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# Value Chain Analysis of Fish Production and Marketing From Lake Tana, Northwestern Ethiopia

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# BAHIR DAR UNIVERSITY

# COLLEGE OF AGRICULTURE AND ENVIRONMENAL SCIENCES

## DEPARTMENT OF RURAL DEVELOPMENT AND AGRICULTURAL EXTENSION GRADUATE PROGRAM

## VALUE CHAIN ANALYSIS OF FISH PRODUCTION AND MARKETING FROM LAKE TANA, NORTHWESTERN ETHIOPIA

**MSc. Thesis**

**By**

**Tigist Genanew Sinishaw**

**December, 2023**

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**THESIS SUBMITTED IN PARTIAL FULLFILMENTOF THE REQUIRMENTS FOR THE DEGREE OF MASTER OF SCIENCE (MSc.) IN RURAL DEVELOPMENT MANAGEMENT**

**MAJOR ADVISOR: AZANAW ABEBE (Associate professor)**

**December, 2023**

**Bahir Dar**

**BAHIR DAR UNIVERSITY**

**COLLEGE OF AGRICULTURE AND ENVIRONMENAL SCIENCES**

**DEPARTMENT OF RURAL DEVELOPMENT AND AGRICULTURAL EXTENSION**

## Approval of Thesis for Defense Result

As a member of the Board of Examiners of the Master of Science (MSc.) thesis open defense examination, we certify that we have read and evaluated this thesis prepared by **Tigist Genanew Sinishaw** entitled **Value Chain Analysis of Fish Production and Marketing from Lake Tana, Northwestern Ethiopia**. We hereby certify that the thesis is accepted for fulfilling the requirements for the award of the degree of Master of Sciences (MSc.) in **Rural Development Management.**

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## DECLARATION

This is to certify that this thesis entitled "**Value Chain Analysis of Fish Production and Marketing from Lake Tana, Northwestern Ethiopia**" submitted in partial fulfillment of the requirements for the award of the degree of Master of Science in "**Rural Development Management**" to the Graduate Program of College of Agriculture and Environmental Sciences, Bahir Dar University by **Tigist Genanew Sinishaw** (ID. No. BDU 1300345) is an authentic work carried out by her under our guidance. The matter embodied in this project work has not been submitted earlier for an award of any degree or diploma to the best of our knowledge and belief.

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# DEDICATION

I dedicate this thesis to my mother and the "*Negede Woito*" Ethnic group who primarily start fish consumption as a source of animal protein around Lake Tana several years ago and transferred the experience to the current fish consumers.

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## ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| **ETB** | Ethiopian ETB |
| **FAO** | Food and Agriculture Organization of the United Nations |
| **FDRE** | Federal Democratic Republic of Ethiopia |
| **FGD** | Focus Group Discussion |
| **GDP** | Gross Domestic Product |
| **GPN** | Gross Production Network |
| **LR** | Likelihood Ration |
| **MoFED** | Ministry of Finance and Economic Development |
| **MLRM** | Multiple Linear Regression Model |
| **MVN** | Multivariate Normal Distribution |
| **MVP** | Multivariate Probit |
| **NGO** | Non-Governmental Organization |
| **OLS** | Ordinary Least Square |
| **PDC** | Planning and Development Commission |
| **RMA** | Rapid Market Appraisal |
| **SML** | Simulated Maximum Likelihood |
| **TLU** | Tropical Livestock Unit |
| **UNIDO** | United Nations Industrial Development Organization |
| **VIF** | Variance Inflation Factor |
| **VA** | Value Addition |
| **VCA** | Value Chain Analysis |

# Value Chain Analysis of Fish Production and Marketing from Lake Tana, Northwestern Ethiopia

## ABSTRACT

*Fisheries are one of the renewable resources that play a significant role on the livelihood of many rural and urban communities. Despite these, the sector is yet underdeveloped in Ethiopia and* the fish value chain was not well addressed in Lake Tana. *This study was carried out in Lake Tana during the 2022 season with four objectives: (1) to map the fish value chain, (2) identify actors and their roles, (3) to analyze the market margin of the actors along the fish value chain, (4) to identify factors that affect the quantity of fish market supply, and (5) to determine the factors affecting value addition participation and intensity. A three stage sampling procedure was adopted to randomly select the respondents from fishermen, fish traders, hotel and restaurant and consumers. The primary quantitative data were collected from 226 fishermen and 34 from traders, hotel and restaurants, and consumers. Descriptive statistics and econometric models, such as multiple linear regression with ordinary least square (OLS), double hurdle (DH), and multivariate probit models were employed for data analysis. The results reveal that input supplier, fishermen, wholesalers, retailers, collectors, cooperatives, vendors, hotels and restaurants, and consumers were the primary actors along the fish value chain. In all cases, hotels and restaurants followed by wholesalers have received the highest profit margin. The OLS result showed that education level, fishing experience, training, and market information have positive influence on fish market supply. On the other hand, farm land, engagement in fishing activity, boat type, market place problem, cold storage problem, and price fluctuation influenced the fish market supply negatively. According to the DH model result, boat type, fish catch/day and fishing experience found to have a positive and significant influence on the intensity of value addition. Whereas, total farm land, cold storage problem and labor cost affect the intensity of value addition negatively. The result of multivariate probit model indicated that education level, total farm land, boat type, engagement in fishing activities, market information, fish catch/day, and distance from landing site to main fish market significantly affected the fish market outlet of the fishermen. All these, suggest that fishery sector have several bottlenecks which needs intervention to better utilize the resources in the future.*

**Key words:** Fishery, Lake Tana, Value chain, Ordinary least square, Profit margin

# Chapter 1. INTRODUCTION

## 1.1. Background and Justification

Agriculture continues to be the backbone of the Ethiopian economy where nearly 85% of the population have engaged and contributing 45% of the GDP and over 90% of the foreign exchange (Welteji, 2018; MoFED, 2003). However, the sector is largely characterized by semi-subsistent with low income and hand to mouth livelihood. With this scenario, however, feeding the ever increasing population of the country will not be easy. Therefore, to make our food system and economy more resilient, it will be wise to consider unexploited sub-sectors of agriculture such as the fisheries. As a result, Ethiopian Ministry of Agriculture considers the fishery sub-sector as one of the potential interventions that could improve the livelihoods of the rural and urban communities through enhancing food and nutrition security, employment, and provide alternative income. Thus, the fisheries proclamation was ratified since 2009 referred to as "Fisheries Development and Utilization Proclamation No. 315/2003" with the objectives of increasing the supply of safe and good quality fish and ensure a sustainable contribution of the sector to food and nutrition security while conserving the fish biodiversity, its environment, and preventing overexploitation of the resource (FDRE, 2010).

Fisheries are considered as one of the renewable natural resource on which the livelihood of many rural and urban communities relies (Awel, 2018).The sector plays an important role for food and nutrition security, source of income and social development around the world particularly in developing countries (Hossain, 2014). Fish is an important food item as source of cheap and quality protein and fatty-acids such as Omega-3 for child mental development in marginal people of developing countries including Ethiopia (Lenihan-Geels *et al.*, 2013; Prasad *et al.*, 2021; Tuluka *et al.*, 2021). The fatty acid content of fish is highly polyunsaturated, thus could play an important role in reducing blood cholesterol. Reports indicated that fish fatty acids provide protection against renal disease (Prasad *et al.*, 2021). Fish is also considered as the main sources of minerals such as calcium, iron, zinc, and phosphorus (Maire *et al.*, 2021; Bogard *et al.*, 2015).

More than 60 million people in the developing countries rely on freshwater fisheries for their livelihood (Abobi and Wolff, 2020). These low-income countries produce nearly 16.6 million tons of fish a year, accounting 20% of the total global fish production and 80% of inland fisheries capture (FAO, 2020). It is also clearly reported that about 116 million people in the developing world are benefited from the fishery sector. About 90% of them are artisanal fishers predominantly subsistence fishing conducted with traditional boats such as papyrus reed boats in the case of Ethiopia (Tewabe, 2015).

The fishery sector comprises two major components, the marine and inland sectors (Failler *et al.*, 2014). The marine sector consists of the sea and the lagoons. It is further categorized into small-scale or artisanal, semi-industrial or inshore, deep sea and the tuna sector. The inland sectors also consist of the lakes, rivers and reservoirs. It is mostly practiced on a small-scale/artisanal basis. In addition, aquaculture, mostly practiced in small artificial ponds can be considered as the third component of the sector. Historically, Africa's fisheries output is dominated by capture fisheries and 25% of it is inland captures. Some African countries are endowed with marine fisheries. However, countries like Ethiopia lack that access. Fortunately, the country has vast water resource and commonly known as, water tower of east Africa and has a number of lakes, rivers, reservoirs, wetlands, springs and untouched underground water. Thus, fishery in Ethiopia comes exclusively from inland sources which has approximately 13,637 $Km^2$ surface area of major lakes, reservoirs with floodplains and 8,065 Km long river networks (Tesfaye and Matthias, 2014; Bezabeh, 2021).Since most inland fish production goes for subsistence or local consumption, inland fisheries are particularly important for food security of low-income communities in Ethiopia (Tesfaye and Matthias, 2014).

The total global fish production is estimated to be about 212.8 million tones and an estimated annual supply of 20.5 Kg per capital as of 2020 (FAO, 2022). This had an estimated total first sale value of 401 billion USD. China, Indonesia, Peru, Russia, USA, India, and Japan are the seven leading capture fish producers accounting 50% of the world production. China (15%), Indonesia, (8%), Peru,(7%), Russia,(6%), USA (5%), India, (5%), and Japan (4%) (FAO, 2022). China is the leading fish producing country in the world with annual production of 11.8 million tons only from capture fishery (FAO, 2022). Uganda, Tanzania, Nigeria, Egypt and Congo are the five leading fish producing African countries from capture fishery (FAO, 2022). Uganda is the leading fish producer among the African countries with

annual production of 600,000 tones. Although Ethiopia is a land-locked country since the secession of Eritrea in 1993, fish production potential of the country from the inland water bodies is estimated to be 94,500 tons per year (Tesfaye and Matthias, 2014). However, this estimation did not include Hidassie, Gibe-III and other recently constructed dams. Thus the current estimation of fish production potential of the country reached 110,000 tons per year (Gashaw Tesfaye *et al*., 2023, unpublished document). However, the actual capture is about 59,200 tons per year (FAO, 2022). The fishery potential of Lake Tana is estimated to 15,159 tons per annum while the actual production is about 7,357 tons (Tewabe, 2015; Tesfaye and Matthias, 2014).

Fish is a well-known source of protein and micronutrients in the diets of millions of people around the world; however, it is consumed in Ethiopia at a lower rate. Ethiopia has a national per capital consumption of less than 1 Kg, which is less than the neighboring countries such as Kenya 4 Kg, Tanzania 8.5 Kg, and Uganda 10 Kg (FAO, 2022).

Lake Tana, found in Amhara Region, is the largest lake in Ethiopia (3,050 $Km^2$) which covers half of the freshwater resource of the country (Vijverberg *et al.*, 2009). The fish in Lake Tana showcase contains an impressive diversity and uniqueness of species (Dejen *et al.*, 2017). The lake is home to the world's unique flock of large cyprinids. Of the 27 known species, approximately 68% are unique to the lake. Most of the habitats with fish diversity in the lake are relatively intact, and are still attractive in nature. The Lake provides commercially important three delicious fish species. Namely, African Cat fish (*Clariusgariepinus*) locally called "Ambaza", Nile tilapia (*Oreochromisniloticus*), locally called "Kereso" and *Labeobarbus* spp., locally called "Nech Asa"**.** It is therefore one of the largest fishing sites in the region and the country which is almost dominated by artisanal fishery: a traditional fishery involving fishing households with relatively small amount of capital and energy, making short fishing trips, close to shore, mainly for local consumption. Fishing in Lake Tana had started earlier than rift valley lakes some 80 years ago by "*Negede-Woito*" ethnic group who were feeding themselves from fishing (Wudneh, 1998). This scenario has changed and it is contributing as fish source for local and the country at large. This lake and adjacent wetlands provide directly and indirectly a livelihood for more than 500,000 people (Vijverberg *et al.*, 2009).

Although there are some good progresses in Lake Fishery development, it is facing critical

problems in siltation due to land degradation, invasive aquatic weeds, illegal fishing, post-harvest handling and processing, and low selling prices (Gebremedhin *et al.*, 2018). According to Cheffo *et al.* (2021) poor fishing net, poor boat service, over fishing and low price were found to be the fish production constraints along the value chain. Some ten years ago, the whole fish price at landing sites ranged from 20 - 25 ETB per kilogram for Tilapia and Barbus (Cheffo *et al.*, 2021) has increased to 80-150 ETB due to increased local consumption. Specialized restaurants on fish have been increasing due to the increased fresh fish consumption around the Lake escalating the price which might change the whole value chain of the fishery sector.

The ultimate objective of the value chain is to produce a value-added product for a market (Trienekens, 2011). The value chain is so important in this era of rapid globalization mainly for three reasons. In the first case, systemic competitiveness has become highly important. Penetrating the global markets by enhancing the efficiency of production which allows sustainable income growth requires an understanding of the dynamic factors along the whole value chain (Kaplinsky and Morris, 2001). Value chain analysis is generally crucial to enhance the efficiency of actors involved in the value chain (Gereffi and Fernandez-Stark, 2011). Thus, fish value chain concept is very important in proper utilization of the fishery resource as well as in maximizing the profitability of the sector. However, such issues have not been well studied and documented in the study area. That is why this study was initiated to fill the knowledge gaps on the determinant factors affecting fish market supply, value addition and their market outlet choices as well as profit margins of all actors and their roles along the fish value chain in Lake Tana. This essential information of value chain of fish and fishery products of Lake Tana are either limited or not comprehensive.

### 1.2. Statement of the Problem

Despite its enormous potential to contribute to food self-sufficiency as a source of healthy animal protein, job creation, income generation, and foreign currency generation, Ethiopian inland fisheries are now predicted to produce 94,500 tons per year (Tesfaye and Matthias, 2014). According to report of Dejen *et al.* (2017) the rate of capture fish is decreasing, while the rate of consumption is increasing, resulting in a demand-supply imbalance.

In Ethiopia most researches and literature in the past focused on fish diversity, limnology (water quality), production, aquatic weed, socio economic importance, and some on marketing. Studies conducted related to fish value chain are scarce and shallow. The study conducted in Lake Hawassa, revealed the determinants of Fish Market Supply (Tuluka, 2019). However, this study focused only on the determinant factors of fish market supply by using multiple linear regression model. Other study by Kamaylo *et al.* (2021) in Gamo zone, Ethiopia focused on fish value chain actors and their market profit share. A study on value chain analysis of fish production and marketing is also conducted in Lake Tana by Cheffo *et al.* (2021). However, the study emphasized on the socio economic characteristics of the fishermen and fish traders. The value chain actors, the determinants of fish supply to the market, factors affecting value addition participation and intensity, the market margin and the market outlet choices were not addressed in the study. On top of that, the study was conducted with only 91 sample respondents in 4 Kebeles which might not represent the whole Lake Tana districts.

At present, however, there is an increase in fish demand due to the rapid population growth with high perception coupled with growing middle income earning Ethiopians. In spite of increasing demand, past studies on the fishery sub-sector indicated that less research has been done on fish value chain in Ethiopia in general and Lake Tana in particular. This indicates that there is inadequate information about the series of activities involved in production through consumption of the fish. There is also little knowledge about the various actors, their functions and existing linkages. The various values added by actors, their cost and returns and the various determinants are not properly defined. This could hinder the ability of policy makers to design and implement beneficial policies and enhance the efficiency of the operations along the fish value chain. In addition, knowledge about the series of activities within the fish value chain would enable the policy makers design valuable market policies and strategies for fish production and trade that can significantly develop and sustain the fisheries sector and lead to higher earnings for value chain actors and the country at large (FAO, 2022). There is, therefore, the needs to ascertain who the players (actors) involved in the fish value chain are and assess how these players interact and benefit along the chain. In addition, the players in the value chain likely to face various challenges, thus the need to pinpoint those determinants in the value chain is paramount important for appropriate management options.

## 1.3. Objective of the Study

The general objective of the study is to assess the fish value chain in Lake Tana, Ethiopia.

**The specific Objectives are:**

1. To map the fish value chain in Lake Tana
2. To identify the actors and their roles in the fish value chain of Lake Tana
3. To analyze marketing margin of actors in the fish value chain
4. To identify the factors that affect fish market supply of the fishers
5. To determine factors affecting fish value addition and their intensity

## 1.4. Research Questions

1. What are the profiles of the main actors and their existing linkages in the fishery value chain in Lake Tana?
2. What are the factors that affect fish production and marketing in this study area?
3. Who is benefited more in the value chain? What is the profit share of each actor in the value chain?
4. What influences fish producers from adding value to fish before providing to the buyers?

## 1.5. Significances of the Study

The identified linkages among the various actors in the value chain would help to understand how actors relate and coordinate activities among each other; hence mapping the power relationship among them. These would inform policy makers how to communicate and implement policies for the sector. Information and knowledge on profitability and determinants of profit for the various actors along the value chain in this study is going to serve as a means of increasing the social welfare gain alongside reducing the cost of production while increasing revenue since actors would now be aware of what affects their profits in the business. It is obvious that increased production without corresponding well-developed and efficient analysis of the value chain may result in wastage of resources. Similarly, knowledge on the distribution of profits along the value chain would attract new

investors to the sector, thereby increasing production to bridge the gap between fish demand and supply in the country. The result from this study would bring to light the constraints and challenges facing the various activities along the value chain and thereby provide a detailed understanding of how to expand the fishery business. It would also inform the policy makers about the new challenges facing the sector, and hence devise appropriate mitigating strategies.

### 1.6. Scope and Limitation of the Study

This study focused on fish value chain from input suppliers to end-users in Lake Tana fishery. In this study important information was collected from fishery cooperatives, fishermen, fish processors, fish traders and other value chain actors involved in the study area. The study addressed the matter with appropriate representation of administrative units and respondents. Due to budget and time constraints however fish product destination such as Dessie, Addis Ababa and Metema were not addressed.

### 1.7. Operational Definition of Terms

**Capture Fishery**– a method of harvesting fish directly from the natural resources such as fresh water and marine environments.

**Aquaculture-** a method of fish farming that involves breeding, rearing and harvesting of fish through the use of cages, ponds, tanks and integrated systems.

**Cage Culture**- a method of aquaculture production system in which fish is held in floating net pens.

**Pond Farming**- an artificial shallow structure filled with water that is used for fish farming.

**Tank Farming**- a method of aqua farming where a tank, bowl or pool is filled with water for breeding and harvesting of fish.

**Fish production**- this generally refers to the farming of fish for commercial purposes.

**Fish landing site-** a place at which fishing or transport vessels discharge a catch of fish to; a location where fishers can sell their catch and obtain supplies such as food, fuel and ice.

# Chapter 2. LITERATURE REVIEW

## 2.1. Definitions in the Value Chain

**Value chain**: The value chain is a concept from business management that was first described and popularized by Michael Porter (Porter, 1985) in his book, Competitive Advantage: Creating and Sustaining Superior Performance as outlined in authors bibliographical review by Kurt Ernst Weil in 1985. The term value chain refers to the full life cycle of a product or process including material sourcing, production, consumption and disposal/recycling processes (WBCSD, 2011). It includes the various value adding activities that firms and workers carryout to bring a product or service from conception and row material sourcing through different phases of production or processing, delivery to consumers, and disposal/recycling (Ponte *et al.*, 2014; Kaplinsky and Morris, 2001). A value chain is the set of input activities that a company carries out in order to create value for its customers (Porter, 1985). The value chain of a product needs coordinated and collaborated system, where separated companies of entities work together for a shared purpose, working or acting together towards a common goal (Moharana *et al.*, 2012). Value chains are generally concerned with what the market will pay for a good or service with the new values added on it. The value chain in the fisheries sub-sector can be defined as the movement of fish from the landing sites along the supply chain to the final consumers taking the whole range of activities into consideration and the subsequent value addition undertaken by different actors at various levels of the chain to maximize the profit from their operation (Kulmiyei, 2010).

**Value-addition**: Value addition is a measure of the value created in the economy and it implies both value creation and value capture (Zamora, 2016). Value-added ideally represents the value created during the manufacturing process conducted by each industrial establishment. In other words, regardless of who drives the chain, value added should be reflected through the natural sequence of operations, from stage to stage. Every strategically significant activity to be performed requires an investment in resources, thus each link in the chain is expected to add value (Richard, 2007).It is measured as the difference between the value of all goods and services produced and the value of those purchased non-labor inputs which have been used in the production process (UNIDO, 2009). Clearly, value

addition is the difference between output value and the cost of raw material and other inputs in the production process (Sikone *et al.*, 2022).

**Value chain actors**: Actors are all the individuals or organizations, enterprises, and public agencies related to a value chain and therefore important for understanding the functioning and performance of the value chain. Value chain actors are those who are actually directly involved in value chain activities. Supporting actors can play an important role, but they are not directly involved in value chain activities (Christian and Barron, 2017). Value chain supporters provide support services and represent the common interest of the value chain operators (Gebre *et al.*, 2019). Input suppliers, producers/fishers, cooperatives, traders, processors, exporters, and consumers are the most important value chain actors in the fish sub-sector (Alemu and Azadi, 2018; Awel *et al.*, 2018).

### 2.2. Value Chain Analysis

Value chain analysis (VCA) is the process of breaking a chain into its constituent parts in order to better understand its structure and functioning. The analysis consists of identifying chain actors at each stage and discerning their functions and relationships (UNIDO, 2009). Value chain analysis is an effective way to examine the interaction among different players in a given industry (Zamora, 2016). Value chain analysis is a valuable tool to investigate the role that value chains can play in achieving specific policy objectives, such as poverty alleviation, sustained growth, and inequality reduction. VCA is the assessment of a portion of an economic system where upstream agents in production and distribution processes are linked to downstream partners by technical, economic, territorial, institutional, and social relationships (Bellu, 2013). Value chain analysis is about understanding how activities and actors that are involved in bringing a product from production to consumption are linked (Stein and Barron, 2017). VCA is used to identify where the firm can increase the value or reduce costs to the customer at each stage of the value chain (Simatupang *et al.*, 2017).

Value chain analysis is one of the basic dimensions in identifying activities, actors, relationships, constraints, and possible upgrading of production and marketing activities to add values and create opportunities for new actors (the poor) or new values/economic benefits for producers (smallholders) and actors in the value chain (Bolwig *et al.*, 2010). Value chain analysis involves analyzing processes (activities), identifying actors and their

roles in the added value and identifying the position of the smallholder (the poor). Moreover, it analyzes the value distribution across actors, the degree of integration and governance among actors and identifies constraints of producers and other actors (Andriesse, 2018).

### 2.3. Value Chain Mapping

Value chain mapping enables to visualize the flow of the product from conception to end consumer through various actors (McCormick and Schmitz, 2001). It also helps to identify the different actors involved in the value chain, and to understand their roles and linkages. The value chain isn't necessarily straight it has vertical relationships as the product moves through different processing stages and it has various horizontal relationships as the product passes to multiple markets (Hempel, 2010). An important concept is that no matter its direction, all decisions made at one step have consequences thereafter. Value chains can be mapped and analyzed further using a value chain analysis framework.

Value chain mapping can be an important means to better understand what opportunities and/or constraints producers face if they are to benefit from participating in value chains. The combination of value chain mapping with visual network research approaches and participatory statistics has the potential to complement existing value chain analysis approaches and to generate new insights that would be difficult to obtain using traditional questionnaire surveys alone (Christian and Barron, 2017). Value chain maps provide an easily digestible way to understand the process and pathways to production and sale by illustrating, in a simple form, complexities of an industry sector and its value chain (Kerr *et al.*, 2015).

### 2.4. Theories and Approaches of Value Chain

The value chain analysis improves the linkages of the producers with various market actors, which may also increase market power benefiting all actors operating in the value chain. Based on rigorous scientific study, scientists have suggested a bunch of theories and approaches of the value chain. Here we mention some of the important approach with greater acceptance and applications.

**The Filiere approach:** The main objective of this approach is to map out actual commodity

flows and to identify agents and activities which is viewed as a physical flow-chart of commodities and transformations. It deals more directly with issues of trade and marketing. This approach focuses on empirical analysis and has mainly attempted to measure inputs and outputs, prices, and value-added along a commodity chain. It mostly focuses on local or national level chains which are less functional to analyze the global world economy (Raikes *et al.*, 2000). The filiere approach is seen by many adherents as a neutral and purely empirical category.

**The Porter Approach:** The term value chain was introduced by Michael Porter for the first time in 1985 in the book of competitive advantage. Porter developed modern value chain analysis as an instrument for identifying the value of each step of the production (Porter, 1985). This approach is used as an ultimate tool for analyzing the value formed at each stage of the production process. It focused on actual and potential areas of competitive advantage for the organization. According to Porter, the value chain is used to analyze the flow of value-adding activities from the raw material supplier to the end customer. However, this approach fails to focus on the interconnections and relationships between vertically grouped actors.

**The global value chain approach:** Global value chain analysis originates from the commodity chain approaches and focuses on the position of the lead firm in value chains and power relationships between developing country producers and western markets or multi-national companies. In this theoretical stream of power relationships and information, asymmetry is key concepts in the analysis of global value chains (Roko and Opusunju, 2016). Global value chain analysis provides a holistic view of global industries both from the top-down and from the bottom-up (Gereffi and Fernandez-Stark, 2011).

**The global commodity chain approach:** This approach has been primarily developed for industrial commodity chains. It is a concept that is mainly focusing on the power relations in the coordination of dispersed but linked production systems (Gereffi, 1999). The main intension of the global commodity chain approach is governance relationships between actors in the value chain. One of the major hypotheses of this approach is that development requires linking up with the most significant lead firms in the industry. A strong point of the global commodity chain is its inclusion of power in economic relations and transactions and the willingness to include the aspects of power excluded from other analyses of international

production and trading relations (Raikes *et al.*, 2000). This approach has generated little quantitative analysis and its conceptual structure and definition would need further elaboration.

**The global production networks approach:** The global production network (GPN) is a concept in developmental literature that refers to the nexus of interconnected functions, operations, and transactions through which specific products and services produced, distributed, and consumed. It is a conceptual framework that is capable of grasping the global, regional, and local economic and social dimensions of the process. These frameworks combine the insights of the global value chain analysis at network theory and literature are providing of capitalism. The global production network provides the relationship of a framework that aims to encompass all the relevant actors in the production systems. The concept combines a sequence of interconnected activities in the process of value creation. This approach is a direct refinement of the global commodity chains (GCC) approach. It allows for far greater complexity and geographical variation in producer-consumer relations than the global commodity chain approach (Henderson *et al.*, 2002).

**The Social network theory:** This theory focuses on the inter-relationships between economic and social interactions in production networks composed of multiple horizontal and vertical relationships between value chain actors. The vertical dimension of network theory reflects the flow of products and services from the primary producer up to the end-consumer and its horizontal dimension reflects relationships between actors in the same chain link (Trienekens, 2011). This theory can be used as a tool to explain the performance of value chains (Mapanga *et al.*, 2017).

## 2.5. Empirical Evidence

### 2.5.1. Production and consumption status of fish

Feeding an ever-increasing world population becomes a challenge. Fish has significant potential to contribute to the goal of reducing food and nutrition insecurity. Fish is one of the key nutrition sensitive interventions to bridge the current and future global food supply and demand gaps. It plays an important role in global food provision, accounting for about

20% of animal protein and 6.7% of all protein consumed by 4.5 billion people (Demilew and Abebe, 2021; Béné *et al.*, 2015).

Before the 1950s, the importance of fisheries to the Ethiopian food system and economy was insignificant due to cultural restrictions, abundant land-based resources and a sparse population density. According to Drewes (1993), the local people around the Ethiopian lakes considered the fish as worms and snakes that is untouched at all. Since the 1950s, however, the rapid population growth, which resulted in a shortage of cultivable land and depletion of land resources, forced the people to look for other occupations and sources of food from water bodies at a very low scale. The rapidly growing demand for fish in the capital city by foreigners and modern town-dwellers contributed to the start of commercial fishing as a new practice in the Rift Valley Lakes in the 1950s and later in Lake Tana in the 1980s (Yalew, 2012). However, conventional fishing has started in Lake Tana earlier than Rift Valley Lakes by "*Negede-Woyto*" ethnic group who fed themselves through hunting Hippopotamus due to lack of access for farm land (Wudneh, 1998). Recently, fish consumption becomes a tradition around Lake Tana, mainly in the cities and the demand is increasing. The cost of fish is also sky rocketing with a sailing price of 500 ETB per dish in the restaurants. The rapid population growth, rising incomes, urbanization, a growing awareness about healthy and nutritious foods, innovations in processing and packaging likely to keep the fish demand increasing in the future.

### 2.5.2. Contribution of fishery to food security

Fish played a great role in food and nutrition security in the world, providing 15 – 17% of animal protein (FAO, 2020). Inland fisheries do contribute more to the local and national food security due to its subsistence nature. Fish is also a reserve food item during drought and hunger periods around the Lakes and tributaries. This directly contributes the local food system more resilient. However, the contribution to food security is usually constrained by stock depletion, lack of access to capital, limited alternative job opportunities, and lack of appropriate technologies (Mengistu *et al.*, 2017; Dejen *et al.*, 2017). Although the capture amount varies with season and consumption by the local people, the fishermen in Lake Tana working with papyrus reed boats could capture on average 37 Kg fish per trip (Chekol, 2013).

