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RESEARCH ARTICLE

DETERMINANTS OF ADOPTION OF IMPROVED PROCESSING TECHNOLOGY AMONG CATFISH PRODUCER-PROCESSORS IN SOUTH WESTERN, NIGERIA

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ABSTRACT

This study investigated the determinants of adoption of improved processing technology among the catfish producer-processors in South Western Nigeria. Ninety (90) catfish producers were selected randomly and total enumeration of 75 catfish producer-processors using the improved catfish processing technology were used. Data were collected using a well-structured and pretested questionnaire and analyzed using descriptive statistics, marketing margin and logit regression. The results showed sex distribution of the catfish producers and producer-processors were dominated by male, 75.6% and 76.0% respectively with the male producer-processors more prone to using the improved technology than their female counterparts. Majority of the producers-processors (93.3%) were using the charcoal powered improved catfish processing technology. The mean ages of the producers and producers-processors were 44.6±13.4 and 35.8±11.3 years, respectively. An analysis of the factors influencing the adoption of the improved catfish processing technology showed that access to credit, membership in association and awareness significantly predicted the probability of the producers adopting the improved processing technology in South Western, Nigeria. Credit facilities should be made available to the catfish producers in order to expand their catfish farm and also for them to be able to acquire the improved catfish processing technology.

KEYWORDS

Catfish, Adoption, Logit regression, Technology, South Western, Nigeria.

1. INTRODUCTION

The production of catfish in Nigeria is on the increase from 138,300 in 2010 to 370,000 metric tonnes in 2016 (CAFAN, 2017). However, catfish producers in Southwest and Nigeria at large were faced with the problem of low pricing from the middlemen or continuous feeding due to low sales leading to low income to the catfish producers. This led the Federal Government of Nigeria propounding a policy on value-addition *through the Agricultural Transformation Agenda (ATA)* to agricultural products especially catfish (FGN, 2011). In the process, an improved catfish processing technology were developed and designed by The Federal Institute of Industrial Research (FIIRO) as approved by NAFDAC for the catfish producers with different components such as those utilizing electricity, gas and charcoal (Abiodun *et al* ,2015).

This new improved technology is adduced to have the following advantages such as the acceptance of processed catfish by the European Union (EU) for exportation, improved quality of the processed catfish for local consumption and also the final processed catfish commanding a better price leading to an increase in the marketing margin of the producers due to forward integration (FGN, 2011). Despite the several advantages associated with the use of the new improved catfish processing technology, it was observed that majority of the catfish producers still do not adopt this improved technology (Abiodun *et.al*, 2015).

However, some studies including (Davies and Davies, 2009; Ogbona *et al.,* 2017; Omodara *et al.,* 2016; Odediran, 2011; George *et al.,* 2014 and Bolorunduro *et.al.,* 2005) have been conducted on catfish production; processing using improved technology among the catfish processors-marketers.

Ogbona *et al.,* (2017) elucidated that the net margin realized from production of catfish were profitable. George *et al.,* (2014) ascertained that the processing of catfish using improved technology commanded better market prices with optimal marketing margin to the processors-marketers. Also, Davies and Davies (2009) ascertained that the criteria that were adopted for selecting a technology were the cost and benefits derived from the use of this technology. However, none of this study had empirically examined the marketing margin differential between the production of catfish and use of improved technology for processing among the catfish producers. Also, none of these studies had examined the factors influencing the adoption of improved processing technology in South Western, Nigeria creating a dearth in knowledge. It is against this backdrop that the study intend to fill the gap in knowledge. Specifically, the study described the socio-economic characteristics of catfish producer-processors; examined the differences in the marketing margin of the various catfish producer- processors and analyzed the factors influencing the adoption of improved catfish processing technology in South West, Nigeria.

2. MATERIALS AND METHODS

The study was carried out in South-Western region of Nigeria. The South-West region of Nigeria represents a geographical area covering latitude 6^0 North and 4^0 South. The South-Western region of Nigeria comprises of six

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states including Osun, Ekiti, Oyo, Ondo, Lagos and Ogun State. The region is bounded in the north by Kogi and Kwara States, in the South by Atlantic Ocean, in the west by Republic of Benin and in the East by Edo and Delta State. The South western region of Nigeria can boost of different varieties of livestock and aquacultures since the climatic conditions support the production of various aquacultures including catfish, tilapia etc. A large proportion of the catfish were being produced and processed in South Western region of Nigeria, hence the choice of the study area for the study.

