

**ANALYSIS OF FACTORS AFFECTING FISH
CATCH LEVELS FROM LAKE TANA, ETHIOPIA**

MSc THESIS

TEWODROS GETACHEW LEGESE

**DECEMBER, 2018
HARAMAYA UNIVERSITY, HARAMAYA**

**Analysis of Factors Affecting Fish Catch Levels
From Lake Tana, Ethiopia**

**A Thesis Submitted to School of Agricultural Economics and Agribusiness,
HARAMAYA UNIVERSITY**

**In Partial Fulfillment of the Requirements for the Degree of
MASTERS OF SCIENCE in Agricultural Economics and Rural
Development**

Tewodros Getachew Legese

**December, 2018
Haramaya University, Haramaya**

**HARAMAYA UNIVERSITY
SCHOOL OF GRADUATE STUDIES**

I hereby certify that I have read and evaluated this Thesis entitled: **ANALYSIS OF FACTORS AFFECTING FISH CATCH LEVELS FROM LAKE TANA, ETHIOPIA** prepared under my guidance by **Tewodros Getachew Legese**. I recommend that it be submitted as fulfilling the Thesis requirement.

Bosena Tegegn, PhD. _____

Major Advisor Signature Date

_____. _____

Co-Advisor

Signature

Date

As members of the Board of Examiners of the M.Sc. Thesis Open Defense Examination, I certify that I have read and evaluated the Thesis prepared by **Tewodros Getachew Legese** and examined the candidate. I recommended that the Thesis be accepted as fulfilling the Thesis requirement for the degree of Master of Science in Agricultural Economics and Rural Development.

_____. _____

Chairperson

Signature Date

_____. _____

Internal Examiner Signature Date

_____. _____

External Examiner Signature Date

Final approval and acceptance of the Thesis is contingent upon the submission of its final copy to the council of Graduate Studies (CGS) through the department or school graduate committee (DGC or SGC)

DEDICATION

This thesis is dedicated to the memory of my father **GETACHEW LEGESE**, who passed away six years before.

STATEMENT OF THE AUTHOR

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

This thesis is submitted in partial fulfillment of the requirements for a M.Sc. degree at the Haramaya University and is deposited at the University Library to be made available to borrowers under rules of the Library. I solemnly declare that this thesis is not submitted to any other institution anywhere for the award of any academic degree, diploma or certificate.

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

Name: Tewodros Getachew legese Signature: _____

Date: _____

School: _____

BIOGRAPHICAL SKETCH

The author was born in Bahir Dar, Amhara National Regional State from his father Getachew Legese and his mother Ayalnesh Biresaw on January 25, 1989. He attended his education from 1995 to 2001 at Megabit 28 Primary School, from 2002 to 2003 at Fasilo and Shimbet junior School, from 2004 to 2005 at Tana Haik Secondary High School. From 2006 to 2007 at Bahir Dar Secondary Preparatory School. After successful completion of his high school level education, he joined Jigjiga University in 2008 and graduated with B.A. degree in Economics in July 2010. Following his graduation, he worked at Ethiopian Revenue and Customs Authority as a spot audit officer. He joined Haramaya University School of Graduate Studies in 2013 in CEP program. In 2015, he joined a vehicle assembling factory named Redawa Motors Industry as Import Manager.

ACRONYMS AND ABBREVIATIONS

ABoARD	Amhara Bureau of Agriculture and Rural Development
ABoFED	Amhara Bureau of Finance and Economic Development
EPLAUA	Environmental Protection, Land Administration & Use Authority
EU	European Union
FAO	Food and Agriculture Organization
FDRE	Federal Democratic Republic of Ethiopia
GDP	Gross Domestic Product
ha	Hectare
kg	Kilogram
LFDP	Lake Fisheries Development Project
m.a.s.l.	Meter above sea level
MoARD	Ministry of Agriculture and Rural Development
MSY	Maximum Sustainable Yield
Mt	Metric ton
NGOs	Non-Governmental Organizations
SD	Standard Deviation
TLU	Tropical Livestock Unit
VIF	Variance Inflation Factor

ACKNOWLEDGEMENT

First and foremost, my heartfelt appreciation goes to my advisor, Dr. Bosena Tegegn, for her insightful guidance, constructive ideas and inspiring approach from the initial construction of this paper to its completion. I am greatly honored to have her as my advisor.

I would like to extend my thanks to Mr. Chalachew Aragaw senior fishery expert in Amhara National Regional State Agriculture and Rural Development Bureau and also thanks to all Amhara fishery research center and Lake Tana fishermen for the response on my interview during the data collection.

Last but not least, I cannot have enough words to express my gratitude to all family members, especially my parents, my mother Ayalnesh Biresaw and my wife Free Kebede for the sacrifices and encouragement they did to me. They are always constant wishers of my achievements, success and to whom I owe a special debt that I cannot repay at all. Finally, my sisters, Nina and Saba, and my brother Minilik, deserve my heartfelt thanks. I can never forget what a family means to me.

TABLE OF CONTENTES

CONTENTS

DEDICATION	iii
STATEMENT OF THE AUTHOR.....	iv
BIOGRAPHICAL SKETCH	v
ACRONYMS AND ABBREVIATIONS.....	vi
ACKNOWLEDGEMENT	vii
LIST OF TABLES	xi
LIST OF FIGURE	xii
LIST OF TABLE IN THE APPENDIX.....	xiii
LIST OF FIGURE IN THE APPENDIX.....	xiv
ABSTRACT	xv
1. INTRODUCTION.....	1
1.1. Background of the study	1
1.2. Statement of the Problem	4
1.3. Objective of the Study	6
1.4. Significance of the Study	6
1.5. Scope and Limitation of the Study	7
2. REVIEW OF LITERATURE	8
2.1. Concepts and Definitions.....	8
2.2. Small-Scale Fisheries in Poverty Alleviation and in Attaining Food Security;	9
2.2.1 Small-Scale Fisheries in poverty alleviation	9

2.2.2 Small-Scale Fisheries in food security:	14
2.3. Nutritional Importance of Fish	16
2.4. Global Fish Production and Consumption.....	18
2.5. Fishery in Ethiopia	19
2.5.1. Genesis of fishery development.....	19
2.5.2. Fisheries resources and level of exploitation	20
2.5.3. Demand and supply of fish in Ethiopia	22
2.5.4. Opportunities and constraints of fishery in Ethiopia	24
2.6. Empirical Literature Review	27
3. RESEARCH METHDOLOGY	30
3.1. Description of the Study Area	30
3.1.1. Location of Lake Tana and its Basin	30
3.1.2. General agricultural situation and food security status	31
3.1.3 Fish species of Lake Tana	32
3.2. Data Type, Source and Method of Data Collection.....	32
3.3. Sampling Technique and Sample Size.....	33
3.4. Method of Data Analysis	34
3.5. Variables Definition and Hypothesis	35
4. RESULTS AND DISCUSSION.....	40
4.1. Descriptive Statistical Analysis.....	40
4.2. Factors Affecting Fish Catch Level	44
4.2.1. Adequacy of the model	44
4.2.2 Regression diagnostics	44
4.2.3. Explanation of the significant variables influencing fish catch level	48
5. SUMMARY, CONCLUSIONS AND RECOMMENDATION	53

5.1. Summary and Conclusions.....	53
5.2. Recommendations	54
6. REFERENCES.....	56
7. APPENDIX	61

LIST OF TABLES

Table	Page
1 World fisheries and aquaculture production in 2016	18
2 Water bodies and their potential and actual fish catch in 2014.	21
3 Distribution of sample fishermen in Bahir Dar site	34
4 Continuous and categorical variables	40
5 Dummy variables	42
6 Factors affecting fish catch level in lake Tana	47

LIST OF FIGURE

Figure	Page
1.Lake Tana catch level from 1996-2010	14
2.Lake Tana total catch distribution on monthly bases in tones	15
3.Traditional fishing at Lake Tana	17
4.Map of lake Tana	21
5.Plot of residuals against predicted value	45
6.Normal probability plot for the residual	46

LIST OF TABLE IN THE APPENDIX

Appendix Table	Page
1. Conversion factors used to estimate TLU	53
2. VIFs for all of the explanatory variables	53

LIST OF FIGURE IN THE APPENDIX

Appendix Figure	Page
1 Major Commercial fish types in Lake Tana	53
2 Fishing techniques in Lake Tana	55

ANALYSIS OF FACTORS AFFECTING FISHCATCH LEVELS FROM LAKE TANA, ETHIOPIA

ABSTRACT

Agriculture plays vital role in Ethiopian economy. However, despite its importance and potential, the sector has remained at subsistence level. One of the traditional sources of animal protein of the developing world is through livestock rearing. Unfortunately, the livestock production is under increasing pressure from the combined effects of human population growth, shortage of grazing land and desertification. Therefore, it is important to look for a better and cheap, alternative source of animal protein that is environmentally friendly. One of the alternative sources of animal protein could be fish. Ethiopia is endowed with lakes and reservoirs, Lake Tana is one of the potential lakes for fishing. However, it is still underdeveloped and its contribution is negligible. This study attempted to examine socio-economic and institutional factors influencing fish catch levels of fishermen from Lake Tana. For the study, primary and secondary data were used. Random sampling procedure was employed to select 134 sample fishermen fishing on Lake Tana. The required primary data were collected through interviews using structured questionnaire. Multiple linear regression model was used to identify factors influencing fish catch level. Results of regression analysis indicated, fisherman's perception about fishery, types of boat the fisherman used in fishing, livestock holding size and income positively; age of the fisherman, family size of the fisherman, distance from the market and fisherman's involvement in nonfarm activity negatively and significantly influenced fish catch level from Lake Tana. The finding of the study revealed that, improving Perception of fisherman in fishing, encouraging youngsters to involve in fishing, larger livestock holding amount of the fisherman and moderating the types of boat the fisherman uses for fishing can improve the amount of fish catch level. However, a fisherman involvements in nonfarm activities, having a larger family size, a longer distance to market and a fisherman's income earned from farm has a negative impact on the amount of fish catch level from lake Tana. The policy implications are a need to aware, subsidies and encourage youngsters to involve in fishing, finding a way to the fisherman's access to modern boat, transportation system, cool preservation facilities and should create nearby markets

Keywords: Lake Tana Fisheries, Ethiopia, OLS, Catch levels.

1. INTRODUCTION

1.1. Background of the study

Fisheries are very important to the economy and well-being of communities, providing food security, job opportunities, income and livelihoods as well as traditional cultural identity (FAO, 2014). Fish and fishery products are vital and affordable source of high-quality protein. Especially in the world's poorest nations in 2013, fish supplied more than 3 billion people with at least 15 percent of their average animal protein intake. Maintaining the long-term prosperity and sustainability of fisheries is significant for political, social, economy and ecology of a nation (FAO, 2014).

The world's fisheries sectors have gone through a dramatic development in the last 60 years, and there have been large increases in production. Total world fish production was only 19.3 million tons in 1950, but it increased dramatically to over 163 million tons in 2010. And an estimated 75% of the world fish production was for human consumption, and the remaining 25% went into non-food production, like production of finfish-derived products and oil (FAO, 2014).

The world's top 15 fish producers and their annual total production in million metric tons are; China (58.8), Indonesia (14.4), India (4.9), Vietnam (3.4), Philippines (2.3), Bangladesh (2.0), South Korea (1.6), Norway (1.3), Chile (1.2), Egypt (1.1), Japan (1.0), Myanmar (0.96), Thailand (0.93), Brazil (0.56), and Malaysia (0.52) by their ranking level (WFP, 2017).

Fisheries in Africa are characterized by large small-scale fisheries contributing greatly to employment. However, while fishing itself is clearly an important source of employment, World Bank (2012) highlighted that the bulk of fisheries employment is in the post-harvest economic activities, which includes fish processing and marketing. The role of small-scale fisheries in Africa has been traditionally under-recorded and unrecognized in most parts of the region, though fishery resources are large and have had a long history of use and impact

(FAO, 2013). However, through initiatives supported by the FAO Sustainable Fisheries Livelihoods Program, the World Bank fish Program, and others, the employment, food supply and economic impact of small-scale fisheries have been reappraised, with confirmation that they contribute very strongly to most national economies, to rural and urban food supply, employment, trade and export potential. There are considerable challenges, not only in establishing and maintaining rights of resource access, and ensuring that these can be sustained, but also in securing the broader means of reducing vulnerability and gaining access to public services, often in conditions where national economies and political processes are heavily pressured by lack of resources and competing development demands (FAO, 2013).

Ethiopia with a population of 106 million is predominantly an agrarian country with the vast majority of the population directly or indirectly being involved in the production of crop and livestock. Hence, agriculture plays a vital role in Ethiopian economy. (UN, 2017)

Agriculture, in Ethiopia, contributes about 46 percent of the GDP and 80 percent of employment and accounts for about 86 percent of the foreign earning and 70 percent of raw material requirement for domestic industries. Subsistence farming using traditional methods is dominant and account for over 90 percent of the output. However, despite its importance in the livelihood of the people and its potential, the sector has remained at subsistence level (MoARD, 2015).

Lake Tana is the largest fresh water covering 3,156 km² (MOA, 2014). The water is also said to have the most varied fishery resource in Ethiopia. Fishing in Lake Tana was started by the Woito ethnic group, which did not own land. Thereafter, poor members of the farming communities gradually adapted to fish consumption and subsistence fishery. Commercial fishing in the Rift Valley lakes started during the 1950s, responding to the demand for fish from foreigners and upper class Ethiopians in Addis Ababa (Mebrat 1993). Due to its isolation from the chain of lakes in the Rift Valley system to the South, Lake Tana has received minimal attention in fishery development projects. The Lake Tana fishery remained almost completely subsistence involving less than 1000 persons, until a fisheries development project assisted by Dutch Non-Government Organizations was launch in the mid-1980s., and the maximum sustainable yield (MSY) from the lake has been estimate at 15,000 metric tons per

year (LFDP). However, contribution of Lake Tana fisheries to the national economy is very low because of it's under development (MoARD, 2014).

Convenient road connections and proximity to the capital city had given the Rift Valley lakes priority in fishery development and research programs. Hence they have been, and still are, the main fish suppliers to the big towns. Especially the major lakes, with important fish resources, Lakes Zewai, Awassa, Langano, Abaya and Chamo have been the subject of several scientific surveys (e.g. Schröder 1984, Wodajo & Belay 1984, Getachew 1987, Tadesse 1988, Dadebo 1988, Teklegiorgis 1990, Mengistou & Fernando 1991a & b, Hailu 1996). The few scientific or biological studies on Lake Tana itself before the nineties were those undertaken during 1938-1940 by a group of Italian scientists (Bini 1940, Brunelli and Cannicci 1940, Lofredo 1940). These studies covered mainly fish taxonomy, and limnological and hydrological aspects of Lake Tana.

The modernization of the fishery has improved the economic position of the fishermen; it has created an opportunity for them to utilize the new resource of the open water fish community i.e. the *C. gariepinus* and the large-sized *Barbus*. The project has created more jobs in fishing and also in net making, fish processing, distribution and marketing sectors. It has increased the availability of fish (as a low priced animal protein) to the consumer public. However, the investment costs of motorized boats are quite high, and without subsidy or encouragement opportunities, it becomes unattainable for most fishermen. Moreover, it is based on the fact that due to shortage of storage and transportation problems, the fishery operates only at a fraction of its capacity.

