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Research Article

Determinants of Fish Market Supply in the Case of Lake Hawassa, Sidama National Regional State, Ethiopia

Tekalign Tuluka*, Ketema Bekele, Kumilachew Alamerie

School of Agricultural Economics and Agribusiness, Haramaya University, Ethiopia

ABSTRACT

Fish provides nutrients that are essential to cognitive and physical development, and an important part of healthy diet. However, resource tragedy, overfishing, employing unrecommended mesh size and low management practices are discouraging fish marketed supply. This study was sought to identify the determinants of fish market supply at Lake Hawassa. The study used cross-sectional data from representative fishers of 166 and key informants. Both descriptive and Multiple Linear Regression (MLR) model were employed to analyze the data. The model indicated that market information, household education, fishing experience, owning of cold storage, credit access, fishing site and post-harvest loss affected the fish supply statistically and significantly. Accessing market information, household education, credit facility, cold storage, and experience sharing are indispensable for better fish supply.

Keywords: Fish market supply; Fish species; Lake Hawassa; Multiple linear regressions

INTRODUCTION

Fishery and aquaculture are the essential sources of food, income and economic development, and plays a crucial role in alleviating poverty [1]. It also provides a food and nutrition security, as food security is becoming a major global concern [2]. Farming of aquatic organisms namely, fish, mollusks, crustaceans and aquatic plants is a major means of global meat production, which ranked fourth after pig, poultry, and beef and buffalo [3]. According to SWFA investigation, aquaculture continues to be the fastest food-producing sector in the world to meet the demands of tremendously increasing population growth [4].

Inland catches are important food sources for several countries in Africa, which accounts 25% of global inland catches [5]. Fishery is the main source of protein supply for people to meet the given demand and minimization of malnourishment [6,7]. Ethiopia is endowed potentially with inland water lakes and rivers for fish harvesting and production [8]. In Ethiopia, fish production is mainly captured from natural lakes, rivers and artificial reservoirs [9]. There are almost 180 different fish species in Ethiopia and out of these, 30 species are native to the country [10]. As [11], commercial scale fishing was dominantly practiced in Lake Ziway, Hawassa, Chamo and Tana. In commercially productive lakes Chamo, Ziway and Tana, the nile tilapia, nile perch, barbus and catfish are found abundantly [2]. In Lake Hawassa, the most important commercial fish species are nile tilapia and catfish [12].

In Ethiopia, agriculture has been the basic driver of economic growth and contributor to the long-term food security. The sector accounts about 42 percent of the GDP, contributes around 90% of the total export earnings and 85 percent of the labor force [13]. It seems that the government of Ethiopia likely stipulates on livestock and crop sectors. The government focuses on commodities like dairy, large and small ruminants and poultry. To balance red meat production-consumption gap, Ethiopian government designed Livestock Master Plan (LMP) to meet by poultry sector excluding fishery sector [14]. It neglects fishery sector. With fewer policies, strategy, plan and low financial support designed and implemented to fishery sectors, the sector dramatically decreased. Therefore, fishing practices in Ethiopia remains infant [11].

Despite of its importance, Ethiopians per-capita consumption of fish from the capture fishery is less than 240 grams per year, which is very small in Sub-Saharan Africa [15]. Production remains promising than an actual practice even though presence of diverse agro-ecologies, water resources and availability of fish species [2]. Further, as the distribution chain of fresh fish is relatively short as most fishers sell their catch to retailers near to harvesting area due to the nature of the product and poor storage/preservation methods. Thus, more fish consumed in areas where the product is more available, in the vicinity of the lakes [16]. Local fish productions do not satisfy demands of big cities and towns [17]. In order to meet this demand, the country imports significant amounts of fish from neighboring countries [18].

