IJIPP

International Journal of Innovation and Professional Practice
Vol. (1), Issue (1) June, 2026.
ISSN NO: XX

SOCIO-ECONOMIC DETERMINANTS OF HOUSEHOLD FISH INCOME IN THE SOUTHERN REGION OF MALAWI: THE ROLE OF GENDER

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ABSTRACT

The study focused on an understanding of the socio-economic factors affecting household fish income among aquaculture farmers in the southern region of Malawi while appreciating the gender-dynamics. The study targeted 4,721 fish farmers (pond owners) in the Southern fish-producing districts of Mulanje, Phalombe, Thyolo, Mwanza and Blantyre who represent 30% of aquaculture farmers nationally. Cochran (1963) formula was used to determine a sample 356 farmers which was increased to 375 fish farmers to enhance the precision. A structured household survey questionnaire was used to collect data from randomly sampled farmers making up 60% male and 40% female. The quantitative primary data collected was analyzed through descriptive statistics, Analysis of Variance (ANOVA) and Ordinary Least Square (OLS) regression models. The regression findings indicated that the source of fish fingerlings was not a significant determinant of HH income in any category (P-Value > 0.05). However, both farmer's age and level of education positively and significantly influenced HH income among single women only ($\beta = 233.19$; $\beta = 2{,}508.92$; P-Value < 0.05) emphasizing the role of education in empowering women to adopt modern aquaculture practices. It was also established that in regard to married women only, HH decision-making positively influenced income, particularly among married women only thus highlighting the collaborative nature of family decisions ($\beta = 555.35$; P-Value < 0.10). For both married women and men, the results revealed that HH size had a positive impact on income but a negative impact on single women, underlining the importance of collaborative family labor dynamics ($\beta = 175.76$; $\beta = 181.18$; P-Value < 0.05). Additionally, experience in fish farming positively influenced income for married women and men, demonstrating the importance of accumulated knowledge ($\beta = 305.66$; $\beta = 61.31$; P-Value < 0.01). The results further demonstrated the importance of accessing various market channels indicating that access to categories of markets positively affected income among married women and men, highlighting the benefits of diverse market channels ($\beta = 4{,}985.91$; $\beta = 1{,}094.87$; P-Value < 0.01). For the three categories, it was established that market distance negatively affected income emphasizing the importance of proximity for market access ($\beta = (6142.39)$; $\beta = (1{,}804.95)$; $\beta = (1{,}357.192)$; P-Value < 0.10). The study recommends a need for interventions that empower and involve women in key decision-making processes; addressing the limited membership in cooperative societies that requires policymakers to focus on awareness campaigns, financial education, and facilitating cooperative establishment tailored to fish farmers' needs; supporting farmers, particularly women, in accessing high-quality fingerlings ; promoting equitable access to education, supporting women in gaining experience and land ownership, and improving market infrastructure. There is also a need for policymakers to explore initiatives enhancing scalability, efficiency, and market access for fish farmers.

Key words: *Aquaculture, Gender, Income, multinomial logistic regression, Malawi.*

How to Cite this Article:

Mange'ni, W. (2026). Socio-Economic Determinants of Household Fish Income in the Southern Region of Malawi: The Role of Gender. *International Journal of Innovation and Professional Practice*, 1 (1), 68 - 86.

IJIPP
International Journal of Innovation and Professional Practice
Vol. (1), Issue (1) June, 2026.
ISSN NO: XX

1. BACKGROUND OF THE STUDY

The aquaculture sector is said to be one of the fastest-growing sectors in the world especially due to declining fish stocks in capture fisheries (Sha & Bukhari, 2019; Gellner *et al*., 2019, Abwao & Fonda, 2019) and increasing demand for fish. According to Food and Agriculture Organization (FAO) 2021 report, aquaculture production will continue to grow but the benefits of this growth must be equitable and fairly distributed. In addition to its role in food security, close to '200 million people directly or indirectly depend on fisheries and aquaculture (Weeratunge *et al*., 2010), of which, more than 25% of people employed in the fisheries and aquaculture sector in Africa are women (Rajaratnum *et al*., 2016). Thus, aquaculture is regarded as a sustainable source of income for those engaged in it and likely to benefit rural women because it can be integrated into prevailing agri-food systems (Sha & Bukhari, 2019). In addition, Kawarazuka and Christopher (2010) assert that aquaculture can be a powerful tool for women empowerment because of their involvement in the entire production process (apart from pond digging). Even in communities where women's mobility is restricted, they can still engage in aquaculture since aquaculture can be a backyard activity (Kaminiski *et al*. 2019).

Despite high hopes for women benefitting from aquaculture, it is becoming increasingly apparent that benefits and opportunities from their participation are not equitably distributed across gender and socio-economic classes (Kruijssen *et al*., 2018). Ndanga *et al*. (2013) suggested that while women produce half of the world's agriculture products, they earn a tenth of the total income from agriculture, including fisheries and aquaculture and only 1% of property and assets. Similar inequalities are reproduced in the aquaculture sector and Morgan *et al*. (2016) agreed that in many areas, benefits for women are lower despite their more active participation in aquaculture operations, post-harvest processing and marketing compared to men. It is hence important that the traditional roles and responsibilities of men and women in fishing activities ranging from but not limited to access to resources, labour division, market participation, decision making power, education and training, social norms and cultural factors be explored. An understanding of disparities alongside these socio-economic factors, as presented by Weeratunge *et al.* (2010) presents a clear empirical evidence as to why women are being relegated further into 'positions of poverty'.

Gender inequalities in agriculture, including aquaculture, have been highlighted and discussed by many studies. The cause of this inequality has been explained in various ways. For example, Morgan *et al.* (2016) attributed gender disparities in benefits from aquaculture to gender norms that can negatively impact women's ability to make decisions over their labour, access information they need, or own assets. Women own fewer assets than men in terms of the number of assets owned and the value of those assets (Kruijssen *et al*. 2018), limiting what women can do, produce and benefit. Gender norms and distribution of resources such as land have often been cited to explain limited engagement by women in the smallholder aquaculture sector in other African countries (Veliu *et al*. 2009; Kruijssen *et al*., 2018; Ndanga *et al*., 2013; Mushili & Musuka, 2015; Banda & Musuka, 2020).

