COLLEGE OF NATURAL SCIENCES

SCHOOL OF GRADUATE STUDIES

DEPARTMENT OF BIOLOGY

Assessment on handling practices and post-harvest loss of fish in Lake Ardibo, South Wolo, Tehuledere Woreda Ethiopia

By: Mohammed Yimer

A Thesis presented to Department of Biology, College of Natural Sciences, Jimma University in Partial Fulfillment of the Requirements for the Degree of Masters of Science in Biology

Advisor:-Tokuma Negisho (PhD Scholar)

Co-advisor:- Sagni Gobena (MSc.)

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Abstract

Ethiopia has substantial fishery resources in the inland lakes and rivers with potential yield of more than 94500 tons per year from the main water bodies like Lakes Tana, Ziway, Langeno, Hawassa, Chamo, Abaya and manmade reservoirs. The fishery sector of Ethiopia is not well developed regarding post-harvest handling practice due to fish post-harvest handling practices and loss are the bottlenecks in fisheries sector. The present study was aimed to assess handling practices and estimate postharvest losses at Lake Ardibo located in Tehuledere Woreda, South Wolo, Amhara Regional State. The data was collected from October, 2018 to May, 2019 using three methods (Informal fish loss assessment methods, Load track methods, and Questionnaire loss assessment method) from all the registered members of the fishermen cooperatives. Questionnaires, observations and participatory rural appraisal were used to collect primary data and additionally secondary data were collected from Tehuledere Woreda, Agricultural office. All of the fishermen were male and 96.32% of them were married. About 33.87% ranges between 6-10 years of experience and 31.02 % ranges between 11-15 years of experience. 40% of the respondents were first cycle (1-4) grade level, 29.79 % were 5-8 grade level and 16.73 % were illiterate. A total of 149463 kg fish was harvested in last year, from these 13574 kg fish was lost. The average weekly and daily fish production was 1542.4 kg and 529kg, respectively and also the average weekly and daily loss of fish was141.4kg and 23.63kg, respectively. The major factors for loss were absence of market linkage between fishermen and traders, lack of enough refrigerators, distance of the lake from town and lack of transportations. Market force loss that leads to both quality and physical loss were dominant at Lake Ardibo. A significant correlation was found between the amount of fish post-harvest lose and the explanatory variables like major factors for PHL, storage time of fish and fishing experience with ($R=0.951$, do = 7, $p <0.001$). At the study area in every 200kg harvested fish 17.5kg fish was lost and totally 13574 kg fish postharvest loss was recorded due to this the fishermen cooperatives lost 1,357,400birr. This calls for effective postharvest management of fish from harvesting to consumption.

Key words: - *fish post-harvest loss, Lake Ardibo, handling practice, Tehuledere Woreda*

Acronyms

AW- Water Activity

IFLAM- Informal Fish Loss Assessment Method

LT- Load Tracking Method

MSY-Maximum Sustainable Yield

FPHL- Fish Postharvest Loss

PHL- Post-Harvest Loss

PRA- Participatory Rural Appraisal

QLAM -Questionnaire Loss Assessment Method

SSI- Semi-Structured Interview

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CHAPTER ONE

1. Introduction

1.1 Background information

Providing adequate food for a rapidly increasing human population is one of the greatest challenges in the developing country (Hirpo, 2017). The problem is particularly acute in countries like Ethiopia so, in addition to increasing food production from land agriculture, it is necessary to sustainably exploit the aquatic ecosystems to contribute towards the effort of food security by virtue of their high productivity (Assefa, 2018). Among aquatic food, fish is one of the most important food and a source of easily digestible animal protein which represents a significant proportion of the nutritious diet in human food. Ethiopia's fish resources could undoubtedly offer one of the solutions to the problem of food shortage in the country (Teklu, 2016).

Ethiopia is endowed with its different geological formations and climatic conditions with considerable water resources and wetland ecosystems, including river basins, major lakes, many swamps, floodplains and man-made reservoirs hence, the water bodies support a diverse aquatic life (Hirpo, 2017). It has substantial fishery resources in the inland lakes and rivers. It's potential yield is estimated more than 94,500 tons per year for the main water bodies, of which only around 24% is exploited presently (Tesfaye and Wollf, 2014).The most highly productive lakes where regular fishing conducted from Lakes Ziway, Langeno, Hawassa, Chamo and Abaya. In addition, fishing is highly practiced in Fincha and Koka reservoirs. Riverine fishing activities, mostly for local consumption, are practiced in Baro River and its tributaries and the Omo River systems (Hirpo, 2017).Fishes have an important contribution in food security, livelihood, source income and social development in developing countries like Ethiopia (Hirpo, 2017; Tesfay and Teferi, 2017; Assefa, 2018).

However, fish postharvest handling and loss is a major challenge for fisheries from landing to marketing. Because fish is one of the most perishable of all staple commodities due to its highly nutritive and fat content (Abelti, 2016).The common causes of losses are due to inadequate handling and processing methods, lack of knowledge and skills amongst producers, as well as poor access to infrastructure, equipment and services such as ice box, electricity, roads and credit (FAO, 2010). Fish post-harvest lose refers to fish that is either discarded or sold at a relatively low price because of quality deterioration. This means that fish operators (fishers, processors, traders, and other stakeholders involved in fisheries) lose their potential income (Diei-Ouadi and Mgawe, 2011). The most frequent types of post-harvest loss are physical loss, quality loss, market force loss and nutritional loss (Ahmed, 2008; Diei-ouadi and Magawe, 2011; Tesfay and Teferi, 2017; Assefa, 2018).

According to Teklu (2016) at Finchawa and Amerti reservoirs from the total annual 98, 784 kg tilapia catch, PHL constitutes 6,816 kg due to less market access, size and species preference, inadequate infrastructure for fish handling, processing, storage, transportation and distance from the central market. As reported by Tesfay and Teferi (2017) physical loss is the major type of loss at Tekeze dam and Lake Hashenge fishery associations. Based on their findings physical loss indicated that in every 200 kg of a catch, 20 kg fish was lost as result of spoilage after landing and the highest proportion of fish loads damaged upon reaching the market was 1–3 kg out of one sack. Both physical and quality losses are high in fisheries sector and these translate into losses in nutritional contribution of fish to the total diet and health of populations (Getu *et al*., 2015).

1.2. Statement of the problem

Fisheries play an important contribution to replace animal protein by supplying fish for many communities in both the developed and developing country. They have significant role in food security, livelihood, source income and social development in developing countries (Hirpo, 2017; Tesfay and Teferi, 2017; Assefa, 2018).

However, fish post-harvest loss is a major challenge in fishery because it occurs at different points from capture to marketing. Fishes are perishable and hence susceptible to high post-harvest losses by different factors because of its nutritious content, if there are no intervention measures that are taken in a place (Tesfay and Teferi, 2017). As reported by FAO (2008) a review of case studies on post-harvest losses in several countries of Africa indicated high levels of losses both in quantity (material or physical losses) and in quality (mostly due to downgrading) of fishery products. These losses have major implications for the nutritional quality and availability of fish products to local populations. Fish spoil very quickly as a result of intrinsic and extrinsic factors like high ambient temperatures which hasten fish spoilage by accelerating the activities of bacteria, enzymes and chemical oxidation of fat in fish flesh (Diei-Ouadi and Mgawe, 2011).

According to the estimation of FAO (2008) FPHL in developing countries estimated to about to50% of the domestic fish production and spoilage accounts loss of 10 to 12 million tons per year. Ethiopia lost one-third of its annual production (Teklu, 2016).According to Assefa (2018) Ethiopia lost 164.4 tons of fish from Lake Hyqe and Tekeze dam from 2012-2017; it is equivalent to 10,934,000 birr or 397600 USD. At Amerti and Finchawa, Ethiopia lost 6.81 tons of fish annually (Teklu, 2016).At Lake Hashenge and Tekeze Dam,Ethiopia lost 107.168 tons of fish from 2009-2015which is equivalent to 4,822,560 birr or 225,765.45 USD (Tesfay and Teferi, 2017). At Lake Hashenge from the total of 7130 kg catch of Nile Tilapia and Carp fishes 895 kg was lost in 12 months (from the last 8 months of 2018 and first 4 months of 2019) **(** Tigabu, 2012). Lake Ardibo can provide sustainable production of fish because the MSY of fish is 206 tons per year (Asnake and Mingist, 2018). So the present study was assessed postharvest handling practices and losses of fish at Lake Ardibo because there was no study about handling practices and fish post-harvest loss at Lake Ardibo.

1.3 Research questions

What type of handling techniques are used to prevent FPHL?

How much kg fish can harvest in your cooperative in a day?

How much kg of fish is lost from your daily catch?

What are the main factors of FPHL?

How do you overcome fish post-harvest loss?

1.4. Objectives

1.4.1. General Objective

- To assess on handling practices and postharvest losses of fish at Lake Ardibo, South Wolo, Ethiopia.

1.4.2 Specific objectives

- To identify fish post-harvest handling practices used at Lake Ardibo by the fishermen cooperatives
- To quantify fish production and measure the extent of FPHL at Lake Ardibo fishermen cooperatives
- To identify major factors for FPHL at Lake Ardibo fishermen cooperatives.
- To assess the Knowledge about fish post-harvest handling practices at Lake Ardibo.