Therefore the current contribution of Lake Tana fisheries to the national economy is very low because of it's under development (MoARD, 2014). The reason for undertaking this study is the actual catch level is too much lesser than its potential, and both the expected catch levels and income generation do not show an expected progress as stated in MoARD, 2014. Therefore, analysis of factors affecting fish catch levels in Lake Tana is considered important and timely.

1.2. Statement of the Problem

Fisheries sub-sector, in spite of its significant potential in contributing for food self-sufficiency as source of animal protein, generation of employment opportunities, and income, is the least exploited natural resources in Ethiopia. The present rate of catch all over the country's inland fisheries has been estimated to be 30 percent of the maximum sustainable yield (Wikipedia, 2015).

According to FAO (2013), national annual per capita fish consumption of Ethiopia is 240 grams per individual, whereas annual per capita fish consumption of neighboring East African countries such as Uganda, Kenya, Sudan, Somalia and Djibouti are 35.7, 14.3, 4.4, 1.6, and 3.3 kg per individuals, respectively. With the aim to utilize this potential fishery resource and to increase its contribution to the national economy, fishery extension has initiated and the modern fishing technology has been introduced during 1980's. However, the sub-sector is still underdeveloped and its contribution to the economy is negligible. The degree of fish exploitation of different lakes differs from one lake to another lake (FAO, 2014).

According to MoARD (2014), the percentage share of fishery resource exploitation of Ziway, Langano, Awassa, Abaya, Chamo and Lake Tana was 83, 63, 140, 69, 97, and 14.5, percent, respectively of the maximum sustainable yield. Almost more than 30 percent of the total potential of the country's lake fishery (that is 51481 metric ton) is found to be available in the Lake Tana (MoARD, 2014),. However, from the above exploitation data it could be understood that, Lake Tana is still under-utilized and its contribution to food self-sufficiency is negligible, compared to other inland water bodies of the country.

Lake Tana's fish types are *C. gariepinus*, *O. niloticus*, and *Barbus* spp. Socio-cultural patterns show absence of strong fishing tradition, and particularly little fish marketing. A large part of the population consumes fish during the fasting periods traditionally in the Coptic religion. The fishery of Lake Tana is at an early stage of development, compared to that of the lakes in the Rift Valley. The major reason for this has been the limited demand for fish in the area, the

low level of technology employed by the traditional fishery and lack of storage, distribution and marketing facilities (BoARD, 2015). Limited demand results in low fish prices and makes this sector less attractive to private investors. Due to low technology input and capabilities, the mobility of the traditional fishermen using papyrus reed boats operated by one person, is very limited. However, they have easy access to the inshore fish community of *O. niloticus* and *Barbus*, which are preferred in the local market and fetch relatively good prices. A reed boat costs relatively low price but has to be replaced after six weeks. Gillnets with a stretched mesh size of 75 to 80 mm and a length of 18 m each are made by the fishermen mostly from nylon rope. Traps and cast-nets are used occasionally. The fish from this traditional fishery are sold by number and prices are negotiable and vary with the seasons (BoARD, 2015). The characteristics of the reed boats imply that it is mostly a subsistence fishery, restricted to the coastal zone, which has left the open water fish community virtually untapped for a long time.

The motorized boat fishery of Lake Tana started with the small-scale fishery development project launched by the Dutch Non-Governmental Organization (NGO), Interchurch Foundation Ethiopia (ISE), in 1986. The major objective of the project was to assist the poor fishermen around Bahir Dar Gulf area and on the nearby Islands by improving their fishing technology and supplying them with modern fishing gear. The introduction of motorized boats offered new opportunities for the fishermen to exploit the deeper, more offshore waters of the Gulf and the river mouth areas North of the Bahir Dar Gulf. Increasing production was possible because it was supported by a parallel improvement in storage and marketing facilities. Later on, the project was jointly supported by two Dutch NGOs: ISE and the Interchurch Coordinating Committee for Development Projects (ICCO - Zeist) with the co-operation of the Ethiopian Orthodox Church and the Ethiopian Ministry of Agriculture. Gillnets with a stretched mesh size of 100-120 mm and an average length of 55 m each are used by the motorized boats. The fishermen are organized in a co-operative and have a management committee which co-operated with the NGO fishery development project management (BoARD, 2015).

The introduction of the motorized boats and the large-sized gillnets has substantially increased the total catch from the lake. The fishing grounds of the motorized boat fishery do not overlap

much with those of the traditional reed boat fishery, which is concentrated in the coastal areas. The average length of *O. niloticus* (26 cm) and *Barbus* (32 cm) in the motorized fishery is larger than in the traditional reed boat fishery which show an average length of 23 and 28 cm respectively. The average size of *C. gariepinus* is 54 cm (BoARD, 2015)

According to ANRS BoARD(2015), there are around 3,000 fishermen and the majority uses traditional way of fishing and some fishermen have some motorized boats. However, most of the families living around lake Tana are participating in farming activities. Therefore, the questions here are that why still the actual amount of fish caught is insignificant as compared to its potential, why lake Tana is the least exploited lake in the country.

Thus, this study was aimed at investigating demographic, socio-economic and institutional factors that influence the fish catch level of inland fisheries with special reference to Lake Tana.

1.3. Objective of the Study

The General objective of this study was to examine the demographic, socio-economic and institutional factors determining fish catch level from Lake Tana.

The Specific objective is to identify factors affecting quantity of fish caught from lake Tana,

1.4. Significance of the Study

The fishery sub-sector plays significant role in the alleviation of poverty and achievement of food security in many parts of the world. Fish is an important and indispensable item in human

diet. The sub-sector provides employment opportunity and raises income level of the people. Fisheries could make the best possible use of underutilized resource presently available to the small farmers to increase their income and also to improve their nutritional status particularly the supply of animal protein.

Agriculture has failed for a long time in the past to meet the subsistence food requirement in the country. As a result, the country suffers from poverty and food insecurity. To alleviate these chronic problems searching for alternative food and income sources and employment opportunities, like fishery sub-sector needs to be given special attention. This study therefore, has tried to assess demographic, social, economic and institutional factors influencing the amount of fish catch from Lake Tana.

Thus, the study provide information on the factors affecting fishery sub sector that can initiate the planning process of fisheries sub-sector, identify the opportunity of fisheries that make the most contribution to economic welfare and ways in which this contribution can be increased, identify causes of gaps between the current exploitation and the existing potential of the fishery resource that may initiate professional researchers for further study on economic aspects of inland fishery resources of the country. Fishermen, local consumers and institutions will be the beneficiaries of this study and also the study could be used as an input for future studies on similar subject matters.

1.5. Scope and Limitation of the Study

The study examined determinants of fish catch level in Lake Tana. LakeTana is a wide lake near to Bahir Dar city. The study was limited to fishermen surrounding the lake. Moreover, the study deals with a limited number of individual fishermen and focused on demographic, socio-economic and institutional factors determining potential fish catch level of the lake. Even if the study is restricted in terms of sample size and area coverage, the findings can be used as a springboard for other more detailed studies.

2. REVIEW OF LITERATURE

2.1. Concepts and Definitions

Fishery: The term "fish" is most precisely used to describe any animal living in water with a backbone, has gills throughout its life, and have limbs (Nelson, 2006). A fishery is an organized effort by human to catch fish. Fishery exists for the purpose of providing human food, sport or recreational fishing or obtaining ornamental fish or fish products such as fish oil. In other words fishery is the industry or occupation devoted to the catching, processing or selling of fish, shellfish or other aquatic animals (Castroand Huber, 2003).

According to Vinyagaram, fishery is concerned with economic exploitation of aquatic productivity. It can be classified into inland fishery and marine fishery. Inland fishery is performed in lakes, irrigation reservoirs, canals and natural and man-made ponds. Fishery is a renewable natural resource that is very often an open access property to a greater or lesser degree. Vinyagaram (2002), further explained that fishery can be viewed as a capital stock that can generate considerable and sustainable social and economic benefits if managed and utilized properly. Like land, water is also capable of producing organic matter that can be converted into valuable food for human beings.

Fishing is an ancient and worldwide practice with various techniques and traditions and it has been transformed by modern technological developments. In addition to providing food through harvesting fish, modern fishing is both a recreational and professional sport. Fishing is a very ancient practice that dates back at least to the Mesolithic period which began about 10,000 years ago. Although fishing is one of the oldest industries of mankind, its progress for many thousands of years has been extremely slow and only in the most recent times have substantial changes occurred through the introduction of improved technologies. Yet these improvements have not spread over the world and thus fishing is still underdeveloped particularly in developing countries (BBC News article, 2012).

2.2. Small-Scale Fisheries in Poverty Alleviation and in Attaining Food Security;

2.2.1 Small-Scale Fisheries in Poverty Alleviation

2.2.1.1. Contribution of small-scale fisheries to economic growth at the national level:

Foreign exchange: Small-scale fisheries can make significant contributions to national economies through the generation of foreign exchange derived from international trade. International trade in fish and fishery products has grown rapidly over the last twenty years. Export values have risen from US\$ 15 billion in 1980 to US\$ 65 billion in 2010. In the same period developing countries' share of total exports has risen from 40 percent to 50 percent, with net receipts (i.e. deducting their imports from the total value of their exports) from fish trade by developing countries increasing from less than US\$ 4 billion to almost US\$ 18 billion. Small-scale fisheries are playing an increasingly important role in the fish exports of many developing countries (World Bank, 2015).

Multiplier/GDP effects: Income multiplier effects can potentially “trickle up” to the national economy ensuring that small-scale fisheries can support national economic growth through contributions to GDP. The contribution made by the fisheries sector to GDP typically ranges from around 0.5–2.5 percent, but may be as much as 7 percent in some countries, such as Senegal, where fisheries are a key economic sector compared to other sectors in the national economy. However, indirect and induced multiplier effects of small-scale fishing activity are generally not disaggregated at national level and are often difficult to estimate (World Bank, 2015).

Tax generation: Taxes provide the state with an opportunity to assist both poverty reduction and poverty prevention initiatives. Taxes made available to national treasuries can be spent on re-distributive mechanisms aimed at targeted poverty prevention or on generic social support. And they might also be used to invest in, and provide support for, infrastructure and services that are vital for economic development, but which would be unlikely to be supplied by the private sector - examples include the construction of transport infrastructure such as roads to

facilitate access to markets, and the provision of education and health care facilities. Taxes, of course, can also be used to support sector-specific aid and development programs, and recurrent budgets (e.g. in the fisheries sector), which might contribute to both poverty prevention and poverty reduction (World Bank, 2015).

Small-scale fisheries can make national-level contributions to economic growth through the generation of a wide range of taxes. This is particularly the case in some countries where fish landings tend to be concentrated at a limited number of sites where it is easy to collect taxes and where the decentralization process is offering opportunities to local governments to collect revenues. As fish is a very visible product, its trade is easily taxed. However, in most developing countries collection of taxes from small-scale fisheries is not well-established due to the organizational difficulties of tax collection, and the inability or reluctance of small-scale operators to keep sufficient records on which tax levels can be calculated or estimated, or on the level of poverty of fishing communities (World Bank, 2015).

2.2.1.2. Contribution of small-scale fisheries to local economies:

Wealth generated by individuals, households or small enterprises can make significant contributions to local economies through income and employment multiplier effects. This is especially the case in fisheries because of the “cash crop” nature of the harvest. Fish may be one of the few products in some rural economies that can generate cash to spur and stimulate demand, because other food products may be more generally bartered or consumed within the household (World Bank, 2015).

As well as the direct impacts related to sales, and to income and employment effects on the producers themselves, which result from changes in the demand or production of fish products, there are indirect impacts “upstream” and “downstream” of the production activity that occur through the commodity/supply chain. “Upstream” activities are those activities supplying inputs to the fishing operation. Typical inputs for small-scale capture fisheries include investment costs in vessels, engines and gear; operational costs of fuel, ice, food, bait; labor costs; financial services; and maintenance costs. “Downstream” activities are those following the harvesting of product, which themselves require inputs. Some examples of the inputs required are: investment in design, construction and equipping, processing and

marketing facilities; labour; transport of fish from landing sites and to markets; financial services; variable costs such as ice, knives, and fish boxes; and maintenance costs. Induced impacts are also brought out in the form of sales, income and employment effects from the changed levels of income and expenditure throughout the local economy as a result of direct and indirect impacts (e.g. fishing crew may use their earnings to purchase household items) (FAO, 2014).

Taking the upstream and downstream indirect activities together, and considering the induced impacts, one can easily imagine how small-scale fishing activities can become the main driver of poverty reduction, with a web of businesses and individuals generating sales, income and employment as a result of the multiplier effects of fishing activity. The impacts on poverty of these upstream and downstream activities may not be the same for men and women, depending on how access to resources and control over infrastructure and services are gendered. Small-scale fisheries may also contribute taxes at the local level, which can subsequently be used for local economic development, including poverty alleviation strategies (FAO, 2015).

According to Kurien (2010), international trade in fish and fishery products has grown rapidly over the last twenty years. Export values have risen from time to time. Developing countries' share of total exports and fish trade increased over time. Small-scale fisheries are playing an increasingly important role in the fish exports of many developing countries. Kurien (2010) explained that, small-scale fisheries can make national-level contributions to economic growth through the generation of a wide range of taxes.

2.2.1.3. Contribution of small-scale fisheries to household poverty alleviation:

Small-scale fisheries as a central element in livelihood strategies: Worldwide about 38 million people are estimated to be fishers and fish-farmers, about 95 percent (36 million) of whom are from Africa, Asia and Latin America. Of these around 68 percent (26 million) are estimated to be involved in marine and inland small-scale capture fisheries. Assuming a 1:3 ratio for employment in direct upstream and downstream activities, over 78 million people depend on small-scale fishing and directly related activities (processing, trading, ancillary

services, etc.) for their livelihoods in developing countries. If on average there are two additional dependents for each job, then it can be estimated that there would be some 234 million people are dependent on fisheries in developing countries (FAO, 2014).

Not included in these estimates, however, are the other hundreds of millions of people who are engaged in temporary fishing activities in rivers, small lakes and reservoirs, seasonal or temporary ponds, wetland and flood plains. In these cases, fishing is not a full-time occupation but represents one component of multi-activity livelihood strategies developed by individuals and households. Within these strategies, fishing may appear amongst activities involving low human and financial capital and undertaken in a rather occasional manner; or may represent a more prominent - but still seasonal -activity strongly integrated into the annual round of livelihood activities. When fishing fits within a flexible matrix of various activities that constitute the basis of a diversified livelihood strategy upon which households rely, it can help to spread risks between various economic activities in an uncertain environment and therefore reduce vulnerability, to create a synergy between the inputs and outputs of these activities and thereby enhance capital accumulation and income opportunities, and to generate cash when other household activities offer little potential for doing so. Fishing as a secondary or complementary activity can thus be essential for households both in terms of income and food security (FAO, 2014).

