EFFECTS OF ADOPTION OF FISH PRODUCTION TECHNOLOGIES ON FOOD SECURITY STATUS OF FARMERS IN UMUAHIA AGRICULTURAL ZONE OF ABIA STATE, NIGERIA

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ABSTRACT
This study analysed the effects of adoption of fish production technologies on the food security status of farmers in Umuahia Agricultural zone of Abia State, Nigeria. Proportionate sampling was used to select ninety-one (91) fish, farmers. Data were collected using a structured questionnaire and analysed using descriptive statistics, Tobit regression, and Z-test analyses. The results showed that, majority (74.72%) of fish farmers were males with a mean age of 42.5 years, mean household size of six (6) persons, 68.83% acquired secondary education with a mean annual on-farm income of ₦291,774.00, and mean cooperative membership of 4.4years. Majority (70.32%) of the fish farmers sourced information from fellow farmers; most (62.64%) reared fish in movable tarpaulin with medium-sized ponds (49.48%) and had high adoption ($\bar{x} = 3.7$) of fish production technologies. Tobit analysis result showed that, age (β = - 0.6579), education (β= 0.3990), farm income (β= 0.3765), occupation (β= 0.3472), pond size (β = - 0.5899), household size (β= 0.3245), farming experience (β= 0.7647) and membership of cooperative societies (β = 0.6745) influenced farmers' adoption of fish production technologies. Z-test results showed a difference in mean food security status for farmers before and after the adoption of fish production technologies at a 1.0% level of probability. Based on the results from this study, fish farmers adopted fish production technologies as they increased their food security status.
Keywords: *Effect, adoptions, fish, production technologies, food security.*

INTRODUCTION

Fish farming as a livelihood activity contributes to the food security of any developing nation such as Nigeria (Food and Agriculture Organization (FAO), 2020a). Africa's most common cultivated fish species include catfish (*Clarias garienpinus*) and *Clarias lazera* and *Heterobranchus spp* (Nlewedim, 2004). The total fish production in Nigeria is about 1.123million metric tonnes, while the annual consumption is about 3.6million (Nanono, 2021). National Bureau of Statistics (2020), in their survey, affirmed that, the total aggregated domestic fish supply from all sources (capture and culture fisheries) was less than 0.7million metric tons per annum to satisfy the dietary requirement of its citizens. Therefore, farmers' management practices of technology adoption are a pre-requisite for food security and economic prosperity in developing nations.

Technology transfer helps to increase agricultural productivity, increases the acceptability of disseminated technology, reduce production costs, and lower consumer prices. Thus, appropriate technologies should be based on simplicity and alignment with the socio-cultural lives of the adopters (Omotesho *et al*., 2019).

The adoption or rejection decision of the farmer is, to a more significant extent, dependent on the degree of risk involved relative to the existing practices (Nwaobiala and Ikpegbu, 2019). In Nigeria, where, most fish farmers cannot produce to their farms' maximum capacity due to lack of understanding of the potentials embedded in aquaculture technologies or insufficient information; well-developed fish technologies are essential to substantiate aquaculture development (Mbah and Njoku, 2021). Furthermore, food security is an essential determinant of a healthy and well-nourished population (Food and Agriculture Organization, 2018) which exist when people have physical and economic access to sufficient, safe, and nutritious food to suit their dietary needs and preferences for ~~a~~ healthy and active lifestyles at all times (Asawalam, 2019).

Notable efforts have been made to disseminate improved catfish production technologies such as; ponds construction, water management, stocking rates, use of nutritious floating feeds, fertilization of ponds, optimum feeding rates, test cropping, fingerlings production, transportation, and processing (Ogunremi and Olatunji, 2019; Food and Agriculture Organization, 2020a). However, it is unclear how these improved fish technology packages have affected the food security of the beneficiary farmers in this study area. In the light of the aforementioned, the responses of fish farmers to the use of new technologies for fish production in Umuahia Agricultural zone, Abia State were investigated in this study. This study premised on two hypotheses for which the Tobit regression model and Z-test analysis were used:

$H0_1$: There is no significant relationship between the selected socioeconomic characteristics of the farmers and their adoption of fish production technologies in the study area.

$H0_2$: There is no significant difference between the food security status of the farmers before and after the adoption of fish production technologies in the study area.

These hypotheses were tested at a 5.0% level of probability.

