



A Study on the Factors Associated with Fish Production in Lake Tana, Ethiopia

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Authors' contributions

This work was carried out in collaboration among all authors. Author AB did the proposal development, data collection, data analysis and writing the draft manuscript. Author TA did the data analysis and manuscript editing and author AM did the proposal review, data analysis, editing and manuscript edition and serving as a corresponding author. All authors read and approved the final manuscript.

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ABSTRACT

The research was conducted cross-sectionally in North-Western part of Lake Tana, from October 2019-May 2020 where three commercially fish species are found with the objective of identifying the determinants of fish production in Lake Tana. The study used random sampling technique in three fishery groups and a questionnaire employed to collect the required information. A total of 95 fishers were interviewed, of which 80% of them were males and aged between 18-25 years. Most fisher individuals were elementary school. High environmental temperature, market problem, illegal fishing, and transportation problem were the most determinant factors, and pollution, seasonal variation, illegal fishing, and access to markets were the challenges for fish catches in the Lake. The government and the community worked together to control the water hyacinth. This study noticed the existing problems and challenges in the fishery sector in Lake Tana. The government and private workers should give emphasis to the sector in order to benefit from it by solving the problems as well as the challenges.

Keywords: Lake Tana; determinants; fishery; production; farm.

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1. INTRODUCTION

Fisheries are renewable natural resources that support the livelihood of many communities and the advantages obtained from fisheries are sizeable where it has an indispensable role in food security, revenue generation, job development and nutrition security at all levels, from local to global [1]. Fishing is an important sector for poverty reduction that should be given an emphasis [2]. For the global food and nutrition security as well as assurances, the Fishery sector plays a very crucial role by providing fish products for foods and diversified nutrients [3] where Fish consumption accounts for about 17% of the animal protein intake of the global populations (Scientists to Global Policymakers, 2021). Although fishery is an important sector, it suffers from challenges such as environmental degradations, management related, Absence of adequate government support, poor policy and regulatory framework, Climatic changes and fish disease, Expansion of water hyacinth, water pollution, Lack of improved technologies and thefts, Lack of basic infrastructure and fishing equipment's, over fishing, urbanization, agricultural expansion and wetland degradation [4].

Like other parts of the world, fishery is practiced in Ethiopia with the challenges and opportunities that could match with other parts of the world. Ethiopia has a number of lakes that support the life of a variety of fish species. Lake Tana, the one in the country, is the largest one and located in the Amhara National Regional State (ANRS) in the North-Western Ethiopian highlands [5]. Fishery is the most important livelihood option for the inhabitants. The potential yield of all species of Lake Tana was estimated between 5000 to 8680 tons per year [6]. The problems in Ethiopian fishes and fishery were, the impact of water hyacinth, expansion of agriculture and industrialization, climate change and post-harvest losses, using improper fishing gears and poison plants, immature fishing and overfishing, wetland degradation and fish diseases [7]. Besides, urbanization and waste discharge, water quality improper fishing activities, chemical products, policy structure and pollution factors that result negative impact on the utilization of fish farming process directly or indirectly by damaging the commercial products and structural composition of fishing process are the challenges [8]. The aim of this research was to identify the key determinants that could affect the utilization of fishery resource in Lake Tana and

assess the challenges as well as opportunities to small scale fisherman in the study area.

2. STUDY METHODOLOGY

2.1 Study Area

The study was conducted in Lake Tana, the largest one having a surface area of 3200 sq/km and the source of Blue Nile River, with the main objective of determining the factors of fish production, Ethiopia. It is situated in the North-western highlands at an altitude of approximately 1800 m. It is a shallow (max depth 14 m, min 8m) lake. The study was carried out in three fishing landing sites along North Western part of Lake Tana (Bahir dar, Gorgora and Delgi). More than 60 small seasonal tributaries and seven perennial rivers (Gumara, Ribb, Megech, Gelgel Abbay, Gelda, Arno-Garno, and Dirma) feed the lake. The climate is semi arid with total precipitation and means temperature of 650mm and 26°C, respectively.

2.2 Study Design

The study followed a cross-sectional study conducted from October 2019 to May 2020 that involved both qualitative and quantitative approaches. The qualitative method was applied for an informal interview, focus group discussion and observation and content analysis. The quantitative method applied for the questionnaires of fishermen.