Fishing (and fish-trading) as a safety-net activity: Although small-scale fisheries may contribute to poverty reduction at the household level, it should be recognized that at the present time the most important contribution of small-scale fisheries to poverty alleviation is probably through their role in poverty prevention. Indeed, experience suggests that for the large majority of households involved in fishing activities (full-time, temporary or occasional fishers) in developing countries, fishing and related activities have not generated high economic returns but instead have helped them to sustain their livelihoods and have prevented them from falling deeper into deprivation (FAO, 2014).

In situations of economically or institutionally restricted access to other capital (e.g. financial capital such as credit) or production factors (such as private land) the relatively easy and free access to fishing grounds allows poor people to rely more heavily on the local commons'

resources to obtain the goods and services they need to sustain their livelihoods, or to gain access to paid employment. Inland fisheries are particularly important in this context. This safety-net dimension of fisheries is of greater importance and relevance to poor and marginalized households - generally those with limited access to land and other resources (FAO, 2014).

Although these poverty prevention mechanisms are perhaps less attractive from a purely economic point of view - in the sense that no significant surplus rent is generated by the activities - the role of small-scale fisheries as a livelihood support and coping mechanism for the poor is crucial from a social point of view, especially in areas where alternative employment may be scarce and social security programs either minimal or non-existent. In these areas fisheries can play a critical role as a “welfare” system, which would otherwise have to be provided through other forms of social support by local or central government (e.g. through “food for work” or unemployment benefit programs) (FAO, 2014).

Small-scale fisheries can also provide a critical safety net for vulnerable households (even those which were not previously poor) when they face a sudden decline in their income. This can happen, for example, when the head of a household loses his or her job; or if farm crops fail; or, on a larger scale, when the local or even national economy deteriorates. Recurrent civil wars or military conflicts, population displacement, and natural disasters also create circumstances where those affected turn to fisheries as additional or alternative sources of income, food, or employment, especially given the open-access nature, or poor management, of many fish resources (FAO, 2014).

The reliance on fisheries to provide income for the poorest not only concerns fisheries activities per se, but applies also to processing and trading activities. This aspect adds an important gender dimension to the discussion, given that women are usually the main participants in these related sectors (FAO, 2014).

From a policy point of view and, in particular, from a poverty prevention point of view, it is important to realize that open-access is the key mechanism which permits the “safety valve” function of fisheries to operate and allows people to engage, temporarily or permanently, in the sector. This raises important questions concerning the trade-offs that may need to be made

if one wishes to maintain the capacity of small-scale fisheries to play their safety-net role (poverty prevention), while at the same time trying to restrict (or at least control) access to these resources for sustainability reasons and to increase their wealth generating potential (poverty reduction) (FAO, 2015).

2.2.2 Small-Scale Fisheries in food security:

2.2.2.1. The contribution of small-scale fisheries to world food security:

At the global level, consumption of fish as food has doubled since 1973 and the developing world has been responsible for over 90 percent of this growth, much of it from small-scale fisheries. Fifty percent of all food-fish originates from small-scale fisheries, and almost all fish from small-scale fisheries is used for food. In contrast, a substantial percentage of the catch from industrial fisheries tends to be used for animal feed and other products and not for direct human consumption (World Bank, 2015).

However, since the late 1980s, population growth (outside China) has outpaced the growth of total food fish supply, resulting in a decrease in per capita fish supply from 14.6 kg in 1985 to 13.9 kg in 2010. Nevertheless, the growth of fish consumption in poorer countries has increased rapidly in recent decades. In particular, the consumption of freshwater fish has grown substantially, primarily in East Asia. Even if China is excluded, per capita supply in Low Income Food Deficit Countries (LIFDCs) has increased from 5.0 to 8.3 kg since 1960 at an annual growth rate of 1.3 percent (World Bank, 2014).

2.2.2.2. Contribution of small-scale fisheries to food security at national level: the issue of trade:

Although very little research has been done to identify the different mechanisms that link small-scale fisheries to national food security, the productive capacity of a country to exploit its own small-scale fisheries resources is not necessarily a sufficient condition to ensure the effective contribution of fish to national food security. Consumption rates in some countries may be low due to cultural reasons, and in others large numbers of the poor may have insufficient assets to purchase fish. Changes in global demand and supply mentioned above have also combined to result in significant increases in trade, driven by exports and imports

from, and to, developing countries. Intra-regional trade between developing countries is expected to rise further in the coming years (FAO, 2015).

If one focuses just on the direct contribution of fish to food security, greater exports than imports of fish and fish products can potentially mean less availability of fish for national consumption. However, the relationship between the balance of trade and food security is more complex than this due to the indirect contribution of exports both through resulting wages and employment, and through the foreign exchange earned at the national level that can be used for imports. There is also the need to consider food security for both producers and consumers (FAO, 2015).

With respect to the ability to import food, exports of high value fish species can enable imports of low value fish species and other food types. Analysis of the food trade for instance shows that in the year 2010, the value of fish exports in Low Income Food Deficit Countries (LIFDCs) corresponded to 50 percent of their import bill for food. Similarly the Asian countries as a group earned enough foreign exchange from fish to finance 34 percent of their food imports in 2010. Analysis of past and projected trade trends indicates that developing countries as a whole have been, and are projected to remain, large net importers of low-value food fish but exporters of high-value finfish (FAO, 2015).

The impacts of increasing trade on food security for the poor are not necessarily clear-cut. While low-value fish have traditionally accounted for a higher share of the animal protein consumption by the poor in developing countries, increased trade may or may not drive up local prices. What is certain is that the effects of fish trade on the price of fish is likely to be a key factor affecting the nutrition of the urban and rural poor in the future (FAO, 2015).

2.2.2.3. Contribution of small-scale fisheries to food security at individual level:

The most direct contribution of fishing activity to food security at the individual level is through consumption of the individual's catch, i.e. self-consumption. Certainly for many poor households engaged in full-time, seasonal or occasional small-scale fishing activities, such contributions are crucial to individual/household food security (FAO, 2015).

The percentage of total household catch that is consumed by the household varies greatly, however, and may depend on both the level of commercialization in the fishery and the level of poverty in the household. The extent to which poverty determines the percentage of the catch that is consumed, is complex and not always clear or well understood. While it is often assumed that the poor consume a greater proportion of their catch, recent field research, in the Lake Chad (Béné et al . 2013), has shown that the poorest households may consume a lower proportion of their catch than better-off households, and instead sell most of their fish in order to be able to purchase cheaper foodstuffs. The direct contribution of fish to food security for the poorest households may therefore be lower than generally thought, preventing these households from accessing the nutritional benefits that fish offers. This is particularly the case for women, because of commonly-found gender inequities in access to fishery resources and to higher-margin trading activities in the post-harvest sector.

If fish (as a subsistence product for fishing households) is potentially an important source of direct food security, its contribution through both bartering and the generation of incomes derived from labour-wages and fish commercialization, can also make it an important indirect source of food security. Harvesting, processing and marketing fish generates livelihoods, employment and income for millions of people around the world. Although employment cannot be taken as the firm assurance of food security for these people, it should be emphasized that in a significant number of cases, small-scale fishing activities take place in areas where alternative employment opportunities may be scarce or even non-existent. In these circumstances, access fishery resources for harvest, processing and/or trade may represent the only option available for making a living and maintaining food purchasing power (FAO, 2015).

2.3. Nutritional Importance of fish

Nutritionally, fish is often presented as an important source of protein, especially where other sources of animal protein are scarce or expensive. FAO (2015) has recently estimated that fish provides about 19 percent of the protein intake in developing countries. This figure, however, represents an average at a global level and does not reflect the very large heterogeneity at the national or, even more importantly, at the local level. The share of fish in animal protein

consumption can for instance exceed 25 percent in many poor countries and reach 90 percent in small-island states and isolated parts of coastal or inland areas.

Fish makes a minor contribution to calorie provision. Fish offers up to 180 calories per capita per day, but reaches such levels only in a few countries where there is a lack of alternative locally produced protein or where a preference for fish has been developed and maintained. More generally on a national basis, fish provides an average of 20 to 30 calories per day (FAO, 2015).

In low-income countries, staples such as rice, wheat, and maize make up the bulk of the food consumed by people, supplying the majority of energy and nutrients. However there are some essential micro-nutrients which are not found in these staples or found only in small quantities - for example: iron, iodine, zinc, calcium, vitamin A and vitamin C. These nutrients must be supplied by other foods such as fish or vegetables. Fish is particularly rich in these micro-nutrients. Fish are also an important source of fatty acids that are necessary for the development of the brain and body. The importance of fish as a crucial element in the diet of a population, therefore, is now widely recognized, especially in the diets of young children, infants and pregnant women (FAO, 2015).

According to Washington Department of Health (2016), fish and its products are low-fat, highly nutritious and are excellent sources of dietary essentials such as protein, minerals and vitamins. The energy content of fish is more than that of beef and chicken egg. About 90-100 percent of fish protein is digestible, hence, fish foods are included in many diets for people with digestive disorders and for convalescent ulcer.

Venkata and Santhanam (1981) further explained that due to the unique chemical nature of fish fats, fish foods are often recommended to people who suffer by heart disease. Vitamin “A” content of fish livers helps for good vision. Other vitamins B6, B12, Biotin and Niacin and minerals such as phosphorus, potassium and iron help in normal growth of human body. The level of calcium, magnesium and chlorine in the fish is also greater than that of meat. Minerals like copper zinc, manganese, cobalt, molybdenum and selenium are found in fish egg. The low incidence of tooth decay in some people has been attributed to high consumption

of fish. More recent medical evidences suggest that a high dietary intake of fish that contains fluoride may prevent certain bone diseases.

2.4. Global Fish Production and Consumption

Global production of fish from capture of fisheries and aqua - culture and the food fish supplies currently at the highest on record and remains very significant for global food security, providing more than 19 percent of total animal protein supply. According to FAO, (2014) the world fisheries product of 23% contributes by developed countries and 77% was produced by developing countries.

According to FAO, in year 2014, average apparent per capita food fish supply was estimated to be about 20.1 kg, much better than in 1992 that were 13.1kg. According to FAO, over the last few years, fishery has been strongly influenced by improvements in transportation, marketing and technology, which are led to significant improvement in efficiency, lower costs, wider choice and safer and improved products. The extent and range of these changes have varied among regions. In general, globally, there has been a growth of fish and fisheryproducts marketing. The share of fisheries product by African countries is significantly increasing from year to year. According to FAO, inland capture fisheries production, Asia with 65.5 percent, and Africa with 24 percent contribute to about 90 percent of global inland captures production.

Table 1. World fisheries and aquaculture production

<i>Production (million tons)</i>	<i>Inland Capture</i>	<i>Marine Capture</i>	<i>Inland Aquaculture</i>	<i>Marine Aquaculture</i>	<i>TOTAL</i>
2011	10.5	79.7	34.3	21.4	145.9
2012	11.3	77.9	36.9	22.1	148.1
2013	11.1	82.6	38.6	23.2	155.5
2014	11.6	79.7	42	24.4	157.8
2015	11.7	81	44.8	25.5	162.9
2016	11.9	81.5	47.1	26.7	167.2

Source: FAO, 2016

Fishery grows more rapidly than all other animal food producing sectors. Worldwide, the sector has grown at an average rate of 8.9 percent per year since 1970, compared with capture fisheries and for global meat production systems, over the same period. In 2014 total world aqua - culture production was reported to be 59.9 million tons by quantity and USD 119 billion by value. Most aqua – culture production of fish comes from fresh water environment (FAO, 2016).

2.5. Fishery in Ethiopia

2.5.1. Genesis of fishery development

It is commonplace to say that in the world, fishing is as old as the settlement of people around the lakes and the rivers. However, fishing for the local land - based population around the lakes of Ethiopia was an unrecognized opportunity until the 1950's. A study by Drewes (1993) revealed that to the local people around the rift valley lakes, fish was considered as worms and snakes, which should never be touched at all. Fishing in Lake Tana was started by the Woyto ethnic groups, which did not own land. Thereafter, poor members of the farming communities gradually adapted to fish consumption and subsistence fishery. Commercial fishing in rift valley lakes started during the 1950's responding to the demand for fish from foreigners and upper class Ethiopians in Addis Ababa (Tesfaye, 1998). Due to its isolation from the chain of lakes in the rift valley system, Lake Tana has received minimal attention in fishery development projects. The lake fishery remained almost completely subsistence, until a fisheries development project assisted by Dutch nongovernment organization (NGO) was launched in mid-1980's, which has introduced motorized vessels, improved gears, and lately by the European Union (EU) assisted Lake Fisheries Development Project (LFDP, 1998).

Aqua - culture is also recognized as an alternative means of achieving food security and poverty reduction strategy in the rural area, and is considered an integral part of rural and agricultural development policies and strategies. However, aqua - culture in Ethiopia remains more potential than actual practice, despite the fact that the country's physical and socio-economic conditions support its development. Extensive aqua -culture in the form of stocking

and enhancing artificial lakes, reservoirs and small water bodies has been practiced since 1975. But, due to the absence of systematic monitoring and evaluation, the success or failure is unknown (MoARD, 2013).

2.5.2. Fisheries resources and level of exploitation

Concerning Ethiopian fish catch level, different sources provide different information. Based on a systematic assessment of the lakes and on length-based empirical models for rivers current annual total fish production potential is estimated to be 51, 481 metric tons (FAO, 2014).

On the other hand, some empirical estimates revealed that Ethiopia's total fish potential, from the main lakes and reservoirs reach 44,000-49,000 ton/year with take up of 25-28 percent (MoARD, 2012). Concerning country's river fishery potential Tiffney (1986), estimated that, river fishery to produce about 7,000 ton/year. Fisheries resource, in Ethiopia, in spite of its significant contribution to poverty alleviation and food security is an unexploited natural resource. The total fish catch level is 15,389 tones, which is about 30 percent of the calculated potential (FAO,2014),These landing come from the major lakes such as Chamo, Ziway, Langano, Awassa, Abaya, Tana and Koka reservoir .

The main commercial species contributing to the total landing are *Oreochromis niloticus*(*Nile tilapia/ "Qereso"*), *Labeo hori*, *Clarias gariepinus*(*catfish/"Ambaza"*), *Barbus sp.*(*"Nech Asa"*), and *Lates niloticus* (Ayalew,2006)The degree of exploitation between individual lakes or reservoirs is not uniform. The fishresources exploitation report of MOA (2013), indicated that, Lakes Awassa, Chamo, Ziway,Abaya, Langano, Koka reservoir and lake Tana exploited by 140, 97, 83, 69, 63, 89 and14.54 percent, respectively.

Convenient road connections and proximity to the capital city had given the rift valley lakes priority in fishery development and research programs. Hence they have been and still are the main fish suppliers to the big towns. Especially the major lakes, with important fish resources, Lakes Zeway, Awassa, Langano, Abaya and Chamo have been the subjects of several scientific surveys (MOA, 2013)

Table 2.Water bodies and their potential and actual fish catch amount in 2015.