MATERIALS AND METHODS

The Study Area

The study was carried out in Umuahia Agricultural zone of Abia State, Nigeria. The zone is made up of seven (7) blocks namely; Umuahia North, Umuahia South, Ibeku, Isiala-Ngwa North, Ohuhu South, and Ohuhu North. The zone is located in the South-East agro-ecological zone of Nigeria and lies between Latitudes 5º5287961N and Longitude 7º 4897325E. The zone has a tropical climate and is humid all year round. The rainy season is from March to October. The dry season occurs from November to February. The mean annual rainfall ranges from 2000mm to 2500mm with the Southern areas receiving more than the Northern area (Abia State sAgricultural Development Programme, 2015).

Sampling Procedure

The sampling frame was drawn from the list of fish farmers in the Umuahia agricultural zone of Agricultural Development Programme headquarters of Abia State, Nigeria. A preliminary survey conducted across the selected blocks showed the existence of one hundred and twenty-nine (129) fish farmers in the selected blocks in the zones that made up the sampling population. Purposive and proportionate sampling techniques were adopted in the study. Four (4) out of seven (7) blocks namely; Umuahia North, Isiala-Ngwa North, Ikwuano, and Ohuhu North in the zone were purposively selected based on the intensity of homestead fish farming in the zone. In the second stage, a proportionate sampling technique was used to select 70% of the existence 129 fish farmers in the selected blocks**.** This gave a total of ninety-one (91) fish farmers selected for the study

Data Analysis

Data generated were analysed using descriptive statistics such as, frequency counts percentages, and mean scores for the socio-economic characteristics of the fish farmers, sources of information on fish production technologies, types of fish production systems practiced by farmers, and levels of adoption of fish production technologies amongst the farmers, while food security status of the farmers before and after adopting fish production technologies was determined using the food security index.

Measurement of Variables

Levels of adoption of fish production technologies among farmers was realized using adoption scale analysis. This was in accordance with Nwaobiala (2014) who used a 5-point type rating scale of; Aware = 1; Interest = 2; Evaluation = 3; Trial = 4; Accept= 5. Farmers with an adoption score of 3.0 and above were regarded as having reached the mean adoption score of technology and below non- adoption. The categorization of adoption were as follows: 1.0 – 1.49 = Awareness, 1.50 – 1.99 = Interest, 2.0 – 2.49 = Evaluation, 2.50 – 2.99 = Trial and 3.0 and above = Adoption of stages of the technology. The food security of fish farmers before and after the adoption of fish production technologies was realized using the food security index.

The food security index was determined by classifying the households into food secure and food insecure households, using the food security index (Fi), according to Oluwayemisi and Oluwakemi, (2016).

$$Fi = \frac{per\ capital\ food\ expenditure\ for\ ith\ household}{\frac{2}{3} mean\ per\ capital\ food\ expenditure\ of\ all\ households} \quad \ldots\ldots (1)$$

Where:

2/3 = Mean per-capita food expenditure of the sampled households

Fi = Food security index (Fi > 1= Food secure i^{th} household and Fi < 1= Food insecure i^{th} household).

The headcount index (H) of food security was calculated to measure the percentage of the population of households that are food secure/insecure.

The headcount index formula is given by;

Headcount index (H) = M/N

Where M = number of food secure/insecure households

N = the number of households in the sample …. (2)

Model Specifications

Hypothesis 1 was tested using Tobit regression model stated thus;

Since the adoption of fish production technologies among farmers cannot be negative (the threshold is zero), the dependent variables can be written using an index function approach.

The empirical model are presented below,

$(I^{*}I = B^{t}X + ei)$ …….. (3)

$(Yi = 0 \text{ if } Ii^{*} = T)$ …….. (4)

$(Yi = I \text{ if } I^{*} > T)$ …….(5)

Where:

Y represents a limited dependent variable, which simultaneously measures the levels of adoption of fish production technologies.

T is an observed threshold level

X is the vector of the parameter to be the estimated error term.

If the non-variables T becomes a continuous function of the independent variables and O otherwise for the generalised case.