Correspondence to: Tekalign Tuluka, School of Agricultural Economics and Agribusiness, Haramaya University, Ethiopia, Tel: +251 914976526; E-mail: tekaligntuluka@gmail.com

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Lake Hawassa is one of the fishing sites of the country with surface area of 90 Km^2 and mean value of 11 m [19]. According to Chekol AA, Lake Hawassa has a potential of 600 tons per year to harvest fish, however, 512 tons per year was realized which is under its harvesting capacity [20]. In Hawassa Mereta ST, et al. identified that, wastes from urban areas and referral hospitals, drain to the Lake [21]. Thus, industrial wastes dropped continuously in the lake leading to water contamination and allergic which causes fish unhealthy and discourage supply.

Improving the volume of fish supply to the market and livelihoods of the fishers may ensure food security [11,17,22]. Better fish production, supply, marketing and distribution are needed to improve household livelihood, income generation, economic growth and food security. Unfortunately, there is lack of research in the study area to distinguish the factors that affect fish market supply. Therefore, the objective of this study is to identify the determinants fish market supply at Lake Hawassa.

This research work attempts to add to the limited empirical literature on fish market supply. The study would help to improve fish marketed supply as well as generate more income to fishers and ensure food and nutrition security. As a result, policy makers and other development practitioners will get comprehensive valuable information to manage fish production and marketing.

RESEARCH METHODOLOGY

Study area

The study was conducted at Lake Hawassa located in Hawassa city in Sidama Region in Ethiopia. Lake Hawassa, popularly referred to as the "lake of love" is one of Ethiopia's natural wonders. Geographically, the lake lies between 6°33'–7°33' N and 38°22'–38°29' E at an altitude of 1680 m.a.s.l. in the Amoragedel Villages. The lake has a surface area of 90 Km^2, a mean depth of 11 m, a volume of 1.036×109m^3 and a drainage area of 1,250 Km^2. It is a terminal lake with no surface out flow and receives surface inflow Tikur Wuha River [23]. Lake Hawassa, an endorheic freshwater lake, is located between 6°5903.91"–7°7042.24" latitude and 38°23017.8"–38°28052.9" longitude in the Sidama and Oromia Regional State, within the Central Ethiopian Rift Valley Basin [24]. In Lake Hawassa, three fish species were found namely tilapia, catfish and labeobarbus. Among these species, tilapia fish harvested more than other species [25].

Data collection and sampling

In this research, both qualitative and quantitative data were used. Sources for the data were primary and secondary. Primary data sources were fishermen. Secondary data sources were published (thesis and dissertation, journal, and books) and unpublished (Agricultural bureau, Hawassa city fishery development office, and Sidama and Oromia region fishery development office documents).

Structured questionnaire and interview schedule were used to obtain accurate information from respondents. The interview schedule was prepared in English language but for the sake of better understanding, it was translated into local languages. Before the main survey, these questionaire and interview schedule was pre-tested to avoid errors.

To select sample respondents, both purposive and random sampling techniques were used. Two–stage-sampling procedure was applied. Firstly, stratified random sampling method was used and landing sites were categorized as Amoragedel, Dorebafano and Tikurwuha. Then by using simple random sampling procedures, the sample fishermen were selected from the three villages on the basis of probability proportional to population size of each landing sites. According to the information obtained from Hawassa City, Sidama and Oromia Region fish development office, there were 495, 240 and 156 fishermen in Amoragedel, Dorebafano and Tikurwuha landing sites, respectively.

The sample size of fishermen was determined based on Yamane's formula (1967). This formula is applicable for a finite population who are homegenous. Yamane T, developed the following equation to yield a representative sample for a proportion [26].

$$n = \frac{N}{1 + N(E)^2} \quad (1)$$

Where, n= sample size, N= population size, e = level of precision. The level of precision is the range in which the true value of the population is estimated to be; it is expressed in percentage points (0.07). The reason behind taking margin of error (MoE) 7% is that to obtain enough representative sample size. [27], used 9% level of precision to obtain the sample that truly represents population. Meseret A, also used 9% level of precision for its accuracy and true representation [28]. If we take 5% margin of error, the sample size becomes 277, also by 10% margin of error, the sample size becomes 89, which is very less.

$$n = \frac{891}{1 + 891(0.07)^2} = 166$$

Where, 891 is total fishermen from three villages

Then applying probability proportional to size to give equal chance of be selecting from each of three villages. This formula is:

$$nk = \frac{nNk}{Nt} \quad (2)$$

Where, n = population size of each village; nk = sample size of each village; Nk = sample size of total population and Nt = total fishermen from three villages. The sample size of fishermen from three villages (Amoragedel, Dorebafano and Tikurwuha) was 92, 45 and 29, respectively. Therefore, the total sample size was 166.