Water bodies type	Name	Area (Km2)	Potential(tn/yr)	Catch (tn/yr)
Major Lakes	Tana	3,500	10,000	1454
	Ardibo & Lugo	51	400	330
	Ziway	434	2941	2454
	Langano	225	240	151
	Abiyata	205	2000	500
	Shala	250	1300	10
	Awassa	97	611	853
	Abaya	1070	600	412
	Chamo	551	4500	4359
	Turkana (1.3% of total area)	94	750	75
	Sub Total	6,477	23,342	10,598
Reservoir or dam	Koka	255	1194	625
	Fincha-Amerti	250	1330	333
	Beseka	39	205	41
	Denbi	72	383	77
	MelkaWakena	82	434	109
	Aba-samuel	44	234	59
	Alwero dam	74	394	79
	Hashengie	20	106	21
	Small Abya	12	66	13
	Wedecha	10	53	11

	Subtotal	857	4,399	1,366
Small water bodies	Southern region (Cheleloka Swamp)	100	423	21
	Gambella (swamps and flood plains)	125	529	132
	Small reservoirs and ponds	50	1000	150
	Subtotal	275	1,952	303
Rivers		7,185		
	Subtotal	Km	21,788	3,121
Total			51,481	15,389

Source: Asefa, 2015

2.5.3. Demand and supply of fish in Ethiopia

According to FAO (2015), annual per capita fish production is less than 240 grams. Despite this, based on only a single factor - population annual demand for fish in the country is estimated at 65, 344 tones. Future demand at the present population growth rate will increase. This is the minimum demand, since factors other than population are not considered. These positive factors which generate demand include the relatively current low fish product price compared to the increasing prices of its substitutes, a rise in real income of the society, the growth and expansion of towns, and improvement and expansion in fish distribution or supply networks and improvement in fish product quality. At present, the country's estimated annual total exploitable fish potential, if fully exploited, can meet only 79 percent of the current actual demand, based solely on population size (FAO, 2015). In view of this, the present fish supply sources are unable to meet the demand. This calls for an increasing focus on stocking and enhancement of better production and development of fishery sector to meet future demand for fish.

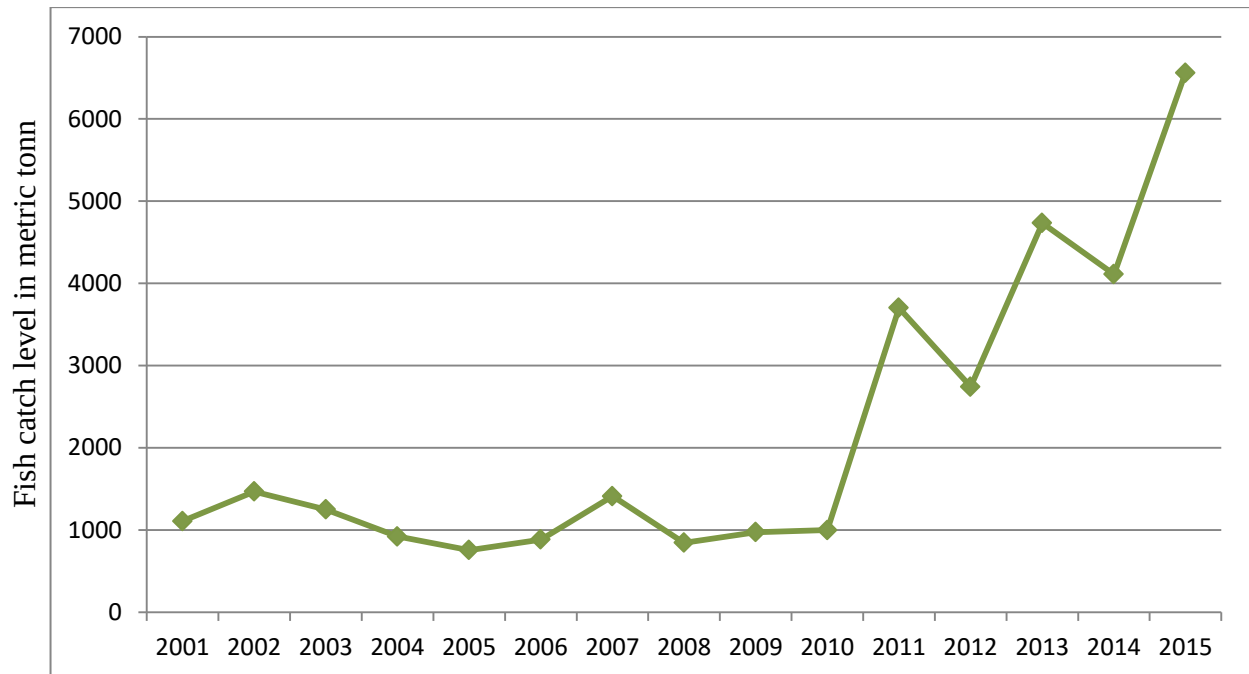


Figure 1:- Lake Tana's fish catch from 2001-2015

Source: ANRS BoARD 2016

Fifty years lake Tana's fish catch level shows it was very small before 2010, which results below 2000 metric ton annually. However after 2010 the amount of fish catches level shows some improvement.

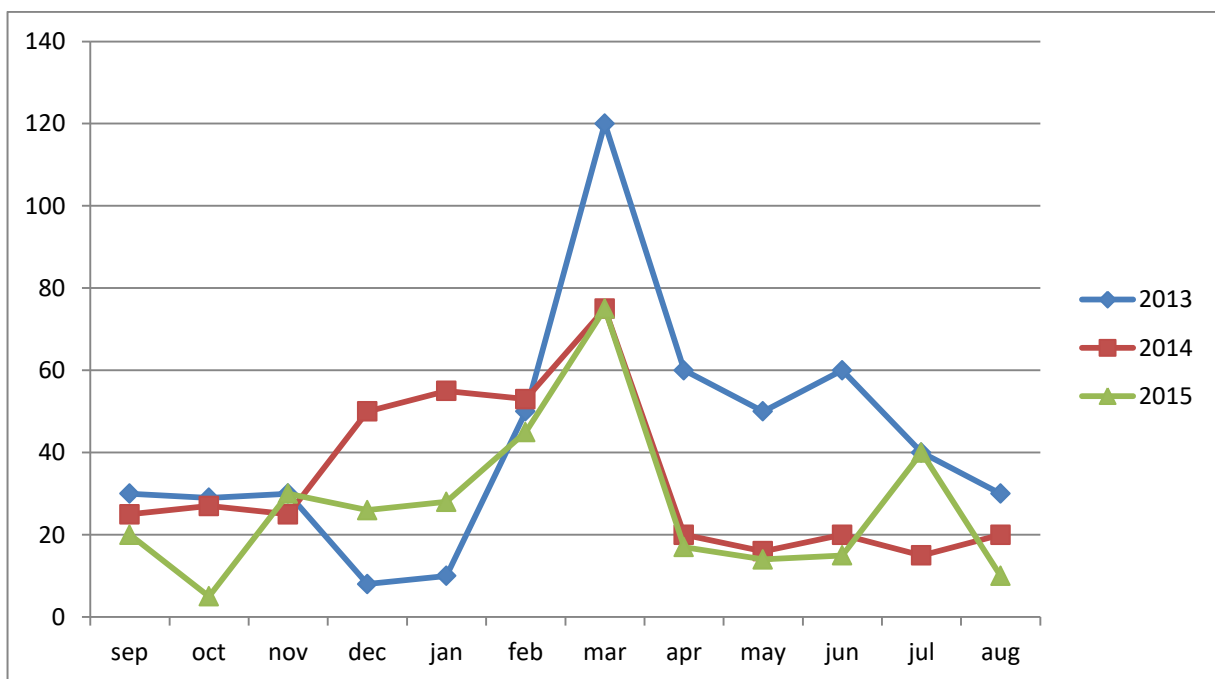


Figure 2:- Lake Tana total catch amount distribution on monthly bases in tones

Total catch distribution shows that, March exhibit the highest catch and it follows with February and April respectively. May, Jun, July and August exhibit the second category for better catch distribution. The least was recorded from September up to December.

2.5.4. Opportunities and constraints of fishery in Ethiopia

The current low level of exploitation of the fisheries leaves considerable room for further expansion, with more additional tons of fish available for further exploitation. However, important constraints remain to be addressed in order to be able to realize the opportunity. Much effort will be needed to improve research, technology and extension; expand and improve support infrastructure such as connecting roads, landing and onshore processing facilities; expand distribution networks, create sustainable markets, strengthen financial institution; and the government fishery administration in the areas for effective resource monitoring, coordination, planning and proper implementation (MoARD, 2014).

Ethiopian lakes, on which the inland fishing is mainly practiced, are threatened by catchment's deforestation, shore damage, water pollution, over fishing and unconventional fishing practice such as the use of chemical poison plants and the use of unregulated mesh sizes. Moreover, lack of government support, remote locations and poor services, low literacy and innumeracy and weak organization capacity are other factors that expose fishing communities to poverty. The number of fishermen and fishing gears increased the fishery resource has become so scarce and the common pool fishery resource which is the source of livelihood to the fishing communities become at risk (Alebachew *et al.*, 2016).

The fish stocks decline and the demand for fish increases, illegal fishing and the trade of illegal fish is becoming an increasingly reactive option for some operators. For the interests of the majority of the fishermen in lake Tana, the management of fisheries is preferably to rely on closed seasons, closed fishing areas, restriction on number of fishers, catch quotas, mesh size

restriction, restriction on beach seines and banning beach seines. It has also been recognized that the efficiency and implement ability of the management measures are often highly dependent on the support gained from the interested parties (Alebachew *et al.*, 2016).

Lack of credit: Most fishing requires some financial investment. In common with small-scale fisheries in Ethiopia, many fishermen in Lake Tana lack the resources to buy fishing gear and nets. Traditional tanqwa, are commonly used types of boat around Lake Tana, where the papyrus is still available. And also fishermen reduce the cost of nets by making their own, but still many fishermen do not have their own nets. This limits fish production. Such constraints create a lower supply to the market. Tana Haik Fishing Co-operative rents out motorized boats to its members on a full cost recovery basis. The co-operative receives no outside support. It too lacks capital to purchase sufficient boats to meet the demand from fishermen (roughly one-third of their memberships are still waiting for boats). There are two sources of credit in Bahirdar: Amhara Credit and Savings Institute offers credit at 18% per annum and the farmers' co-operatives make loans at 12.5% per annum, but are not present in all the kebeles and therefore not accessible to everyone. According to Amhara Regional Agricultural research institution, 2014 most fishermen in Bahir dar do not use either of these two credit sources to purchase fishing gear because of high interest rate. However at times of crisis, a fisherman takes emergency short-term loans from traders. (ARARI, 2014)

Relatively high cost of fishing with motorized vessels: price of fish caught by using motorized vessels is the same with fish caught by using traditional tanqwa, when finally reached to the market. Households' consuming a fish do not consider how it was caught, rather they need quality fish with the minimum price, so it has a big impact on the producers. The major marketing constraints faced by the fishermen are physical access to landing points, unremunerative fish prices, loss of quality because of limited options for storage and time/distance from trading points as Amhara Region Agricultural Research Institute stated in 2014.

According to ARARI (2014), the size of mesh should be greater than 20cm for Nile tilapia and between 5-18cm for *L. barbus* specious. The major reason for the collapse of these fish species

is due to destructive fishing during their spawning season and destruction of the river ecology that serves as a spawning ground.



Figure 3:- traditional fishing at Lake Tana

Poor institutional support and lack of skilled human resource: The fisheries and aquaculture administration is under the supervision of the Bureau of Agriculture and Rural Development. This Bureau didn't give emphasis on the subsector. It is not currently discharging its responsibility with one man section at the Regional level. Other institutions like water resources, cooperatives, investment, city council etc.. have also some relations with the fisheries. Poor linkage and coordination, absence of effective line of communication to the field level, lack of attention for the subsector are among the serious institutional problems facing the sub-sector.

There is critical shortage of skilled manpower in the fisheries and aquaculture sector in the regions as well as at Federal level. In Amhara Region only 1 fishery expert is assigned at the Bureau of Agriculture and Rural Development. There are no fishery experts at Zone, Woreda and Kebele level. There are about 6 researchers working on the fisheries and aquaculture in the region. Most of them focus on the biology of fish. There are no experts in fishing gear technology, fish processing and marketing.

Public and private investment in fishery and aquaculture is low and the infrastructure inadequate. There is also an urgent need to invest in modern value chain-based fish processing and marketing infrastructure. Local fish demand can be greatly increased with a change in the people's food habit, in favor of fish. Improvement in fishing techniques, technology transfer to

fishers, training of fishery management personnel, attraction of financial capital to the industry, fish value chain improvement, and aquaculture, can all result to increased fish production and catch level, increased trade and overall economic development of the country.

The responsible organ for fisheries management is the federal states with some oversight from the Ministry of Agriculture and Rural Development. A number of fisheries research stations are in place, centrally funded and with facilitated research programs, under the umbrella of the Ethiopia Institute for Agriculture Research. The National Plan for Accelerating Sustainable Development to End Poverty (PASDEP) prioritizes fisheries. Also, both the National Strategy and the Development Plan for Aquaculture acknowledge the indispensability of the sector, though implementation has been a challenge (FAO, 2015).

Fishery policy of the Government of Ethiopia: According to (MoA, 2014) at present the relevance of the fisheries for addressing the problem of food self-sufficiency and rural development is well recognized by the Federal as well as regional governments. According to (GTP, 2010) with a view to improve the poor economic and social performance of the country, the Growth and Transformation Plan was considered as the fundamental strategy for meeting a long - term economic development. In this GTP consistent with the rural and agricultural sector policy objectives, fishery is increasingly recognized as an alternative means of addressing the problems of food security and poverty in the country, with specific objectives of increasing fish consumption and the nutritional status of the population, particularly in rural areas; improve employment and income opportunities and hence the living conditions of fishery communities; improve post-harvest activities to cut losses and improve fish quality; supply industries and export markets with sufficient quantities of good quality fish; increase fisheries contribution to national income, including export earnings; Improve complementarities' and efficiency in fish farming systems through integration with other agricultural activities; and ensure sustainable use of fish stock and the aquatic environment.

2.6. Empirical Literature Review

The existing studies mainly focus on the biology of the lake fishery. However, there are some studies like Ikiara (1999), Mwakubo *et al* (2007), Inoni and Oyaide (2007), Akanni and Akinwumi (2007), and Akanni (2010) and briefly revised.

Ikiara (1999) estimates Kenya's Lake Victoria fisheries production function to identify the key dimension of effort that lead to catch variations using Transcendental Logarithmic (translog) and Cobb-Douglas functional form with data from 482 fishing unit sample. The former could not be used due to degree of freedom and multicollinearity problems, however, the later suggested, vessel mode of propulsion, crew size, fishing experience and number of days fished were highly significant in explaining catch variations.

Mwakubo *et al* (2007) examined the determinant of catch level using socio-economic, ecological and fish catch data from Yala swamp of ten landing sites. To incorporate seasonal variation data were obtained from June 2004 to January 2005 for the period of ten days in each month. Using Ordinary Least Square (OLS) model, estimations showed that household sizes, length of boat, total nitrogen, and phosphorus were positively correlated with catch level. While educational level, age, non-fishing income, level of nitrates and chlorophyll-a were found to be correlated negatively.