### 2.5.3. Socio-economic benefits of fishery

Fisheries in Lake Tana support large numbers of fishers and fish traders in ten districts of the three administrative zones. According to Chekol (2013), there were about 5043 family heads benefited from the fishery activities around Lake Tana. Others also benefited with job opportunities in the fish processing, transportation, fish trading including the restaurants and net making activities. Nearly half of the fish body was wasted as offal thrown in and around the lake. Now a day, however, due to the expansion of poultry farms around Bahir Dar city, a significant amount of the waste has channeled to meal processing unit. On top of additional income generation, this has reduced the ecosystem pollution.

According to Amare *et al.* (2018), private fishers dominate the Lake Tana fishing activity (82.9%) whereas 17% are members of the fishing cooperatives around the area. Socio-economic characteristics such as age, sex, education, and active family size are the main drivers of the household to fishing activities (Alemu and Azadi, 2018). Several studies also indicated that male and young household heads are significantly more motivated to fishing (Amare *et al.*, 2018; Alemu and Azadi, 2018). Fishers who have formal education accounted for about 41.5% including one year collage training and others nearly 20% have attended literacy campaign program (Amare *et al.*, 2018). Education has thus contributed more to fishing activities (Alemu and Azadi, 2018). Households who practice fishing have significantly higher income compared to non-fishing households (Alemu and Azadi, 2018). This study also indicated less income inequalities among the fisher households operating in cooperatives than private fishing households.

### 2.5.4. Value chain actors and their roles

Value chains are a way of understanding the interaction of people and firms in the domestic as well as global markets. Value chain actors can be categorized as primary/main/direct actors and supportive/indirect actors. Indirect actors can further be classified as input suppliers, and enablers (Tefera, 2014). Primary actors perform a selection of primary functions along the value chains. These typically includes input supply, production, processing, storage, marketing (wholesaling, retailing, vending), and consumption. Indirect actors or support service providers perform supporting activities to the primary actors.

Support service providers facilitate the overall process of the primary functions to realize the targets of primary actors (Mitchell *et al.*, 2009).

### 2.5.5. Determinants of market supply

There are several factors that affect market supply as well as participation in the market. Market information, household education, fishing experience, owning cold storage, credit access, fishing site and post-harvest loss affected the volume of fish market supply significantly (Tuluka *et al.*, 2021). According to this study, the results of the multiple linear regression models indicated that market information, household education, fishing experience, owning cold storage, credit access positively and significantly the volume of the market participation. Whereas fishing site and post-harvest loss affects the volume of fish market supply negatively and significantly. The study conducted by Cheffo *et al.* (2016) education level, credit facility and ownership of fishing licenses are significantly affects household market supply participation. The OLS result in this study indicated that Education of the respondent positively and significantly related to the supply of fish. The possible reasons are literate fishers are more willing to adopt better harvesting technologies of using appropriate mesh size, accept technical advice from extension workers especially post-harvest handling and saving their money for buying modern fishing equipment.

The study conducted by (Tilahun *et al.*, 2020), milk yield per day, age of the household head, land size, milk consumption of household, number of local lactating cow, dairy farming experiences, family size, distances to the market ,membership to fishery cooperative and milk market experiences affects the probability of raw milk supply. According to the results of this study, all the above factors have a significant impact on milk supply to the market. As the results of the bivariate Probit indicated that one litter increase in volume raw milk size increases the raw milk market participation decision by 4.7 %.

### 2.5.6. Determinants of value addition decision and intensity of participation

The quantity of value-added can be calculated by subtracting the value of raw material and other inputs used in the processing from the output value (Padangaran *et al.*, 2019). A study conducted by (Awel *et al.*, 2018)education level, fishing equipment, accessing competitive marketing agents, Extension service, access to market information, and Access to credit

service were important factors influencing individual fishermen processing and value addition. The result of this study using binary logit model indicated that education level, fishing equipment, accessing competitive marketing agents, extension service, access to market information, and access to credit service influences the value addition decision positively and significantly.

According to the study by Ayele *et al.* (2018) on analysis of market decisions and intensity of market participation of smallholder wheat farmers in Adola-Rede district of Oromia regional state, land allocated for wheat, age of the household, and quantity of wheat produced are significantly influencing market participation decision. The study conducted by (Tilahun *et al.*, 2020) land size, dairy farming experiences, membership to cooperative, value addition experiences and distance from dairy market affects the probability of value addition and intensity of participation significantly. The result of the bivariate Tobit showed that land size, distance to dairy market and number of local lactating cows influence the probability of value addition participation negatively and significantly. Whereas, membership to cooperative and market experiences influences the probability of value addition decision positively and significantly. On the other hand, land size and distances from dairy market affects the intensity of value addition positively and significantly. Whereas dairy farming experience and membership to cooperatives showed a significant negative effect on the intensity of value addition.

The study conducted on smallholder farmer's decision to participate in *teff* market is affected significantly and positively by agro ecology, access to credit, farm size, and perception of lagged market price and ownership of transport equipment while it is significantly and negatively affected by family size (Turaa *et al.*, 2016). Similarly, the study conducted in delta state, Nigeria, using Probit model confirmed that age, level of education, household size, access to credit, income and access to market have a significant positive influences on the process of value addition participation (Anyim *et al.*, 2021).

### 2.5.7. Marketing margin and profit shares in the value chain

Marketing margin is commonly used to measure the performance of the marketing system. It is associated with the selling price of the producers and the price paid by the end users/customers. Thus, the total gross marketing margin is the difference between the price

received by producers and paid by the final consumers. Gross marketing can also be calculated by subtracting the purchase price from the selling price at each consecutive stage of the marketing channel along the value chain. Most of the time the shortest marketing channel is preferred by the consumers since it reduces the purchasing prices by reducing the number of intermediaries in the market. Clearly, the marketing and profit margins of each actor in the market are different along the different marketing channels (Awoke and Molla, 2018). According to this study, processors incurred the highest cost since they are performing more value-adding activities among traders in the market. Producers can receive relatively good gross profit as compared to traders (Abajobir, 2018).

Research findings suggested that the majority of the fishermen in Lake Tana have engaged as fulltime fishing activity. For instance, Amare *et al.* (2018) reported 58.5%, full time. Other groups of fishers who engaged fishing seasonally accounted for 26.8% and the remaining 14.6% engaged as a part time activity (Amare *et al.*, 2018). Fishing activity served as sources of income, food security, and employment for about 34.1%, 56.1%, and 2.4% respectively. It is reported that the fishermen earned an average annual income of 13,492.9 - 15,076.77 ETB by providing whole and gutted and filleted fishes with 1583.9 ETB margins for value addition (Amare *et al.*, 2018). In addition to increased income, The rural households fish consumption habit has been increasing through time, implying the tremendous potential of fish to food and nutrition security (Alemu and Azadi, 2018).

### 2.5.8. Econometric models used in value chain analysis

Ordinary Least Square (OLS), Tobit, Heckman two-stage, Double-hurdle, Multinomial logit, and Multivariate probit models are used to examine market supply participation, value addition participation and market outlet choice along the value chain. The selection of the model depends upon the nature of the study and underlying assumptions of the models. When all respondents are market participants and the dependent variable has a continuous nature, multiple regressions using Ordinary Least Squares (OLS) can be used for the analysis of determinants (Lamsal *et al.*, 2015).

Tobit model is a statistical model used to describe the relationship between non-negative dependent and independent variables (Tobin, 1958). Similarly, Hobbs (1997) and Holloway *et al.* (2004) used the Tobit model to model farmers' market participation behavior. The

Tobit modeling approach assumes that the market participation and quantity of market supply decisions are made simultaneously and hence factors that affect the participation and the quantity of market supply decisions are the same (Tobin, 1958). This model is therefore, prone to the limitation of the assumption that the same set of parameter and variables determine both the probability and the level of value addition participation. A two-step model relaxes the Tobit model assumption by allowing different mechanisms to determine the discrete probability of participation and level of participation. These models allow for separation between the initial decision to participate and the level of participation. In such cases the sample selection model of Heckman (1979) or the Omiti *et al.* (2009) double hurdle model could be considered.

Heckman two-stage model has been used extensively to correct for biases arising from sample selection. The Heckman procedure provides consistent and asymptotically efficient estimates for all the parameters (Heckman, 1979). This model assumes that the missing value of dependent variable implies that the dependent variable is unobserved (not selected). Heckman's model first uses a Probit regression with all variable data to estimate the probability of value addition participation. Then the inverse Mills ratio, computed from the Probit regression, is used with other explanatory variables to help explain variances to the continuous, non-zero dependent variables.

In the case of double hurdle model, value addition participation is seen as a two-step decision process. This is based on the assumption that primary actors make two separate decisions which involves the decision to participate in the value addition or not and the extent/intensity of participation. The model estimation involves Probit regression to identify factors affecting the decision to participate in value addition using all samples in the first stage, and a truncated regression model using participant actors to analyze the extent of participation, in the second stage. The double-hurdle model is designed to analyze instances of an event that may or may not occur, and if it occurs, takes on continuous positive values. According to (Burke, 2009), the double hurdle model is useful because it allows a subset of the data to pile-up at some value without causing a bias in estimating the determinants of the continuous dependent variable in the second stage. Hence, we can obtain all the data in the remaining sample for the participants. Thus, in double hurdle model, there are no restrictions regarding the elements of explanatory variable in each decision stage. Moreover, there is no a theoretical base for the type of variables to be used for the two separate

decisions.

Multinomial logistic model is the most appropriate model to estimate nominal outcomes of unordered categories and applicable if marketing channels are mutually exclusive and farmers can choose one best channel as their market outlet (Zegeyesh, 2016). That means it does not allow correlation or substitution between them.

Multivariate Probit (MVP) model is mostly applied for the household's variation in the choice of a market outlet and to estimate several correlated binary outcomes jointly. Multivariate Probit approach simultaneously models the influence of the set of independent variables on choice of market channels, while allowing for the potential correlations between unobserved disturbances, as well as the relationships between the choices of different market channels (Belderbos *et al.*, 2004).

### 2.5. Conceptual framework

Strengthening the value chain of fish plays an important role for the competitiveness of the business in the sector at the regional, national, and international levels. Generally, from production, processing, marketing, consumption, and waste management several actors could involve. Clearly, several factors that potentially impact the performance of the primary actors particularly in their value addition and market supply capacities in general and the market performance in particular need to be identified and assessed. As indicated in Figure 1 below, it was hypothesized that demographic, institutional and socio-economic variables could impact the whole value chain of fish in Lake Tana positively or negatively.

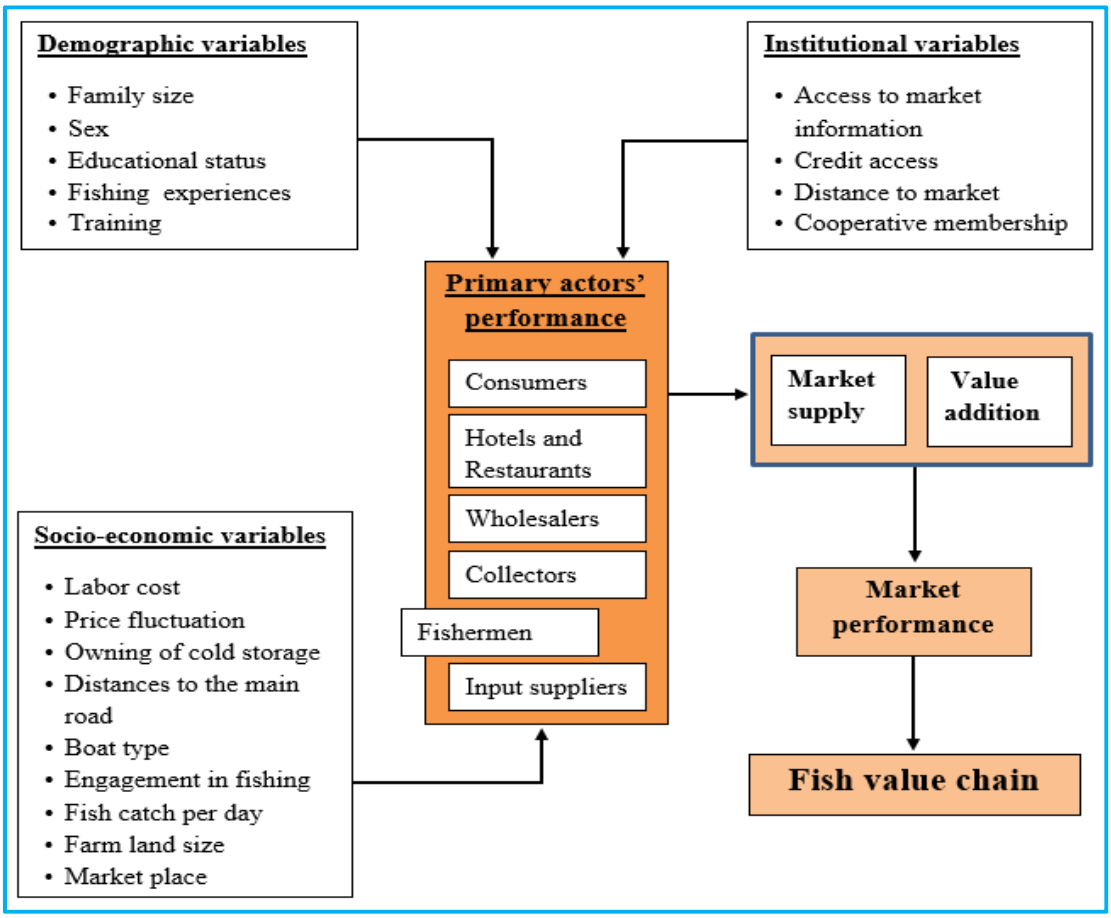


**Figure 1.** Conceptual framework of the study on fish value chain in Lake Tana

# Chapter 3. MATERIALS AND METHODS

## 3.1. Description of the Study Area

Lake Tana is situated in the North-western highlands of Ethiopia, laying between 11° 6' - 12°3' N and 37° 01' – 37° 6' E on a basaltic plateau with an altitude of 1,830 meters above sea level. The Lake is sounded with six districts (Figure 2). The water body covers an area of 3,050 km$^2$ (Dejen *et al.*, 2017). It is the source of the Blue Nile River, with a catchment area of 16,500 km$^2$. The land use in the Lake Tana basin is predominantly cultivable land (71%). Other land use land cover types of the area includes: water bodies, wetlands, forest, wood land, shrubs, rangeland, grassland and settlements (Goshu and Aynalem, 2017). Lake Tana is shallow in depth with an average depth of 8 meters and a maximum depth of 14 meters. Seven permanent and more than 40 small seasonal rivers are reported as tributaries of the lake. However, the Blue Nile is the only out flowing river through the Lake (Dejen *et al.*, 2017). Out of the ten districts surrounding Lake Tana having a total of 51 Kebeles, the lower government administrative structure, we selected six districts from which ten Kebeles were considered to randomly choose the sample respondent fishermen (Appendix table 1).

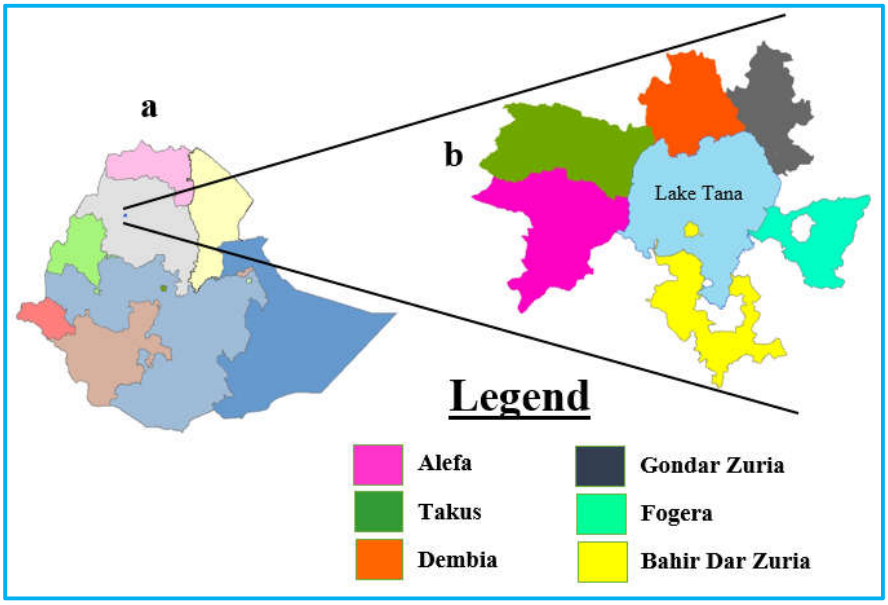


**Figure 2.** Map of the study area. a) represents country map, Ethiopia, b) shows the sampling districts surrounding Lake Tana

### 3.2.Sampling Techniques and Procedures

The formal survey was performed using structured questionnaires (Appendix 2) and checklist prepared for each node (Individual fishermen, cooperatives, collectors, wholesalers, retailers, and restaurants/hotels). The informal survey was done using rapid market appraisal (RMA) technique with checklists. A three-stage sampling procedure was adopted to select the respondents (Figure 3). In the first stage six districts (Fogera, Dembia, Alefa, Takusa, Gondar Zuria, and Bahir Dar Zuria) were purposively selected based on their fish production potential. In the second stage, ten Kebeles from the six selected districts were selected purposively based on the intensity and experience of fishing activity (Nabega Georgis, Wagetera, Achera, Gorgora, Dengel Ber, Delgi, Chachinalwa, Sheha Gomengie, Mitriha Abawarka, and Sekelet). The third stage was sample respondents were selected from the target fishermen by using simple random sampling techniques. In addition, fish traders and hotels and restaurants were selected purposively.

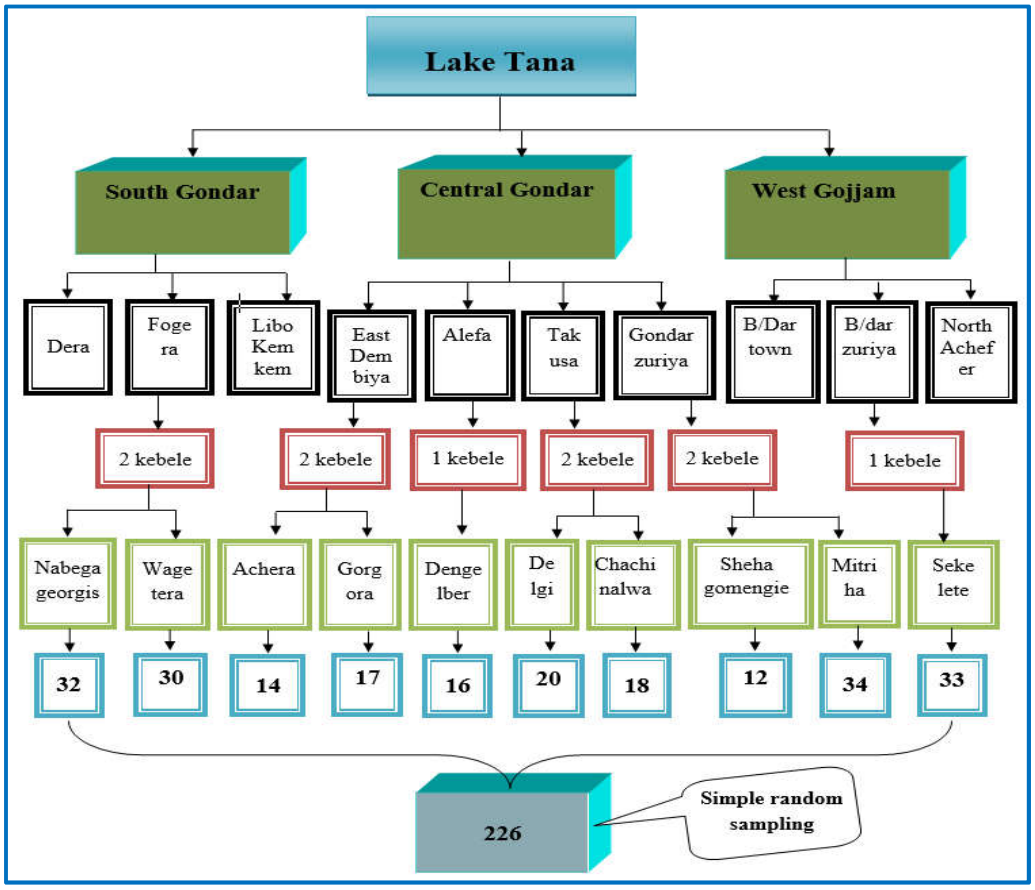


**Figure 3.** Schematic representation of sampling techniques followed in this study

### 3.3. Sample Size Determination

The sample size was determined based on Yamane's 1967 simplified formula. This formula is applicable for a finite population who are homogenous. Almost all fishermen in Lake Tana bordering districts (ten districts), have similar fishing practices, agro-ecology and there is no high degree of variability regarding their fishing activities. For this reason the precision level lies on 6.5%. Therefore, by using the above formula the required sample size was calculated as follows.

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

Where, **n** = sample size, **N**= population size, **e** = level of precision.

The level of precision is the range in which the true value of the Population is estimated to be; it is expressed in percentage points of precision to obtain the sample that truly represents the population. To calculate the sample size of each kebele based on number of fishermen (Appendix table 1), the following formula was adopted.

$$\mathrm{nk} = \frac{\mathrm{nN_k}}{\mathrm{N_t}} \qquad \text{---------- (2)}$$

Where, **n** = population size of each kebele, **nk** = sample size of each kebele, $\mathbf{N_k}$ = sample size of total population, and $\mathbf{N_t}$ = total fishermen from six Kebeles.

According to Tewabe and Asmare (2020), the total number of fishermen in the study area is 5403, thus:

$$Total\ sample\ size = \frac{5403}{1 + 5403(0.065)^2} = 226$$

### 3.4. Data Collection

Both cross-sectional quantitative and qualitative data were collected from secondary and primary data sources. Primary data (socio-economic, institutional, and market related data)

were collected from actors involved in the fish value chain such as respondent fishermen, fish traders, fish processors (hotels and restaurants), and individual consumers. On the other hand, secondary data were collected from journal articles, published books and reports (published and unpublished). The primary data was collected through various instruments that have designed in line with the study objectives and research questions. Questionnaires and checklists have been developed independently for each actor. To collect these data both informal and formal survey methods were employed. During the informal survey, Focus Group Discussion (FGD) was conducted whereas in the formal survey**,** pre-tested semi-structured questionnaire was prepared to collect data from respondent fishermen, fish traders, fish processors (hotels and restaurant), and individual consumers. Quantitative data like the amount of fish capture per trip, the amount of fish sold by each actor, the amount value added fish, and the amount of fish allocated for home consumption were collected. To complement the quantitative data, qualitative data was collected from 10 FGDs with 7 members per group and 8 key informants through interviews from 10 sample Kebeles with experienced fishermen to triangulate the quantitative data. FGD members were selected based on their experience and knowledge about fish production and marketing.

### 3.5. Data Analysis

The primary data was analyzed using the three commonly applied techniques of data analysis procedures. Descriptive statistical analysis, Econometric analysis, and marketing margin analysis were undertaken with STATA (version 17.2) and SPSS (version 22) software packages.

To see the demographic and socio-economic characteristics of the fishermen, descriptive and inferential statistics were computed. Descriptive and inferential statistics were also used to describe the demographic characteristics of sample traders, fish restaurants and consumers. The fish value chain was analyzed through marketing margin analysis which includes a map of the value chain actors and their respective roles, marketing margins, marketing channels, and benefit shares of each actor along the value chain. Finally, the determinant factors that affect the quantity of fish market supply and the intensity of value addition in the study area were analyzed using econometric models. The market outlet choice of the fishermen was also computed using multivariate Probit model.

### 3.5.1. Descriptive statistics - based analysis

Descriptive statistics such as mean, percentage, maximum, minimum, frequency, and standard deviation were used to figure out the socio-economic and demographic characteristics of the fishermen, traders, and consumers. Similarly, tables and figures were used as a tool to present the results.

### 3.5.2. Econometric - based analysis

#### 3.5.2.1. Model specification for econometric analysis

Empirical studies on analysis of market participation have used various analytical models depending upon their nature of the dataset. These analytical models include, Ordinary Least Squares (OLS), Tobit model, Heckman two stage models, and double hurdle model. The selection of the model depends upon the nature of the study and underlying assumptions of the models. If all fishermen are market participants, the preferred model to be used is Ordinary Least Squares (OLS). In the study area fishermen harvest fish for marketing purpose. Due to this reason Ordinary Least square (OLS) model are more appropriate model to identify factors influencing fish supply to the market.

$$Y_i = X_i\beta + U_i \quad \text{---------- (3)}$$

Where; $Y_i$ = quantity of fish market supply, $X_i$ = independent variables that affect fish market supply, i = 1, 2, 3 … nth, β = the coefficient of variable to be estimated, and $U_i$ = unobserved disturbance term.

All fishermen in this study area were not participating in value addition; that means there are participants and non-participants. Now, the optional models could be Tobit, Heckman two stages and double hurdle. Model specification tests made between Tobit and double hurdle, and double hurdle and Heckman two stages. Within this context of a study of the determinants value addition, the rationale for a corner solution model is that a value addition value of zero is a valid economic choice to be explained, not a reflection of missing data. The standard approach to modeling a corner solution dependent variable is to use Heckman, Tobit or a double-hurdle (DH) model. Cragg (1971) modifies the Tobit model to overcome

the restrictive assumption inherent in it, namely, he suggests the "double-hurdle" model to tackle the problem of too many zeros in the survey data by giving special treatment to the participation decision. The model assumes two hurdles to overcome to observe positive values. A non-zero value addition amount can be observed if, first a decision whether to participate or non-participant value addition decision is made, and second random circumstances permit intensity of participation, once it is participating. The Heckman and the double-hurdle models are similar in identifying the rules governing the discrete (zero or positive) outcomes. Both models recognize that outcomes are determined by the selection and level of participation. They also permit the possibility of estimating the first- and second-stage equations using different sets of explanatory variables. However, the Heckman model, as opposed to the double-hurdle, assumes that there are no zero observations in the second stage once the first-stage selection is passed. In contrast, the double-hurdle considers the possibility of zero realizations (outcomes) in the second-hurdle arising from the individuals' deliberate choices or random circumstances.

According to the Heckman model, only non-participants respondents can report zero intensity of value addition participation. The model further assumes that individuals who participate in the value addition do not report zero values at all. On the other hand, the double-hurdle model assumes that zero values can be reported in both decision stages. The zeros reported in the first-stage arise from non-participants and those in the second stage come from non-participant due to the respondents' deliberate decisions or random circumstances.

The main objectives are to understand both the factors affecting the probability of value addition and the intensity of value added. When the fishermen value addition participation decisions and intensity are made simultaneously, the Tobit model is appropriate for analyzing the factors affecting the joint decisions. On the other hand fishermen decision regarding whether to add value (participation) and what quantity to add to be determined by different underlying processes double hurdle is more appropriate. Hence, selection of appropriate model was made between Tobit and double hurdle models using a method called likelihood ratio (LR) test statistics. Using the procedure outlined in Greene (2012), the likelihood ratio (LR) test statistics "Γ" was computed as:

$$\Gamma = -2\,[\ln L_{Tobit} - (\ln L_{Probit} + \ln L_{Trucated})] \sim \chi 2_k \text{ ---------- (4)}$$

Where, **Γ** = likelihood ratio statistic; **ln** = natural logarithm; **LTobit**, **LProbit** and **LTruncated** are likelihood values for Tobit, Probit and truncated regression models respectively; **χ2** = Chi-square statistic, and **k** is the number of independent variables in the equation.

Based on Eq. (3), the value of likelihood ratio statistic (Γ) (99.08) was greater than the value of the chi-square statistic (18.31) at 10 degrees of freedom. This indicates the superiority of the double hurdle model over the Tobit model. Hence, factors that influence the probability of the fishermen participation in value addition and its intensity can be determined separately in the double hurdle model. This model allows in modeling the decision process in two steps. First, fishermen decide on value addition (VA decision) and then they decide the amount they can add value (intensity decision). Therefore, the first decision (first hurdle) was specified using Probit model as follows:

$$VA^{*}I = \alpha+\beta`Xi +ui \text{ ---------- (5)}$$

$$VA_i = \begin{cases} 1 \text{ if } VA>0 \\ 0 \text{ otherwise} \end{cases} \text{ ---------- (6)}$$

Where, $\mathbf{VA_i}$ is a dummy variable that takes the value 1 if the fishermen adds value on his captured fish, zero otherwise; **Xi** is a vector of fishermen characteristics and **α** is a vector of parameters.