It has also been suggested that aquaculture is labor-intensive, especially in relation to pond construction, which may discourage women from being engaged (Mushili, 2015; Banda & Musuka, 2020). On the contrary, study conducted in Tanzania by Chenyambuga et al. (2011) noted that women who own ponds are likely to be divorced, widowed and single—in other words, not having access to husbands to dig and maintain ponds for them. Gopal et al. (2020) suggested a different viewpoint for capture fisheries that can also apply to aquaculture. She notes that 'women subjected to social pressures within the household experience greater difficulty than widowed or divorced women in participating' to imply that the analysis should go beyond just mentioning that 'digging ponds' is difficult for women, to consider other support such as access to finance and other productive resources that can promote women's participation.

In some South-East Asian countries such as Bangladesh, aquaculture is regarded as attractive to women since it can be conducted closer to home and needs minimal investments (Shah & Bukhari, 2019). In some African countries, however, the opposite is true. Due to the high initial costs of expected investments to start aquaculture farming, women's engagement in aquaculture is much lower than in crop farming. Aquaculture is often associated with higher initial costs primarily related to pond construction and stocking. In some African countries it has been suggested that women may not actively

engage in aquaculture because they lack the start capital and have no access to appropriate financial products (Banda & Musuka, 2020; Brugere & Williams, 2017, Dambatta et al. 2016; Veliu et al., 2009; Ndanga et al., 2013). Lack of access to capital can also result in women not being able to adopt better management practices for aquaculture, such as using clean seed, commercial feeds and others, affecting their productivity and competitiveness in the sector (Veliu et al., 2009).

Limited decision-making power by women on land use, decision to access credit or other resources and lack of decision-making power and control over products of their labour put women at a disadvantage in agriculture and aquaculture production (Kruijssen et al., 2018). It has been noted that the inability of women to make decisions, low education levels and lack of access to information and services impact their productivity and on households' capabilities to move out of poverty (Weeratunge et al., 2010). Domestic labour demands can also prevent women from participating in and benefiting from aquaculture (Morgan et al., 2016). When other domestic demands already overburden women, they are often unwilling or unable to take on more roles in the aquaculture sector.

2. CONTEXTUAL BACKGROUND

Although fish farming in Malawi started in 1906 with the introduction of rainbow trout (Onchorhynchus mykiss) for angling, the sector only contributes 2% of fish supply in Malawi (Kassam & Mtethiwa, 2017). The contribution of the fisheries sector to per capita fish consumption has dropped by 37% in Malawi due to decline in fish availability and overfishing, giving room for the aquaculture sector to flourish. A vibrant aquaculture sector could fill this gap and give capture fisheries a chance to recover. However, the aquaculture sector in Malawi is plagued by low performance. The government estimated that fish from aquaculture has increased from 800t in 2006 to 3600t in 2016 (Department of Fisheries, 2016) produced by an estimated 6000 smallholder fish farmers. Fish farming in Malawi is dominated by stallholder farmers estimated at about 15,465 smallholder aquaculture farmers (Department of Fisheries). Only one large scale commercial fish farm is located on lake Malawi (Limuwa et al., 2018).

The low productivity and production in aquaculture are due to a number of challenges faced by fish farmers including the lack of quality inputs such as fingerlings and seed and lack of extension services (Limuwa et al., 2018). While studies in Malawi have illustrated the importance of fish farming for women, the sector is male dominated (Limuwa et al., 2018). For example, it has been noted that for female headed households affected by HIV and AIDS, integrated agriculture aquaculture farming was critical in providing their food, nutrition and income security in Malawi (WorldFish, 2011). However, there is a lack of sex disaggregated statistics for the sector in Malawi. CASA (2020) estimated that 38.5% of aquaculture farmers in Malawi are women. Several authors such as Chiweza and Nagoli, 2017 acknowledge the importance of gender in aquaculture but has been very limited studies on this. A dearth of sex-disaggregated statistics has been noted in the aquaculture sector according to Brugere and Williams, (2017) who indicated that 'sex-disaggregated statistics that could track women in aquaculture are scarce, and therefore women's presence, influence and interests are invisible'. Motivated by these, this paper sought to contribute to and fill this gap by conducting a sex-disaggregated analysis of socio-economic determinants of household income among aquaculture farmers in Malawi's southern province.

3. DATA AND METHODS

3.1. Study Area, Target Population and Sampling Approaches

The study was conducted in the Southern region of Malawi. A multi-stage sampling design was employed to select target respondents. The first stage entailed the selection of districts whereby the fish-producing districts in the province that is Mulanje, Phalombe, Thyolo, Mwanza and Blantyre districts were selected. Secondly, in the five target districts, three Extension Planning Areas (EPAs) per district were randomly selected. Thirdly, a random selection of villages was conducted where ten villages were selected in each of the EPAs. Finally, a random selection of households was conducted in the villages. The number of households were proportionate to the population of fish farmers. The sampling was based on a sampling frame provided by the Department of Fisheries (DoF).

The five districts have an estimated population of 4,721 fish farmers (DoF, 2018), representing 30% of aquaculture farmers nationally (15,465). The study adopted Cochran (1963) formula to determine a sample 356 farmers. To increase the precision, a total of 375 fish farmers were sampled to cover for none-response rate. A structured household survey questionnaire, coded in Kobo Collect Toolbox was used to collect data. However, prior to data collection, a pilot survey was undertaken to pre-test the questionnaire where the tools validity and reliability were tested. The target respondents were either head of households or spouse to the household head owning ponds. Up to 60% of the respondents were male and 40% female.