The value of log likelihood function is given as an empirical model presented below;
Where;
$Y = f(\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7, \beta_8, \beta_9, \beta_{10}, \beta_{11} + \beta_{12} + \beta_{13} + ei)$ …….. (6)
Y = levels of adoption of fish production technologies (measured by mean scores).
β_0 = constant
β_1 = gender (male – 1, female=0)
β_2 =age of respondents (years)
β_3 = marital status (married =1, otherwise = 0)
β_4 = household size (number of people living under one roof)
β_5 = education level (years spent in school)
β_6= annual farm income (₦)
β_7= non–farm income (₦)
β_8= fish farming experience (years)
β_9 = pond size (m^2)
β_{10} = number of ponds (mean)
β_{11} = occupation (farming= 1, otherwise = 0)
β_{12}= cooperative membership (numbers)
β_{13}= extension contact (numbers of visits)
ei= error term

Hypothesis 2 was tested using Z-test analysis

The model for Z-test analysis of comparison is specified thus:

$$Z = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}} \quad \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

$n_1 + n_2 - 2$ degrees of freedom

Where:
Z = Z Statistic
$\bar{X}_1$ = sample mean of food security status before the adoption of fish production technologies
$\bar{X}_2$ = sample mean of food security status after the adoption of fish production technologies
σ^2_1 = standard deviation of farmers before the adoption of fish production technologies
σ^2_2 = standard deviation of farmers after the adoption of fish production technologies
n_1 = sample size for fish farmers before the adoption of fish production technologies
n_2= sample size for fish farmers after the adoption of fish production technologies

RESULTS

Socio-Economic Characteristics of the Farmers

Results of the socio-economic characteristics of the fish farmers in Table 1 showed that, the mean ages of the fish farmers was 42.5years. The result also indicated that most (68.83%) of the farmers had secondary education with a mean farm income of ₦291, 774.00 per annum, which translated to ₦24, 314.50 per month. In addition, the farmers' had a mean household size of 6 persons and cooperative membership and 4.4years, respectively.

Table 1: Selected Socio-economic Characteristics of the Fish Farmers in the Study Area

Variables	Frequency (n = 91)	Standard Deviation
Age (years)	42.5	± 37.6
Education (secondary) (%)	68.63	± 56.83
Farm income (naira)	291,774.00	±256,764
Household Size (numbers)	6	± 4.3
Cooperative membership (years)	4.4	± 2.6

Source: *Field Survey, 2022*

Sources of Information on Fish Production Technologies

The sources of information on fish production technologies are shown in Figure 1. The result indicated that, most of the fish farmers sourced information from fellow farmers (70.32%) and personal observations (57.14%).