1.5. Significance of the study

Fish and fish products are highly perishable and susceptible to post-harvest loss due to its protein rich nature which become soon spoil after catch. Poor handling practice, spoilage, breakage, size, discarding of by-catches and operational losses are some of the factors accelerate fish perishability. Accordingly, this research output will play a pivotal role in providing baseline information on concrete postharvest loss factors and its extent in the lake Aridbo. Additionally, this study result will help the local fisheries officer, in providing information how fish has lost after catch so that they will get awareness and act for the solution.

CHAPTER TWO

2. Literature review

2.1 Fish postharvest handling practices and loss

Fishery plays a significant role in food security, livelihood, source income and social development for developing countries (Assefa, 2018). Ethiopia has substantial fishery resources in the inland lakes and rivers. The annual fish production potential of Ethiopia reaches more than 51,000 tones, however the actual production is much less than the potential that the country has, only around 24 % is exploited presently (Hirpo, 2017; Assefa, 2018).

The major consumable fishery resources to the big cities and towns in Ethiopia are captured from the rift valley lakes and Lake Tana. The Ethiopian Rift Valley contains a chain of small to medium-sized lakes. The most highly productive lakes where regular fishing activities conducted are Lakes Ziway, Langeno, Hawassa, Chamo and Abaya. In addition, fishing is highly practiced in Finchawa and Koka reservoirs (Hirpo, 2017).

The fishery sector of Ethiopia is not well developed regarding pre and post-harvest handling practices (Assefa, 2018). According to Teklu (2016) at Finchawa and Amerti reservoirs from the total annual 98, 784 kg fish catch the post-harvest loss constitutes 6,816 kg due to different factors including less market access, size and species preference, inadequate fish handling, processing, storage, transportation and distance from the central market. Fish post-harvest losses along the chain of the landing, processing and marketing point at different location is caused due to inadequate handling and processing methods, lack of knowledge and skills amongst producers, as well as poor access to infrastructure, equipment and services such as water, ice, electricity, roads and credit are all fundamental (FAO, 2010; Operon and Ladle 2016).The most frequent types of post-harvest loss are physical loss, quality loss, market force loss and nutritional loss (Ahmed, 2008; Diei-ouadi and Magawe, 2011; Assefa, 2018).

According to Tesfay and Teferi (2017), physical loss is the major type of losses at Tekeze dam and Lake Hashege fishery associations, northern Ethiopia. Based on their findings physical loss indicated that in every 200 kg of a catch, about 20 kg of fish was lost. As reported by Abelti (2016) the root cause for the post-harvest quality loss and nutritional loss at Genale River was spoilage due to the long distances transportation of fresh fish, high ambient temperature in combination with the poor handling practice. Without properly handling practice and cooling, in tropical countries fish spoiled quite rapidly within a few hours of landing. These Poor qualities of fish constitute an economic loss to fishermen, processors and fish traders (FAO, 2010).

2.2 Main types of post-harvest losses of fish

Fish is the most important (preferred) food due to the presence of omega-3 but fish is easily perishable by different causes as indicated in table 1 due to high nutritive and fat/oil content. Physical loss: Physical fish loss refers to fish that, after capture or landing, is not used either thrown away accidentally, voluntary or as authorized. It is caused by poor preservation or the discarding of bycatch, theft, insects eating, bird or animal predation, Poor packaging (Getu *et al*., 2015).

Quality loss refers to fish that has undergone changes owing to spoilage or physical damage and has suffered quality deterioration. This is the most common Post harvest fish lose in many areas. According to Abelti (2016)out of 176 kg of Bagrus fish harvested from Genale River, 60 kg offish was deteriorated and discarded by fish trader.

Market force loses: is a loss caused by unexpected market demand and supply situations these cause operators to sell their product at a price below expectations. If the fishermen have not availability of market linkage with the fish traders they undoubtedly exposed to high physical and quality fish post-harvest loss due to this the fishermen sell their fish at a price below expectations (**Fig.1)**.

The major market for most of the fish production in Ethiopia is domestic and the current per capita fish consumption is about 0.24 kg per year which is in the lower rank as compared to beef consumption which is as large as 8.4 kg per capita per year (Wakjira *et al.*,2013). The first-in, first-out rule is not always applied in many small-scale fish markets, where the most recently arrived fish is the first to be sold and fish already in storage is left and can suffer quality deterioration, which will affect its eventual selling price (Diei-Ouadi and Mgawe, 2011).

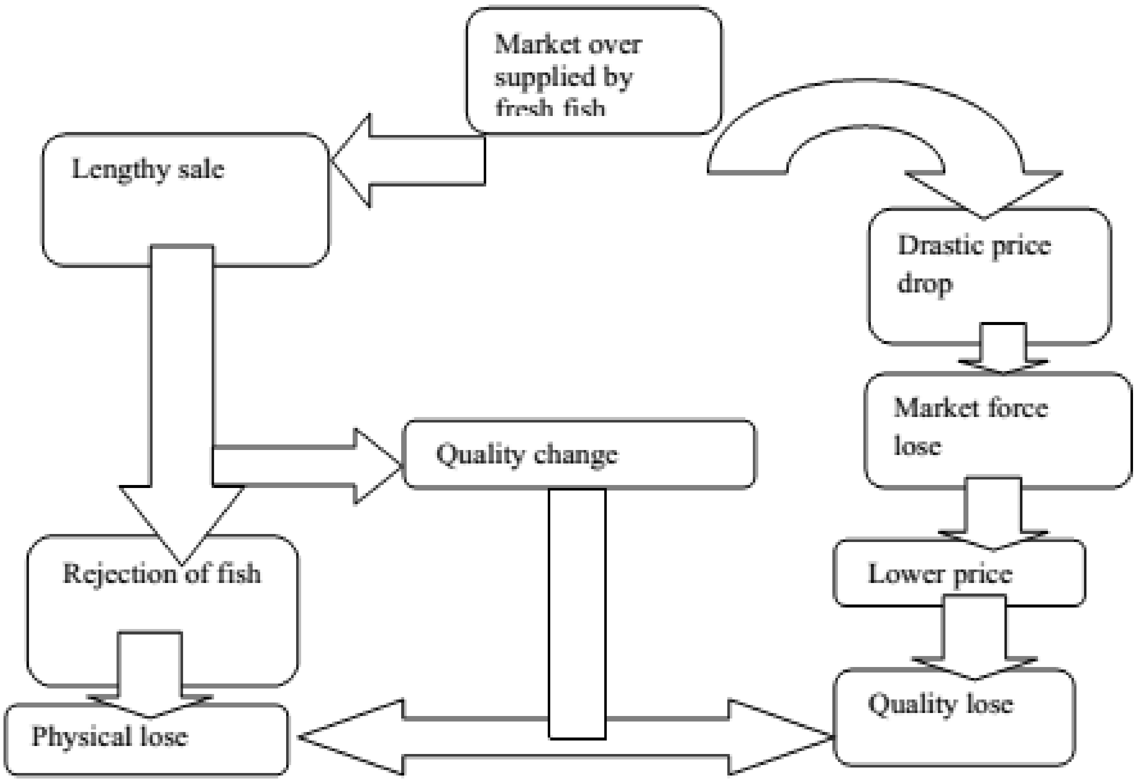

Figure 2. Shows Market force lose resulting quality and physical lose (Getu *et al*., 2015)

Table 1 . Main causes of the three types of loss at different stages of the distribution chain

Stage	Causes for loss	Loss type
During fishing	Use of destructive/harmful methods of fishing, such as dynamite resulting in harvesting fish that is already damaged	Physical, quality
	Falling from the net or discarded as by catch	Physical
	Setting fishing gear for long periods, causing fish to spoil	Physical, quality
During unloading	Poor hygienic practices causing contamination	Quality
	Fish falling from the pan/crate/basket on to the shore	Physical
	Theft at the landing site during offloading of fish	Physical
Fresh fish	Inadequate application of ice, and no insulated container used	Quality, physical

	Limited preservation capacity during bumper catches, e.g. ice, processing equipment	Quality, physical
	No access of marketing information, with oversupply of market	Market, quality, physical
	Deliberate delay in purchasing the fish by traders	Quality
During processing and packaging	Processing of already spoiled/poor-quality fish Processing fish under unhygienic conditions, allowing blowfly infestation	Quality, physical Quality, physical
	Inadequate control of heat intensity during smoking leads to over smoking of fish and possible burning	Quality, physical
	Drying fish unsupervised, on ground, rocks or herbs	Quality, physical
	Breakage or damage owing to inadequate packaging method and materials	Quality, physical
	Oxidation of fatty fish leading to rancidity	Quality
During storage	Growth of mould causes spoilage and makes the fish damp	Quality
	Insects consume fish during storage	Quality, physical
	Discoloration owing to chemical changes	Quality
	Inadequate storage facilities	Quality, physical
During distribution	Damage to fish during transportation	Quality physical
During marketing	Delays in selling	Quality
	In adequate cold-storage facilities and warehouses and lack of ice	Quality, physical
	Supplying the market at the “wrong time”	Market
	Poor purchasing power of buyers/consumers	Market

Source: (Diei-Ouadi and Mgawe, 2011)

Economic loss: The losses of material will inevitably involve a loss in value, as the fisherman, processor, or distributor has less weight of material to sell. Furthermore, the material may command a relatively lower price. Dried fish which has been attacked and partly eaten by insects will be less attractive to consumers than undamaged fish and its price per kilogram will usually be lower. Not only is there less to sell, but what can be sold is worth relatively less. Here, we have a material loss and a bigger financial loss, as someone in the chain has lost the value of the weight of fish eaten by insects and a drop in value of the remainder (Getu *et al*., 2015).

