of fishing practices used in the four lakes (Tana, Ziway, Hawassa, and Chamo). To address the household-level determinants of fish production, a regression model was fitted to different variables. For this particular study, the Ordinary Least Squares (OLS) method of linear regression was used to analyses the determinants of fish production by fishers. The study used the volume of fish production as a dependent variable and the factors that are expected to affect fish production as independent variables. The functional form of the regression equation is presented as:

$$Y = f(X_1, X_2, X_3 \ldots X_i) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1.$$

Where, Y is the average fish production given as a function of the independent variables, X's.

Estimating the sample linear regression function, as the most common method, is to use the OLS regression given that OLS assumptions are satisfied. According to Gujarat (2004) model, OLS regression can be specified as follows. The dependent variable (Yij) is defined as if $j^{th}$ fishers for $i^{th}$ variable is marketable supply of fish (average fish production), otherwise (j ranging from 1-450). Therefore, the general model of volume of fish production has a form of:

$$Y_{ji} = \beta_0 + \beta_1 X_{1j}, \beta_2 X_{2j}, \beta_3 X_{3j \ldots} \beta_i X_{ij} + e \quad \ldots\ldots\ldots\ldots\ldots\ldots 2.$$

Where; $Y_j$ is the dependent variable; $\beta_0$is a constant value that represents the Y intercept; $\beta 1$, $\beta_2$,$\beta_3$, …, $\beta_i$ are coefficients or slopes of $X_1$, $X_2$, $X_3$, …, $X_i$ respectively, and $X_1$, $X_2$, $X_3$, …, $X_i$ are explanatory variables, i is the

number of coefficients and j is the number of observations,
and e is error term.

The hypothesized independent variables for fish production function include:

Y= f (income, education level, fishing trip, gillnet number, credit access, fishing ground distance, fishing experience, boat number, distance to market and age ).

The estimation of market margin was considered most appropriate for this study to analyze performance of the market (Mendoza, 1995). This was found to be very effective when there are several participants in the market chain, and hence the margin is calculated by finding the price variations at different segments of the chain and then comparing them with the final price at the consumer end. Hence, the consumer price was taken as the base or common denominator for all marketing margins (Mendoza, 1995). The relative size of the various market gross margins of the participants can indicate where in the marketing chain value is added and/or profits are made (Mendoza, 1995; Cramer and Jensen, 1982). Mathematically, this can be expressed as:

$$P_S = \frac{P_x}{P_r} = 1 - \frac{MM}{P_r}$$

Where, $P_S$ = Producer's share
$P_X$ = Producer's price of fish
$P_r$ = Retail price of fish
MM = Marketing Margin

The Total Marketing Margin (TGMM) was calculated using the following formula (Mendoza and Mark Rosegant, 1995; Abebe Cheffo, 2016):

$$\text{TGMM} = \frac{\text{Consumer Price} - \text{Fishers Price}}{\text{Consumer Price}} \times 100$$

The margins at each stage of the different channels were then compared against each other.

# CHAPTER FOUR

## 4. Results and Discussion

### 4.1. Demographic Characteristics of fishers

Fishers are diversified in their demographic aspects by sex, age, marital status, income levels, ownership of the business education level, etc. In the study areas under this investigation, 98.9% of the sampled fishers were males; while 1.1% of them were females. It implies that fishing activities were male-dominated and so is the ownership question (Table 6). The majority of the fishers (79.1%) were married, 20.4% were single, and the rest (0.4%) were divorced. Besides that, 19.3% of fishers were illiterate, while the rest ranged from simple writing and reading skills up to preparatory school levels, which is equivalent to Grade 8 in the Ethiopian standard. According to the reports of Hoppe (2002), Sewmehon Demessie (2003), and Mfinanga (2014), fishing activity is male-dominated due to its distress, the need for a high level of physical work, the requirement of experience with age and the source of initial capital. It was also found that the age of the fishers ranged from 18 to 70 years with a mean age of 38.2 years (Fig.6), and the actively working-age group was between 25 and 50 years old (Wubeshet Birhanu, 2015; Abebe Chafo *et al*., 2016; Tekalign Tuluka *et al*., 2021).The mean age of heads of fishers for all lakes showed an almost equivalent distribution of 39.5 for Tana, 38.9 for Ziway, 38.5 for Hawassa, and 34.6 for Chamo (Table 6). According to the same figure, most of the fishers at Lakes Chamo and Hawassa are below the average age of 38.2 while in Lake Tana most wereabove this average age and at Lake Ziway the age distribution was fairly wide. The concentration of younger and older aged fishing communitiies in different fishery systems may have implications on the levels of fishing effort exerted on the specific study areas.

Table 6. Socio-economic characteristics of sampled fishers

| Variables | | Sampled fishers in Lakes | | | | | | | | Total | % |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Tana | % | Ziway | % | Hawassa | % | Chamo | % | | |
| **Sex** | Male | 150 | 100 | 122 | 97.6 | 89 | 98.9 | 84 | 98.8 | 445 | 98.9 |
| | Female | 0 | 0 | 3 | 2.4 | 1 | 1.1 | 1 | 1.2 | 5 | 1.1 |
| **Education level** | Illiterate | 25 | 16.7 | 17 | 13.6 | 24 | 26.7 | 21 | 24.7 | 87 | 19.3 |
| | Read and write | 35 | 23.3 | 10 | 8.0 | 12 | 13.3 | 22 | 25.9 | 79 | 17.6 |
| | First cycle | 32 | 21.3 | 39 | 31.2 | 17 | 18.9 | 5 | 5.9 | 93 | 20.7 |
| | Second cycle | 46 | 30.7 | 41 | 32.8 | 29 | 32.2 | 31 | 36.5 | 147 | 32.7 |
| | High school | 8 | 5.3 | 17 | 13.6 | 8 | 8.9 | 5 | 5.9 | 38 | 8.4 |
| | Preparatory | 1 | 0.7 | 0 | 0 | 0 | 0 | 1 | 1.2 | 2 | 0.4 |
| | Above preparatory | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0.7 |
| | Religious school | 0 | 0 | 1 | 0.8 | 0 | 0 | 0 | 0 | 1 | 0.2 |
| **Marital status** | Single | 28 | 18.7 | 27 | 21.6 | 16 | 17.8 | 20 | 23.5 | 91 | 20.2 |
| | Married | 122 | 81.3 | 98 | 78.4 | 74 | 82.2 | 63 | 74.1 | 357 | 79.3 |
| | Separated | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2.4 | 2 | 0.4 |
| **Total** | | 150 | 100 | 125 | 100 | 90 | 100 | 85 | 100 | 450 | 100 |

Table 7. Age ranges of fishers in years

| Age range of fishers in years | Sampled fishers in Lakes | | | | | | | | Total | % |
|---|---|---|---|---|---|---|---|---|---|---|
| | Tana | % | Ziway | % | Hawassa | % | Chamo | % | | |
| 18-25 | 26 | 17 | 21 | 16.8 | 7 | 7.8 | 10 | 11.8 | 64 | 14.1 |
| 26-50 | 101 | 67 | 82 | 65.6 | 69 | 76.7 | 71 | 83.3 | 323 | 71.7 |
| >50 | 24 | 16 | 22 | 17.6. | 14 | 14.4 | 4 | 3.5 | 64 | 14.2 |
| **Total** | **150** | **100** | **125** | **100** | **90** | **100** | **85** | **100** | **450** | **100** |

The fisher's working experience ranged from 2 to 41 years, with a mean of 17.8 years for all lakes, which was 18.8 years for Tana, 19.1 years for Ziway, 16.9 years for Hawassa, and 14.8 years for Chamo (Tables 7 and 8). Hence, most respondents have been involved in fisheries activities for the last fifteen years (Table 8 and Fig. 6). This also indicates that the fishery in the study lakes is still inviting new fishers, as the profession is a quick source of supplementary income. As argued by Megerssa Endebu *et al*. (2015), most of the fishers have long experience fishing at Lake Ziway. Tekalign Tuluka *et al*. (2021) also stated that the majority of experienced fishers feel a greater sense of ownership over the fishery resources than the less experienced, young, and newcomer fishers. As a consequence, fishers with long fishing experiences are familiar with the lake system, and they are knowledgeable on issues such as areas of fish abundance, fishing practises, fishing hours, and fishing seasons (Table 8).

Table 8. Fishing working experience in years

| **Fishing working experience in years** | **Sampled fishers in Lakes** | | | | | | | | **Total** | **%** |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Tana** | **%** | **Ziway** | **%** | **Hawassa** | **%** | **Chamo** | **%** | | |
| 2-15 | 64 | 42.6 | 66 | 52.0 | 49 | 54.4 | 57 | 67.1 | 236 | 52.4 |
| 16-30 | 62 | 41.3 | 30 | 24.0 | 26 | 28.8 | 25 | 29.4 | 143 | 31.8 |
| 31-41 | 24 | 16.0 | 29 | 23. 2 | 15 | 16.7 | 3 | 3.5 | 71 | 15.8 |
| **Total** | **150** | **100** | **125** | **100** | **90** | **100** | **85** | **100** | **450** | **100** |

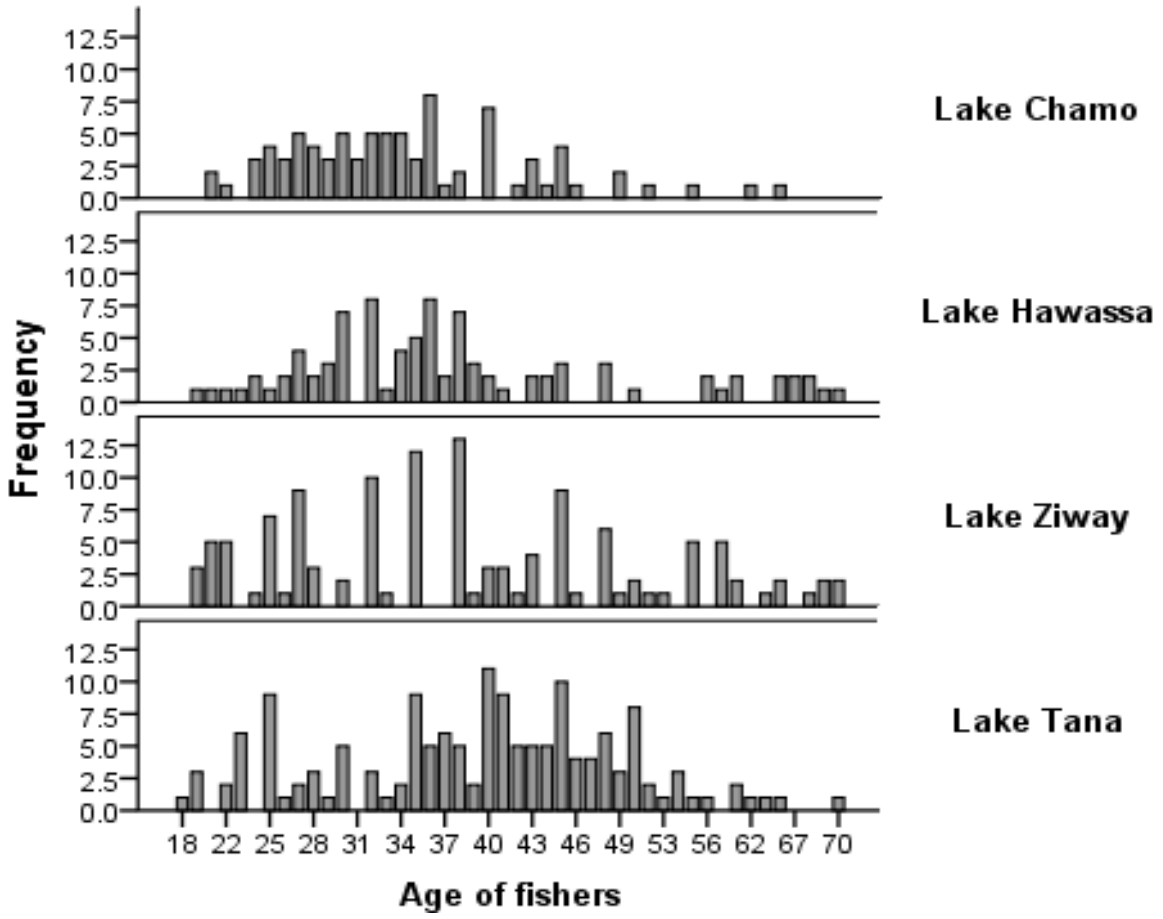


Fig. 6. Age distribution of the respondents (fishers) in years

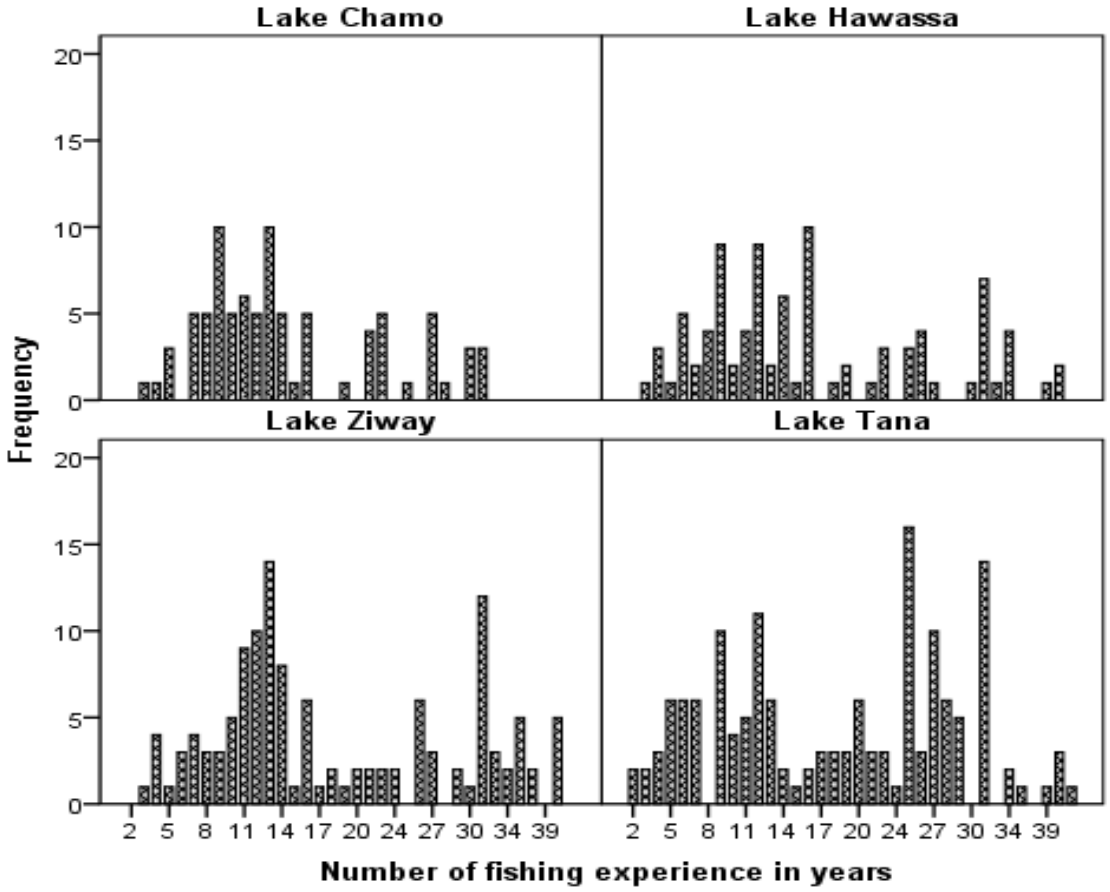


Fig. 7. Work experience of fishers from Lakes Tana, Ziway, Hawassa and Chamo

## 4. 2. Sources of income of fishers

The sampled fishers in Lakes Tana, Ziway, Hawassa, and Chamo were engaged in fishing, crop production, animal husbandry, petty trade, causal labour, and house rent, respectively (Fig.8). Of the sampled fishers, fishing was the first major source of income and contributed 67%, 73%, 68.9%, and 59.3% of fishing at Lakes Tana, Ziway, Hawassa, and Chamo, respectively, which is comparable to the reports of 64.6% by Sewmehon Demessie (2003), 70% by Berihun Tefera *et al*. (2009), and 60% by Kidanie Misganaw and Addis Getu (2016) from Lake Tana. Fig. 8 indicates or suggests that fishers in the mentioned lakes prioritize fishing over crop production as their main livelihood. This does not necessarily imply that crop production is declining overall, but rather that it constitutes a smaller portion of the fishermen's income compared to fishing. Megerssa Endebu *et al*. (2015) showed that in addition to fishing, there are a few fishers who diversify their income sources into other activities such as gear making, crop production, and animal husbandry. However, accessing loans from formal financial sources could empower fishers in other non-fishing activities such as petty trade and Animal husbandry, which may result in a reduction in fishing dependence and the management of fisheries resources. As argued by Be'ne *et al*. (2007) and Mfinanga (2014), lack of access to land is one of the major barriers that significantly affects the fishers livelihood and increases their open access in the lakeshore area. Likewise, Khan (2000), Kumar (1996), and Mfinanga (2014) reported that land ownership is an important requirement for accessing credit from the formal banking system. Also, for many rural households in sub-Saharan Africa, land is considered a key asset and serves multiple uses, including cultivation, sustaining livestock, storing wealth, and providing collateral for financial credit (Ley *et al*., 2007).

According to the respondents, the number of fishers has increased over time. This implies that there is an increase in the number of fishing gears, pressure on the fishery resources of the study lakes, and a high level of completion among fishermen to improve their incomes. Roche (2007); Mfinanga (2014) stated that fishing is the only easily accessible income generating activity for poor coastal people due to the free-access nature of water bodies and resources. These suppose that water bodies are public property with free access for all and

that it is very difficult to implement conservation actions for the sustainability of the resources. Furthermore, Silva (2006) and Mfinanga (2014) found that the low initial cost of fishing is influencing coastal people to be occupied in fishing as compared to other activities that need high capital, like agriculture, which requires some assets like land and fertilizer. This scenario has made fishing the easiest and quickest income-generating activity when compared with other livelihoods such as crop and animal production, where farmers would have to wait months or years to gain the benefits, whereas other activities like crop production and animal husbandry require staying for months to get returns (Fig. 8).

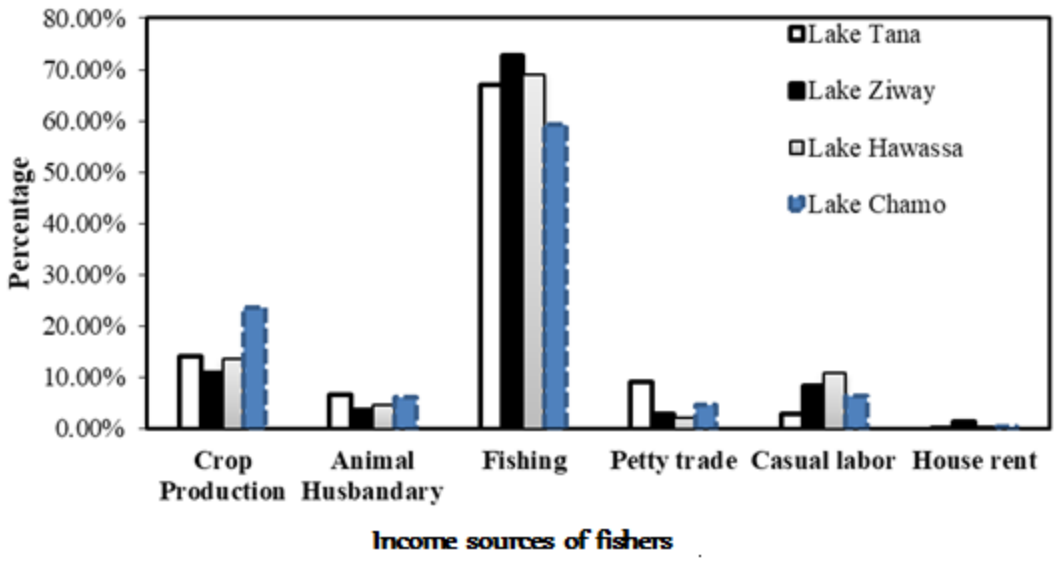


Fig. 8. Sources of income of fishers at Lakes Tana, Ziway, Hawassa and Chamo

Monthly incomes from fishing fluctuate from 350 to 15000 ETB per month, with an average of 2039 ETB per month (equivalent to 45 USD) (Fig. 9). The average for all the study lakes is less than 5000 ETB. The level of mean monthly income from fish also significantly differed among the fishermen from the study lakes ($p<0.001$). The average income for fishermen was 8334 ETB (Shewit Gebremedhin *et al*., 2013) and 13492.86 ETB (Dagninet Amare *et al*., 2018). Shewit Gebremedhin *et al*. (2013) also stated that the minimum and maximum income of fishers were 1020 and 30,000, respectively, in Lake Tana. The study result indicated a lower average income source as a result of increasing pressure on fishers, and many fish stocks are now depleted, which is reducing fish catches.