Methods of data analysis

Both descriptive statistics and econometric analysis were used to analyze the data collected from fishermen.

Descriptive statistics: Descriptive statistics was used to present socio-economic and demographic characteristics of fishermen. Mean, frequency, maximum, minimum and variance were used.

Econometric analysis: Unlike other agricultural products, almost all fish harvested is supplied to market unless it is diminished by post-harvest loss. Thus, all producers either fully or partially involved in market orientation. Therefore, to identify the factors that affect the volume of fish market supply, multiple linear regression (MLR) model is appropriate and relevant [29]. Multiple linear regression is a statistical model that utilizes two or more quantitative and qualitative explanatory variables (X1,....., Xp) to predict a quantitative dependent variable of Y.

The MLR is specified as:

$$Yi = \alpha \pm \beta Xi + Ui$$

Where; Yi = Fish market supply, Xi = Explanatory variables and "i" 1, 2, 3,...., α = an intercept, β = coefficient of i^{th} explanatory variables, Ui = unobserved disturbance term.

As a result, some of the assumptions of the Classical Linear Regression (CLR) model may be violated and the parameter estimates of the model may not be Best Linear Unbiased Estimator (BLUE). The problem of multicollinearity occurs when there is relationship among explanatory variable or correlation among explanatory variables [30]. Multicollinearity is considered severe and becomes a problem when this correlation is high and interferes with the estimation of the model's parameters at the desired level of statistical certainty. In this study, the measure that was suggested to test the existence of multicollinearity was Variance Inflation Factor (VIF). Thus, Variance Inflation Factor (VIF) was used to check multicollinearity among independent variables. According to Maddala GS [30], VIF can be defined as:

$$VIF(xi) = \frac{1}{1 - Ri^2}$$

Where; Ri^2 = the squared multiple correlation coefficients between xi and other explanatory variables. As a rule of thumb, if the VIF is greater than 10 (this will happen if R^2 is greater than 0.90), the variable is said to be highly collinear [31].

Model specification is one of the first step in the regression analysis which converting the theory in to a regression model [32]. While converting, specification errors occurred due to wrong functional form, omission of relevant variables or inclusion of irrelevant variables, measurement error and incorrect specification of stochastic error term. Therefore, they are tested to the assumption of Classical Linear Regression (CLR) model.

Examination of the model is a good visual diagnostic to detect hetroscedasticity. Hence, there are many tests to detect this problem namely: Breusch-pagan, Park, LM, Godfrey, White's test, Koenker Bassett (KB) tests for hetroscedasticity. These tests of hetroscedasticity tend to incorporate whether the independent variables have a significant relationship to the goodness of the fit of the model. Due to its simplicity, Breusch-Pagan test of heteroscedasticity was employed for detecting heteroscedasticity in this study. The different tests of hetroscedasticity are based on the auxiliary regressions for the OLS residuals to the squares. As usual, we reject, if the observed value of the test statistics exceeds an appropriate critical value. Rejection implies that hetroscedasticity is present. Therefore, this test was done to examine whether estimated variances of the residuals from a regression are dependent on the values of the explanatory variables.

To test omitted variables, there are a number of tests such as Examination of the residuals, Durbin-Watson d, Ramsey's RESET and Lagrange Multiplier (LM). Ramsey's RESET test is not only for testing omitted variables but also for functional form correction [33]. For its simplicity in this study, Ramsey's RESET test was employed.

RESULTS

This chapter deals with the findings of the descriptive statistics and econometric model. It mainly discusses the factors that affect fish market supply.

Demographic and socio-economic characteristics of fishers

This section describes the demographic and socio-economic characteristics of sample fishers. The survey was conducted with 166 respondents.