2.3. Fish spoilage

Spoilage is usually changed in physical characteristics which are caused by the action of enzymes, bacteria and chemicals present in the fish. Change in color, odor, texture, and softness of the muscle are some of the characteristics observed in spoiled fish (Diei-Ouadi and Mgawe, 2011). Spoilage is caused by the action of microbs, enzymatic activity and oxidation of nutritive elements present in the fish. In addition to these improper handling, high moisture content of the fish, weak muscle tissue and ambient temperature are some Factors that tend to increase the spoilage of fresh fish (Getu *et al*., 2015).

Extrinsic parameters and intrinsic parameters are the major factors for fish spoilage. Some of the extrinsic parameters are temperature of storage, relative humidity, oxygen concentration, salinity and load of external microorganisms in the fish body and also some intrinsic parameters are moisture content, pH, physical and chemical content of fish. By controlling these parameters it is possible to control fish spoilage (Subhendu, 2013). Higher the temperature such as 20 °C makes the quicker dissolution of rigor and onset of autolysis and bacterial decomposition because it creates favorable conditions for the bacterial metabolism. Both the postmortem formation of amino acids and their rapid decarboxylation biochemically or microbiologically are temperature dependent that leads to spoilage. Low temperatures, such as 5 °C and below, slow the action of bacteria and the rate of spoilage, helping to reduce losses (Akinola *et al*., 2006; Subhendu, 2013).

Poor handling practices lead to sustained and increased microbial contamination by hastening the spoilage rate of fish. Such practices include: using dirty canoes, equipment, fish boxes and baskets, not washing fish, placing fish on dirty surfaces (Diei-Ouadi and Mgawe, 2012).

2.4 Fish spoilage mechanisms

Autolytic enzymatic spoilage: Shortly after capture, chemical and biological changes take place in dead fish due to enzymatic breakdown of major fish molecules. It reduces textural quality during early stages of deterioration. This indicates that autolytic degradation can limit shelf-life of processed fish (Ghaly *et al*., 2010).

Oxidative spoilage: Lipid oxidation is a major cause of deterioration and spoilage for the fish with high oil/fat content. Lipid oxidation involves a three stage free radical mechanism: these are initiation, propagation and termination. Initiation involves the formation of lipid free radicals through catalysts such as heat, metal ions and irradiation and these free radicals that react with oxygen to form peroxyl radicals. During propagation, the peroxyl radicals reacting with other lipid molecules to form hydroperoxidase and a new free radical. Termination occurs when a buildup of these free radicals interact to form non radical products (Diei-Ouadi and Mgawe, 2011).

Microbial spoilage: Composition of the micro flora on newly caught fish depends on the microbial contents of the water in which the fish live. Microbial growth and metabolism is a major cause of fish spoilage which produce amines, organic acids, sulphides, alcohols, aldehydes and ketones with unpleasant and unacceptable off-flavors (Ghaly *et al*., 2010).

2.5 Fish Preservation Techniques

Drying, smoking, freezing, brining, and canning extend the self-life of seafood's and meat products and also low temperature storage and chemical techniques are important to control, enzymatic, oxidative and microbial spoilage as well as water activity (Akinola *et al*., 2006).As reported by Ghaly *et al*. (2010) high ambient temperature makes deteriorate the fish flesh due to the presence good nutritive content but low temperature storage is used for the preservation of wide varieties of seafood's by retarding the growth of microorganisms. Storing fresh fish at (-1 °C to +4 °C) inhibits the growth of microorganisms and Freezing at (-18 to -30°C) completely stops bacteria from growing. Chilling is the applications of temperature in ranges of 0 °C – 8° C that is above the freezing point of the food. Freezing is the use of temperature well below the freezing point of the food, conventionally below 18 °C. The use of ice is important for

- Maintaining uniform low temperature,
- Reducing autolysis and bacterial degradation and
- Providing good washing/cleaning effect during melting

Controlling water activity: The term water activity (wa) refers to the water which is not bound to food molecules and can support the growth of bacteria, yeasts and moulds (fungi). Fish spoilage can be prevented by controlling water activity. For the growth of every microorganism there are minimum, optimum and maximum water activity same like pH and temperature. Therefore, lowering water activity (wa) can minimize putrefaction and improve preservation of fish (Abbas *et al*., 2009). The control of water activity in fish is accomplished by drying, adding chemicals, or a combination of both methods. Sugars and sodium chloride have been used to bind up the free water molecules and create an osmotic imbalance resulting in cell growth inhibition (Ray, 2004).

Controlling autolytic activity: As the fish degradation process begins with autolytic activity, it is important to slow the action of the digestive enzymes to improve preservation. This can be accomplished by removing the enzymes or by developing techniques that inhibit their activities. Gutting of the fish immediately after capture can avoid the invasion of digestive tract proteases through the abdominal cavity to the tissue and prevent or slow degradation. Addition of sodium chloride and acids (lactic acid, acetic acid or propionic acid) important to inactivate autolytic enzymes and inhibit autolytic spoilage for fish or marine species (Ghaly *et al*., 2010).

Controlling oxidative and microbial spoilage: To ensure maximum lipid yield, lipid oxidation and inhibition needs to be studied and understood. In order to inhibit lipid oxidation, the free radical mechanism catalysts (molecular oxygen and transition metals) need to be removed. Antimicrobial compounds can be found in food naturally formed during processing or added as an ingredient (Ray, 2004). Common antimicrobial compounds include: nitrites, sulfides and organic acids, nitrite salts are extremely effective in controlling color, odor and lipid oxidation (Archer, 2002; Ray, 2004; Chipley, 2005).

CHAPTER THREE

3. Materials and methods

3.1 Description of the study area

The study was conducted at Lake Ardibo which is situated in the north eastern part of Ethiopia, Amhara National Regional State, South Wolo Administration Zone, Tehuledere Woreda on 274 km far from the capital city, Addis Ababa and 30 km far from the Zonal capital city, Dessie. Geographically, it is located between 11° 14' N and 39° 42' E latitude and an altitude of 2,120 meter above sea level.

The lake area and its catchment are about 21 km^2 and 52.6 km^2, respectively with the maximum depth of 65 meter. The climate was sub-humid with maximum 26.48°C and minimum 9.5°C average annual temperature and mean annual rain fall of 94.58 mm (**Fig**. 2).

Lake Ardıbo watershed is relatively well protected as compare to the nearby Lake, Lake Hyqe and the area is over all high elevation/ altitude described by spread trees and bushes as well as natural-grazing field. Lake Ardibo is one of the most important bird areas of Ethiopia (Asnake and Mingist, 2018). The Lake has almost similar pH with that of Lake Hyqe (8.5). The surface oxygen is about 4.15 mg/L and surface temperature is relatively colder than Lake Hyqe (16.3 °C). The lake is more turbid with vertical visibility of 1.4 m. Ankerka River flows out of Lake Ardibo and drain into Lake Hyqe (Ayenew and Demellie, 2004).

Two fish species namely, Nile tilapia (*Orechromis niloticus*) and Common carp (*Cyprinus carpio*) are known fish species in the Lake Ardibo for fishery. The MSY of the Lake was estimated to be 206 tons per year (Asnake and Mingist, 2018).The lake is a freshwater lake using for drinking purposes and catering of livestock populations (Ayenew and Demellie, 2004;Yesuf *et al*., 2013; Asnake and Mingist, 2018).