3.2. Data Analysis

The quantitative primary data collected was analyzed using quantitative data analysis procedures. Specifically, descriptive statistics, Analysis of Variance (ANOVA) and Ordinary Least Square (OLS) regression models were adopted. The specific descriptive statistics was frequency, percentages, mean and standard deviation while ANOVA was used to test whether there was a statistically significant difference in the socio-economic factors as well as income from fish farming among the married women, single women and men. Considering that the dependent variable (household income from fish farming) was a continuous variable, multiple OLS regression models were conducted in STATA 16.1 to determine its social economic determinants. However, before estimating the OLS models, the assumptions of classical linear regression models (Multicollinearity, Autocorrelation, Heteroscedasticity, Normality) were tested. Multicollinearity was tested using Variance Inflation Factor (VIF) method, Autocorrelation was tested using Durbin Watson method, Heteroscedasticity was tested using Breusch-Pagan method and Normality was tested through Kolmogorov-Smirnova method. To disaggregate the results by gender, three independent multiple regression models were estimated namely:

Model 1: Multiple regression model for Single women (unmarried, separated, divorced and widowed)

Model 2: Multiple regression model for Married women (married and cohabiting)

Model 3: Multiple regression model for men

The general form of the models was specified as follows:

$$Y_i = \alpha_i + \beta_i X_i + \cdots + \beta_n X_n + \varepsilon \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where:

Y = Household Income from Fish Farming (Measured in Malawian Kwacha – MWK) ; $\mathbf{X_1}$ = Distance to the Market (Measured in Kms) ; $\mathbf{X_2}$ = Farmer's Age (Measured in Years) ; $\mathbf{X_3}$ = Farmer's Level of Education (Measured as total years of schooling years) ; $\mathbf{X_4}$ = Household Size ; $\mathbf{X_5}$= Land Size under Fish Farming / Pond Size (Measured in M^2) ; $\mathbf{X_6}$= Farmer's Experience in Fish Farming (Measured in Years) ; $\mathbf{X_7}$= Stocking Density (Number of Fingerlings per M^2) ; $\mathbf{X_8}$= Membership to a Cooperative Society (Binary Variable; 1 = Member; 0 = Otherwise) ; $\mathbf{X_9}$= Source of Fingerlings (Binary Variable; 1 = Recycling own Fingerlings; 0 = Otherwise) ; $\mathbf{X_{10}}$= Categories of accessible Fish Markets (Binary Variable; 1 = Neighbors and Friends, 0 = Otherwise) ; $\mathbf{X_{11}}$= Number of Extension Visits in a Fish Farming Season ; $\mathbf{X_{12}}$= Household Decision Maker (Binary Variable; 1 = Decision Maker, 0 = Otherwise) ; $\boldsymbol{\alpha}$= Constant ; $\boldsymbol{\beta_{i-12}}$ = Beta Coefficients and $\boldsymbol{\varepsilon}$ = Error term.

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4. FINDINGS

4.1. Response Rae

The study targeted 375 fish farmers owning ponds. Therefore, an equivalent number of questionnaires was used and the response rate was 100%.

4.2. Socio-Economic Characteristics of Fish Farmers in Southern Malawi

The descriptive analysis of socio-economic characteristics of aquaculture farmers in Southern Malawi was established. Table 1 presents the findings of categorical variables, that is HH decision maker, membership to a cooperative society, source of fish fingerlings category and categories of accessible fish markets. ANOVA was used to test whether there was a statistically significant difference in the socio-economic factors as well as income from fish farming among the married women, single women and men.

Table 1: Socio-Economic Characteristics of Fish Farmers in Southern Malawi (Categorical Variables)

Socio-Economic Factor	Category	Single Women (n =53) f (%)	Married Women (n = 97) f (%)	Men (n = 225) f (%)	ANOVA F-Statistic, P-Value
HH Decision Maker	Not Myself	14 (26.4)	84 (86.6)	3 (1.3)	373.81; 0.000
	Myself	39 (73.6)	13 (13.4)	222 (98.7)	
Membership to a Cooperative Society	No	38 (71.7)	71 (71.2)	148 (65.8)	1.01; 0.367
	Yes	15 (28.3)	26 (26.8)	77 (34.2)	
Source of Fish Fingerlings Category	Not Recycling Own Fish Fingerlings	23 (43.4)	45 (46.4)	136 (60.4)	4.27; 0.015
	Recycling Own Fish Fingerlings	30 (56.6)	52 (53.6)	89 (39.6)	
Categories of Accessible Fish Markets	Others Markets	18 (34)	63 (64.9)	216 (96)	83.67; 0.000
	Neighbors and Friends	35 (66)	34 (35.1)	9 (4)	

The results in Table 1 indicate that in men-headed households, up to 98.7% of the men made decisions. This was the highest compared to 73.6% of single ladies making decisions in their households and only 13.4% of married women making decisions in their households. This difference in HH decision making among the single women, married women and men was established to be statistically significant (P-value < 0.05) to imply that among small holder fish farmers in Southern Malawi, majority of HH decision makers were men. The importance of decision making among fish farmers lies in the understanding that the decision maker is the primary orchestrator of critical choices that influence the entire aquaculture operation. As the key figure responsible for determining resource allocation, investment decisions, and overall management strategies, the decision maker shapes the direction and viability of the fish farming venture. Moreover, the decision maker's role extends beyond operational considerations to encompass strategic planning and market engagement, thereby shaping the economic viability of the household's involvement in fish farming.

The results further demonstrated that membership to cooperative societies was not a common practice among the fish farmers in Southern Malawi region. Specifically, it was noted that only 34.2% of the men fish farmers, 28.3% of the unmarried women fish farmers and 26.8% of the married women fish farmers belonged to cooperative saccos. The difference in membership to cooperative societies among the single women, married women and men was however established to be

statistically insignificant (P-value > 0.05) to imply that regardless of the category, few small holder fish farmers in Southern Malawi belonged to a cooperative society. Membership to cooperative society holds significant importance for fish farmers as it provides them with access to essential financial resources and support. In the dynamic and capital-intensive field of fish farming, securing funds for investments in infrastructure, equipment, feed, and other operational expenses can be challenging and hence it can be argued that given the low membership rate to cooperatives, the farmers are likely to experience resource constraints which may affect their fish farming incomes.

Given its importance, the study also analyzed the sources of fish fingerlings among the farmers given that it the optimal growth, health, and productivity of fish stocks hinge on the quality and genetic integrity of the fingerlings acquired. Therefore, selecting a reputable and reliable source ensures that the fingerlings are disease-free, genetically robust, and well-suited to the local environment. The results in Table 1 demonstrated that majority of the men fish farmers (60.4%) source their fingerlings from sources other than recycling them. This is high compared to 46.4% of married women fish farmers and 43.4% of the single women fish farmers who rely on recycling their own fingerlings as opposed to sourcing from alternative sources. Additionally, this difference in sourcing for fingerlings among the single women, married women and men was established to be statistically significant (P-value < 0.05) to imply that while most men fish farmers in Southern Malawi sources for fingerlings from alternative sources, women fish farmers opted to recycle them. Given the advantages of selecting a reputable and reliable source in ensuring that the fingerlings are disease-free, genetically robust, and well-suited to the local environment, both single and married women are likely experience lower returns.