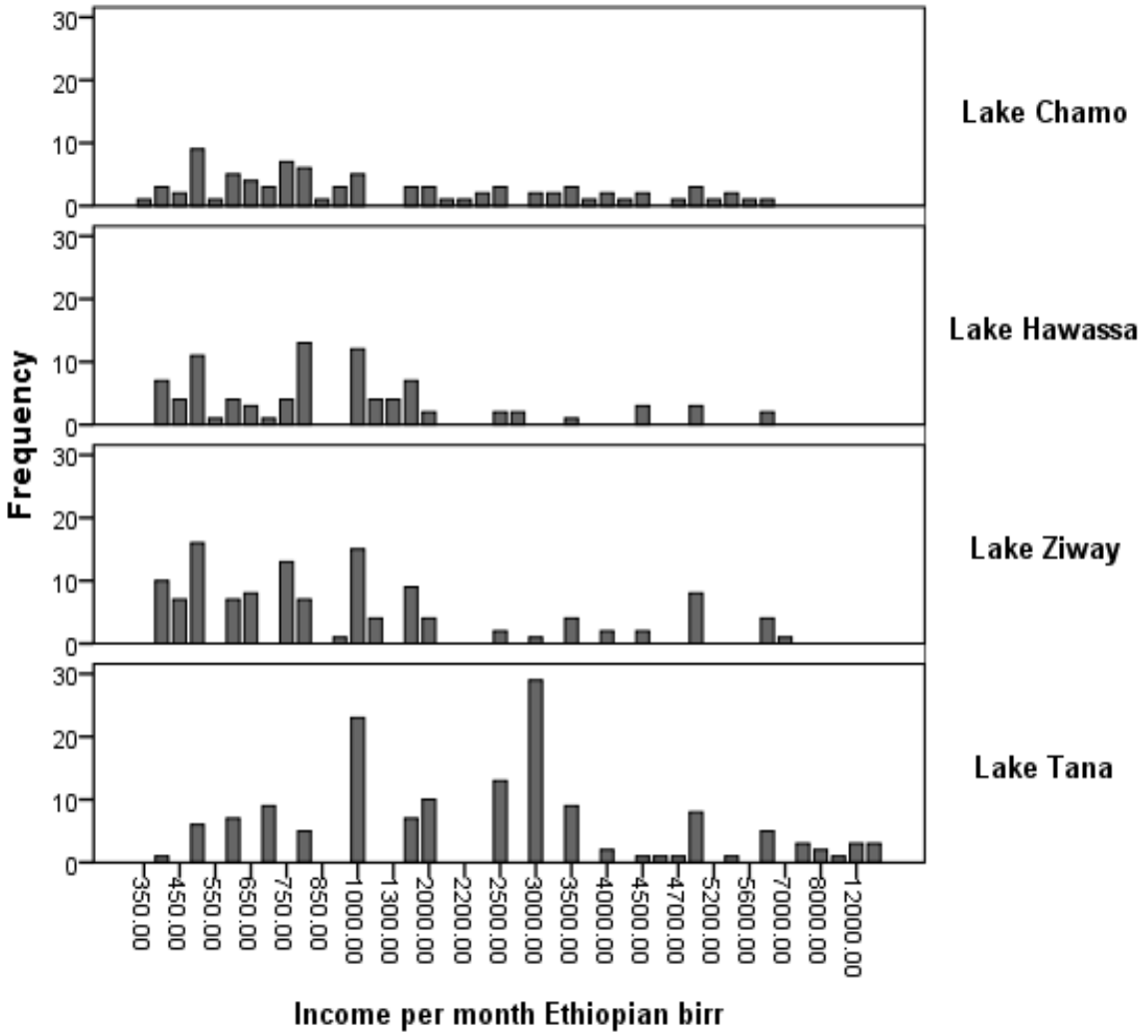


Fig. 9. Level of fishers income in Ethiopian Birr from fishing per month in the study areas

### 4.3. Fishing practices

The results also showed that fishers spent 13 to 27 days (22.58 days, on average) per month, or 8.92 months per year, in fishery operations at Lakes Tana, Ziway, Hawassa, and Chamo. The majority of the fishers spent more than 8 months per year (Fig. 10). According to Sewmhon Demessie (2003), fishing was ranged between 257 and 300 days at Lake Tana, but this survey result showed it was ranged between 150.8 and 334.6 days per year at all study areas. The respondents at Lake Ziway spent 25.25 days per month, or 10.1 months per year, in fishery operations, which is more than any other studied lake (Fig. 10). The fishery

operation days are higher in the Lakes due to an increase in the number of fishers, fishing boats, and fishing gear types and numbers. Despite the fact that efforts increase, total annual fish production from the Lakes decreases. Megerssa Endebu *et al*. (2015) and Eshete Dejen *et al*. (2017) also stated that increasing the number of gear and boats would increase pressure on fishery resources, which would decline commercial catch.

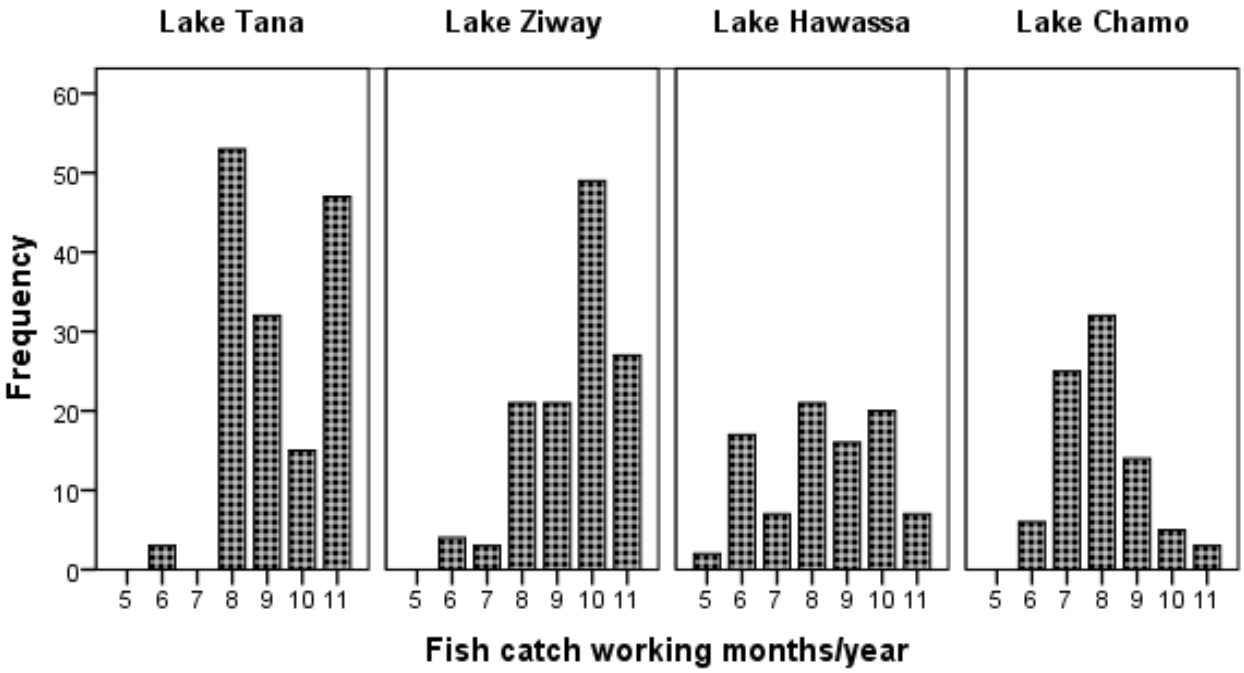


Fig. 10. Frequency of working months/year of fishers in the study lakes

## 4.4. Determinants of fish production volume by fishers for the study of lakes agroecology

The major determinant factors forfish production volume by fisherswere estimated by the linear OLS regression model, as shown in Tables 9, 10, 11, and 12. Remarkably, the distance to the preferred marketing center is positively correlated with the supply of fish to the market. Hence, the variable was meant to increase in distance, and the probability of producing a fish supply increased due to less fishing gear and market competition at the fishing grounds. Olale and Henson (2012) and Dawit Garoma *et al*. (2013) confirmed that fishing grounds have a significant impact and play an important role in fisheries returns. Although Onoja *et al*. (2013) found that fishers who are nearer to the market outlet are more likely to sell their fish than those living in distant places, it is interesting to mention that fishers who are at the same distance from markets do sell their fish on a regular basis.

In contrast, the age of the fishers is positively linked and has a statistically significant effect on fish production (Table 10). As an individual stays long age fish catch also increases, this is due to the fact that as age increased, years of experience also increases which have better knowledge and will decide to allocate more size mesh andproduce good quality fish and a positive contribution to fish catch level. However, Acquah et *al*. (2011) and Mfinanga (2014) found that age was irrelevant in influencing people to become fishers. This could be because some elders were also fishing by using less intensive fishing gear like cast nets, which do not require much energy.

It is fundamental to note that petty trade as an alternative source of income has insignificant effect on the production of fish. However, these variables were meant to examine how those involved in other income-generating activities minimize their fishing activities (Dawit Garoma *et al*., 2013). This implies that the existence of alternative sources of fishers' income is a key factor in supporting the sustainability of fishery resources. A study by Iddo *et al.* (2006) confirmed that non-farm income has a negative impact on farmer's decisions to sell their farm output (market participation) in rural Georgia.

The results also revealed that marital status had a significant impact on the production of marketable fish. The effect of marital status implies that married fishers had a higher probability of expanding marketable fish supplies compared to those who were single (Table 11). Olale and Henson (2012) found that married couples are able to jointly generate income that meets their household consumption requirements. Additionally, some married couples may want to stay together and, therefore, may prefer undertaking fish work collectively, rather than undertaking separate activities.

The educational level of the fishers has positive effects on improving the fish production process and the market supply(Table 10). Those fishers with a higher level of education have a higher chance of being involved in fishing activities because their education level helps them understand fishing practices and technology better (Mwakubo *et al*., 2007). Besides that, fishers with highly qualified technologies that need technical skills and scientific knowledge can adopt better practices than illiterates. According to Akanni (2008) the low level of fishing education and social status of the artisanal fishermen were some of the constraints to their fish catching and indeed their development. Holloway *et al*. (1999) argued that education had a significant positive effect on the quantity of milk marketed in the Ethiopian highlands. They provide education to improve the technical skills of fishers to improve fisheries resource management.

Fisher's own consumption per yearwas found to be significant (Tables 11 and 12). The possibility of being involved in the fish production and supply market grew as fishers personal consumption increased. This impies that fishers in Lakes Chamo and Hawassa have a tendency to use and eat a lot of fish. Over time, eating fish has become quite common along these lakes.

Furthermore, land ownership had a significant negative effect on the production of marketable fish (Table 9). An increase in land ownership in hectares decreases the probability of participation in fishing. The result implies that increased ownership of land in hectares means a lower chance of participating in fishing activities. Elbers and Lanjouw (2001); Mfinanga (2014) found that land scarcity is related to participation in a low-return non-agricultural activity, such as fishing.

The number of gillnets and boats used in fishing operations also positively affected the market supply by influencing the volume of fish supplied to the market (Tables 9,10,11 and 12). In practice, fishers who own gillnets are more likely to produce more fish for the market. Meanwhile, the fishing trip has a statistically significant positive effect on producing fish (Tables 9 and12). This indicates that fishers in Lakes Tana and Chamo show a tendency to use traditional reed boats, wooden boats with more working days in a month, and fishing trips, implying that the higher the operating costs, the higher the fish production.

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Table 9.Determinants of fish production volume at Lake Tana (OLS result)

| *Model* | *Un-standardized Coefficients* | | *Standardized Coefficients* | *t* | *Sig.* | *Co-linearity Statistics* | |
|---|---|---|---|---|---|---|---|
| | *B* | *Std. Error* | *Beta* | | | *Tolerance* | *VIF* |
| Nearest market | 22.855 | 33.580 | .042 | .681 | 0.497 | .868 | 1.152 |
| Age of fishers | -6.512 | 6.061 | -.150 | -1.075 | 0.284 | .170 | 5.879 |
| Working experience | 3.801 | 5.790 | .086 | .657 | 0.513 | .192 | 5.206 |
| No. of gillnets | 36.085 | 4.173 | .825 | 8.648 | 0.000*** | .363 | 2.753 |
| Fishing ground | -23.777 | 18.431 | -.079 | -1.290 | 0.199 | .884 | 1.131 |
| Petty trade | .607 | 1.715 | .023 | .354 | 0.724 | .783 | 1.277 |
| Educational level | -56.718 | 19.993 | -.172 | -2.837 | 0.005** | .901 | 1.110 |
| Marital status | 12.306 | 78.559 | .011 | .157 | 0.876 | .691 | 1.447 |
| Land owned for production Ha | -319.596 | 141.582 | -.143 | -2.257 | 0.026* | .825 | 1.212 |
| Fishing trips per year | 83.269 | 29.628 | .251 | 2.810 | 0.006** | .412 | 2.425 |
| No. of reed boats | 281.916 | 72.307 | .318 | 3.899 | 0.000*** | .498 | 2.010 |
| No. of motorized boats | 235.489 | 59.740 | .318 | 3.942 | 0.000*** | .508 | 1.969 |
| Constant | -449.276 | 394.968 | | -1.137 | 0.257 | | |
| $R^2$ /R Square/ | 0.548 | | | | | | |
| F Value | 13.818 | | | | | | |

*Dependent Variable: Production of fish quantity in kg per year*
Selecting only cases for Lake Tana
***Note**:* *** represents significance at 0.1%, ** at 1%and * at 5%.

Table 10.Determinants of fish production volume at Lake Ziway(OLS result)

| *Model* | *Un-standardized Coefficients* | | *Standardized Coefficients* | *t* | *Sig.* | *Co-linearity Statistics* | |
|---|---|---|---|---|---|---|---|
| | *B* | *Std. Error* | *Beta* | | | *Tolerance* | *VIF* |
| Nearest market | -83.257 | 148.809 | -.041 | -.559 | 0.577 | .756 | 1.323 |
| Age of fishers | 30.262 | 15.098 | .282 | 2.004 | 0.047* | .202 | 4.939 |
| Working experience | -15.052 | 19.625 | -.113 | -.767 | 0.445 | .184 | 5.432 |
| No. of wooden boats | -37.546 | 173.032 | -.015 | -.217 | 0.829 | .824 | 1.214 |
| No. of gillnets | 53.630 | 16.151 | .370 | 3.321 | 0.001** | .323 | 3.098 |
| Selling price per kg | -11.618 | 15.203 | -.050 | -.764 | 0.446 | .945 | 1.058 |
| Fishing ground | 46.940 | 52.261 | .059 | .898 | 0.371 | .931 | 1.074 |
| Petty trade | .393 | 20.835 | .001 | .019 | 0.985 | .901 | 1.110 |
| Educational level | 158.084 | 78.810 | .145 | 2.006 | 0.047** | .771 | 1.297 |
| Constant | 1517.0950. | 1039.930 | | 1.459 | 0.147 | | |
| $R^2$ /R Square/ | .543 | | | | | | |
| F Value | 13.562 | | | | | | |

*Dependent Variable: Production of fish quantity in kg per year*
Selecting only cases for Lake Ziway
***Note**:* *** represents significance at 0.1%, ** at 1%and * at 5%.

Table 11.Determinants of fish production volume at Lake Hawassa(OLS result)

| *Model* | *Un-standardized Coefficients* | | *Standardized Coefficients* | *t* | *Sig.* | *Co-linearity Statistics* | |
|---|---|---|---|---|---|---|---|
| | ***B*** | ***Std. Error*** | ***Beta*** | | | ***Tolerance*** | ***VIF*** |
| Nearest market | -50.711 | 16.280 | -.566 | -3.115 | 0.004** | .412 | 2.426 |
| Fishing ground | -22.930 | 11.605 | -.385 | -1.976 | 0.056* | .359 | 2.789 |
| Marital status | 99.792 | 43.919 | .351 | 2.272 | 0.029* | .570 | 1.754 |
| Educational level | -3.785 | 6.066 | -.088 | -.624 | 0.537 | .688 | 1.454 |
| Land owned for production Ha | -27.814 | 27.594 | -.139 | -1.008 | 0.320 | .714 | 1.401 |
| No. of wooden boats. | 15.953 | 16.630 | .138 | .959 | 0.344 | .661 | 1.514 |
| No. of gillnets | 12.491 | 2.361 | 1.098 | 5.290 | 0.000*** | .316 | 3.160 |
| Selling price per kg | .485 | 1.381 | .048 | .351 | 0.728 | .733 | 1.365 |
| Consumed kg per year | -.793 | .236 | -.511 | -3.367 | 0.002** | .592 | 1.690 |
| Fishing trips per year | 12.089 | 7.877 | .291 | 1.535 | 0.134 | .378 | 2.645 |
| Constant | -340.808 | 141.693 | | -2.405 | 0.022 | | |
| $R^2$ /R Square/ | 0.523 | | | | | | |
| F Value | 2.949 | | | | | | |

*Dependent Variable: Production of fish quantity in kg per year*
Selecting only cases for Lake Hawassa
***Note****:* *** represents significance at 0.1%, ** at 1%and * at 5%.

Table 12. Determinants of fish production volume at Lake Chamo(OLS result)

| *Model* | *Un-standardized Coefficients* | | *Standardized Coefficients* | *t* | *Sig.* | *Co-linearity Statistics* | |
|---|---|---|---|---|---|---|---|
| | *B* | *Std. Error* | *Beta* | | | *Tolerance* | *VIF* |
| Nearest market | .355 | .429 | .141 | .828 | 0.412 | .211 | 4.750 |
| Fishing ground | .594 | .327 | .339 | 1.816 | 0.076* | .175 | 5.709 |
| Age of fishers | -.006 | .009 | -.073 | -.644 | 0.523 | .480 | 2.085 |
| Working experience | .007 | .010 | .093 | .750 | 0.457 | .396 | 2.527 |
| Marital status | .559 | .235 | .237 | 2.382 | 0.022** | .618 | 1.617 |
| Educational level | .033 | .039 | .076 | .842 | 0.405 | .759 | 1.317 |
| Land owned for production Ha | .096 | .410 | .042 | .234 | 0.816 | .186 | 5.374 |
| No. of wooden boats | .079 | .102 | .067 | .773 | 0.444 | .809 | 1.237 |
| No. gillnets | -.106 | .043 | -.490 | -2.472 | 0.018* | .156 | 6.422 |
| Selling price per kg | -.077 | .111 | -.139 | -.692 | 0.493 | .152 | 6.587 |
| Consumed per kg per year | .015 | .005 | .719 | 2.941 | 0.005** | .102 | 9.788 |
| Fishing trips per year | .282 | .075 | .459 | 3.753 | 0.001** | .408 | 2.452 |
| Constant | -.823 | .817 | | -1.007 | 0.320 | | |
| $R^2$ /R Square/ | 0.744 | | | | | | |
| F Value | 9.366 | | | | | | |

*Dependent Variable: Production of fish quantity in kg per year*
Selecting only cases for Lake Chamo
***Note:*** *** represents significance at 0.1%, ** at 1%and * at 5%.

The degree of co linearity among the explanatory variables has been tested using VIF and $R^2$. The results for all VIF were ranging between 1.058 and 9.788, and $R^2$ was 0.523 and 0.744 Hence, VIF was less than 10 and $R^2$ was below 0.90, multi-co-linearity may not be suspected.

## 4.5. Fish market structure

The fish market structures of the study areas were found to involve marketing agents like fishermen, cooperatives, retailers, assemblers, hotels and restaurants, and consumers.

### 4.5.1. Business experience

The survey of the traders showed that most of them have been in the fish trading business for a very long period of time. In terms of age, fish traders ranged from 18 to 63 years of age, and a total of 93.3 percent were males; while (6.7%) were females. The wholesalers and cooperatives had 7 to 42 years of fish trading experience, and the assemblers and retailers had 8.5 to 12 years of experience, respectively. Overall, the results indicated that 80% of the sampled fish traders had more than five years of fish trading experience, while 20% had less than five years. According to Yonas Mebrate and Aemro Worku (2019), 75% of the fish traders had more than one year of experience in fish trading. Most traders seemed to have sufficient experience and awareness to understand the changes in buying and selling prices. They seemed to be proactive in detecting trends in price fluctuations and deciding when to buy or sell fish.

#### 4.5.2. Working capital

As shown in Table 13 below, on average, the wholesalers and cooperatives had a purchasing capacity of 12.8 and 15 quintals (Qt) of fish per day, while the assemblers and retailers had a capacity of 0.06 and 8.9 Qt per day, respectively. The percentage of sources of working capital of fish traders' through almost comparable distribution Lakes Tana (70%), Ziway (82.7%), Hawassa (84.2%), and Chamo (76.5%). On average, the survey result indicated that about 77.5% of fish traders had their own sources of working

capital, while the rest (22.5%) didn't have any source from which they could solicit working capital. However, working capital ranging from 100,000 to 885,000 ETB was suggested by respondents to enter the business and become a competent member of a cooperative.

Table 13. Commercial profile of fish traders in Lakes Tana, Ziway, Hawassa and Chamo

| Characteristics of traders | Wholesalers | Cooperatives | Assemblers | Retailers | Range |
|---|---|---|---|---|---|
| Number (N) | 4 | 8 | 47 | 30 | |
| Average employees | - | 69 | 1.20 | 9 | 0- 150 |
| Average purchase (Qt/day) | 15 | 12.8 | 0.06 | 4 | 0.01-21.9 |
| Average initial capital in Birr | - | 550,000 | 100,000 | 104,000 | 100,000-885,000 |

### 4.5.3. Legal and policy constraints

Licensing is a major barrier to many business activities, including the fishery business in Ethiopia. There are no concessionaires in Ethiopia. It was observed that most of the traders and fishermen operating in the study area had no fishing licenses. Table 14shows that 94.0% of the fishers taken as subjects of this study do not have fishing licences, so technically they can be considered illegal fishers. The study lakes and especially Lake Ziway are increasingly under extensive fishing pressure due to increasing numbers of unlicensed fishers, and hence many fish stocks are now depleting both in catch and individual sizes of the fish (MOA, 2019).

Table 14.Status of licensing of fishers in the study lakes

| **Responses** | **Tana** | **%** | **Ziway** | **%** | **Hawassa** | **%** | **Chamo** | **%** | **Total** | **%** |
|---|---|---|---|---|---|---|---|---|---|---|
| Yes | 135 | 90.0 | 121 | 96.8 | 87 | 96.7 | 80 | 94.1 | 423 | 94.0 |
| No | 15 | 10.0 | 4 | 3.2 | 3 | 3.3 | 5 | 5.9 | 27 | 6.0 |
| **Total** | **150** | **100** | **120** | **100** | **90** | **100** | **85** | **100** | **450** | **100** |

Based on the survey results, on average in all of the study areas, 65.2% of the respondents are not licenced in fish trading (Table 15). Lack of fish trading licences is the highest at Lake Ziway (73.9%), followed by Lake Chamo (64.7%), Lake Tana (63.3%), and Lake Hawassa (57.9%). Yonas Mebrate and Aemro Worku (2019) recorded in their report that 61% of fish traders had no fishing licences in Ethiopian fishing areas. This assessment implied that the absence of fishing and trading licences has not restricted fishers and traders from entering and practicing the fishing business. The poor law enforcement of government institutions and cooperatives has resulted in an increase in illegal fish trading and, hence, a decline in fish stocks. It is necessary to implement and enforce the rules and regulations to support fisheries, increase the economic value of fish products, and empower those who conduct legal practices.

Table 15. Status of licensing of fish traders in the study lakes

| **Responses** | **Tana** | **%** | **Ziway** | **%** | **Hawassa** | **%** | **Chamo** | **%** | **Total** | **%** |
|---|---|---|---|---|---|---|---|---|---|---|
| Yes | 19 | 63.3 | 17 | 73.9 | 11 | 57.9 | 11 | 64.7 | 58 | 65.2 |
| No | 11 | 36.7 | 6 | 26.1 | 8 | 42.1 | 6 | 35.3 | 31 | 34.8 |
| **Total** | **30** | **100** | **23** | **100** | **19** | **100** | **17** | **100** | **89** | **100** |

Regarding the technical support fish traders obtain from the extension workers of the government, they were asked about their perceptions, constraints, and attitudes towards the services. Overall, 44.9% of the respondents had access to extension services (Table 16). This implies that the fishery sector received less attention in the government's planning and development projects. It is characterized by a lower budget and poor extension activities in fish production, processing, and fisheries management. Moreover, there is not a sufficient number of fishery experts in each *Woreda*, let alone providing guidance and training through extension programs.