In the second hurdle, the decisions on the maximum amount of value addition (VA) was specified as follows:

$$MaxVA^{*}i = \beta_o +\gamma`Xi+ \varepsilon i \text{ ---------- (7)}$$

$$MaxVAi = \begin{cases} 1 \text{ if } MaxVA^{*}i>0 \\ 0 \quad \text{otherwise} \end{cases} \text{ ---------- (8)}$$

Where, **MaxVAi** represents the maximum amount that the fishermen add value on the captured fish; **Xi** is a vector of the individual's characteristics and **βo**, **γ** is a vector of

parameters.

The choice of marketing outlet was based on fishermen' socio-economic characteristics and relevant factors influencing the choice included in each channel. The basis for market channel choice is the theory of rational choice which assumes that participants select alternative marketing outlet to maximize their benefit. The fishermen's market outlet choice can be conceptualized using a random utility model. The model is particularly applicable for modeling discrete choice decisions such as market outlet choices. It is an indirect utility function where an individual with specific characteristics associates an average utility level with each alternative outlet in a choice (Ali *et al.*, 2008).

Multinomial logistic model is the most appropriate model to estimate nominal outcomes of unordered categories and applicable if marketing channels are mutually exclusive and farmers can choose one best channel as their market outlet (Zegeyesh, 2016). It also assumes independence across the choices. That means it does not allow correlation or substitution between them.

However, in this study fishermen might choose more than one market outlets simultaneously, and then the decision to supply to market '**k**" affects the amount of fish to be supplied to other market outlets. In addition to that, the interdependence of irrelevant alternative assumption in a mutually inclusive market outlet choice is violated. Therefore, market outlets choice is not mutually exclusive, considering the possibility of simultaneous choices of outlets and the potential correlations among these market outlets choice decisions. MVP model was applied for the household's variation in the choice of a market outlet and to estimate several correlated binary outcomes jointly. Multivariate Probit approach simultaneously models the influence of the set of independent variables on choice of market channels, while allowing for the potential correlations between unobserved disturbances, as well as the relationships between the choices of different market channels (Belderbos *et al.*, 2004). In Lake Tana fishermen faces different choices of market outlets like: wholesalers, retailers, collectors, hotel and restaurant, and consumers. By considering the possibility of simultaneous choices of outlets and the potential correlations among these market outlet choice decisions multivariate Probit model was appropriate to capture fishermen variation in the choice of market outlets and to estimate several correlated binary outcomes jointly.

The observed outcome of market outlet choice can be modeled by the following random utility formulation. Consider the $j^{th}$ fishermen (j =1, 2….. M), facing a decision problem on whether or not to choose available market outlets. Let $U_n$ represent the benefits to the fishermen who chooses wholesalers and let $U_k$ represent the benefit of fishermen to who choose the $K^{th}$ market outlets: where K denotes choices of wholesalers (Y1), retailer (Y2), collectors (Y3), hotel and restaurant(Y4) and consumers s (Y5). The farmers decide to choose the $K^{th}$ market outlet if:

$$Y^*_{jk=} U^*_{k-}U_n >0 \text{ ---------- (9)}$$

The net benefit ($Y^*_{ik}$) that the fishermen derives from choosing a market outlet is a latent variable determined by observed explanatory variable (Xi) and the error term (Ɛi):

$$Y^*_{jk} = X'\beta_k + Ɛi(K=Y1<Y2,Y3,Y4,Y5) \text{ ---------- (10)}$$

Where, in this study, Y1= wholesalers, Y2= retailers, Y3= collectors, Y4= hotels and restaurants, and Y5 =consumers. Using the indicator function, the unobserved preferences in the above equation translates into the observed binary outcome equation for each choice as follows:

$$Y^*_{jk} = \begin{cases} 1 \text{ if } X'\beta_k + Ɛi > 0 \\ 0 \text{ if } X'\beta_k + Ɛi < 0, \end{cases} \quad \text{Where, K = Y1, Y2, Y3, Y4, Y5 ---- (11)}$$

Where, x' is a vector of explanatory variables; β denotes the vector of parameters to be estimated; and ε are random error terms distributed as multivariate normal distribution with zero mean and unitary variance. Yj is a set of binary dependent variables such that: Y1 = wholesaler, 1 for the fishermen who choose wholesalers, 0otherwise; Y2 = retailer, 1 for the fishermen who choose retailer, 0 otherwise; Y3 = collector, 1 for the fishermen who choose collectors, 0 otherwise and Y4 = hotel and restaurant, 1 for the fishermen who choose hotel and restaurant, 0 otherwise and Y5=consumer, 1 for the fishermen who choose, 0 otherwise.

In multivariate Probit model, where the choice of several market outlets is possible the error terms jointly follow a multivariate normal distribution (MVN) with zero conditional mean

and variance normalized to unity (for identification of the parameters) where (μy1, μy2 ,μy3, μy4, μy5) $MVN \sim (0, \Omega)$ and the symmetric covariance matrix Ω is given by:

$$\boldsymbol{\Omega} = \begin{bmatrix} 1 & \rho y1\rho y2 & \rho y1\rho y3 & \rho y1\rho y4 & \rho y1\rho y5 \\ \rho y2\rho y1 & 1 & \rho y2\rho y3 & \rho y2\rho y4 & \rho y2\rho y5 \\ \rho y3\rho y1 & \rho y3\rho y2 & 1 & \rho y3\rho y4 & \rho y3\rho y5 \\ \rho y4\rho y1 & \rho y4\rho y2 & \rho y4\rho y3 & 1 & \rho y4\rho y5 \\ \rho y5\rho y1 & \rho y5\rho y2 & \rho y5\rho y3 & \rho y5\rho y4 & 1 \end{bmatrix} \text{ ---------- (12)}$$

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

Following the formula used by Cappellari and Jenkins (2003), the log-likelihood function associated with a sample outcome is then given by:

$$\ln L = \sum_{i=0}^{n} \varpi_i \, t\phi_i(\mu_i, \, \Omega) \text{ ---------- (13)}$$

Where, $\varpi_i$ is an optional weight for observation i, and Φ is the multivariate standard normal distribution with arguments μi and Ω, where μi can be denoted as;

$$\mu i = (ki1\beta 1xi1, ki2\beta 2xi2, ki3\beta 3xi3) \text{ ---------- (14)}$$

When Ωik =1 for j=k

$$\Omega jk = \Omega kj = kijkjk\rho jk \text{ for } j \neq k, k = 1, 2, 3, 4 \ldots \text{ with } k_{ik} = 2yik - 1 \text{-------- (15)}$$

Prior to running the econometric models, econometric assumptions of the Classical Linear Regression Model such as VIF (to detect multicollinearity problem), Omitted variable test (to detect misspecification problem), and heteroskedasticity (to test for constant variance of

each error term from each individual data) were executed. The value of Variance Inflation Factor (VIF) and Contingency Coefficients were computed using the corresponding formulas. The Contingency Coefficient was used to test the correlation between categorical variables.

$$\mathrm{VIF}_{(\mathrm{xi})} = \frac{1}{1-(R_J)^2} \text{ ---------- (16)}$$

Where, $R^2$ stands for square multiple correlation coefficients between and other explanatory variable. Practically, there was no any variable which is not correlated with other explanatory variables. If the VIF values exceed 10, the problem is serious which results in the inflated standard errors (Greene, 2008 ). On the other hand, contingency coefficient for dummy variables was calculated as follows:

$$\mathrm{CC} = \sqrt{\frac{\sqrt{\chi^2}}{\mathrm{n}+\chi^2}} \text{ ---------- (17)}$$

Where, $\boldsymbol{\chi^2}$ stands for chi-square and **n** stands for sample size. According to (Greene, 2008 ), when the **CC** value exceeds 0.75, the variables are said to be seriously collinear.

### 3.6. Definitions of Variables

Prior to data collection, it is crucial to properly identify and define the variables that could answer the research questions of the study. To identify the factors that affect fish supply to the market, and value addition participation and its intensity on fish, the following explained variables were assumed to affect the dependent variables in the overall processes of this study.

#### 3.6.1. Dependent variables

**Quantity of fish supply to the market**: It is a dependent variable that represents the amount of fish supplied by the fishermen to the market in 2022 fishing season measured in kilogram.

**Value addition decision and intensity of participation:** It is the dependent variable that represents whether the fisherman participates in value addition or not. It is a dummy variable

that takes the value of 1 for participating fishermen in value addition and 0 for non-participating fishermen in value addition and the measurement is in terms of participation in value addition. Firstly**,** sampled fishermen take a value of 1 if they participate in value addition and 0 otherwise. Secondly, households who participated in value addition take the percentage amount of fish sold to total fish produced and 0 otherwise.

**Market outlet choices:** It is a categorical binary dependent variable measured by a choice of outlets defined and measured as binary outcome. The multivariate Probit model has a set of categorical binary dependent variables (Yi) such as: $Y_1$ = wholesalers; $Y_2$ = retailers; $Y_3$= collectors; $Y_4$ = hotels and restaurants, and $Y_5$ = consumers for the fishermen who choose wholesalers, retailers, collectors, hotel and restaurant, and consumers respectively.

### 3.6.2. Independent variables in quantity of fish supply to market

**Family size (Totfamsz):** It is a continuous variable measured in adult equivalent. Since the fishing activity and its marketing are labor intensive, the fishermen are usually used their family as a labor. This variable was hypothesized to have a positive and significant effect on the quantity of fish market supply.

**Education (Educ):** It is a continuous variable which can be measured in years of schooling. Education is believed to improve the knowledge of the household to increase the quantity of fish production and supply to the market. The study conducted by Cheffo *et al.* (2016) indicated that education level of the fishermen had positive and significant influence on fish market supply participation. Based on the study by Nyein *et al.* (2018), education level of the household head showed a significant positive influences on the probability of market participation. Thus, this variable was hypothesized as a positive and significant influence on fish market supply.

**Training (Training)**: It is a dummy variable and took the value of 1, if the fishermen took a training on fishing and fish post-harvest handling activities and 0, if not took a training related to fishing. Thus, this variable was hypothesized as a positive and significant influence on the quantity of fish market supply.

**Market information (MKTinformation):** It is a dummy variable that took the value of 1,

if the fishermen have access to market information and 0 for not accessed. According to Tuluka *et al.* (2021) market information has positively and significantly affected the quantity of fish market supply at 1% significance level. Janko (2013), found that having market information increases the probability of entering into the market and market supply of haricot bean. Thus, from this variable it is expected and hypothesized a positive and significant influence on fish supply to the market.

**Access to Credit services (Creditaccess):** It is a dummy variable that took the value of 1, if the fishermen have access to credit and 0 for who have no credit access. According to (Tuluka *et al.*, 2021) access to credit has positively and significantly influence on the quantity of fish market supply at 10% level of significance. Thus, this variable was hypothesized as a positive and significance influences on the quantity of fish market supply.

**Fishing experience (Fishexp):** It is a continuous variable measured by the numbers of years that the fishermen have engaged in fishing activities. Fishing experience has a positive and significance influence on the quantity of fish supply to the market (Tuluka *et al.*, 2021). Thus, this variable was hypothesized as having a positive and significances influence.

**Cold storage problem (Coldstorage):** It is a dummy variable that affect the quantity of fish market supply. It took the value of 1, if the fishermen have cold storage problem and 0, if have not a problem.

**Land size (Totfamlan):** It is continuous variable that refers to the total land size owned by the fishermen. This variable was hypothesized to affect the quantity of fish supplied to the market negatively and significantly. This variable was also hypothesized to affect the value addition participation decision and intensity of participation negatively.

**Boat type (BoatType):** It is a dummy variable that assigned the value 1, if the fishermen have motorized boat and 2 for having reed boat. Thus, it was hypothesized as having a positive and significant influence on the quantity of fish supplied to the market.

**Engagement on fishing activities (EngfishA):** It is also another variable that affect fish supply to the market. It took the value of 1, if the fishermen participate on full time and 2, if the fishermen participate on seasonal. This variable was hypothesizing to affect the

quantity of fish supplied to the market positively or negatively depending on the participation type. If the fishermen participated in full time, it is expected to have a positive and significant influence on volume of fish market supply, otherwise negative.

**Price fluctuation problem (Prfluctuationprob):** It is dummy variable that affect the quantity of fish market supply. It took the value of 1, if the fishermen have price fluctuation problem and 0, if not a problem. This variable was hypothesized and expected to affect the quantity of fish supply to market negatively and significantly.

**Cooperative membership (MembersfishCoop**): It is a dummy variable and assigned a value of 1 for those farmers who are member of the cooperative and 0 for non-members. Thus, this variable was hypothesized to affect the quantity of fish supply to market positively or negatively.

**Market place problem (MKTplaceProb)**: It is a dummy variable that affect the quantity of fish market supply. It took the value of 1, if the fishermen have market place problem and 0 = if not have a problem. This variable hypothesized that it affects the volume of fish supply to the market positively or negatively.

**Livestock holding (TLU):** It is a continuous variable which is measured in total tropical livestock unit (Appendix table 2). Thus, this variable was hypothesized to affect the quantity of fish supply to market negatively. The fishermen who have more livestock take more time to care this reduce the participation of the fishermen on fishing and fish marketing activities.

**Table 1.** Description of explanatory variables and hypothesis in multiple linear regression model (MLRM)

| Variables | Symbol | Type | Measurement | Expected sign |
|---|---|---|---|---|
| Education level of fishers | Educ | Continuous | Year of schooling | + |
| Total family size | Totfamsz | Continuous | Years | +- |
| Total farm land | Totfamlan | Continuous | Hectare/timad | - |
| Experiences of fishing activity | FishExp | Continuous | Years | + |
| Engagement of fishing activities | EngfishA | Dummy | 1= full time ,2 seasonal | +- |
| Boat type | BoatType | Dummy | 1=motorized ,2 reed boat | +- |
| Training | Training | Dummy | 1=yes , 0 no | + |
| Market information | Mktinformation | Dummy | 1=yes , 0 no | + |
| Market place problem | MKTplaceprob | Dummy | 1=yes , 0 no | - |
| Cold storage problem | Coldstorage | Dummy | 1=yes , 0 no | - |
| Price fluctuation problem | PrfluctuationProb | Dummy | 1=yes , 0 no | - |
| Number of gillnet used | ngillnet | Continuous | Number | +- |
| Membership to fishery cooperative | MembersfishCoop | Dummy | 1=yes , 0 no | +- |
| Credit utilization | Creditutilization | Dummy | 1=yes , 0 no | +- |
| Tropical livestock unit | TLU | Continuous | Number | +- |

### 3.6.3. Independent variables in value addition and intensity of participation

**Family size (Totfamsz):** It is a continuous variable measured in adult equivalent. Fish processing and marketing are labor intensive activities; fishermen used family labor for these activities. This variable expected and hypothesized that positive and significant effect on the value addition intensity of fishermen.

**Education (Educ):** It is a continuous variable which can be measured in completed years. According to Awel *et al.* (2018), education affects the fish value addition positively and significantly. Odebiyi *et al.* (2013), also indicated that education is an important factor

which can determine level of awareness on the value addition in fish. Thus, this variable was hypothesized to influence the fish value addition intensity positively and significantly.

**Fishing experience (FishExp):** It is a continuous variable that is measured in years. Which indicates the year that household engaged in value addition. Experience on fishing enhances knowledge on fish processing and marketing activities. Thus, this variable was hypothesized to affect fish value addition participation and intensity positively and significantly.

**Boat type (BoatType):** It is a dummy variable that assigned and hypothesized as, positive and significance influence on value addition intensity of the fishermen. That took the value 1 if the fishermen have motorized boat and 2 for those who have reed boat.

**Training (Training)**: It is a dummy variable and took the value of 1 for those fishermen who took training on fishing and fish post-harvest handling activities and 0 for non-trained fishermen. Thus, this variable was hypothesized to affect fish value addition participation intensity positively.

**Storage problem (Coldstorage)**: It is dummy variable and assigned 1 (yes) for households who have a storage problem and 0 (no) for those who have not facing storage problem. Storage plays crucial role for fish processing and marketing activities. This variable was hypothesized to have a negative and significant effect on the value addition intensity of the fishermen.

**Land size (Totfamlan):** It is a continuous variable that is measured in hectare. A study conducted by Tegegne *et al.* (2017), showed that land holding size had negative relationship with household likelihood of value addition and level of value addition participation. Thus, this variable was hypothesized to affect value addition participation decision and intensity of participation negatively.

**Labor Cost (Laborcost):** It is a continuous variable measured on man day equivalence. Fishing and fish processing was labor intensive activities. Fishermen need extra labor to fillet, gut, salt, and dry their fish products. It was hypothesized that this variable have a negative and significant effect on the value addition intensity of the fishermen.

**Fish capture/day (fishcatchda):** It is a continuous variable that is measured in kilo gram. The fishermen have a chance to allocate certain amount of fish for value addition when the captured fish per day is high. Beyene *et al.* (2017), Lemma *et al.* (2017), Karna (2015), Mamo *et al.* (2014), and Tilahun *et al.* (2020) found that increase in milk yield per day enhanced milk value addition participation. Therefore, this variable was hypothesized to affect fish value addition and intensity positively.

**Table 2.** Description of explanatory variables considered in the double hurdle model

| Variables | Symbol | Type | Measurement | Expected sign |
|---|---|---|---|---|
| Education level of fishers | Educ | Continuous | Year of schooling | + |
| Total family size | Famsize | Continuous | Years | +- |
| Total farm land | Totfamlan | Continuous | Hectare/timad | +- |
| Experiences of fishing activity | FishExp | Continuous | Years | + |
| Boat type | BoatType | Dummy | 1=motorized ,2 reed boat | + |
| Training | Training | Dummy | 1=yes , 0 no | + |
| Price fluctuation problem | PrfluctuationProb | Dummy | 1=yes , 0 no | +- |
| Cold storage problem | Coldstorage | Dummy | 1=yes , 0 no | +- |
| Labor cost for value addition | Lobourcost | Continuous | ETB | - |
| Amount of fish catch/day | fishcatchda | Continuous | Kg | + |

### 3.6.4. Independent variables in market outlet choice of the fishermen

**Market outlet choice**: It is a categorical binary dependent variable measured by a choice of market outlets, defined and measured as binary outcome. The multivariate Probit model has a set of categorical binary dependent variables (Yi) such as: $Y_1$ = wholesalers; $Y_2$ = retailers; $Y_3$= collectors; $Y_4$ = hotels and restaurants, and $Y_5$ = consumers for the fishermen who choose wholesalers, retailers, collectors, hotel and restaurant, and consumers respectively.

**Table 3.** Description of explanatory variables in the multivariate Probit model (MVPM)

| Variables | Type | Measurement | Expected sign | | | | |
|---|---|---|---|---|---|---|---|
| | | | **Wholesaler** | **Retailer** | **Collector** | **Hotel/Restaurant** | **Consumer** |
| Educ | Cont | Year of schooling | +- | +- | - | + | + |
| Totfamlan | Cont | Hectare/timad | +- | +- | +- | - | - |
| BoatType | Cont | 1=motorized ,2 reed boat | + | +- | - | +- | +- |
| EngfishA | Cont | 1= full time ,2 seasonal | +- | +- | +- | +- | +- |
| Training | Cont | 1=yes , 0 no | +- | +- | +- | + | + |
| Mktinformation | Dum | 1=yes , 0 no | +- | +- | +- | + | + |
| fishcatchda | Dum | | + | +- | + | +- | - |
| DsLsitmainFishMKT | Dum | Minutes of walk. | + | +- | + | - | - |

*Note: "Cont" stands for continuous and "Dum" for dummy variables*

# Chapter 4. RESULTS AND DISCUSSION

In this chapter the major findings of the study are presented and discussed accordingly. Firstly, the demographic and socio-economic characteristics of sample fishers are presented and discussed by using Descriptive and inferential statistics. The demographic characteristics of sample traders, fish restaurants and consumers are also discussed. The fish value chain is also discussed in terms of marketing margin analysis which includes a map of the value chain actors and their respective roles, marketing margins, marketing channels, and benefit shares of each actor along the value chain. Finally, the determinant factors that affect the quantity of fish market supply and intensity of value addition in the study area are included. The market outlet choice of the fishers is also part of this chapter.

## 4.1. Demographic and Socio-economic Characteristics of the Fishermen

The demographic characteristics of the fishers include age, sex, and family size, education level, training, and fishing experience. The results of the study revealed that almost all of the fishermen were capturing fish mainly for marketing purposes. All fishers have been provided their fish to the market unless it is diminished by post-harvest loss. The study result indicated that 195 (86.28%) sample fishermen have participation in some value-adding activities whereas 31 (13.72%) fishermen have no participation in any value-adding activities. Although most of them participated in value-adding activities like filleting, gutting, salting and drying but the estimated value-added was not significant as compared to other developing country.

**Sex of fishers**: The result indicated that all observed fishers in study area were men. It implies that fishing activities are male controlled (Table 4). This might be due to the fact that fishing activity by itself needs energy and strength while surfing in the lake, laying the net and collecting the caught fish to the boat. In line with this finding, Alemu and Azadi (2018) reported that fishing activity is entirely male dominated in their value chain study on Lake Tekeze, Ethiopia. Similarly, the study by Asmare *et al.* (2017) in Lake Tana depicted that fishing is usually considered as occupation of men, emphasizing women's responsibility during post-harvest processing and marketing.

**Training of fishermen:** The survey result indicated that 97 (42.92%) of sampled fishermen have got basic training on fishing and fish post-harvest handling techniques (Table 4). The majority of the fishermen, 129 (57.08%), have not participated in any of the trainings. Out of the trained fishermen, 81 (83.5%) respondent fishermen had participation in value adding activities. Whereas 16 (16.5%) of the trained fishermen have not yet participating in value adding activities. On the other hand, from the 129 none-trained fishermen, 114 (88.4%) of them have participation in value adding activities. Whereas, 15 (11.6%) have no participation in value adding activities. The chi-square test ($\chi 2 = 1.10$) did not show evidence for the presence of a significant association between the two groups. This implies that most training did not consider the key gaps of the fishermen, most of the time the training focuses on the fishery production and management. In addition, the trainers are not professionals of the subject matter.

**Table 4.** Socio-economic and demographic characteristics of the fishermen based on categorical variables

| Variable Variable | Participation on value addition | | | | |
|---|---|---|---|---|---|
| | **Category** | **Participant N=195** | **Non-participant N=31** | **All case N=226** | **$X^2$-value** |
| Sex | Male | 195(86.28%) | 31(13.7) | 226(100) | - |
| | Female | 0(0.00) | 0(0.00) | 0 (0.00) | |
| Training | Yes | 81(83.5%) | 16(16.5%) | 97(42.92) | 1.10 |
| | No | 114(88.4%) | 15(11.6%) | 129(57.08) | |

**Source:** Own computation from the 2022survey

**Family size**: The average family size of the fishermen who involved in value addition is 3.79, whereas the non-participant fishermen have a family size of 3.0 with standard deviation of 1.96 and 1.89respectively (Table 5). Similarly, 3 was reported as the mean fishermen family size in a fish value chain analysis study in Gilgel Gibe Dam I reservoir, Southwestern Ethiopia (Awel *et al.*, 2018). The family size of the fishermen in our study area has less family size compared to other areas in Ethiopia. For instance, Alemu and Azadi (2018) in their value chain study reported 5.7 as the mean family size of the fishermen in Tekeze reservoir, Northern Ethiopia.

**Age of fishermen**: Age plays an important role in any type of business, especially in fishing and fish post-harvest handling activities. Age further reflects the productivity of the

population since it has an indication on the overall situation of health within the community. The mean age of the fishermen in Lake Tana is found to be 32 years with a standard deviation of 8.84 (Table 5). The participant fishermen in value addition have significantly higher age (older) than the fishermen who have no participation in value addition with 32.84 and 28.40 years respectively. This implies that, the fishermen household heads were relatively younger and the fishing activity attracts younger labor force. Similarly, Alemu and Azadi (2018) reported that fishing household heads were relatively younger than the non-fishing household heads. The t-test (2.75**) indicates that there has been a significant mean difference between the two groups in terms of age. The result also shows relatively older fishermen have involved in value addition activities. This further implies experience matters in fish value addition. The study by Asmare *et al.* (2017) reported the average age of the fishermen was 36.5 years and Cheffo *et al.* (2021) reported 35.5 years which are a bit higher than the current finding. This discrepancy might be due to sample size, sampling strategy and area coverage difference.

**Fishing experience**: The survey result indicated that the average fishing experience of the fishermen in the study area is 12.65 years. Fishermen who have participated in value addition have better fishing experience, 13.16 years, than the non-participants which is about 9.50 years (Table 5). The t-test (2.63**) evidenced for the presence of a significant mean difference between the two groups in terms of fishing experience. The positive sign of the t-value further indicates the fishermen who participate in value-addition were more experienced than the non-participants.

**Education level:** the survey result indicated that the mean education level of the participants and non-participants in value addition are 4.7 and 6.6, respectively (Table 5). The t-test (-2.75***) indicates the presence of a significant mean difference between the two groups in terms of education level. The negative sign of the t-value indicates that households who participate in value-addition are less educated than the non-participants. This implies that education yet not contributes to fish value addition and the majority of fishermen follow the traditional way of doing the business.

**Fish catch/day:** the survey result indicated that the mean catch of participants and non-participants are 28.58Kg and 31.24 Kg fish per day respectively. The t-test (-0.94) indicated that no significance mean differences the two group in terms of amount of fish catch per day.

**Table 5.** Socio-economic and demographic characteristics of the fishermen based on continuous variables

| Variables | Participation on value addition | | | |
|---|---|---|---|---|
| | Participant N=195 | Non participant N=31 | All case N=226 | t-value |
| Family size | 3.79 (1.96) | 3.0 (1.89) | 3.67 (1.92) | 2.14* |
| Age | 32.84 (8.67) | 28.41 (7.83) | 32.2 (8.84) | 2.75** |
| Fishing experience | 13.15 (7.30) | 9.5 (6.3) | 12.65 (7.30) | 2.63** |
| Education level | 4.73 (3.68) | 6.58 (3.64) | 5.0 (3.75) | -2.75** |
| Fish catch per day | 28.58(14.56) | 31.24(15.56) | 28.94(14.7) | -0.94 |

**Source:** Own survey result, 2022. Numbers in parenthesis indicates the standard deviation.

**Market information:** out of the total respondent fishermen, 212 (93.8%) have market information access while the remaining respondents, 14 (6.19%), do not have market information access (Table 6).The average quantity of fish market supply by fishermen who have market information access is about 7842.96 Kg per annum whereas fishermen who do not have market information access can supply up to 3983.14 kilo gram fish per annum. The t-test (3.12***) indicates that there was a significant mean difference between the two groups in terms of the quantity of fish market supply at 1% level of significance. The positive sign of t-value further implies that fishermen who have market information access supplied more fish to the market. Friends, neighbors and traders are the major sources of market information for most fishermen.

**Membership to fishery cooperative:** the result indicated that out of the total interviewed fishermen (226), only 77 (34.07%) are cooperative members whereas 149 (65.93 %) of them were not cooperative member. Similarly, Amare *et al.* (2018) reported that private fishermen dominated in the Lake Tana fishing activity. The result in this study showed that cooperative membership have increased compared to what Amare *et al.* (2018) reported (17 %). The average annual quantity of fish supply to the market, by cooperative members and non-members is 7254 and 7784.40 Kg during the 2022 fishing season, respectively. The negative value of the t-test (-0.82), although non-significant, implies that cooperatives likely delivered less fish to the market compared to non-members together. Clearly, non-members contribute slightly greater quantity of fish to the fish market supply. This might be due to the fact that most fishery cooperatives are weak, older, and yet not able to empower

individual members. On top of this, the policies and the legal systems in the fishery sub-sector yet not support and protect cooperatives; it is rather a common pool resource that any interested person could engage in the fishing activity.

**Training**: The study showed that the fishermen who have got training could supply more fish (9332.45 Kg) to the market than the non-trained fishermen which is about 6304.07 Kg per annum (Table 6). The t-test (5.22***) implies that there is a significant mean difference between the two groups in terms of quantity of fish market supply at 1% level of significance. This might be due to the fact that the fishermen who have accessed training can have a better awareness about how to use fishing equipment, fishing season, and any new technologies.

**Credit access**: The result indicated that 40 (17.70 %) of the respondent fishermen have utilized credit access whereas 186 (82.30 %) have not utilized credit access (Table 6). As indicated in Table 4.3, the average quantity of fish supplied to the market by the fishermen who have credit access is higher (8948 Kg) than the fishermen who have not access to credit (7314.7 Kg) though it is non-significant. This might be due to the fact that, fishermen who have utilized credit access can buy modern fishing equipment like fishing nets, fishing boats and fish post-harvest handling facilities which could empower the capturing capacity of the fishermen and help to supply more fish to the market. Microfinance, local money lenders, saving and credit associations and friends were found to be the main credit sources for the fishermen in the study area.

**Boat ownership:** The survey result indicated that out of the total respondent fishermen, 24(10.62%) owned motorized steel boat and the remaining 202 (89.38 %) have only papyrus reed boat**.** As indicated in table 6 below, the fishermen who used motorized boat could supply an average quantity of 15318.63 Kg fish to the market during the 2022 fishing season. Whereas, the fishermen who owned papyrus reed boats could only supply an average quantity of 6684.86 Kg fish to the market. The t-test (10.78***) confirmed the presence of a statistically significant mean difference between the two groups in terms of the quantity of fish supplied to the market. More importantly, the result confirmed that the fishing activity in Lake Tana is still dominated by artisanal fishing. The fishermen who had motorized steel boat supplied more fish to the market since they were able to cover wide and distant areas of the lake during fishing activities compared to reed boat users.