The study also established the categories of accessible fish markets across the three categories of fish farmers and established that the main sources of market for majority of the men and married women fish farmers (96% and 64.9% respectively) were alternative sources other than neighbors and friends. However, up to 66% of the single women fish farmers relied on neighbors and friends as the main markets for their fish. The difference in market access among the single women, married women and men fish farmers was also established to be statistically significant (P-value < 0.05) implying that while majority of the men and married women fish farmers in Southern Malawi were not over-reliant on friends and neighbors as their sole markets for fish, single women had little options. This poses as a risk for single women fish farmers given important role of having alternative market sources to help build resilience and mitigate risks associated with market volatility. Relying on diverse market outlets allows fish farmers to adapt to changing demand, price fluctuations, and unforeseen disruptions. By exploring various channels such as local markets, restaurants and community-supported fisheries, rather than relying on friends and neighbors, fish farmers can optimize their market strategies, reaching a broader consumer base and potentially securing more stable prices for their products which can result to higher incomes. The results for the continuous variables are as shown in Table 2.

Table 2: Socio-Economic Characteristics of Fish Farmers in Southern Malawi (Continuous Variables)

	Single Women (n =53)		Married Women (n = 97)		Men (n = 225)		ANOVA
Socio-Economic Factor	**Mean**	**Std. Dev**	**Mean**	**Std. Dev**	**Mean**	**Std. Dev**	**F-Statistic, P-Value**
HH Income from Fish Farming (MKW)	86,357.91	8,657.07	48,259.13	4233.29	82,092.47	1,978.16	2,494.66; 0.000
Farmer's Age	49.54	9.73	43.96	5.47	50.02	8.22	20.89; 0.000
HH Size	3.70	1.03	4.73	1.18	5.64	1.11	73.49; 0.000
Farmer's Level of Education (Years of Schooling)	5.49	1.59	5.91	1.47	8.28	2.14	78.94; 0.000
Farmer's Experience in Fish Farming (Years)	6.66	4.10	8.63	3.67	13.18	4.91	64.06; 0.000
Land Size dedicated to Fish Farming	291.30	80.15	397.08	92.04	516.73	97.46	147.81; 0.000
Distance to the Market	3.26	0.29	4.17	0.47	5.37	0.60	407.45; 0.000

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Vol. (1), Issue (1) June, 2026.
ISSN NO: XX

Socio-Economic Factor	Single Women (n =53)		Married Women (n = 97)		Men (n = 225)		ANOVA
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev	F-Statistic, P-Value
Stocking Density	198.77	62.68	199.48	62.94	404.04	67.37	438.55; 0.000
Number of Extension Visits	2.15	1.63	3.21	2.33	4.29	2.67	18.92; 0.000

Further results in Table 2 indicate that unmarried women and men fish farmers in the southern Malawi region earn an average of 86,357 MKW (USD. 51.3) and 82,092 MKW (USD. 48.8) from fish farming activities which is significantly higher than married women who earn 48,259 (USD. 28.7). The differences in earnings across the three categories is significant as shown by a significant P-Value (< 0.05) and this may be attributed to various factors. The results also showed that on average, slightly older fish farmers in the region are men with an average age of 50.02 years followed by single women with an average age of 49.5 years and lastly married women with an average age of 43.9 years. The results further demonstrated existence of a statistically significant difference in the age of fish farmers in Southern Malawi disaggregated as married women, unmarried women and men (P-value < 0.05) where older farmers are mostly men. In aquaculture, age is an important factor given that younger farmers may bring fresh perspectives, technological adeptness, and adaptability to emerging trends and innovations in fish farming practices. Their energy and openness to new methods may contribute to the industry's dynamism and capacity for sustainable growth. Conversely, older fish farmers, with years of hands-on experience, may possess valuable traditional knowledge, wisdom, and practical insights that can enhance the overall resilience and efficiency of fish farming operations.

It was further determined that on average, male fish farmers have higher levels of education (on average 8.3 years of schooling) compared to both married women (an average of 5.9 years of schooling) and unmarried women (5.5 years of schooling). Furthermore, as indicated by a significant p-value (P-value < 0.05), it can be ascertained that the disparity in the level of education among the three categories is significant. The level of education among fish farmers can directly influence the adoption of modern aquaculture practices, technological advancements, and sustainable management strategies. Higher levels of education equip fish farmers with the knowledge and analytical skills necessary to implement best practices, make informed decisions, and adapt to changing market dynamics. Educated fish farmers are more likely to embrace innovations in disease prevention, and efficient feed utilization, contributing to increased productivity and profitability.

Another significant disparity was established in the farmers experience in fish farming where it was established that on average, men fish farmers have an average experience of 13.2 years of fish farming compared to both married and the unmarried women fish farmers with an average fish farming experience of 8.63 and 6.66 years. This disparity in the experience of fish farming was also established to be statistically significant among the three categories to imply that men fish farmers were more on average more experienced than their women counterparts. Fish farming experience is invaluable for fish farmers as it represents a repository of practical knowledge, insights, and adaptive skills crucial for success in the aquaculture industry. Seasoned fish farmers bring a deep understanding of the specific challenges associated with raising fish, including disease management, water quality control, and feeding strategies among others which allows them to make informed decisions, troubleshoot issues effectively, and implement time-tested practices that contribute to optimal fish health and growth hence increasing incomes.

As an indicator of asset ownership, the land size dedicated to fish farming was also established across the three categories. It was similarly established that men fish farmers in Southern Malawi own an averagely larger proportion of land for fish farming (an average of 516.7 m^2) compared to both married women (an average of 397.08 m^2) and unmarried women fish farmers (an average of 291.3 m^2). This difference, based on the significant p-value, was also statistically significant to imply that on average, men fish farmers owned more land for fish farming compared to both married and single women (P-

value < 0.05). Land ownership serves as the foundational asset for establishing and sustaining aquaculture operations. Owning land provides fish farmers with the autonomy to design and develop ponds or other aquaculture infrastructure, allowing for long-term planning and investment. Land ownership therefore offers security and stability, enabling farmers to make substantial improvements and optimizations to enhance the productivity and efficiency of their fish farming ventures resulting to more income. It also facilitates access to financial resources, as land can be used as collateral for loans, enabling farmers to invest in technology, equipment, and sustainable practices.