When asked if the water level of the respective lakes has decreased over the years, (Table 16), fishers responded that 95.7% have perceived a decrease in the water level of Lake Ziway, while only 4.3% indicated that there have been no observed changes. In contrast, at Lake Tana (86.7%), Lake Hawassa (94.7%), and Lake Chamo (88.2%), they perceived decreased water levels (Table 16).

Table 16. Constraints and attitudes of fish traders in the study sites

| Variable | Fish landing sites (Lakes) | | | | Total |
|---|---|---|---|---|---|
| | Tana | Ziway | Hawassa | Chamo | |
| | No. (%) | No. (%) | No. (%) | No. (%) | |
| (a) Extension services | | | | | |
| Yes | 22 (73.3%) | 8(34.8%) | 10(52.6%) | 9(52.9%) | 49(55.1%) |
| No | 8(26.7%) | 15(65.2%) | 9(47.4%) | 8(47.1%) | 40(44.9%) |
| (b) Water level fluctuation | | | | | |
| Yes | 26(86.7%) | 22(95.7%) | 18(94.7%) | 15(88.2%) | 81(91.0%) |
| No | 4(13.3%) | 1(4.3%) | 1(5.3%) | 2(11.8%) | 8(9.0%) |

## 4.6. Fish market conduct

### 4.6.1. Producers (fishers) behavior

In this survey, it was observed that whatever small catch fishers have, they mostly sell them right at the landing sites to hotel owners or to middlemen to collect immediate cash for home use. Besides this, a considerable number of fishers suggested that they take no fish or a negligible quantity for family consumption. In due course, it is usually observed that a small fraction of the catch is wasted due to mishandling and poor sanitation practices. Survey results also showed that fishers spent 13 to 27 days (22.58 days, on average) per month, or on average 8.92 working months per year, in fishery operations at Lakes Tana, Ziway, Hawassa, and Chamo (Fig.10). The fishermen at Lake Ziway spent 25.25 days per month, or 10.1 working months per year, in fishery operations, more than any other studied lake (Fig.10). According to Sewmehon Demessie (2003), fishing was practiced for about 257 and 300 days per year at Lake Tana. This study showed that on average, Lake Tana fishery was found to be actively engaged in fishery activities for about 150.8 and 334.6 days per year. Despite this, it was observed that fishing is an important source in Ethiopian conditions, with an average of 2039 ETB/month (equivalent to 45 USD) and job opportunities for many in Lakes Tana, Ziway, Hawassa, and Chamo fishing areas (Fig. 9). The responses of the fishers indicated that the periods from February to April of each year were the highest fish supply times for tilapia, June to

September for catfish, and June to October for *Labeobarbus* species. These periods are likely to be associated with the feeding and migration patterns of the various fish species (Brook Lemma, 2007; Wassie Anteneh *et al.*, 2012; Shewit Gebremedhin, 2018).

### 4.6.2. Trader's behavior

In most cases, the informal marketing system for fish was characterized by no licencing requirements to start the operation, low cost, and no regulations for operation and sanitation. Fish traders are more aware of the supply and demand conditions at Lakes Tana (62.7%), Ziway (69.6%), Hawassa (52.6%), and Chamo (49.4%) when compared to fishermen. According to Yonas Mebrate and Aemro Worku (2019), there were no operational brokers in the Ethiopian fish market. The fish retailers were found to purchase fish, preserve fish, and transport the same either directly from fishermen at fish landing sites and/or assemblers in their surroundings and sell it at local markets in Addis Ababa, at hotels and restaurants, and to individual consumers (Fig. 12).

Table 17shows that the percentage of preserved fish kept in freezers until sold in the areas of Lake Tana reaches up to 50%. This is higher than in the areas of the remaining lakes, e.g., at Lake Ziway (30.4%), Hawassa (47.4%), and Chamo (29.4%). Nearly 69.6% of fish traders did not use any types of preservation in Lake Ziway, while 64.7%, 52.6%, and 46.7% indicated they did not preserve fish until sold to market in Lakes Chamo, Hawassa, and Chamo, respectively. Due to the inaccessibility of working places in the market and the lack of an appropriate transportation system, these traditional methods often cause considerable economic and postharvest losses.

Table 17. Preserved fish until fish are sold out

| Variable | Fish landing sites (Lakes) | | | | Total |
|---|---|---|---|---|---|
| | Tana No. (%) | Ziway No. (%) | Hawassa No. (%) | Chamo No. (%) | |
| **Freezer** | 15(50%) | 7(30.4%) | 9(47.4%) | 5(29.4%) | 36 (40.4%) |
| **Coldroom** | 1(3.3%) | 0(0.0%) | 0(0.0%) | 1(5.9%) | 2(2.2%) |
| **None** | 14 (46.7%) | 16(69.6%) | 10(52.6%) | 11(64.7%) | 51(57.3%) |
| **Total** | **30(100%)** | **23(100%)** | **19(100%)** | **17(100%)** | **89 (100%)** |

Using the Chi-square test ($\chi^2$) the responses of fish traders regarding the mode of transportation of fish from the landing sites to stores or user hotels and restaurants indicated that there is an association only between the fish traders (Table 18). About 42.1% of the fish traders at Lake Hawassa replied that '2-wheelers' are efficient transporters of fishery products, while relatively small fish are transported by 2-wheelers, namely, 34.8% at Lake Ziway, 17.6 % at Lake Chamo, and 13.3% at Lake Tana.

Table 18. Mode of transportation used from collection point to storage site: **Note-** Chi-Square ($\chi^2$=24.71); Fifteen degrees of freedom; P<0.053

| | **Tana** | **%** | **Ziway** | **%** | **Hawassa** | **%** | **Chamo** | **%** | **Total** | **%** |
|---|---|---|---|---|---|---|---|---|---|---|
| **Manual** | 12 | 40.0 | 1 | 4.3 | 1 | 5.3 | 3 | 17.6 | 17 | 19.1 |
| **3-wheelers** | 4 | 13.3 | 6 | 26.1 | 4 | 21.1 | 2 | 11.8 | 16 | 18.0 |
| **Refrigerated cars** | 2 | 6.7 | 1 | 4.3 | 1 | 5.3 | 6 | 35.3 | 10 | 11.2 |
| **Carts** | 3 | 10.0 | 5 | 21.7 | 2 | 10.5 | 0 | 0.0 | 10 | 11.2 |
| **Not used** | 5 | 16.7 | 2 | 8.7 | 3 | 15.8 | 3 | 17.6 | 13 | 14.6 |
| **Bicycles** | 4 | 13.3 | 8 | 34.8 | 8 | 42.1 | 3 | 17.6 | 23 | 25.8 |
| **Total** | **30** | **100** | **23** | **100** | **19** | **100** | **17** | **100** | **89** | **100** |

### 4.6.3. Traders pricing behavior

The survey results revealed that major factors, namely, seasonal rainy periods and dry seasons, social festival days, non-fasting, and fasting periods, were found to exert considerable impact on fish pricing behaviors. It was observed that the price of fish reached its peak during the big social festivals, meetings, and fasting periods when guests come to Bahir Dar (city on the shores of Lake Tana), Ziway, Hawassa, and Arba Minch City, found in close proximity to Lake Chamo, and to large cities like Addis Ababa (Table 19). In the fasting periods, followers of Orthodox Christianity do not consume animal products, but tradition has it that they revert to fish and fish products to supplement their animal protein needs. At such moments, fish prices stagger a bit higher than usual. At such moments, some retailers and assemblers were making inappropriate

and fake price increases to obtain unfairly raised incomes. This behavior of altering prices in their favour is expressed in the form of compromised quality. Selling undersized (3-5 cm) fish, catches in cold rooms or freezers, and adulteration of fishery products.

Table 19 indicates that unhygienic fish handling and processing and ignorance of standard sanitary procedures increase at such fasting periods as observed at the fish processing centers of Lake Hawassa (by 94.7%), higher than the remaining Tana (by 70%), Ziway (by 82.6%), and Chamo (by 76.5%). Almost all lakes have poor quality fish processing due to inadequate fish postharvest handling, sanitation techniques, and a lack of clean water for fish processing (Table 19). It was very common to see and collect feedback during cross-examinations during interview sessions that small scale retailers and assemblers were found to adulterate fish after filleting, particularly at Lake Tana.

Table 19.Assess fish supply and fish handling in the Lakes

| Variable | Fish landing sites (Lakes) | | | | Total |
|---|---|---|---|---|---|
| | Tana No. (%) | Ziway No. (%) | Hawassa No. (%) | Chamo No. (%) | |
| **Unhygienic fish handling and processing** | | | | | |
| **Yes** | 21(70%) | 19(82.6%) | 18(94.7%) | 13(76.5%) | 71(79.8%) |
| **No** | 9(30%) | 4(17.4%) | 1(5.3%) | 4(23.5%) | 18(20.2%) |

### 4.6.4. Strategies of setting purchasing and selling price by traders

The survey results showed that negotiation was found to be the most frequently used fish marketing strategy. At each level of product exchange, particularly at landing sites, each buyer finds himself or herself negotiating the price based on the volume of fish on sale, sizes, species type, and freshness of the landed fish. However, during the visits of landing sites and later in the discussions made during the interview of key informants, it was found out that the price of fish per kilogram differed from landing site to landing site and lake to lake, which was based on the volume of catch and the demand at each occasion, accessibility of infrastructure, storage, transport, and access to fish market centres and fishing grounds (Table 21). As stated above, the purchasing as well as selling price of fish usually differed based on fish species types, with *L. niloticus* (Nile perch) fetching

the highest price, followed by *O. niloticus* and the rest in their appearance order here (*C. gariepinus*, *Labeo barbus*, *C. carpio*, *C. carassius*,and *Bagrus docmac*) (Table 18), transportation (Meberat Alem, 2001), and based on the consumer's preference. It was observed that the consumers had to pay the highest average price of 200 ETB/kg for Nile perch at Lake Chamo, which obviously fetches three or four times more when it reaches the big hotels in Addis Ababa, 500 km from Chamo. Nile tilapia was sold at 180 ETB/kg at the landing site, Lake Chamo, and African catfish fetched 60 ETB/kg at Lake Hawassa. In contrast, the lowest market price for common carp was 11.5 ETB/kg at Lake Ziway (Table 21). Nile Tilapia was the most dominant species by volume of catch, followed by African catfish. Consumers preferred mainly the Nile Tilapia species since it is commonly available at all the study sites, has year-round availability, and has reasonably good taste. The fishery business, the selling prices of fish at Hawassa landing site are set each day by the relations of supply and demand in fish markets. On the other hand, in the Lakes Tana area, fish traders responded that market prices are set by negotiation, where at Lake Tana (30.0%), Lake Ziway (34.8%), and Lake Chamo (52.9%) (Table 20).

Table 20. Assessment of fish price setting

| Responses | Tana | % | Ziway | % | Hawassa | % | Chamo | % | Total | % |
|---|---|---|---|---|---|---|---|---|---|---|
| **Yes** | 9 | 30.0 | 8 | 34.8 | 12 | 63.2 | 9 | 52.9 | 38 | 42.7 |
| **No** | 21 | 70.0 | 15 | 65.2 | 7 | 36.8 | 8 | 47.1 | 51 | 57.3 |
| **Total** | **30** | **100** | **23** | **100** | **19** | **100** | **17** | **100** | **89** | **100** |

Table 21. Current fish price at Lakes Tana, Ziway, Hawassa and Chamo

| No. | Fish species | Tana | | Ziway | | Hawassa | | Chamo | |
|---|---|---|---|---|---|---|---|---|---|
| | | **Whole (ETB/Kg)** | **Filleted (ETB/Kg)** | **Whole (ETB/Kg)** | **Filleted (ETB/Kg)** | **Whole (ETB/Kg)** | **Filleted (ETB/Kg)** | **Whole (ETB/Kg)** | **Filleted (ETB/Kg)** |
| **1** | **Nile Tilapia (*O.nilotics*)** | 40-60 | 95-160 | 15-31 | 50-80 | 21-35 | 60-100 | 40-60 | 100- 180 |
| **2** | **African Catfish (*C. gariepinus*)** | 15-30 | 35-50 | 16.5-20.5 | 28.7-50 | 15-30 | 25-60 | | 30-40 |
| **3** | ***Lebeobarbus*** | 13-20 | 25-35 | | | | | | |
| **4** | **Common Carp (*C. carpio)*** | | | 11.5-15 | 19-40 | | | | |
| **5** | **Crucian Carp (*C. carassius)*** | | | 11.5-15 | 19-22.5 | | | | |
| **6** | **Nile perch (*L. niloticus*)** | | | | | | | 50-100 | 150-200 |
| **7** | **Kerkero (*Bagrus docmac*)** | | | | | | | 40-80 | 120- 180 |

**4.7. Market performance:**Marketing costs, gross margin and profit margin of traders

Table 22. Marketing margins analysis considering the central market

| Cost components | Cost (Ethiopian Birr/Quintal) | % cost share |
|---|---|---|
| **Producers/fishers (N = 450)** | | |
| Estimated labor cost of fish production (50 ETB/day) | 500 | 85.3 |
| Boat and gillnet cost | 60 | 10.3 |
| Fuel cost | 26 | 4.4 |
| Total cost | 586 | |
| Producers' gross profit | 1514 | |
| Average selling price | 2100 | |
| **Assemblers (N = 47)** | | |
| **Assemblers' purchase price from fishers** | **2000.5** | |
| Loading/Unloading costs ( 50ETBr/Qt) | 50 | 13.2 |
| Transportation cost (From fish landing site to market) | 28 | 7.4 |
| Cost of plastic | 25 | 6.6 |
| Cost of filleting (2 ETB/kg) | 200 | 53.0 |
| Personal travel cost | 50 | 13.2 |
| Communication | 25 | 6.6 |
| Total cost | 2378.5 | |
| Average selling price | 3950.6 | |
| Margin | 1949.5 | |
| Assemblers gross profit | 1571.5 | |
| **Fishers share from assemblers** | **46.82%** | |
| **Cooperatives (N = 8)** | | |
| Cooperatives' purchase price from fishers | 2150 | |
| Loading/Unloading costs (50 ETB/Qt) | 50 | 11.2 |
| Cost of plastic | 50 | 11.2 |
| Cost of filleting (2 ETB/kg) | 200 | 45.0 |
| Transportation cost (From fish landing site to market) | 59.33 | 13.3 |
| Communication (400 ETB/month) | 19 | 4.2 |
| Fuel cost | 42 | 9.4 |
| Employers salary (100 ETB/day) | 25 | 5.7 |
| Total cost | 2595.3 | |
| Average selling price | 3200.3 | |
| Margin | 1145.6 | |
| Cooperatives gross profit | 1050.3 | |
| **Fishers share from cooperative** | **3.18%** | |
| **Retailers (N=30)** | | |
| Retailers' purchase price from fishers | 2130 | |

| Cost components | Cost (Ethiopian Birr/Quintal) | % cost share |
|---|---|---|
| Storage (20-66 ETB/day) | 43 | 9.5 |
| Cost of plastic | 100.8 | 22.4 |
| Cost of filleting | 200.0 | 44.4 |
| Personal travel cost (725 ETB/month) | 81.6 | 18.1 |
| Communication(412 ETB/month) | 25.0 | 5.6 |
| Total cost | 2580.4 | |
| Retail price | 4200.5 | |
| Margin | 2080.0 | |
| Retailers' gross profit | 1619.6 | |
| **Fishers share from retail price** | **50%** | |

Table 22shows an overview of the distribution of marketing margins among different actors in the chain. Retailers get the highest gross marketing margin (value added), which is 2,080 ETB/Qt. According to Yonas Mebrate and Aemro Worku (2019), the share of margins of retailers reached the highest margin of all other fish marketing agents. Cooperatives and assemblers got gross margins of around 1,146 and 1950 ETB/Qt, respectively. But cooperatives got the lowest margin (1146 ETB/Qt). Producers (fishers) share from assemblers, cooperatives, and retailers was 46.8%, 3.2%, and 50%, respectively (Table 22). Fish retailers and assemblers obtained the highest gross profit of 1620 and 1572 ETB/Qt, respectively, whereas fishers and cooperatives got the lowest gross profit of 1514 and 1050 ETB/Qt, respectively (Tables 22and 23).

Table 23. Summary of marketing cost, margins and profit of fishersand traders

| Cost Items | Cost and Prices (ETB/Qt) | Gross Marketing margin (1) | Total marketing cost (2) | Profit margins (ETB/Qt) (3)=(1)-(2) |
|---|---|---|---|---|
| **I.** Fishers (N=450) | | 1600 | 86 | 1514 |
| 1. Production cost /Qt | 500 | | | |
| 2. Total marketing cost | 86 | | | |
| 3. Cost price (3=1+2) | 586 | | | |
| 4. Average selling price | 2100 | | | |
| **II.** Assemblers (N=47) | | 1949.5 | 378 | 1571.5 |
| 1. Production cost /Qt | 2000.5 | | | |
| 2. Total marketing cost | 378 | | | |
| 3. Cost price (3=1+2) | 2378.5 | | | |
| 4. Average selling price | 3950.6 | | | |
| **III.** Cooperatives (N=8) | | 1495.6 | 445.33 | 1050.3 |
| 1. Production cost /Qt | 2150 | | | |
| 2. Total marketing cost | 445.33 | | | |
| 3. Cost price (3=1+2 | 2595.99 | | | |
| 4. Average selling price | 3200.33 | | | |
| **IV.** Retailers (N=30) | | 2070.4 | 450.4 | 1619.6 |
| 1. Production cost /Qt | 2130.0 | | | |
| 2. Total marketing cost | 450. | | | |
| 3. Cost price (3=1+2) | 2580.4 | | | |
| 4. Average selling price | 4200.5 | | | |

**Notes:** **(1)** Gross marketing margin (value added) =Average selling price–Average buying price.
**(2)** Average selling/buying price at different level was based on the survey made in this study in 2019.
**(3)** The time dimension for profit margin is one year (2019)

Although fish retailers got the highest marketing margin, they incurred the marketing cost of 450 ETB/Qt. Assemblers got the lowest marketing cost (among traders excluding fishers) and cooperatives the lowest profit margin.

### 4.7.1. Characterization of fish marketing actors

There were several actors in the market chains who engaged themselves in various activities at Lakes Tana, Ziway, Hawassa, and Chamo (Figs. 12,13,14 and15), although most traders, assemblers, retailers, and brokers are not licensed (65.2%), as compared to the licensed ones with 34.8%. Based on their roles and responsibilities, the market participants (actors) present in the chains are classified as follows:

**Fishers**:These groups contained the largest number of actors and are considered the primary link in the marketing chain. The members were exclusively men (98.9%). According to the Ministry of Agriculture (MOA) report for 2020, they can be classified as full-time, part-time, or contractual occasional fishers. The later ones are likely to use motorized wooden boats, rafts, and reed boats (*Bofofe* or *Yabala*: local names for rafts) at all the study sites.

**Fishers using motorized boats** commonly put up their catches for sale to the Tana Haik Number One Fishers Cooperative and the Fisheries Production and Marketing Enterprise (FPME), where their daily supplies are recorded and they collect their pay monthly. They also sell some remaining catches, possibly of lesser quality, e.g., sizes of individual fish, to local customers, hotels, and traders coming to their landing sites, mainly from towns or villages in close proximity, such as Bahir Dar town, Woreta, Infranz, and Dera Hamusit. These sales give the fishers immediate daily supplementary income.

**Fishers working with reed boats** (*Tankua*: local name) sell fish to different customers, including Tana Haik No. ONE Fishers Cooperative, Georgis Fishers Group, local village markets like Zegie, Bata Mariam, Delgie, Goregora, and Infranz) or other local collectors. They also sell their products to retailers, hotels, restaurants and individual consumers, and traders coming to the lakeshore or landing sites. Most of the income of these fishers is earned on a daily basis.

**Fishers with wooden boats:** on Lakes Ziway, Hawassa, and Chamo, fishers are using wooden fishing boats and rafts to sell fish to cooperatives, wholesalers, retailers, hotels or restaurants, and consumers.

**Fishers with steel motorized boats** are mainly used to collect or purchase fish from fishermen at landing sites or in open water to sell fresh fish further to the nearest towns, as in the Lake Ziway area at Batu Town, the Lake Hawassa area at Hawassa Town, and the Lake Chamo area at Arba Minch Town. These fishers are sort of disjointed from the rest and the majority of poor and low-level fishers. The capacity of their boats, their speed to bring fresh fish to the market, and so on gave them the advantage of reaching out to the lucrative markets of the bigger towns, hotels, and restaurants. Such fishermen are also paid better than ordinary fishers, and in many cases, they make small contracts with their buyers in the towns (Mfinanga, 2014). Through all these processes of exchange of fish catches, it was observed that large amounts of fish were passing

through the market chains in the months of the fasting period of each year, especially in the months from February to April. Supplies of fish decreased in the months of June through October of each year, reaching their lowest level, mainly due to the heavy rains and coldness of these periods.

a) **Fishers cooperatives** of the respective study sites do both catching by employing their own fishermen and selling of fish and fish products to different actors and/or customers, such as wholesalers, retailers, hotels or restaurants, and consumers, as well as other traders coming to landing sites and their storage facilities (Figs. 12,13,14 and15).

   Generally, the fish resources of the study lakes are officially expected to be used by cooperatives organized and recognized by Ministry of Agriculture, Regional Fishery Offices, and their branch offices. Technical and extension workers also visit them and provide them with training and fishing materials at subsidized costs. But private fishermen, individually or as a group, operate in the same ways as the fishers captured in the cooperatives, and they are referred to by the cooperatives as "illegal fishermen", although Ethiopian waters are free to be accessed by anyone who wishes to do fishing, a tradition that cascaded from the socialist government of 50 or so years ago.

   In the case of Lake Tana, the cooperatives, after collecting fish from their own fishers, private assemblers (rural and urban), and fishers and assembling them from different fishing grounds, store the fish in cold rooms and refrigerators. These cooperatives have fish stores and shops in towns. In contrast, the fish captured from Lakes Ziway, Hawassa, and Chamo seem less organized as the cooperatives may not have stored their products in cold rooms or refrigerators, as these facilities are non-existent. According to Abebe Cheffo *et al*. (2016), at these sites, fish are mostly sold out or go completely into the market chains each day, and fishermen are paid their dues in most cases daily.

b) **Wholesalers** don't move from one market to another like petty fish traders. They rather, permanently reside in cities such as Addis Ababa with their permanent fish

stores and collect fish from Lakes Tana, Ziway and Chamo Cooperatives through their representatives. These are fewer in number, and most of the time they sell out fish to individual consumers and hotels (Figs. 12,13 and15).

c) **Processors**participated in the gutting, filleting, salting, drying and other similar activities of fish processing, using the labor of their family members such as women and children. However, the larger volumes of fish processing at cooperatives, enterprises, wholesalers, retailers and exporters are done by specialized processors at Lakes Tana and Chamo. In these institutions, mainly women were doing the gutting and filleting of fish at the respective processing plants and landing sites of Lakes Tana and Chamo(Figs. 12 and15). These women were paid based on the weight of fish they processed, i.e., 1 kg of fish with 2 ETB for cooperatives and 2.50 ETB for individual customers (Kidanie Misganaw personal observations, 2019). At the production chains of Lakes Tana, Ziway, Hawassa and Chamo one rarely sees the value addition practices. Particularly, at Lakes Tana and Chamo, some level of quality preservation and the fish handling process appeared to be in the form of washing the fish with clean tap water (which is prone to frequent interruptions) and then chilling the catch in cold rooms from two months up to a year, although this study did not make how the fish quality would change over a long period of preservation given the frequent power interruptions at the freezing facilities (Kidanie Misganaw personal observation), 2019. Other fish processing activities are continuing as business-as-usual.