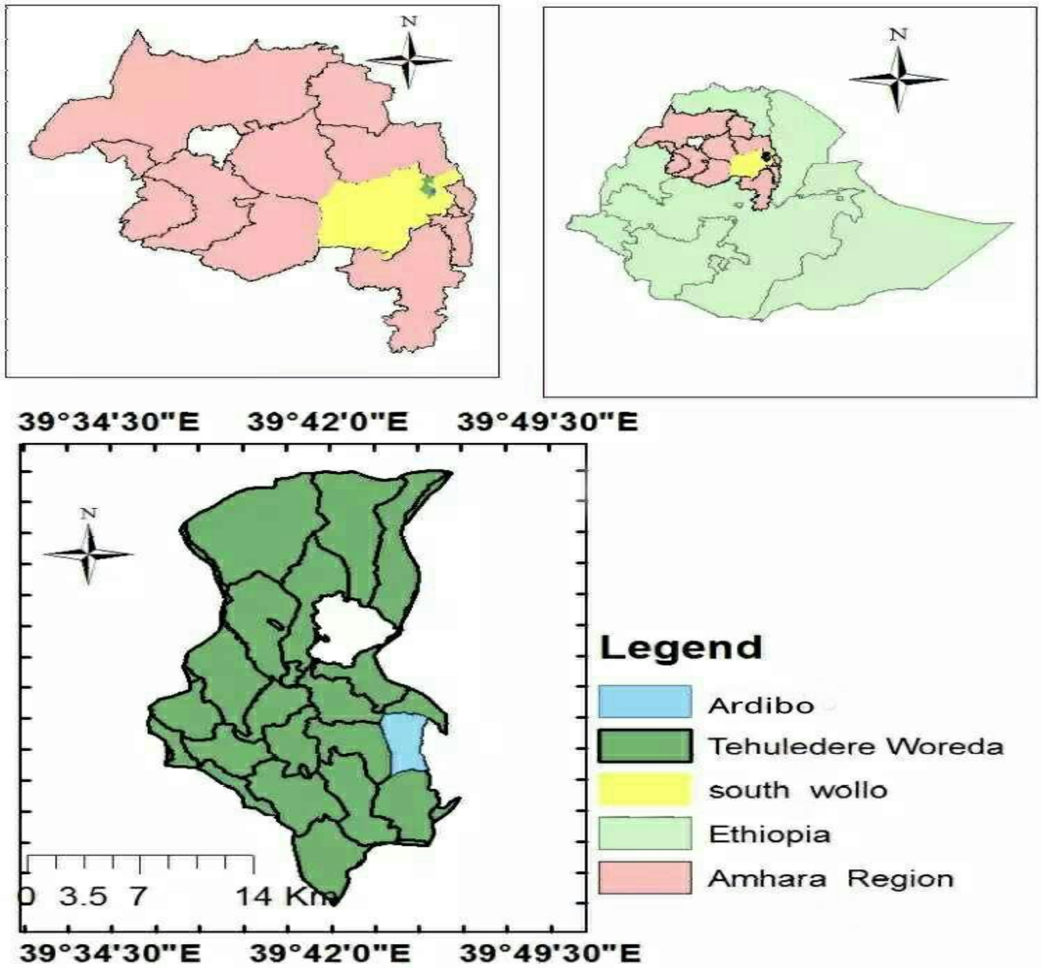

Figure 3. Location map of study area

3.2 Study design and period

To achieve the desired objective, quantitative and qualitative study design were employed which was carried out from October, 2018 to May, 2019.

3.3 Sources of data and study population

In the study area there were three fishermen cooperatives, namely Ambo-Ardibo Hyqe, Lego-Ardibo and Andinet fishermen cooperatives with 82, 86 & 77 registered members were source of primary data and Secondary data was collected from Tehuledere Woreda Agricultural Office.

3.4 Data collection techniques

The data collection techniques were interviews, questionnaires and observations by adopting three methods recommended by FAO for FPHL namely IFLAM, LTM and QLAM from November 2018 to May 2019.

IFLAM was used to understand the knowledge and situations about PHFL by reviewing of secondary data of postharvest loss, observation fish production and loss, by semi-structured interviews (SSI) and applying PRA that helps to develop qualitative understanding of losses and provides indicative quantitative data on PHFL.

LTM was used to measure losses during processing, transportation and marketing by weight balance and to estimate the value of losses in monetary terms

QLAM was used to generate information about fish postharvest loss, reasons for loss and variables that affect loss (like fishing gear type, seasons) and to quantify and validate loss data.

Secondary data for estimation of PHL was calculated using the following formula.

Monetary value of PHL= amount of fish loss in kg **X** price of fish per kg X number of year

Primary data were collected through questioners and interviews and observations then calculated using the following formulas

Total weekly catch = $\frac{\text{Sum of sample days catch in (kg)} \times \text{ weekly fishing day}}{\text{Number of sampling day}}$ …eq.1

Total weekly loss = $\frac{\text{Sum of sample days discard in (kg)} \times \text{ weekly fishing day}}{\text{Number of sampling day}}$ …eq.2

Total monthly catch was calculated by= $\frac{\text{Sum of sample days catch in (kg)} \times \text{ Monthly fishing day}}{\text{Number of sampling day}}$ … eq.3

Monthly lost was determined by = $\frac{\text{Sum of sample days discard in (kg)} \times \text{ Monthly fishing}}{\text{Number of sampling day}}$ … eq.4 (Tigabu, 2012; Teklu, 201).

Percent of lost=$\frac{\text{total weight of lost (kg)} \times 100\%}{\text{total weight of catch (kg)}}$. eq.5 (Ward, 2000; Tigabu, 2016; Assefa,2018).

3.5 Data Collection Procedures

In order to collect the necessary information, the following procedures were employed. First, a pilot study of fish postharvest handling practices and loses was carried out in the study area that helped to carry out PRA with SSI and modifies or manage any problems related to distributing, collecting and administering the data. Then, the interview and questionnaires were used with the fishermen.

3.6 Data processing and analysis techniques

The data process and analysis was done by using descriptive statistics of the Explanatory Variables (both qualitative and quantitative data) in SPSS software. Correlation analysis was used to examine the relationship between variables such as major factors for FPHL, educational status, fishing experience, age of respondent with PHL at Lake Ardibo fishermen cooperatives (Tesfay and Teferi, 2017).

Multiple regression was used to determine the contribution of independent variables such as age, fishing experience, and educational status, storage time of fish, proportion of fishing net per boat, proportion of fishermen per boat to postharvest loss (Adelaja *et al*., 2018).The model was as follows:

$$Y = B_o + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + B_5X_5 + B_6X_6 + E$$

Where

Y= postharvest lose

B_o = *constant*

$B_{1\text{-}6}$=*coefficient of explanatory variables*

X_1= *age of respondents*

X_2=*educational status*

X_3 =*fishing experience (year)*

X_4=*Storage time of fish*

X_5= *proportion of fishing net per boat*

X_6 =*proportion of fishermen per boat*

E= error term

CHAPTER FOUR

4. Results

4.1 Socio-demographic information

A total of 245 fishermen members grouped in to three cooperatives (86 in Lego-Ardibo, 82 in Ambo-Ardibo and 77 in Andinet) were interviewed to assess handling practices and extent of FPHL at Lake Ardibo. All of the fishermen involved in the study were males, from those majorities of the respondents (96.32 %) were married. About 37.14 % falls in age range between 31 and 40, and 30.2 % were between 21 and 30 also the remaining 8.57 % and 3.26 % were grater 50 and less than 20 years old, respectively. The educational status result shows that 16.73 % was illiterate, 40 %, was 1-4 grade level, 29.79 % was 5-8 grade level and 13.46 % are above grade 9^{th}. The fishing experience indicated that about 77.15 % had more than five year of fishing experience and the remaining 22.85 % had less than five years of fishing experience (Table 2).

Table 2. Socio-demographic status of the fishermen

Variables	Frequency	(%)
age (year)		
<20	21	8.57
21-30	74	30.20
31-40	91	37.14
41-50	51	20.81
>-50	8	3.26
Mean ± SD	32.55±9.60	
Sex		
Male	245	100
Female	0	0
Marital status	9	3.67
Single	236	96.32
Married		
Household size		
1-3	85	34.69
4-6	109	44.48
>6	51	20.81
Mean ± SD	4.66 ± 1.95	

Fishing experience (year)		
1- 5	59	22.85
6-10	83	33.87
11-15	76	31.02
> 15	27	11.02
Mean ± SD	9.55±4.85	
Illiterate	41	16.73
1-4	98	40.0
5-8	73	29.79
9-10	24	9.79
Above 10	9	3.67

4.2 Fish post-harvest handling practices at Lake Ardibo

Proposing management strategies to reduce fish post-harvest losses are crucial for anyone involved in fishery activities, and some of the potential intervention strategies at the study area were listed in Table 4with their corresponding frequency and percentage values. For instance, 47.75 % of the respondents tried to overcome fish post-harvest losses by decreasing production when refrigerators were full. According to the responses of the respondent, fish processing (filleting and gutting) was done under the shady areas (64.89 %), in cool and ventilated areas (21.22 %) and everywhere around the lake (13.87 %) to reduce post-harvest loss. When the respondents asked an open ended question to answer “Please Describe how do you have tried to reduce losses?” most of the respondent said that there were shortages of transportation accesses due to this they harvested at early morning until 1:30 hour to reach the harvested fishes by public transport to the main storage and tried to separate the spoiled fishes from healthy ones. At Lake Ardibo all (100 %) of the fishermen didn’t use any preservatives (like salt) drying and smoking as shown (Table 3).

Table 3. Post-harvest handling practices and response of the respondent

Variables.	No (%)	
Ways to overcome fish post harvest loss		
a. Decrease production when refrigerators are full	117 (47.75)	
b. Don't know (not solved still now)	64 (26.12)	
c. Try to add refrigerators and reach on time to refrigerators	44 (17.96)	
d. Do not faced post-harvest loss	20 (8.16)	
Places of keeping the fish during processing (filleting & gutting)		
a. In shady areas (under trees)	159 (64.89)	
b. In cool areas, early morning and ventilated areas	52 (21.22)	
c. Everywhere around lake	34 (13.87)	
	yes	No
Use of ice box after harvest until reach on your store	7(2.9)	283 (97.1)
Use of salting, drying and smoking	0 (0)	245 (100)
Use of preservatives (like salt) to preserve fish spoilage	0 (0)	245 (100)

4.3 Amount of fish production and extent of PHL at Lake Arbibo

At the study area (Lake Ardibo) there were two types of fish named Nile tilapia (*Orechromis niloticus*) locally called Kereso and Carp (*Cyprinus carpio*) locally called Dube that harvested by fishermen. A total of 149,463 kg of fish were harvested by three cooperatives at 2011EC. Out of the total harvested fishes 79,039 kg were Nile tilapia (*Orechromis niloticus*) and the rest 70,424kg of fishes were Carp (*Cyprinus carpio*). The result shows that Nile tilapia (*Orechromis niloticus*) fish was more harvested than Carp (*Cyprinus carpio*) type of fish but less in lost than carp (Table 4).According to the fishermen Nile tilapia fish was preferred over Carp by local consumers. The fishermen cooperatives were used beach seine net for fishing while canoe, woody and steel boat were used to collect their harvested fish. And then the harvested fish were stored in box covered by plastics and goes to the main storage site used by public transport unsuitable manner.