In regard to the distance to the market, the study established disparities in the km^2 covered to access the markets where men fish farmers on average cover more distance (an average of 5.4 kms) compared to both married women fish farmers (an average of 4.2kms) and unmarried women (an average of 3.26kms). This disparity in the distance covered to the market was also established to be statistically significant (P-value < 0.05) to imply that on average, men cover longer distances to the market than women. This may be attributed to the earlier finding that men have alternative sources of markets than reliance on friends and neighbors and therefore they have to cover longer distances compared to the women. Market distance directly influences the accessibility of markets and the economic viability of aquaculture ventures. Proximity to markets reduces transportation costs and ensures fresher products, enhancing the competitiveness of fish farmers in meeting consumer demands. Shorter market distances facilitate efficient distribution, direct sales, reduce post-harvest losses, and enable farmers to respond more promptly to market fluctuations hence enhancing incomes.

The study also sought to establish whether they existed any differences in the stocking density (number of fingerlings per m^2) across the three categories. The results as indicated in Table 2 showed that on average, men fish farmers had larger stocking densities (an average of 404.0 fingerlings per m^2) compared to an average of 199.5 and 198.8 for both married and unmarried women. This disparity was also established to be statistically (P-value < 0.05) implying that on average, the men fish farmers in the Southern region of Malawi had more stocking densities compared to women fish farmers. Stocking densities influence the growth, health, and overall productivity of the fish population within an aquaculture system given that appropriate stocking density is crucial for maximizing the efficient use of resources, optimizing water quality management, and preventing overcrowding-related stress and disease outbreaks. Carefully determining the number of fish to stock in a given area ensures that the available space and resources are effectively utilized, promoting optimal growth rates and minimizing competition for food and oxygen.

The results on the number of extensions visits similarly indicated that compared to both married and unmarried women fish farmers, men fish farmers received an average of 4.3 extension visit in a single fish farming season. Married women received an average of 3.2 extension visit and unmarried women received an average of 2.2 extension visits in a single farming season. The results further showed that this disparity was statistically significant to imply that the men fish farmers benefited more from extension services compared to women (P-value < 0.05).

4.3. Regression Model's Diagnostic Tests

Before running the Ordinary Least Square multiple regression models, the study conducted diagnostic tests to establish whether the assumptions of classical linear regressions were violated. The study established the linearity tests, multicollinearity tests, autocorrelation tests, Homoscedasticity Test and normality test of the dependent variable. The normality of the dependent variable, HH income from fish farming was tested using Kolmogorov-Smirnova normality tests as presented in Table 3.

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Table 3: Kolmogorov-Smirnov Normality Test

	Statistic	df	Sig.
Household Income	0.033	375	.200*
* This is a lower bound of the true significance.			
a Lilliefors Significance Correction			

The results indicated that the dependent variable had insignificant Kolmogorov Smirnov value (P-value > 0.05) at 5% level of significance implying that the null hypothesis that the dependent variable is not normally distributed was not rejected. Since the data for the dependent variable was normally distributed, it was suitable to conduct ordinary least square multiple regression analysis. Multicollinearity test was conducted on the independent variable to find out whether they were highly correlated. A Variance Inflation Factor (VIF) method was adopted and the results are presented in Table 4.

Table 4: Variance Inflation Factor test of Multicollinearity

	Model 1 (Single Women)		Model 2 (Married Women)		Model 3 (Men)	
Independent Variables	**Tolerance**	**VIF**	**Tolerance**	**VIF**	**Tolerance**	**VIF**
Farmer's Age	0.74	1.35	0.96	1.04	0.98	1.02
HH Decision Maker	0.80	1.25	0.73	1.36	0.90	1.11
HH Size	0.87	1.15	0.62	1.61	0.64	1.57
Farmer's Level of Education (Years of Schooling)	0.50	2.00	0.51	1.96	0.54	1.87
Farmer's Experience in Fish Farming (Years)	0.84	1.20	0.47	2.14	0.61	1.64
Land Size dedicated to Fish Farming	0.85	1.18	0.91	1.10	0.57	1.74
Distance to the Market	0.60	1.68	0.42	2.40	0.48	2.08
Stocking Density	0.63	1.58	0.59	1.71	0.77	1.29
Membership to a Cooperative Society	0.68	1.48	0.29	3.41	0.52	1.92
Source of Fish Fingerlings Category	0.71	1.41	0.90	1.11	0.92	1.08
Categories of Accessible Fish Markets	0.79	1.27	0.22	4.50	0.93	1.08
Number of Extension Visits	0.76	1.32	0.89	1.13	0.97	1.03
Dependent Variable: HH Income from Fish Farming (MKW)						

Presence of multicollinearity inflates the standard errors of a regression model thus giving spurious results. The results as indicated in Table 4 indicated that there was no problem of multicollinearity since the variables had a VIF value less than 10 as required. Based on that, it was suitable to use the same data to run regression analysis since the results would not be affected by presence of multicollinearity. Durbin -Watson test was also used to test for existence of serial correlation in the residuals of the 3 models as presented in Table 5.

Table 5: Durbin-Watson Test of Serial Correlation

Model	Durbin-Watson Statistic
1 (Single Women)	1.522
2 (Married Women)	2.278
3 (Men)	1.953

The results indicated that the DW statistic for the residuals of each of the 3 models was within the recommended range of 1.5 to 2.0. This therefore ruled out presence of serial correlation hence suitable to run the OLS multiple regression models. Lastly, heteroscedasticity test was conducted to determine whether the variance in residuals of the 3 models was constant. Breusch-Pagan test was used and the results are presented in Table 6.

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Table 6: Breusch-Pagan Test of Heteroscedasticity

Model	Ho: Constant Variance
1 (Single Women)	Chi2 (3) = 0.768
	Prob > Chi^2 = 0.234
2 (Married Women)	Chi2 (3) = 0.479
	Prob > Chi^2 = 0.112
3 (Men)	Chi2 (3) = 0.498
	Prob > Chi^2 = 0.146

The results indicated in Table 6 indicated insignificant p-values (P-Value > 0.05) for each of the 3 models implying that the null hypothesis of constant variance was not rejected for any of the models. Therefore, it was established that there existed constant variance in the error terms of the 3 models and hence the assumption of classical linear regression on homogeneity was not violated thus suitable to model OLS regression models.