   In the current fish value chains, particularly at Lakes Ziway and Hawassa, there were no proper preservation facilities and the fish handling process appears to be improper since tap water was not regularly available and the preservation in cold rooms and deep freezers was impacted by frequent power blackouts. In the southern gulf of Lake Tana, the middlemen and cooperative members washed and packed fishes in clean plastic bags at specific masses to transport and sell them to consumers in Bahir Dar City or even further in Addis Ababa, over 600 km away. This is to preserve the quality of the fish and to avoid unnecessary foul smells that would affect the value of the products.

d) **Retailers**are usually those that sell whole fish at landing sites or nearby destinations sites accessible by road (e.g., the cities of Bahir Dar, Gondar, Ziway, Hawassa, Arba

Minch and Addis Ababa) or to other retailers, hotels, household users by collecting it from fishers and local assemblers. Dried fish fetches relatively better prices when sold to exporters to Sudan particularly from the northern Lake Tana (Fig. 12). Such dried fish retailing activities were done with gutted, filleted or wet fish in all areas the study areas.

e) **The Fish Production and Marketing Enterprise (FPME)**has a licensed legal firm retailing fish since 1970 G.C. and actively operates at all four study sites. It is specialized to sell fish, which handles about 30% of the fish that enters the national fish market chain, mostly coming from Lake Tana (Abebe Getahun et al., 2008). The southern part of Lake Tana, where the regional city of Bahir Dar is located, fishermen have good access to potentially diverse traders and market chains because of the existence of FPME, cooperatives and others. At the same time they have the alternative of selling fish to household consumers, hotels and export, whenever they feel they get better prices for their products.

Recently, the price of filleted fish increased dramatically and currently filleted Nile-tilapia, catfish and *labeobarbus* spp. costs 160, 50 and 35 Ethiopia ETB/kg, respectively (Kidanie Misganaw personal communication, FPME sellers, 2019 G.C). Since a few years before the start of this study, the services of the FPME are not anymore available at Lakes Ziway, Hawassa and Chamo market outlets. Over time, It has been replaced by other retailers that supplied fishes at lesser prices outcompeting FPME and that started to add considerable value to their products by using clean tap water for washing and filleting, preservation of whole and filleted fishes in cold rooms until such time as transportation facilities are organized to sell products at competitive prices in larger markets of big cities such as Addis Ababa (Figs. 12,13 and15). With gradual increase in production and demand fish catches from these lakes are decreasing in individual sizes and volume from time to time (Fig. 11). According to FPME head office, 2019 stated that there are no integration government offices (*woreda*, zonal, regional and federal governments).

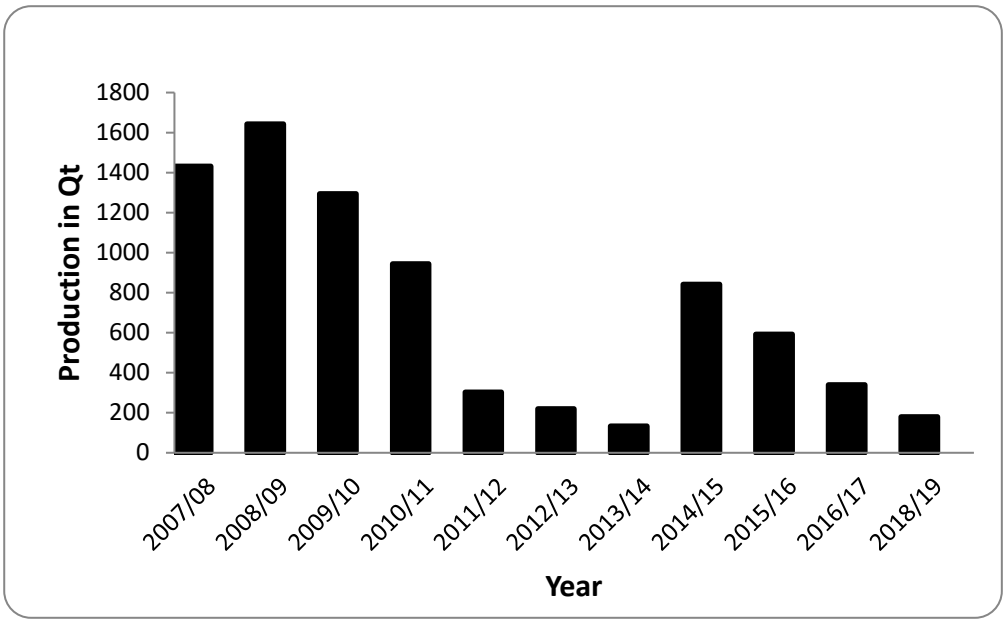


Fig. 11. Marketed fish statistics from the FPME Head office in Addis Ababa, 2019

**f) Dried fish exporters** are the last link in the market chain in the domestic trade. The survey result indicates that most traders in dried fish market business were not licensed, they purchase poor quality fish (such as those dried in traditional ways and poorly handled fish), dried it and export it to the Sudan. In recent years, marketing of dried fish is attracting a good number of fishers and traders in the north-western side of Lake Tana, where it is very close to the Sudan (Fig. 12). The business has increased in recent years with road access and slowly it is gaining popularity among fishers and retailers of the region and at the same time it has become a source of earning some foreign currency on a regular basis (Berihun Tefera *et al*., 2009).

**g) Assemblers (Rural/urban)** were high in number who collected fish from fishers at local markets and fish landing sites. There are unlicensed and comprise of high numbers of informal traders in Lakes Tana, Ziway, Hawassa and Chamo. Assemblers are the primary market chain actors that assemble fish from fishers at the landing site and transport either the whole or filleted fish to sell it at the nearby urban centers(Figs. 12,13,14 and15). The landing sites are open to all actors, usually once daily and usually early in the mornings when fresh fish land after overnight fishing operations. From here, retailers, assemblers of various levels distribute fresh fish local/village and obtain

the best bargain those that reach the market early enough out-competing their colleagues. Depending on the volume they transport, some transported fish personally in sacs some use motorcycles and carts and three wheelers to get to the nearest market to fetch better bargains at the village markets of Bahir Dar, Ziway, Hawassa and Chamo, as the case may be**.** Open markets are very common types of the markets in Lakes Tana, Hawassa, Ziway and Chamo. It was observed in this study that the most dominant forces in the retail trade are the small traders with regular spots in the open markets, who generally buy fish from freelance or non-cooperative fishers and who flexibly sell their fishery products at landing sites, by road sides, by moving from village to village (door-to-door selling), and at public places (Figs. 12,13,14 and15).

### 4.7.2. Fish market channels

The analysis of market chains of fish in Ethiopia is a very difficult task. This is mainly due to the difficulties mentioned above, among which are:

**a.** Catches are too limited and seasonal to warrant permanent means of livelihood to those involved in the market chain.

**b.** Catches are seasonal, adding to the difficult of maintaining permanent job.

**c.** Catches are strictly come from the wild. There is no fish farming practice in Ethiopia to warrant the permanent flow of products into the market chain.

**d.** The handling, processing and transportation of fish and fishery products are very poor by any standards which again, added to the above points; do not attract consumers and investors to improve quality.

**e.** The fishery industry in Ethiopia is also impacted by the policy that allows anyone with some kind of facilities to access the natural stocks and harvest at his/her will.

Despite these backdrops, this study has attempted to highlight the different channels through which fish and fishery products harvested from the wild may eventually reach the consumers, directly or indirectly, formally or informally (Figs. 12,13,14 and15).

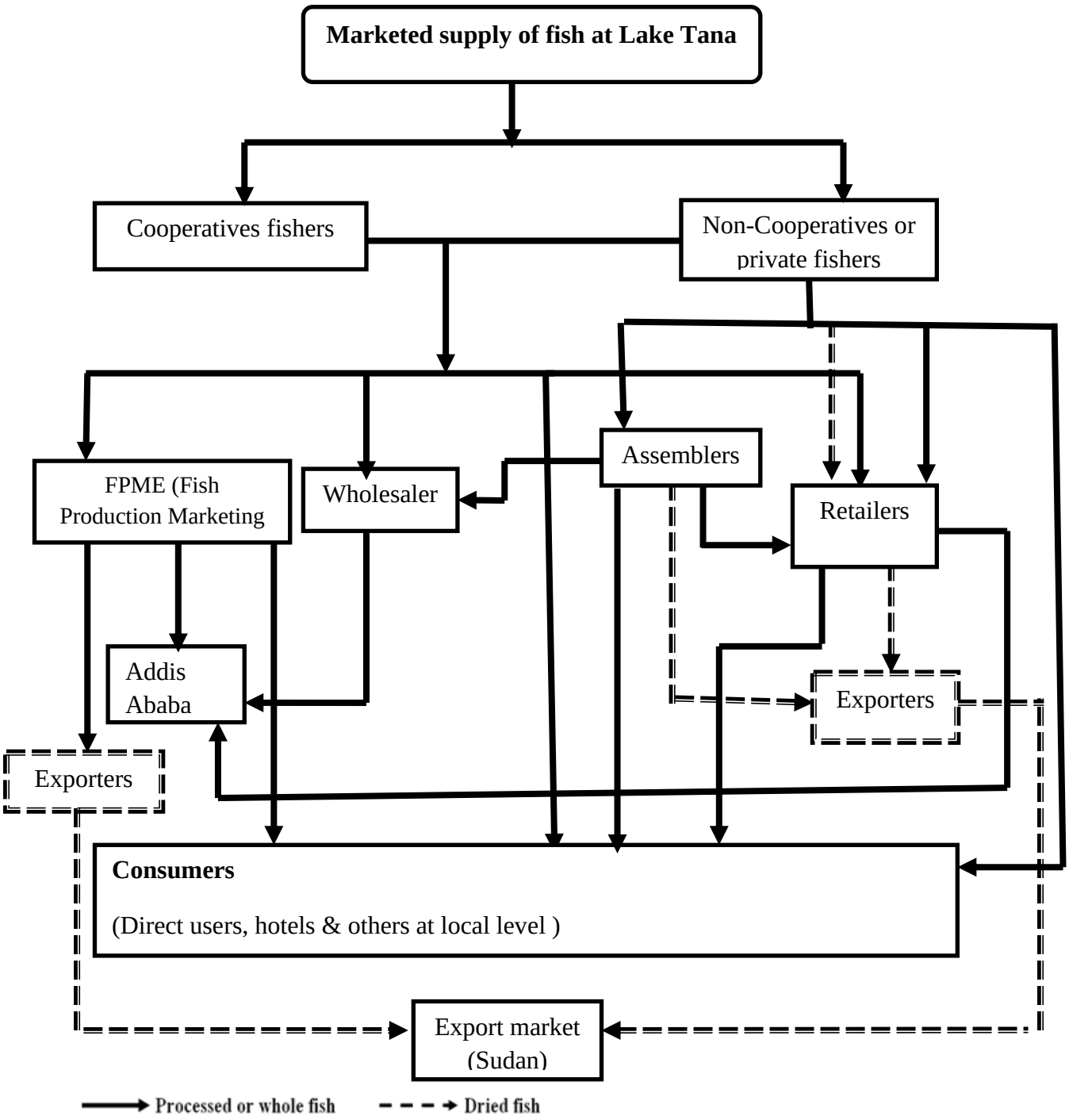


Fig. 12. Market supply chain of fish from Lake Tana

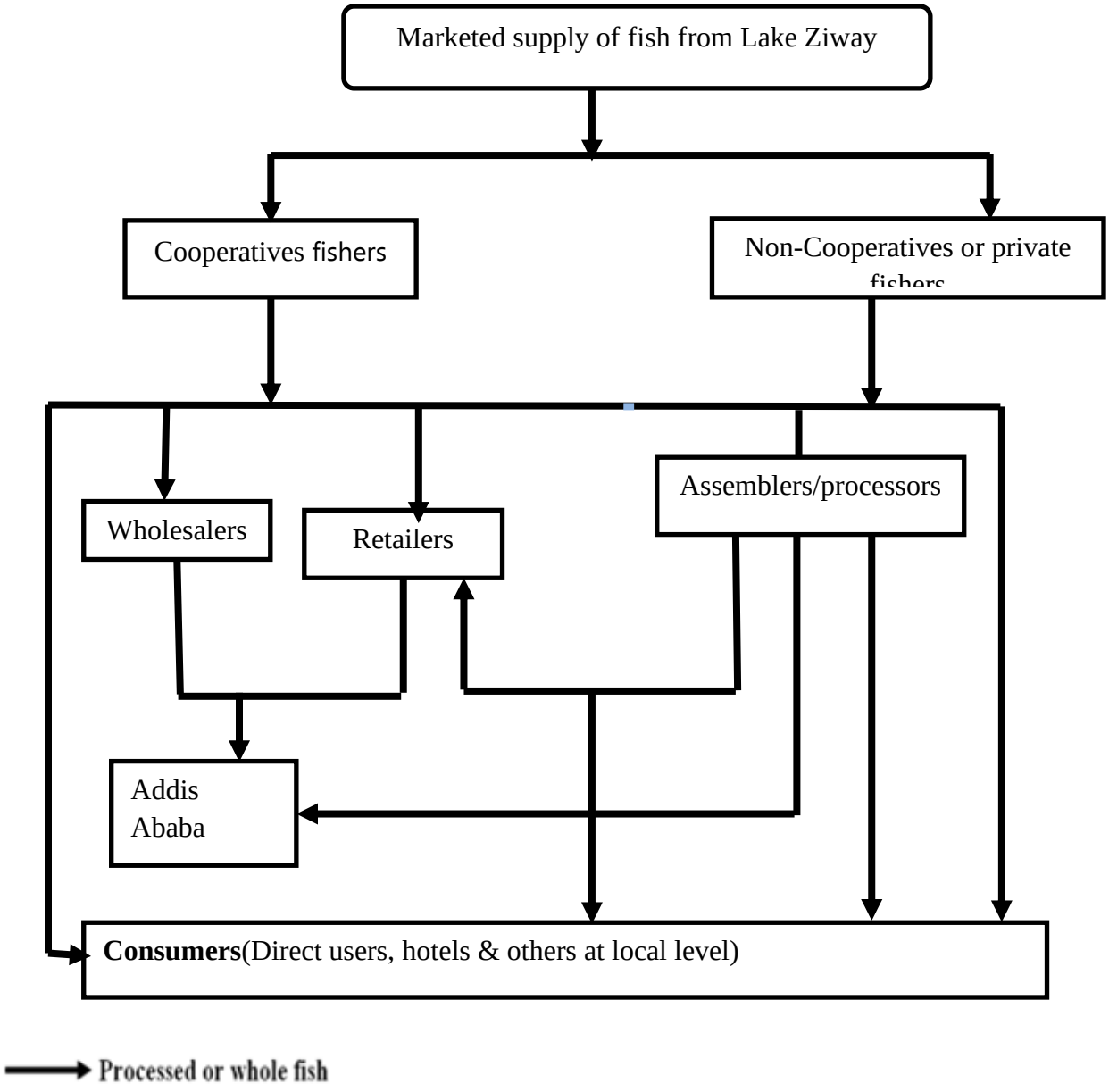


Fig. 13. Market supply chain of fish from Lake Ziway

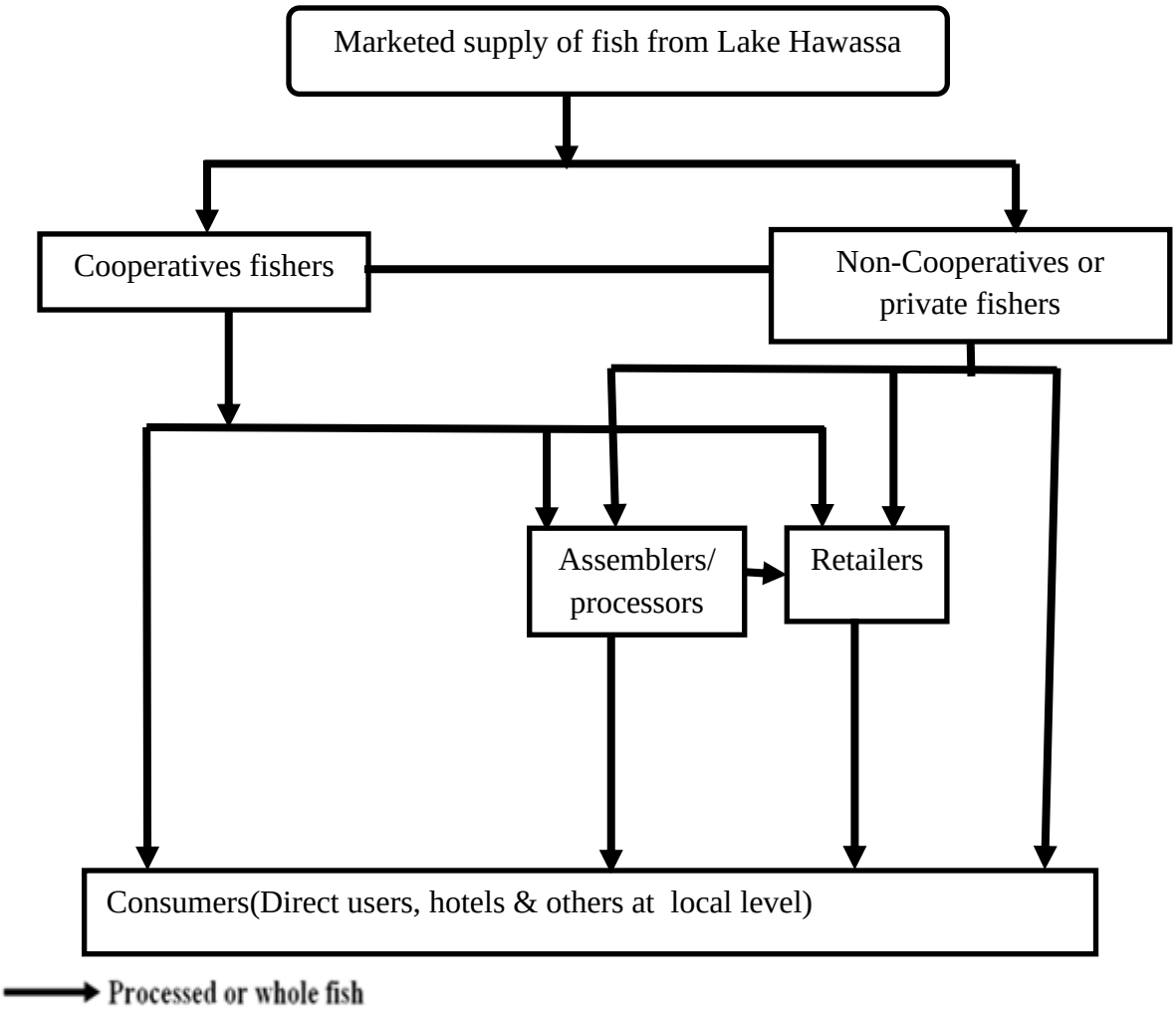


Fig. 14. Market supply chain of fish from Lake Hawassa

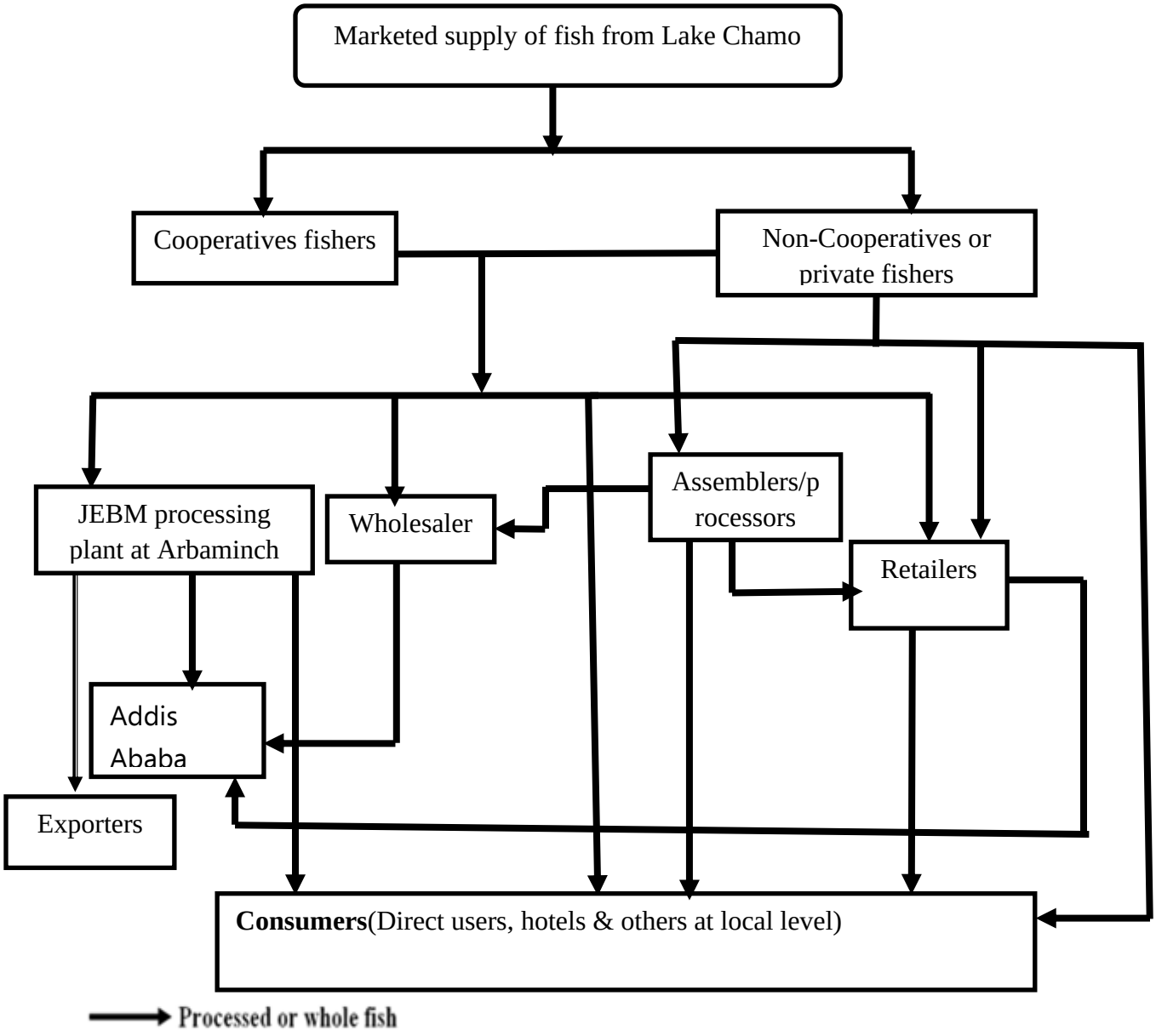


Fig. 15. Market supply chain of fish from Lake Chamo

The market supply chains of fish from the four lakes in Ethiopia Lake Tana, Lake Ziway, Lake Hawassa, and Lake Chamo exhibit both similarities and differences.