2.3 Data Collection

The fish production was selected on the basis of the size of the operation, a number of farms and backward linkages and the volume of daily activities. Random sampling techniques were employed to select fishers. There were 8 fishery groups in Lake Tana and constituting a total of 250 members. For the purpose of the study, 3 fishery groups were selected randomly from 3 sites. A total of 95 fishers were interviewed in the three sites and each site was sampled once in a month. Thirty questionnaires were distributed to Gorgora, 23 to Delgi and the rest 42 to around Bahir Dar and Bahir Dar fish hatchery center project and Amhara regional agricultural research institute. The respondents were characterized on the basis of gender, age, educational back ground marital status and religion. Fish samples were collected using both primary and secondary data. The primary data

was collected by employing a questionnaire survey, key informant interviews, focus group discussions, and observation. Secondary data including different newspapers, documents from Bahir Dar research laboratory of Fisheries books, internet materials, published and unpublished works were used to obtain appropriate information for the study of fish production in Lake Tana.

2.4 Method of Data Management and Analysis

All the information were coded and entered into statistical package for social science (SPSS) version 16.0 for analysis. The data described using frequencies, percentages and means. Tables and figures used to present the results.

3. RESULTS

3.1 Demographic Characteristics of Questionnaire Survey Respondents in Lake Tana

As shown in the Table 1 below 80% of respondents were males and 20% of them were females. The age of respondents ranging from 18 to 24 had the greater value accounting about 43.2% followed by age ranged from 25 to 34 (38.9%). The remaining 35 to 44, 45 to 54 and >55 contributed to 10.5%, 6.3% and 1.1%, respectively. Of the participants 82.1%, 8.4%, 6.3% and 3.2% were Orthodox, Catholic, Muslim and Protestant religion followers, respectively. Sixty seven point four percent of fishermen were elementary and 17.9% of high school students while 12.6% and 2.1% had university degree and postgraduate ones. Majority (60%) of the respondents was single and 27.7% were married (Table 1).

There were two types of boats in Lake Tana; namely, reed (87%) and wooden boats (73.2%). For a wooden boat, the fisher had a maximum catch of 180kg per day while reed boat users had a maximum catch of 142kg per day. The mean catch for wooden and reed boats were 98 kg and 73.5kg per day, respectively. Furthermore, out of the total sample 40% of the respondent used reed boats whereas the rest 60% used wooden boats (Table 2).

One way ANOVA indicated that reed boat operators had lower catch compared to wooden boat operators ($p < 0.001$) and the difference was

statistically significant. The mean difference was significant at 0.01 and 0.05 levels (Table 3).

3.2 Challenges of Fish Production

The main reasons for the underutilization of the fishery resource in the studied areas were rudimentary and labor intensive fishing gears, inaccessibility to potential market areas, absence of the use of methods that could prolong the shelf life of products for safe, transportation to the distant potential market, absence of efficient fishing gears and lack of training and extension services. Landing sites, storage and transportation facilities with refrigeration, processing capacity and marketing infrastructure are absent. Given the possibilities of developed infrastructure and adequate facilities for processing, handling and transportation, these areas can benefit from these resources by selling fish products to towns where there are a higher fish demand and a better purchasing power. Some fishermen were totally livestock keepers without engaging in crop production.

The lake is freely open to everyone in the surrounding, and close to half of the respondents confirmed that anyone interested is free to join the fishing business. The only criteria to join into the fishing business are to be a member of one of the fishing cooperatives legally recognized in the area. Therefore, membership to a cooperative is used as a license to join into the fishing business. Another challenge for optimal fish production in Lake Tana is the deposition of wastes and chemicals from the environments, farms and motors in the area. Close to 72.6% of the respondents reflected that lake pollution as one of the main reasons for the decline of fish production in the area.

3.3 Challenges of Fish Production Related to the Ecology of Lake Tana

As 72.6% participants responded, the major challenges of fish production related to the ecology of fish in Lake Tana was pollution or waste disposal from farm and motor in the area, which of the individual respondent. Another challenge for optimal fish production in Lake Tana was water hyacinth (*emboch*), which accounted about 27.4% of in the fish production and close to 18% of the respondents reflected that deforestation as one of the reasons for the decline of fish production in the area. According to the respondents, predators and climate change has less challenge on the production of fish (Table 4).