4.4. Regression Analysis Results

Following the tests of classical linear regression, 3 OLS multiple regression models were estimated. The regression model summary presented in Table 7 indicate that the 12 socio-economic factors tested under the study explained a variation in HH income from fish farming among the men (85.8%) followed by married women (81.5%) and lastly 54.7% among single women. This implies that the socio-economic factors under the study account for up to 85.8%, 81.5% and 54.7% of the variations in HH income from fish farming among the men, married women and single women fish farmers respectively.

Table 7: Regression Model Summaries

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1 (Single Women)	.807	0.651	0.547	5829.331
2 (Married Women)	.908	0.824	0.815	851.849
3 (Men)	.936	0.876	0.858	1596.376
Predictors: (Constant), Number of Extension Visits, HH Size, Land Size under Fish Farming, Categories of Accessible Fish Markets, Famer's Level of Education, Farmer's Experience in Fish, HH Decision Maker, Source of Fingerling, Farmer's age, Stocking Density, Membership to a Cooperative, Distance to the Market				
Dependent Variable: HH Income				

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ANOVA test was used to establish the model fitness of the three regression models estimating the socio-economic determinants of HH incomes from fish farming as shown in Table 8.

Table 8: Regression Model's ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1 (Single Women)	Regression	2.54E+09	12	2.11E+08	6.224	.000
	Residual	1.36E+09	40	33981103		
	Total	3.9E+09	52			
2 (Married Women)	Regression	1.51E+09	12	1.26E+08	49.257	.000
	Residual	2.14E+08	84	2548417		
	Total	1.72E+09	96			
3 (Men)	Regression	7.23E+08	12	60225130	82.995	.000
	Residual	1.54E+08	212	725647.5		
	Total	8.77E+08	224			

The ANOVA results showed that the 3 regression models were significant and good fits (Sig < 0.05). This therefore implies that the 3 models were good predictors of socio-economic determinants of HH incomes from fish farming in the Southern Malawi region. The regression model coefficients are as presented in Table 9.

Table 9: Regression Model's Coefficients

	Model 1			Model 2			Model 3		
	B	Std. Error	Sig.	B	Std. Error	Sig.	B	Std. Error	Sig.
(Constant)	76252.31	15570.17	0.000	49,709.41	3,663.32	0.000	82,159.25	1,223.15	0.000
Farmer's Age	233.19	96.39	**0.020**	(49.74)	30.42	0.106	3.25	6.98	0.642
HH Decision Maker	2048.33	2029.77	0.319	1,077.39	555.35	**0.056**	29.92	521.39	0.954
HH Size	-674.64	841.84	0.428	362.45	175.759	**0.042**	181.18	64.59	**0.005**
Farmer's Level of Education	2,508.92	720.05	**0.001**	192.65	154.90	0.217	59.76	36.43	0.102
Farmer's Experience in Fish Farming	14.22	215.94	0.948	305.66	64.91	**0.000**	61.31	14.84	**0.000**
Land Size dedicated to Fish Farming	8.57	10.97	0.439	1.76	1.85	0.346	5.47	0.77	**0.000**
Distance to the Market	(6142.39)	3628.50	**0.098**	(1,804.95)	534.54	**0.001**	(1,357.192)	135.68	**0.000**
Stocking Density	9.38	16.22	0.566	0.710	3.39	0.834	3.68	0.960	**0.000**
Membership to a Cooperative Society	2131.82	2163.19	0.330	597.05	675.54	0.379	519.78	165.74	**0.002**
Source of Fish Fingerlings Category	1368.90	1916.51	0.479	101.58	342.450	0.767	40.00	120.93	0.741
Categories of Accessible Fish Markets	2511.89	1907.36	0.195	4,985.91	720.49	**0.000**	1,094.87	300.98	**0.000**
Number of Extension Visits	1039.12	568.21	**0.075**	133.27	74.15	**0.076**	35.74	21.59	0.099

The regression findings as shown in Table 9 show that only the source of fish fingerlings was not a significant determinant of HH income from fish farming in any of the 3 categories among the farmers southern Malawi region (P-Value > 0.05). This contradicts the findings by Limuwa *et al*., (2018) who attributed low productivity and production in aquaculture to a number of challenges faced by fish farmers including the lack of quality inputs such as fingerlings and seed and lack of extension services. However, all the other socio-economic factors contributed to HH income in at least one category among the three. Specifically, it was established that the effect of farmer's age on HH income from fish farming was positive across the three categories. This was however significant among single women only (β = 233.19; P-Value < 0.05) but not significant among married women and men. The positive effect of age and HH income from fish farming among single women, compared to married women and men, may be attributed to the cumulative benefits of experience, network development, and resource management over time. Given that single women may have fewer family obligations compared to their married as well as male counterparts, they can demonstrate a greater capacity for long-term planning and efficient resource management, contributing to stable fish production and increased income.

The results also demonstrated that the effect of farmer's level of education on HH income from fish farming was positive across the three categories. This was however significant among single women only (β = 2,508.92; Value < 0.05) but not significant among married women and men. A higher level of education positively affects household (HH) income from fish farming due to the knowledge, analytical skills, and adaptability that education imparts. With a higher educational level, single women are more likely to adopt modern aquaculture practices, implement efficient resource management strategies, and navigate market dynamics effectively. Weeratunge *et al*., (2010) similarly indicated that the inability of women to make decisions, low education levels and lack of access to information and services impact their productivity and on households' capabilities to move out of poverty.

It was also established that the effect of HH decision making on HH income from fish farming was positive across the three categories was positive. This was however significant among married women only (β = 1,077.4; P-Value < 0.100) but not significant among single women nor men. This may be attributed to the collaborative and synergistic nature of family decision-making dynamics where married women may share responsibilities and decisions with their spouses, enabling them to leverage diverse perspectives and skills. This collaborative decision-making can lead to more strategic choices regarding resource allocation, investment decisions, and overall management strategies in fish farming compared to the individual cases of single women and men. Additionally, the stability and support provided by a marital partnership can contribute to long-term planning, risk mitigation, and sustained commitment to fish farming activities, ultimately enhancing the economic viability of the household's involvement in fish farming and positively influencing HH income. These findings are consistent with that of Morgan *et al.* (2016) who attributed gender disparities in benefits from aquaculture to gender norms that can negatively impact women's ability to make decisions over their labour, access information they need, or own assets. Kruijssen *et al*., (2018) similarly noted that limited decision-making power by women on land use, decision to access credit or other resources and lack of decision-making power and control over products of their labour put women at a disadvantage in agriculture and aquaculture production.