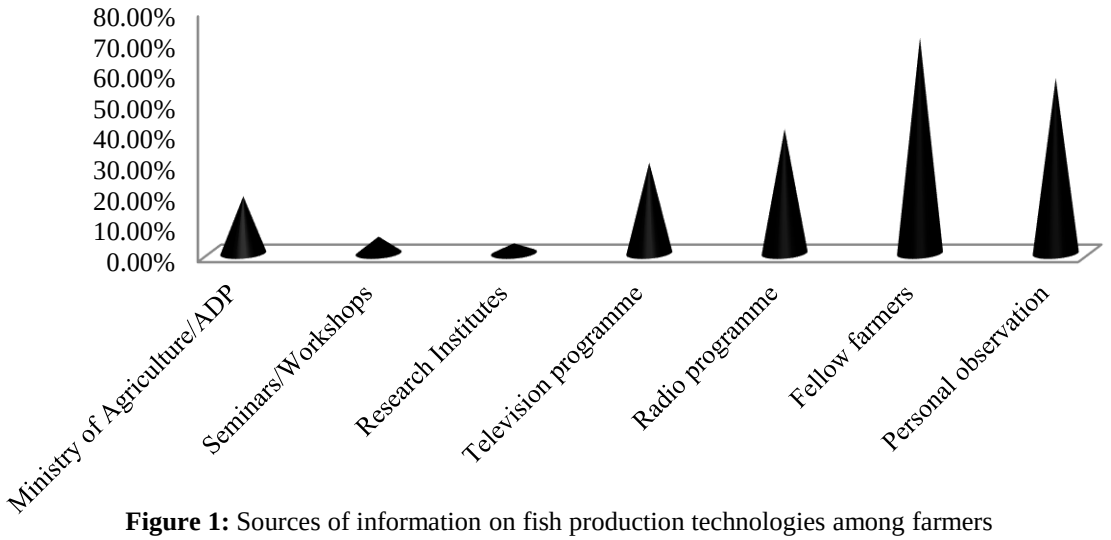

Figure 1: Sources of information on fish production technologies among farmers

Types of Fish Production Systems

Table 2 shows farmers' different fish production systems in the study area. The results indicated that, most (62.64%) of fish farmers reared fish in movable tarpaulin, 15.38% in concrete and earthen ponds, respectively, while (7.00%) in fiber tanks. Furthermore, a moderate proportion (48.35%) of the fish farmers had between 3-4 ponds, 39.56% had between 1-2 ponds while, 12.09% had between 5 – 6 ponds. The mean number of the fish ponds per farmer was 4. Farmers reared fish on medium pond sizes (42.85%), small ponds (32.47%), and large ponds (4.41%). However, the majority of the farmers reared catfish (79.12%), 10.98% (tilapia), and 9.9% (carp).

Table 2: Distribution of Respondents on the Types of Fish Production Systems Practiced by Farmers in the Study Area

Fish Production Systems	Frequency (n=91)	Percentage
Types of Pond		
Movable tarpaulin	57	62.64
Concrete	14	15.38
Fibre tanks	6	7.00
Earthen pond	14	15.38
Number of Ponds		
1 – 2	36	39.56
3 – 4	44	48.35
5 – 6	11	12.09
Mean ($\bar{X}$)		**4**
Pond Size (m^2)		
Small (4x2x1) 11.2	39	40.20
Medium (10x5x1) 70	48	49.48
Large above (10x5x1) 70	4	4.41
Species of fish reared/stocked		
Tilapia	10	10.98
Catfish	72	79.12
Carp	9	9.9

Source: *Field Survey, 2022*

Levels of Adoption of Fish Production Technologies

The result in Figure 2 showed that, the farmers had high adoption ($\bar{x} = 4.5$) of the transportation of fingerlings. The fish farmers had high adoption of stocking of ponds ($\bar{x} = 3.7$), feeding/feeding rates, and harvesting techniques with mean ratings of 3.6, respectively. They also adopted pond site selection, pond installation, pond fertilization/liming technologies with mean scores of 3.5 and water control ($\bar{x} = 3.4$). More so, the farmers recorded a moderate adoption of pond construction ($\bar{x} = 2.7$) and fish preservation and processing ($\bar{x} = 2.6$). The mean adoption score for

the adopted technologies among the fish farmers was 3.4, indicating high adoption

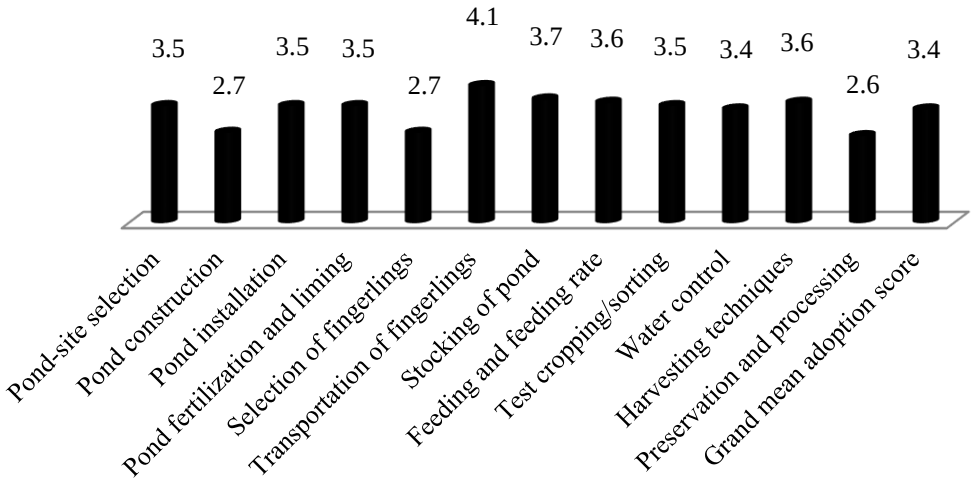

Figure 2: Levels of adoption of fish production technologies among farmers

Food Security Index of Farmers Before and After Adoption of Fish Production Technologies

For the food security index (Fi), Table 3 showed that, there was more food security (45.06%) for farmers after adopting fish production technologies than before adoption (31.87%).