A multistage sampling technique was used. Oyo and Osun State were choosen in South Western Nigeria. The first two stages included the purposive sampling method based on concentration of catfish producers in the areas. Hence, three (3) Local Government Areas (LGAs) were selected from the three agricultural zones in Osun State. These were: Ife - Central, Osogbo, and Iwo. In Oyo State, the 3 Local Government Areas (LGAs) selected from the four agricultural zones included, Egbeda, Kajola, and Ibarapa East. Three towns were also selected in each of the Local Government Areas in the two States. At the stage three, 5 catfish producers who were non-processors were randomly selected in each town making a total of 90 catfish producers in both Osun and Oyo States. The total number of catfish producers using the improved technology for processing was 35 in Osun State (information obtained at the monthly meeting of Catfish Farmers Association of Nigeria (CAFAN) Osun State branch held on Thursday 8th March 2018). A total enumeration was thus used for the study. Total enumeration of 40 catfish producer-processors using the improved technology for processing in Oyo State were also utilized (information obtained from Catfish Farmers Association of Nigeria (CAFAN) Oyo State branch, 2018). Thus, a total of 75 catfish farmers who used the improved catfish processing technology were administered questionnaires in Osun and Oyo States. Also, a total of 90 catfish producers who are non-processors were used for the study in Osun and Oyo States. Thus, a grand total of 165 respondents were used for this study in South Western Nigeria. Data used for this study were primary. These data were collected with the aid of detailed and well-structured pretested questionnaire which was administered to the respondents. Descriptive statistics were used to described the socio-economic characteristics of the catfish producer-processors. The marketing margin analysis that was used to obtain the marketing margin is presented in the equation below:

2.1 For catfish producers-processors

$$GMM = SP - PP \quad \ldots\ldots (1)$$

$$NMM = GMM - MC \quad \ldots\ldots (2)$$

Where:

GMM = Gross marketing margin

SP = Selling price

PP = Purchase price

NMM = Net marketing margin

MC = Marketing cost

The **SP (Selling price)** represents the total revenue generated from the sales of the smoked catfish and fresh catfish and also the revenue generated from processing catfish for other producers/marketers. The average price of the smoked catfish is ₦500 per 500gram while the price of the fresh catfish ranges from ₦600-₦700 per kg. The price for smoking catfish for others ranges from ₦15- ₦25.

The **Pp (Purchase price)** represents the cost of fingerlings purchased during stocking. The average price of the fingerling ranges from ₦15 - ₦25.

The **MC (Marketing cost)** represents the cost of feeds, transportation cost and other variable and depreciated fixed cost (in years) of catfish processing.

The **NMM (Net marketing margin)** represents the profits realized from the smoking of the catfish.

2.2 Marketing Efficiency (ME)

$$ME: \quad \frac{\text{Selling price} - \text{Purchase price}}{\text{Marketing Cost}} \times 100\% \quad \ldots\ldots (3)$$

When ME = 100%, it implies that the participant just recovered the cost incurred in carrying out the marketing services

ME > 100%, means the participants recovered the cost of production and make profits

ME < 100%, means the participants is operating at a loss

2.3 For catfish producers;

$$GM = TR - TVC \quad \ldots\ldots (4)$$

$$NM = GM - TFC \quad \ldots\ldots (5)$$

Where:

GM = Gross margin

TR = Total revenue

TVC = Total variable cost

TFC = Total fixed cost

NM = Net margin

The **TR (Total revenue)** represents the total amount generated from the sales of the fresh catfish. The average price of the fresh catfish ranges from ₦600-₦700 per kg.

The **TVC (Total variable cost)** represents the costs of fingerlings, feeds, fertilizers e.t.c

The **TFC (Total fixed cost)** represents the cost of land acquisition which was the amount payable on rentage of ponds. It also represents the cost of pond construction which was the amount payable on pond preparation and clearing. The cost of well construction, pumping machine and so on which are depreciated in years constituted the total fixed cost in this study.

The **NM (Net margin)** represents the profits realized from the production of the catfish.

To measure profitability, the following ratio was used:

$$\text{Benefit Cost Ratio (BCR)} = \frac{TR}{TC} \quad \ldots\ldots (6)$$

2.4 Logit Regression

Logit Regression (LR) was used to analyze the factors influencing the adoption of improved catfish processing technology in the study area. Logit Regression (LR) was used because it permits the analysis problems in which there are one or more independent variables which determine an outcome that is measured with a dichotomous variable in which there are only two possible outcomes, (True=1 or False 0) (Oscal *et al.*,2012). The logit regression model that was used follows the approach of Budry *et al.*, (2006), and Bandara and Thiruchelvam (2008) to express the probability of catfish producers adopting the improved catfish processing technology.