Inoni and Oyaide (2007) used Ordinary Least Square (OLS) model to identify the effect of socio-economic factors on fish output using a sample of 198 fishers in the South Agro-ecological zone of Delta State. Examination result from the postulated economic model indicated that fishing vessels, household size, labor, fishing experience, gender and season had statistically significant effect on catch level.

Akanni (2010), analyzed the fish catch level using Ordinary Least Square (OLS) model and, found that labor use, credit, and cold storage facilities as major determinants of the fish catch. The result suggested that increase in the use of these resources and empowering artisanal fisheries to acquire more versatile and larger fishing boats to increase fishing capabilities to offshore and deep area where fisheries resources are abundant can possibly increase their catch.

Binyam (2011), analyzed the fish catch level determinants in Eritrea using Ordinary Least Square (OLS) model and find boat type, fishing experience, household size, access to ice have positive and significant link with fishery catch. Whereas access to credit, fisher's age and non-fishing income are connected to reduce fish catch. The means of boat propulsion highly and significantly explicated fish catch. Primitive fishing units tend to harvest less fish irrespective of the capture technology they employed as technological impediments restrict them to fishing. Subsequently, the study confirmed the significant and negative effect of fisher's age on fish catch levels as well as restriction imposed on young fishers, the study found that fisheries with acute problem of young and productive fishers. On the other hand, until an optimal size is reached, hiring more crew can help fishers to undertake more trips and thus increase catch levels. Further, fishing experience rather than fisher's education significantly explains fish catch level. It seems that the education is not the kind of expertise required for fishing practice rather the fishing experience likely to provide better knowledge of fishing expedition. Owing to their entire livelihood associated with the sea, some of the fishers are well informed of weather pattern, location and type of the resources.

Ayetegeb (2013), figured out that access to credit was positively and significantly related to the fish catch level. However, the existing credit system focuses on short-term credit given mainly for fertilizer, seed and fattening programs. The provision of medium and long-term credit especially from formal sources directed to the promotion of fishery resource development would, therefore, be a vital step to encourage fishery resource utilization. Training of farmers in fishery resource management, utilization and fishing technologies and acquaintance with the techniques of their application was appreciated and important for managing the resource sustainably. Hence, promoting and expanding training would result in more rational decision, accurate implementation and sustainable utilization of the resource. And he suggests the provision of due attention to household characteristics such as education. Education is one of the demographic characteristics of households, which have an important role to increase the farmers' ability to obtain and use information relevant to fishing techniques. The study revealed that the status of education was found to be positively and significantly related to the fish catch level. Thus, there is a need to educate farmers at least up to the level of primary education via adult education system.

3. RESEARCH METHDOLOGY

3.1. Description of the Study Area

3.1.1. Location of Lake Tana and its Basin

Lake Tana is located at the Northwest of the country adjacent to Bahir Dar city, a capital of Amhara National Riginal State, with the natural altitude of 1785 m.a.s.l. It is situated 560 km from Addis Ababa, the capital city of Ethiopia. Lake Tana, acts as water control basin to collect the flood from the sub basin and allow flowing to the Blue Nile River (Tesfaye, 2000).

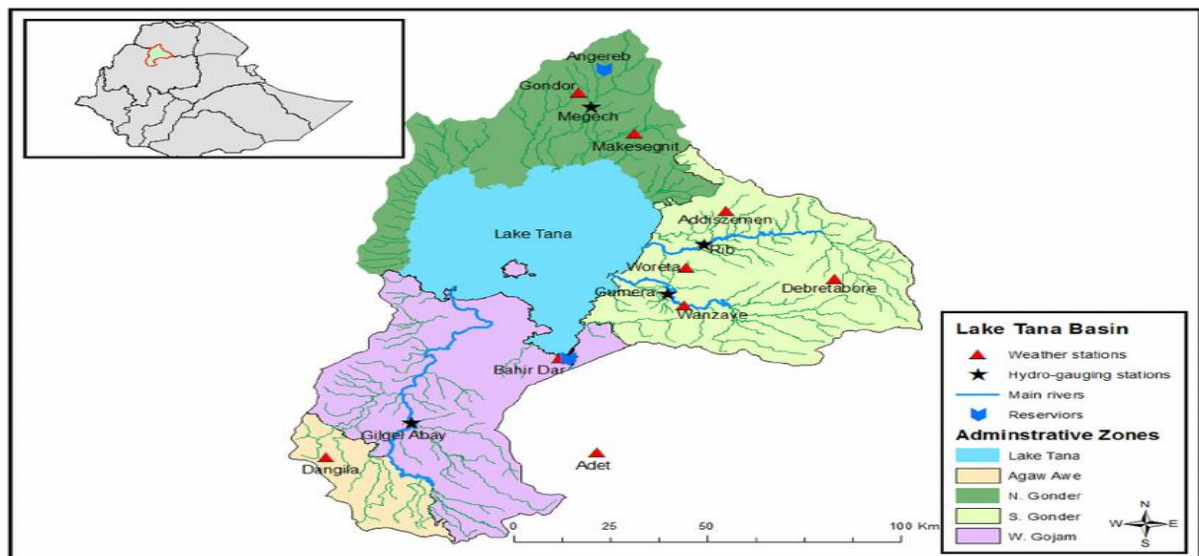


Figure 4:- map of Lake Tana

Lake Tana has been formed through volcanic blocking of the Blue Nile in early times. It has an average depth of 8 meters and a maximum depth of 14 meters, maximum length of 78 km, and maximum width of 67 km, the shoreline of 385 km and 3156 km² of total area (Moher, 1962). The Lake Tana basin is rich in biodiversity with many endemic fish flocks, plant species and cattle breeds; it contains large areas of wetlands; it is home to many endemic birds and cultural and archaeological sites. The basin has also critical national significance as it has

the potential to be the breadbasket of Ethiopia; vast water resources potential for irrigation, enormous potential to develop hydroelectric power, rich potential for development of high value crops and livestock production, high potential for eco-tourism and other livelihood strategies outside farming, flood plains potential for rice field (Ayalew, 2006).

About 65 percent of the catchments are seasonally flooded. There are five major permanent rivers; Gelgel Abbay, Gumara, Rib, Megech and Dirma, as well as more than 30 seasonal streams feed the lake, whereas the Blue Nile River is the only outflow from Lake Tana. (Ayalew, 2006)

The climate of Lake Tana is characterized by main-rainy season with heavy rains during July-September, a dry season during December-April, and two minor rainy seasons during May-June (pre-rainy season) and October-November (post-rainy season) (Tesfaye, 2000).

According to projections made by the population department of BoFED (2010), the total size of population living in the Lake Tana watershed was estimated to be 5.29 million. And most of them live in the rural areas.

3.1.2. General agricultural situation and Food security status

Agriculture is the mainstay of the economy of the region in general and that of the Woredas of the Lake Tana watershed in particular. It is also the source of livelihood of 92 percent of the total population. Farming in the area is of mixed type with crop production and livestock rearing. Since the production system is mainly characterized by traditional subsistence farming, the level of productivity in the agricultural sector is very low. According to the socio-economic survey result, farmlands have been cultivated for a long period of time and as a result land fertility has been diminishing from time to time. The practice has been more disastrous in areas where there is high population density like in the watershed. (BoFED, 2010).

According to the study conducted by Ministry of Finance and Economic Development (2015), per capita income of the population of the region was 120 USD of which household saving estimate accounts about 4.8 percent.

According to the household survey result (BoFED, 2010) about 76 percent of the households have faced food shortage, out of which nearly 80 percent faced the problem for about 2-5 years. Since almost all the rural households depend directly or indirectly on agricultural production, they have experienced the deficit in every harvesting season. Food poverty is more prevalent in rural areas, where the majority of the population lives, than in urban centers.

3.1.3 Fish species of Lake Tana

Lake Tana has 26 to 28 fish species and one sub-species, of which 20 species and one subspecies are endemic to the country. Eighteen species are endemic to Lake Tana (Nagelkerke, 1997; De Graaf, 2003; Eshete, 2003). Main Feeder Rivers have considered as part of the lake because they are spawning grounds for the Barbs species during the wet months (Golubtsob and Mina, 2003).

The commercial fishery consists of an endemic flock of large *Labeobarbus* spp. (Cyprinidae), *Oreochromis niloticus* (Cichlidae), *Clarias gariepinus* (Clariidae) and *Varicorhinus beso* (Cyprinidae). The largest fish family in the lake is the Cyprinidae, represented by three genera: *Labeobarbus*, *Garra*, and *Varicorhinu* (Amhara BoARD, 2014)

3.2. Data Type, Source and Method of Data Collection

In this study both primary and secondary data were used for this study. Primary data were collected from fishermen living around lake Tana. Data regarding the fishermen characteristics (age, education, family size, perception on fish), and physical characteristics (distance of lake from home, market and transport accessibility) was collected. Information on institutional

support like credit, extension services and training in fishery resource management and utilization provided to fishermen were also collected from the sample fishermen.

The survey was carried out by employing semi-structured questionnaire for interviewing sample fishermen. Before starting the actual data collection, the questionnaire was pre -tested in the field. The data was collected by enumerators. These enumerators were trained on the content of the questionnaire, method of data collection and how to approach sample fishermen during the interview.

Secondary data were also collected from different previous studies, journals and reports which are directly related to the study and fishery sector as a whole. Data collected from secondary sources helps to figure out different variable factors affecting the fish catch amount and set hypothesis, and to find previous studies major concern and and to fill their gap.

3.3. Sampling Technique and Sample Size

This study was a cross sectional study and a primary data on amount of annual fish catch and variables were used.

According to ANRS Agricultural and Rural Development Bureau (2015), from different fishing site the most exploiting area is Bahirdar, and there are about 3,000 fishermen fishing around Lake Tana. There are two fishing sites in Bahirdar named St. Michael and St. Giorgis. From both sites 134 sample individual fishermen were selected using a simple random sampling formula as stated below. According to their percentage to the total fishermen, 93 sample fisherman were selected from St. Michael site and 41 sample fishermen were selected from St. Giorgis site.

Table 3: Distribution of sample fishermen in both Bahirdar site.

Site	Number of fishermen	Percentage	sample
St. Michael	2082	69.4	93
St. Giorgis	918	30.6	41
Total	3000	100	134

In any research determining the appropriate and adequate sample size is vital, since using inadequate or small sample size, the study will lack the precision to provide reliable answers to the questions that are under consideration. Random sampling was adopted as sampling technique in this study. Sample size determination procedure should match the sampling design used in the study. Therefore, the sample size determination procedure in this study follows simple random sampling technique (Cochran, 1977 and Al-Subaihi2013).

$$n = \frac{N S^2}{(N - 1) \frac{d^2}{Z^2} + S^2}$$

Where n is the sample size needed, N = 3000 is population total (total number of fishermen), Z = 1.96 is the inverse of the standard normal cumulative distribution that correspond to the level of confidence. S^2 an estimate for population variance which is obtained from a pilot survey conducted prior to the actual study to determine the sample size (or n), which was found to be 146kg. $d= 2\text{kg}$ is the maximum allowable difference between the estimate and the true value (margin of error) with 95% confidence level.

3.4. Method of Data Analysis

In the study of factors affecting the catch levels of fish, the dependent (response) variable was the amount of fish caught in kilogram per year. For such continuous dependent variables, the appropriate model to evaluate the factors affecting fish catch level is multiple linear regression model.

Ordinary Least Square (OLS) method was used to analyze factors affecting fish catch level. To estimate the population regression function (PRF) on the basis of the sample regression function (SRF) the method of OLS is used extensively in regression analysis, because it is intuitively appealing and mathematically much simpler than other methods.

The model expresses the value of a response variable as a linear function of one or more predictor variables and an error term:

$$Y_i = \beta_0 + \beta_1 x_{i,1} + \beta_2 x_{i,2} + \dots + \beta_k x_{i,k} + \varepsilon_i, i= 1,2, \dots, n \dots \dots \dots (1)$$

where,

$x_{i,k}$ = Value of the k^{th} explanatory variable of i^{th} observation

β_0 = Regression constant (intercept)

β_k = Coefficient of the k^{th} predictor

k = Total number of predictors

y_i = The value the dependent variable of the i^{th} observation

3.5. Variables Definition and Hypothesis

Variables considered in the study were selected based on some previous studies and those expected to be factors affecting fish catch level.

I. Dependent Variable

The dependent variable of this study is the amount of annual fish catch level in kilogram by a fisherman.

II. Independent variables

The independent variables in this study were classified as socio-economic, demographic and institutional factors. The variables included in this model were:

Age of the Fisherman: This is the age of the fisherman engaged in fishing activity and is measured in years. According to Asefa (2014), as a fisherman gets older and older, his physical strength is expected to decrease. Hence, since fishing activity requires strength, it was hypothesized to negatively affect amount of fish caught.

Education of the Fisherman: It is a categorical independent variable measured in grade, categorized as illiterate, only read and write, primary and secondary. According to MOA (2015), an educated fisherman is more likely to have the ability to perceive and interpret, and thus, adopt relatively better technology much faster than uneducated one. In this study, education was hypothesized to positively affect the volume of fish caught.

Family size of the fisherman: It is continues variable, which refers to the total number of family member living with the household. Fishing activity requires additional labor force in the family. Therefore, the number of family members was expected to influence level of fish caught positively (Asefa, 2014).

Distance of the lake from the home: This is a continuous independent variable representing the nearness or farness of the residence of the fisherman from the lake in kilo meters. There seem to be limited opportunity of fishing practice if the distance between the lake and the home is far off (Lemma, 2012). Hence, the distance from the lake to home was hypothesized to negatively affect amount of fish caught.

Distance of local market from home: This is a continuous independent variable that includes the closeness or farness of the fisherman's home to the local market in kilo meters. According Global fish alliance (2010), there seems to be limited opportunity for marketing of most of the fish products because they are highly perishable in nature and hence have limitations to transport over long distances. Hence, the prolonged distance from home to market place was hypothesized to negatively affect the volume of fish caught.

Farm land holding size: Farm land size is the total area of the farm in hectare owned by the sample fisherman and it is a continuous independent variable. Farmers owning relatively more land tend to spend more labor and time on farm activities to produce more crops than those with small land holders (BoFED, 2015). In this study, farmland size was hypothesized to negatively influence the amount of fish caught.

Livestock holding: This represents the size of the livestock holding measured in tropical livestock unit (TLU) owned by the fisherman. According to Gordon *et al.* (2007) those fishermen who have large number of livestock may likely spend their time and labor on livestock rearing than on fishery practice. There for, in this study livestock ownership was hypothesized to affect the amount of fish caught negatively.

Non - farm activity involvement: This is representing fisherman engagement in non-farm activities, like handicraft, petty-trade and labor sale activities. It is a dummy variable representing by 1 if involved and zero otherwise. Fishermen engaged in such activities, in addition to agriculture is likely to be negatively related to the amount of fish caught because they spend more labor and time on such activities rather than fishing (MoFED, 2014).