**Type of fishing participation:** As indicated in table 6 below, 155 (68.5%) of the respondent fishermen were full time participants. Whereas, 71 (31.4%) of the respondent fishermen are seasonal participants in fishing activities. When we see the quantity of fish supply to the market during the 2022 fishing season, the full timer has a lion share contribution which is about 8787.18 Kg fish supply while the seasonal participants supply only 5020.56 Kg. The t-test (6.22**) indicates the presence of a significant mean difference between the two groups in terms of the quantity of fish supply to the market. Fishing is the main livelihood strategy for the full-time participants so that they know well about the fish abundance of each segment of the Lake, the fish behavior, fishing time, and what type of fishing equipment to be used.

**Table 6.** Relationship of quantity of fish market supply with categorical variables

| Variables | Category | Respondents (N = 226) | Quantity of fish supply | | |
|---|---|---|---|---|---|
| | | | **Mean** | **SD** | **t-value** |
| Market information | Yes | 212 (93.81%) | 7842.96 | 4520.17 | 3.12*** |
| | No | 14 (6.19%) | 3983.14 | 3631.78 | |
| Membership to coop. | Yes | 77 (34.07%) | 7254.50 | 2989.13 | -1.24$^{ns}$ |
| | No | 149 (65.93%) | 7784.40 | 5188.97 | |
| Training | Yes | 97 (42.92%) | 9332.45 | 4759.77 | 5.22*** |
| | No | 129 (57.08%) | 6304.07 | 3948.46 | |
| Credit access | Yes | 40 (17.7%) | 8948.3 | 5516.43 | 2.07$^{ns}$ |
| | No | 186 (82.30%) | 7314.73 | 4289.27 | |
| Boat type | Motorized | 24 (10.57%) | 15318.63 | 6035.8 | 10.78*** |
| | Reed | 202 (89.43%) | 6684.86 | 3339.9 | |
| Fishing participation | Full time | 155 (68.58%) | 8787.18 | 4610.9 | 6.22*** |
| | Seasonal | 71 (31.42%) | 5020.56 | 3192 | |

**Sources:** own survey result, 2022. **ns** = non-significant difference, SD = standard deviation.

**Farm land and Livestock holdings:** The study findings showed that the average total farm land for participants and non-participants in value addition were 1.97and 1.04 "*Timad*" which is equivalent to 0.49 and 0.26 ha, respectively. The average TLU for participants and non-participants in value addition is 2.24 and 2.40 respectively. The t-test (2.36**) shows evidence for the presence of a significant mean difference between the two groups in terms of total farm land holding (Table 7). However, the t-test (0.3) doesn't show any evidence for the presence of a significant mean difference between the two groups in terms of TLU.

**Table 7.** Land and livestock ownership of respondent fishermen

| Variables | Participation in value addition | | | |
|---|---|---|---|---|
| | Participants N=195 | Non participants N=31 | All case N=226 | t-value |
| Total farm land | 1.97 (2.11) | 1.04 (1.26) | 1.8 (2.0) | 2.36** |
| TLU | 2.40 (2.77) | 2.24 (2.72) | 2.38 (2.7) | 0.30ns |

**Sources:** own survey result, 2022. Numbers in parenthesis indicates the standard deviation.

### 4.2. Institutional Characteristics of the Fishermen

**Cooperative membership**: The survey result indicated that 76 (33.63%) and 119 (52.65%) of households were cooperative members from participants and non-members respectively. From the non-participant respondents, 1 (0.44%) of them was cooperative member and 30 (13.27%) were not member. The chi-square test ($\chi 2 = 15.2$***) shows that there was a significant association between cooperative membership and value addition at less than 1% significant level.

**Distance from home to landing site:** The study result revealed that average travel time for participant and non-participant households was 22.05 and 19.22 minutes, respectively to reach from home to landing site (Table 8). The t-value (0.85) has no evidence for the presence of a significant mean difference between the two groups in terms of travel time.

**Distance from landing site to main fish market:** The study result indicates that the average travel time for participant and non-participant fishermen in value adding activities were found to be 127.66 and 61.61 minutes respectively to reach the main fish market. The t-test (5.20) has showed evidence for the presence of a significant mean difference (P = 0.01) between the two groups in terms of travel time to the main fish market (Table 8). The positive sign of the t-value also indicates that the participant fishermen in value adding activities travelled more distance, more than double, compared to the non-participants. The distance travelled from landing site to the main marketplace by the participant fishermen were significantly (P = 0.1) longer than the non-participant fishermen households (Table 8). This is mainly to preserve the fish and reduce the post-harvest loss during traveling. In other

words, those fishermen close to the main market have a chance to reach the market with fresh fish than the faraway fishermen.

**Distance from landing site to local fish market:** As indicated in Table 8 below, the average travel time for participant and non-participant households was 20.46 and 16.22 minutes respectively. The t-value (1.76) is evidence for the presence of a significant mean difference between the two groups in terms of travel time at less than 10% significant level.

**Distance from landing site to input supply market:** the result as presented in Table 8 below indicated that the average travel time for participant and non-participant fishermen were found to be 139.0 and 170.5 minutes, respectively. The t-value (-2.58) is evidence for the presence of a significant mean difference between the two groups in terms of travel time at less than 5% level of significance. The negative sign of t-value implies that participants travelled less distance as compared to non-participants due to the closeness of the market.

**Table 8.** Institutional characteristics of respondent fishermen

| Variables | Participation on value addition | | | |
|---|---|---|---|---|
| | Participant N=195 | Non participant N=31 | All case N=226 | t-value |
| Distance to landing site | 22.1 (17.7) | 19.2 (12.6) | 21.7 (17.7) | 0.85 |
| Distance to main market | 127.7 (65.2) | 61.6 (68.0) | 118.6 (69.3) | 5.20 |
| Distance to local market | 20.5 (18.7) | 16.2 (12.4) | 19.9 (18.2) | 1.76 |
| Distance to input supply | 139.0 (62.2) | 170.5 (67.6) | 143.3 (62.8) | -2.58 |

**Sources:** own survey result, 2022. Numbers in parenthesis indicates the standard deviation.

**Input utilization:** The main fishing equipment that the fishermen used at Lake Tana were gill-nets, motorized fishing boats, reed boat which is made of local materials, fishing hooks**;** filleting knife were the fishing equipment. Almost all fishermen use monofilament gill net that was less than 6cm mesh size.

**Fishing frequency:** Table 9 displays the fishing frequency of the fishermen across the different seasons. The average fishing days for individual fishermen during the active fishing season is found to be 6 days per week, ranging from 3 to 7 days per week. Similarly, the average fishing days for individual fishermen during the medium fishing season is 6

days per week with the minimum and maximum of 2 and 7 days per week. During the passive fishing season on the other hand, individual fishermen could practice fishing for 5 days per week. However, our result confirmed that there is no significant mean difference between the participant and non-participant fishermen in value addition activities in terms of fishing frequency.

**Table 9.** Fishing frequency of the respondent fishermen per week in Lake Tana

| Season | Mean | Minimum | Maximum | SD |
|---|---|---|---|---|
| Active season | 6.50 | 3 | 7 | 0.97 |
| Medium season | 5.95 | 2 | 7 | 1.24 |
| Passive season | 4.88 | 0 | 7 | 2.11 |

**Sources:** own survey results, 2022. SD stands for the standard deviation.

### 4.3. Fish Production and Marketing by Fish Species

The result of this study showed that all the respondent fishermen participate in fish marketing (Table 10). As this study, the mean capture of 3027.48, 2584.15 and 2762.58 Kg of Tilapia, Barbus, and Catfish per year respectively was recorded. On average from the three commercial fish types in Lake Tana, 7944.15 Kg of fish per annum has caught during the 2022 season. The average quantity of fish capture by participant and non-participant fishermen in value adding activities is 7809.36 and 8792 Kg respectively. Although, it seems it has a quantitative difference, the t-test (1.08) does not confirm the presence of a significant mean difference between the two groups. Considering the Tilapia fish species alone, the participant fishermen in value adding activities has caught significantly less quantity of fish (2736.52 Kg) than the non-participant fishermen (4827.54 Kg) at 1% level of significance. The average quantity of Barbus fish capture by participant and non-participant fishermen in value adding activities is 2716 and 1651.66 Kg per year respectively. The t-test (2.83) indicates that there is a significant mean difference between the two groups at 5% level of significance. The positive t-value further implies that the participants capture more Barbus fish species compared to the non-participant fishermen in value adding activities. On the other hand considering the Catfish alone, the participant and non-participant fishermen in value adding activities could capture an equivalent quantity of Catfish which is about 2760.95 and 2773.2 Kg per annum respectively. Generally, the survey result showed that

out of the total quantity of all fish species caught (1,795,379 Kg/year), 1,718,473 Kg/year (95.71%) was supplied to the market through various channels. However, according to the information obtained from focus group discussions and key informants, the current fish production trend is declining. This is mainly due to the different challenges such as illegal fishing, recession agriculture, over fishing, and invasion of water hyacinth.

**Table 10.** Average fish production and volume sold of the participant and non-participant fishermen in value adding activities by fish species

| Variables | Production by participation in value addition | | | |
|---|---|---|---|---|
| | Participant N=195 | Non participant N=31 | All cases N = 226 | t-value |
| Tilapia | 2736.5 (1986.4) | 4827.5 (3946.0) | 3027.0 (2454.0) | -4.6*** |
| Barbus | 2716.6 (1711.7) | 1651.7 (1810.0) | 2584.2 (1755.1) | 2.83** |
| Catfish | 2761.0 (1680.6) | 2733.2 (2025.8) | 2762.6 (1725.6) | 0.036$^{ns}$ |
| Total | 7809.4 (4453.0) | 8792.0 (6064.4) | 7944.2 (4702.7) | 1.08$^{ns}$ |
| | Volume sold by participation in value addition | | | |
| Tilapia | 2594.8 (1932.3) | 4697.3 (3776.5) | 2887.1 (2381.7) | -4.78 |
| Barbus | 2507.8 (1624.4) | 1713.4 (1818.9) | 2416.3 (1662.1) | 2.12 |
| Catfish | 2717.6 (1651.8) | 2773.2 (2025.8) | 2725.0 (1701.3) | 0.16 |
| Total | 7446.0 (4290.7) | 8597.0 (5975.5) | 7603.9 (4559.8) | -1.30 |

**Sources:** own survey result, 2022. Numbers in parenthesis indicate the standard deviation.

As indicated in Table 10 above, the mean quantity of fish sold by participant and non-participant households was 7445.97 and 8597.03 Kg respectively. However, the t-test (-1.30) has no evidence for the presence of a significant mean difference between the two groups regarding to the quantity of fish sold. The survey result indicated that the mean quantity of Tilapia sold by participant and non-participant households was 2594.80 and 4697.29 kilo gram respectively. The t-test (-4.78***) has an evidence for the presence of a significant mean difference between the two groups regarding to quantity of fish sold at 1% level of significant. The negative sign of t-value indicates that participants were provided and sold less tilapia product as compared to non-participants households. On the other hand, the participant fishermen in value adding activities sold significantly more Barbus fish species (2507.84 Kg) compared to the non-participant fishermen which are about 1713.45

Kg. However, the average quantity of Catfish sold by participant and non-participant fishermen is almost equivalent which are about 2717.63 and 2773.2 Kg per year respectively.

### 4.4. Fish production, selling and consumption by boat type and district

The fishing boats that the fishermen in Lake Tana have used are the reed and motorized boats. The majority of the respondent fishermen used the reed boat which is locally made by papyrus trees. This further indicates the fishing activity in Lake Tana is still traditional way of fishing usually called artisanal. This result indicated that the daily average fish capture of an individual fisherman who implemented motorized and papyrus reed boat is found to be 52.02 and 26.84 Kg/person, respectively, during the 2022 fishing season (Table 11). Thus, the total volume of fish capture by motorized and reed boat users are equivalent to 377,413 and 1,417,966 Kg/year respectively. Fishing with motorized boats is 3.76 times more efficient than the papyrus reed boats. From this result, it is clear that the total volume of fish produced by the respondent fishermen all together is 1,795,379 Kg/year. This is by far larger quantity of fish capture than other Lakes and reservoirs. For instance, Awel *et al.* (2018) reported a total capture of 196,885 Kg/year in Gilgel Gibe Dam-I reservoir, southwest Ethiopia. According to the respondent fishermen, nearly 95.7% of their capture is directly supplied to market through different market channels. It is only 3.7% of their capture goes to home consumption. The remaining 0.6% is lost in different ways before marketing.

**Table 11.** Fish production, selling and consumption by boat type

| Boat type | Number of fishers | Average fishing days/year | Total capture/year (ton) | Average capture/ day/fisher (Kg) | Total sold/year (ton) | Annual consumption (ton) | Loss (ton) |
|---|---|---|---|---|---|---|---|
| Motorized | 24 | 302.3 | 377.4 | 52.02 | 367.6 | 8.80 | 0.98 |
| Reed | 202 | 261.5 | 1418.0 | 26.84 | 1350.8 | 58.11 | 9.03 |
| Total | 226 | 265.9 | 1795.4 | 29.88 | 1718.5 | 66.90 | 10.01 |

It is reported that, the fishermen in Gilgel Gibe Dam-I reservoir have used about 16.4% of their captured fish for household consumption (Awel *et al.*, 2018). Thus, the fishermen

households in Lake Tana are the least fish consumers. However, the fishermen in Lake Tana could be characterized by having insignificant loss compared to other studies. For instance, Awel *et al.* (2018) reported about 4.5% loss in Gilgel Gibe Dam-I reservoir. This discrepancy might be due to fishing experience and the availability of marketing options.

The result of this study showed that the lowest quantity of fish daily capture is observed in Takusa district, 21.9 Kg/person during the 2022 fishing season (Table 12). The largest volume of fish daily capture is in Bahir Dar zuria district which is about 34.96 Kg/person followed by Fogera district with 33.56 Kg/person. On the other hand, districts such as Dembia, Gondar zuria, and Alefa have almost equivalent daily fish capture which is about 29 Kg/person. According to the result, fishermen in Alefa district is found to be the most fish consumer with 5.9% of their capture goes to home consumption followed by Takusa, Dembia, and Gonder zuria fishermen who consume more than 4% of their capture. Fishermen in Bahir Dar zuria district consume nearly 3% of their capture. Whereas, fishermen in Fogera district consume the lowest portion of their capture which is about 2.75%. The main reason of the lowest consumption by Fogera and Bahir Dar zuria districts might be the market accessibility of the area that encourages them to take most of their fish capture to the market.

**Table 12.** Fish production, selling and consumption by district

| **Districts** | **Number of fishers** | **Average fishing days/ year** | **Total capture/ year (ton)** | **Average capture/ day/fisher (Kg)** | **Total sold/ year (ton)** | **Annual consumption (ton)** | **Loss (ton)** |
|---|---|---|---|---|---|---|---|
| Alefa | 16 | 264.2 | 119.58 | 28.3 | 111.14 | 7.00 | 1.43 |
| Dembia | 31 | 231.6 | 213.35 | 29.71 | 201.10 | 8.92 | 3.33 |
| Gondar | 46 | 289.4 | 385.84 | 28.98 | 366.39 | 15.91 | 3.54 |
| Fogera | 62 | 273.32 | 568.78 | 33.56 | 552.59 | 15.69 | 0.50 |
| Bahir Dar | 33 | 241.9 | 279.19 | 34.96 | 269.39 | 8.78 | 1.02 |
| Takusa | 38 | 274.6 | 228.64 | 21.90 | 217.86 | 10.59 | 0.20 |
| Total | 226 | 265.9 | 1795.4 | 29.88 | 1718.47 | 66.90 | 10.01 |

### 4.5. Processing and the Role of Women in Fish Post-harvest Handling

The Lake Tana Fishermen supplied their caught fish to the market in the form of whole, filleted, gutted, salted and dried fish. Clearly, most fishermen in this study area accomplish only the preliminary fish processing activity such as: washing, filleting, gutting, cleaning and some of them add some processing and preservation activity such as salting and sun drying. As indicated in Table 13, the various forms of fish supplied to the market comprised of 641,002.4 Kg (37.30%) whole, 244,791 Kg (14.24%) filleted, 203,249.56 Kg (11.32%) gutted, 32,684.6 Kg (1.82%) salted, and 596,746.8 Kg (34.72%) dried forms. After the fish is caught by the fishermen, women are usually responsible for the post-harvest handling and processing activities (washing, gutting, cleaning, salting and drying).Then, they take the fish directly to the market for selling by carrying on the shoulder/head, motor boat, Bajaj and motor cycle without any further processing and preservation techniques that leads some to spoil.


Figure 4. Fish post-harvest handling. a) the role of women in filleting and gutting, and b) the drying method of fish

**Table 13.** The existing ways of fish processing and value addition in this study area

| Types of processing and value addition | Participant N=195 | | Remark |
|---|---|---|---|
| | Frequency | Percentage (%) | |
| Washing | 188 | 83.18 | These are the preliminary processing stage |
| Cleaning | 183 | 80.97 | |
| Filleting | 187 | 82.5 | |
| Gutting | 87 | 35.8 | |
| Salting | 128 | 56.6 | Secondary processing (kind value additions) |
| Sun drying | 174 | 77.0 | |

### 4.6. Description of Fish Traders

#### 4.6.1. Demographic and Socio-economic characteristics of traders

All sampled traders in the study area are males. As indicated in Table 14, out of the total sample traders, 12 (100%) were male. Regarding marital status of sample traders 11 (91.7%) are married whereas only 1 (8.3%) is single. Concerning the religious status, all the sample traders are found to be Orthodox Christian.

**Table 14.** Distribution of sample traders by sex, marital status and religious

| Variables N=12 | Category | Number | Percent |
|---|---|---|---|
| Sex | Male | 100 | 100% |
| | Female | 0 | |
| Marital status | Married | 11 | 91.7% |
| | Single | 1 | 8.3% |
| Religious | Orthodox christian | 12 | 100% |
| | Muslim | 0 | |
| | Protestant | 0 | |

**Sources:** own survey result, 2022

As indicated in Table 15, the mean age of sample fish traders is 39.75 years with standard deviation of 7.5. The average family size of sample traders is about4.8 persons with a standard deviation of 2.67. Concerning educational status of fish traders, the average

number of years of schooling completed was 8.92 years with a standard deviation of 3.75. On average, traders have 7.75 years of experience in fish trading.

**Table 15.** Distribution of sample traders by age, family size and education

| Variable N=12 | Mean | Standard deviation |
|---|---|---|
| Age | 39.75 | 7.50 |
| Family size | 4.80 | 2.60 |
| Education level | 8.92 | 3.75 |
| Fish trade experiences | 7.75 | 2.70 |

**Sources:** own survey result, 2022

### 4.6.2. Financial assets of fish traders

**Initial working capital**: The result indicated that the mean initial working capital of sample fish traders was 8,125.00 ETB with the minimum and maximum initial capital of 3,000 ETB and 30,000 ETB respectively. Whereas the current working capital of the sample fish traders has increased to 226,666.67 ETB with the minimum and maximum working capital of 40,000 ETB and 500,000 ETB respectively during the study period (Table 16).

**Table 16.** Financial asset of sampled traders

| Description | Mean | Standard deviation | Minimum | Maximum |
|---|---|---|---|---|
| Initial working capital | 8,125.00 | 7,268.03 | 3,000 | 30,000 |
| Current working capital | 226,666.67 | 223,742.76 | 40,000 | 500,000 |

**Sources:** own survey result, 2022

### 4.6.3. Price setting strategies of traders for fish purchasing

Most traders, 8 (66.7%), have been purchased fish three days a week. The remaining 4 (33.3%) of the fish traders have purchased throughout a week (Table 17). The terms of payment for purchasing are in cash. All the respondents confirm that they purchase fish year round. Most traders (75%) responded that the purchasing price of the fish is set by the market and the other 25% of the traders responded that the price setting is through negotiation.

However, the traders' responses contradict with the fishermen regarding to price setting strategies. During the focus group discussion in each sample kebele, most fishermen responded that the selling price of fish is usually set by wholesalers/traders and they do not have power to influence the selling price. This is mainly due to lack of some preserving facilities in the hands of the fishermen. Thus, the situation affects the incomes of the fishermen negatively. Most traders (83.3%) responded that they are buying fish at the landing site (Table 17). It is only 16.7% of the traders purchase fish in the district markets. On the other hand, 66.7% of the traders purchase directly from the fishermen while the remaining 33.3% purchase from fish collectors. The main marketing channels of the traders particularly the gutted and filleted fish forms is found to be Gondar, Bahir Dar, Woreta, Dessie and Addis Ababa. The dried and salted fish forms are usually channeled to Metema, Zarima, Dansha, and Adiremet.

**Table 17.** Time of fish purchasing and price setting strategies

| Variables N=12 | Category | Number | Percent |
|---|---|---|---|
| Marketing day per week | Throughout a week | 4 | 33.3% |
| | Three times a week | 8 | 66.7% |
| Time of purchasing | Year round | 12 | 100% |
| | During peak times | | |
| Terms of payment | Cash | 12 | 100% |
| | Credit | - | - |
| Price setting strategy | By the market | 9 | 75% |
| | Negotiation | 3 | 25% |
| Place of buying | Landing site | 10 | 83.3% |
| | Local market | 0 | |
| | District market | 2 | 16.7% |

### 4.7. Socio-economic Characteristics of Fish Hotel and Restaurant Owners

Out of the total sample fish restaurant owners, 5 (62.5%) were females while the remaining 3 (37.5%) were found to be males. Regarding the business type, 2 (25%) are shared and the remaining 6 (75%) are individually owned. The majority of the respondent restaurants, (87.5%), are specialized who provide only fish based food and drinks whereas the remaining 12.5% considered fish as one dish. Most restaurants particularly the specialized purchase fish throughout the week directly from fishermen and/or from the wholesalers.

Regarding the working capital, the mean initial working capital of the sample fish restaurants was 4,250.00 ETB with the minimum and maximum initial capital of 1,500.00 ETB and 10,000.00 ETB, respectively. However, the current working capital of the fish restaurants has raised to 109,375.00 ETB with the minimum and maximum working capital of 25,000.00 ETB and 600,000.00 ETB respectively. This clearly indicates that the fish consumption tradition in the restaurants has increased through time making the business more profitable.

### 4.8. Consumer Characteristics

Among the total interviewed consumers, 66.67% were males whereas 33.33% of the consumers were females. These consumers are households who purchased fish in whole or filleted forms in Woreta, Takusa, and Bahir Dar. The educational level of consumer's ranges from illiterate to BSc/BA degree and above level holders. Both government and private employees, drivers and the trading community livelihoods were the main fish consumers. The mean age and family size of the consumers are found to be 32.13 years and 3.7 family members respectively. However, most consumers emphasized that mostly fish based foods prepared at home are served for their infants and children. Consumers purchased the fish directly from fishermen, retailers and vendors in whole and filleted forms. Consumers who are found in the restaurants are mostly visitors. Residents however, go to fish restaurants usually with their family members together particularly in the weekend. The common food forms served in the fish restaurants are mainly *Cotlate*, *Gulash*, *Tibis*, *Wote*, *Lebileb*. *Kurit*, and *soup* form.

### 4.9. The Fish Value Chain Actors and Functions

This study identified several actors who involved in various activities from fishing to retailing along the Lake Tana fish value chain (Table 18). These actors have found to play defined roles specific to the activities they perform and/or services they provide. The map sketched in Figure 5 highlighted the involvement of various actors who have participated directly or indirectly in the fish value chain of Lake Tana with their respective functions. According to KIT *et al.* (2006), the direct actors are those involved in commercial activities in the chain (input suppliers, fishermen, traders, and consumers). The indirect actors are

those that provide financial or non-financial support services which includes credit agencies, business service providers, government organizations particularly extension agents, NGOs, research institutions, and universities.

**Table 18.** Actors involved along the fish value chain in Lake Tana

| Primary/Direct actors | Supportive/Indirect actors |
|---|---|
| • Fishermen<br>• Fishery cooperatives<br>• Input suppliers<br>• Wholesalers<br>• Retailers<br>• Vendors<br>• Processors/fish hotels and restaurants<br>• Collectors<br>• Consumers | ▪ Development agents<br>▪ Universities<br>▪ Trade and industry office<br>▪ Transport service providers<br>▪ NGOs<br>▪ Agriculture offices<br>▪ Livestock and fishery offices<br>▪ Bahir Dar fishery and other aquatic life research center<br>▪ Micro finances like saving and credit association, local money lenders |

**Sources:** own survey result, 2022

### 4.9.1. Primary value chain actors and their functions

The primary actors of the fish value chain in this study area are input suppliers, individual fishermen, fishery cooperatives, fish traders and consumers. Each of these actors may add values in the process of changing product title. Some functions or roles are performed by more than one actor. In other words, some actors perform more than one role.

**Input suppliers:-**At this stage of the value chain, there are many actors who are involved directly or indirectly in fish input supply in the study area. These are Bahir Dar fishery and aquatic life research center, NGOs, Universities, fish traders, and traders are the main input suppliers. Among the inputs that input suppliers provide are those used mainly for the operation of fishing activities such as gill net, motorized boat, reed boat, cold storage, and hooks and lines.

**Fishermen:** Fish catchers are the major value chain actors following input suppliers in fish value chain. They are individuals or households who support their livelihood by capturing/trapping fish resources. Fish catchers/fishermen are the first link and major actors

who perform the fish capturing and supply to the market and it is the backbone of the fish value chain in the study area. Two types of fishing practices has been identified in Lake Tana. The first type is setting the net in the lake in the afternoon and collects the captured fish in the next day morning. The second type of fishing practice is the active fishing that means setting the net into the lake and waits some time until the fish get into the net then collects the captured fish. Most of the time the second type of fishing is practiced during rainy season/flood time, which is June to August. Fishermen in this study area can be categorized based on their level of participation. This includes full-timers, seasonal, and part-timers. Fishermen who participate seasonal fishing practiced active fishing. It is observed that most fishermen uses monofilament net having mesh size of less than 6cm and traps. This type of net is non-selective that captures very small fish which in turn affect the productivity of the Lake. In addition to capturing the fish, the fishermen in Lake Tana perform several functions in the value chain such as washing, cleaning, gutting, filleting, drying, salting, and transporting to their next customers to take the advantage of form, place and time utility. The filleting and gutting are usually performed at the landing site by using knife on big stones in the beach without using any preservatives. The modes of transportation are on foot using head load and motor cycle, "Bajaj"- a three wheel vehicle, and motorized boats. As the survey result of this study indicated, the average fish supply to the market is found to be 7603.86 Kg per fishermen per annum in Lake Tana during the 2022 fishing season.

**Fish Collectors:** They are fishermen who implement motorized boat then; they capture fish in the lake and also act as traders who collect fish from individual fishermen at their catching site /landing area for the purpose of reselling. As indicated from this study, they use their financial resources and their local knowledge to handle and transport their fish to their customer area. They play an important role in the fish value chain in linking fish catchers particularly the artisanal fishermen with wholesaler, retailers, hotels, restaurants, and consumer markets in the nearby cities and towns. Thus, the function of these actors is doing for time and place utility that is buying, transporting and selling to the next actors along the value chain.

**Wholesalers:** Wholesalers are individual traders who collect large volume of fish from different suppliers mainly the fishermen and collectors originated from different landing sites and distribute others actors. They are the main assembly centers for fish in their

respective surrounding areas and play an important role in linking fish catchers and collectors with the other actors who came from distant cities and towns such as Addis Ababa, Gondar, Wolkaite, and Shire. They have better storage facility, transportation and communication access than any other actors in the value chain.

**Retailers:** They are key actors in this value chain who link between fish catchers and consumers. They are small traders which come from nearby districts or in districts and stands for market stability. They are individuals and cooperatives who buy small amounts of fish and retail either on the market or in small shops. Mostly they buy from the fishermen and wholesalers. As observed in this study area, they clean and store then vend the fish and their products directly to the final consumers and sometimes to restaurants and hotels.

**Fishery Cooperatives:** called a group of fishermen's; this is another actor in the fish market which serves as the intermediary between traders and fishermen. They are organized and licensed by the government body. In case of Lake Tana most fishery cooperatives are not functional.

**Fish restaurants and hotels (processors):** The fish restaurants and hotels are the other value chain actors where the consumers get value added fish. Once they buy fresh fish from fishermen, wholesalers and collectors they store in refrigerators. Based on the order from the customers, they prepare fish based dish by roasting and pickling (addition of spice and vegetable) in the form of locally called *Asa-batikilt* (Fish with vegetables), *Asa-tibse* (Roasted fish), *Asa-cotelete* (Fish cotlate), *Asa-gulash*, fish soup, *Asa-lebileb*, *Asa-wot*, and *Asa-firifir*. They are more responsible for time, place, and form utility for their customer.

**Vendors:** They are other chain actors in the fish value chain who link between producers and consumers. They buy fish directly from the fishermen or retailer in small amount and sell to consumers in local markets. However, they usually prefer to sell their fish by moving through villages also called a door to door services.