At Lake Tana, the marketed supply flows from cooperative and non-cooperative/private fishers to the Fish Production Marketing Enterprise (FPME), which then distributes the fish to consumers, wholesalers, assemblers, retailers, and exporters, including both dried fish (broken arrow) and processed/whole fish (unbroken arrow) channels. The Lake Ziway fish market supply chain also involves cooperative and non-cooperative/private fishers, but the distribution is focused on wholesalers, local consumers, retailers, and assemblers/processors, primarily for the processed and whole fish market (unbroken arrow). For Lake Hawassa, the marketed supply originates from cooperative and non-cooperative/private fishers, reaching consumers, assemblers/processors, and retailers in the local market. The Lake Chamo fish market chain is more complex, with cooperative and non-cooperative/private fishers supplying fish to a JEBM processing plant in Arba Minch, as well as to local consumers, wholesalers, assemblers/processors, retailers, and exporters, including the processed and whole fish market. A comparative analysis of these four lake fish market chain reveals differences in the efficiency of distribution channels, the role of cooperatives versus private fishers, and the impact on local and export markets. For instance, Lake Tana's market chain includes both dried and processed/whole fish, while Lake Ziway and Lake Chamo focus more on the processed and whole fish market. Additionally, the variations in the involvement of processing plants, wholesalers, and exporters across the lakes suggest differing levels of market integration and access to broader distribution networks.

From this analysis and the challenges observed in each lake market chains, potential enhancements can be suggested based on best practices. Some potential improvements that could be considered for the fish market chains from the four lakes in Ethiopia can be summarized as follows:

**Lake Tana**: Enhancing cooperative networks among fishers around Lake Tana could involve establishing cooperative storage and processing facilities to improve market access and product quality. Additionally, investing in value addition techniques like smoking or filleting could help diversify product offerings and cater to different market segments. Strengthening transportation

infrastructure to connect fishers with markets in Addis Ababa and beyond could also boost efficiency and reduce post-harvest losses.

**Lake Ziway**: For Lake Ziway, focusing on market diversification by exploring niche markets for specialty fish products could be beneficial. Strengthening or developing additional processing facilities near the lake to add value to the fish products before reaching Addis Ababa markets could enhance profitability. Improving cold chain logistics and storage facilities to maintain product quality during transportation could also be a key improvement tailored to Lake Ziway's characteristics.

**Lake Hawassa**: In the case of Lake Hawassa, investing in regulatory frameworks to ensure sustainable fishing practices and quality standards could be crucial. Strengthening cooperative management practices and providing training programs for fishers to improve market access and bargaining power could enhance the efficiency of the supply chain. Developing partnerships with local retailers and processors to create a more integrated market system could also be a specific improvement for Lake Hawassa.

**Lake Chamo**: Specific improvements for Lake Chamo could include supporting the JEBM processing plant in Addis Ababa to enhance processing capacity and product quality. Strengthening linkages between cooperative and non-cooperative fishers to ensure a consistent supply of fish to the processing plant and other market actors could improve market stability. Investing in export market development and compliance with international standards could also be a tailored improvement for Lake Chamo.

## 4.8. Fish Production constraints

### 4.8.1. Illegal fishing gear and practices

According to the field surveys and observations, fishers use of illegal fishing practices on average ranks first at 94% (catch undersized fish by using narrow mesh size) in Lakes Tana, Ziway, Hawassa, and Chamo (90.0%; 96.8%; 96.7%; and 94.1%, respectively) (Table 24). In this study as well, the major fishing gears used by fishers in the lakes were those gears that are discarded with many patches in them, illegal fishing gear (e.g. beach seines with narrow meshsizes used in breeding grounds) and regularly using narrow mesh monofilament gillnets, which happen to be highly common among fishers (Fig. 16). Dereje Tewabe (2013) and Eshetie Dejen *et al*. (2017) stated that illegal fishing gear was introduced in 2008, during an earlier period in Sudan. The fishers strongly prefer monofilament to multifilament gillnets because they are twice to four times as efficient (Eshetie Dejen *et al*., 2017). Approximately, 97% of fishers catch fish by using monofilaments in Lakes Ziway and Hawassa (Table 24). The total number of gillnets and boats used increased steeply from year to year (Shewit Gebremedhin *et al*., 2013; Eshete Dejen *et al*., 2017). A range of mesh sizes has been used for fishing different fish species from the lakes, including 5 cm-8 cm in Lake Tana, 4 cm-7 cm in Lake Ziway, 4 cm-8 cm in Lake Hawassa, and 5-12 cm in Lake Chamo (personal communication and measured in field visits, 2019 and 2021). Dereje Tewabe (2013) and Eshetie Dejen *et al*. (2017) stated that almost all fishers use undersized (5-7cm) stretched mesh monofilament gillnets. Moreover, there is a silly and unsustainable exploitation of the fisheries resources by using illegal fishing vessels and illegal local fishers who target lake resources.

Fig. 16. Monofilaments nets in Hawassa (LEFT); undersized fish at Lake Ziway (RIGHT)

Table 24.Fishers perceptions towards the constraints related to fish production in Lakes Tana, Ziway, Hawassa and Chamo

| Variable | Responses | Fish landing sites (Lakes) | | | | Total | Rank | df | $X^2$ | P-Value |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Tana No. (%) | Ziway No. (%) | Hawassa No. (%) | Chamo No.(%) | | | | | |
| a) Illegal fishing gear and practice | Yes | 135 (90%) | 121(96.8%) | 87 (96.7%) | 80 (94.1%) | 423(94%) | I | 3 | 7.130 | 0.068 |
| | No | 15(10%) | 4(3.2%) | 3(3.3%) | 5(5.9%) | 27(6%) | | | | |
| b) Over exploitation fish resources | Yes | 101(67.3%) | 85(68%) | 55(61.1%) | 50(58.8%) | 291(64.7%) | V | 3 | 2.843 | 0.417 |
| | No | 49(32.7%) | 40(32%) | 35(38.9%) | 35(41.2%) | 159(35.5%) | | | | |
| c) Fish breeding and habitat degradation | Yes | 129(86%) | 105(84%) | 70(77.8%) | 35(41.2%) | 339(75.3%) | IV | 3 | 67.894 | 0.000 |
| | No | 21(14%) | 20(16%) | 20(22.2%) | 50(58.8%) | 111(24.3%) | | | | *** |
| d) Agricultural land expansion | Yes | 120(80%) | 123(98.4%) | 70(77.8%) | 70(82.4%) | 383(85.1%) | III | 3 | 24.842 | 0.000 |
| | No | 30(20%) | 2(1.6%) | 20(22.2%) | 15(17.6%) | 67(14.9%) | | | | *** |
| e) Water pollution | Yes | 139(92.7%) | 122(97.6%) | 76(84.4%) | 65(76.5%) | 402(89.3%) | II | 3 | 27.730 | 0.000 |
| | No | 11(7.3%) | 3(2.4%) | 14(15.6%) | 20(23.5%) | 48(10.7%) | | | | *** |
| f) Water hyacinth (*Eichhorniacrassipes*) infestation | Yes | 149(99.3%) | 42(33.6%) | 0(0%) | 2(2.4%) | 193(42.9%) | VI | 3 | 324.11 | 0.000 |
| | No | 1(0.7%) | 83(66.4%) | 90 (100%) | 83(97.6%) | 257(57.1%) | | | 7 | *** |
| **Total** | | **150 (100%)** | **125(100%)** | **90(100%)** | **85(100%)** | **450(100%)** | | | | |

Note: *** represents significance at 0.1%.

### 4.8. 2. Overexploitation of fish resources

Table 24fishers perceptions survey result indicated excessive pressure, unwise use of fishing gear, and an increase in the number of fishers over time. According to the respondents in the study, lakes, especially Lake Ziway (68%), are under increasing pressure from fishers, and many fish stocks are now depleted, which increases variability and reduces the resilience of stocks and catches (Table 24). This fact, along with the presence of unmarketable fish sizes in the lake, is affecting the sustainability of Lake Ziway (Fig. 16). This indicates that fishing activity is free and provides open job access not only for poor and illiterate communities but also for students and others to get job opportunities. Besides, they were commonly using three types of fishing boats in the Rift Valley Lakes (Ziway, Hawassa, and Chamo): simple wooden fishing boats, steel boats, rafts, bofofe, and yabala used for fishing activities (personal communication). Adami Tullu Ziway, Hawassa, and Arbaminch *Woreda (*Agriculture Office, Fishery Expert, 2018); de Graaf *et al*. (2004); Brihan Mohammed *et al*. (2013); Megerssa Endebu *et al.* (2015); and Eshete Dejen *et al*. (2017) stated that increasing the number of motorized and reed boats increases pressure on fishery resources. In addition, to compensate for the declining commercial catch, the fishermen sharply increased their fishing effort (Eshete Dejen *et al*., 2017).

### 4.8. 3. Fish breeding habitat degradation or deforestation

In Table 24 and Fig. 17, fishers perceptions indicated that intense agricultural expansion, free animal grazing, urbanization, population growth, and other reductions in the vegetation of the catchment areas of Lakes Tana, Ziway, Hawassa, and Chamo have affected the fish breeding habitat and sustained fish resources. Negash Atnafu *et al.* (2011) and Eshetie Dejen *et al*. (2017) declared that with increasing population pressure and limitations of land and water, farming moved to wetlands, including shorelines of lakes and river banks. Wetlands are often the last targets for livestock for free grazing and watering

during the dry season, which results in a direct collapse of the lakeshore wetlands and reduced fish resources, especially in Lakes Tana and Ziway. Fish breeding habitats (bush and wetlands) most deteriorated in Lakes Tana between 1986 and 2018 (-1480 $km^2$) (Dires Tewabe & Temesgen Fentahun, 2020), Ziway 1990 to 2020 (-1201 $km^2$) (Ibrahim, 2021), Hawassa 1987 to 2019 (-47.7 $km^2$) (Yonas Girma *et al*., 2020), and Chamo (1990-2019) (247.67 $km^2$) (Zekarias *et al*., 2020). Shewit Gebremedihn *et al*. (2012) and Eshetie Dejen *et al*. (2017) also found that habitat degradation, which is the loss of spawning grounds and disjoining of the river from the lake and blocks the return of juveniles into the lake, causes the decline of the *Labeobarbus* stock in Lake Tana. Besides that, farmers often cultivate the shore area of the lake by deforesting, even to the extent of burning macrophytes (Ayalew Wondie, 2010; Eshetie Dejen *et al*., 2017).

### 4.8.4. Agricultural land expansion

According to the fishers perception and field observations, youth are cultivate the shore areas of the lakes without leaving any buffer zones by deforesting vegetation and the macrophytes in the littoral zones of the lakes where fish usually tend to breed, causing major changes in fish resources and land cover. Land use and land cover change detection in the lake basin revealed that agricultural land increased in Lake Tana from 1986 to 2018 (1954 $km^2$) (Dires Tewabe & Temesgen Fentahun, 2020), Ziway 1990 to 2020 (1308.42 $km^2$) (Ibrahim, 2021), Hawassa 1987 to 2019 (121.7 $km^2$) (Yonas Girma *et al*., 2020), and Chamo 1990 to 2019 (30.65 $km^2$) (Zekarias *et al*., 2021). Table 23 and Fig. 17 indicate that 80 % of Lake Tana, 98 % of Lake Ziway, 77.8% of Lake Hawassa, and 82.4% of Lake Chamo fishers perceptions indicate that using water pump irrigation, floriculture activities, and diverting water from the lake result in changes in water level and from the lakeshore during the breeding season, which most likely cause alteration or loss of spawning grounds, eggs of fish, and breeding places for wetland birds. As stated by Ayalew Wondie (2010) and Negash Atnafu *et al*. (2011), increasing population pressure and limitations on land caused agricultural activities to move to wetlands, including the shorelines of lakes and river banks. Due to population growth, agricultural land throughout the

catchments increased at the expense of other land uses. The decrease in bush and wetland cover is related to the expansion of agricultural lands. This has already resulted in a decrease in the biodiversity of the fish fauna in the different drainage basins and the Rift Valley Lakes (Abebe Getahun and Stiassny, 1998).

Fig. 17. Lake shore agricultural land expansion and fish breeding habit degradation Lake Tana (LIFT) and Lake Ziway (RIGHT)

### 4.8.5. Water Pollution

The fishers perceptions survey result indicated that their concern for Lake Ziway, the Sher Ethiopia Flower Farms, the industrial park in Hawassa, and the industrial effluent chemicals (e.g., wasted fossil fuels, heavy metals, etc.) or municipal discharges result in the pollution of water resources and changes in the composition of phytoplankton in the lakes and fish resources (Table 24 and Fig. 18). As declared by Tenalem Ayenew and Dagnachew Legesse (2007), Hayal Desta *et al*. (2020) of Sher Ethiopia Flower Farm occupies due to excessive abstraction of water for floriculture and irrigation developments; the water level of Lake Ziway has been declining. In both floriculture and agricultural input use in terms of water, fertilizers, pesticides, and crop protection agents, which affect the quantity and quality of local water resources and fish production at the studied lakes.

In the Lake Tana catchment area, rice cultivation becomes the major crop in the Fogera and Dembia floodplains. The use of fertilizers and pesticides to maximize rice production has a significant impact, especially on the floodplain wetlands

(Wollala and Shesher) and, to a large extent, on Lake Tana (Ayalew Wondie, 2010). Growing urbanization and unplanned tourism development activities around the lake in the absence of adequate sanitation along the lakeshore and adequate infrastructure facilities have negatively affected the lake's recreational values. The proximity of industries to wetlands and lakeshores, such as those in Bahir Dar, Ziway, and Hawassa, has a significant impact on their normal operation, impairing their ability to clean waste water and reduce stream siltation (Ayalew Wondie, 2010).

Fig 18. Disposal of industries untreated waste effluents in to Lake Tana (LIFT) and Lake Ziway (RIGHT).

### 4.8.6. Water hyacinth (*Eichhornia crassipes*) infestation

In Table 24 and Fig. 19, it is shown that 99% of fishers perceptions are that the northern, north-eastern, and north-western shores of Lake Tana have been covered by water hyacinthcausing physical interferences in fish landing sites, grazing and agricultural land, and blockage of irrigation canals and water pumps. Yilebes Addisu*et al*. (2021) declared that the weed had a maximum coverage in the winter (15.35 $km^2$) while the minimum was in the autumn (4.14 $km^2$). Approximately, the water hyacinth had a spatial coverage of Lake Tana of 11.22 $km^2$ in the year 2019. As a consequence of the high pressure of water hyacinthweeds, this frequently depends on the direction of lake winds and affects the breeding grounds for fish. Besides, there are economic impacts when the weed blocks water pumps and reed boats, twisting their nets and access. It has also impacted the lakeshore, surrounding human communities, and its catchment by reducing fish catches. Wassie Anteneh *et al*. (2015) confirmed that juvenile fish need lakeshores covered by macrophytes and should avoid water hyacinth-infested

areas. The shore macrohabitats of Lake Tana became infested by water hyacinth in 2011 (Wassie Anteneh *et al*., 2015).

Fig 19. Water hyacinth infestation at Lake Tana

## 4. 9. Fish marketing constraints

### 4.9.1. Illegal fish trading

The result indicated in Fig.20 that the majority of fish traders were unlicensed traders (65.2%), which probably contributed to the creation of unhealthy competition among unlicensed fish traders and assemblers that caused price fluctuations and made it difficult to predict prices (Table 22). Fish retailers and assemblers obtained the highest gross profit from purchases and sold fish freely in the study lakes. In this study, traders were not observed to narrow their margin to overcome competition and cover checkpoint charges. Rather, they deducted the charge from the purchase price, and thus checkpoint charges affect fishers directly or indirectly. Even so, a considerable proportion of fishermen had access to transportation, storage, and market information. The majority of fishers used telephones to call their neighbours and cooperatives for information on the local market.

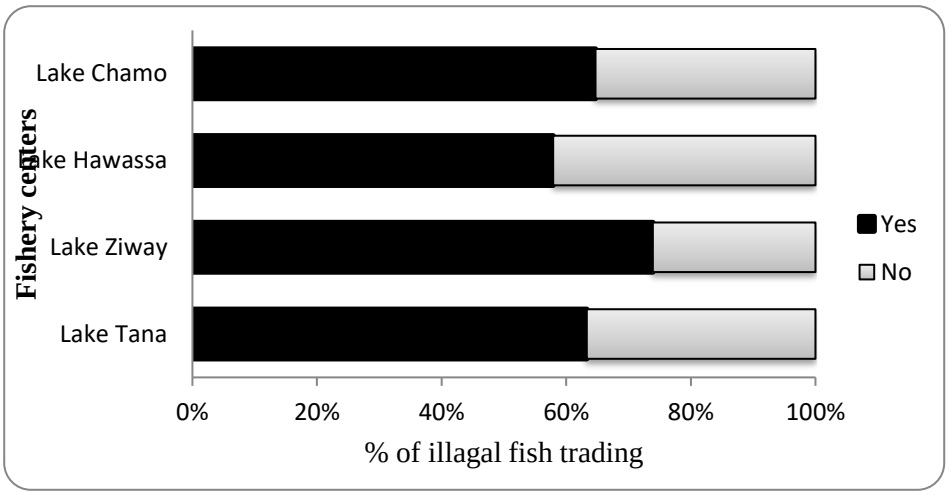

Fig. 20. Fish traders' constraints related to illegal fish trading

### 4.9.2. Sanitary problems in fish handling and processing

Fish traders perceptions indicated that in Figs. 21 and 22, traditional post-harvest handling practices in Lake Hawassa (94.7%) were higher than those in Tana (70%), Ziway (82.6%), and Chamo (76.5%). Unluckily, these traditional methods lead to economic and quality post-harvest losses due to the absence of appropriate transportation, the unavailability of working places in the market, traditional drying methods, poor sanitation of landing and processing sites, poor preservation (storing for a long time inside a refrigerator), a lack of storage facilities, undersizing, and a lack of access to the market. With regard to the handling of fish, ignorance or carelessness in hygienic fish landing centres has led to a bad reputation for quality (off-smell) due to inadequate fish post-harvest handling and sanitation techniques and a loss of quality because of limited options for conservation and time or distance from trading points.

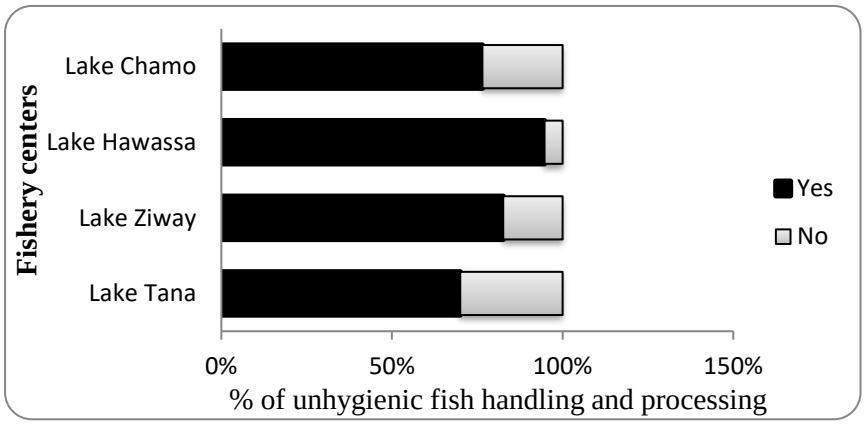


Fig. 21. Fish traders' constraints related to unhygienic fish handling and processing

Fig. 22. Poor sanitation of landing and processing site at Ziway (LEFT) and Hawassa (RIGHT)

#### 4.9.3. Marketing of table-size fishes and their quality

The perception of fish traders in Table 25 indicated that the percentage of lack of table-size fishes (standard grade) and their quality (e.g., undersized fish of 3-5 cm length and poorly washed fish), where Lake Ziway reached 91.3%. In the Lakes Tana area, it reached 76.3%, at Lake Hawassa, 78.9%, and at Lake Chamo, 70.6%. Besides, the informal survey revealed that small-scale retailers and assemblers were found to adulterate fish after filleting, particularly in Lake Tana. However, value additions rarely take place in very rare circumstances, such as Lake Chamo, with value additions in the JEBM processing plant's product supplied according to the international fish handling standard (Fig. 23). The situation, therefore, impacts the retailer, wholesaler, and cooperative, which are always looking for ways to prevent the fish from going bad. At this level, either the fishers or the trader takes on the burden of value addition through preserving, drying, and smoking the fish. Fishers mostly sell fresh fish because of the demand from consumers and traders. It is observed among fishers, especially in Lake Tana, that, due to poor preservation and transportation facilities and techniques in the Northwestern part of Tana, the post-harvest losses are higher for marketable fish. Mostly, dried fish is targeted for export to Sudan, where it is not feasible to transport fresh fish. Export fish has poor handling and drying facilities at the border with Sudan, and with the closure of the border, there is no alternate place to store it. While in the southern Gulf of Lake Tana, the middlemen and

cooperatives washed and packed the produce with plastic to sell to consumers. This was done to protect the quality and avoid some bad smells while adding value. Lake Ziway, Hawassa, and Chamo: there is no protection to keep and no way to avoid bad odour.

Fig. 23. Value additions in the JEBM processing plant at Arbaminch

Table 25. Lack of standard grade and quality of fish

| | Tana | % | Ziway | % | Hawassa | % | Chamo | % | Total | % |
|---|---|---|---|---|---|---|---|---|---|---|
| Yes | 23 | 76.7 | 21 | 91.3 | 15 | 78.9 | 12 | 70.6 | 71 | 79.8 |
| No | 7 | 23.3 | 2 | 8.7 | 4 | 21.1 | 5 | 29.4 | 18 | 20.2 |
| **Total** | **30** | **100** | **23** | **100** | **19** | **100** | **17** | **100** | **89** | **100** |

### 4.9.4. Problems related to transportation

Out of the major lakes, Tana, Ziway, Hawassa, and Chamo are relatively good in terms of road condition, availability, and transport rates, which are fishers lower transportation problems. However, these factors are not evenly distributed to all fish landing sites and have caused problems in the case of Lakes Tana and Chamo. There is a critical shortage of landing points and physical access to landing points and cooling and processing facilities around the lakes until fish are sold to the market. Besides, there is no cold chain to use it for preservation types

to minimise the transportation losses for fish traders in the lakes (See Table 17). During the rainy season at Nabega, near Lake Tana, excessive flooding is a common problem, transportation is difficult, and preservation is important. Many are constrained by a lack of all-weather access roads to fishing land areas, which makes transporting the outputs immediately after harvesting difficult. Fish transportation is done by fishers, women, assemblers and brokers, retailers, and wholesalers to lakes in the marketing place.