The mean age of fishers was 32 years with the minimum and maximum age of 17 and 56 years, respectively. This implies that, the household heads were relatively younger, attracting young labor force. The mean experience of fishers was 7 years with minimum 1 and maximum 40 years. Hence, more experienced fishers can know fish abundance area, harvesting techniques and harvest more fish. The mean education level was 7 with minimum and maximum value of 0 and 13, respectively (Table 1).

The mean value of fishers' family size was 2 persons with the minimum and maximum 1 and 7, respectively. Thus, small family size pushes them to be involved in fishing. The mean value of fish post-harvest loss was 9.48 Kilogram with the minimum and maximum of 1 and 20 Kg/day, respectively. Hence, post-harvest loss has a significant influence on reducing fish market supply and performance. The mean value of market price was 48.1 birr per Kilogram with the minimum and maximum value of 25 and 75 birr per Kilogram, respectively.

As Table 2 indicates, all observed fishers in study area were men. It implies that fishing activities were male dominated. Refrigerator is one of the most pieces of equipment for keeping fish food safe. However, only 28.3% of samples respondents owned refrigerator. About 48% fishers got training services. Only 20.5% of the fishers accessed credit. Access to extension services diversifies other agricultural activities other than fishing. The summary statistics shows that, 18% fishers got extension services. To sell and/or purchase fish immediately and by affordable price, market information is crucial. Thus, 75.3% of fishers accessed market information. Membership to cooperative help to build negotiation power, facilitate fishing materials and arrange distribution systems. Hence, 58.7% of fishers were member to cooperatives. To meet the consumer's utility and/or to maximize the fisher's profit, value addition on fish is indispensable. Thus, 36.1% of fishers were undertaken the value addition activity. At Lake, 64.5% fishers owned boat, however, some fishers were using hooks and line to harvest fish. Majority of fishers existed at Amoragedel landing site, which accounted 55.4%.

Multiple Linear Regression (MLR) model results

Econometric analysis emphasize that endogenous variables could

Table 1: *Summary statistics of characteristics of sample fishers (Continuous variables).*

Variables	Mean value	Minimum	Maximum	Variance
Age	31.94	17	56	57.676
Experience	7.02	1	40	30.657
Education	7	0	13	9.886
Post-harvest loss	9.48	1	20	32.93
Market price	48.1	25	75	53.05
Family size	2.35	1	7	1.51

Source: Own survey result, 2018

be determined by both quantitative and qualitative exogenous variables. Likewise, data obtained from 166 fishers were used to run MLR analysis. Before fitting MLR regression, the basic problems related to OLS model were tested. The critical assumptions such as multicollinearity, hetroscedasticity and specification error that ignore statistical properties of OLS were tested. Breusch-pagan/cook Weisberg test was applied to identify the existence of hetroscedasticity. In a sense, there was hetroscedasticity problem that ignore BLUE properties of OLS with inconsistency problem. Therefore, Robust MLR result detects different covariate characters to bring constant variance through overcoming hetroscedasticity problems.

To identify the presence of multicollinearity in the data set, VIF was used. The result of VIF was less than 10 for each regressed variables with mean value of 1.91. Again to identify specification error occurred due to adding irrelevant and/or omitting relevant variables, Ramsey reset test using the power of fitted value was applied. The result of MLR showed that there was no omitted relevant variable for the fish market supply (F = 2.03 (P = 0.11)).

To identify the determinants of fish market supply volume, 12 explanatory variables were used. Out of these, market information, household education, fishing experience, owning cold storage, credit access, fishing site and post-harvest loss affected the volume of fish market supply significantly. Results depict that, market information, household education, credit access, experience of fishers and owning cold storage affected positively and statistically; whereas Dorebafano site and post-harvest loss affected negatively and significantly.

As depicted in Table 3, the model was statistically significant at

Table 2: Summary statistics of characteristics of sample fishers (Categorical variables).