On farm Income: This is the income of the fisherman from farming activity and is continues variable measured in birr. A fisherman with lower farm income, cannot afford the cost of using advanced motor boats and modern nets, used in fishing (lemma, 2012). On farm income was hypothesized to affect fish catch levels positively.

Types of boats: It refers to the type of boat used by the fisherman (whether it is traditional or advanced). It is a dummy variable taken “1” if the fisherman uses motorized boats and “0” if the fisherman uses traditional boat. According to Aragaw, (2010) using motorized boats has positive relationship with fish caught levels.

Access to Extension and Training on fish Production: The capacity development of human beings is essential for effective implementation and can be defined as: the process by which individuals, groups, organizations, institutions and societies develop their abilities - both individually and collectively to set and achieve objectives, perform functions, solve problems and to develop the means and conditions required to enable this process (FAO, 2014). It is a dummy independent variable that refers whether or not the sample fisherman has got access to extension and training on fishing. If the sample fisherman has got the access it was represented by “1” and “0” otherwise. Extension and training were hypothesized to increase the volume of fish caught positively.

Religion: Among the various social factors, religion plays most important role as it can influence on fish eating habit. The Orthodox Christian community residing around the lake does not consume fish during the fasting months and dates (Ayalew, 2010). Therefore, Orthodox Christian religion was hypothesized to affect fish catch level negatively. Thus, if the respondent was Christian “0” and “1” otherwise.

Credit Access: It is a dummy variable, and if the fisherman uses credit for fishing the value was “1” and “0” otherwise. Credit availability has been believed to have significant and positive consequences on various outcomes, including technology use (Diagne *et al.*, 2000). Fisherman who have access to credit are likely to invest more on technologies (Peder and Kerr, 1998). Hence, the availability of credit to the farmers around the lake was hypothesized to have positive relationship with the amount of fish catch level.

Market accessibility: According to Global Fish Alliance (2010), market accessibility is referred to as availability of demand and fair price for fish products on every production day either at the local market or at the landing sites. And it is very crucial for fish producers because they cannot store it as other farm products. It is a dummy variable that it takes the

value of “1” if there is market access to fish products, “0” otherwise. Therefore, it was hypothesized to have positive association with fish catch level.

Transport accessibility: According to global fish alliance (2010), access to transport refers to accessibility of transport facilities such as truck, boat and cool storage system. It is a dummy variable with value of “1” if transport facilities are available for fish products, “0” otherwise. It was hypothesized to have positive relationship with fish catchment level.

Types of nets used: It refers to the type of net used by the fisherman (whether it is traditional or advanced). It is a dummy variable taken “1” if the fisherman uses advanced net and “0” if the fisherman uses traditional nets. According to Aragaw, (2010) using advanced mesh size nets has positive relationship with fish caught levels.

4. RESULTS AND DISCUSSION

In this chapter results and discussions of descriptive and econometric analysis in relation to factors affecting fish catch level in Lake Tana are presented.

4.1. Descriptive Statistical Analysis

The descriptive statistics was conducted to see the distribution of the independent variables. The socio-economic and institutional characteristics of the fisherman were analyzed.

Table 4: Continues and categorical variable

Variable	Frequency	Percent
Educational level		
Illiterate	68	50.75
read and write	34	25.37
Primary	25	18.66
Secondary	7	5.22
Total	134	100
Religion with Eating Habit		
Orthodox (Always except fasting)	126	94.03
Muslim (Always)	8	5.97
Total	134	100
Land holding size (ha)		
<=0.5	27	20.15
0.51-1	34	25.37
1.01-2	56	41.79
>2	8	5.97
None	9	6.72
Total	134	100
Distance to lake (Km)		
<2.5	61	45.52
2.51-5	42	31.34
5.01 -7.5	31	23.13
Total	134	100

Educational status of sample fishermen (EDUCATION): The total sample respondents in terms of literacy level have shown that 50.75 percent were illiterate and 25.37 percent could read and write, 18.66 percent had attended formal primary education from grade 1– 8, and the remaining 5.22 percent had attended secondary school from grade 9 – 12 (Table 4). The study revealed most fishermen are illiterate.

Religion and fish eating habit of fishermen (RELIGION): Among the various social characteristics of a population, religion plays an important role in influencing various types of behavior. Orthodox Christians were the dominant community around the lake. The study revealed that among the total respondents, 94.03 percent were Orthodox Christians and only 5.97 percent were Muslims. Comparing the fish eating habit of the two religion follower fisherman, the Muslim community consumes always while Christians do not eat during fasting period. (Table 4)

Fishermen's land holding size (LANDSIZE): It is a continuous variable, the landholding size of sample respondents varied from landless to greater than two hectare. The survey result showed that from the total respondents, 20.15 percent owned half a hectare, 25.37 percent owned between 0.51 to 1.0 hectares, 41.79 percent owned between 1.01 to 2.0 hectares, only 5.97 percent respondents owned above 2.0 hectares of land and the remaining 6.72 percent of respondents were the landless. The study result revealed that most of the sample fishermen having land, which can be other source of income for the fisherman. (Table 4)

Distance of the lake from fisherman's home (DISTLAKE): It is a continuous variable. The distance of the lake from the fisherman's home varied from below a kilometer to greater than 5km, and tried to summarize and categories only for discussion. The survey result indicated that 45.52 percent of sample fisherman's home is less than 2.5Km away from the lake, 23.13

percent of the fisherman lives 5 Km and above far from the lake. This means most fishermen are residing relatively near the lake.

Table 5: Dummy variables

Variable	Frequency			Percentage		
	Yes	No	Total	Yes	No	Total
Training access	43	91	134	32.09	67.91	100
Extension service	52	82	134	38.81	61.19	100
Credit Access	78	56	134	58.21	41.79	100
Market access	63	71	134	47.01	52.99	100
Transport access	30	104	134	22.39	77.61	100
Net (Modern)	79	55	134	58.96	41.04	100

Access to training and extension service (TRAINACC) (EXTENSION): To create awareness and run the skill on fishery resource utilization and management, to encourage others to engage in fishing activity, training plays an important role. Among the total number of respondents only 32.09 percent of the respondent had obtained training in fishery resource management and utilization. This indicates that most fishermen do not have access to training on fishery resource management and utilization. (Table 5)

The study result has also revealed that from the total respondents 38.81 percent were receiving extension services on fishery. And the rest 61.19 percent of the total respondents do not get extension service on fishery. This means most fishermen have no access to extension service on fishing techniques and technology or fishery resource utilization and management. (Table 5)

Access to credit (CREDITACC): Credit is very much required to purchase and fulfill fishing equipment such as motor boat and modern fishing net. The survey result indicated that 58.21 percent of the total sample respondents had access to credit in the previous years. This implies relatively that most fishermen had access to credit.

Market accessibility: Market accessibility such as demand and fair price payment for fish products is of paramount, which help in enhancing fish producers. For fisherman's access to market to its catch is prerequisite as fishes cannot be stored like other farm products. Of the total respondents 47.01 percent had access to market like direct sell to consumers, village fish shops and hotels. However, most fishermen which is 52.99 percents did sell their fish catch at the landing site (seashore) for fish collectors with low price. (Table 5)

Transport access (ACCESTRANS): Transport facilities such as cool storage and vehicles are crucial service for fishermen as it helps them to transport their catches to markets. For fishermen it is more decisive in that fish is perishable product and hence it needs to be transported to the market place as soon as possible. Among the total respondents, 22.39 percent responded to have access to transport. And the rest 77.61 percent of fishermen had not access to transport. This implies that most fishermen have no access to transport facilities. (Table 5)

Types of net used for fishing (NETTYPE): Net type has played a role in fishing activities. Having a small mesh size net for fishing cannot prevent infant fishes from being trapped. Infant fish catches cannot be marketed and it can be the reason for being the specious endanger. The survey result indicated that 41.04 percent of the total sample fishermen use traditional net type for fishing, and 58.96 percent uses modern net type. These shows numbers of fishermen still using the traditional narrow mesh size nets are relatively large. (Table 5)

4.2. Factors Affecting Fish catch Level

4.2.1. Adequacy of the Model

The overall model was statistically significant at 1% level of significance since the P value for ANOVA is zero. This implies that the multiple linear regression model has a good fit to the data. In addition, R-square for the model was 0.74; this indicates that about 74 percent of the total variation in total amount of fish catch was explained by the explanatory variables included in the model.

4.2.2 Regression Diagnostics

Multicollinearity Test

To formally diagnose the presence of Multicollinearity problem, Variance Inflation Factors (VIF) was applied. These estimate how much of the variance in the estimated regression coefficients is caused by multicollinearity. For each coefficient variance inflation factor was calculated and if $VIF \geq 10$, then it shows multicollinearity problem in the model (J. DeCoster, 2003).

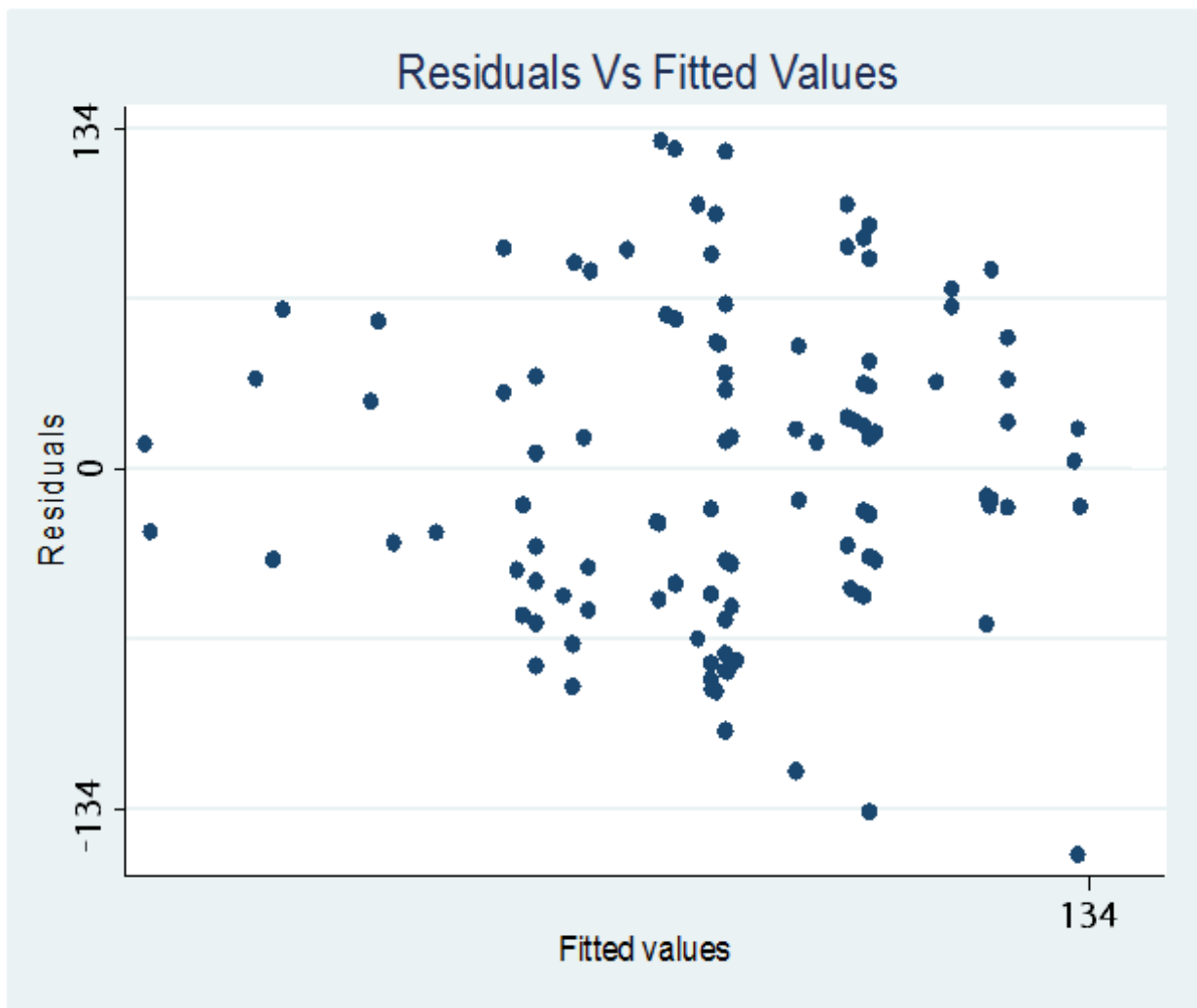
As shown in appendix Table 2, VIFs for all of the explanatory variables were less than 10 which imply that there is no multicollinearity between any of the explanatory variables.

Homoscedasticity Test

In Multiple Regression model the variance in the residuals has to be homoscedastic or constant. To check for homoscedasticity of error terms, the residual plot of residuals against predicted value is employed. Residuals form a random sample from a Normal distribution and so this plot should show a shapeless cloud of points: any discernible pattern is bad news for the model. When plotting standardized residuals versus predicted values the plot should not show any pattern at all (Stock and Watson, 2003). As displayed in the figure below the

residuals showed random pattern. This shapeless cloud of residuals suggests that the error terms have constant variance.

Figures 5:- plot of residuals against predicted value



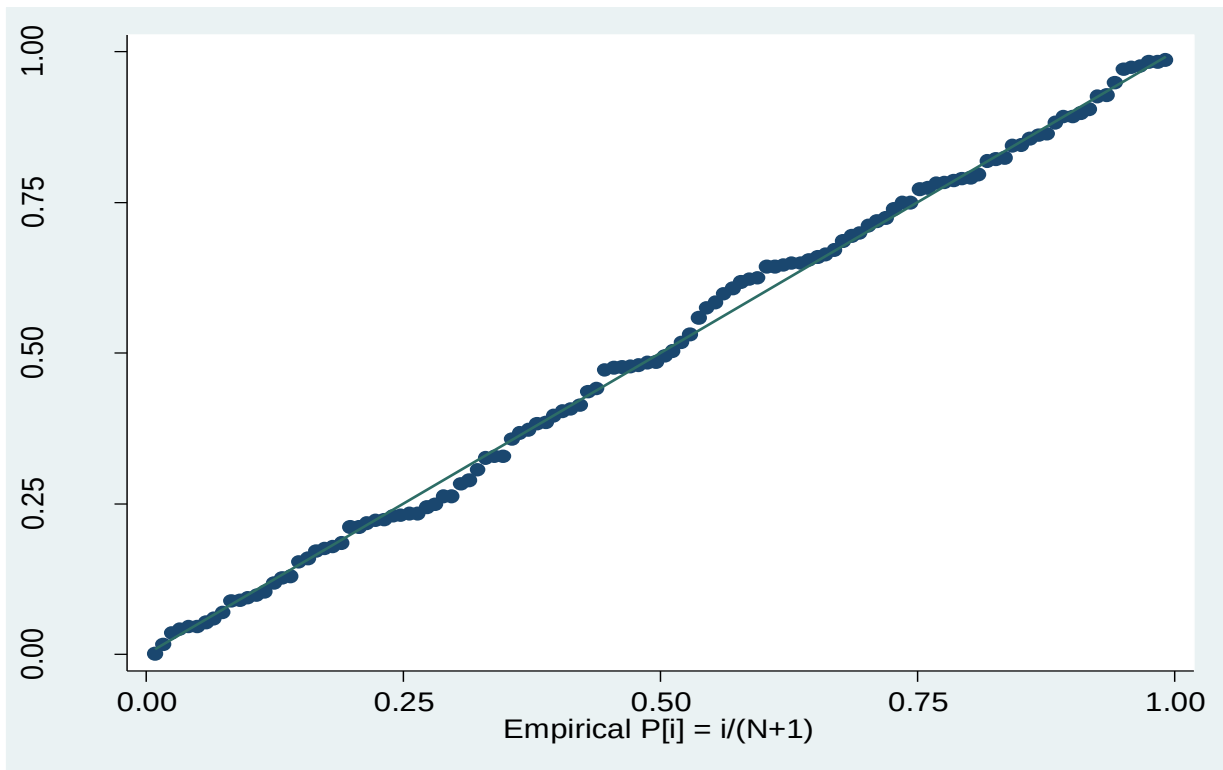
Normality Test

Normality of the error term is one of assumptions of multiple linear regression model. Under this assumption the error terms of the multiple linear regression model should follow normal distribution with mean zero and constant variance. Normality of the error term can be checked by plotting the quantiles of the observed sample against the corresponding quantiles of a

standard normal distribution. A normal probability plot of the standardized residuals will give an indication of whether or not the assumption of normality of the random errors is appropriate. If the normal probability plot shows a straight line, it is reasonable to assume that the observed sample comes from a normal distribution. If, on the other hand, the points deviate from a straight line, there is statistical evidence against the assumption that the random errors are an independent sample from a normal distribution (Stock and Watson, 2003).