From the total of 149,463 kg harvested fish 13,574 kg was lost. From the total fish loss, 6,617 kg and 6975 kg were Nile tilapia and carps, respectively. Based on the local market assessment 1 kg fish was sold by 100 birr so, with simple multiplication the fishermen cooperatives 14,946,300 birr were earned and 1,357,400 birr lost per a year.

As indicated in (Table 5) the total harvested fish by Lego Ardibo fishermen cooperative was 56704 kg per a year with mean and SD of 7087.5 and 619.78, respectively. The total loss of the above cooperative was 5158 kg per year with mean and SD of 644.75 and 58.06, respectively. In contrast between associations, Lego-Ardibo fishery cooperative lost the highest number of fish that were 4957 kg (2387 kg Nile tilapia and 2570 kg Carp) while Andinet fishery cooperative and Ambo-Ardibo fishery cooperative lost 4065 kg (2018 kg Nile tilapia and 2047 kg Carp) and 4552 kg (2212 kg Nile tilapia and 2340 kg Carp) respectively (Table 4).

Table 4. Total fish harvest and loss at Lake Ardibo in the year (2011 EC)

Month	Name of fishery association	Total monthly		Average harvest per		Average loss per	
		harvest(kg)	loss (kg)	week(kg)	day (kg)	week (kg)	day (kg)
October	Lego-ardibo	7629	625	1907.25	317.87	156.25	26.04
	Andinet	4197	471	1049.50	175.87	117.75	19.60
	Ambo-Ardibo	6038	494	1509.50	251.58	123.50	20.60
Total		**17864**	**1590**	**1488.75**	**248.44**	**132.50**	**22.06**
November	Lego-ardibo	7259	704	1814.75	302.50	176.00	29.00
	Andinet	5079	492	1269.75	211.60	123.00	20.50
	Ambo-Ardibo	6343	562	1585.75	264.30	140.50	24.60
Total		**18681**	**1758**	**1556.75**	**259.46**	**146.50**	**24.70**
December	Lego-ardibo	7366	694	1841.50	307.00	173.50	29.00
	Andinet	6498	409	1624.50	270.75	102.25	17.10
	Ambo-Ardibo	6783	513	1695.75	282.60	128.25	21.40
Total		**20647**	**1616**	**1720.58**	**286.78**	**134.67**	**22.50**
January	Lego-ardibo	7935	694	1984.75	330.60	173.50	28.90
	Andinet	6322	501	1580.50	263.45	125.25	21.00
	Ambo-Ardibo	6237	603	1247.40	260.00	150.75	25.00
Total		**20494**	**1798**	**1604.22**	**284.68**	**149.83**	**24.97**
February	Lego-ardibo	7153	688	1788.25	298.00	172.00	29.00
	Andinet	5817	623	1454.25	242.40	155.75	26.00
	Ambo-Ardibo	6186	544	1546.50	257.75	136.00	22.60

total		**19156**	**1855**	**1596.30**	**266.05**	**154.58**	**25.86**
March	Lego-ardibo	6461	559	1615.25	281.00	139.75	23.30
	Andinet	5729	526	1432.25	239.00	131.50	22.00
	Ambo-Ardibo	5946	463	1486.50	247.75	115.75	19.29
Total		**18136**	**1548**	**1511.33**	**255.92**	**129.00**	**21.53**
April	Lego-ardibo	6871	620	1717.75	286.00	155.00	25.80
	Andinet	4953	548	1238.25	206.50	137.00	23.00
	Ambo-Ardibo	5913	627	1478.25	246.33	156.75	26.00
Total		**17737**	**1758**	**1478.10**	**246.28**	**149.60**	**24.90**
May	Lego-ardibo	6026	574	1508.50	251.25	143.50	24.00
	Andinet	5142	528	1285.50	214.00	132.00	22.00
	Ambo-Ardibo	5580	512	1395.00	232.50	128.00	21.30
Total		**16748**	**1614**	**1386.33**	**232.58**	**134.50**	**22.43**
Grand total		**149463**	**13574**	**1542.42**	**259.04**	**141.40**	**23.63**

Table 5. Mean and standard deviation of harvested and loss of fish per a year

Cooperatives	Total harvest	Mean ± SD	Total loss	Mean ± SD
Lego-Ardibo	56704	7087.50±619.78	5158	644.75 ± 58.06
Andinet	43737	5404.62±763.00	4098	512.25± 61.96
Ambo-Ardibo	49022	6128.25± 354.21	4318	539.75± 55.54

The secondary data that recorded from Tehuledere Woreda Agricultural Office shows increment of both fish production and fish postharvest loss from year to year. For example as indicated in figure below (**Fig**. 3) in a year 2013, 80000 kg, in 2014, 91200 kg, in 2017, 126400 kg, in 2019, 149463 kg fish production was harvested also as the same year 8524 kg, 8603 kg, 12432 kg and 13574 kg fish postharvest loss was recorded.

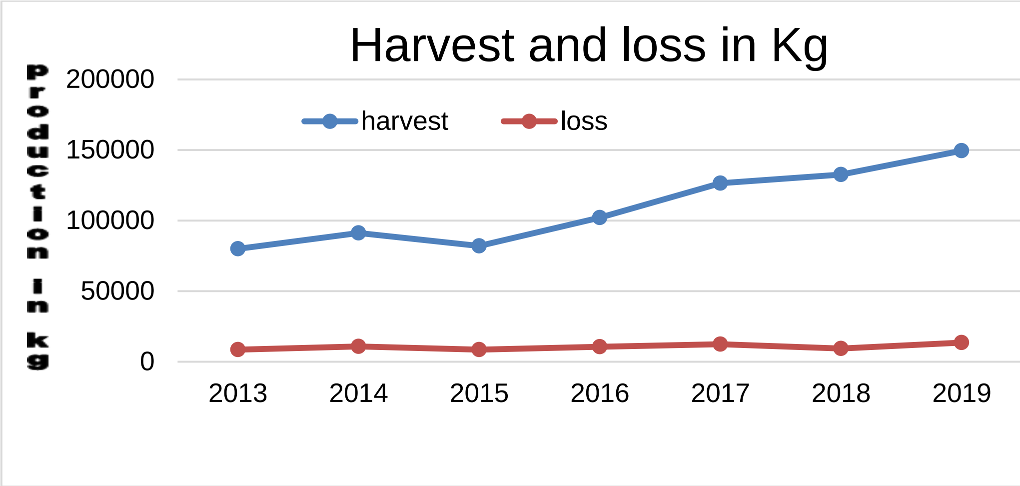

Figure 4. Trend of harvest and PHL of fish in Lake Ardibo (Secondary data from the past seven years)

A significant correlation was found between fish post-harvest lose and the explanatory variables with (R = 0.951, df = 7, p <0.001). The variables age of the respondents, fishing experience (year), storage time, major factors for FPHL and post-harvest loss (PHL) have strong significant correlation at 0.001 significant levels, p-value <0.001 (Table 6).

Table 6. Correlations of explanatory variables at Lake Ardibo

	PHL	age	education	Experience	storage	net per boat	fisherman per boat	major factors
PHL								
R= value	1.000							
P = value	0.000							
age								
R= value	0.924	1.000						
P = value	0.000							
Education	0.828							
R= value	0.000	0.882	1.000					
P = value		0.000						
Experience								
R= value	0.858	0.866	0.934	1.000				
P = value	0.000	0.000	0.000					
Storage time								
R= value	0.927	0.904	0.873	0.894	1.000			
P = value	0.000	0.000	0.000	0.000				
Net per boat								

R= value	0.856	0.865	0.864	0.818	0.825	1.000		
P = value	0.000	0.000	0.000	0.000	0.000			
Fisherman per boat								
R= value	0.823	0.883	0.936	0.903	0.848	0.813	1.000	
P = value	0.000	0.000	0.000	0.000	0.006	0.000		
Major factors								
R=value	0.898	0.891	0.901	0.916	0.923	0.849	0.875	
P=value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000

The regression model was statistically significant at alpha level 0.001 (R = 0.951, df = 7, P <0.001). The value $R^2$is 0.908, which indicates that 91.8% of the variance in postharvest loss can be described by the dependent variable. Age of respondents, Educational status, Fishing Experience (year), storage time and proportion of fishing net per boat were statistically significant (P< 0.001). This indicates that the null hypothesis (H_0) is rejected because there is one variable that different from zero and the alternative hypothesis (H_a) is accepted. The coefficient parameter simply shows that for every unit increase or decrease on the independent variable, the dependant variable either increase or decrease. For instance the predictors age of respondents, Fishing Experience (year), storage time and proportion of fishing net per boat increase by one value, post- harvest loss decreased by 0.48, 0.28, 0.19 and 0.34 respectively. While the predictors, educational status and Proportion of fisherman per boat decreased by one value, postharvest loss increased by the value of 0.34 and 0.13, respectively (Table 7).