Variables		No of respondents			Percent
Male		166			100
Refrigerator		47			28.3
Access to fishing training services		80			48
Access to credit services		34			20.5
Access to extension services		29			18
Access to market information		125			75.3
Membership to cooperative		98			58.7
Value addition		60			36.1
	Site	**Motorized**	**Unmotirized**	**Hooks/Line**	
Boat ownership	Amoragedel		41	17	
	Tikurwuha	2	32	20	64.5
	Dorebafano		24	22	
	Amoragedel	**Tikurwuha**	**Dorebafano**		
Landing site	92	29	45		100

Source: Own survey result, 2018

Table 3: Determinants of fish market supply (MLR result).

Variables	Coefficient	Robust Std. Error	P-value
Access to market information	14.000	2.565	0.000***
Household education level	0.836	0.438	0.058*
Access to credit services	7.935	4.056	0.052*
Fishing experience	0.652	0.231	0.005***
Market price	0.093	0.192	0.63
Access to fishing training	-0.992	2.781	0.722
Value addition	-0.618	2.39	0.796
Owning cold storage	14.562	3.105	0.000***
Cooperative membership	0.592	2.221	0.79
Boat ownership	2.407	2.65	0.365
Landing site (cf. Amoragedel)			
Tikurwuha	-1.686	2.859	0.556
Dorebafano	-5.578	3.155	0.079*
Post-harvest loss	-0.381	0.198	0.056*
Number of Observation		166	
Constant	19.718	9.553	0.041
F (13, 152)		36.17	
R- Square		0.756	

Note: *** and * indicates significance at 1% and 10% probability levels respectively.
Source: Survey outcome in 2018

1% significance level implies that, the goodness of fit of the model to explain the relationships of the hypothesized variables. The coefficient of multiple determinations (R^2) indicates that 76 percent of the variation in the quantity of fish supplied to the market was explained by the variables included in the model. The effects of the significant explanatory variables on the dependent variable are discussed hereunder.

Market information (MKTINF): As a survey result shows that, market information positively and significantly affected the volume of fish market supply at 1% significance level. If fishers get accurate, valid and updated market information, fish market supply increases by 14 Kilograms. Hence, fishers harvest fish daily and sell immediately. Similarly, Janko A has found that, having market information increases the probability of entering in market and supply of haricot bean [34]. A fisher who gets current information can apply modern technology to his daily operation. This information was accessed through telephone, radio, fish traders and fish training extension agents.

Household Education Level (EDUC): Education has showed positive effect on fish supplied to the market with less than 10% significance level. The survey result showed that, if fishermen get educated, the fish volume supplied to the market increases by 0.836 Kilogram. Pursuing formal education can improve skills and knowledge of fishers on adopting latest fishing technology. This is in line with Cheffo A, et al., who investigated that literacy reduces the risk of depletion of fish genetic resources by applying recommended sized mesh [35]. The fishers, who educated more, can supply the more fish to the market by applying their knowledge on harvesting and supply techniques.

Access to Credit services (CRDT): It affected fish market supply positively and significantly at less than 10% level of significance. If fishers access credit, fish supply to the market increases by 7.935 Kilograms. Meseret A, found that, the amount of credit used increased the malt barley marketed supply and ensure market stability of farmers [28]. The fishers who obtain credit and spent on fish harvesting and market operation item, supplied more fish to the market. This is in line with the find by Cheffo A, et al., stating that household who get opportunity to receive credit build his capacity to buy and use mesh and boat [35]. According to Janko A, the households accessed credit services in a better way might be involved in producing much haricot bean and can potentially supply to the market [34].

Fishing experience (EXPOFF): The result of the model showed that, experience of fishers in fish harvesting affected market supply positively and significantly at 1% level of significance. If fishers' experience increases by 1 year, the fish supply to the market will increase by 0.652 Kilograms. Experienced fishers supply more fish to the market than new entrants do. Likely, Kabtamu supported that, farm experience of household head affected positively and significantly in mango supply in Babile district [36].