Marginal effects were also computed to access the effect of one-unit change in each of the significant explanatory variables on the likelihood of adopting the improved catfish processing technology. The empirical specification for examining the influence of explanatory variables on the adoption of the improved catfish processing technology is given as follows:

$$Y_i = [1 + \exp\{-\beta_0 - \beta_1 x\}]\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \mu \quad \ldots\ldots (7)$$

Where:

Y_i = Improved processing technology (1= adopted, 0 = non-adopted)

X_1 =Age (years)

X_2 = Sex (1=male, 0 = female)

X_3 = Level of education (Years)

X_4 = Years of experience (years)

X_5 = Access to credit (1=yes, 0 = no)

X_6 = Net Margin (NM) (₦)

X_7 = Membership of association (1=yes, 0 = no)

X_8 = Awareness (1=yes, 0 = no)

X_9 = Cost of the technology (₦)

μ = error term

3. Empirical Results and Discussion

3.1 Socio economics Characteristics of the Respondents in South Western, Nigeria

The distribution of the respondent by sex in Table 1 indicates that 75.6% of the producers were male while 24.4% were female. The table further revealed that 76.0% of the producer-processors were male while 24.0% were female. This finding show that the production of catfish is male dominated in South Western, Nigeria. This could have resulted from the drudgery of fish farming especially when it involves earthen ponds. It can also be affirmed from the result that the use of the improved catfish processing technology is male dominated. In terms of age (Table 1), largest percentages (63.3% and 73.33%) of the producers and producers-processors respectively were around the ages 31-50 years. The mean age is 39.44±11.47 years.

This suggests that majority of the catfish producers and producers-processors using improved processing technology were in their active age and are thus expected to be productive and be open to accepting and adopting the improved technology. The result of the t-test of the two categories of respondents shows no significant difference between the ages of catfish producers and producer-processors. According to marital status of the respondents, the result (Table 1) shows that majority (72.8%) of the respondents were married and thus have responsibilities. It could also be implied that marriage is highly cherished especially among the sampled catfish producers and producers-processors. This implied that the use of family labour for production and processing might be possible. Considering the level of education attained by the respondents, Table 1 shows that majority (96.7%) of the respondents had some form of education as 35.6% of the producers had primary education, 47.8% had secondary education while 13.3% had tertiary education. However, only 3.3% of the producers had no formal education. It was also observed from Table 1 that 24.0% of the producer-processors had primary education, 28.0% had secondary education while 48.0% had tertiary education. This distribution shows a very high level of literacy as majority of the respondents had at least secondary education. This is expected to positively contribute to the likelihood of accepting and adopting the improved catfish processing technology. However, it should be noted that in the producer-processors category, the distribution revealed highest proportion in tertiary education followed by secondary education which shows that respondent in this category had the required education and might have been responsible for their early adoption of the improved technology as educational level of the fish processors affected the level of investment and capital outlay. In term of years of experience of respondents in production, the results on Table 1 showed that the average years of experience for the respondents are 13.6±9.2 years. It was shown that for the catfish producers, the average years of experience was 8.0±6.3 and that of the producer-processors was 4.0±2.4. This indicated that about 37.8% of the producers have been on the job between 7-12 years which is expected to help them increase their production. Years of experience is expected to positively influence the likelihood of adopting the improved catfish processing technology. The t-test result of the production experience shows that there is no significant difference in the years of experience in the production of catfish between the producers and producer-processors. Table 1 also revealed the years of experience of respondents in processing. The results showed that the average years of experience for the respondents are 4.6±2.5 years. This indicated that majority (82.7%) of the producer-processors have been on the job between 1-5 years. This could be traced to the period during which the improved processing technology was adopted which is expected to help them increase their production efficiency. According to membership in association, it was shown from Table 1 that 95.6% and 92.0% of the catfish producers and producer-processors respectively belong to one association or the other. Most of the respondents belong to Catfish Farmers Association of Nigeria (CAFAN) including the producer-processors. This implies that they have a very good platform for dissemination of vital information and also experience the benefits of group dynamics. Table 1 also revealed the respective types of fish pond that both the producers and producer-processors use on their farm. It was shown that majority (88.5%) of the respondents made use of earthen fish pond. However, it should be noted from the Table that all the producer-processors who use the improved catfish processing technology use earthen ponds. This may be attributed to the fact that all of the producer-processors surveyed have a relatively large catfish farm size. Credit facilities have been seen as a very important requirement for any agricultural enterprises. Table 1 revealed that majority (85.3%) of the producer-processors had access to credit facility in the time past. This might have helped them in purchasing the improved catfish processing technology. However, considerable proportion (46.7%) of the catfish producers did not have access to credit facilities. This could be a hindering factor for not adopting the improved catfish processing technology.