## 4.10. Financing and institutional constraints

### 4.10.1. Lack of governmental support

The data presented in Table 26 and Fig. 24 reveal a concerning trend among fishers across Lakes Tana, Ziway, Hawassa, and Chamo regarding the perceived lack of governmental support in fisheries management. A significant majority of fishers in each lake, ranging from 69.3% to 80%, expressed acknowledgment of coordination challenges among key government bodies, including the Ministry of Agriculture (MOA), Bureau of Agriculture (BOA), Zonal Agricultural Offices, Woreda Agricultural Offices, and fishery centers cooperatives. These findings underscore systemic issues, including the absence of clear legal mandates for issuing directives required for the effective implementation of regulatory frameworks such as Proclamation and Regulation No. 315/2003. As noted by Hayal Desta et al. (2020), inadequate government efforts have been observed in managing and protecting Lake Ziway, exacerbating the challenges faced by fishermen. The lack of governmental support manifests in various detrimental consequences for fisheries management. Insufficient institutional, technical, and financial assistance impedes effective monitoring, control, and surveillance of fish resources. Furthermore, inadequate planning to address issues such as overfishing, careless handling of fish products, and unrestricted access to water bodies exacerbates environmental degradation and threatens the sustainability of fish stocks. Moreover, the absence of clear directives and stable institutional structures contributes to a climate of uncertainty and hampers long-term planning and investment in the fisheries sector. The lack of human resources further compounds these challenges, limiting the capacity for effective governance and enforcement. To address these critical issues, it is imperative to develop comprehensive

management plans tailored to the unique needs and dynamics of each lake ecosystem. These plans should encompass measures to enhance regulatory enforcement, promote sustainable fishing practices, and foster collaboration among government agencies, local communities, and other stakeholders.

### 4.10. 2. Theft of gear (fishing materials)

During the survey, it was observed and fishers also reported that each day fishing gear are stolen in the night loaded with their catches. Fishers reported regularly to the fishing center (Table 26) that their gears are stolen and each morning theey come to the center and landing sites to look for their stolen fishing materials (gear and boats). The existence and increase in the number of illegal fishers (jobless) in the lakes (Tana, Ziway, Hawassa, and Chamo) result in the everyday loss of operating fishing materials. This is caused by a lack of control and protection through rules and regulations and most of all due to lack of regulating the fishery sector and the policy of "open-access" of the lakes to anyone who wishes to do fishing.

### 4.10.3. Limited extension service

As shown in Table 26 and Fig. 25, fishers perceptions recognized that having access to extension services contributed to improving production and was thus significantly associated with a higher probability of increasing the marketed supply of fish and producing good-quality fish (standard size of fish). In this study, only 76%, 58%, 57.8%, and 55.3% of the respondents had access to extension services in Lakes Tana, Ziway, Hawassa, and Chamo, respectively. This implies that the fishery sector receives less consideration in government planning, stackholder coordination, and development projects. It is characterised by a lower budget and poor extension activity in production, processing, marketing, and consumption.

### 4.10.4. Lack of credit facilities

The findings from this study shed light on the financial constraints faced by fishers operating in Lakes Tana, Ziway, Hawassa, and Chamo. As illustrated in Table 26, it is evident that access to credit facilities is severely limited among fishers in these areas. This lack of access to credit has far-reaching implications, potentially hindering fishermen's ability to engage in non-fishing activities and diversify their livelihoods. The inability to access credit may contribute to the prevalence of illegal fishing practices, such as the use of unauthorized fishing gear, as highlighted in the data. This phenomenon can be attributed to several factors, including the insufficient availability of resources and the inflated prices of standard-size or legal fishing equipment. Such financial constraints not only impede fishers compliance with regulatory standards but also hinder their capacity to invest in sustainable fishing practices. Numerous studies have underscored the importance of financial resources in facilitating livelihood diversification among fishing communities (Gorden *et al*., 2007). Fishers who have access to credit are more likely to invest in alternative income-generating activities, thereby reducing their reliance on natural resources for sustenance. Paris (2002) and Brugère *et al*. (2008) have highlighted the critical role of targeted credit provision in enabling impoverished fishermen to expand their economic opportunities and reduce their dependency on traditional fishing practices. Furthermore, the shortage of financial resources emerges as a pervasive challenge faced by both fishers and traders within the fishing industry. The need for immediate capital, both pre and post-harvest, underscores the urgency of addressing financial barriers to sustainably manage fishery resources and enhance the socio-economic well-being of fishing communities. In summary, the findings emphasize the pressing need for interventions aimed at improving access to financial resources and credit facilities among fishermen operating in Lakes Tana, Ziway, Hawassa, and Chamo. Addressing these financial constraints is paramount to promoting sustainable livelihoods, reducing reliance on natural resources, and fostering economic resilience within fishing communities.

Table 26.Fishers perceptions towards related to financing and institutional constraints in Lakes Tana, Ziway, Hawassa and Chamo

| Variable | Responses | Fish landing sites (Lakes) | | | | Total | Rank | degrees of freedom | Chi-Square ($X^2$) | P- Value |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Tana No. (%) | Ziway No. (%) | Hawassa No. (%) | Chamo No. (%) | | | | | |
| a) Lack of governmental support | Yes | 104(69.3%) | 99(79.2%) | 72(80%) | 65(70.6%) | 340(75.6%) | II | 3 | 5.044 | 0.169 |
| | No | 46(30.8%) | 26(20.8%) | 18(20%) | 20(23.5%) | 110(24.4%) | | | | |
| b) Theft gear (fishing materials) | Yes | 142(94.7%) | 99(79.2%) | 72(80%) | 64(75.3%) | 377(83.8%) | I | 3 | 20.460 | 0.000*** |
| | No | 8(5.3%) | 16(20.8%) | 18(20%) | 21(24.7%) | 73(16.2%) | | | | |
| c) Extension service | Yes | 114(76%) | 85(68%) | 52(57.8) | 47(55.3%) | 298(66.2%) | IV | 3 | 13.995 | 0.003** |
| | No | 36(24%) | 40(32%) | 38(42.2) | 38(44.7%) | 152(33.8%) | | | | |
| d) Increase price of gillnet and material input | Yes | 92(61.3%) | 90(72%) | 74(82.2%) | 78(91.8%) | 334(74.2%) | III | 3 | 30.029 | 0.000*** |
| | No | 58(38.7%) | 35(28%) | 16(17.8%) | 7(8.2%) | 116(25.8%) | | | | |
| e) Lack of credit service | Yes | 48(32%) | 86(68.8%) | 77(85.6%) | 65(76.5%) | 276(61.6%) | V | 3 | 87.840 | 0.000*** |
| | No | 102(68%) | 39(31.2%) | 13(14.4%) | 20(23.5%) | 174(38.7%) | | | | |
| **Total** | | **150 (100%)** | **125(100%)** | **90(100%)** | **85(100%)** | **450(100%)** | | | | |

Note: *** represents significance at 0.1% and ** at 1%

## 4.11. The value chain, activities, and causes

During a field surveys and observations in Lakes Tana, Ziway, Hawassa, and Chamo, the physical flow of fish, current practices in value chains with regards to production and distribution, marketing, and constraints were examined (Fig. 24). The main market actors were fishers, assemblers/brokers, cooperatives, retailers, and wholesalers. At various locations in Bahir Dar, Batu (Ziway), Hawassa, and Arba Minch, fish markets can be found near Lakes Tana, Ziway, Hawassa, and Chamo. Unlicensed fishermen (94%) and illegal fish traders (65.2%) dominated the domestic fish markets and distribution. Most fish markets have inadequate facilities; usually, they lack cold storage, preservation, transporting facilities, and good hygiene. In long supply chains where there are many intermediaries between the producers and consumers, value addition starts from the first dealing of fish at the landing site and continues up to the consumer, increasing along the way as it passes through different intermediaries (Kruijssen *et al*., 2020). Nick (2014) also stated that the value chain is a sequence of enterprises or activities that add value to a product. This value is added from primary production, through processing and marketing, to the final sale to the consumer. As a result, value chain activities ensure that the product passes in an orderly way, and obviously, the product gains some value at each activity stage.

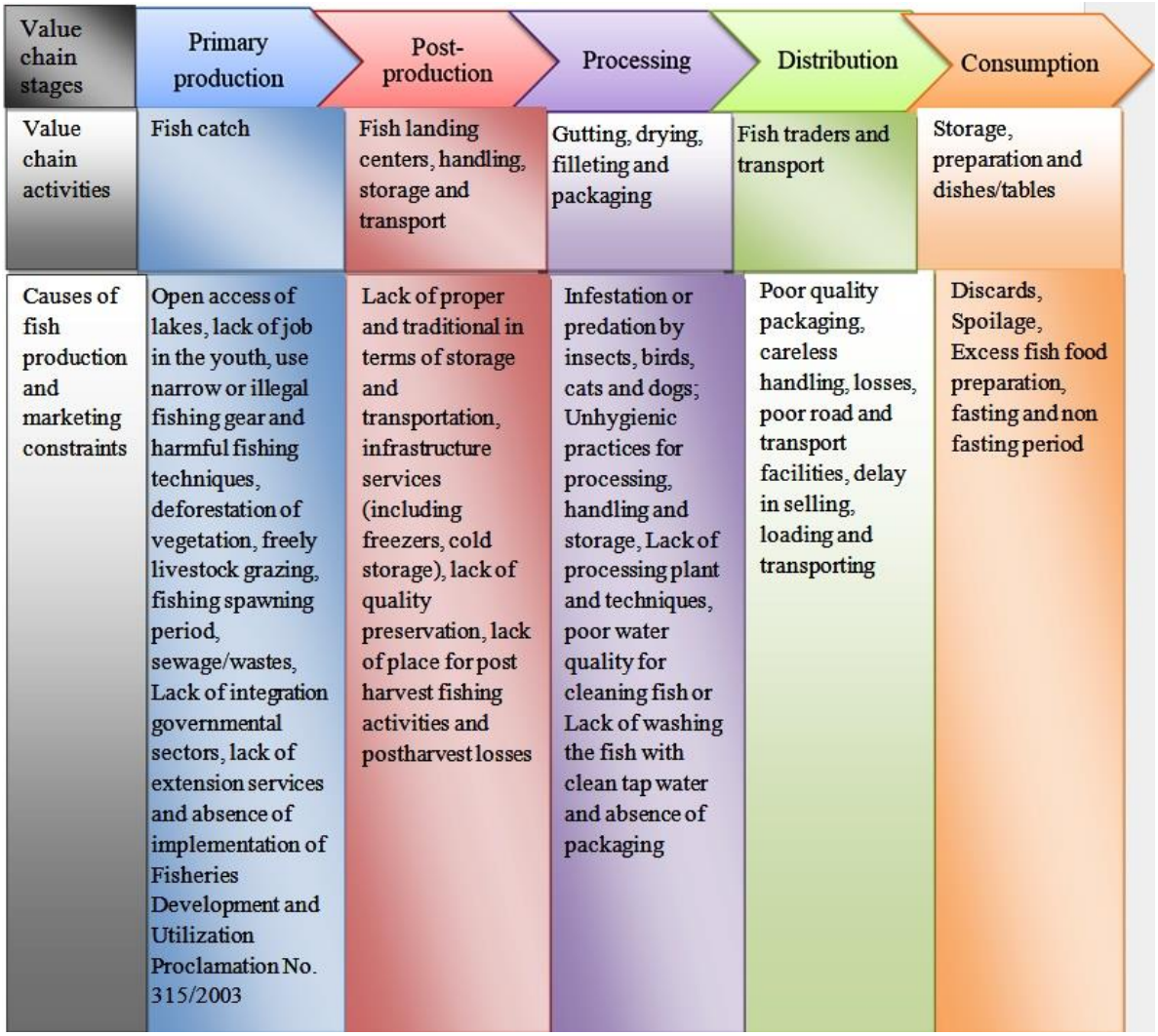


**Fig. 24**. Fish production and marketing constraints along the fish value chain: stages and causes

### 4.12. Opportunities for the improvement of fish production and marketing systems

Through extensive focus group discussions, key informant views and thorough secondary data collection, the study has identified several key opportunities for enhancing the production and sustainable utilization of fishery resources, thereby maximizing fish production along the value chain.

Firstly, there is a noticeable surge in the demand for fish within the market, driven primarily by population growth and a growing awareness of the health benefits associated with fish consumption (Thurstan and Roberts, 2014). Furthermore, shifts in lifestyle preferences due to

urbanization have contributed to this demand, making fish an appealing choice for tourists visiting the area, particularly around lakes boasting renowned monasteries, hotels, and restaurants.

Secondly, Ethiopia's abundance of lakes, rivers, reservoirs, and small water bodies presents a significant opportunity for fish production. With a total lake and reservoir area of approximately 7,740 km² and 1,447 km², respectively, and an extensive river network spanning over 8,065 km, coupled with numerous small water bodies totaling around 4,450 km² (Gashaw Tesfay and Wolff, 2014), Ethiopia possesses substantial fishery potential. The country is home to over 200 fish species (Abebe Getahun, 2007; Redeat Habteselassiie, 2012), with a projected sustainable yield of 94,541 metric tonnes per year (Gashaw Tesfaye and Wolff, 2014). Additionally, Ethiopia's ongoing construction of various dams for hydroelectric power generation, irrigation, and water supply offers further opportunities for fishery development if managed appropriately.

Thirdly, the existence of the Federal Fish Resource Development and Utilization Proclamation 315/2003 serves as the legal framework for fisheries management in Ethiopia (Federal Democratic Republic of Ethiopia, 2003). While not fully implemented, this proclamation aims to safeguard the rights of fishermen, protect fish biodiversity and the environment, and prevent overexploitation of fisheries resources. It includes management measures within the catchment areas to bolster fishery protection. Leveraging this proclamation, organizing cooperatives with legal recognition and licensing could facilitate its implementation, thereby enhancing fish supply across the country (Vijverberg *et al*., 2012). Furthermore, Ethiopia's adoption of a sustainable fish resource utilization policy in 2004 continues to guide fishery management efforts (Goraw Goshu *et al*., 2010).

# CHAPTER FIVE

## 5. Conclusions and Recommendations

### 5.1. Conclusions

In general, Ethiopian fishery industry operates at major inland water bodies (lakes, reservoirs, dams of various sizes and types, and rivers). Despite its estimated annual total fish production potentials of about 94,500 t/yr, it has not reached that amount annually. For this reason alone, fisheries assessment needs to be done for each major water body separately to estimate the actual level of fishing and optimize management measures for the sustainable use of fisheries' resources. These facts have determined the factors that affect fish production and distribution in the country and thereby improved the livelihoods of poor fishermen in the Ethiopian Rift Valley Lakes and Lake Tana.

The major quantities of fishery products exclusively come from inland water bodies, and the fish production of the country is not consistent or poorly documented in adequate catch statistics. In some instances, the recored data by various governrmrtal and communal organizations (e.g., MOA, BOA, Zonal, and Woreda reports) even contradict each other. Because of poor documented catch statistics, managers cannot take measures to ensure that fish populations are managed sustainably. Estimates of potential sustainable fish yields are valuable for the sound management of existing fisheries resources, if they are documentd in a more reliable and reproduceable manner. This indicates that there is clearly a need to work out the fishing operations in the country that can optimize the sustainability of the catch over time and the conservation and rehabilitation of the fish fauna.

In the study lakes, primary fishing was entirely seen to be the responsibility of males. This might be due to leadership in the family and ownership of family properties by tradition go to the husbands. At the same time, fishing operations are believed to require high-level manual physical work of men and females are disconnected from fishing by looking after kids and the elderly at home, although it is known globally that the fishery industry cannot succeed without the active participation of females.

Through econometric analysis and field surveys, the research identified key determinants of fish production and their impact on the livelihoods of local fishing communities. Fishing is one of the main sources of income and contributed 67%, 73%, 68.9%, and 59.3%, respectively, at Lakes Tana, Ziway, Hawassa, and Chamo. In addition, the major determinant of fish production were estimated by linear OLS regression. The income from petty trade, number of gillnets and reed boats, land owned for production, and fishing trips found significant evidence. Additionally, at each research site limited numbers of women appear to participate more in gillnet making, fish processing, and the marketing of fish. Despite this, there will be a need to provide incentives to females, such as training them, supporting them with credits, reducing their household and family responsibilities, and allowing them some level of ownership in the family; so that they can meet the challenges of producing fish, processing it, and marketing it (as per FAO standards). Therefore, stakeholders should be given a great role in the most significant determinants; they may also deal with those with moderate effects and enhance the sustainable development of fisheries and fish production.

The study on fish market chains and livelihoods of fishers in the four Ethiopian lakes Lake Tana, Lake Ziway, Lake Hawassa, and Lake Chamo highlights both the similarities and differences in their market supply chains. While all lakes rely on both cooperative and non-cooperative/private fishers, their distribution networks, market integration, and product offerings vary significantly. The comparative analysis reveals that Lake Tana's market chain is more diversified, including both dried and processed/whole fish, whereas Lake Ziway and Lake Chamo focus primarily on processed and whole fish markets. The involvement of processing plants and exporters also varies, indicating different levels of market integration and access to broader distribution networks. These differences impact the efficiency of distribution channels, the role of cooperatives versus private fishers, and the potential for market enhancements.

Besides, the existing market chains revealed several challenges and the fish market in the country has been dominated by a large number of intermediaries (illegal fishers and traders). Based on the analysis of the members of the fish market channels, it was clear that they tended to be predominantly traditional, divided, and had far too many channels that

are mostly unregulated and out of the control or management oversights of the responsible government and private offices. This irregularity expresses itself by the presence of numerous unlicensed or unregistered operators at all levels of the fish market chains of the country. In addition, the fish marketing system in the studied areas were characterized by disorganized and poor recording of catch and other data.illegal practices and, necessitating the development of alternative market chains. In most cases, this situation brings fishers and consumers face-to-face to deal with each other without involving other intermediaries as it is commonly observed in most countries of the world where the fishery industry thrives to support social development by generating national revenues.

It was also observed that most fish markets have inadequate facilities. They lack the appropriate fishing gears and infrastructural limitations that match the fish structures of the water bodies, cold storages, preservation and transportation trucks, hygienic conditions, and communication links. Value-adding activities have not been applied in Lakes Tana, Ziway, Hawassa, and Chamo. The personnel engaged in the business do not seem to have an awareness or appreciation of value addition. All activities continue as they were traditionally in this highly technologically challenging world setting.

Fishery sector was not receiving the due attention from the government as stipulated in the Fisheries Development and Utilization Proclamation No. 315/2003, which stated the use of licences for all fishers and traders and there are no laws and regulations for productive utilization of fish value chains and marketing policies. Government finance, planning, coordination, and policies in the fisheries value chain of Ethiopia are poor as the government has not allocated sufficient annual budget to the development of the fishery sector, particularly aquaculture,which is non-existent in Ethiopia.The findings offer valuable insights for policymakers, emphasizing the need for sustainable management practices to preserve fish stocks and improve fishermen’s livelihoods.

The lakes under study are experiencing an increase in fish demand, but the market is unable to meet the rising demand. In addition, fish production and marketing in Lakes Tana, Ziway, Hawassa, and Chamo lack quality assurance and infrequently provide value. The main obstacles to fish production and marketing include illegal fishing methods, the

destruction of fish breeding habitats, lakeshore agricultural land expansion, overgrazing, post-harvest handling, traditional fish storage and transportation methods, a lack of locations for such activities, illegal fish traders, a lack of government support, a lack of extension services, a lack of credit services, and an increase in the cost of gillnets and raw materials. Furtermore, the sector's institutional, technical, and financial capacity for resource monitoring, control, surveillance, planning, and coordination is limited.

Generally, it is generally known that fishing efforts has reached an unfavourably high level, and stakeholders suggested that efforts may be reduced by regulating fishery practices to curb down the numbrr of illegal actors all along the value chain strting with the fishers, the number of boats that one person should possess, capping the number of standarsized gears allowed on each boat, and providing alternate means of subsistence.

Furthermore, fishing communities should receive periodic trainings in fishery management and the efficient use of fishery revenue. Access to the fishery should be restricted through licensing, which should be strengthened and updated from time to time. Such effors can help implement the Fisheries Development and Utilization Proclamation No. 315/2003 and bging more meaning to the fishery management of the country with th direct involvement of all stkeholders. Besides this, all fishers and traders involved in the fish catch, handling, transporting, processing, and marketing and environment protection agencies business should be responsible for their part in the value chain. Government finance, planning, coordination, and policies in the fisheries value chain of study lakes have not given due attention to allocating much of their annual budget to the support of the fishery sector. Therefore, to take immediate actions, every possible measure must be underatken, and the fisheries sector must focus on particular upgrading activities at the different stages in the chain for the benefit of all actors and sustainable utilization of the lake resources so as to realize the contribution of fish resources to the food problem of the country.

Based on the findings of this study, the following recommendations should be considered for implemenation for the sake of rehabilitating the eccosysetms of Ethiopian water bodies and maintaining fisheries resources of Ethiopia sustainably.

## 5.2. Recommendations

**For Sustainable Fish Stock Management:**

- The fishing effort, number, and size of boats, as well as the maximum number of gillnets, longlines, and hooks per boat, as well as the fish marketing chain should be neatly recorded in a national database for designing appropriate policies and better forecasts of the fishery practices.
- Implement improved national and regional fishery development plans, build on the awareness of all involved in the value chain of fish and fishery products management with the fishery preservation and utilization proclamation.
- Implement a regulated fishing schedule to prevent overfishing during critical breeding seasons.
- Develop community-led conservation programs to protect endangered fish species.
- Gear restrictions such as regulating standard meshsizes based on periodic stock assessments to avoid overfishing
- Work on integrated watershed management (land use planning and management) approach to the lake and its surroundings should be developed rather than focusing only on lakes.
- Rebuilding and maintaining overfished stocks is necessary for the implementation of fishery management policies and strategies that will produce optimum yield from the fishery resources and protect the fish stocks.

**For Improving Fishers Livelihoods:**

- Possible alternative income-generating activities should be promoted so that the livelihoods of fishers could be diversified as a safety mechanism in case fish production gets limited in some seasons.
- Introduce microfinance programs to support the purchase of sustainable fishing gear.
- Provide training on alternative income-generating activities during off-season periods.
- Access to finance can be improved by providing fishers and women affordable revolving credits in order to improve the fishery facilities and its sanitary systems.