In regard to HH size, the results demonstrated that the effect of HH size on HH income from fish farming was positive among married women and men but negative among single women. Additionally, the effect of HH size was significant among married women and men but not single women (β = 362.45; P-Value < 0.05) and (β = 181.18; P-Value < 0.01) respectively. The positive and significant impact of HH size on HH income from fish farming among married women and men as opposed to single women, may be attributed to the collaborative labor and resource-sharing dynamics within larger households. In married settings, a larger HH size may imply cheaper labour for fish farming activities such as pond maintenance, harvesting, and marketing. This increased labor force can lead to higher productivity and efficiency in fish farming activities, ultimately translating into enhanced income. The findings are consistent with that of Omeje *et al*. (2021) who also revealed that household size had a positive and significant effect on net-farm income from fish farming

due to increased labour options.

The study also established that farmer's experience in fish farming had a positive effect on HH income from fish farming. However, the effect was only significant among married women and men but not single women (β = 305.66; P-Value < 0.01) and (β = 14.84; P-Value < 0.01) respectively. This may be attributed to accumulated knowledge, skills, and adaptive strategies that come with years of engagement in the sector. Those with less experience, may face a steeper learning curve and potentially lack the depth of insights and networks that come with long-term involvement in fish farming, impacting their ability to maximize income from their aquaculture activities. The findings are consistent with those by Ukagwu, Sampson and Nkulo (2020) who also established that years of farming experience are positively correlated with net farm returns in fish farming in Owerri North LGA of Imo State.

It was also established that land size dedicated to fish farming had a positive effect on HH income from fish farming. However, the effect was only significant among men and not married nor single women (β = 61.31; P-Value < 0.01). This may be attributed to the fat that men, often having larger land holdings (as established in the descriptive statistics) can allocate more extensive areas for fish farming, allowing for increased production and potential economies of scale. In contrast, both married and single women, who may have smaller land holdings, could face constraints in scaling up their fish farming activities, limiting the scope for diversified operations and overall income generation. These findings have been supported by other studies such as Veliu et al. 2009; Kruijssen et al., 2018; Ndanga et al., 2013; Mushili & Musuka, 2015; Banda & Musuka, 2020 who indicated that gender norms and distribution of resources such as land have often been cited to explain limited engagement by women in the smallholder aquaculture sector in African countries

Distance to the market, was associated with a negative effect on HH income from fish farming across the three categories. The effect was also significant across the three categories of single women, married women and men (β = - 6,142.39; P-Value < 0.10); (β = 1,804.95; P-Value < 0.01) and (β = 1,357.19; P-Value < 0.01) respectively. These results imply that market distance directly influences the accessibility of markets and the economic viability of aquaculture ventures. Proximity to markets reduces transportation costs and ensures fresher products, enhancing the competitiveness of fish farmers in meeting consumer demands. Shorter market distances facilitate efficient distribution, direct sales, reduce post-harvest losses, and enable farmers to respond more promptly to market fluctuations hence enhancing incomes. Prince, A. (2020) similarly established that access to market in significantly affects the profits of fish farming in the southern sector of Ghana.

The study further established that stocking density has a positive effect on HH income from fish farming. However, the effect was only significant among men and not married nor single women (β = 3.68; P-Value < 0.01). The positive impact of stocking density on household (HH) income from fish farming is potentially more pronounced among men than women due to the scalability and efficiency that higher stocking densities can offer in larger-scale operations. Men, often engaged in more extensive and commercially oriented fish farming activities, may have the capacity to manage higher stocking densities, leading to increased fish production and income. The ability to optimize the use of available resources, such as pond space, becomes more viable with higher stocking densities. In contrast, women, who may be involved in smaller-scale or subsistence-oriented fish farming, could face challenges associated with managing higher stocking densities without adequate resources and infrastructure, potentially limiting the positive impact on HH income. The findings are consistent with those of Kruijssen *et al*. (2018) who established that women own fewer assets than men in terms of the number of assets owned such and the value of those assets, limiting what women can do, produce and benefit. The same applies to stock density of fingerlings.

It was also established that the effect of membership to a cooperative society had a positive effect on HH income from fish farming. However, the effect was only significant among men and not married nor single women (β = 519.78; P-Value < 0.01). The result may imply that men fish farmers may have historically enjoyed greater access to economic resources, financial education, and networking opportunities, making them more likely to join and benefit from cooperative societies

which offer them the chance to pool resources, access credit facilities, and collectively invest in advanced technologies or larger-scale farming practices, contributing to increased productivity and income. In contrast, women, facing systemic barriers and limited access to financial resources, may encounter challenges in joining or actively participating in such cooperatives, potentially constraining the positive impact on HH income from fish farming. The findings support the arguments by Banda & Musuka, 2020; Brugere & Williams, 2017, Dambatta *et al*. 2016; Veliu *et al*., 2009; Ndanga *et al*., 2013 who documented that in some African countries, women may not actively engage in aquaculture because they lack the start capital and have no access to appropriate financial products.

Access to markets was also positively related to HH income from fish farming. However, the effect was only significant among married women and men as opposed to single women (β = 4,985.91; P-Value < 0.01); (β = 1,094.87; P-Value < 0.01) respectively. These results may be attributed to access to alternative markets other than reliance on friends and neighbors (as indicated in the descriptive statistics among single women). Married women and especially men, often with more extensive networks and access to resources, may have the capacity to explore diverse market channels beyond friends, neighbors, local or traditional outlets. This flexibility enables them to adapt to changing market dynamics, leverage diverse market sources, and potentially secure more favorable prices for their fish products thus realizing higher incomes. Brummett, Gockowski, Pouomogne and Muir (2011) similarly noted that good market access leads to increased productivity, profitability, and net returns from aquaculture.