Table 3: Frequency Distribution of Food Security Index of Fish Farmers before and after the Adoption of Fish Production Technologies

Variables	**Before Adoption**		**After Adoption**	
Food security index	**Frequency**	**Percentage**	**Frequency**	**Percentage**
Food insecure	62	68.13	50	54.94
Food secure	29	31.87	49	45.06

Source: *Field Survey, 2022*

Relationship between Selected Socio-economic Characteristics of Respondents and their Adoption of Fish Production Technologies

Table 4 showed the estimated results of the Tobit regression analysis of the adoption of fish production technologies in Umuahia Agricultural zone of Abia State, Nigeria. The Chi square ($\varkappa^2$) of 69.91 was significant at a 1.0% probability level. The pseudo R^2 value of 0.6891 indicated 68.91% variability which was a goodness of fit of the Tobit regression line. The coefficients for age (β = - 0.6579) and pond size (β = - 0.5899) were negative and highly significant at 1.0% level of probability in the study area. The coefficients for education (β = 0.3990) and farm income (β = 0.3765) were positive and significant at a 5.0% probability level. The coefficients for occupation (β = 0.3472), household size (β = 0.3245), and membership in cooperative societies (β = 0.6745) were significant at 5.0% and had a direct relationship with farmers' adoption of fish production technologies in the study area. The coefficient for farming experience (β = 0.7647) was positive and significant at a 1.0% probability level

Table 4: Tobit Regression Estimates the Relationship of Selected Socio-economic Characteristics of Farmers' Adoption of Fish Production Technologies among Farmers in the Study Area

Variables	Parameters	Coefficients	Standard Error	T-value
Constant	β_0	31.434	16.5654	11..31***
Gender	β_1	0.6146	0.0026	0.4651
Age	β_2	- 0.6579	-1.4440	6.23***
Marital status	β_3	0.0342	0.0026	0.118

Household size	β_4	0.0872	5.3245	4.877***
Education	β_5	0.3990	4.679	2.53**
Annual farm income	β_6	0.3765	3.3180	2.64**
Non-farm income	β_7	-0.0078	- 0.1864	-0.74**
Farming experience	β_8	0.7647	0.4481	3.16***
Pond size	β_9	- 0.5899	-4.2927	-7.92***
Number of ponds	β_{10}	0.1444	0.1478	0.44
Occupation	β_{11}	0.3472	3.7694	2.72**
Cooperative membership	β_{12}	0.6745	3.7856	2.20**
Extension contact	β_{13}	0.1153	0.9583	0.763
Chi^2 ($\varkappa^2$)		69.91***		
Pseudo R^2		0.6891		
Log likelihood		**44.4481**		

Source: Field Survey, 2022
** $P \leq 0.05$ and *** $P \leq 0.01$

Differences between Food Security Status of Farmers before and after Adoption of Fish Production Technologies

The result of the difference in mean food security status for farmers before and after the adoption of fish production technologies in the study area is presented in Table 5. It revealed that, the mean food security status for the farmers before and after the adoption of fish production technologies were 19,520.42 and 14,894.42 respectively. The difference in mean between the two groups of farmers was 4,262.6 with a standard deviation of 3,590.0. The result indicated that fish farmers had food security after the adoption of fish production technologies.

Table 5: Z-Test of Significant Differences between Food Security Status of Farmers before and after the Adoption of Fish Production Technologies in the Study Area

Variables	Mean	Standard Deviation	Z-Cal	Z –Tab
Before Adoption	19,520.42	16,342.11		
After Adoption	14,894.42	12,752.20		
Combined	33,414.87	2880107.53		
Difference	4,262.6	3,590.0	4.31***	2.58

Source: *Field survey, 2022*
Key: *** $P \leq 0.01$

DISCUSSION

The fish farmers were young, active, and capable of undertaking activities involved in fish farming, such as; test cropping, water control, and cleaning of ponds were consistent with the finding of Okorie *et al*., (2019), who affirmed that, farmers within active age group have more innovative ability and agricultural production efficiency for household food security. From the findings, farmers were literate and capable of accepting fish production technologies. Alfa and Adejo, (2019), and Mbah and Njoku, (2021), postulated that, the more educated the farmer is, the more he/she is civilized and informed about scientific practices and thus, found literacy as a determinant for fish technology adoption. Farm income from sales of fish is as a result of the total output of stocked in a given pond. Household sizes have provided cheap labour in agricultural activities, especially fish farming (Agwu *et al*., 2019). Fish farmers belonging to cooperative groups enhance their access to production inputs such as improved fingerlings, fish feeds and credit access. Yusuf, (2018) asserted that, farmer cooperatives enhance advantages of the economics of scale, overcome the barrier to assets, provide better management of available resources, and provide access to information delivery on agricultural production.