Table 7. Coefficients of the explanatory variables

Variables	coefficients μ±SD	P = value	R^2
1(Constant)- PHL	-0.193± 0.111	0.084	0.918
Age	0.479 ± 0.040	0.000	
Education	-0.335± 0.059	0.000	
Experience	0.279 ± 0.047	0.000	
The storage time to the market	0.188± 0.028	0.000	
Proportion of fishing net per boat	0.335± 0.054	0.000	

Proportion of fisherman per boat	-0.131± 0.057	0.023

As indicated in the table below (Table8) about 90.2 % of the respondent face postharvest loss and the highest loss was incurred during storage. This indicates that there was no more market access. The highest percentages (34 %) of PHL were occurred at December month due to high production of fish after the reproduction period. The highest proportion fish loss from landing to marketing was 1-3 kg out of 50 kg. About 39 % of the respondents says that the storage time of processed fish before sending the market was3-5 days. The highest proportion of fishermen per boat and fishing net per boat was two fishermen per boat and two net per boat, respectively (Table 8).

Table 8. States of fish post-harvest loss at Lake Ardibo

Interview questions	Yes No. (%)	No No. (%)
Experience post-harvest fish losses	221 (90.20)	24 (9.80)
Throw any fish in to the lake before landing because of spoilage	49 (20.00)	196 (80)
Get lower price due to low quality of fish	63 (25.72)	182 (74.28)
The state of incurring losses	No (%)	
During fresh fish handling	53 (21.63)	
During processing	17 (6.93	
During storage	128 (52.24)	
During distribution	47 (19.18)	
Month with high loss	No (%)	
October	59 (24.08)	
December	84 (34.28)	
February	39 (15.91)	
April	34 (13.87)	
January	29 (11.83)	
The storage time of processed fish before sending to the market	No (%)	
1-2 days	81 (33.06)	
3-5 days	96 (39.18)	
1week	46 (18.77)	
>1 week	22 (8.97)	
Mean ± SD	4.12 ± 2.41	
Proportion of fishing net per boat	No. (%)	
1 net for 1 boat	41 (16.73)	

2 net for 1 boat	148 (60.40)
3 net for 1 boat	56 (22.85)
proportion of fisherman per boat	No (%)
1 fisherman for 1 boat	22 (8.980)
2 fisherman for 1boat	113 (46.12)
3 fisherman for 1 boat	75 (30.61)
> 3 fisherman for 1 boat	35 (14.28)
Proportion of fish loss from landing to the market	No (%)
1-3 kg out of 50 kg	116 (47.34)
4-6 kg out of 50 kg	52 (21.22)
7-8 kg out of 50 kg	41 (16.73)
>8 kg out of 50 kg	12(4.89)
We don't face fish damage	24 (9.79)
Mean ± SD	3.97 ± 2.08
Number of refrigerators for fishermen cooperatives	No. of Ref.reg.
A) Lego-Ardibo fishermen cooperatives	8
A) Andinet fisher men cooperatives	4
C) Ambo-Ardibo fisher me cooperatives	5

4.4 Major factors for FPHL at Lake Ardibo fishermen cooperatives

At the study area, about13,579 kg of fish was lost from October to May, 2011 EC due to different factors contributed to fish postharvest losses. According to the respondents, lack of market linkage, infrastructure-related problems (like shortage of refrigerators, lack of storage at the landing site, Lack of transport, power fluctuations), high ambient temperature, lack of credit and distance of the Lake from town were the major factors for FPHL (**Fig**.3). Over-stuffed of refrigerators and mixing of the new with the old product (poor storage) also cause of fish post-harvest losses. In addition, death of fish due to the long period of setting the nets or early fish death in the net before hauling were the reason for fish loss.

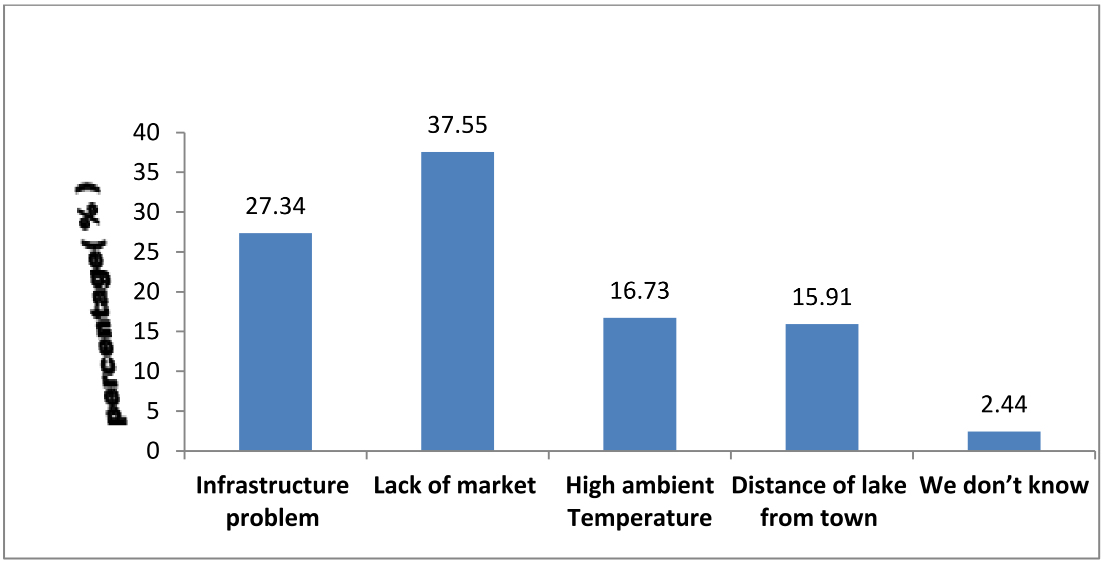

Figure 5. Percentage of loss with major reasons of PHL at Lake Ardibo

Four level of agreement were assessed between respondents regarding the contributory factors to post-harvest losses in the fishery. About 60.8% and 37.14 % of respondents strongly agreed that, long hours of setting net before hauling and catching small fishes were the major factor for easily spoilage and low quality of products, respectively. However, 55.51 % of them strongly disagreed on the store accessibility located their fishing site (area) which means that the storage was not accessible to their fishing site (Table 9).

Table 9 . Data about Likert scale continuum questions

Value statement	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
	No (%)	No. (%)	No. (%)	No. (%)	No. (%)
Long hours of setting net before hauling cause post-harvest quality loss	149 (60.8)	76 (31.02)	14 (5.71)	6 (2.44)	0 (0)
The store accessibly located your fishing site (area)	0 (0)	0 (0)	3 (1.22)	109(44.48)	136(55.51)
Fish post-harvest loss & spoilage occur even after refrigerated	84 (34.28)	97 (39.59)	15 (6.12)	36(14.69)	13 (5.3)
Small fishes easily spoiled and cause low quality product	91 (37.14)	65 (26.53)	38(15.51)	43(17.55)	8 (3.26)

5. Knowledge about fish post-harvest handling practices at Lake Ardibo

According to the respondents, poor quality of fish and good quality of fish were distinguished by using color changes in scales and textures as well as presence bad smell. They explained that spoiled fish flesh becomes greenish, cloudy and whitish with a very soft texture and deteriorated appearance.

As indicated in the table below, 68.16 % of the respondents check their fishing nets also 64.89 % said that, fish processing (filleting and gutting) was done under shade area or under trees to reduce downgrades of harvested fish at their landing sites. However, 51.83 % of the respondents did not received any technical training related to fish quality (Table 10).

Table 10. Knowledge about fish post-harvest handling techniques

variables				
Places to keep the fish cool during processing (filleting and gutting)	Number (%)			
A) In shady areas(under trees)	159 (64.89)			
B) In cool areas, early morning and ventilated areas	52 (21.22)			
C) Everywhere around lake	34 (13.87)			
Wash fish after harvest	Yes	No (%) 85 (35.91)	No	No (%) 157 (64.08)
Receive any training on fish quality	Yes	No (%) 118 (48.16)	No	No (%) 127 (51.83)
Observation any of change in the fish	Yes	No (%) 193 (78.77)	No	No (%) 52 (21.22)

CHAPTER FIVE

5. Discussion

In the study area (Lake Ardibo) a total of 245 fishermen members grouped in to three fishermen cooperatives were involved in the present study. All of the fishermen involved in the study were males, because in culture; Ethiopian men dominates most of the agricultural practices that need labor. Fishing activity also needs labor which take many hours and that might take place at night. Similar observations were reported by Omwega *et al.*(2006) at Lake Victoria. Majority of the respondents (96.32 %) involved in the fishery activity were married, of them (44.48 %) had between 4-6 household sizes. Higher numbers of fishermen (37.14 %) were falls in are range between 31 and 40 years old and were congruent with Adelaja *et al*., (2018) in Ondo State, Nigeria, that were 37 %. Educational back grounds of the respondents were nearly correlated with (Omwega *et al*,. 2006) at Lake Victoria; their report said that 60.9 %of the fishermen had went to primary education level, in present study, 69.79 % of the fishermen went school up to primary level. At Lake Ardibo, only 14.5%of the respondent went secondary cycle and above, which is not in agreement with the report of Tesfaye and Teferi (2017), at Tekeze dam and Lake Hashenge, they were reported that, 48.5 % of the respondent went secondary cycle and above. At Lake Ardibo most villagers’ assume agricultural practices and fishing is a work of someone who can’t able to learn higher education level by different reasons like lack of enough result (point) to went to secondary school or economic problems, due to these the majority of the fishermen had only primary education level.