3.4 Challenges of Fish Production Related to Small Scale Fisheries in Lake Tana

The most serious problem mentioned by the fishers in Lake Tana is the operation of illegal fishers, which was mentioned by close to 22.1% of the respondents. Transportation issues (20%), limited government support (18.95%) and lack of modern fishing materials (15.79%), where the challenges for fish production (Fig. 1).

The majority of the fishers (78.9%) were full-time workers; fishing throughout the year and trained whereas 21% of them were not trained and full timer as well. Fifty four point seven percent of fishers had access to finance to buy boats, spare parts and nets. About 57.9% of the fishers had no marketing problem. Fishers sell the fish with fair price, although they are unable to change their boats and net. As observed in the field, most of the fisher’s gears and their boats were very old (Table 5).

3.5 Seasonal Variations

Of the respondents, 44.2% stated that there was high number of fish catch that can reach up to 42 fish per day during the summer season while during autumn there was less catch (10.5%) as compared to other season that could reach up to 10 fish per day. Respondents used to fish during night, morning and afternoon times and the preference varies where 47.4% used to fish during night, 33.7% afternoon and 18.9% morning times (Table 6). Majority (56.9%) of those fishers who used beach lien did their fishing activities during night times, while most of long line 4.9% and gill net (41.1%) users did their fishing activities during morning times. The most common fishing gear was hook and line to fish all Gorgora, Delgi and Bahir Dar. Fish processing techniques practiced by the fishermen were, gutting, filleting and sometimes drying (Table 7).

Table 1. Sociodemographic characteristics of the respondent in Lake Tana, Ethiopia. 2020

Variables		Frequency	Percentage	Cumulative percentage
Sex	Male	76	80	100
	Female	19	20.0	20.0
	Total	95	100.0	
Age	18-24	41	43.2	43.2
	25-34	37	38.9	82.1
	35-44	10	10.5	92.6
	45-55	6	6.3	98.9
	>55	1	1.1	100
	Total	95	100.0	
Religion	Orthodox	78	82.1	96.8
	Muslim	6	6.3	14.7
	Catholic	8	8.4	8.4
	Protestant	3	3.2	100
	Total	95	100.0	
Educational back ground	Elementary	64	67.4	67.4
	High school	17	17.9	85.3
	University degree	12	12.6	100
	Post graduate	2	2.1	87.4
	Total	95	100.0	
Marital status	Single	57	60	93.7
	Married	26	27.4	33
	Divorced	5	5.3	6.3
	Widowed	6	6.3	100
	Total	95	100.0	

Table 2. Fish catch based on boat types in Lake Tana, Ethiopia, 2020

Boat type	Proportion in %	Average catch	Total catch		Ownership	
			Min	Max	Yes	No
Wooden boat	60	98kg	20kg	180kg	87%	13%
Reed boat	40	73.5kg	25kg	142kg	73.2%	27.7%

Table 3. ANOVA analysis result showing the mean catch d/c between wooden and reed boat in Lake Tana Ethiopia 2020

		N	Mean	Min	Max	F	Sign
Catches	Wood	81	41.59	8	145.54	27.5	.001
	Reed	56	13.56	7.33	143.33		

Table 4. Challenge of fish production related to ecology in Lake Tana, Ethiopia 2020

So	Factor	Frequency	percentage	Cumulative percentage
1	Climate change	11	11.6	11.6
2	Deforestation	17	17.9	29.5
3	Pollution	22	22.6	52.1
4	Predator	5	5.3	57.4
5	Water hyacinth	26	27.4	84.8
6	Water quality	14	14.7	99.5
7	Total	95	100	