The study also revealed that, information source(s) play(s) vital role(s) in technology adoption. It facilitates access to improved farm inputs and boosts the confidence of the farmers who utilizes them (Nwaobiala and Ile, 2016).

The study suggested that, fish farmers preferred rearing fish in movable tanks because of space, convenience, and flexibility in relocating

them when needed which was in line with the findings of (Idowu, 2013). This study agreed with that of Nwaobiala, (2014), who found that, fish farmers in Cross River State, Nigeria operated between 3 – 4 ponds. The study showed that, fish farmers in the study area had medium pond sizes in fish production. Kudoro, (2013, affirmed that, the adoption of fish production technologies is enhanced when farmers practice the technology on a medium scale. According to Adeboye and Daramola, (2013), farmers in Nigeria raise catfish because it is one of the safest animal protein sources, has low cholesterol content, and provides better protein nutrition than other fish. The adoption of innovation disseminated to farmers through agricultural promoted programs has been shown to improve farmers' farming practices, which are geared toward improving their livelihoods and ensuring food security (Okoronkwo and Umeh, 2018).

The study showed that, after adoption of fish production technologies, a good proportion (54.94%) of farmers were food insure as against 45.06% that were food secure. The result implied that adoption of fish production technologies by farmers has increased their food security status by 13.19%. The food security status of fish farmers was consistent with the findings of Kinde and Eforuoku, (2020); Otekunrin, (2021) who noted that, two third of the farming households in Nigeria's study were not food secure.

It was found through regression analyses that as age and pond size increased, fish production technology adoption decreased. Younger farmers were more likely to be involved in fish farming in the study area, which implied that, many of the tasks associated with this industry are labour-intensive. This corroborated the findings of Oluwatayo and Adedeji (2019) and Nwaneri *et al*. (2018). The result on pond size was against a *priori* expectation with small farms; it has been argued that, high fixed cost is a constraint to technology adoption (Mbah and Njoku, 2021). This implied that, any increase in these variables will lead to an increase in the adoption of fish production technologies. This agreed with the findings of Shettima *et al*., (2014), as they opined that, education increases productivity and enhances farmers' ability to understand, evaluate and adopt new production technologies. In Nigeria, Ijah *et al*., (2020), found a positive relationship between farm income and fish production technology adoption. The findings of this study suggested that, increasing these variables will increase fish production technology adoption in the study area. This agreed with the Food and Agriculture Organization (2020b) and the Federal Department of Fisheries (2018), as they reported in their surveys that, the majority of farmers engaged in fish farming activities were full-time farmers. A larger household size has shown to be an essential input for unpaid labour (Nwaobiala 2014). One of the benefits of professional organisation membership is access to market and technical knowledge. Nwaobiala *et al*., (2019) noted that, farmers who are members are better placed to participate actively in the programs than those that do not belong. This implied that, any increase in farming experience will increase the adoption of fish production technologies. Aphunu and Agwu, (2014) reported that, the farming experience positively affected farmers' decision to adopt improved fish technologies. The findings agreed with the Federal Ministry of Agriculture and Rural Development (2020) report, which showed that, access to food in rural areas of Nigeria increased availability based on agricultural-driven innovations as disseminated to farmers.

The study revealed that famers were food secure after adoption of fish production technologies. This implied that the food security status of farmers when compared were different before and after the adoption of fish production technologies (as the calculated "Z" was 4.31, which was greater than the tabulated "Z" of 2.58 and statistically significant at a 1.0% level of probability). Adoption of agricultural technologies has remarkable increase in the production of various commodities such as fish that had positive impacts on the food security and livelihoods of rural farmers as it integrate food stability, access, and availability of nutritionally adequate food for utilization. This finding is in consistent with Nguka *et al*., (2017) which revealed that fish farming adoption has effect on food security status of farmers in Western Kenya.

CONCLUSION

From the findings of this study, fish farmers adopted fish production technologies at a high rate, with age, education, farm income, occupation, pond size, household size, farming experience, and membership in cooperative societies all playing their roles. In addition, fish farmers' were food secure after adoption of fish production technologies.

The study recommends that, relevant agencies and the government develop policies to strengthen extension delivery on fish production technologies and form cooperative groups for access of farm inputs such as, hybrid fish seeds, feeds, and credit.

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