The figure shows that the normal probability plot for the residual was approximately straight line, which indicates that the observed sample comes from a normal distribution. The figure shows that the normal probability plot for the residual was approximately straight line, which indicates the error terms of model follow normal distribution with mean zero and constant variance

Figure 6:- normal probability plot for the residual



Therefore multiple linear regression model was used to identify factors affecting the Fish catch level of fishermen in Lake Tana. The multiple linear regression coefficients were estimated using ordinary least squares method. The variables that are found statistically significant are age, non-farm activity involvement, family size, distance from market, livestock holding of the fisherman, types of boat used for fishing and farm income of the fisherman.

Table 6: Factors affecting fish catch level from lake Tana

Fish amount	Coefficient	SE	t	P-Value
AGE	-20.64001***	6.818199	-3.03	0.003
INVNONFARM	-6.929796**	3.387563	-2.05	0.043
FAMILYSIZE	-1.867978**	0.7440543	-2.51	0.014
LANDSIZE	0.159099	1.719017	0.09	0.926
DISLAKE	0.51088	0.7160041	0.71	0.477
DISMARKET	-1.25301***	0.4749121	-2.64	0.01
EXTENTION	4.656392	3.631425	1.28	0.203
LIVSTKHLING	20.50854***	6.421618	3.19	0.002
RELIGION	-0.602689	5.102905	-0.12	0.906
EDUCATION	-0.186055	3.166744	-0.06	0.953
CREDITACC	0.187556	2.531236	0.07	0.941
TRANSACC	1.894946	4.219157	0.45	0.654
BOATTYP	27.18083***	4.086367	6.65	0.008
NETTYP	0.170049	2.485525	0.07	0.946
INCOMFF	-15.22497***	3.23171	-4.71	0.003
MARKETACC	-0.889504	3.097698	-0.29	0.775
TRAINACC	-6.042161	4.038957	-1.5	0.138
Constant	90.97534	10.14639	8.97	

N= 134 **R-squared**=0.7440 **Adj R-squared**=0.6818

***= Significant at 1% **= Significant at 5%

4.2.3. Explanation of the significant variables influencing fish catch level

Multiple linear regression model was used to identify the variables that influence Lake Tana's fish catch level. In the model, 4 continuous variables and 13 categorical variables were entered. Out of the total of 17 explanatory variables, 7 variables are found significantly influence fish catch levels of the Lake. Variables found significant are; age (AGE), family size (FAMILYSIZE), non-farm activity involvement (INVNONFARM), livestock holding of the fisherman (LIVSTKHLDDING), types of boat used for fishing (BOATTYPE), Distance to the market (DISMARKET) and fisherman's income from farm (INCOMFF) were found significant. (Table 6)

The effect of the significant explanatory variables on the fish catch levels of Lake Tana are discussed below.

Age of the fisherman (AGE): This explanatory variable was found to be significant at 1% significant level. The coefficient age is -20.64, which shows an increase in fisherman's age by 1 year reduces annual fish catch amount by 20.64.

The reason may be that young fishermen landholding compared to the older ones is smaller and cannot generate enough income to keep their family. Therefore, they intend to search alternative income sources to compensate their livelihood. It has a negative association with the fish catch amount, and this negative association of this variable with dependent variable confirmed the prior hypothesis.

This result is in line with Akanni (2010) who found that, younger people have the capability to fish more than older fishers. Similarly, Pasience (2009) argued, as fishers getting older, performance deteriorated and hence the level of fish catches.

Fisherman's Involvement in nonfarm activities (INVNONFARM): This is dummy explanatory variable significant at 5% significant level. The coefficient of involvement in nonfarm activities is -6.93, which implies a fisherman who involves in other nonfarm activities

has annual fish catch amount of a 6.93 times lesser than a fisherman who do not involve in nonfarm activities.

Therefore, an individual fisherman who involves in other activities has lesser catch level than that of an individual fisherman who does not involve on other activities and spent all its working time on fishing. Other activities can bring other income for the fisherman, so this individual will spent its working time on both fishing and other activities, which reduce the amount of fish catch level. It has a negative association with the fish catch amount, and this negative association of this variable with dependent variable confirmed the priori hypothesis.

Family Size of the Respondents (FAMILYSIZE): This continues explanatory variable was found to be significant at 5% significant level. The coefficient of the family size of a fisherman is -1.87, which implies an increment in family size of a fisherman by one person will have a decreasing effect by 1.87kg on the total fish catch amount.

Therefore, an individual fisherman who has a larger family size has lesser catch level than that of an individual fisherman who has a smaller family size. A fisher man with large family size will engage in different income generating activities to full fill his/her families need than that of a fisherman with smaller family size, which reduce the time allocation of the fisherman for fishing and help the fisherman to spend more on a better income generating activities. It has a negative association with the fish catch amount, and this negative association of this variable with dependent variable does not confirm the priori hypothesis.

However, according to Mwakubo et al. (2007), family size exerted a positive impact on the level fish catch. Large household size might imply higher subsistence needs and hence, fishing effort has to be increased to meet financial responsibility of their families. And also according to Inoni and Oyaide (2007), since fishing is labour intensive, family members may become part of significant share of the labour demand. This showed that family size is significant in explaining catch level.

Distance from Market (DISMARKET): This continues explanatory variable was found to be significant at 1% significant level. The coefficient of fisherman's distance to the market is -

1.25, which implies a one kilometer increment in distance to the market will decrease the total fish catch amount by 1.25.

Therefore, a long distance to the market will have a negative impact for fisherman who has a perishable product without any transport and storage facility. A fisherman who has a nearest market will catch much more than that of a fisherman with a long distance market. It has a negative association with the fish catch amount, and this negative association of this variable with dependent variable confirmed the prior hypothesis.

Perception of fisherman (PERCEPTION): This dummy variable was found significant at 1% significant level. The coefficient of fisherman's perception of fishing is 11.41, which implies a fisherman, who has a perception of fishing as means of income and livelihood, can catch 11.41 times greater than others who do not have such perception on fishing.

Therefore, having positive perception on fishing as other means of income and livelihood brings a positive effect on the total fish catch amount. This positive association of this variable with dependent variable confirmed the priori hypothesis.

Livestock holding size of the fisherman (LIVSTKHLING): The types of livestock found in the study area were cattle, sheep, goats, equine, chicken and honeybees. To help the standardization of the analysis, the livestock number was converted to tropical livestock unit (TLU). The conversion factor used was based on Freeman et al. (1996) (Appendix Table 1).

This variable was found significant at 1% significant level. The coefficient livestock holding size is 20.51, which implies a fisherman, a 1 TLU increment in livestock holding size can increase annual fish catch level by 20.51 times.

Livestock holding has a positive relationship with the amount of fish catch level. Livestock rearing do not take a fisherman's working time unlike involving in other activities, so a fisherman with more livestock holdings can get more income which helps to buy better

equipment for fishing that leads a more fish catch level. But this positive association of this variable with dependent variable do not confirm with the priori hypothesis.

Types of boat used for fishing (BOATTYPE): This dummy explanatory variable was found to be significant at 1 percent significant level. The coefficient of the types of boat a fisherman uses for fishing is 27.18, which implies a fisherman who uses modern boat can catch a fish 27.18 times greater than that of a fisherman who uses traditional boat.

Modern boats can carry large volume of fish catch per a trip than that of traditional boats. Modern boats are with engine that makes them faster and a fisher man with modern boat can have large number of trips than that of a fisherman with traditional boats. Therefore, having modern boat have a positive effect on the fish catch amount and this positive association with dependent variable do confirm with the priori hypothesis.

Boat type has a positive and significant effect on fish catch, this is due to the fact that the engine type and capacity of the boat greatly facilitates its operation as it is capable of covering long distance, far better carrying capacity and more economical. In contrast, the physical and technological attributes, such as engine type and capacity, fishing distance limit, limited carrying capacity deters its fishing operation. The result pursuant with the findings by Ikiara (1999) who indicates dummy variables employed to capture difference in vessel mode were statistically significant. Fishing boats, therefore, those are technologically restricted to fishery harvest less and thus vessel mode significantly explains the catch size.

Income of the fisherman from Farm (ANNUALINCOM): This continuous explanatory variable was found significant at 1% significant level. The coefficient of annual income of a fisherman from farm is -15.22, which implies an increment fisherman's annual income will reduce the fish catch level by 15.22 kg.

An individual fisherman who has a larger income from farm activities has lesser catch level than that of an individual fisherman who has a smaller income from farm activities. And the fisher man with large farm income will not spent all its working time on fishing. Farm

activities can bring other income for the fisherman, so this individual will spent its working time on both fishing and other activities, which help to reduce the amount of fish catch level. It has a negative association with the fish catch amount, and this negative association of this variable with dependent variable does not confirmed the priori hypothesis.

This might imply that the existence of alternative sources of livelihood is a key factor in supporting fishery resources under-utilization. This is similar to the finding by Mwakubo et al. (2007) that the availability of farm income has a negative and significant effect on fish catch.

5. SUMMARY, CONCLUSIONS AND RECOMMENDATION

This part summarizes briefly the findings of the study and provides conclusion and forwards some recommendations.

5.1. Summary and Conclusions

In developing economy, the fisheries like other industries provide employment opportunities and raise income of the people. It plays an important role in the alleviation of poverty and the achievement of food security. Also it is main source of animal protein.

Fisheries sub sector, in spite of its significant potential to contribution for food self-sufficiency, source of animal protein, generation of employment opportunities and income, is a least exploited natural resource in Ethiopia in general and Lake Tana fishery in particular.

Lake Tana accounts for over 30 percent of the country's fish resource. However, its current exploitation is estimated to be only 14.5 percent. This study attempted to identify the factors that influence the amount of fish catch of Lake Tana and has tried to quantify the relative importance of various factors. To address the objective of the study, relevant and related studies were reviewed, general and secondary information about the study area and the lake were collected from various publications, reports, and personal contacts with concerned offices were also made. But, the major source of data on which the study mainly depended, was collected from 134 sample fishermen fishing in Bahirdar. A structured survey questionnaire was used to interview the selected sample respondents. A random sampling technique was employed for the study.

Multiple linear regression model was used to identify factors influencing fish catch levels of lake Tana. Among 17 explanatory variables included in the model, age (AGE), non-farm activity involvement (INVNONFARM), family size (FAMILYSIZE), Distance from market (DISMARKET), livestock holding of the fisherman (TLU), types of boat used for fishing

(BOATTYPE) and annual income of the fisherman (ANNUALINCOM) were found statistically significant.

Age has a negative association with the fish catch amount. A younger fisherman annual fish catch amount much greater than an older fisherman. On the other hand, A fisherman having big family size will have a lower fish catch level than a fisherman who has small family size because of time allocation decisions of the fisherman between a more income generating activities and fishing. An individual fisherman who involves in other activities has lesser catch level than that of an individual fisherman who does not involve on other activities and spent all its time on fishing. A market with long distance will prevent the fisherman to catch more than the other fisherman near to the market. livestock holding size shows a positive effect on the amount of fish catch level. A fisher man having livestock holdings will not spent time with livestock because rearing livestock needs feeding process which takes a few time or can be handle by childe or relatives, rather it do not need the fisherman to stay much time with livestock. A fisher man having modern boat can have much more fish catch amount however increasing annual income from farm will have a negative impact on fisherman's fish catch level.

5.2. Recommendations

Training fishermen would result in more accurate implementation of rational decision on fishing. Fishermen engaged in farm and nonfarm activities and earn income from those activities should be aware of fishing is an activity which yields a better income for the fisherman and its family, if the sector develops.

The finding of this study suggests the provision of due attention to fisherman characteristics such as age. Age is one of the demographic characteristics of fisherman where young age has an important role to increase the fish catch level. The study revealed that the age was found to be significantly related to the amount of fish catch level. Thus, there is a need to subsidies and encourage youngsters to involve in fishing practice.

Boat type is founded as a major factor influencing fish catch level, and the study concluded that a fisherman fishing with modern boat have a bigger advantage than that of who use traditional one. To improve this sector and increase the catch level every concerning party should find a way to the fisherman's access to modern boat through subsidies or credit facility. The empirical result of this study figured out that access to credit was not significantly related to the fish catch level. However, credit can be a means to have modern boats for fishermen.

One of the main causes that make a bottleneck to invest in fishery was the lack of nearby market access for fish. Due to the market distance and lack of preservation facilities, fishermen feel extremely dissatisfied and always frustrated in marketing their catch. Middlemen were exploiting them and fishermen did not receive fair price for their harvest. Even some times if middlemen are absent, they are obligated to dump their products since they do not own cold storage facilities for preservation. Fish is aquatic inhabitant and it should be preserved properly as soon as it is caught. Adequate storage facilities play a vital role in marketing fish products. But in the study area, it was hardly possible to find preservation facilities such as ice box which puts the fishermen in hardship. A lot of wastage takes place that is primarily due to absence of preservation facilities. Therefore, in order to enhance the participation in fishing thereby to enhance contribution of fishery to economic welfare, development and expansion of facilities such as creating nearby markets, develop transportation system, prepare access for cool preservation, and maintain sustainable market for fish product is fundamental issue.