**Fish consumers:** Consumers are those who purchase the fresh fish products usually in the form of filleted and gutted from different fish suppliers for home preparation and consumption purpose. They consume fish as a substitute of animal protein foods especially at Christian fasting seasons. Now a day however, fish based dish preparation and

consumption becomes more common during the non-fasting days. They prefer fresh and quality fish for home consumption particularly Tilapia. The reason might be taste and fear of spoilage and contamination.

### 4.9.2. Supportive actors and their functions

Supporting actors are those who provide supportive services for fish producers in the study area. They play crucial roles in providing awareness creation, financial services, information and consultation services (like extension services), training, credit services, market information, and research based new technology services (Figure 5). Supportive actors are usually determined to create conducive environment for the primary actors to accomplish a successful role along the fish value chain. According to Martin *et al*. (2007), access to information or knowledge, technology and finance are the keys to the state of success for value chain actors.

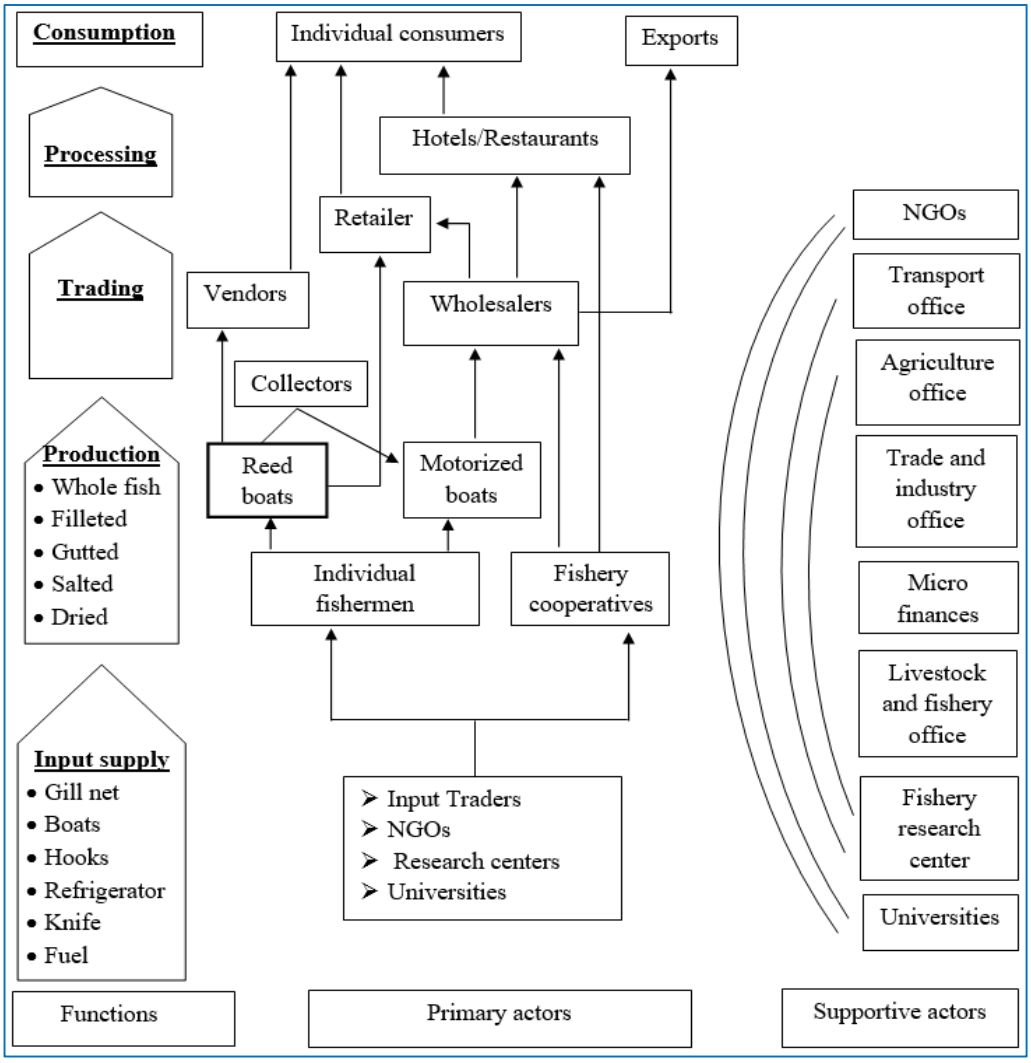


**Figure 5.** Value Chain Actors, Functions and Support service providers. The curve lines from the supportive actors indicate the flow of support to the primary actors

### 4.10. Mapping of the Fish Value Chain

Once the various actors and there functions have identified, the next crucial part in value chain analysis is chain mapping. Value chain mapping is the first step to conduct value chain analysis (Fabe *et al*. 2009). It is a system of sketching to show the product flow from producers up to final consumers by passing different stages including input providers (Figure 6). With the aim of giving justification for the identified actors in the chain and roles they undertake, information and financial flows in the chain. The map indicates the activities of actors, their relationship, and value-added at each stage of the value chain.

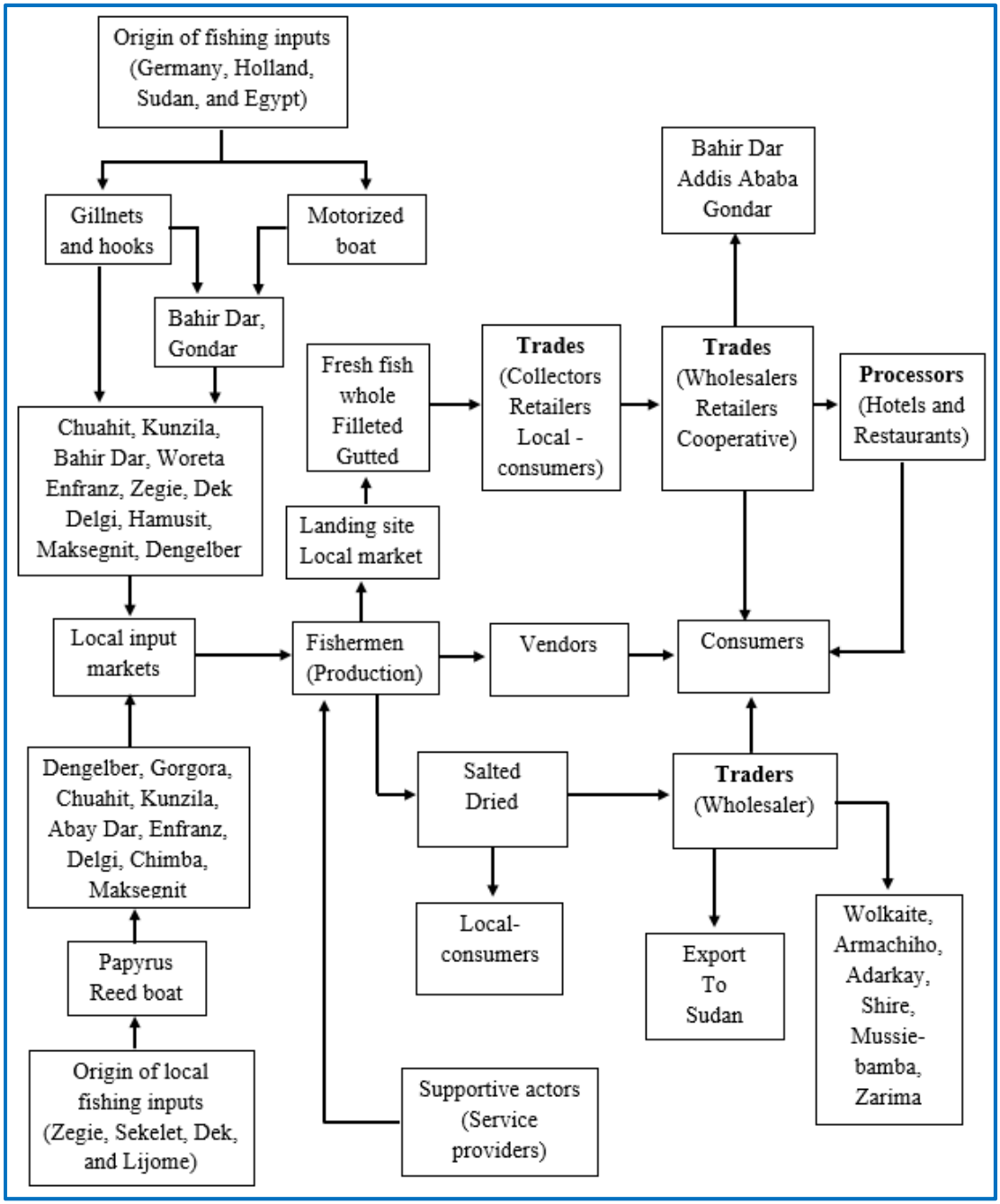


**Figure 6.** Map of fish value chain in Lake Tana based on 2022 survey

### 4.11. Fish Market Outlet Choices

The survey result showed that the fishermen in Lake Tana have sold their capture fish through different marketing outlets. The main recipient of the captured fish around Lake Tana are wholesalers, retailers, collectors, consumers, hotels and restaurants, vendors, and fishery cooperatives. The result of the survey as presented in Table 19 indicated that out of

the total 195 participant fishermen in value adding activities, 155 (79.5%) have sold their fish output to wholesalers. Whereas among the non-participants, 17 (54.8%) have sold their fish output to the wholesaler. The fishermen sold their highest quantity of fish to the wholesalers, whereas consumers were found to be the least quantity recipient from the fishermen (Table 20). The chi-square test ($\chi 2 = 8.9^{***}$) shows evidence for the presence of a significant relationship between whether to choose wholesalers and value addition at 1% level of significance. Similarly, higher number of participant fishermen, 57 (29.2%), have sold their fish outputs to the retailers than the non-participants which is only 4 (12.9%). The chi-square test ($x^2=3.61^{**}$) also confirmed a significant relationship between choice to retailers and value addition participation at 5% level of significance.

**Table 19.** Fish Market outlet choices of Lake Tana

| Variable | Participation on value addition | | | | |
|---|---|---|---|---|---|
| | **Category** | **Participant N=195** | **Non participant N=31** | **All case N=226** | **$X^2$ value** |
| Wholesaler | Yes | 155(79.5%) | 17(54.8%) | 172(76.1%) | 8.9*** |
| | No | 40(20.5%) | 14(45.2%) | 54(23.9%) | |
| Retailer | Yes | 57(29.2%) | 4(12.9%) | 61(26.99%) | 3.61** |
| | No | 138(70.8%) | 27(87.1%) | 165(73.01%) | |
| Collector | Yes | 48(25%) | 10(32.2%) | 58(25.66%) | 0.81 |
| | No | 147(75%) | 21(67.8%) | 168(74.34%) | |
| Consumer | Yes | 103(52.8%) | 7(22.58%) | 110(48.67%) | 9.79*** |
| | No | 92(47.2%) | 24(77.42%) | 116(51.33%) | |
| Hotel and restaurant | Yes | 54(27.7%) | 5(16.1%) | 59(26.11%) | 1.85 |
| | No | 141(72.3%) | 26(83.9%) | 167(73.89%) | |
| Vendor | Yes | 4(2%) | 2(6.45%) | 6(2.65%) | 2.00 |
| | No | 191(98%) | 29(93.55%) | 220(97.35%) | |
| Cooperative | Yes | 2(1%) | 11(35.5%) | 13(5.75%) | 58.58*** |
| | No | 193(99%) | 20(64.5%) | 213(94.25%) | |

**Sources:** own survey result, 2022

**Table 20.** Quantity of fish sold by the fishermen to different actors in Kg

| Variable | Participation on value addition | | | |
|---|---|---|---|---|
| | Participant (N=195) | Non participant (N=31) | All case (N=226) | $X^2$ value |
| Wholesaler | 6121.9 (4672.5) | 8043.3 (6913.1) | 6320.7 (4959.9) | -1.56 |
| Retailer | 3130.7 (2197.7) | 2856.4 (1550.5) | 3121.1 (2168.6) | 0.174 |
| Collector | 4451.6 (3293.1) | 7602.8 (72.5.2) | 4967.2 (4255.8) | 2.09** |
| Consumer | 591 (788.3) | 1403.8 (1972.1) | 643.9 (916.1) | 2.31** |
| Hotel and restaurant | 1271.0 (1139.3) | 2119.1 (2760.2) | 1324.0 (1257.9) | 1.13 |
| Vendor | 158.1 (108.9) | 2976 (-) | 1097 (1457.6) | -34.51*** |
| Cooperative | 1219.3 (349.8) | 2314.0 (1574.1) | 2145.6 (1498.0) | 0.94 |

**Sources:** own survey result, 2022

### 4.12. Fish Marketing Channels in Lake Tana

The fish marketing channel is a pathway through which the product is traveling from the landing sites to the final destination for consumption by different actors with or without value addition. Lake Tana fish marketing channels starts at the landing sites of the Lake and reaches to the final individual consumer by passing through several channels involving a number of actors. During the 2022 season, a total quantity of 1,795,379 Kg fish have captured by the respondent fishermen. This study identified eight different fish marketing channels along the fish value chain in Lake Tana as detailed below and in Figure 7. Compared to previous studies, the fishermen in Lake Tana have better marketing channel options than other lakes. For instance, Mebrate and Worku (2020) identified only five fish marketing channels in Lake Zeway, central Ethiopia.

**Channel - I (Fishermen to consumer):** This is the shortest and simplest channel identified from the other channels. Through this channel, the fishermen sell their fish products directly to the consumers without the involvement of other actors. This channel represents 669,541.6 Kg (4.04%) of the fish market transaction. Whole, gutted, and filleted fish forms are the dominant fish products marketed in the channel with insignificant amount of dried and salted forms.

**Channel - II (Fishermen to wholesaler to retailer to consumer):** in this channel the fishermen sells their fish products to the wholesalers, then the consumers get the fish via retailers. From the total amount of fish supplied to the market, 1,099,802.4 Kg (76.1%) of the fish transaction is made through this channel. This is the largest fish marketing channel in Lake Tana in terms of fish quantity supply.

**Channel - III (Fishermen to retailers then consumers):** In this channel, the fishermen sell their fish products to the nearby retailers and then the retailers distribute the fish to the final consumer. From the total volume of fish supplied to the market, 177,900.82 Kg (10.35%) of the fish transaction is accomplished through this channel.

**Channel - IV (Fishermen to fishery cooperative to wholesaler to retailers then consumers):** This channel is the longest of all channels which holds about 27,893 Kg (1.62%) of the fish transaction. The small proportion of fish transaction through this channel might indicate that the fishery cooperatives are weak in the study area. This in turn is due to weak internal leadership and less emphasis and support by the government policy.

**Channel - V (Fishermen to collectors to wholesalers then hotels and restaurants):** this is another fish marketing channel which involves collectors. Fish collectors are either agents who have a prior agreement with the wholesalers or motorized fishermen who purchase fish from the artisanal fishermen at different landing sites in addition to their capture. In this study area a total quantity of 273,198.8 Kg (15.9 %) fish passes through this marketing channel. This is also another channel which could be categorized among the longest channel. This channel actually ends with consumers which have different characters than the other consumers. Consumers in this channel means who used value added fish products usually visitors or residents who go out to fish hotels and restaurants with family member to consume fish in the weekend and during holydays.

**Channel - VI (Fishermen to wholesaler then hotels and restaurants):** in this channel the fisherman sells their fish products to wholesalers. The wholesalers then sell their stored fish directly to the hotels and restaurants.

**Channel - VII (Fishermen to vendors then consumers):** Although very small amount of

fish products has been exchanged through this channel, it is the second shortest channel in the chain. In this channel another actor called vendors are involved to bridge between the fishermen and consumers. This kind of actors usually carry small amount of fish products and sell to consumers on the local market and by traveling through villages. This channel represents about 0.4% of the fish market transaction around Lake Tana.

**Channel - VIII (Fishermen to hotels and restaurants):** In this channel, hotels and restaurants directly purchase fish products from the fishermen. Then the hotels and restaurants sell to consumers described above in channel-V by adding serious of values depending on their preference. This channel represents about 63,554.01 Kg (3.69%) share in the fish market transaction.

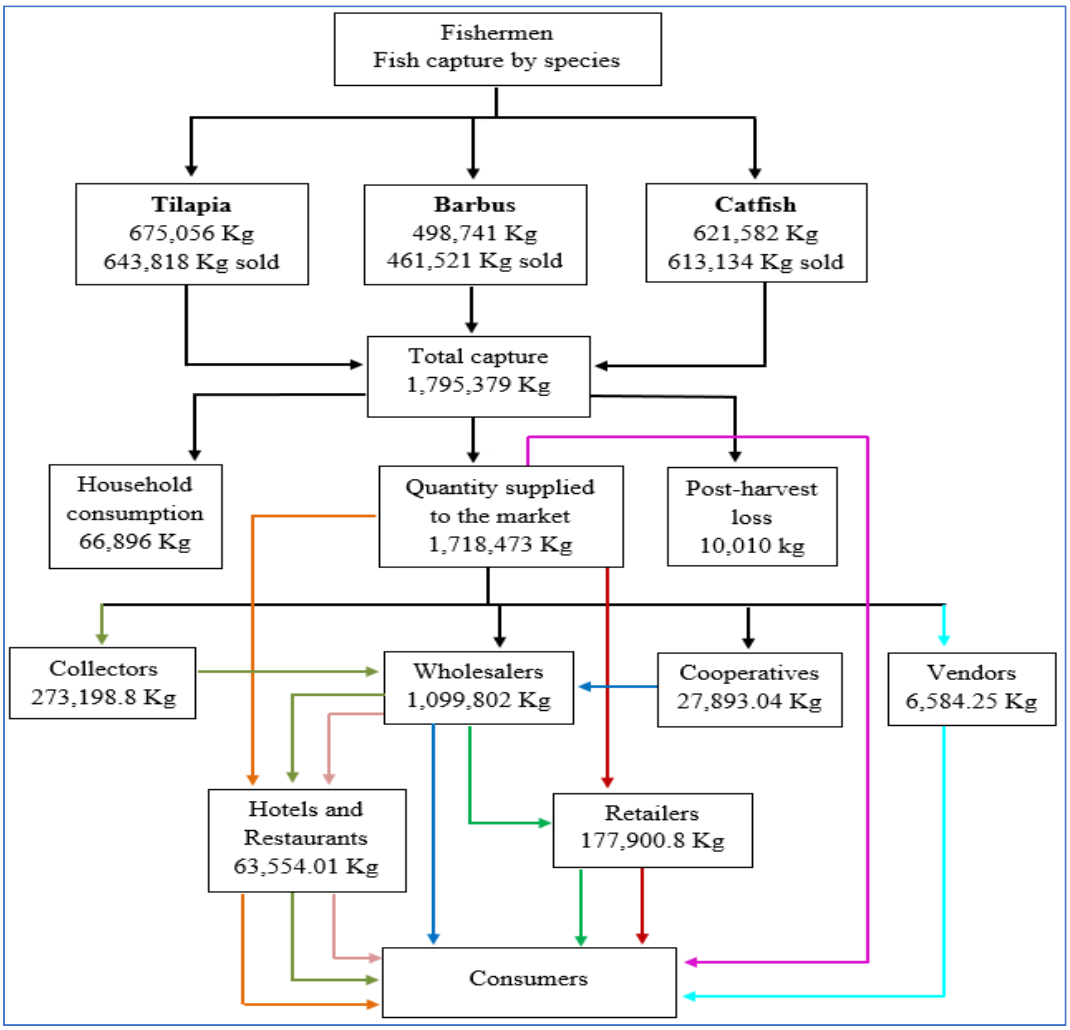


**Figure 7.** Marketing channels of the various actors along the fish value chain in Lake Tana, 2022

## 4.13. Market Margin Analysis

Analysis of the marketing margin along the value chain is an important indicator of the market performance (Olukosi and lsitor, 1990). To compute the marketing margins correctly, it is very crucial to identify the potential cost of production and the selling price of fish and its products by different actors along the value chain. In this study, the cost and revenue are presented and discussed for the six sampling districts separately with the three commercial fish species in five different forms.

### 4.13.1. Fish production cost and profit margin of the fishermen

The survey result presented in Table 21 indicated that the total catching cost in Fogera district for whole fish form is found to be 2, 276,570 ETB/year. In addition, the total filleting, gutting, salting and drying costs are 87275.8 ETB, 59373.4 ETB, 8,400 ETB, and 58,411 ETB/year for all fish species together (Tilapia, Barbus, and Catfish). Thus, the total production cost in Fogera district amounts to 2,490,030.2 ETB/year. On the other hand, the fishermen in Fogera district have got a total revenue of 10,519,538 ETB/year which is 5,739,523.5 ETB from whole fish selling, 1,407,887.6 ETB from filleted, 2,128,163.7 ETB from gutted, 84,848 ETB from salted, and 1,159,116 ETB from dried per year from all fish species together. Thus, it is clear that the fishermen in Fogera district have got a total gross profit of 8,029508 ETB/year. Therefore, an individual fisherman at Fogera district could make an average gross benefit of 160,590.16 ETB/year.

Concerning the fishermen who used motorized boat in this district have incurred total production cost of 2,661,506.7 ETB/year for whole fish capturing activities. In addition, the cost of semi-processing activities amounts to 86,388 ETB/year which arises for filleted (18,481 ETB), gutted (36,662 ETB), and dried (31245.3 ETB). Clearly, the total cost of catching for motorized fishermen in Fogera district is about 2,834,282.7 ETB/year. The revenue gained by the motorized fishermen in Fogera district on the other hand, are 3,457,016 ETB from whole, 410,115 ETB from filleted, 746,875.2 ETB from gutted, and 786,534.2 ETB from dried fish forms which amounts a total revenue of 5,400,540.4 ETB/year. Thus, the total gross benefit of the motorized fishermen in the district is about 2,566,257.7 ETB/year. This mean, an individual motorized fisherman in Fogera district could make a gross benefit of 213,854.8 ETB/year.

In Dembia district, the total production cost for whole fish capture is about 1,125,235 ETB/ year. In addition, the total cost for filleting (3,334.9 ETB), gutting (13,100 ETB), and drying (123,778.4 ETB) which is about 140,213.3 ETB is also considered for all fish species together. Thus the total production cost in Dembia district amounts to 1,265,448.3 ETB/year. The total revenue of the reed boat user fishermen in Dembia district from whole fish selling is 1,501,926.8 ETB/year, filleted fish selling is 86,157.3 ETB, gutted fish selling is 304,884, and dried fish selling is 2,644,592 ETB/year from all fish species together. Clearly the fishermen who used reed boat earn a total amount 4,537,560.1 ETB/year. The survey result as presented in Table 4.18 showed that the total gross benefit of the fishermen who used reed boat is found to be 3,272,111.8 ETB/year which is equivalent to 121,189.3 ETB per year per person.

On the other hand, the total production cost for motorized boat user fishermen in Dembia district is about 988,656.7 ETB/year. In addition, the cost of semi-processing such filleting (7,335 ETB), gutting (6,581 ETB), and drying (4,495.1 ETB) per year is also considered. The motorized fishermen in Dembia district incur a total cost of 18,411.1 ETB/year for semi-processing activities which amounts the total cost of production to 1,007,067.8 ETB/year. Whereas the revenue gained includes 928,823.8 ETB from whole fish, 195,600 ETB from filleted, 65,808 ETB from gutted, and 89,778.7 ETB from dried fish forms which amounts to a total revenue of 1,280,010.5 ETB/year. The motorized fishermen in Denbia have got a total gross benefit of 272,942.7 ETB/year which is equivalent to 68,235.7 ETB/year/person.

In this district, drying is also the most common preservation technique to sale their fish product during high demand season. During focus group discussion the fishermen said that they do not practice fishing from May to November. This is mainly due to two reasons. The first might be the difficulty of drying the Barbus and Catfish during the summer season. The second reason is the dried fish demand in the lowland, such as Wolkaite, Armachiho, Adarkay, Humera, and Zarima becomes negligible since they prefer to consume milk and milk products than dried fish. During this season, Tilapia fishing is performed only with motorized boats. This is mainly due to the breeding and nesting ground of Tilapia species is in the off shore which is Hippopotamus risky area of the Lake which in turn hinders the reed boat users from fishing. It is also noted that most of the time Tilapia is sold in fresh.

The survey result as presented in Table 21 below indicated that, the total production cost for papyrus reed boat users in Alefa district is about 748,935 ETB/year for Whole fish without value addition. In addition, the filleting (4,118 ETB), gutting (9,137.8 ETB), salting and drying (75,425.68 ETB) costs per year have also considered for all fish species (Tilapia, Barbus, and catfish) together. The total value adding cost in Alefa district amounts to 88,681.5 ETB/year. Thus the total fish production and processing cost in Alefa district is about 837,616.5 ETB/year. The result, on the other hand, indicated that the total revenue of the fishermen who implement papyrus reed boat in Alefa district is about 811,881.6 ETB from whole fish selling. The revenue from the semi-processed fish products is found to be 98,976.67 ETB, 154,773.4 ETB, and 1,133,245 ETB from sales of filleted, gutted, and dried forms respectively with Tilapia, Barbus, and Catfish together. The total revenue gain by the papyrus reed boat user fishermen from the semi-processed fish products only amounts to 1,386,995 ETB/year. Thus, the total revenue of the fishermen from three commercial fish species in all forms is about 2,198,876.7 ETB/year. Thus, the fishermen in Alefa district have got a total gross profit of 1,361,260.2 ETB/year which is equitant to 85,078.8 ETB/person/year. According to the information from the focus group discussion, salting and drying are the most common preservation technique in Alefa district. This is mainly because the landing site in Alefa (Dengel-Ber) is far from the main market. Thus, the main marketing place for the district was the lowland area including the Sudan. However, the marketing channel to Sudan is terminated due to several problems which need a strong support to re-open it. The remaining marketing opportunity for the salted and dried fish forms of the district is the lowland areas of Alefa and nearby districts particularly during the fasting periods.

The total production cost of reed boat users in Takusa district is found to be 2,254,280 ETB/year for both whole fish and semi-processing activities. In addition, 130,619.5 ETB/year is also incurred for drying as a means of preservation. The fishermen in Takusa district have got total revenue of 4,186,792 ETB/year from whole fish selling and 2,698,063 ETB/year from dried fish selling which amounts to a total revenue of 6,884,855 ETB/year. Clearly, the fishermen in Takusa district could make a total gross benefit of 4,499,955.5 ETB/year which is equivalent to 118,419.9 ETB/year/person.

Since the district is bordering with lowland areas, salting and drying is the most common fish processing and preserving technique. However, the salting preservation technique is

diminished since the Sudan market blocked due to the current security problem. As a result, salted fish wholesalers in this district are resigned and shifted to other businesses. This in turn reduces the selling price of dried fish as low as 70-100 ETB/Kg compare to other districts.

Gondar Zuria district fishermen who used reed boat incurs a total production cost of 2,073,910 ETB/year for whole fish capturing and 412,515 ETB/year for semi-processing activities such as filleting, gutting, salting and drying together with total cost 2486425 ETB/year. Whereas, the total revenue of the fishermen is found to be 966,444.2 ETB/year from whole fish selling and 9,269,578 ETB from semi-processed forms with total revenue 10236022 ETB/year. Thus the total gross benefit of the fishermen in Gondar Zuria district is about 7,749,595.2 ETB/year. Clearly, an individual fisherman who used papyrus reed boat could make a gross benefit of 172,213.2 ETB/year.

On the other hand the fishermen who implement motorized boat have incurred production cost of 805,393.3 ETB/year and 32,070.4 ETB/year for semi-processing activities such as filleting, gutting, and drying with total cost 837,463.7 ETB/year. Whereas, the fishermen have earned 2,135,275.4 ETB/year from selling of both whole and semi-processed fish forms. Thus, the motorized fishermen in Gondar Zuria district have a gross benefit of 1,297,811.7 ETB/year/person.

In this district, more than 50% of the revenue is gained with whole fish selling. The fishermen themselves are collectors (vertical integration or functional upgrading) to minimize transaction costs. Wholesaler to wholesaler horizontal integration is also practiced in this marketing chain for dried fish to Metema - Galabat, Humera, Waldiba-Gedam, Bahir Dar, and Gorgora. Salted fish with Bahir Dar and Gorgora. Fresh fish Woreta, Maksegnit, and Gondar.In this district, filleting and drying is the most common processing and preservation techniques.

The total production cost in Bahir Dar zuria district is found to be 1,018,280 ETB/year for fishing and 89,343.4 ETB/year for semi-processing activities. This accounts to a total production cost of 1,107,623.4 ETB/year. The total revenue of the fishermen who used papyrus reed boat in Bahir Dar zuria district is 3,656,810 ETB/year from whole fish selling and 1,563,312 ETB/year from semi-processed fish selling such as filleted and dried forms.

The total revenue of the fishermen is about 5,220,122 ETB/year. Thus, the total gross benefit of reed boat user fishermen in Bahir Dar zuria district is found to be 4,112,499 ETB/year which is equivalent to 158,173.04 ETB/year/person. Fishers who implement motorized boat incurred the production cost 3,773,317 ETB/year and 32,837.2 ETB/year for semi processing activities with total production cost 3,806,154.2 ETB/year. The survey result indicated that the total revenue gain, 3,849,238 from whole fish, 81,645 from fillet and 970769.4 ETB/year from dried form. The total revenue gain motorized users are 4,901,652.4 ETB/year. Thus the total gross benefit of motorized user fishermen in this district is 1,095,498.2 ETB/year, which is equivalent to 156,499.74 ETB/year/person. In this district, more than 75% revenue is gained through whole fish selling. This is mainly because high numbers of foreign and local visitors found in Bahir Dar city have preference to consume fresh fish in hotels and restaurants.