- Fishers should be able to establish networks so that they can support each other, share experiences, and improve the production of good quality fish as required by the market.
- Improve the cold chain (storage and transportation), packaging materials, transportation logistics, and communication throughout the value chains.
- Implement activities that help in the dissemination of improved fish post-harvest technologies to reduce post-harvest losses.

**For Policy Development:**

- The establishment and development of protected areas, the issuance of permits, and the implementation of strict rules and regulations to restrict fishing activity and time in order to protect spawning grounds from illegal fishers, boost fish stocks, and raise sustainable yields.
- Formulate policies that balance ecological conservation with economic development.
- Collaborate with local communities to ensure policies are culturally sensitive and practically applicable.
- Facilitate a shift from competitive to more collaborative horizontal and vertical governance structures (collective action and contracts).
- Include key government agencies that can restructurefishers cooperatives with a focus on women and give correct data on the fish supply in order to boost fish production, maintain stocks, and reach the potential for sustainable annual fish production.
- Governmental organizations should design strategies to facilitate, plan, and promote massive awareness-creation programs to influence society, especially fishers, towards sustainable fish resource utilization.
- The market chain should be supported by revised future intervention strategies and policies that guide the development of the fish value chain and the sustainability of fish stocks.
- Policies should be put in palce to promote sustainable aquaculture growth, which will eventually alleviate the pressure on natural stocks.

**Directions for Future Research:**

- Investigate the impact of climate change on fish stock levels and migration patterns.
- Explore the adoption of technology in fishery practices and its socioeconomic effects.
- Food processing and handling practices being practised along the value chains.

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# 7. Appendices

## Appendix: I. Questionnaire

Part I. Fishers

Part II. Retailers, Wholesalers, FPME, Cooperatives & assemblers

Part III. Hotels/restaurants

Part IV. Consumers

Part V. Institutions

Part I

Fishers

Questionnaire number_____

Name of enumerator:_____

Date: _____/_____/_____

I. Area information

1. Research Location: _____

2. Name of the landing site_____

3. Distance of your residence from the nearest market center_____ walking time in a single trip (minutes)

4. Distance of your residence to the nearest development agent _____ walking time in single trip (minutes)

5. Distance from the fishing grounds to market landing sites _____walking time in single trip (minutes)

II. Demographics

1. Name_____Age _____years

2. Sex 1/ Male 2/ Female

3. Religion 1/ Orthodox Christian 2 /Muslim 3 /Protestant 4/Catholic 5 / other (specify)

4. Marital status 1/ Single 2/ Married 3/ Separated 4/ other specify_____

5. Education level 1/ Illiterate 2/ Read and write 3/ First cycle (1-4 grades)

4/ Second cycle (5-8 grades) 5/ High schools (9-10 grades) 6/ Preparatory school (11-12)

7/above preparatory 8/Religious school 9/others (specify) _____

6. Who from the family participates in fishing practice?

| No | Name | Age | Sex | | Education level use code from (Q.5) |
|---|---|---|---|---|---|
| | | | M | F | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

III. Resource ownership

7. Ownership Resource

| No | Resource | Item | 1/yes | 2/No |
|---|---|---|---|---|
| 1 | Type of house owned | 1/ Grass roofed | | |
| | | 2/Iron sheet roofed | | |
| | | 3/ Iron sheet with concrete Blocks | | |
| | | 4/House rent | | |
| 2 | Means of transport | 1/ Bicycle | | |
| | | 2/On foot | | |
| | | 3/Boat | | |

| | | | | |
|---|---|---|---|---|
| 3 | Communication | 1/Telephone | | |
| | | 2/Letter | | |
| | | 3/Others(specify)_____ | | |
| 4 | Skill/knowledge | 1/ By their own | | |
| | | 2/trained | | |
| | | 3/Experience | | |
| | | 4/other (specify)_____ | | |

8. Production asset

| S/n | Item | Unit | No | Remark |
|---|---|---|---|---|
| 1 | Land for living | Ha | | |
| 2 | Land for production | Ha | | |
| 3 | Land for grazing | Ha | | |
| 4 | Land for forest | Ha | | |
| 5 | Reed boat | Unit | | |
| 6 | Motorized boat | Unit | | |

9. Livestock ownership

| No | Type of livestock | Number owned |
|---|---|---|
| 1 | Cows | |
| 2 | Oxen | |
| 3 | Heifers | |
| 4 | Calves | |

| | | |
|---|---|---|
| 5 | Sheep | |
| 6 | Goats | |
| 7 | Donkeys | |
| 8 | Horses | |
| 9 | Mules | |
| 10 | Poultry | |
| 11 | Bee colony | |
| 12 | Other(specify)_____ | |

IV. Income by source

10. Source of income household head

| No | Activity | Primary | % age | Secondary | % age | Territory | % age |
|---|---|---|---|---|---|---|---|
| 1 | Crop | | | | | | |
| 2 | Animal husbandry | | | | | | |
| 4 | Fishing(Capture, Culture) | | | | | | |
| 5 | Petty Trade | | | | | | |
| 6 | Casual labor | | | | | | |
| 7 | Other (specify)_____ | | | | | | |

11. When did you start fishing ---------- Years?

12. How about fishing? 1/ Seasonal fishing 2/ any time in and off fishing 3/ yearly fishing 4/other specify)

13. Level of income per month----------Birr

14. From major occupations (per day/month/year maximum------ Optimum------Minimum-----

15. What does the importance of this job mean to you_____?

Access to Services

16. Did you get extension service in relation to fish production before this year 2018/19?

1/ Yes 2/ No

17. If yes, how often has the extension agent contacted you in the year? □

1/ Weekly 2/ Monthly 3/ during harvesting time 4/ Once in a year

5/ any time when I ask them 6/ other specify) _____

18. What is the extension advice on? □

1/ Fish harvesting 2/ Post harvest handling 3/ Type of gear used

4/ Marketing 5/ other (specify) ------

19. Did you need credit in 2018/19 related to your fish production? 1/ Yes 2/No

20. Did you get credit in 2018/19 related to your fish production? 1/ Yes 2/ No

21. If yes, how much did you get?_____Birr

22. For what purpose do you take credit? □

1/ To purchase a motorized boat 2/To purchase a reed boat 3/ To purchase gear

4/ To purchase food grain 5/ To pay tax 6/ other (specify)_____

23. From whom do you get credit? □ 1/ cooperative 2/ Trades 3/ Micro finance institutions

4 /NGO 5/ Agricultural Office 6/ ACSI 7/ Other (specify) ----------

24. Do you have access to water bodies/Lake for fish production? 1/ Yes 2/ No

25. If yes, ---------- catches per trip or per day----------

26. Fishing trips per year or per season----------

**VI. Production characteristics**

27. Production of fish and food in 2018/19

| No | Type of fish | Season/ month | Quantity Produced (Qt) | Quantity Consumed (kg) | Quantity lost (kg) | Quantity Sold (kg) | Selling Price(kg) |
|---|---|---|---|---|---|---|---|
| 1 | Nile Tilapia | | | | | | |
| 2 | African Catfish | | | | | | |
| 3 | Barbus | | | | | | |
| 4 | Common Carp | | | | | | |
| 5 | Nile Perch | | | | | | |
| 6 | Other specify_____ | | | | | | |
| Your common fish relative to level of cash income; (use code from fish type) | | | | 1/ Primary | | | |
| | | | | 2/ Secondary | | | |
| | | | | 3/ Tertiary | | | |

28. Average and value fish production seasons per year and marketable surplus last two to three years

| No | Fish | Average production seasons the year 2017 | | | | | | Average production seasons the year 2018 | | | | | | Production seasons the year 2019 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | NT | AC | B | CC | NP | Oth. | NT | AC | B | CC | NP | Oth. | NT | AC | B | CC | NP | Oth. |
| 1 | Total amount of Production in (Qt) | | | | | | | | | | | | | | | | | | |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | Average unit price per kg | | | | | | | | | | | | | | | | | | |
| 3 | Total sold value in Birr | | | | | | | | | | | | | | | | | | |

NT- Nile Tilapia; AC- African Catfish; B- Barbus (Labeobarbus); CC- Common Carp NP- Nile Perch; Oth.- Others

29. What are your materials/ input s for fish production & their sources?

| No | Type | 1/yes | 2/No | Source of input (use the code) | Amount use (Birr) | Value (in Birr) | 1=Cash 2=Credit 3=Replaced in kind |
|---|---|---|---|---|---|---|---|
| 1 | Moterized boat | | | | | | |
| 2 | Reed boat | | | | | | |
| 3 | Wooden boat | | | | | | |
| 3 | Gill net | | | | | | |
| 4 | Monofilament | | | | | | |
| 5 | Traps | | | | | | |
| 6 | Long line | | | | | | |
| 7 | Scoop net | | | | | | |
| 8 | Hooks | | | | | | |
| 9 | Other specify | | | | | | |

Source of materials 1/From market 2/ Bureau of Agriculture 3/ Cooperatives 4/ Own production/Purchase 5/ NGOs 6/ Through rent 8/ Other (specify) _____

30. What is the type of vessel used?

1/Motorized boat 2/ Reed boat 3/ Wooden boat 4/other specify_____

31. What is the type of gear used for fish production, and which types are productive?

1/Gillnet (8cm-12cm) 2/Monofilament (3cm-5cm) 3/Monofilament (8cm-12cm)

4/Hook 5/Traps 6/ Scoop net

7/Long line 8/other (specify) _____

32. In the above type of gear, which type is attractive attribute for market, please ranks it?

33. Are you involved in fishing activity 1/Yes 2/No

34. If yes ,by what type 1/employee 2/your own 3/Cooperative 4/others (specify) _____

35. Employee status 1/Full time 2/part time 3/Occasional 4/Seasonal 5/ other specify

36. When do you set the net and collect the fish?

1/4:00 -6:00 pm (afternoon) 2/Early morning (4:00-6:00 Am)

3/Morning 4/After harvesting set net

37. What are the most commonly harvested fish species/types?

1/Nile Tilapia 2/African Catfish 3/Barbus 4/ Common Carp 5/Perch 6/other (specify)__

38. What is the most popular fish among consumers/families?

1/Nile Tilapia 2/African Catfish 3/Barbus 4/Common Carp 5/ Perch 6/other (specify)___

39. Do you dried/preserve fish? 1/Yes 2/ No

40. If yes, how long did you dry it? _____ Days/months

41. How did you dry fish? □

1/ Placing in Sunlight 2/ Placing in Kote 3/Smoking

4/ Mix with salt and insert with sack 5/ Placing in rope with sun light 6/ other (specify)

42. If you dry, what is the motive behind drying? □

1/ Expecting high price 2/ Lack of market demand 3/ No alternative

4/ Weight for a long time 5/ Other (specify) _____

43. If you expected a better price, are you selling your fish product at the expected price?

1/ Yes 2/ No

44. Is there any change in the quantity (weight) and quality of the dry fish?

_____

45. What is your packaging material for your product?

1/Plastic sack 2/Basket 3/Sack 4/ Other (specify) _____

## V. Marketing characteristics

46. Supply of fish to the market and to market agents in 2018/19?

| No | Time of sale | Fish Species | Where did you sale Market (use the code below) | To whom did you sell? | Relationship (use code below) | Benefits of the relationship | % age share of buyers | Terms of sale<br>1= Cash<br>2= Credit<br>3= Partial payment and others on credit |
|---|---|---|---|---|---|---|---|---|
| 1 | Fresh whole fish | | | | | | | |
| 2 | After Gutted | | | | | | | |
| 3 | After filleted | | | | | | | |
| 4 | After dried | | | | | | | |
| 5 | Other specify | | | | | | | |

Fill the following available options into the above table provided spaces

| **Type** | **Where** | **To whom** | **Relationship** | **Advantages** |
|---|---|---|---|---|
| 1.NileTilapia<br>2.African Catfish<br>3.Barbus<br>4.Common Carp<br>5.Nile Perch<br>6. Others | 1.Village market<br>2.Cooperatives<br>3.Bahir Dar<br>4.Gonder<br>5. Hawassa<br>6. Arba Minch<br>7. Ziway<br>8. Addis Ababa<br>9.Hotel owners on a contract basis<br>10.Small fish cooking restaurants<br>11.Other (specify)____ | 1. Cooperatives<br>2.Hotel/Restaurant<br>3 .Direct to Consumer<br>4.FPME<br>5.Retailer<br>6.Wholesalers<br>7. Assemblers<br>8 .Other (specify)____ | 1. The same religion<br>2.The same origin<br>3. Meet socially<br>4. No relationship<br>5. Other (specify)____ | 1. Reduce transport cost<br>2 .Give high price<br>3 .Scaling fair<br>4. other (specify) |

Multiple answer is possible

47. On average how long does it take you to sell fish to different buyers? □

1/ < 1 hour 3/ 3-6 hours 5/ 9-12 hours

2/ 1-3 hour 4/ 6-9 hours 6/ Other (specify) _____

48. Do you face difficulty finding customers when you want to sell? 1/ Yes 2/ No

49. If yes, what is the reason? □

1/ Inaccessibility of market 2/low price offers 6/ Small size of the fish

3/ Lack of information 4/ Lack of transportation 5/ Low quality of your product

7/ other (specify) _____

50. What do you do when the fish you offered to the market is not sold? □

1/ Take back home 2/ Sell on anther market day 3/ Sell at a lower price 4/ Dampen or throw it

5/ Other (specify) _____

51. Who sets your selling price? □

1/ Yourself 2/ Buyers 3/ Cooperative 4/ Negotiations with buyers

5/ Determined by supply and demand6/ Other (specify)

52. What do you use to transport your fish from lake to market? □

1/ Head/back loading 2/ Animal's cart 3/Pack animals

4/ Bajaj or Car 5/ Other (Specify) _____

53. Do you know the nearby market price before you sold your fish? 1/ Yes 2/ No

54. How do you get information on supply, demand and price of fish before you sell your product?

| | Use code □ | Source of information |
|---|---|---|
| Supply | | 1. Other fish traders 7. News paper<br>2 .Radio and TV 8.No any option<br>3 .Telephone 9. Others<br>4 .personal observation 10.Best friends<br>5 .Cooperative<br>6 .Agricultural output case team |
| Demand | | |
| Price | | |

55. How do you qualify your source of information? □

1/ It was reliable, but it was not timely 2/ It was not reliable but timely

3/ It was reliable and timely 4/ It was not reliable and timely

5/Other (specify) _____

56. Whose information you primarily trust? □

1/ Other fish traders 2/ Radio and TV 3/ Telephone 4/ Agricultural output case team

5/ Cooperative 6/ News paper 7/ Best friends 8/ Other (specify) _____

57. Do you face problem of fish production and marketing? If yes what is the cause and your suggestions to solve the problems?

| No | Problem faced | Is there any problem? | | If yes what do you think was/ were the cause/s of this problem? | What is your suggestion to solve each problem? |
|---|---|---|---|---|---|
| | | 1/Yes | 2/No | | |
| 1 | Illegal fishing practice | | | | |
| 2 | Illegal fish trading | | | | |
| 3 | Market policy | | | | |
| 4 | Price setting | | | | |
| 5 | Price fluctuation | | | | |
| 6 | Credit service | | | | |
| 7 | Less competition b/n buyers | | | | |
| 8 | Infrastructure | | | | |
| 9 | Theft gear | | | | |
| 10 | Overexploitation | | | | |
| 11 | Standard grade and quality of fish | | | | |
| 12 | Extension service | | | | |
| 13 | Increase price of gillnet and material input | | | | |
| 14 | Transportation | | | | |
| 15 | Poor supply | | | | |
| 16 | Lack of storage facilities | | | | |
| 17 | Lack of appropriate fishing gears/technologies | | | | |
| 18 | Water level fluctuation | | | | |
| 19 | Distraction of fishing ground | | | | |
| 20 | Rise in fuel cost | | | | |
| 21 | Durability of the fishing boat | | | | |
| 22 | Lack of labor | | | | |
| 23 | Lack of processing facilities | | | | |
| 24 | Absence of licensing | | | | |
| 25 | Water hyacinth | | | | |
| 26 | Water pollution | | | | |
| 27 | Absence of government support | | | | |
| 28 | Other (specify) | | | | |

## Part II

### Retailers, Wholesalers, FPME, Cooperatives & Assemblers

Questionnaire number_____

Date: _____/_____/_____

**I. General information**

1. Name_____

2. Location _____

3. Established in_____year.

4. Experience in fish trading _____years

5. Distance from office to near by marketKm and____walking time in a single trip (minutes)

6. Major businesses in 2019. □

1. Wholesaler 2.Retailers 3.Processors 4.Rural Assemblers

5. Other specify_____

7. Total number of persons employed in your organization in 2019?

| Employee | Permanent | | | Temporary | | |
|---|---|---|---|---|---|---|
| | M | F | T | M | F | T |
| Members | | | | | | |
| Administration | | | | | | |
| Processing | | | | | | |
| Total | | | | | | |

8. Which fish species are you are using for trading? □

1/Nile Tilapia 2/African Catfish 3/Barbus 4/ Common Carp 5 /Perch

6/Any type Processed and packed 7/other specify

9. Where is your main market _____

10. How did you do your business in 2018/19?

1/ When purchasing price low high supply 2/during holidays only 3/ Market day only

4/ Year round 5/ other (specify)_____

**II. Capital**

**1. Financial capital**

11. What is the amount of initial working capital when you started this business (fish trading)? _____Birr

12. How much the amount of your working capital?_____Birr

13. What is the source of the working capital? □

1/ own 2/ Share 3/ loan 4/ gifts 5/ others (specify)

14. If it is loan, from whom did you borrow? □

1/ Relative/family 2/ NGO 3/ other traders 4 /Bank

5/ Friends 6/ micro finance institution 7/ other, (specify)_____

15. How much is the rate of interest? _____% Birr for formal _____ for informal

16. How is the repayment schedule? □

1/monthly 2/quarterly 3/ when we get money

4/ annually 5/ other (specify)_____

17. Is there any change in accessing finance for fish trade these days?

1/ improved 2/ deteriorated 3 / no change 4.Other (specify)_____

**2. Social capital**

18. How do you attract your supplier? □

1/ by giving better price 2/ by giving bonus 3/ by fair scaling (weighing)

4/ other (specify)_____

19. How do you attract your buyers? □

1/ By providing better price 2/By giving credit 3/ Quality of fish product 4/ By fair scaling (weighing) 5.Other (specify)_____

20. How many regular suppliers do you have? □

1/Fishers _____ 2/Other retailer_____ 3/ Cooperatives_____

4/ Other (specify)_____

21. How many regular buyers do you have? □

1/ Directly consumers_____ 3/ Other retailer_____

2/Hotel/Restaurant_____ 4/ Other (specify) _____

22. How do you treat your customaries? _____

23. How do you treat your employees? _____

**III. Purchase practice**

24. From which market and supplier do you buy fish?

| No | Purchased from sellers, | Purchased from Market (use code) | Relationship (use code) | %age share of the seller | Average quantity purchased per market in a day (Kg) | How many months did you operate in this market in 2019? | Average price for each species per kg | | | | | | Term of payment 1=cash 2= credit 3= partial payment and the remain on credit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | NT | AC | B | CC | NP | Others | |
| 1 | Fishers | | | | | | | | | | | | |
| 2 | Other retailers | | | | | | | | | | | | |
| 3 | Urban/rural assemblers | | | | | | | | | | | | |
| 4 | Retailers | | | | | | | | | | | | |
| 5 | Wholesalers | | | | | | | | | | | | |
| 6 | Cooperatives | | | | | | | | | | | | |
| 7 | Processors | | | | | | | | | | | | |
| 8 | Other (specify) | | | | | | | | | | | | |

**From sellersRelationship**NT= Tilapia

1. Village market 5. Arba Minch 1. The same religion AC= Catfish
2. Bahir Dar 6.Ziway 2. The same origin B=Barbus
3. Addis Ababa 7. Others (specify)_____3. Meet socially CC= Common Carp
4. Hawassa 4. Others (specify) _____ NP= Nile Perch

25. From which market(s) do you prefer to buy most of the time (2018/2019)?

Use from the above table.