The reproduction period of fish at Lake Ardibo was from June to September and also the period from October to May was fish harvesting period. At the study area (Lake Ardibo)Nile tilapia locally called Kereso and Common carp locally called Dube were harvested by fishermen. A total of 149,463 kg of fish were harvested by three cooperatives, from these 79,039 kg was Nile tilapia and the rest 70,424 kg of fish was Common carp. However 13,574 kg fish were lost from the total of 149,463 kg of fish at Lake Ardibo in 2011 EC. From the total loss of 13,574 kg fish, 6617 kg was Nile tilapia and the rest 6957 kg of fish was Common carp.

In contrast between associations, Lego-Ardibo fishermen cooperative lost the highest number of fish, 4,957 kg (2,387 kg Nile tilapia and 2,570 kg Common carp) while Andinet fishermen cooperative lost 4,065 kg (2,018 kg Nile tilapia and 2,047 kg Common carp) and also Ambo-Ardibo fishermen cooperative lost 4,552 kg (2,212 kg Nile tilapia and 2,340 kg Common carp) fish.

At Lake Ardibo, the fishermen works six days in a week and the average harvest and loss of fish within a week was 1542.42 kg and 141.4 kg, respectively while the average harvest and loss of fish within a day was 259 kg and 23.6 kg, respectively. According to the fishermen 1kg of processed fresh fish was sold by 100 Ethiopian birr. With simple multiplication, the total loss at the study area (Lake Ardibo) was found to be 1,357,400 birr in year 2011 EC. The average estimation of secondary data of FPHL at the study area with the current price was 1, 054,144 birr within seven years from 2005-2011 EC.

The present finding highlighted that, in every 200 kg of the catch, about 17.5 kg of fish was lost and the highest proportion of fish loads damaged upon reaching the market was 1-3kg out of 50 kg; this is in line with report of Tesfaye and Teferi (2017) at Tekeze dam and Lake Hashenge.

At Lake Victoria, Mgawe (2008) reported that, quality lose occurs along entire fish value chains due to damage during handling and transportation, insect infestation and spoilage. Likewise at Lake Ardibo high amount of quality lose was occurred during handling, transportation and storage that cause a decrease in price and totally removal of the fish.

Market force loss that leads to quality and physical loss was one major problem for fishermen's involved at Lake Ardibo, about 37.55 % of the respondents said that FPHL was occurred by absence of market linkage between the fishermen cooperative and fish traders this idea were almost similar with the finding of (FAO, 2010, Fisheries and aquaculture topics: Food security and fisheries).Due to this the fishermen were enforced to delay their fish at refrigerator. This makes them sold their delayed fish below the expected value or rejected their fish. This result goes line with Tesfaye and Teferi, (2017) in Fish post-harvest losses in Tekeze dam and Lake Hashenge Northern Ethiopia and Akande and Diei-Ouadi, (2010) PHL at selected five sub Saharan African countries). At the study area more than 51.83 % of the respondents did not received any technical training related to fish quality and didn't wash their fish after harvested. Some of the fishermen also processed their fish in the boat without proper cleaning and removing of polluted water from the boat (**Fig**.5).

Figure 6. Unhygienic filleting and gutting of fish at the ground and in a boat

However, some of respondent were also able to differentiate poor quality fish and good quality fish by using the signs and color changes. Based on fishermen's explanation the color changes in scales, texture and presence of bad odor were the signs that used to differentiate the poor and good quality of fish. The spoiled fish flesh becomes greenish and cloudy with soft texture and deteriorated appearance. Such kinds of discolorations of fish spoilage was reported and discussed by Tesfaye and Teferi (2017) at Tekeze dam and Lake Hashenge; Akande and Diei-Ouadi, 2010 PHL at selected five sub Saharan African countries and Mgawe, 2008 at Lake Victoria).

Different types of preservation methods such as drying, smoking, freezing, using preservatives, and canning are extend the self-life of harvested fish (Akinola *et al.*, 2006). However, these were not agreement with Lake Ardibo fishermen cooperatives because the entire respondent said that these methods were not common and all (100 %) of the fishermen didn't use any preservatives (like salt), drying, and smoking to preserve their fish. Good hygienic practices during fish processing and use of ice for fresh fish handling, distribution and marketing, were very important to keep fish quality but at Lake Ardibo about 7 % were used cooling box.

Reducing post-harvest losses requires careful use of resources by reducing spoilage to converting low-value resources into high value products on a sustainable basis for direct human consumption. Spoilage were reduced by improve fishes safety during handling, processing, and transportation systems, however almost all of which were not properly practiced at Lake Ardibo fishermen cooperatives. Lack of enough transportation to reach the main storage and market, absence of market linkage, lack of enough refrigerators, and lack of credit as well as power fluctuation (on/off) during storage were the main constraints that exposed the fishermen to FPHL. Most the respondent said there were no many predators but sometimes eagle and villager cats were their fish predators.

CHAPTER SIX

6. Conclusion and Recommendation

At Lake Ardibo (study area) the fishermen tried to overcome fish postharvest loss harvest by harvesting at early morning, decrease fish production when refrigerators full, processed their fish in shady and ventilated areas. However, these were not protected them from exposing high fish postharvest loss of fish. At the study area from 149,463 kg total production of fish 13,574 kg post-harvest loss was occurred. In every 200 kg harvested fish about 17.5 kg fish was lost due to different reasons like distance of the lake from town, lack of market linkage and enough refrigerator, poor handling practice and processing methods, high environmental temperature and absence of storage at the landing site. Market force loss that leads to quality and physical loss was the dominant loss at the study area. Absence of market linkage between the fishermen cooperatives and the fish traders makes delay of fish due to this the fishermen sold their fish below the expected value and exposed to spoilage. At Lake Ardibo 1kg processed fish was sold by 100 birr due to this the fishermen cooperatives lost 1,357,400 birr in 2011 EC. This high amount of loss calls for effective postharvest loss management of fish from harvest to the mouth of consumers.

Based on the above conclusion the following recommendations are drawn

- ✓ Tehuledere Woreda Agricultural office and stakeholders could create awareness for fishermen cooperatives about how fish post-harvest loss managed.
- ✓ Tehuledere Woreda Agricultural office could provide training for fishermen about good handling practice and processing of fish.
- ✓ Stakeholders could provide good infrastructures and create market linkage to improve the income of fishermen by reducing fish post-harvest losses.
- ✓ Stalk holders could also support for fishermen cooperatives different equipment like freezers, generators, boats, net, and car as much as possible.

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Appendix

Appendix1 Questionnaires filled by Participants

First of all I want to say thank you for giving your willingness to fill this questionnaires.

I. <u>Socio- demography of Fishermen (participants)</u>

Name__________________ age___ sex____ marital status ___. A. (single) B. (married)

Educational back ground_________ house hold size _______ fishing site_______

Fishing experience in year_______ Name of association________

II. Kn**owledge of fisheries about FPHL (Please circle your answer from the alternative)**

1. Do you use cooling box (ice box) for fishes after harvest until reach your storage?

   A. Yes B .No

2. Do you use preservatives to increase shelf life of fish (what type of preservative. if you use?)

A. Yes (________________).B. No

3. Is drying, salting or smoking of fish is common in this area? A. Yes B. No

4. Do you observe any change in your fish during harvest? A. Yes B. No

5. Where do you keep your fish cool during processing in your working area?

   A. In shady area(under tree) or using woods and clothes
   B. In cool area, early morning and well-ventilated areas
   C. Everywhere around the Lake

6. Do you wash your fish after harvest? A. Yes B. No

7. Have you received any training on fish quality? A. Yes B. No

III. Major factorsof FPHL

1. Which one is the major cause of fish PHL?

A. Infrastructure problems

B. Lack of market

C. High temperature

D. Distance and geographic problem

IV. Likert scale continuum questions

Activity	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
1.Long hours of setting gear before hauling causes high post-harvest quality loss	(1)	(2)	(3)	(4)	(5)
2. The store is accessibly located your fishing site (area)	(1)	(2)	(3)	(4)	(5)
3. High post-harvest fish loss occurs during rainy season	(1)	(2)	(3)	(4)	(5)
4.Small fishes easily spoiled and cause low quality product	(1)	(2)	(3)	(4)	(5)