**Table 21.** Production cost, revenue, and gross benefit of the fishermen by boat type

| **Cost/ Revenue** | **Papyrus reed boat users** | | | | | |
|---|---|---|---|---|---|---|
| | **Fogera** | **Dembia** | **Alefa** | **Takusa** | **Gondar zuria** | **Bahir dar zuria** |
| Production cost | 2,276,570 | 1,125,235 | 748,935 | 2,254,280 | 2,073,910 | 1,018,280 |
| Cost Semi – processing | 213,459 | 140,213.3 | 88,681.5 | 130,619.5 | 412,515 | 89,343.4 |
| Revenue whole | 5,739,523 | 1,501,926.8 | 811,881.6 | 4,186,792 | 966,444.2 | 3,656,810 |
| Revenue semi-processed | 4,780,015 | 3,035633 | 1,386,995 | 2,698,063 | 9,269,578 | 1,563,312 |
| Total revenue | 10,519,539 | 4,537,560 | 2,198,877 | 6,884,855 | 10,236,022 | 5,220,122 |
| Gross profit | 8,029,510 | 3,272,112 | 1,361,260 | 4,499,956 | 7,749,595 | 4,112,499 |
| Gross profit/ person | 160,590.2 | 121,189.3 | 85,078.8 | 118,419.9 | 172,213.2 | 158173.04 |
| **Motorized boat users** | | | | | | |
| Production cost | 2,661,507 | 988,656.7 | - | - | 805,393.3 | 3,773,317 |
| Cost Semi – processing | 172,776 | 18,411.1 | - | - | 32,070.4 | 32,837.2 |
| Revenue | 5,400,540 | 1,280,010.5 | - | - | 2,135,275. | 4901653 |
| Gross profit | 2,566,258 | 272,942.7 | - | - | | 1095498.2 |
| Gross profit/ person | 213,854.8 | 68,235.7 | - | - | 1,297,811.7 | 156499.74 |

**Source:** own computation from 2022 survey

Generally, the survey result from the six districts with 226 respondent fishermen showed that 9,497,210 ETB for fish capturing and 1,074,833 ETB for semi-processing activities has been incurred as a total cost of production in every year. Whereas, 39,596,975 ETB transaction as total revenue and 29,024,932 ETB as a gross benefit for the fishermen has been performed in the fish value chain of Lake Tana. Regardless of the boat type the fishermen used, it is possible to get a gross benefit of 128,428.9 ETB/individual fishermen per year.

In 2022 fishing season, fishermen who implement reed boat captured an average of 2,466.1 Kg Tilapia, 2,430.8 Kg Barbus, and 2,545.3 Kg Catfish. On the other way from 100 Kg Tilapia, 33.3 Kg filleted, 40 Kg gutted, and 20 Kg dried fish product could be obtained. From 100 Kg Barbus 33.3 Kg gutted, 33.3 Kg salted and 16.6 Kg dried forms could possible. Whereas, 50 Kg filleted, 50 Kg gutted, and 22.2 Kg dried, fish were obtained from 100 Kg Catfish. From Tilapia, 41 ETB/Kg, 88 (29.33) ETB/Kg, 48 (19.2) ETB/Kg, and 116 (23.2) ETB/Kg was the gross profit margin of the fishermen from whole, filleted, gutted and dried forms respectively. From Barbus, 31 ETB/Kg, 27 (9) ETB/Kg, 12 (4) ETB/Kg, and 106 (17.7) ETB/Kg was the gross profit margin of the fishermen from whole, gutted, salted, and dried forms respectively. From Catfish, 11 ETB/Kg, 58(29) ETB/Kg, 27 (13.5) ETB/Kg, and 106 (23.5) ETB/Kg was the gross profit margin of the fishermen from whole, filleted, salted, and dried forms respectively.

### 4.13.2. Market margin and profit share of fish value chain actors

The survey result presented in Table 22 shows that from tilapia in the form of whole fish, the processor (fish hotels and restaurants) received the highest marketing margin which is 320 ETB/Kg followed by the fishermen (38.5 ETB), wholesalers (35 ETB), and collectors (15 ETB) per Kg of fish. Clearly collectors received the least marketing margin than the other actors along the fish value chain of Lake Tana. Similarly, the processors (Hotels and Restaurants) received the highest profit margin with 250 ETB/Kg (77.39%) followed by the fishermen, wholesaler, and collectors with the respective profit margin 36.5 (11.30%), 26.5 (8.20%), and 10 (1.13%). In case of both filleted and gutted forms, processors have also received the highest market margin which is 200 and 310 ETB/Kg followed by wholesalers, collectors, and fishermen with the respective market margin value of 70/60 ETB/Kg, 50/20

ETB/Kg, and 35.2/16.17 ETB/Kg. Thus, the highest profit margin goes to processors account which is 150 ETB (51.74%) and 260 ETB (76.24) per Kg. Wholesalers and collectors received 61.5/51.5 ETB/Kg and 45/15.5 ETB/Kg profit margin from Filleted/gutted fish forms. The profit margin share of the wholesalers accounts for 8.20%, 21.21%, and 15.10% of the total profit margin from whole, filleted, and gutted Tilapia fish forms respectively. The fishermen, however, received the least profit margin share which is 11.5% and 4.25% of the total profit margin of filleted and gutted Tilapia fish forms respectively.

**Table 22.** Profit share of fish market actors from Tilapia species in Lake Tana

| Forms | Actors | Tilapia | | | | | |
|---|---|---|---|---|---|---|---|
| | | Average Selling price /Kg | Average cost /Kg | Market margin | Margin Share (%) | Gross profit | Profit Share (%) |
| Whole | Fishermen | 50 | 13.5 | 38.5 | 9.42 | 36.5 | 11.30 |
| | Collector | 65 | 5 | 15 | 3.67 | 10 | 1.13 |
| | Wholesaler | 100 | 8.5 | 35 | 8.56 | 26.5 | 8.20 |
| | Processor | 420 | 70 | 320 | 78.33 | 250 | 77.39 |
| Filleted | Fishermen | 100 | 16.5 | 88.5(35.2) | 9.90 | 83.5(33.4) | 11.52 |
| | collector | 150 | 5 | 50 | 14.07 | 45 | 15.52 |
| | Wholesaler | 220 | 8.5 | 70 | 19.70 | 61.5 | 21.21 |
| | Processor | 420 | 50 | 200 | 56.30 | 150 | 51.74 |
| Gutted | Fishermen | 60 | 16.5 | 48.5(16.17) | 1.5 | 43.5(14.5) | 4.25 |
| | Collector | 80 | 5 | 20 | 4.92 | 15 | 4.39 |
| | Wholesaler | 140 | 8.5 | 60 | 14.77 | 51.5 | 15.10 |
| | Processor | 450 | 50 | 310 | 76.32 | 260 | 76.24 |
| Dried | Fishermen | 130 | 18.5 | 128.5(25.7) | 26.85 | 111.5(22.5) | 27.27 |
| | Wholesaler | 200 | 10 | 70 | 73.15 | 60 | 72.73 |

**Source:** Own computation from 2022 survey

The survey result presented in Table 23 shows that from whole Barbus fish species, the processors (hotels and restaurants) received the highest marketing margin which is about 200 ETB/Kg followed by fishermen, wholesalers, and collectors with the marketing margin value of 28.5, 20, and 15 ETB/Kg respectively. Consequently, the highest profit margin goes to the processors which are about 130 ETB/Kg. The fishermen also received the second highest profit margin (26.5) ETB/Kg in case of selling whole Barbus fish form. On the other

hand, the wholesalers and collectors received a profit margin of 11.5 and 10 ETB/Kg respectively. The survey result also indicated that the processors received the highest marketing margin and profit by making different food items a using gutted Barbus fish form which is about 250 ETB/Kg. The fishermen, however, received the least marketing and profit margin by selling gutted Barbus fish than other actors which is 3.57 %. The profit margin share of processors accounts for 73.03%and 75.18%of the total profit margin by selling whole and gutted Barbus respectively. Whereas, the profit margin share of wholesalers accounts 11.5% and 31.5% of total profit margin due to selling whole and gutted Barbus respectively.

**Table 23.** Profit share of fish market actors from Barbus species in Lake Tana

| Forms | Actors | Barbus | | | | | |
|---|---|---|---|---|---|---|---|
| | | **Average Selling price /Kg** | **Average cost /Kg** | **Market margin** | **Margin share (%)** | **Gross profit** | **Profit share (%)** |
| whole | Fishers | 40 | 13.5 | 28.5 | 10.8 | 26.5 | 14.88 |
| | Collector | 55 | 5 | 15 | 5.69 | 10 | 5.61 |
| | Wholesaler | 85 | 8.5 | 20 | 7.59 | 11.5 | 6.46 |
| | Processor | 280 | 70 | 200 | 75.9 | 130 | 73.03 |
| Gutted | Fishers | 45 | 16.5 | 33.5(11.2) | 3.2 | 28.5(9.5) | 3.57 |
| | Collector | 70 | 5 | 30 | 8.3 | 25 | 9.39 |
| | Wholesaler | 140 | 8.5 | 70 | 19.36 | 31.5 | 11.84 |
| | Processor | 350 | 50 | 250 | 69.15 | 200 | 75.18 |
| Dried | Fishers | 120 | 18.5 | 108.5(18) | 18.36 | 101.5(16.9) | 19.45 |
| | Wholesaler | 200 | 10 | 80 | 81.64 | 70 | 80.55 |

**Source:** own computation from the survey of 2022

### 4.14. Econometric Model Based Analysis

When the dependent variable has a continuous nature; multiple regressions models can be used (Lamsal *et al.*, 2015). However, it is crucial to check whether the assumptions of econometric analysis have met before running the multiple linear regression analysis. Thus, multicollinearity problem was checked through variance inflation factor (VIF) analysis for continuous explanatory variables. As indicated in Appendix table 3, the results obtained ranged from 1.09 to 2.03 with the average value of 1.65 which confirms no problem of multicollinearity among the continuous explanatory variables. On the other hand, multicollinearity problem for dummy/categorical explanatory variables was checked with

contingency coefficient (CC) analysis. The result ranges between 1.05 and 1.36 which has an average value of 1.19 (Appendix table 4). This result also implies there is no multicollinearity problem between dummy/categorical explanatory variables included in the model. The problem of heteroskedasticity was checked by using Breusch-Pagan/Cook-Weisberg test and corrected by robust regression and omitted variables. Moreover, the model was tested for its omitted variables using a Ramsey RESET test which indicated that no evidence of functional form misspecification in the model.

Unlike other agricultural products, almost all fish harvested is supplied to market unless it is diminished by post-harvest loss. That mean all fishermen participate in the market either fully or partially. Therefore, to identify the factors that affect the quantity of fish market supply, multiple linear regression model using Ordinary Least Square (OLS) was employed.

### 4.14.1. Determinant factors affecting fish market supply

All the coefficients of the independent variables are included in Table 24 which shows the amounts of change in the quantity of fish supply for a unit change of the listed independent variables. The coefficient of determination ($R^2$) that shows the explanatory power of the model also indicated. Based on the result of the OLS model, the coefficient of determination ($R^2$) is found to be 0.70. This implies that 70% of the variation observed on the dependent variable, quantity of fish supply to the market, is explained by the independent variables included in the model. The calculated F-statistic ($F = 29.21$, $P > 0.0000$) indicated that the overall model is significant at 1% level of significance.

The quantity or volume of fish supply to the market was explained by 15 independent variables. Out of a total 15 variables, 11 variables were significantly affect the quantity of fish market supply. The result of multiple linear regression (OLS) showed that education level, farm land, fishing experience, engagement on fishing activity, boat type, market place problem, training, market information, cold storage, and price fluctuation problem are the independent variables that affect the dependent variable, fish market supply, significantly.

**Education Level of the fishermen (Educ):** Out of the sampled fishermen (226), only 21.2% of the respondents were illiterate, whereas the remaining have attended their education at various schooling level. As hypothesized, education level had a positive and

significant influence on the quantity of fish supplied to the market (Table 24). Holding other factors constant, an increase in education level by one year could increase the quantity of fish supplied to the market by 244 Kg. The possible explanation for such positive relationship is that education could enhance the fishermen's knowhow about the fishery resources and its way of utilization. More importantly, education always associated with an improvement in skill and knowledge about modern technology utilization. Thus, educated fishermen are expected to capture more fish and avoid the potential post-harvest loss by adopting various preservation techniques. This result is in line with the findings of Tuluka *et al.* (2021) and Cheffo *et al.* (2016) who reported that educated fishermen supplied more quantity of fish to the market. In another study, multiple linear regression models revealed that the education level increases the quantity of marketable product supply to the market (Ayele *et al.*, 2021; Regasa and Degye, 2018).

**Land Size (Totfamlan):** It shows negative association with the quantity of fish market supply. The OLS result indicated that land size affects the quantity of fish market supply negatively and significantly at 5% level of significance. The OLS coefficient for land size implies that an increase of land size by a quarter of a hectare, the quantity of fish supplied to the market is found to be decreased by 217 Kg assuming other factors remain constant. This might be due to the fact that, the fishermen who have large land holding spend more time on crop production which costs the time allotted for fishing activity. These in turn decreased their quantity of fish market supply. Similarly, Tilahun *et al.* (2020) reported that land size was negatively associated with milk market supply participation. This result also agrees with a study reported by Mebrate and Worku (2020) and Birhanu (2015) who found a significant and negative impact of non-fishing income on fish market supply.

**Fishing experience (FishExp):** The result of the OLS model indicated that, fishing experience affected the market supply positively and significantly at 1% level of significance. As the fishing experience increases by 1 year, the quantity of fish supply to the market has increased by 149 Kg assuming other factors remain constant. This result might be due to the fact that experienced fishermen know the basics of fishing business such as fish abundant area and time, harvesting techniques, type of fish they harvest aligned with the customers' preference and market demand. The result is in line with Tuluka *et al.* (2021) reported as fishing experience increased by one year, the fish supply to the market increased by 0.65 Kg. Similarly, Giziew (2018) showed that onion market supply is increased by 1.9

Kg as the onion farming experience increased by a year. In addition, farm experience of the household head affected positively and significantly in soybean, teff, and mango supply to the market (Modeste *et al.*, 2018; Melaku and Ashalatha, 2016). This result also agrees with the findings of Workiye *et al.* (2022), and Tamirat *et al.* (2017) who found a strong and positive relationship between farming experience and quantity of sesame and haricot bean marketed.

**Engagement in fishing activities (EngfishA):** It was hypothesized that engagement in fishing activities affect the quantity of fish supplied to the market positively and significantly. The result revealed that the full time fishing participants have supplied 722 Kg more fish to the market compared to seasonal fishing participants. Since fishing is the main livelihood strategy of the fishermen who have engaged in full time fishing related activities, they used their maximum efforts to capture more fish as much as possible.

**Boat type (BoatType):** The OLS result indicated that boat type affects the fish market supply positively and significantly at 1% significant level. The fishermen who implemented motorized boat had 4,766 Kg fish market supply advantage over those using reed boats. The reason behind these might be individual fishermen who implemented motorized boat have used more gillnet as compared with reed boat users. Clearly, the number of gillnet also decided the quantity of fish captured per trip. In addition, motorized fishermen usually collect fish from other fishermen who lack transport access to other market places with more buyers available. Thus, the motorized fishermen could better exploit the place utility advantage over the reed boat users. This result coincides with the finding of Paulos (2018) and Tarekegn *et al.* (2017) who investigated using improved bee hive increases the quantity of honey supply to the market compared to traditional hives.

**Access to market information (Mktinformation):** The result showed that, access to market information affected the quantity of fish market supply positively and significantly at 5% level of significance. If the fishermen have got accurate, valid and updated market information, fish market supply increased by 1,627 Kg. This is mainly because, a well-informed fishermen could understand the market demand and customers' preferences, thereby make a decision on what type of fish to capture, which market place to sell with what price. It is found that the fish market supply has increased by 14 Kg when the fishermen got accurate and updated market information (Tuluka *et al.*, 2021). Similarly, market

information increased the probability of entering into the market and supply of potato, soybean, and haricot bean (Awoke and Molla, 2018; Zamasiya *et al.*, 2014; Janko, 2013). The finding is also consistent with the results of Abajobir ( 2018) who found the existence of positive relationship between the market information and market participation decision of maize at Horo Guduru district, Oromia.

**Market place problem (MKTplaceprob):** As hypothesized**,** this variable affected the quantity of fish market supply negatively and significantly at 1% level of significance. The fishermen who have market place problem have a decreased quantity of fish supplied to the market by 2,457 Kg compared with those have no market place problem. Most of the fishermen sell their fish at the landing site (73%) or at the shore of the Lake and 53% at local markets.

**Training (Training):** Access to training positively and significantly affected the quantity of fish market supply at 1% level of significance. The result of multiple linear regression model showed that the fishermen who have training access could increase the quantity of fish market supply by 1,085 Kg than who could not access a training. The result is in line with Borena *et al.* (2022), Ababulgu *et al.* (2021), and Toma *et al.* (2017) who confirmed that training has a direct and significant influence on the quantity of honey market supply. This result is similar with Meleaku *et al.* (2020) who found that households having access to training increased the quantity of Sorghum market supply by 18.04 % compared to those who did not have access to training.

**Price fluctuation problem (PrfluctuationProb):** The OLS model result indicated that price fluctuation problem affected fish market supply negatively and significantly at 5% level of significance. The quantity of fish supplied to the market by the fishermen who faced price fluctuation problem have decreased by 1,580 Kg compared with the fishermen who did not face price fluctuation problem. The fish price might vary due to market access, season, and number of traders participated in the market. This finding is consistent with Abebe and Debebe (2020) on factors affecting chickpea market chain. In addition, Dessie *et al.* (2018) confirmed that lagged price has a positive and significant influence on the quantity of red pepper.

**Cold storage problem (Coldstorage):** The OLS result also indicated that cold storage

problem affected the fish market supply negatively and significantly as expected at 5% of significance. The quantity of fish supply to the market by the fishermen who faced storage problem is found to be 731 Kg less than the supply by the fishermen who had no cold storage problem.

**Table 24.** Determinants of fish market supply using multiple linear regression (OLS) model

| Variables | Coefficient | Robust Standard error | t-value | p-value |
|---|---|---|---|---|
| Educ | 244.9365*** | 56.51768 | 4.33 | 0.000 |
| Totfamsz | -95.05321 | 136.739 | -0.70 | 0.488 |
| Totfamlan | -219.3649** | 100.0935 | -2.19 | 0.030 |
| FishExp | 148.524*** | 33.74871 | 4.40 | 0.000 |
| EngfishA | -722.9471*** | 205.0065 | -3.53 | 0.001 |
| BoatType | -4766.062*** | 943.7539 | -5.05 | 0.000 |
| Training | 1080.524*** | 409.8091 | 2.64 | 0.009 |
| Mktinformation | 1627.776** | 768.6624 | 2.12 | 0.035 |
| MKTplaceprob | -2456.719*** | 496.032 | -4.95 | 0.000 |
| Coldstorage | -733.5541** | 302.3207 | -2.43 | 0.016 |
| PrfluctuationProb | -1582.876** | 642.1653 | -2.46 | 0.015 |
| ngillnet | .6871913 | 13.11517 | 0.05 | 0.958 |
| MembersfishCoop | -714.3245 | 465.2599 | -1.54 | 0.126 |
| Creditaccess | 15.81118 | 464.1973 | 0.03 | 0.973 |
| TLU | -61.89373 | 84.81281 | -0.73 | 0.466 |
| cons | 17398.26 | 2444.724 | 7.12 | 0.000 |
| R-square | 0.70 | | N | 226 |
| F -test | 29.21 | | Pro > F | 0.0000 |

Note: ***, ** and * indicates the significant levels at 1%, 5%, and 10% respectively

### 4.14.2. Determinants of fishermen value addition participation decision

The Wald chi-square value is 36.89 for value addition participation decisions that are significant at 1% significance level indicating the explanatory variables jointly explained the probability of participating in fish value addition. The fishermen decision to participate

in fish value addition is determined significantly and positively by land size, family size, boat type, and fishing experiences (Table 25).

**Land size (Totfamlan)**: land size affects the probability of value addition participation positively and significantly at 10% significant level. The result is opposite to expectation and the average marginal effect of 1st hurdle model indicated that, a unit change in fishermen's land size increased the likelihood of the fishermen value addition participation by 2%. If the fishermen who had additional means of income or activities other than fishing, they would have resources to hire additional labor for value addition. The result is consistent with the findings of Ayele *et al.* (2018), and Hailu (2016). Similarly, the land size of the farmer and milk value addition participation showed a positive relationship in Amhara Regional State, Mecha district (Tilahun *et al.*, 2020).

**Family size (Totfamsz**): Family size is positively associated with the probability of value addition participation at 10% level of significance. The average marginal effect of the 1st hurdle model indicated that as the family size increased by one unit of adult equivalent, the likelihood value addition participation of the fishermen also increased by 2%. The reason is that fishing and fish processing is labor intensive activity and the family is used as the main source of labor for those activities. Family size translated to labor availability is expected to increase fish value addition participation. Thus, the fishermen who have more family size take more advantage of value adding instead of selling whole fish. Previous findings indicated that as the family size of the fishermen increased by one unit of adult equivalent, the participation decision of the household increased by 1.8% (Tilahun *et al.*, 2020; Emukule *et al.*, 2018; Tadesse *et al.*, 2016). However, this result contradicts with the findings of Turaa *et al.* (2016) who found that as family size increased the probability of participation in value addition decreased.

**Boat type (BoatType):** Boat type is positively associated with the probability of value addition participation at 1% level of significance. The result of the 1st hurdle model indicated that the likelihood of value addition participation of the fishermen who implement reed boat has increased by 16%, compared with motorized boat users. The reason behind might be the fact that motorized fishermen used their motorized boat as a means of transport and could reach the market as quick as possible which in turn reduce their post-harvest losses. This result is in line with the finding of Lemma *et al.* (2017) who showed that as cross breed

cows increased, value addition decreased. This might be due to the large volume of milk produced by the cross breed cows could encourage the farmer to supply row milk to the market.

**Fishing experience (FishExp):** fishing experience is positively associated with the probability of value addition participation at 5% level of significance. The average marginal effect of the 1st hurdle model indicated that as the fishing experience increased by one unit, the likelihood of value addition participation of the fishermen increased by 0.9%. The fishermen who had more fishing experience could acquire more skill on fish processing, market knowledge, and customer preference which could in turn increase the likelihood of value addition participation.

### 4.14.3. Determinants of fishermen value addition participation intensity

Out of the 10 variables included in the model, six were found to affect the intensity of value addition participation significantly. These are total farm land, boat type, cold storage, fish catch/day, fishing experience, and labor cost. On the other hand, Boat type, fish catch/day, and fishing experience affects the intensity of value addition positively and significantly (Table 25). Whereas total farm land, cold storage problem, and labor cost affected the intensity of value addition negatively and significantly.

**Land size (Totfamlan)**: land size is negatively associated with value addition intensity at 1% significance level. Thus, holding the effect of other factors constant, an increase in land size by one "*timad*" decreased the amount that the fishermen could add value on its fish by 488 Kg. if the fishermen who have additional means of income or activities other than fishing, they prefer to sell more quantity of fish in the whole fish form instead of adding value to save their time for their farming activities. This result is in line with the finding of Tegegne *et al.* (2017) who reported that an increase in farm land size decreased the intensity of milk value addition. This result however, contradicts with the finding of Tilahun *et al.* (2020) who indicated that an increase in farm land size also increased the value addition intensity.

**Boat type (BoatType):** Fishermen who implemented reed boat type is positively associated with the of value addition intensity at 5% level of significance. By keeping the effect of

other factors constant, the quantity of fish value addition by the fishermen who used reed boats increased by 2,365 Kg, compared with motorized boat users. The reasons behind that might be due to the fact that fisherman who used reed boat required to travel longer time to reach the market which in turn increase the probability of spoilage.

**Table 25.** Determinants of the fishermen value addition participation intensity, a double hurdle model

| Variables | 1st Hurdle | | | 2nd hurdle | | |
|---|---|---|---|---|---|---|
| | Coefficient | Std. Error | Marginal effect | Coefficient | Std. Error | Marginal Effect |
| Educ | -.0294 | .0415 | -.0045 | 53.57 | 76.71 | 53.57 |
| Totfamlan | .1439* | .0776 | .0221 | -488.8*** | 139.09 | -488.8 |
| Totfamsz | .1249* | .0748 | .0191 | 179.1 | 141.11 | 179.1 |
| BoatType | 1.1089*** | .4108 | .1699 | 2365.4** | 1001.8 | 2365.4 |
| Coldstorage | -.2852 | .1804 | -.0437 | -1211.5** | 522.9 | -1211.5 |
| fishcatchda | .0086 | .0121 | .0013 | 197.9*** | 22.28 | 197.9 |
| FishExp | .0586** | .0228 | .0090 | 172.3*** | 37.77 | 172.3 |
| Training | -.1070 | .2712 | -.0166 | 727.0 | 526.15 | 727.0 |
| PrfluctuationProb | .03035 | .3615 | .0047 | -516.9 | 718.6 | -516.9 |
| Lobourcost | - | - | - | -22.4*** | 6.317 | -22.37 |
| Cons | -2.122 | 1.121 | - | -4191.9 | 2434.6 | - |
| Wald/LR Chi square(9) | 36.89 | | Wald chi2 (10) | 220.23 | | |
| Log-likelihood | -71.90 | | Log-likelihood | -1768.38 | | |
| Observations | 226 | | Observations | 195 | | |
| Pseudo $R^2$ | 0.2041 | | Prob> $chi^2$ | 0.0000 | | |
| Prob> $chi^2$ | 0.0000 | | | | | |
| y = Pr (Valueadd) (predict) | .9167 | | y =Linear prediction | 4509.44 | | |

**Source:** Own computation from 2022 survey

**Note:** ***, **, and * are significant levels at 1%, 5%, and 10% respectively

**NB:** In nonlinear econometric models, such as Logit, Probit and double hurdle, the coefficients have no meaningful and direct interpretation. Thus, the marginal effect is used for the interpretation. However, for the second hurdle (in the double hurdle model), which is a truncated regression, running the marginal effect is optional because the first coefficient and the marginal effect have similar value.

**Cold storage problem (Coldstorage):** Cold storage problem is negatively associated with intensity of value addition at 5% significant level (Table 25). Thus, holding the effect of other factors constant, the amount of value addition by the fishermen who had cold storage problem decreased by 1,211 Kg. This affirms the reality that the fish value addition in Lake Tana is not to maximize the marginal profit, rather to increase the shelf life of the fish. Hence, cold storage is a crucial equipment in fish business. So the fishermen who have no cold storage they prefer to sell much amount of their fish in whole fish form instead of value adding mainly to reduce post-harvest loss. This finding agrees with the report of Negasa and Bati (2019) who found that producers could no maximize the time value of their product due to poor storage conditions. Similarly, Hagos and Bekele (2018) and Prabakaran *et al.* (2018) confirmed that suitable storage condition increased the time value of the products by storing for a long time without losing the nutrient composition.

**Fish catch per day (fishcatchda):** Fish catch per day is positively associated with value addition intensity at 1% significant level (Table 25). The result of the 2nd hurdle model indicated that keeping the effect of other factors constant, an increase in fish catch per day have increased the intensity of value addition. Clearly, the amount of fish catch per day determines the intensity of value addition. Similarly, Tilahun *et al.* (2020) reported that the volume of milk produced per day increased the intensity of value addition positively.

**Fishing experience (FishExp):** fishing experience is positively associated with the probability of value addition participation at 5% level of significance. Thus, holding the effect of other factors constant, an increase in fishing experience by one unit could increase the amount fish that the fishermen could add value by 172 Kg (Table 25). Those fishermen who had more experience in fishing, have more skill on fish processing and preservation techniques, market and customer preference. This result disagrees with the findings of Tilahun *et al.* (2020) who showed the negative influence of dairy farming experience on the intensity of milk value addition.

**Labor cost (Lobourcost):** Labor cost is negatively associated with the intensity of fish value addition in Lake Tana at 1% significant level. By holding the effect of other factors constant, an increase in labor cost by one unit have decreased the amount of value add by 22 Kg (Table 25). The Rational behind that might be due to the labor intensive nature of fish value adding activity that needs strength and extra labor.