The number of extension visits was also lastly linked to positive effect on HH income from fish farming. However, the effect was only significant among single and married women as opposed to men (β = 1,039.12; P-Value < 0.01); (β = 1,0133.27; P-Value < 0.01) respectively. The number of extension visits can have a more pronounced positive impact on household (HH) income from fish farming among women compared to men due to potential gender-specific challenges and the empowerment potential of targeted extension services. Women, who may face systemic barriers and limited access to resources and information, benefit significantly from extension services that offer tailored guidance, training, and support which may enhance women's knowledge of modern and sustainable fish farming practices, disease management, and market access, thereby improving the efficiency and productivity of their operations. In contrast, men, who may traditionally have more access to information and resources, might already possess a baseline level of knowledge that makes the incremental impact of extension services on HH income less pronounced. Therefore, increasing the number of extension visits is particularly crucial for empowering women in fish farming, ultimately contributing to elevated incomes and sustainable practices within women-led households. This supports the findings by Limuwa *et al*., (2018) who attributed low productivity and production in aquaculture to a number of challenges faced by fish farmers including the lack of quality inputs such as fingerlings and seed and lack of extension services.

5. CONCLUSION

Based on the findings, several key conclusions can be drawn. Firstly, there is a significant gender disparity in household decision-making among smallholder fish farmers in Southern Malawi, with the majority of decision-makers being men. This underscores the importance of understanding the pivotal role of decision-makers in shaping the direction and economic viability of fish farming ventures. Secondly, membership in cooperative societies is not widespread among fish farmers in the region, indicating potential challenges in accessing essential financial resources and support. Given the capital-intensive nature of fish farming, low cooperative membership rates may lead to resource constraints impacting farmers' incomes. Thirdly, the study highlights variations in sourcing fish fingerlings, with a significant number of men opting for alternative sources, while women, especially single women, tend to recycle their own fingerlings. This distinction has implications for disease control and genetic quality in fish stocks. Additionally, market access varies, with single women having fewer alternatives than men and married women, posing a potential risk in market volatility. Lastly, disparities in income, education, experience, land ownership, and market distance were observed across gender categories, indicating the need for targeted interventions to address these inequalities in the Southern Malawi fish farming context.

The regression findings reveal nuanced patterns regarding the determinants of household (HH) income from fish farming across different categories of farmers in Southern Malawi. Farmer's age positively influenced HH income among single women, reflecting the cumulative benefits of experience, network development, and resource management over time. The positive impact of age on income was not significant among married women and men, suggesting that single women, with potentially fewer family obligations, demonstrate a greater capacity for long-term planning and efficient resource management. Similarly, the positive effect of farmer's level of education on HH income was significant only among single women, highlighting the role of education in empowering women to adopt modern aquaculture practices and navigate market dynamics effectively. HH decision-making positively influenced income among married women, emphasizing the collaborative and strategic choices made in family decision-making dynamics.

In contrast, HH size had a positive impact on income among married women and men, reflecting the collaborative labor and resource-sharing dynamics within larger households, while it had a negative impact among single women, possibly due to limited resources in smaller households. Farmer's experience in fish farming significantly influenced income among married women and men, showcasing the accumulated knowledge and adaptive skills crucial for success in the sector. Land size dedicated to fish farming positively impacted income, but the effect was significant only among men, indicating the scalability and efficiency advantages men with larger land holdings may enjoy. Market distance had a negative effect on income across all categories, emphasizing the importance of proximity to markets in reducing transportation costs and ensuring fresher products.

Stocking density positively influenced income among men, highlighting the scalability and efficiency in larger-scale operations, while the effect was not significant among women, suggesting potential challenges in managing higher stocking densities without adequate resources. Membership to a cooperative society positively influenced income among men, underscoring the historical gender disparities in access to economic resources and networking opportunities. Access to markets positively influenced income among married women and men, reflecting the benefits of diverse market channels beyond local outlets. The number of extensions visits positively influenced income among women, emphasizing the empowerment potential of targeted extension services to enhance knowledge and productivity. Overall, these contrasting conclusions underscore the importance of considering gender-specific factors and contextual nuances in designing interventions to improve HH income from fish farming in Southern Malawi.

6. RECOMMENDATIONS AND POLICY IMPLICATIONS

The findings lead to several policy implications for enhancing the economic viability and sustainability of smallholder fish farming in Southern Malawi underscoring the importance of a gender-sensitive and context-specific approach to foster inclusive and sustainable development in the Southern Malawi fish farming sector. Firstly, acknowledging the significant gender disparity in household decision-making underscores the need for targeted interventions to empower and involve women in key decision-making processes. Initiatives that promote gender equality, provide education and training for women in fish farming practices, and encourage their active participation in decision-making forums can contribute to more inclusive and resilient fish farming ventures.

Secondly, addressing the limited membership in cooperative societies among fish farmers is crucial for overcoming financial constraints. Policymakers should focus on promoting cooperative participation through awareness campaigns, providing financial education, and facilitating the establishment of cooperatives tailored to the needs of fish farmers. Access to financial resources and collective support can enhance the capacity of farmers to invest in necessary infrastructure, technology, and sustainable practices, ultimately improving their incomes.

Thirdly, recognizing the variations in sourcing fish fingerlings highlights the importance of supporting farmers, especially women, in accessing high-quality fingerlings. Initiatives that provide training on proper fish breeding techniques, disease control, and the advantages of sourcing fingerlings from reputable sources can contribute to improved genetic integrity

and overall productivity in fish farming.

Additionally, addressing disparities in income, education, experience, land ownership, and market distance across gender categories calls for a comprehensive approach. Policymakers should design interventions that promote equitable access to education, provide targeted support for women in gaining experience and land ownership, and improve market infrastructure to reduce transportation costs and increase market access for all fish farmers.

Furthermore, recognizing the positive impact of stocking density, membership in cooperative societies, and access to alternative markets on household income among men emphasizes the need for tailored support for male fish farmers. Policymakers should explore initiatives that enhance scalability, efficiency, and market access for men, while concurrently designing targeted extension services to empower women in fish farming practices, ultimately contributing to increased incomes and sustainability.

7. ACKNOWLEDGMENTS

This study and manuscript would not have been possible without the availability of 4,721 fish farmers (pond owners) in the Southern fish-producing districts of Mulanje, Phalombe, Thyolo, Mwanza and Blantyre who voluntarily participated in the study.

8. ETHICAL APPROVAL AND CONSENT

All procedures performed in this study were in accordance with the required ethical standards and research protocol / proposal by National Commission for Science and Technology, Malawi.

9. DECLARATION OF CONFLICT OF INTEREST

The author declares that he has no conflict of interest.

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