Appendix 2. Monthly and annual rain fall and temperature of Tehuledere Woreda

Source: Amhara Meteorological Agency, East Amhara Meteorological Center, Kombolcha)

mn/yr	**2013**	**2014**	**2015**	**2016**	**2017**
January	22.6	27.4	27.2	23.6	25.0
February	27.0	26.9	27.5	28.0	23.7
March	28.0	27.3	28.2	26.5	25.9
April	28.0	27.3	28.2	26.5	27.5
May	29.5	27.0	28.1	27.8	26.9
June	30.3	30.1	29.0	29.0	30.3
July	27.0	28.8	27.6	27.5	28.7
August	24.9	26.0	26.5	26.4	26.2
September	26.3	25.8	26.6	26.6	26.3
October	24.9	24.3	24.5	27.4	25.0
November	24.4	24.3	24.6	25.4	24.4
December	23.5	23.7	23.2	23.8	23.3
AVE	26.4	26.6	26.8	26.5	26.1

Tehuledere Woreda monthly total amount of rain fall

mn/yr	2013	2014	2015	2016	2017
January	35.7	12.9	19.4	39.2	0.0
February	2.4	24.3	4.8	29.0	118.5
March	95.8	108.3	82.0	98.3	160.3
April	13.8	89.5	2.2	106.6	49.3
May	31.2	87.2	191.0	101.7	207.3
June	20.7	16.1	18.0	77.7	16.6
July	382.8	274.0	61.7	286.1	207.3
August	266.3	369.9	268.8	362.1	364.7
September	72.2	100.8	66.4	115.1	139.0
October	92.0	94.9	20.8	53.9	55.4
November	3.6	13.1	75.2	41.4	0.0
December	0.0	4.0	22.4	0.0	0.0
AVE	**84.7**	**99.6**	**69.4**	**109.3**	**109.9**

Tehuledere Woreda Monthly Average Minimum Temperature

mn/yr	2013	2014	2015	2016	2017
January	6.8	6.9	5.8	10.5	1.0
February	6.2	9.9	4.8	8.0	9.9
March	11.7	9.6	7.6	7.6	10.0
April	12.0	11.1	8.7	13.8	8.8
May	12.0	11.3	12.2	11.9	11.8
June	12.9	10.6	12.0	11.5	10.4
July	13.4	12.6	11.6	13.1	12.2
August	13.7	12.3	13.4	12.8	12.2
September	12.1	11.5	12.4	11.4	11.4
October	9.0	9.1	8.1	7.4	9.5
November	7.3	7.2	9.2	4.9	5.8
December	3.7	4.8	10.2	4.1	1.4
AVE	10.1	9.7	9.7	9.7	8.7

Appendix 3. Secondary data collectedfrom fishermen cooperative

1	[illegible]	[illegible]	–	–	–	–	–	–	–	–	–
2	[illegible]	"	–	–	–	–	–	–	–	20344	00
3	[illegible]	"	5086	3	50	17801	00	4	00	168	00
4	[illegible]	"	28	4	50	126	00	6	00	136	00
5	[illegible]	"	34	3	00	102	00	4	00	134	00
6	[illegible]	"	67	1	50	100	50	2	00	20782	00
						18129	50				

12.12.2009

1	[illegible]	[illegible]	–	–	–	–	–	–	–	–	–	
2	[illegible]	"	7155	3	50	25042	50	4	00	28620	00	
3	[illegible]	"	22	4	50	99	00	6	00	132	00	
4	[illegible]	"	4	3	00	12	00	4	00	16	00	
5	[illegible]	"	10	1	50	15	00	2	00	20	00	
6	[illegible]	"								28788	00	
						25168	00					

ከ19/12/2009 — 25/12/2009 ዓ.ም

ተራ ቁጥር	የዕቃው ስም	መለኪያ	መግዣ የአንዱ ዋጋ ብዛት	ብር	ሳ	ጠ/ድምር ብር	ሳ	መሸጫ የአንዱ ዋጋ ብር	ሳ	ጠ/ድምር ብር	ሳ
1	[illegible] 1	ኪሎ	2	10	50	21	00	12	00	24	00
2	[illegible] 2	"	—	—	—	—	—	—	—	—	—
3	[illegible]	"	4955	3	50	17342	50	4	00	19820	00
4	[illegible] 1	"	11	4	50	49	50	6	00	66	00
5	[illegible] 2	"	8	3	00	24	00	4	00	32	00
6	[illegible]	"	32	1	50	48	00	2	00	64	00
						17485	00			20,006	00

ከ27-12-2009 — 3.13.2009 ዓ.ም

ተራ ቁጥር	የዕቃው ስም	መለኪያ	መግዣ የአንዱ ዋጋ ብዛት	ብር	ሳ	ጠ/ድምር ብር	ሳ	መሸጫ የአንዱ ዋጋ ብር	ሳ	ጠ/ድምር ብር	ሳ
1	[illegible] 1	ኪሎ	—	—	—	—	—	—	—	—	—
2	[illegible] 2	"	—	—	—	—	—	—	—	7740	00
3	[illegible]	"	1935	3	50	6772	50	4	00	9517	50
3	[illegible]	"	2135	4	00	8460	00	4	50	132	00
4	[illegible] 1	"	22	4	50	99	00	6	00	28	00
5	[illegible] 2	"	7	3	00	21	00	4	00	64	00
6	[illegible]	"	32	1	50	48	00	2	00		
						15400	50			17481	[illegible]

ተቀ/12

ከ13.1.2010 — 19.1.2010 ዓ.ም ድረስ

ተራ ቁጥር	የሸቀጡ ዓይነት	መለኪያ	መግዣ የአንዱ ዋጋ ብዛት	ብር	ሣ	ጠ/ድምር ብር	ሣ	መሸጫ የአንዱ ዋጋ ብር	ሣ	ጠ/ድምር ብር	ሣ	ምርመራ
1	[illegible] 1	ቁጥር	–	–	–	–	–	–	–	–	–	
2	[illegible] 2	〃	–	–	–	–	–	5	00	5600	00	
3	[illegible]	〃	1120	4	50	5040	00	6	00	270	00	
4	[illegible] 1	〃	45	4	50	202	50	4	00	256	00	
5	[illegible] 2	〃	64	3	00	192	00	2	00	826	00	
6	[illegible]	〃	413	1	50	619	50			6952	00	
						6054	00					

ተረካቢ

[illegible]

ያስረከበ

[illegible]

ከ20.01.2010 — 26.01.2010 ዓ.ም.

ተራ ቁጥር	የሸቀጡ ዓይነት	መለኪያ	መግዣ የአንዱ ዋጋ ብዛት	ብር	ሣ	ጠ/ድምር ብር	ሣ	መሸጫ የአንዱ ዋጋ ብር	ሣ	ጠ/ድምር ብር	ሣ	ምርመራ
1	[illegible] 1	ቁጥር	–	–	–	–	–	–	–	–	–	
2	[illegible] 2	〃	–	–	–	–	–	–	–	–	–	
3	[illegible]	〃	1805	4	50	8122	50	5	00	9025	00	
4	[illegible] 1	〃	72	4	50	324	00	6	00	432	00	
5	[illegible] 2	〃	40	3	00	120	00	4	00	160	00	
6	[illegible]	〃	595	1	50	892	50	2	00	1190	00	
						9459	00			10807	00	

ተረካቢ

[illegible]

ያስረከበ

[illegible]

[illegible]

ከ27.01.2010 — 3.02.2010 ዓ.ም. ድረስ

ተራ ቁጥር	የዕቃው ዓይነት	መለኪያ	መግዣ የአንዱ ዋጋ ብዛት	ብር	ሣ	ጠ/ድምር ብር	ሣ	መሸጫ የአንዱ ዋጋ ብር	ሣ	ጠ/ድምር ብር	ሣ	ምርመራ
1	[illegible] 1	[illegible]	–	–	–	–	–	–	–	–	–	
2	[illegible] 2	[illegible]	–	–	–	–	–	–	–	–	–	
3	[illegible]	〃	1175	4	50	5287	50	5	00	5875	00	
4	[illegible] 1	〃	28	4	50	126	00	6	00	168	00	
5	[illegible] 2	〃	25	3	00	75	00	4	00	100	00	
6	[illegible]	〃	–	–	–	–	–	–	–	–	–	
						5488	50			6143	00	

ያስረከበ [illegible]

የተረከበ [illegible]

ከ14.2.2010 — 14.2.2010 ዓ.ም. ድረስ

ተራ ቁጥር	የዕቃው ዓይነት	መለኪያ	መግዣ የአንዱ ዋጋ ብዛት	ብር	ሣ	ጠ/ድምር ብር	ሣ	መሸጫ የአንዱ ዋጋ ብር	ሣ	ጠ/ድምር		ምርመራ
1	[illegible] 1	[illegible]	–	–	–	–	–	–	–	–	–	
2	[illegible] 2	〃	–	–	–	–	–	–	–	–	–	
3	[illegible]	[illegible]	780	4	50	3510	00	5	00	3900	00	
4	[illegible] 1	〃	10	4	50	45	00	6	00	60	00	
5	[illegible] 2	〃	–	–	–	–	–	–	–	–	–	
6	[illegible]	〃	355	1	50	532	50	2	00	710	00	
						4087	50			4670	00	

የተረከበ [illegible]

ያስረከበ [illegible]