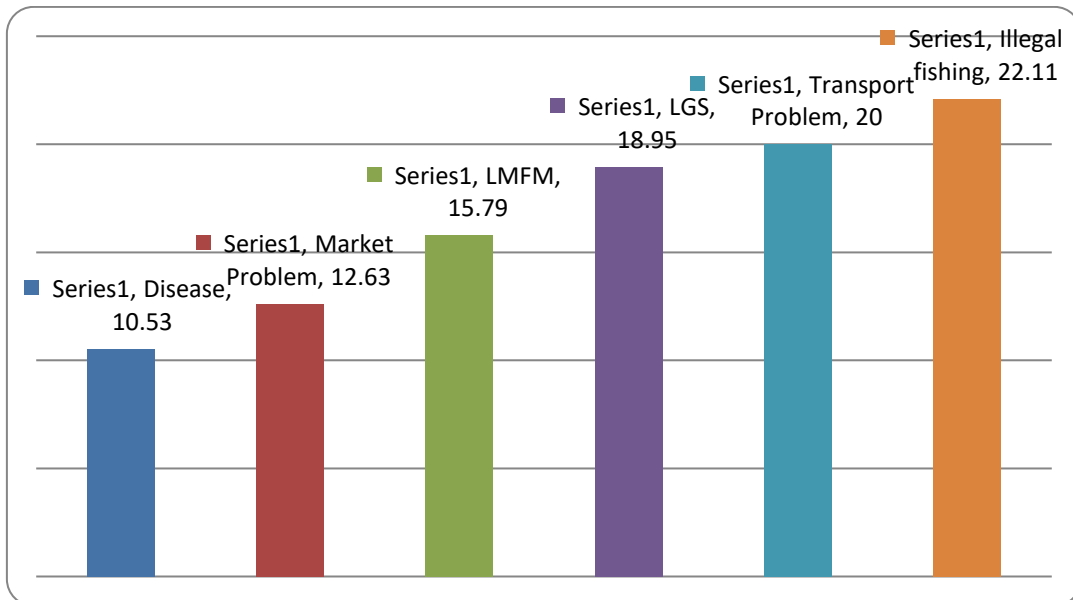


Fig. 1. Constraints of fish production in percent in Lake Tana, 2020
 LMFM=lack of Modern fishing material, LGS= Lacks of government support

Table 5. Fisher men access to finance, market and training in Lake Tana, Ethiopia, 2020

Variables	Frequency with percentages	
	Yes	No
Access to finance	52 (54.7%)	43 (45.3%)
Access to market	55 (57.9%)	40(42.1%)
Access to training	75(78.9%)	20 (21.1%)

Table 6. Seasonal variation of fish catches in Lake Tana, Ethiopia, 2020

So	Seasons	Frequency	Percentage	Time of fishing		
				Morning	Afternoon	Night
1	Autumn	10	10.5	32 (33.7%)	45(47.4%)	18(18.9%)
2	Spring	22	23.2			
3	Summer	42	44.2			
4	Winter	21	22.1			
	Total	95	100			

Table 7. Type of fishing gears used to catch fish in Lake Tana, Ethiopia 2020

Gear	Frequency	Percentage
Gill net	39	41.1
Beach seine	52	56.9
Long line	4	4.9
Total	95	100.0

4. DISCUSSION

Despite having challenges fishing is an area where people around the water bodies support their lives. In this study, although majority of the fishing activities done by males, 20% of the respondents were females. The finding was totally different from the reports done in Lake Chamo where all the fishers were males [6]. This difference might be explained by the changes in the attitude of the community through education that females can participate in an areas where males can work (gender in equality) and also females have an ability to keep the environment clean and safe especially during transport and storage of fish and fish products require more secured and women having fewer opportunity and receive smaller return from fishery even women’s perform post harvest activities.

Based on Oluwemimo & Damilola [9] report, years of schooling enables fishers understand the technical requirements of fish farming. Education may influence fishing practices through a better understanding of government policy implications and facilitated collaboration with concerned institutions; and the most educated fishermen are more likely to use the recommended fishing gears. In terms of proportion, the majority (67.4%) of the fishermen finished their primary schools, 17.9% of the fishers were high school and the rest 12.6% had university degrees.

Nearly seventy nine percent (78.9%) of the fishermen were trained. According to [10] to promote production and to ensure enough supplies of fish to the consumers at reasonable prices, quantities with high quality and an

efficient fish marketing system would be required. In the marketing system storage, transport and processing are the key elements. Of these transport incriminated as a challenge by the respondents.

Pollution factors and water hayacine were the main challenges in the ecology of fish production. Chemicals and waste products may store to the town and inter in to the lake, which affects the water quality and then the fish. Water hayacine were secondary challenge of fishery by covering the fish catch instruments and reduce the amount of water. The branch and root of water hayacine hanging the ecology of fish habitat even they cannot move freely in to different directions. Water loss through evapotranspirations, which alter the balance of water body, decrease oxygen concentration, blocking the sunlight used for photosynthesis, soil erosion drastically by altering the physical and chemical property of the water and the environment of fish caught.