### 4.14.4. Determinants of market outlet choices

The multivariate Probit model is used to estimate several correlated binary outcomes jointly. In this study the decisions of fishermen choosing wholesalers, retailers, collectors, hotels and restaurants and outlets are correlated. Since the decisions are binary the multivariate Probit model was found to be appropriate for jointly predicting these five outlet choices on an individual-specific basis and the parameter estimates are simulated maximum likelihood (SML) estimators. Thus, an econometric approach was employed to test effects of the explanatory variables on the selection of a particular market outlet. The Wald $chi^2$ (40) = 182.40 is significant at 1% significance level, which indicates that the subset of coefficients of the model is jointly significant and that the explanatory power of the variables included in the model is acceptable. The results of likelihood ratio test in the model shows that likelihood ratio test of chi2 (10) = 189.2, Prob > $chi^2$ = 0.000 is statistically significant at 1%significance level, indicating the null that choices of the five market outlets is independent is rejected and there are significant joint correlations for two estimated coefficients across the equations in the models (Table 26). The likelihood ratio test of the null hypothesis of independency between the market outlet decision (rho21 = rho31 = rho41 = rho51 = rho32 = rho42 = rho52 = rho43 = rho53 = rho54 = 0=) was significant at 1%. Therefore, the null hypothesis that all the ρ (Rho) values are jointly equal to zero is rejected, showing the goodness-of-fit of the model. So, there are differences in market outlet selection behavior among fishermen/fish catchers, which are reflected in the likelihood ratio statistics.

Separately considered, the ρ values ($\rho_{ij}$) indicate the degree of correlation between each pair of dependent variables. The $\rho_{21}$ (correlation between the choice of retailer and wholesalers outlet), $\rho_{31}$ (correlation between the choice of collectors and wholesalers outlet), $\rho_{43}$ (correlation between the choice hotel and restaurant and collector outlets) and $\rho_{53}$ (correlation between choice of consumer and collector outlets) are negative significant at 1% significance level and, $\rho_{42}$ (correlation between the choice of hotel and restaurant and retailer outlet), $\rho_{52}$ (correlation between choice of consumer and retailer outlets) and $\rho_{54}$ (correlation between choice of consumer and hotel and restaurant outlets) are positively significant at 1% significance level and $\rho_{41}$ (correlation between the choice of hotel and

restaurant and wholesalers outlet) is positively significant at 5% level of significance. This result showed that fishermen selling their fish to the wholesaler outlets are less likely to deliver to retailer and collectors' outlets. Similarly, those fishermen selling their fish to the collector outlet are less likely to deliver to hotel and restaurant and consumers market outlets (Table 26). The simulation results also indicate that the marginal success probability for each equation (outlet choice decision) is reported below. The likelihood of choosing collector outlet is relatively low (25.8%) as compared to the probability of choosing hotel and restaurant outlet (26.9%), retailer outlet (27.1%), consumer outlet (50.1%) and wholesalers' outlet (76.4%). This is an indicator that wholesaler is the most likely chosen market outlet by fishermen.

**Table 26.** Estimated correlation matrix

| | $\rho_1$ | $\rho_2$ | $\rho_3$ | $\rho_4$ | $\rho_5$ |
|---|---|---|---|---|---|
| $\rho_1$ | **1** | | | | |
| $\rho_2$ | -.6381*** | **1** | | | |
| | (.096) | | | | |
| $\rho_3$ | -.5074*** | .040 | **1** | | |
| | (.088) | (.107) | | | |
| $\rho_4$ | .1985** | .2773*** | -.6777*** | **1** | |
| | (.090) | (.091) | (.087) | | |
| $\rho_5$ | -.0644 | .4705*** | -.5361*** | .7345*** | **1** |
| | (.122) | (.083) | (.086) | (.061) | |

Likelihood ratio test of rho21 = rho31 = rho41 = rho51 = rho32 = rho42 = rho52 = rho43 = rho53 = rho54 = 0:

$Chi^2$ (10) = 180.522 Prob > $Chi^2$ = 0.0000

Symbols: *, **, and *** indicates statistical significance at 10, 5, and 1% respectively.

RSE is robust standard error

**Note:** Coefficient and standard errors in the parentheses

The result in Table 27 indicated that out of explanatory variables used in the multivariate Probit model, educational level of fishermen, land size of fishermen ,engagement of fishing activities, boat type , market information ,fish catch per day and distance from landing site to main fish market were found to significantly affect the market outlet choice behavior of the fishermen.

**Education level of the fishermen, (Educ)**: Education level of the fishermen had positive and significant effect on choosing consumers outlet at 5% probability level. Positive

relationship between education level and selling to consumer outlet shows the fact that being educated enhances the capability of fishermen in making informed decisions with regard to the choice of fish marketing outlet to sell their fish based on the benefit they obtain. Education is believed to give individuals with the necessary knowledge that can be used to collect information, interpret the information received, and make products and marketing decision. This result is in line with the findings of Mossie *et al.* (2020) and Chernet *et al*. (2021) who showed literate farmers more likely to sell onion and chickpea to wholesalers and consumers than other market outlets. This result disagrees with the result of Getahun *et al.* (2020) who reported that educated farmers less likely to choose consumers outlet.

**Land size of the fishermen (Totfamlan):** Land size of the fishermen had negative and significant effect in choosing wholesaler and collector outlet at 5% probability level. On the other hand, land size of the fishermen showed positive relationship with the likelihood of choosing retailer outlet at 5% level of significance. The negative relationship indicates that fishermen having large land size is less likely to choose wholesaler and collector because of the time considered for farming and less concern for fish supply.

**Boat type (BoatType):** Fishermen who implemented reed boat had positive and significant association with the likelihood of choosing hotel and restaurant outlet at 10% level of significance.

**Engagement of fishing activity (EngfishA):** Engaging seasonal in fishing activity associated negatively and significantly with the likelihood of choosing hotel and restaurant outlet at 1% level of significance, compare engaging with full time fishing activities. The reason behind that might be full time fishing participants search for better benefit than seasonal fishing participants.

**Market information (Mktinformation):** market information has negative and significant effect in choosing hotel and restaurant outlet less 10% level of significances. This implies that fishermen who access to market information have an advantage to select other actors with price advantage than hotel and restaurant. The negative relationship might be due to that most respondents were from area far from towns (where fish hotels and restaurants are found) hence their choice would be restricted to other actors such as wholesaler, collector, and consumers.

**Table 27.** Determinants of market outlet choices of the fishermen, a multivariate Probit model

| Variables | Wholesaler | Retailer | Collector | Hotel | Consumer |
|---|---|---|---|---|---|
| | Coefficient (RSE) | Coefficient (RSE) | Coefficient (RSE) | Coefficient (RSE) | Coefficient (RSE) |
| Educ | .0316 | -.0124 | -.0448 | .0300 | .0672** |
| | (.0289) | (.0314) | (.0279) | (.0265) | (.0277) |
| Totfamlan | -.1345 ** | .1120** | -.1269** | .0237 | .0700 |
| | (.0537) | (.0504) | ( .0472) | (.0445) | (.0487) |
| BoatType | .1040 | -.0333 | .5313 | .6664* | .5121 |
| | (.3201) | (.3586) | (.3764) | (.3810) | (.3282) |
| EngfishA | .0056 | .1265 | .0853 | -.4803*** | -.1199 |
| | (.1068) | (.1061) | (.0963) | (.1206) | (.1008) |
| Training | -.1896 | .0079 | -.1117 | .2140 | .1368 |
| | (.2151) | (.2093) | (.1940) | (.1948) | (.1918) |
| Mktinformation | -.5547 | .6574 | .0586 | -1.448*** | -.3525 |
| | (.400) | (.4053) | (.3398) | (.3716) | (.3606) |
| fishcatchda | .0193 ** | -.0103 | .0227*** | -.0132 | -.0195** |
| | (.008) | (.0102) | (.0081) | (.0081) | (.0080) |
| DsLsitmainFish | .0057*** | -.0009 | .0028** | .00096 | .0013 |
| MKT | (.001) | (.0013) | (.0015) | (.0014) | (.0013) |
| Cons | .0631 | - 1.135 | -2.393 | -.1547 | -.5679 |
| | (.864) | (.9261) | (.9108) | (.9846) | ( .8989) |
| Predicted probability | 0.764 | 0. 271 | 0.258 | 0.269 | 0.501 |
| joint probability of success | | | 0.0022 | | |
| joint probability of failure | | | 0.0219 | | |
| Number of draws (#) | | | 5 | | |
| Observation | | | 226 | | |
| Log likelihood | | | -519.32 | | |
| Wald $X^2(40)$ | | | 140.39 | | |
| Prob>$X^2$ | | | 0.000 | | |

**Fish catch/day (Fishcatchda):** Fish catch per day has positive and significant effect in choosing wholesaler and collector's outlet at 1% and 5% probability level, respectively (Table 27). On the other hand, fish catch per day had negative relationship with the likelihood of choosing consumer outlet at 5 % level of significance. The positive relationship between fish catch per day and selling to wholesaler and collector outlets, and the negative relationship between fish catch per day and selling to consumers outlets shows the fact that the fishermen who catch more fish per day could make informed decisions on

the choice of fish marketing outlet to maximize the advantage. This implies that when the quantity of fish catches per day becomes large, the fishermen would prefer the market outlet that could buy large volume of fish at fair price. This finding is similar with Malit *et al.* (2021) who reported that the quantity of fish produced influences the market outlet choices. This finding also agrees with the finding of Wosene *et al.* (2018) reported the quantity of pepper produced positively affected lucrative market outlets.

**Distance from the main fish market:** Distance from the main fish market had positive and significantly association with the likelihood of fishermen to choose wholesalers and collector outlet at 10% and 5% level of significance respectively (Table 27). This implies that the landing site located far away from the main fish market forced to sell their fish to wholesalers and collectors due to the perishable nature of fish product coupled with lack of transportation services. Selling fish to main fish market requires adequate transportation facilities and labor endowment is required to reach the main fish market which increases the costs and fish spoilage. Thus, most fishermen prefer to sell their fish in the nearest market. This result disagrees with the finding of Getahun *et al.* (2020) who showed that households located far away from the main market is less likely to choose wholesaler outlet.

## 4.15. Challenges and Opportunities

Most of the fishery sectors in Ethiopia are open access that are at the infant stage (Meko *et al.*, 2017). During focus group discussion and key informant interviews, a number of production and marketing constraints were explained in study area.

### 4.15.1. Production constraints

**Theft of fishing equipment's:** One of the challenges during fishing in Lake Tana is that fishermen face loss of fish harvesting materials like loss of fishing nets and boat engine. Sometimes, the robbery is life threatening for fishermen since the crimes are carried out with guns. This limits the fishermen to conduct their fishing activity very close to their districts rather than reaching to distant and potential areas of the lake.

**Illegal fishing material and methods:** During focus group discussion and field observation monofilament gill net and traps were used in Lake Tana. Which is less than the

recommended mesh size and non-selective net type. During focus discussion indicated that this illegal fishing gillnets (monofilament) is imported through illegal market route (contraband) from Sudan and Egypt. In addition, trawling and seining are becoming common fishing methods in Lake Tana. The small mesh sized trawl net which costs about 60,000 ETB, is non-selective fishing material. According to the participants, these recently introduced materials and fishing methods are considered as a visible threat for the sustainability of fish production. There are also other destructive fishing methods mentioned by the group such as chasing (encircling and striking the surrounding with sticks). Generally, illegal fishing material and methods are mentioned as concerning issues for sustainable fish production of Lake Tana.

**Figure 8.** Illegal fishing gillnet called trawl

**Water hyacinth:** For more than a decade water hyacinth (Eichhorniacrassipes) has been one of the most concerning problems in Lake Tana. This rapidly reproducing infested weed has spread very significantly since its appearance in 2011 (Tewabe, 2015; Abebe et al., 2023).This aquatic weed has covered a very wide area of the lake in a very short period of time. During this study period, it is observed in the southern gulf of the lake where the weed

was absent for long time. The weed has different negative effects on the lake fishery and other activities on the lake. It has affected the spawning grounds of lake, spawning migration of labeobarbussp, fishing activities of the fishermen, and movement of reed and motorized boats during fishing this has an effect on fish productivity and production of Lake Tana.

**Illegal fishermen and fishing license:** Currently, the fishery resources of Lake Tana are open access to all where fishing license is not mandatory. Hence, most of the fishermen are not licensed to the job. This has allowed the illegal fishermen to use illegal fishing materials and methods. The illegal fishermen usually implement fishing techniques which are not recommended for Lake Tana fishery such as trawling and seining. These people are the ones who repeatedly break "closed breeding seasons and breeding site."

**Lack of law enforcement:** The Amhara Regional State has issued a proclamation on "fisheries development, prevention and utilization" in 2003. The proclamation states that any person who does not hold a legal fishing permit shall not undertake commercial fishing from any water body. However, law enforcement is lacking and anyone who has interest and capacity can exploit the resource without holding fishing permit. Moreover, governing body of the resource has very little chance to enforce locally recommended breeding seasons and breeding sites.

**Dams and Recession Farming**: Ribb and Megech irrigation dams have a tangible effect on the fish stock of Lake Tana. The dams lack fish ladders which would allow migratory fishes to go upstream of these tributary rivers and reproduce. Similarly, Tana Beles irrigation canal has affected the fish population through letting go down the canal and fish mass kill at the base of the canal. In addition, recession agriculture is becoming a common practice around Lake Tana which affects breeding sites and the chemicals being used will have short and long term consequences.

**Fishery Financing**: Subsistence fishing was predominant and wide spread throughout the lake since fishermen could not afford to upgrade to commercial level due to lack of finance. These fishermen indicated that purchasing fishing boat, engine and sufficient gillnets is beyond their capacity. Credit service system are not inviting to fishermen with lower income. This constraint limits the fishermen on their fish production capacity.

### 4.15.2. Marketing constraints

**Poor market linkage and improper market place:** In most cases, landing sites are places where fishermen sell their products. Fishermen have to sell as soon as they offload from boats to minimize post-harvest loss. This is happens due to lack of proper market place, storage and transportation. Absence of proper market areas (lack of permanent fish market places) forces the fishermen to sell fish at lower price, and sometimes to go door to door or on street market. This discourages the fishermen in their fish production.

**Figure 9.** Local fish marketing place around Lake Tana

**Post-harvest loss:** Post-harvest loss was found to be a prominent problem in fish production of Lake Tana. The problem is observed from fish catching to selling stages in the segment of the chain. Almost all fishermen did not have cold storage to preserve the fish immediately after separating the fish from the fishing net. Due to this problem fish may spoil while fishermen travel from fishing site to landing site. Moreover, almost all landing sites are far below the standards and unhygienic. Here, post-harvest activities such as filleting and trading takes place in in unhygienic manner, and sometimes may lead to fish spoilage and ultimately loss. Transporting of fish from landing site to selling was carried out with shouldering on a stick where direct sun light hits and microbes could easily land and multiply.

The other way of transportation include bicycle, three wheel vehicles, public transports and trucks without cold storage which are usually inconvenient for fish transportation.

**Price fluctuation and price monopoly:** Free marketing system affects the fishery economy since the prices set solely by a few fish traders who manipulates the market. Moreover, the price fluctuates due to season, and fasting and non-fasting periods. This price fluctuation affects the courage of the fishermen in their fish production activity.

**Storage and Transportation problem**: Because of its high protein content, fish is one of the most perishable foods that can be spoiled easily so it needs safe post-harvest handling and road access. Most fishing communities are located distant from main roadways, and the fish harvested from the lake is transported to markets by traditional means of transportation (carrying and bicycles). Due to poor road and transport access fish caught from Lake Tana may spoil before it reaches the market. The problems exacerbate with lack of electricity and storage (refrigerator). This problem forces most fishermen to sell their fish catch at landing site with lower price.

### 4.15.3. Trader's constraints

During individual discussions, traders also identified a number of problems they are facing as follows:

- ✓ Price fixing by the dominant trader and illegal competition
- ✓ Inadequate supply of catch or less catch due to illegal fishing practices
- ✓ Less working capital
- ✓ Inappropriate working place
- ✓ Failure of fishery cooperative
- ✓ Illegal traders and arbitrages
- ✓ No cooperation between traders and fishermen leading the fishermen to waste their time for marketing and the fish spoiled.

### 4.15.4. Opportunities of the fishermen in Lake Tana

The presence of Lake Tana is a huge potential resource for Lake Tana bordering zones and the country as a whole. It creates job opportunities both men and women especially for the young who have no more land called landless rural and urban dwellers that are jobless. The sector improves livelihoods of many households by creating employments and generates income. The presence of papyrus tree (type of tree) used for the production of a traditional boat called reed boat helps fishermen to operate fishing.

# Chapter 5. CONCLUSION AND RECOMMENDATION

## 5.1. Conclusion

Although fishing through motorized boat is expected to be efficient, 89.4% of them are using papyrus reed boat, confirming that fishing activities in Lake Tana is still artisanal. On the other hand, fishing practices in Lake Tana are entirely performed by men while women have significant involvement on the post-harvest activities. The present study also revealed that young men are more attracted to the fishing activities, whereas the, relatively older and experienced fishermen tend to involve in value addition activities. Moreover, most of the fishermen are not cooperative members, indicating that the existing cooperatives are unable to support its members in any ways.

This study investigated that the lowest quantity of daily fish capture was observed in Takusa district (22 Kg/person) while Bahir Dar zuria district had the largest daily capture per individual fishermen (35 Kg). Districts such as Dembia, Gondar zuria, and Alefa had equivalent daily fish capture, which is about 29 Kg/person. The fishermen in Alefa district can be characterized by consuming more fish, which is about 5.9% of their capture goes for household consumption. The main reason that Fogera and Bahir Dar zuria district had the lowest household fish consumption which is about 3% of their capture might be market accessibility of the area encourages to sell most of their fish.

The fishermen, wholesalers, retailers, collectors, cooperatives, vendors, hotels and restaurants, and consumers are found to be the primary actors along the fish value chain of Lake Tana. The study affirms that hotels and restaurants have received the highest share of the profit margin. The OLS result showed that education level, fishing experience, training, and market information have positive influence on quantity of fish market supply. On the hand, farm land, engagement in fishing activity, boat type, market place problem, cold storage problem, and price fluctuation influenced the quantity of fish market supply negatively.

The study revealed that 86.3% of the fishermen have participation in some value adding activities, such as filleting, gutting, salting, and drying. Participant fishermen in value

adding activities has captured significantly less quantity of Tilapia fish indicating value adding activities took considerable time that the fishermen could otherwise allot for fishing activity. However, due to value addition (semi-processing), the fishermen could not get any profit margin rather a loss. The only reason that the fishermen engage in filleting, gutting, salting and drying is to reduce the post-harvest loss and probably to maintain the preference of the clients. Boat type, fish catch/day and fishing experience have affected the intensity of value addition positively. Whereas total farm land, cold storage problem, and labor cost affects the intensity of value addition negatively. The multivariate Probit model indicated that education level, total farm land, boat type, engagement in fishing activities, market information, fish catch per day, and distance from landing site to main fish market significantly affect the fish market outlet of the fishermen.

Generally, Lake Tana fishery management from production through marketing and waste disposal is under developed and traditional. The Lake is still facing a number of constraints: illegal fishing, siltation due to environmental degradation, invasive weeds such as water hyacinth, poor post-harvest handling mainly lack of sanitation during fish processing have been found significantly threatening the fishery resource sustainable utilization.

### 5.2. Recommendations

Based on the results of this study, the following viable suggestions should be considered for a sustainable use of the fishery resources in Lake Tana.

- The decision whether to engage in fish value addition is positively influenced by boat type, thus it is very helpful to consider and transform the artisanal fishermen to motorized fishing activities. In addition, the negative effect of cold storage problem on fish value adding intensity might be one of the focus areas to empower the bargaining capacity of the fishermen in the market.

- Expensiveness of fishing inputs such gillnets, and motorized boats coupled with capital shortage and negligible credit access might be a good opportunity for micro-finances, NGOs, and Government projects to consider the sector transformation.

- Almost all fishermen use monofilament gillnet that captures undersized fish together which in turn affects the sustainability of the system. The government or any concerned body should develop and implement appropriate control mechanisms and advocate wise use strategies.

- Since this study did not detailed, the export market particularly to Sudan and faraway cities such as Addis Ababa, a comprehensive national level investigation is needed in the near future.

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# APPENDICES

Appendix table 1. Sample distributions across the study Kebeles

| Kebeles | Total fishers | Total sample size | Proportion |
|---|---|---|---|
| Dengelber | 74 | 16 | 7% |
| Gorgora | 79 | 17 | 7.52% |
| Achera | 65 | 14 | 6.2% |
| Mitiriha abawarka | 158 | 34 | 15% |
| Shehagomengie | 56 | 12 | 5.3% |
| Nabega georgies | 148 | 32 | 14.16% |
| Delgi | 94 | 20 | 8.85% |
| Sekelet | 152 | 33 | 14.6% |
| Chachi alwa | 83 | 18 | 7.96% |
| Wagetera | 140 | 30 | 13.27% |

Appendix table 2. Tropical Livestock Unit conversion factor (TLU)

| Categories of livestock | Conversion factors |
|---|---|
| oxen | 1.1 |
| Cow | 0.8 |
| Heifers | 0.5 |
| Bulls | 1.1 |
| Sheep | 0.09 |
| Goat | 0.09 |
| Poultries | 0.01 |
| Donkeys | 0.36 |
| Mules | 0.8 |
| Horses | 0.8 |

Source; ILRI (international livestock research institution)

Appendix table 3. Test of multicollinearity problem for continuous independent variable (OLS)

| Variable | VIF | 1/VIF |
|---|---|---|
| Totfamlan | 2.03 | 0.493208 |
| Totfamsz | 1.95 | 0.513642 |
| TLU | 1.89 | 0.528518 |
| FishExp | 1.62 | 0.618889 |
| Educ | 1.29 | 0.772612 |
| ngillnet | 1.09 | 0.913394 |
| Mean VIF | 1.65 | |

Appendix table 4. Contingency Coefficients (CC) for Dummy Variables (OLS)

| Variables | EngfishA | BoatType | Training | Mktinforma~n | MKTplaceprob | Coldstorage | Prfluctuat~b | Membersfis~p |
|---|---|---|---|---|---|---|---|---|
| EngfishA | 1.0000 | | | | | | | |
| BoatType | 0.1405 | 1.0000 | | | | | | |
| Training | -0.2210 | -0.2234 | 1.0000 | | | | | |
| Mktinforma~n | -0.2215 | -0.0886 | 0.0745 | 1.0000 | | | | |
| MKTplaceprob | 0.1271 | 0.1821 | -0.1108 | 0.0744 | 1.0000 | | | |
| Coldstorage | -0.0207 | -0.0841 | 0.0817 | -0.0133 | 0.1262 | 1.0000 | | |
| Prfluctuat~b | 0.1172 | 0.2542 | -0.0950 | 0.0112 | 0.3185 | 0.0348 | 1.0000 | |
| Membersfis~p | -0.1647 | 0.2175 | 0.3197 | 0.1460 | 0.0453 | 0.0688 | 0.0804 | 1.0000 |
| Credituti l~n | -0.0641 | -0.2165 | 0.2303 | 0.0711 | 0.0104 | 0.2380 | -0.0301 | 0.0580 |

Appendix table 5. Model Specification Test

| Model | hypotheses | Calculated value | Tabulated value | Decision |
|---|---|---|---|---|
| Double hurdle vs.tobit | Ho: Tobit model is appropriate | Tobit test =99.08 | Df = 10 at 5% | Reject tobit model |
| | H1: double hurdle is appropriate | | $X^2$= | |

Appendix table 6. Results from Multivariate Probit model

```
Iteration 0:   log pseudolikelihood = -609.86626  (not concave)
Iteration 1:   log pseudolikelihood = -543.62852
Iteration 2:   log pseudolikelihood = -524.65394
Iteration 3:   log pseudolikelihood = -519.86237
Iteration 4:   log pseudolikelihood = -519.32859
Iteration 5:   log pseudolikelihood = -519.32217
Iteration 6:   log pseudolikelihood = -519.32217

Multivariate probit (SML, # draws = 5)          Number of obs   =        226
                                                Wald chi2(40)   =     140.39
Log pseudolikelihood = -519.32217               Prob > chi2     =     0.0000
```

| | Coefficient | Robust std. err. | z | P>\|z\| | [95% conf. | interval] |
|---|---|---|---|---|---|---|
| **Wholseller** | | | | | | |
| Educ | .0316158 | .0289971 | 1.09 | 0.276 | -.0252176 | .0884492 |
| Totfamlan | -.1345986 | .0537463 | -2.50 | 0.012 | -.2399394 | -.0292579 |
| BoatType | .1040872 | .3201869 | 0.33 | 0.745 | -.5234676 | .7316419 |
| EngfishA | .0056145 | .1068813 | 0.05 | 0.958 | -.203869 | .2150979 |
| Training | -.1896978 | .2151366 | -0.88 | 0.378 | -.6113578 | .2319621 |
| Mktinformation | -.5547897 | .4009872 | -1.38 | 0.166 | -1.34071 | .2311308 |
| fishcatchda | .0193587 | .0082857 | 2.34 | 0.019 | .0031191 | .0355983 |
| DsLsitmainFishMKT | .0057421 | .0014794 | 3.88 | 0.000 | .0028425 | .0086417 |
| _cons | .0631176 | .8643646 | 0.07 | 0.942 | -1.631006 | 1.757241 |
| **Retailer** | | | | | | |
| Educ | -.0124685 | .0314622 | -0.40 | 0.692 | -.0741333 | .0491963 |
| Totfamlan | .1120822 | .0504299 | 2.22 | 0.026 | .0132414 | .210923 |
| BoatType | -.0333966 | .3586328 | -0.09 | 0.926 | -.736304 | .6695108 |
| EngfishA | .1265461 | .1061979 | 1.19 | 0.233 | -.081598 | .3346901 |
| Training | .0079004 | .2093871 | 0.04 | 0.970 | -.4024908 | .4182915 |
| Mktinformation | .657495 | .4055763 | 1.62 | 0.105 | -.1374199 | 1.45241 |
| fishcatchda | -.0103023 | .0102719 | -1.00 | 0.316 | -.0304349 | .0098302 |
| DsLsitmainFishMKT | -.0009872 | .0013835 | -0.71 | 0.476 | -.0036989 | .0017245 |
| _cons | -1.135359 | .9261669 | -1.23 | 0.220 | -2.950613 | .6798944 |
| **Collector** | | | | | | |
| Educ | -.0448752 | .0279658 | -1.60 | 0.109 | -.0996872 | .0099368 |
| Totfamlan | -.1269001 | .0472227 | -2.69 | 0.007 | -.2194549 | -.0343452 |
| EngfishA | .085367 | .0963042 | 0.89 | 0.375 | -.1033858 | .2741199 |
| BoatType | .5313352 | .3764419 | 1.41 | 0.158 | -.2064773 | 1.269148 |
| Training | -.1117949 | .1940788 | -0.58 | 0.565 | -.4921824 | .2685925 |
| Mktinformation | .0586681 | .3398187 | 0.17 | 0.863 | -.6073642 | .7247004 |
| fishcatchda | .0227728 | .0081209 | 2.80 | 0.005 | .0068561 | .0386895 |
| DsLsitmainFishMKT | .0028654 | .0014228 | 2.01 | 0.044 | .0000768 | .0056539 |
| _cons | -2.393694 | .9108887 | -2.63 | 0.009 | -4.179003 | -.6083846 |
| **Hotel** | | | | | | |
| Educ | .0300174 | .0265386 | 1.13 | 0.258 | -.0219973 | .0820322 |
| Totfamlan | .023735 | .0445647 | 0.53 | 0.594 | -.0636102 | .1110803 |
| BoatType | .6664445 | .3810215 | 1.75 | 0.080 | -.0803439 | 1.413233 |
| EngfishA | -.4803525 | .1206086 | -3.98 | 0.000 | -.7167254 | -.2439797 |
| Training | .2140472 | .1948196 | 1.10 | 0.272 | -.1677923 | .5958867 |
| Mktinformation | -1.44898 | .3716714 | -3.90 | 0.000 | -2.177443 | -.7205177 |
| fishcatchda | -.0132006 | .0081398 | -1.62 | 0.105 | -.0291544 | .0027532 |
| DsLsitmainFishMKT | .0009667 | .0014546 | 0.66 | 0.506 | -.0018843 | .0038178 |
| _cons | .1547455 | .9846439 | 0.16 | 0.875 | -1.775121 | 2.084612 |
| **Consumer** | | | | | | |
| Educ | .0672802 | .0277507 | 2.42 | 0.015 | .0128899 | .1216705 |
| Totfamlan | .0700223 | .0487632 | 1.44 | 0.151 | -.0255518 | .1655965 |
| BoatType | .5121633 | .328261 | 1.56 | 0.119 | -.1312166 | 1.155543 |
| EngfishA | -.1199311 | .1008417 | -1.19 | 0.234 | -.3175773 | .0777151 |
| Training | .1368558 | .1918798 | 0.71 | 0.476 | -.2392217 | .5129333 |
| Mktinformation | -.3525684 | .3606568 | -0.98 | 0.328 | -1.059443 | .354306 |
| fishcatchda | -.0195077 | .0080586 | -2.42 | 0.015 | -.0353023 | -.003713 |
| DsLsitmainFishMKT | .0013937 | .0013609 | 1.02 | 0.306 | -.0012737 | .0040611 |
| _cons | -.5679626 | .8989224 | -0.63 | 0.528 | -2.329818 | 1.193893 |