26. Why do you prefer this/those market(s)? □

1/ Better quality 2/ High supply 3/ Shortest distance 4/ other specify_____

27. Who purchase fish for you? □

1/ yourself 2/ Family members 3/ Friends 4/ through broker 5/ other (specify) ___

28. If you used broker, what is the advantage of using brokers? □

1/ you could get buyers and sellers easily 3/ Brought many buyers and sellers

2/ Purchased at low price 4/Saved your time
5/ you could get quality fish type 6/ other (specify)_____

29. If you used a broker, what problems were created by them? □

1/ Lost the sellers & buyers to other trader(s) 5/ wrong price information

2/ cheating scaling (weighing) 6/ didn't buy enough quantity

3/ charged high brokerage 7/ other (specify)_____

4/ cheating quality

30. At what season is it preferable to purchase fish in terms of quantity? □

1/Summer 2/Winter 3/Spring 4/Autumen 5/ No classification

31. At what month is it preferable to purchase fish in terms of price? □

1/ September/October 2/ November/December 3/ January/ February 4/ March/ April

5/ May/ June 6/ July/August

30. Is your usual purchasing price higher than your competitors? 1/ Yes 2/ No

31. If yes, what is the reason? □

1/ To attract more suppliers 2/ To get better quality fish 3/To buy more quantity 4/ To kick out your competitor from the market 5/Other (specify) _

32. How much was the average purchasing price of fish species last year?

1/ Nile Tilapia (whole fish)____Birr/kg 2/ African Catfish_____ Birr/kg 3/Barbus_____ Birr/kg 4/Common Carp _____ Birr/kg 5/ Perch_____ birr /kg 6/ Others specify

33. Who set your purchasing price? □

1/ Yourself 2/ Other traders 3/ The seller 4/Negotiations 5/Other (specify) _____

34. Is there any grading system when you buy fish? 1/Yes 2/No

35. If yes, the grading system is based on: 1/ Size 2/Quality 3/Origin 4/ Other( Specify)_____

36. What is your packaging material for processed fish?

1/ Plastic sacks 2/ Sisal sack 3/Aluminum fall 4/ Other (specify)_____

37. When do you set purchasing price? □

1/ Early in the morning of the market day 2/ At midday of the market day

3/ At the time of purchase 4/Availability of the product

5/ Others (specify)_____

38. How many districts/areas/ do you cover in collecting fish?

1/ only within the same district 2/ additional districts/area 3/ all over the region

4/ beyond the region 5/other (specify)

| No | To whom did you sell □ | Where did you sell on Market Place (use code)? | Relationship (use code)□ | %age share of buyers | Average quantity sold per week in this the market | How many weeks did you operate in this markets? | Average price of fish species/kg | | | | | | Terms of sale 1=cash 2=credit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | NT | AC | B | CC | NP | Others | |
| 1 | Wholesalers | | | | | | | | | | | | |
| 2 | Retailers | | | | | | | | | | | | |
| 3 | Primary Cooperatives | | | | | | | | | | | | |
| 4 | Hotel/Restaurant | | | | | | | | | | | | |
| 5 | Consumers | | | | | | | | | | | | |
| 6 | FPME | | | | | | | | | | | | |
| 7 | Fish processors | | | | | | | | | | | | |
| 8 | Other (specify) | | | | | | | | | | | | |

**IV. Selling practices**

39. To which market and whom do you sell in 2019?

**Where Relationship**

1. Village market 6. Hawassa 1.the same religion NT= Nile Tilapia
2. Bahir Dar 7.Arba Minch 2.the same origin AC=African Catfish
3. Gondar 8. Ziway 3. Meet socially B= Barbus
4. Primary cooperative 9. Others (specify)___4. Other (specify) CC= Common Carp
5. Addis Ababa NP= Nile Perch

40. How much was the average selling price of fish species last year?

1/ Nile Tilapia (whole fish)_____Birr/kg 2/African Catfish_____ Birr/kg

3/Barbus_____ Birr/kg 4/ Dried African Cat fish_____ Birr/Kg

5/ Common Carp_____ Birr/Kg 6/Perch _____Birr/Kg 7/ Other specify_____

41. Do you have other branch shops to sell your fish? 1/yes 2/No

42. Who decided on your selling price 2018/19? □

1/ Yourself 2/negotiation 3/Purchaser 4/ By the market

5/ other traders 6/ Resource availability 7/Other (specify)_____

43. If you decide on the selling price, how do you set the price?

1/ Individually 2/ Consultation with other traders 3/ Other (specify)_____

44. What is the major problem with entering the fish trade? □

1/ License 2/no enough fish 3/ Lack of capital 4/Not a profitable business

5/ Government policy 6. Other (specify_____

**V. Marketing Services**

45. Do you store fish before selling it? 1/ Yes 2/ No

46. If yes, for how long do you store maximum? _____Days

47. How do you preserve your fish until they are sold out?

1/Ice 2/Freezer 3/Cold room 4/Nothing 5/ Other (specify)_____

48. If you put ice on your fish, is the price higher than the fish without ice?

1/ Yes 2/ No 3/ Not applicable

49. Indicate your average cost incurred per quintal in the trading process in 2018/19?

| No | Marketing cost components in the chain | Source (use code) | Source (use code) | Source (use code) |
|---|---|---|---|---|
| | | Birr/Qt | Birr/Qt | Birr/Qt |
| 1 | Packaging material | | | |
| 2 | Fill the plastic bag | | | |
| 3 | Load | | | |
| 4 | Maintenance of gear/vessel | | | |
| 5 | Transportation | | | |
| 6 | Fuel and oil costs | | | |
| 7 | Storage cost (rent) | | | |
| 8 | Electricity | | | |
| 9 | Water | | | |
| 10 | Telephone expense | | | |

| | | | | |
|---|---|---|---|---|
| 11 | Boat cost | | | |
| 12 | Personal travel and other expenses | | | |
| 13 | Others (specify) | | | |
| 14 | Total costs | | | |
| 15 | Selling quality fish per quintal | | | |
| 16 | Gross margin | | | |

**Source (<u>Purchased from):</u>**

1/ Wholesaler 4/ assembler 7/other specify_____

2/Retailers5/ Fishers (collector)

3/ Primary Cooperatives 6/ Fisher men

**VII. Information**

50. How did you get information on the supply, demand and price of fish in other markets?

| | Use code □ | Source of information: multiple answers are possible |
|---|---|---|
| Supply | | 1. Other fish traders 7. personal observation<br>2. Radio and TV 8. Broker<br>3. Agricultural output case team 9. Others (specify)<br>4. cooperatives<br>5. Telephone<br>6. news paper |
| Demand | | |
| Price | | |

51. Is there a transportation problem? 1. Yes 2. No

52. If yes, what is the problem? □

1/ No transportation service 2/It was seasonal 3/ No cooler trucks 4/Other (specify) _____

53. What mode of transportation do you use from collection point to store? □

1/ Head/back load 3/ Vehicle

2/ Pack animals 4/ Not necessary

5/ Carts 6/ Refrigerated trucks/cooler truck 7/ Other (specify) _____

54. What preservation modalities do your transport facilities have?

1/Chillers 2/ Freezers 3/Ice 4/No preservation at all 5/ Other (specify)_____

55. Do you follow any regulations for the transport of fish? 1/ Yes 2/ No

56. If yes. Which regulations and who formulated them?

_____

57. Do you have a storage facility to keep your fish? 1/Yes 2/No

58. If yes, what kind of storage facilities do you have?

_____

59. Do you know the hygiene regulations for fish? 1/ Yes 2/ No

60. If yes, which regulations do you know?

_____

61. Do you think you can improve the hygienic condition of your work? 1/Yes 2/No

62. If yes, in what ways can you improve it?

_____

**VIII. Linkage among traders and sub-sector outcomes**

63. What are the linkages between your trade enterprise and the following organizations?

| No | Organization | Did you have a relationship? | | Degree of linkage 1. Smooth. 2. Satisfactory 3. loose | Benefit (use code) | Benefit for your business on fish |
|---|---|---|---|---|---|---|
| | | 1. Yes | 2. No | | | |
| 1 | Ministry of Agriculture and Livestock | | | | | 1. Access to credit 2.You get financial support when you incur a loss. 3. Encourage people to save 4. Facilitate joint marketing 5. No benefit 6. Got market information 7. Coordinate purchase and sale 8. Protection against unfair competition 9. Credibility 10. To provide technical support 11. Other (specify |
| 2 | Bureau of Agriculture and Livestock | | | | | |
| 3 | FPME | | | | | |
| 4 | Bureau of Trade and Industry | | | | | |
| 5 | Wholesalers | | | | | |
| 6 | Retailers | | | | | |
| 7 | Cooperatives | | | | | |
| 8 | Importers and exporters | | | | | |
| 9 | Financing institutions | | | | | |
| 10 | Processors | | | | | |
| 11 | NGOs | | | | | |
| 12 | Other specify | | | | | |

64. With whom do you think is necessary to establish marketing cooperation? 

1/ with fishers
2/ with cooperatives
3/ with other fish trader
4/ with FPME
5/ with Consumers
6/ with financial institutions
7/ with governmental organization
8/ with Nongovernmental organization
9/ with Hotels/restaurant
10/ others (specify)

65. Are there problems or constraints on fish marketing? If yes, what are the problems, and what are your suggestions to overcome each problem?

| No | Problem | Are there problems? | | If yes, what do you think is the cause of problem? | What are your suggestions for solving each problem? |
|---|---|---|---|---|---|
| | | 1/ Yes | 2/ No | | |
| 1 | Infrastructure | | | | |
| 2 | Administrative measure (illegal trading and fishing ) | | | | |
| 3 | Shortage of supply | | | | |
| 4 | Storage problem | | | | |
| 5 | Fish quality/size | | | | |
| 6 | Price fluctuation of fish | | | | |
| 7 | Marketing policy | | | | |
| 8 | Information flow | | | | |
| 9 | Capital shortage | | | | |
| 10 | Access to credit | | | | |
| 11 | Technical training | | | | |
| 12 | Absence of government support | | | | |
| 13 | Lack of demand (low price) | | | | |
| 14 | Fishers reluctance to sell due to lower price | | | | |
| 15 | Transportation | | | | |
| 16 | Absence of effective transportation mechanism | | | | |
| 17 | Other (specify) | | | | |

66. If there are other constraints or problems

_____

67. Causes of the problem

_____

68. Suggested solutions

_____

**Part III**

**Hotels/Restaurants**

Questionnaire number_____

Date: _____/_____/_____

**I. General information**

1. Location _____

2. Name of Hotel/Restaurants _____

3. Established in_____year.

4. When have you begun fish trading for consumers _____years?

5. How long have you traded fish? _____ Years

6. Which fish species were handled (main species) and their quantity per day:

| Main Species | Quantity per day/kg | Origins of fish | % share |
|---|---|---|---|
| Nile Tilapia | | | |
| African Cat fish | | | |
| Barbus | | | |
| Common Carp | | | |
| Nile Perch | | | |
| Other specify | | | |

7. Which fish species do your customers most commonly prefer? 

1/Nile Tilapia 2/African Catfish 3/ Barbus 3 /Common Carp 4/Nile Perch 5/other specify

8. In what form do you get these products?

1/ Fresh 2/Frozen 3/Dried/ salted 4/ Dried without salt 5/ any type Smoked dried 6/ Gutted fish

9. How often do you purchase fish?

1/ Yearly 2/ Monthly 3/weekly 4/Daily 5/ Daily morning

6/ Daily afternoon 7/daily noon 8/every other day 9/ Wednesday and Friday

10. What kinds of storage facilities do you have in your storage facilities?

1/ Chillers 2/ Freezers 3/ Ice 4/No storage facilities at all 4/other specify _____

11. What are you going to do with the unsold fish? _____

12. How do you fix the number of fish you are going to buy daily or weekly? _____

13. How often does your family eat fish per week? _____

14. Over the past year, has there been a change in the price at which you buy fish? 1/Yes 2/No

15. If yes, what change? 1/Increased 2/Decrease 3/ not known 4/Other (specify) _____

16. Do you know any hygienic regulations about fish? 1/Yes 2/No

17. If yes, which regulations do you know? _____

18. Do you think you can improve the hygienic conditions of your work? 1/ Yes 2/No

19. If yes, in what ways can you improve it? _____

20. Fish product type in 2018/19?

| No | Type of fish product | | Season (month) | Average quantity traded/kg | Buying price/kg | Selling price /kg |
|---|---|---|---|---|---|---|
| 1 | Nile Tilapia | Fresh whole fish | | | | |
| | | Gutted | | | | |
| | | Dried | | | | |
| | | Filleted | | | | |
| | | Canned fish products | | | | |
| 2 | African Catfish | Fresh whole fish | | | | |
| | | Gutted | | | | |
| | | Dried | | | | |
| | | Filleted | | | | |
| | | Canned fish products | | | | |
| 3 | Barbus | Fresh whole fish | | | | |
| | | Gutted | | | | |
| | | Dried | | | | |
| | | Filleted | | | | |
| | | Canned fish products | | | | |
| 4 | Common Carp | Fresh whole fish | | | | |
| | | Gutted | | | | |
| | | Dried | | | | |
| | | Filleted | | | | |
| | | Canned fish products | | | | |
| 5 | Perch | Fresh whole fish | | | | |
| | | Gutted | | | | |
| | | Dried | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | Filleted | | | | |
| | | Canned fish products | | | | |
| | Your common fish, relative to the level of cash, prefers using the code for the fish product type. | | | | 1-Primery | |
| | | | | | 2-Secondary | |
| | | | | | 3-Teritary | |

## II. Purchase practice

| No. | To whom did you purchase | Where market place Purchase, (use code) | Relationship (use code) | %age share of the seller | Average quantity purchased per market in a week (kg) | Average price per kg | | | | | | Term of payment 1= cash 2= credit 3= partial payment and the remain on credit |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | NT | AC | B | CC | NP | Others | |
| 1 | Fishers | | | | | | | | | | | |
| 2 | Cooperatives | | | | | | | | | | | |
| 3 | Wholesalers | | | | | | | | | | | |
| 4 | Retailers | | | | | | | | | | | |
| 5 | FPME | | | | | | | | | | | |
| 6 | Local assemblers | | | | | | | | | | | |
| 7 | Fish processors | | | | | | | | | | | |
| 8 | Other (specify) | | | | | | | | | | | |

21. From which market and supplier did you buy fish in 2019?

**Where Relationship**

1. Village market
2. Bihar Dar shop
3. Gondar
4. Primary cooperative office
5. Arba Minch
6. Hawassa

1. the same religion
2. the same tawn
3. Cooperative members only
4. Meet socially
5. Other (specify)

NT- Nile Tilapia
AC- African Catfish
B-Barbus
CC- Common Carp
N P- NilePerch

22. To whom do you prefer to purchase fish from the above table most of the time? List Order

23. Why did you prefer this/that market(s)? 

1/Better quality 2/high supply 3/shortest distance 4/other specify_____

24. In what season was it preferable to purchase fish in terms of quantity?

1/ September/October 2/ November/December 3/ January/ February

4/ March/ April 5/ May/ June 6/ July/August

25. In what month was it preferable to purchase fish in terms of price?

_____

| No | To whom did you sell buyers | Where did you sale Market (use code) | Relationship (use code) | %age share of buyers | Average quantity fish sold per day/kg | Average price | | | | | | Terms of sell 1=cash 2=credit 3=advance receive |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | NT | AC | B | CC | NP | Others | |
| 1 | Tawn Residents | | | | | | | | | | | |
| 2 | Guest (Ethiopian) | | | | | | | | | | | |
| 3 | Guest(foreigners) | | | | | | | | | | | |
| 4 | Other (specify)___ | | | | | | | | | | | |

**III. Selling practices**

26 .To which market and to whom do you sell?

**Where Relationship**

1. Hotel 1. The same religion NT- Nile Tilapia
2. Restaurants 2. The same taw AC- African Catfish
3. Moveable shop 3. Cooperative member B-Barbus
4. Village market 4. Meet socially CC- Common Carp
5. Others (specify)___ 5. Other (specify) NP- Perch

27. Did you have other branch Hotel/Restaurant to sell your fish food? 1/ Yes 2/ No

28. Who decided on your selling price 2019?

1/Owners 2/By the market 3/ Consumers 4/ other hotel/restaurant

5/Negotiation 6/Government 7/other specify_____

29. If you decided on the selling price, how did you set the price?

1/Individually 2/Consult with other hotels/restaurants

3/ Depend on the government 4/Other specify_____

30. Approximately how many consumers do you sell to per day you operate?

_____

**IV. Information**

31. How do you get information on supply, demand & price of fish in other markets?

| | Use code □ | Source of information multiple answer is possible) |
|---|---|---|
| Supply | | 1. Other hotel/restaurants 4. Radio and TV<br>2. Other fish traders 5. News paper<br>3. Personal observation 6. Telephone<br>7.FMPE and cooperatives<br>8 Others specify |
| Demand | | |
| Price | | |

**V. Linkage among traders and sub sector outcomes**

32. What are the linkages between the following organizations (service business)?

| No | Organization | Did you have relation? | | Degree of linkage<br>1. Smooth.<br>2 Satisfactory<br>3. loose | Benefit (use code) □ | Benefit for your business on fish |
|---|---|---|---|---|---|---|
| | | 1/Yes | 2/ No | | | |
| 1 | Cooperative | | | | | 1. You got financial support when you incur a loss<br>2. facilitate joint marketing<br>3. no benefit<br>4. Got market information<br>5.Coordinate purchase and sale<br>6. Protection against unfair competition<br>7. Other (specify |
| 2 | Wholesalers | | | | | |
| 3 | FMPE | | | | | |
| 4 | Bureau of trade and industry | | | | | |
| 5 | Financing institutions | | | | | |
| 6 | Others (specify) | | | | | |

33. If there are other constraints or problems_____

34. Causes of the problem_____

35. Suggestion solutions_____

**Part IV**

**Consumers**

Questionnaire number_____

Location :_____

Date_____/_____/_____

**I. Personal information**

1. Name _____Age _____years

2. Sex 1/ Male 2/ Female

3. Religion 1/ Orthodox Christian 2 /Muslim3 /Protestant 4/Catholic 5 / Other (specify) _____

4. Marital status 1/ Single 2/ Married 3/ Separated 4/ other specify----------

5. Education level 1/ Illiterate 2/ Read and write 3/ First cycle (1-4 grades)

4/ Second cycle (5-8 grades) 5/ High schools (9-10 grades) 6/ Preparatory school (11-12)

7/ Diploma and above 8/Degree and above 9/ others (specify) _____

6. What is your work? 1/ Farming 2/Trading 3/ Salary employee 4/other specify

7. Do you eat fish? 1/Yes 2/No

8. If No, why _____

9. How is the fish supply in the market? 1/ Sufficient 2/ Not sufficient 3/ Over supply

**II. General information**

10. Which fish species are most supplied in the market? □

1/ Nile Tilapia 2/ African Catfish 3/ Barbus

4/ Common carp 5/You do not know 6/ other specify

11. Which fish species do you most commonly preferred why and what form? □

1/Nile tilapia 2/African catfish 3/Barbus

4/Common Carp 5/Any type processed and packed fish 6/other specify

12. How often does your family eat fish per week? _____

13. Over the past year, has there been change in price?

1/ Yes 2/No

14. If yes, what change? 1/Increased 2/Decreased (what is the reason)

_____

15. What is your perception of fish quality in the market?

1/Good 2/ Acceptable 3/ Not good

16. Are you concerned about the health hazards of contaminated fish in the market?

1/ Yes 2/No

17. Fish type and food market?

| No | Type of fish product | | Average quantity Buying/kg | Buying price/kg | Where do you buy? |
|---|---|---|---|---|---|
| 1 | Nile Tilapia | Fresh whole fish | | | |
| | | Gutted | | | |
| | | Dried | | | |
| | | Filleted | | | |
| | | Canned fish products | | | |
| 2 | African Catfish | Fresh whole fish | | | |
| | | Gutted | | | |
| | | Dried | | | |
| | | Filleted | | | |
| | | Canned fish products | | | |
| 3 | Barbus | Fresh whole fish | | | |
| | | Gutted | | | |
| | | Dried | | | |
| | | Filleted | | | |
| | | Canned fish products | | | |
| 4 | Common Carp | Fresh whole fish | | | |
| | | Gutted | | | |
| | | Dried | | | |
| | | Filleted | | | |
| | | Canned fish products | | | |
| 5 | Nile Perch | Fresh whole fish | | | |
| | | Gutted | | | |
| | | Dried | | | |
| | | Filleted | | | |
| | | Canned fish products | | | |
| | 1-Primery | | | | |
| | 2-Secondary | | | | |
| | 3-Teritary | | | | |

**IV Purchase practices**16.

| No | To whom did you purchase □ | Where do you purchase Market (use code) □ | Relationship (use code)□ | %age share of sellers | Average quantity (kg) bought per week | Terms of sell 1=cash 2=credit □ |
|---|---|---|---|---|---|---|
| 1 | Hotel/restaurants | | | | | |
| 2 | Fishers | | | | | |
| 3 | Cooperatives | | | | | |
| 4 | Wholesalers | | | | | |
| 5 | Retailers | | | | | |
| 6 | FPME | | | | | |
| 7 | Assemblers | | | | | |
| 8 | Fish processors | | | | | |
| 9 | Road side fish cookers | | | | | |
| 10 | Other (specify) | | | | | |

18. From which market and supplier do you buy fish in 2019?

**Where Relationship**

1. Hotel/ restaurants
2. Cooperatives
3. Bahir Dar
4. Village market
5. Hawassa
6. ArbaMinch
7. Ziway

1. The same religion
2. The same ethnic
3. Cooperative members
4. Meet socially
5. Other (specify)

8.Others(specify)_____

17. To whom prefer to purchase fish in the above table? List in order

18. How often do you buy fish for home use?

1/ Daily 2/ More than twice a week 3/ Every week 4/ Every month 5/Occasionally

19. How is fish prepared at home? _____

20. How often do you eat fish at restaurants?

1/ Daily 2/More than once a week 3/Once a week 4/rarely

21. How do you like your fish to be prepared if you eat at a restaurant? _____

22. Can you identify or detect good quality fish in the market? 1/Yes 2/No

23. How do you decide on the quality of the fish you buy?

1/ By the color of the gills 2/By the smell of the fish 3/By the color of the eyes

4/Firmness of the meat or texture 5/ All of the above

24. How do you suggest price trend of fish from year to year?

_____

25. Are there problems (constraints) on fish food marketing? If yes, what are the problems?

_____

26. Cause of the problem

_____

27. Suggestions to overcome/solution each problem?

_____

## Part V

## Institutions

Questionnaire number_____

Name ofinstitution/organization_____

Location _____

Date_____/_____/_____

1. What are the most available fish species on the market? Please write the most available first and the least available last.
   a. _____
   b. _____
   c. _____
   d. _____
   e. _____
2. Which is the most expensive fish from the list in Question No. 1? Please write the most expensive first and the least expensive last.

   a. _____
   b. _____
   c. _____
   d. _____
   e. _____
3. What is the role of your institution in enhancing fish trade and marketing?

   _____
   _____
4. What are the main issues that affect the domestic fish market?
   1/Supply 2/ Price 3/ Quality 4/ Lack of facilities and infrastructures 5/ Lack of consumer demand 6/Seasonality of consumption 7/Lack of capacity 8/others specify
5. How do you link fisheries with research centers and NGOs?
   _____
   _____
6. What is the major market channel in the area?
   _____
   _____
7. Do you have fishery specialists in districts with a considerable budget and attention to the extension service?
   _____
   _____
8. What do you think of the steps taken to enforce the country's fishing regulations?
   _____
   _____

9. What do you think of the enforcement of quality control measures in your country?

_____
_____

10. Do you have consideration for fisheries in the planned and started development projects of the government?

_____
_____

10. Do you have credit facilities to purchase fishing and storage facilities for fishers and fish traders?

_____
_____

11. Do you have appropriate fishery management regulations in place? If Yes
What kinds of management measures are implemented in the country?

_____
_____

12. What are the control mechanisms for illegal fishing practices and illegal trading?

_____
_____

13. Are there problems (constraints) in fish Production and marketing? If yes, what are the problems?

_____
_____

14. Cause of the problem?

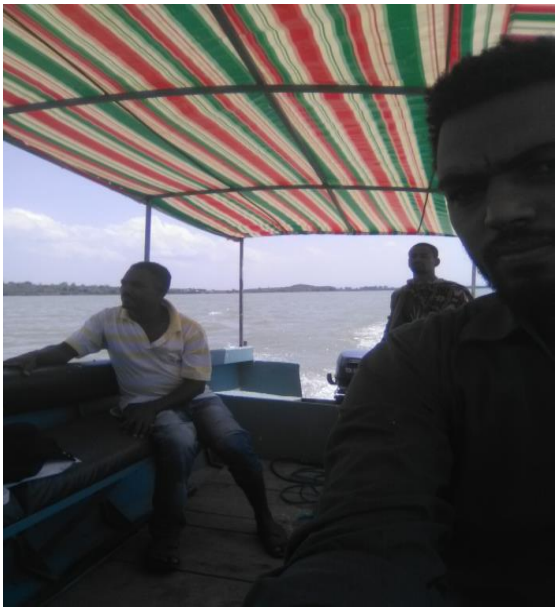
_____
_____

15. Suggestions to overcome or solve the problem

_____
_____

**Thank you!**






Appendix: II. Local fish market and fillating of fish at Lake Tana




Appendix: III. Harvested, Filleting and marketing of fish at Lake Ziway

Appendix: IV. Filleting and marketing of fish at Lake Hawassa






Appendix: V. Filleting and marketing of fish at Lake Chamo