Entry into the fishing business in Lake Tana is similar to the cases in other lakes and rivers in Ethiopia, favoring illegal fishing and all the resources are exploited based on the principle of open access to the water resources [11]. The most serious problem mentioned by the fishers in Lake Tana is the operation of illegal fishers, which was mentioned by close to 22% of the respondents. Illegal fishery action consists of unfair computation, affecting legal fishing activities and fish stocks, even catching immature fish and changing to money. About 150 illegal fishers operating in the Lake but according to the respondents the number is more than this and the number also fluctuates in off-farm and

fasting seasons during which the number of illegal fishers increases tremendously.

The other variable which had significant and positive impact was the time of fishing. Changing the time of fishing creates approximately 14.5% difference on fish production. Fishers who did fishing during night times had higher catch than those who did fishing during day times. In Lake Tana traditionally fishers believed that large number of fish can be caught during night times since the net and beach seine and gillnet is not visible for the fish. The fishers also prefer night times where the water body is quite while there is active movement of fish that increases the probability of catching. The other reason explained by considerable number of fishers was that if the direction of the wind is towards the fishery site the chance of catching large number of fish is high.

According to Jones et al. [12] work regarding the impacts of light on availability of fish; they reported that vertical migrations and resting behavior of different fish species vary between day and night time. The availability of fish will depend on their action of movement, which although varying widely in scale, are rarely random. Activities of fish such as feeding, spawning, aggregating, resting, and predator evasion are usually linked to changes in the environment findings of Blaxter [13] who stated the vertical migrations of many pelagic fish species is closer to the water surface during night than day times.

Marketing fishery products was a serious problem and had a significant effect on catch level. Those who had no market problem had 20kg difference in their catch from those having market problems. According to the fishing operators interviewed there was no market provided to their fish, all delivered to local traders and directly to the consumer at the price set by the local traders. In addition, fishers were not satisfied with the price as it did not allow them to cover their basic expenses. This finding was supported by Njagi *et al.* [14], which states that fishers harvest is directly related with access to market. Furthermore, according to Kariuki [10], to promote production and to ensure enough supplies of fish to the consumers at reasonable prices, quantities and with high quality, an efficient fish marketing system would be required. Three issues; namely, storage, transport and processing were important in the marketing process. Storage will ensure that

enough supplies will be available during the off-season. Transport is a service to transfer from surplus areas to deficit regions in the country. Type of fishing instrument, type of boat and boat ownership were less contributors in fish catches. Whereas access to training and access to finance were found to be important variables in the fish catch [15,16].

Fish production in Lake Tana also creates job opportunities for the surrounding communities. As per discussions made with some respondents depending on the season and variation of the year the fishers can generate ETB 200-500 per day. Especially in the season of summer (September, October November and December), the fisher men can generate even more than 50 fish catch per day. One of the limitations of the current study was being cross-sectional.

5. CONCLUSION AND RECOMMENDATIONS

From local to global levels, fisheries play important roles in food supply, income generation and nutrition. The fishery sector in the study area has been contributing to a significant role to the community. Recently the government gave attention to fisheries cooperative establishment to lower the unemployment level, especially in the in Lake Tana. High environmental temperature, harvesting immature fish, the presence of predators, transportation problem, disease, flood, predators and delay before marketing were the most determining causes for fish production in the study area. Night times were more preferred by fishers compared to morning and afternoon. Illegal fishing was a big issue mentioned by fisher men. The fishing sector has various problems, among others climate change, mismanagement of the resource, inappropriate policies and institution, inadequate technical and material backup to the sector and markets were the major ones. Even though, there are certain opportunities for fishery in the country, fish production is still an infant. Based on the conclusion, awareness creation, fulfilling infrastructures, disease and water spoilage prevention, capacity building, prevention of illegal fishing with and further research were suggested.

CONSENT AND ETHICAL APPROVAL

The ethical clearance was obtained from the ethical review committee of the College of Veterinary Medicine and Animal Sciences,

University of Gondar, an written consent was taken from each participant after briefing the objective of the study.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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