Appendix table 7. Correlations matrix of market out let choices

| | | | | | | |
|---|---|---|---|---|---|---|
| /atrho21 | -.7549736 | .1631189 | -4.63 | 0.000 | -1.074681 | -.4352665 |
| /atrho31 | -.5592976 | .1190713 | -4.70 | 0.000 | -.7926731 | -.3259221 |
| /atrho41 | .2012511 | .0945979 | 2.13 | 0.033 | .0158426 | .3866596 |
| /atrho51 | -.0644991 | .1225307 | -0.53 | 0.599 | -.3046549 | .1756566 |
| /atrho32 | .0407679 | .1071864 | 0.38 | 0.704 | -.1693137 | .2508494 |
| /atrho42 | .2848081 | .0989591 | 2.88 | 0.004 | .0908519 | .4787644 |
| /atrho52 | .5107629 | .1066433 | 4.79 | 0.000 | .3017459 | .7197799 |
| /atrho43 | -.8248934 | .1621153 | -5.09 | 0.000 | -1.142634 | -.5071532 |
| /atrho53 | -.5987832 | .1208459 | -4.95 | 0.000 | -.8356367 | -.3619296 |
| /atrho54 | .9385814 | .1332618 | 7.04 | 0.000 | .6773932 | 1.19977 |
| rho21 | -.6381068 | .0967001 | -6.60 | 0.000 | -.7912182 | -.4097132 |
| rho31 | -.5074561 | .0884091 | -5.74 | 0.000 | -.6599207 | -.3148519 |
| rho41 | .1985774 | .0908676 | 2.19 | 0.029 | .0158413 | .3684769 |
| rho51 | -.0644098 | .1220224 | -0.53 | 0.598 | -.2955667 | .173872 |
| rho32 | .0407453 | .1070085 | 0.38 | 0.703 | -.1677141 | .2457169 |
| rho42 | .2773493 | .0913469 | 3.04 | 0.002 | .0906027 | .4452535 |
| rho52 | .4705394 | .0830317 | 5.67 | 0.000 | .2929095 | .616773 |
| rho43 | -.6777245 | .0876541 | -7.73 | 0.000 | -.815299 | -.4677241 |
| rho53 | -.5361831 | .0861036 | -6.23 | 0.000 | -.6834911 | -.3469126 |
| rho54 | .7345698 | .0613547 | 11.97 | 0.000 | .5898221 | .8335843 |

Likelihood ratio test of rho21 = rho31 = rho41 = rho51 = rho32 = rho42 = rho52 = rho43 = rho53 = rho54 = 0:
chi2(10) = 181.088 Prob > chi2 = 0.0000

Appendix table 8. The predicted probability of each market out let choice and joint probability success/failure

| Variable | Obs | Mean | Std. dev. | Min | Max |
|---|---|---|---|---|---|
| pall1s | 226 | .002253 | .004899 | 2.52e-07 | .0382015 |
| pall0s | 226 | .0219052 | .0277738 | 4.51e-06 | .1463379 |
| pmargm1 | 226 | .7642631 | .1480344 | .3336263 | .9962733 |
| pmargm2 | 226 | .2716814 | .1170154 | .0480632 | .6401219 |
| pmargm3 | 226 | .2583197 | .1193066 | .0444837 | .60122 |
| pmargm4 | 226 | .2689083 | .1638844 | .0169425 | .9100814 |
| pmargm5 | 226 | .5018226 | .1498362 | .0749167 | .8206005 |

**A Survey Questionnaire prepared to conduct a study on value chain analysis of fish in Lake Tana, Amhara Region (2022)**

## I. Fishermen / Respondents' general information

**Date _____Interviewer Name: _____**

**Personal profile /demographic data/**

1) zone: 1= South Gondar 2= Central Gondar 3 = West Gojjam
2) Woreda: 1= Alefa 2= Dembiya 3= Gondar Zuriya 4= Fogera 5= Bahir Dar Zuriya 6= Takusa
3) Kebele: 1= DengelBer 2= Gorgora 3= Achera 4= MitriAbawarka 5=Sheha Gomengie 6= NabegaGeorgies 7= Delgi 8= Sekelet 9=chachalwa 10=wagetera
4) Respondents' name _____ Age_____ Sex: 1=male 0=female
5) Religion: 1. Muslim 2. Orthodox Christian 3. Protestant 4. Other_____
6) Marital Status: 1. Single 2. Married 3. Widowed4. Divorced
7) Educational level_____
8) Total family size __ capable to work (>15 &<64): __ not capable to work (<15 &>64): ___
9) How long it will take from your home to reach the landing site _____ in walking minutes
10) How long it will take from landing site to the nearest main fish market …..... in walking minutes
11) How long it will take from thelanding siteto the local fish market …..... in walking minutes
12) How long it will take from the resident to the nearest fishing net or input selling market …..... in walking minutes

13) How long it will take from the resident to the agricultural extension office …..... in walking minutes

## II. Households' Economic Activities

14) What is the household's main livelihood strategy? 1= Crop production and livestock rearing 2= Fishing 3= Petty trading 4= Casual worker / laborer 5=Others_____

15) Land ownership and allocation

| No. | Land types | Allocation (Timad/Kada) |
|---|---|---|
| 1 | Farm land (Rain fed) | |
| 2 | Farm land (irrigated) | |
| 3 | Grazing land (private) | |
| 4 | Coffee | |
| 5 | Fruits and vegetables | |
| 6 | Forest land (like Eucalyptus) | |
| 6 | Total land | |

16) What livestock do you have and how many?

| Type | Oxen | Cow | heifers | Bulls | Sheep | Goat | poultries | Donkey | Mules | horses |
|---|---|---|---|---|---|---|---|---|---|---|
| Number | | | | | | | | | | |

## III. Fish handling related questions

1) How long did you engaged in fishing activities?_____ years
2) Type of engagement in the fishery activities?
   1= Full time 2=Part time 3=Seasonal
3) How long fishing take per trip? _____Hours/days
4) Which fish species/type you most commonly harvest or you like to harvest currently?
   1. Tilapia 2. Bar bus 3. Catfish 4.Beso 6. All fish type
5) What is the trend of fish production across the years looks like since you started fishing;
   A) By amount: 1. Increased 2. Decreased 3. No change
   B) By fish size: 1. Increased 2. Decreased 3. No change

6) If your answer for Q5 is decreased by amount what are the reasons for decreasing?
   1= recession agriculture 2= due to water hyacinth 3= illegal fishing 4= huge number of fishers / overfishing 5= due to destruction of fish breading areas 6 =other reasons specify (_____)
7) If the answer for Q5 is decreased; how sever is the rate of decreasing? 1= Very sever 2= Sever 3= Medium 4= less severe
8) If the answer for Q5is decreased;when was the catch per effort started decreasing? 1= within 5 years 2= between 5 to 10 year 3= before 10 year
9) If your answer for Q5is decreased by fish size what are the reasons for decreasing the size of the fish_____?

10) How many days do you go for fishing per week (on average) in peak fishing season? _____days/ a week and _____days/month
11) How many days do you go for fishing per week (on average) in medium season? ……. days/ week and ---------- days/month
12) How many days do you go for fishing per week (on average) in passive season? _____days/ a month and _____days/month
13) Active months _____ No. ___
14) Medium months _____ No. ___
15) Passive months _____ No. ___
16) If you have been catching different fish species, what is the fish yield during active, medium and passive season and which months?

| Season | Fish species | Fish yield in kilogram per trip | Consumed amount each trip | Sold in each trip | |
|---|---|---|---|---|---|
| | | | | amount (Kg) | Price (ETB/Kg) |
| Active season | Tilapia | | | | |
| | Bar bus | | | | |
| | Catfish | | | | |
| | Beso | | | | |
| Medium | Tilapia | | | | |
| | Bar bus | | | | |
| | Catfish | | | | |
| | Beso | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Passive | Tilapia | | | | |
| | Bar bus | | | | |
| | Catfish | | | | |
| | Beso | | | | |

## IV. Fishing equipment

1) What type of fishing boat you used? 1. Motorized boat 2. Reed boat

2) What type offishingnetyou have used for fishing:

a) Gillnet: Number_____; length in meter_____
Mesh size: a) < 6 cm___, b) 6-8cm___, c) 8-10cm___, d) >10cm_____

b) Hook & Line: Number____, Length in meter _____, Types of bait used_____

c) Traps: Number_____, Size (L X Diameter in m) _____, Mesh Size_____

3) Sourcesand cost of fishing inputs in Ethiopian ETB per trip (2013)

| **Items** | **Sources** | **Quantity used per trip** | **Unit price/ wage or rent (ETB)** |
|---|---|---|---|
| Fishing boat | | | |
| Fishing nets | | | |
| Hook | | | |
| Trap | | | |
| Crews per boat | | | |
| Fuel/oil per round trip | | | |

4) Maintenance costs per year (2013**)**

| **Items** | **Frequency per year** | **Annual Cost / ETB** |
|---|---|---|
| Maintenance of fishing boat | | |
| Maintenance of fishing gear | | |
| **Total** | | |

5) Numbers of averagecrews per boat per trip? _____individuals

6) How long it takes for collecting the harvest? _____minute

7) How long it takes for returning from harvesting site to the landing site?
_____minute

8) Daily wage rate for laborers either in fishing or others _____ETB

## V. Value addition

1. Do you preserve and process your fish product before selling? 1 = Yes 0= No

2. **If yes for Q1**, which value adding activity you perform? 1=filleting 2=gutting 3=salting 4=drying

   1. Transporting cost per trip _____ETB
   2. Storage cost per trip _____ETB
   3. Filleting cost per trip _____ETB
   4. Gutting cost per trip _____ETB.
   6. Washing cost per trip _____ETB
   7. Salting cost per trip _____ETB

3. Is there price difference due to value adding activities? 1 = Yes 0= No

4. When you have started processing and preserving before selling _____years?

5. If No for Q1, what is the reason? 1=due to labor shortage 2= Lack of knowledge/experience 3= value addition is not paying

## VI. Fish Market related questions

### *A. Marketing System and their association*

1. Do you sell fish last year (2013) 1= Yes 0= No
2. **If yes for Q1,** where do you sell your d catch? 1) Local market 2) Landing site 3) Door to door 4) district market 5) zonal market
3. To whom? 1) Whole sellers 2) Hotel and restaurants 3) Retailers 5) vendors 6) Consumers
4. Why you prefer for selling the selected actor? 1= price difference from others 2= closeness of the buyer in distance 3= transport availability 4= customer relationship 5= others _____

5. If you sold your product to more than one actor for please estimate the amount and selling price for each actors per trip

| Fish species | Forms of fish | How much sold (percentage) and unit price across actors | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | For whole seller | | For retailer | | For hotel and restaurants | | For vendors | | For consumer | | Collector | |
| | | % | price | % | price | % | price | % | price | % | price | % | price |
| Tilapia | Whole fish | | | | | | | | | | | | |
| | Filleted | | | | | | | | | | | | |
| | Gutted | | | | | | | | | | | | |
| | Salted | | | | | | | | | | | | |
| | Dried | | | | | | | | | | | | |
| Barbus | Whole fish | | | | | | | | | | | | |
| | Filleted | | | | | | | | | | | | |
| | Gutted | | | | | | | | | | | | |
| | Salted | | | | | | | | | | | | |
| | Dried | | | | | | | | | | | | |
| Cat fish | Whole fish | | | | | | | | | | | | |
| | Filleted | | | | | | | | | | | | |
| | Gutted | | | | | | | | | | | | |
| | Salted | | | | | | | | | | | | |
| | Dried | | | | | | | | | | | | |

6. Do your customers demand more fish than before? 1= Yes 0=No

   Why _____

7. Do you believe there is market problem? 1= Yes 0= No

8. If yes for Q7, what are those problems 1_____
   2_____ 3_____
9. Which customers mostly purchase your product? 1) Whole sellers 2) Hotel and restaurants 3) Retailers 5) vendors 6) Consumers7=collector 8= others
10. When do you get good market? Season_____? Months_____?
11. What type of relation you have with buyer/s? 1= customer relation 2 = no relation 3= friend 4= relative 5 = others (specify_____)
12. Do you have long standing customer (buyer)? 1= Yes 0= No
13. To decide for whom to sell, what factors you consider?price,_____

**B. Fish market Price**

14. Is the price of fish attractive today than the past? 1= Yes 0= No;
    Why_____
    _
15. Who decides/control the fish price? 1) The fishers (producers) 2) whole sellers 3) Retailers 5) hotels and restaurants 6) vendors 7) consumers 8/ collectors 9= Other specify_____
16. In which month/s the fish price is high/low? High_____ Low_____
    Why_____
    _____
    _____
17. Why the prices vary through the week, month, and season in your place?
    _____
    _____
    _____

## VII. Factors affecting fish market supply

1. Are there fish market supply problems? 1 = Yes 0 = No
2. **<u>If yes for Q1</u>**what are the factors that affect fish market supply?

| No | Factors | 1= Yes<br>0=No | Rank 1=very series<br>2= series 3=moderate |
|---|---|---|---|

| | | | 4= not series at all |
|---|---|---|---|
| 1 | Low prices (price fluctuation problem) | | |
| 2 | Seasonality | | |
| 3 | High transportation cost | | |
| 4 | Lack of cold storage | | |
| 5 | Poor power supply | | |
| 6 | Improper market place | | |

## VIII. Transportation and storage

1. What is your means of transportation for transporting fish to the market? 1. Human carrying 2.By bicycle 3.Motor cycle 4.by car 5 other (specify) _____
2. Who pays for the transport to different marketing places?
   1. Fishery cooperatives2. Yourself 3.Buyer4. others _____
3. How much is the transport costs from landing site to area of sale? _____ ETB
4. How long does it take you to reach the market to sell your fish? _____minutes
5. Have you got losses for fish yield? 1= Yes 0= No
6. If yes for Q5, what are the causes of the losses? 1. Price fluctuation 2. Storage problem 3. Lack of transport facility 4. Poor linkage with actors 5.Othersspecify_____

## IX. Training

7. Have you ever participated on fishing and processing relatedtraining/s? 1= Yes 0= No
8. If yes, was the training satisfactory? 1= Yes 0=No
9. Who delivered the fishing training?
   1. Bureau of agriculture 2. Woreda agriculture office 3. Research centre4.Non-government organization 6. Regional fishery Agency 7. Others_____
10. Do you need training for the future? 1= Yes 0= No;
11. If yes, what type of training do you need?

_____

## X. Credit services

12. Have you ever used credit for fishing? 1=Yes 0=No

13. If yes for Q12, from where did you get the credit? 1 = Micro finance 2 = NGOs 3 = local money lenders 4 = saving and credit association 5 = Banks 6 = others _____

14. If yes for Q12, what amount of loan did you get in the last years? _____ ETB

15. If No for Q20,Why? 1 = high interest rate 2 = no need credit 3 = fear of repayment due to in ability 4 = no service 5 = lack of awareness about the service 6 = others

16. Did you use the credit offered for fishing to other purposes? 1= Yes 0= No

17. If yes for Q16, for what purpose did you use? 1. for educating children 2. for purchasing cloth 3. for purchasing seed, fertilizer 5. For purchasing goat or sheep or oxen

6. Any other (specify)_____

## XI. Sources of market information

1. Do you get market information before taking your fish to the market? 1= Yes 0= No
2. If yes for Q1, where you get the information? Please fill the following table.

| Information sources | Sources of information | 1= Yes 0 = No |
|---|---|---|
| Professional/ personal networks | Traders | |
| | Friends/neighbors | |
| | Development agents | |
| | Others (specify_____) | |
| Public information system | From market bulletins | |
| | Radio | |
| | Television | |
| | Message blackboards at market | |
| | places/ECX board | |
| | Others (specify _____) | |

## XII. Membership in cooperatives

1. Are you a member of fishery cooperatives? 1= Yes 0= No
2. If No for Q1, Why? _____

3. If yes for Q1, how long have you been the member of the fish cooperative? _____years

4. Why do you become the member of fishingcooperative?

1=the cooperative provides better price

2= It makes timely payment

3= gives an input through credit

4= others _____

5) How much you earn per annum from?
   a) Sales of crops _____ETB/year
   b) Sales of fruits and vegetables _____ETB/year
   c) Sales of coffee _____ETB/year
   d) Sales of livestock _____ETB/year
   e) Sales of livestock products (Butter, milk and egg…)_____ETB/year
   f) Forest _____ETB/year
   g) Off/none farm income _____ETB/year)
   h) Others (Specify) _____ETB/year

6) Do you have a knowhow about the Government laws and regulations on fishing activities? 1= Yes 0= No
7) Is there implementation of the laws regarding fisheries resource use? 1= Yes 0= No
8) If yes for Q7, which government laws have been implemented?

_____

_____

## A Survey Questionnaire for Fish Traders

**Zone _____ Woreda _____Town _____Kebele _____**

1) Respondents' name _____, Age_____, Sex: 1=male 0=female
2) Religion: 1. Muslim 2. Orthodox Christian 3. Protestant 4. Other_____

3) Marital Status: 1. Single 2. Married 3. Widowed 4. Divorced
4) Educational level: 1. Illiterate 2. Read & write 3. Primary (1-8) 4. Secondary (9-12) 5. College graduated and above
5) Are you involved in trading other than fish? 1 = Yes 0 = No
6) If yes for Q5, what is that? 1. Crop trading 2. Livestock trading 3. Livestock products trading 4. Petty trading 5. Others_____
7) Business type 1=private 2=partnership
8) Are you involving in fish trading? 1= yes 0= No
9) Year of involvement on fish trading _____ years
10) If yes forQ8 which type of trader you are? 1= Whole seller 2= retailer
11) Time of fishtrading1 = Year-round 2 = during high demand3 = during high supply 4= Others (_____)
12) Number of marketing days you purchase fish per week 1. Two times a week 2. Three times a week 3. Throughout the week 4. _____ times
13) What was the amount of your initial working capital when you start fish trading? _____ETB, current capital _____ ETB
14) Have you ever participate in training? 1=Yes 2=No
15) <u>If Yes for Q14</u> what type you participate?

_____

_____

16) Did you get credit access? 1 = Yes 0= No
17) <u>If Yes for Q16</u> what are your sources of credit? 1. Micro finances 2. Bank 3. Local credit services5. Relatives 6. Friends
18) <u>If Yes for Q16</u>, for what purpose did you used the credit? 1 = to expand fish trading 2 = to purchase fish transport vehicles 3. =to purchase storage facilities 4 = for transportation of fish from one market place to others5= to add values (processing and preserving) 6= any others (specify) _____
19) If No for Q16 what is the reason? 1 = high interest rate 2 = no need credit3 = fear of repayment due to in ability 4 = no access5 = lack of awareness 6 = others_____
20) From which market you buy fish? 1= landing site 2 = village market 3 = district market
21) From whom you buy fish? 1 =Fishermen2= fish collectors 3= whole seller 4=others _____
22) How many Kg of fish you bought per month in **<u>active</u>** fishing months in 2013 fishing

months? _____Kg

23) How many Kg of fish you bought per month in **medium** fishing months in 2013 fishing months? _____Kg

24) How many Kg of fish you bought per month in **passive** fishing months in 2013 fishing months? _____Kg

25) What was the total fish you bought in 2013? _____Kg

26) What are your means of attracting your suppliers? 1 = by giving better price relative to others 2 = by fair weighing 3 = contractual agreement 4=Others_____

27) To whom you sell the collected fish? 1 =hotel and restaurants 2 = consumers 3= retailers 4 = vendors 5=others _____

28) How do you attract your buyer/s? 1 = by providing a quality product 2 = by giving fair price relative to others 3 = by giving bonus 4 = others_____

29) To which market destination you usually sell fish (market channel)? 1= Gondar city 2= Bahir Dar city 3=Desie city 4= Addis Ababa 5= Outside the country (Specify) _____ 6= others_____

30) Who sets the fish selling price? 1 = negotiation 2 = by the market 3 = by the buyer 4 = by the seller 5 = others _____

31) If you have decided the selling price by yourself, when did you set the price? 1 = one day before the market day 2 = a week before the market day 3 = Early in the morning during the market day 4= at the time of selling

32) What type of fish species you prefer to buy? 1. Tilapia 2. Barbus 3. catfish: Why_____

33) What is the preferable season of the year for purchasing the fish? _____

34) What is the preferable season of the year for selling the fish? _____

35) Have you ever stopped purchasing fish due to lack of supply? 1 = Yes 0= No

36) **If yes for Q35**, for how long? _____

37) Do you preserve and process fish before selling? 1. Yes 0= No

38) **If yes for Q37**, what are the preservation and processing activities you perform? 1. Gutting 2. Filleting 3. Drying 4. Salting 5. Cold storage

39) When did you start preserving and processing fish before selling? _____

40) Is there price difference due to preserving and processing the fish? 1 = Yes 0= No

41) **<u>If yes for Q40</u>** what is your estimation of price difference due to value addition during **active, medium, and passive** seasons? Fill below table

| Fish species | Preserved and processed fish forms | Fish products sold | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Active season | | | Medium | | | Passive | | |
| | | Quantity Kg | Unit price | Market destination | Quantity Kg | Unit price | Market destination | Quantity Kg | Unit price | Market destination |
| Tilapia | Whole fish | | | | | | | | | |
| | Filleted | | | | | | | | | |
| | Gutted | | | | | | | | | |
| | Salted | | | | | | | | | |
| | Dried | | | | | | | | | |
| Barbus | Whole fish | | | | | | | | | |
| | Filleted | | | | | | | | | |
| | Gutted | | | | | | | | | |
| | Salted | | | | | | | | | |
| | Dried | | | | | | | | | |
| Catfish | Whole fish | | | | | | | | | |
| | Filleted | | | | | | | | | |
| | Gutted | | | | | | | | | |
| | Salted | | | | | | | | | |
| | Dried | | | | | | | | | |

42. Please estimate the amount and selling price for each actors

| Fish species | Forms of fish | How much sold (percentage) and unit price across actors | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | For whole seller | | For retailer | | For hotel and restaurants | | For vendors | | For consumer | |
| Tilapia | Whole fish | % | Price | % | Price | % | Price | % | Price | % | Price |
| | Filleted | | | | | | | | | | |
| | Gutted | | | | | | | | | | |
| | Dried | | | | | | | | | | |
| | Salted | | | | | | | | | | |
| Barbus | Whole fish | | | | | | | | | | |
| | Filleted | | | | | | | | | | |
| | Gutted | | | | | | | | | | |
| | Dried | | | | | | | | | | |
| | Salted | | | | | | | | | | |
| Cat fish | Whole fish | | | | | | | | | | |
| | Filleted | | | | | | | | | | |
| | Gutted | | | | | | | | | | |
| | Dried | | | | | | | | | | |
| | Salted | | | | | | | | | | |

42) Indicate the average costs incurred per Kg in fish trading activities

| **Activities** | **Cost costs** |
|---|---|
| Transportation | |
| Preservation cost | |
| Processing cost | |
| Labor for packing | |
| Storage cost | |
| Telephone cost | |
| Total cost | |

43) Do you face fish supply problem? 1 = Yes 0= No

44) **<u>If yes for Q43</u>**what are those problems that affect fish market supply?

| **No** | **Factors** | **Yes / No responses** | **Rank** | | | |
|---|---|---|---|---|---|---|
| | | | V. Serious | Serious | Moderate | Less serious |
| 1 | Low prices (price fluctuation problem) | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2 | Poor road access | | | | | |
| 3 | High transportation cost | | | | | |
| 4 | Lack of cold storage | | | | | |
| 5 | Poor power supply | | | | | |
| 6 | Improper market place | | | | | |
| 8 | Others | | | | | |

45) How long it will take from your home to the nearest main fish market …..... in walking minutes

46) How long it will take from the your hometo the local fish market …..... in walking minutes

47) State the relationship each value chain actors

| **Value chain actors** | Level of relationship 1=high 2=medium 3=low | | | | express the relationship 1=credit 2= give storage spaces 3=others |
|---|---|---|---|---|---|
| | Whole seller | Retailer | vendor | Consumer | |
| Fisher men | | | | | |
| Whole seller | | | | | |
| Retailer | | | | | |
| vendor | | | | | |
| consumer | | | | | |

## A Survey Questionnaires for Hotels and Restaurants

**Zon_____ Woreda _____Town _____Kebele _____**

1) Name of restaurants _____
2) Year of establishment_____
3) Type of business 1=private 2=shared
4) If shared how many members it contains? _____
5) Kind of specialization 1=only fish-based foods 2=fish and other food items
6) From whom you buy fish? 1=fishermen 2=whole sellers 3=fish collectors 4=retailers
7) Number of days you purchase fish: 1= every day 2=two days a week 3= three days a week

8) How many Kg of fish you bought at one purchasing day? Please fill the following table

| Fish species | Fish forms | Quantity (Kg) | Unit cost |
|---|---|---|---|
| Tilapia | Whole fish | | |
| | Filleted | | |
| | Gutted | | |
| Barbus | Whole fish | | |
| | Filleted | | |
| | Gutted | | |
| Catfish | Whole fish | | |
| | Filleted | | |
| | Gutted | | |

9) What is your daily fishselling amount?

a) Maximum _____Kg/day, When? 1= fasting season 2= non-fasting season 3= weekend 4= working days

b) Minimum _____Kg/day, When? 1= fasting season 2= non-fasting season 3= weekend 4= working days

10) How many fish-based food items you could prepare? Please fill the following table

| **Fish species** | **Food items** | **Number of dish/Kg(piece)** | **Selling price/dish** | **Cost /dish** |
|---|---|---|---|---|
| Tilapia | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| Barbus | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
| Catfish | | | | |
| | | | | |
| | | | | |
| | | | | |
| | | | | |

11) What was the amount of your initial working capital when you start this business? _____ETB

12) What is your current capital? _____ETB

13) Did you get credit access? 1 = Yes 0= No

14) If Yes for Q13, what are your sources of credit? 1. Micro finances 2. Bank 3. Local credit services 5. Relatives 6. Friends

15) If Yes for Q13, for what purpose did you used the credit? 1 = to expand our service 2=to purchase storage facilities 3 = to open additional branches 6= others (specify) _____

16) If No for Q13, what is the reason? 1= high interest rate 2= no need credit 3= fear of repayment due to inability 4= no access 5= lack of awareness 6 = others_____

17) What are your weekly expenses? Please fill the following table

| Activities | Costs/weak |
|---|---|
| Cooking oil | |
| Boiling oil (AsaTibs) | |
| Hot pepper | |
| Onion | |
| Garlic | |
| Spices | |
| Electricity | |
| Charcoal | |
| Water | |
| Transportation | |
| Labor(filleting, gutting, washing) | |
| Salary (waiters) | |
| Salary (cooker) | |
| Telephone | |
| Rent | |

**A Questionnaires for focus group discussion and key informant interview**

**Date_____ Woreda _____Kebele_____**

1. Do you think fish production problem? 1. Yes, 0. No

2. If yes what are these problems_____
3. Do you think fish marketing constraint? 1. Yes , 0.No
4. How do see the production trend of fish? 1. Increases 2. Decreases
5. What are the cause of decreasing or increases?_____
6. If yes what are these constraints_____
7. What corrective measures should be taken to correct the above constraints? _____

**A Questionnaire for fish consumers**

**Date_____ woreda _____kebele_____**

**Respondent name ----------**

***I.* Socio demographic characteristics**

1. Sex 1. Male 2.Female

2. Age ----------

3. Educational status ----------

4. Marriage status 1. Single 2. Married 3. Widow 4.Divorced

5. Total Family size _____

6. Religion 1. Orthodox 2. Muslim 3. Protestant 4. Other specify_____

7. Major livelihood 1. Government employed 2. Private employed 3.Merchant_____4.other _____

8. From who buy fish? 1. Fishermen 2.collector, 3.wholesaler, 4.retailer, 5.hotel and restaurant.

9. Who decide the price fish and fish products? 1. Buyers 2.sellers 3.both 4 market

10. How many times in a month do you buy fish? (Frequency per month) _____

11. What quantities of fish do you buy in a month? (In kg per month) _____

12. At what price do you buy fish? (Birr per Kg) _____

13. Do you consider this price affordable? 1. Yes 0. No

14. Do you consider fish type when you purchase fish and fish products? 1. Yes 0. No

15. If yes which type of fish you prefer? 1. Tilapia 2. Barbus 3. Cat fish

Why_____

16. How do you think about the quality of fish that you buy? 1. Good 2. Average 3. Poor

17. What would you like to suggest to improving the quality of fish being sold for human consumption? _____

# AUTHOR BIOGRAPHY

The author was born in Dangila district, Awi zone of Amhara Regional State in September 1990. She attended her primary education at Felege Abay Primary School and her junior at Ewuket Fana Junior School, Bahir Dar. She attended her Secondary School Education at Bahir Dar zuria district Secondary high school and her preparatory at Bahir Dar Preparatory School in Bahir Dar. After completion of her preparatory school, she joined Debre Markos University College of Agriculture in November 2011 and graduated with BSc. Degree in Rural Development in 2014. After graduation, she was employed at Adet Agricultural Research Center as a junior researcher in Agricultural Extension and Socio- economic Directorate. In 2018, the author joined Bahir Dar Fishery and other Aquatic Life Research Center where she served as assistance researcher in Agricultural Extension and Socio-economic Directorate until she joined Bahir Dar University in 2021 to pursue her MSc. Degree in Rural Development Management in the regular program.