6. REFERENCES

- Amhara Regional Agricultural research institute jornal,2014. Socio - economic study of Lake Fisheries in Lake Tana, Aschalew D. December 2004 pp 34-42
- Akanni, K. and J. Akinwumi 2007. 'Determinants of Variations in Fish Catch Levels in Artisanal Fishing of Lagos State, Nigeria', *Research Journal of Fisheries and Hydrobiology*. October 2007, pp110
- Akanni, K. 2010. 'Fishing Technologies and Catch Levels among Small-Scale Fishers in Lagos State, Nigeria', *North American Journal of Fisheries Management*. June, pp 89
- Akanni, K. 2008. 'Catch Levels and Capital Investment of Artisanal Fishermen in Lagos State, Nigeria', *Turkish Journal of Fisheries and Aquatic Sciences*. February, pp 63
- Alebachew Tilahun, Adamo Alambo and Abebaw Getachew, 2016) Fish Production Constraints in Ethiopia, 2Agarfa Federal Agricultural Teaching Vocational and Educational Training College, Ethiopia
- Al-Subaihi, A. A. 2003. Sample size determination: Influencing factors and calculation strategies for survey research. *Saudi Medical Journal*, 24(4), 323-330. Retrieved May 20, 2015, from <http://www.smj.org.sa/index.php/smj/article/viewFile/4379/2153>
- Aragaw C, 2010: Pond fish farming in practice: Challenges and opportunities in Amhara Region. In: “Management of shallow water bodies for improved productivity and peoples’ livelihoods in Ethiopia”, the Proceedings of the Ethiopian Fisheries and Aquatic Sciences Association (EFASA), Addis Ababa University Press, Addis Ababa, Ethiopia. pp. 61-68.
- Asefa Mitike Janko, 2014. Fish Production, Consumption and Management in Ethiopia, Zeway Fisheries Resources Research Center, January, pp 52-70
- Ayalew Wondie, 2006. Current status and future challenges of fisheries in Lake Tana. Proceeding of the National Consultation and Promotional Workshop on Lake Tana and

- its Environs: Conservation, Utilization, Development and Threats. November 6-7 2006, Bahirdar. pp130-143.
- Ayetegeb Anteneh. (2013), Management and livelihood opportunity of lake Tana, Ethiopia. MSc thesis, Norwegian college of fishery science, December 23, 2013, pp 46
- Bene, 2003. Inland fisheries, poverty and rurallivelihoods in the Lake Chad Basin. *Journal of Asian and African Studies*, 38(1): pp17–51.
- Binyam Afework 2011, Determinant of fishery in artisanal fishing in Eritria, MSc thesis, international institution of social studies, Hague, Netherland, November 2011 pp 53.
- BoARD, 2015. Amhara National Regional Bureau of Agriculture and Rural Development, Fisheries Department, summary report on fish production of Lake Tana, December, pp 69
- BoFED, 2010. Bureau of Finance and Economic Development, Rural Households Socio-Economic Baseline Survey of 50 Woredas in Amhara Region. Volume II, VII, IX, Bahirdar, October, pp 15
- BoFED, 2010. Bureau of Finance and Economic Development, Development Indicators of theAmhara National Regional State. Bahir Dar. July 94p.
- BoFED, 2015, Bureau of Finance and Economic Development, Annual Report, june, pp34.
- Cochran, 1997, Sample size determination: calculation strategies for survey research. *Journal*, 24(4), 323-330. Retrieved April 20, 1997
- Drewes, S., 1993. Socio - economic study of Lake Fisheries in the Rift Valley and Lake Tana,Addis Ababa, Ethiopia, September 1993, pp 9-11.
- De Graaf, M., 2003. Lake Tana’s piscivorous *Barbus* (Cyprinidae, Ethiopia): Ecology,Evolution, Exploitation. Ph.D. Dissertation, Wageningen University, Netherlands. 239p.
- Eshete Dejen, 2003. Ecology and potential for fishery of the small barbs of Lake Tana, Ethiopia, Ph.D. Dissertation, Wageningen University, Netherlands. 180p.
- FAO, 2013, Mainstreaming fisheries into National development and poverty reduction strategy; Current situation and opportunities. February, pp-45

- FAO, 2014. towards sustainable agriculture and rural development in the Ethiopian high Lands. Proceeding of the technical workshop on improving the natural resources base and rural wellbeing. February, pp-63
- FAO, 2015, The state of world fisheries and aquaculture, Fisheries Department, February pp-46
- FAO, 2015, Increasing the contribution of small-scale fisheries to poverty alleviation and food security
- FDRE Fishery Development and Utilization Proclamation No. 315/2003. *Federal Negarit Gazetta* 9th Year 2003No. 32.
- Global Fish Alliance, 2010. The importance of capture fisheries in food security in Ethiopia. Fact sheets on state of fisheries in African countries.
- Golubtsob, A.S. and Mina, M.V., 2003. Fish species diversity in main drainage system of Ethiopia. Current status knowledge and research perspectives. *Ethiopian Journal of Natural Resources*. 2003. 5(2): 281-318.
- Gordon, A., Sewmehon, D.T., Melaku, T. (2007).Marketing systems for fish from Lake Tana, Ethiopia: Opportunities for improved marketing and livelihoods.IPMS (Improving Productivity and Market Success) of Ethiopian Farmers Project Working Paper 2. ILRI (International Livestock Research Institute), Nairobi, Kenya.49 pp.
- Gujarati, D. N. 2004. Basic Econometrics. 4th Edition Mc Graw-Hill, Inc. New York.
- Ikiara, M.M. 1999. Sustainability, Livelihoods, Production and Effort Supply in a Declining Fishery. The Case of Kenya's Lake Victoria Fisheries'. Kenya.
- Inoni O.E. and W.J. Oyaide, 2007. 'Socio-Economic Analysis of Artisanal Fishing in the South Agro-Ecological Zone of Delta State, Nigeria', *Agricultura Tropica et Subtropica*. pp 102.
- Jamie De Coster 2003. Notes on Applied Linear Regression. Department of Social Psychology, Free University Amsterdam, Netherland.

- Jonathan Taylor 2009. Introduction to Applied Statistics. Department of Statistics, Stanford University.
- Kurien, J. 2010. Responsible fish trade and food security. FAO Fisheries Technical Paper. No.456. Rome, FAO. 102 p.
- Lemma, B., 2012. Report on the value Chain Assessment of the Fishery Sector in Ethiopia. Food and Agriculture Organization Sub- Regional Office for Eastern Africa. Addis Ababa, 2012.131p.
- Maddala, G. S. 1997. Limited Dependent and Qualitative Variables in Econometrics. Economic Society Monography, No. 3, Cambridge University Press, Cambridge, USA. 456p.
- Misikire Tessema, 2001. *Oreochromis niloticus*, Ph.D. dissertation, Institute of Animal Husbandry and Genetics.Georg-August University of Gottingen. pp3 -7.
- MOA, 2013. Ministry of Agriculture and Rural Development Annual Performance Report, Addis Ababa, Ethiopia. 22p
- MOA, 2014. Ministry of Agriculture and Rural Development Annual Performance Report, Addis Ababa, Ethiopia. 38p
- MOA, 2015. Ministry of Agriculture and Rural Development Annual Performance Report, Addis Ababa, Ethiopia. 17p
- MoARD, 2014. Ethiopian Minister of Agriculture and Rural Development, Department of Livestock and Fisheries Development, summary report on fish production and utilization, 28p.
- MoFED 2014. Ministry of Finance and Economic Development, Poverty and Food Security situation report, 2014, Addis Ababa, Ethiopia.
- Moher, P., A., 1962. The geography of Ethiopia, Addis Ababa, Ethiopia: University college of Addis Ababa press. 128p.
- Mwakubo, S.M., M.M. Ikiara and R. Abila, 2007. 'Socio-Economic and Ecological Determinants in Wetland Fisheries in the Yala Swamp', *Wetlands Ecology and Management*. December pp-74

- Nagelkerke, L.A.J., 1997. The barbs of Lake Tana, Ethiopia. Morphological diversity and its implications for taxonomy, tropic resource partitioning and fisheries. Agricultural University Wageningen, Netherlands. 296p.
- Nelson, Joseph S. 2006. Fisheries of the World. John Wiley and Sons Inc. pp 2-3.
- Pasience P.M. 2009 'Overview of Eritrean Fishery Sector', *National Agricultural and Pilot Fishery Programme*, Massawa, Eritrea.
- Tesfaye Wudneh, 1998. Biology and Management of Fish Stocks in Bahir Dar Gulf, LakeTana, Ethiopia. Ph.D. Dissertation, Wageningen, Agricultural University institute of Animal Science. Netherlands, 143p.
- Stock and Watson, 2003
- Venkataramanujam, K., and Sathanam, R., 1981. "Why should we eat Fish?", Vol 8, No 4, pp21-26.
- Vinyagaram, A., 2002. A Study of Inland Fishery With special reference to pond fishery in Kanyakumari district. A Ph.D. Dissertation, Manomaniam sundaranar University, Tirunelveli, India. 206p.
- Washington state department of health journal, October 2016. Frank k, pp- 41
- Wetengere, K. 2010. Socio-Economic Factors Critical for Adoption of Fish Farming Technology The Case of Selected Villages in Eastern Tanzania', *International Journal of Fisheries and Aquaculture*. January, Tanzania, Vol 6, pp87-103.
- William G. Cochran, 1977. Sampling techniques, 3rd edition, John Wiley and Sons publishing, New York. USA
- World Bank, 2014, annual report on world fishery development.
- World Bank, 2015, annual report on world fishery development.
- Worldo Meter, countries statistical report, August 2017. <http://www.worldometer.com>
- Wooldridge, J.M. 2009. *Introductory Econometrics, A Modern Approach*. South-Western Pub.

7. APPENDIX

7.1. Appendix I. Tables

Appendix Table 1: Conversion factors used to estimate TLU

TYPES OF ANIMALS	TLU
Cow	1
Ox	1
Bull	1
Heifers	0.75
Calve	0.4
Sheep/Goat	0.1
Donkey	0.5
Horse/ Mule	0.8
Camel	1

Source: Freeman *et al.* (1996)

Appendix Table 2: VIFs for all of the explanatory variables

Variables	VIF
AGE	2.13
INVNONFARM	1.55
FAMILYSIZE	1.92
LANDSIZE	1.26
DISLAKE	1.61

DISMARKET	1.19
EXTENTION	2.56
PERCEPTION	1.53
LIVSTKHLDDING	1.67
RELIGION	1.2
EDUCATION	1.55
CREDITACC	1.27
TRANSACC	2.08
BOATTYP	2.01
NETTYP	1.22
INCOMFF	2.08
MARKETACC	1.95
TRAINACC	2.91

7.2. Appendix II. Figures

Appendix Figure 1: Major Commercial fish types in Lake Tana

Fig.1.1: *Labeobarbus spp.*(Barbus) (*Nech Asa*)



Fig.1.2. *Oreochromis niloticus* spp. (Nile tilapia) (Qereso)



Fig.1.3. *Clarias gariepinus* spp. (African cat fish) (Ambaza)



Appendix Figure 2: Fishing techniques in Lake Tana

Fig. 2.1. Reed boat locally made up of papyrus (*tankua*)



Fig.2.2. Fishing with hook



Fig.2.3: Steel boat



7.3. Appendix III: Survey Questionnaire

The Name of the respondent: _____

Zone: _____ kebele; _____

Date of interview: _____

1. Characteristics of respondent

1.1. Sex: ♂Male ☐ ♀Female ☐

1.2. Age: _____

1.3. Educational level

♂Illiterate ☐ ♂Read and write ☐

♂Primary School, (1 - 8) ☐ ♂High school (9 - 12) ☐ ♂College graduate ☐

1.4. Number of family members: _____

2. Religion of the respondent

2.1. What is your religion?

♂Orthodox Christian ☐ ♂Catholic ☐ ♂Protestant ☐ ♂Muslim ☐ ♂Other ☐

2.2. According to your religion do you eat fish? ♂Yes ☐ ♂No ☐

2.3. If the answer is yes, what is your fish eating habit?

♂Always ☐

♂Always except fasting time ☐

3. Awareness and perception of fishery

3.1. How far is your home from the Lake? _____ km

3.2. Do you ever think that fishing is alternative means of income and livelihood?

♂Yes ☐ ♂No ☐

3.3. Type of Boat and Net used for fishing purpose

3.3.1. Type of Boat: ♂Modern (motorized) ☐ ♂Traditional (“*tankua*”) ☐

3.3.2. Type of Net: ♂Modern ☐ ♂Traditional ☐

3.4. Is your catch spoil before you sale or consume?

♂Yes ☐ ♂No ☐

3.4.1. If your answer is yes, what is average percent that is spoiled per trip? ____%.

3.4.2. What are the reasons for the spoilage?

✕ The market is far ☐

✕ No means of transport (no road) ☐

✕ No ice-box (refrigerator) ☐

4. Other Means of Income and Livelihood

4.1. Do you have your own farm land? ✕Yes ☐ ✕No ☐

4.1.1. If the answer is yes, how large is your farmland size?

4.2. Livestock holding of the respondent

Type of livestock Quantity (No)

➤ Cow: _____

➤ Oxen: _____

➤ Bull: _____

➤ Heifer: _____

➤ Calve: _____

➤ Sheep: _____

➤ Goats: _____

➤ Horses: _____

➤ Mules: _____

➤ Donkeys: _____

4.3. Do you have another means of income other than Farming & Livestock Keeping?

✕Yes ☐ ✕No ☐

4.4. How much is your annual income from farm? _____

5. Institutional support

5.1. Do you get extension service on Fishery resource management and utilization?

✕Yes ☐ ✕No ☐

5.2. Have you received training on fishing methodology, fish preservation and marketing, preparation of fishing materials and employing technology?

☒ Yes ☐ ☒ No ☐

5.2.1. If your answer for question 5.2 is No, do you need training? ☒ Yes ☐ ☒ No ☐

5.3. Have you get credit for fishing activities over last year? ☒ Yes ☐ ☒ No ☐

5.3.1. If your answer is yes, was the credit you received enough to fulfill your objective?

☒ Yes ☐ ☒ No ☐

5.3.2. If your answer for question number 5.3.1 is No, do you want credit for fishing activity?

☒ Yes ☐ ☒ No ☐

5.3.3. If your answer for question number 5.3.2 is yes, for what fishing activities?

☒ To purchase fishing materials ☐

☒ To purchase preserving material ☐

☒ To hire labor ☐

☒ Other's specify _____

6. Market

6.1. Is market accessible for your fish product? ☒ Yes ☐ ☒ No ☐

6.2. What is the distance of the market from your home? _____ km

6.3. Who does buy your fish?

☒ fish collectors at site ☐ ☒ Wholesalers ☐ ☒ Retailers ☐ ☒ Consumers ☐ ☒ Hotels ☐

6.4. The Current price of fish per kilo gram paid by

☒ Retailers (Birr) _____

☒ Wholesalers (Birr) _____

☒ Fish cooperative (Birr) _____

☒ Consumers (Birr) _____

☒ Others' (specify) _____

7. how many kilograms of fish will you catch per day?

8. Describe problems generally facing you in your fishing activity?

8.1. _____

8.2. _____

8.3. _____

8.4. _____

8.5. _____