Owning Cold storage (OWCST): This implies that, owning cold storage positively and significantly affected fish supply to the market at 1% significance level. If fishers own cold storage, the supply of fish to the market increases by 14.562 Kilogram. Poor availability of refrigerator at the production level hinders the fishermen toward shelf life and market supply which is supported by the research result in Oromia Region, Ethiopia [11]. Refrigerator was the most influential storage facility in fishing area with its cooling and shelf life extending ability. By using the cooling facility, the fishers save their resource from unnecessary market price failure that leads to market force loss and cheap selling price.

Landing Site (LS): The outcome of the model reveal that, site Dorebafano negatively and significantly affected fish supply to the market at less than 10% significance level. If the fishers are from Dorebafano, the supply of fish to the market decreases by 5.578 Kilogram than those of two sites namely Amoragedel and Tikurwuha do. Due to inconvenient of site regarding infrastructure like poor road, electricity and transport vehicles the site is more likely restricted from supplying more fish to the market. In addition to this, during transporting to the market, inconvenient road leads to cracking fish and exposed to temperature and spoilage. This site incurs likely high cost while moving fish and buying inputs since it is far away from the town. Meseret A suggested that, distance affected malt barley marketed supply negatively and significantly at 5% significance level [28]. Since the landing site far from the market center, it increases transportation cost and expose fish to post harvest loss due to ambient temperature and poor cooling facility.

Post-harvest loss (PHL): Post-harvest loss negatively and significantly affected the fish marketed supply at less than 10% significance level. If fishers are exposed to fish post-harvest loss, the supply of fish to the market decreases by 0.381 Kilogram. Post-harvest loss has the serious influence on the fishers' income and food security. For instance, as Abelti AL elaborated, from 176 Kg of Barbus harvested per day, 60 Kg (34.09%) of fish could be discarded because of low quality[37]. Occasionally, fishers exposed to market force loss which is caused by difference in expected value and actual value [38]. Janko AM said that, quantity loss is the loss after harvesting, the fish totally not use it thrown away either voluntarily or authorized [17]. According to Teklu D Ethiopia produced 28,000 tons of fish, out of these [39]; one-third of its annual production, 10,000 tons of fish per annum was lost due to poor post-harvest handling practices [39-44]. Due to its natural characteristics, fish spoiled instantly after harvest as not put in cold storage.

CONCLUSION AND RECOMMENDATIONS

Lake Hawassa is one of the most sources of income and livelihoods to Hawassa city inhabitants and its localities. The Lake also created enabling environment for fish harvesting and marketing activities. It opens job opportunities to youth, contributes to GDP, economic development and food security. However, all fishers at Lake Hawassa were men. The highly preferred and consumed fish types at Lake Hawassa are two namely, Tilapia and Catfish. The main fish market destination was Hawassa city, Addis Ababa, Zeway, Shashemene, Dilla, Wondogenet, Alettawondo, Arsinegelle, Yirgalem, Lakko and Tula.

Multiple linear regression results revealed that access to market information, access to credit services, household education, fishing experience and owning cold storage affected fish marketed supply positively and significantly while post-harvest loss and fishing site (Dorebafano), affected fish market supply negatively and significantly.

The harvesting and processing activities in the fishing site were male dominated. Hence, empowering female in those activities should be encouraged. Illegal fishers have been harvesting

immature and juvenile fish and creating resource tragedy. Therefore, establishing strong fishers' cooperatives should take place to sustain fish harvesting and market supply. Providing basic inputs namely; nets, boats, refrigerators and motorized boat to fishers and fishers' cooperatives should increases fish market supply. Provision of accurate and updated market information for fishermen can enhance the market supply of fish. Enhancing the educational center for the fishermen and motivate them to get educated can improve the knowledge on harvesting and processing of fish. Facilitating open credit access to the fishermen is needed to improve harvesting and enhance the market supply of fish. Fish market supply would be highly increased, if fish harvest is kept fresh with refrigerator. Thus, provisions of refrigerator to the fishermen are needed. Facilitating infrastructure to all landing site especially to Dorebafano can reduce post-harvest fish loss and enhance market supply. Long distance, high ambient temperature, poor packaging materials, poor transportation, poor harvesting and processing techniques increase fish loss. Hence, appropriate post-harvest handling practices are needed enhance fish market supply.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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