Table 1: Socio- Economic Characteristics of the Respondents

Variables	Producers f (%) (n = 90)	Producer-Processors f (%) (n = 75)	Pooled Data f(%)(n = 165)
Sex			
Male	68(75.6)	57(76.0)	
Female	22(24.4)	18(24.0)	
Total	90(100.00)	75(100.00)	
Age			
≤ 30	7(7.8)	--	7(4.2)
31-40	19(21.1)	12(16.0)	31(18.8
41-50	38(42.2)	43(57.33)	81(49.1)
51-60	15(16.7)	13(17.34)	28(17.0)
> 60	11(12.2)	7(9.33)	18(10.9)
Mean	44.6	35.8	39.44
Std. Dev	13.4	11.3	11.47
t-value	0.098(1.5165)		
Marital Status			
Single	13(14.4)	5(6.7)	18(10.9)
Married	62(68.9)	58(77.3)	120(72.8)
Widowed	9(10.0)	11(14.7)	20(12.1)
Divorced	6(6.7)	1(1.3)	7(4.2)
Education Level			
None	3(3.3)	--	3(1.8)
Primary	32(35.6)	18(24.0)	50(30.3)
Secondary	43(47.8)	21(28.0)	64(38.8)
Tertiary	12(13.3)	36(48.0)	48(29.1)
Years of experience of respondents in production			
1-6	25(27.8)	56(74.7)	81(49.1)
7-12	34(37.8)	13(17.3)	47(28.5)
13-18	16(17.8)	6(8.0)	22(13.3)
19-24	11(12.2)	--	11(6.7)
≥ 24	4(4.4	--	4.(2.4)
Mean	8.0	4.0	13.6
Std. Dev.	6.3	2.4	9.2
t-value	2.616(0.8809)		
Years of experience of respondents in Processing			
1-5	62(82.7)		
6-10	13(17.3)		
>11	-- --		
Total	**75(100.00)**		
Mean	4.6		
Std. dev	2.5		
Membership of Association			
Belong	86(95.6)	69(92.0)	155(93.94)
Do not belong	4(4.4)	6(8.0)	10(6.06)
Types of Fish Pond			
Earthen	71(78.9)	75(100.0)	146(88.5)
Concrete	6(6.7)	--	6(3.6)
Vault(polythene)	8(8.9)	--	8(4.9)
Plastic tank	5(5.5)	--	5(3.0)
Access to Credit			
Yes	48(53.3)	64(85.3)	112(67.8)
No	42(46.7)	11(14.7)	53(32.2)

Figures in parentheses are percentages

3.2 Power source of improved technology

Table 2 revealed the categories of the improved catfish processing technology that the producer-processors use. Majority (93.3%) use charcoal powered improved catfish processing technology, while only few (6.7%) used gas powered improved catfish processing technology. However, none of the respondents surveyed used electricity powered improved catfish processing technology in the area surveyed. This might be due to the relative availability of charcoal and also the fact that they are used to cooking more with charcoal within the household. Also, the none availability of constant supply of electricity in Nigeria might also be responsible for the respondents not adopting electricity powered technology. This result agrees with the result of (Davies and Davies, 2009) that processors preferred charcoal powered improved catfish processing technology due to its cheap source of energy (charcoal) and availability.

Table 2: Distribution of respondents by power source of improved technology

Category	Frequency	Percentage (%)
Charcoal	70	93.3
Gas	5	6.7
Electricity	--	--
Total	**75**	**100**

3.3 Marketing Margin Analysis (MM)

3.3.1 Marketing Margin Analyses of an average Catfish Producers and Producer-Processors

In other to ascertain the profitability of the catfish production and processing businesses, the Gross Margin (GM), the marketing Margin and Marketing Efficiency (ME) of an average producer and producer-processor were calculated. The input used, cost, output data generated from the catfish producers and producers-processors were used to compute the marketing margin and the profitability of catfish processing and production.

The costs and returns and marketing margin for the catfish producers and catfish producer-processors were presented in Tables 3 and 4 respectively. The results revealed the variable cost, fixed cost, and total cost of producing and processing catfish for an average producer and producer-processor. The results also revealed the revenue generated (₦542,669.22) from the sales of an average of 834kg of fresh catfish at an average price of ₦650 per kg by the catfish producers (Table 3). Also, from Table 4, revenues were generated from the sales of smoked catfish (₦1,350,550.00), fresh catfish (₦640,245.73) from sales of an average of 2,701.1gram and 985kg of smoked and fresh catfish respectively and also the revenue (₦260,274.00) generated from smoking an average of 490.4gram of catfish for others including marketers and few producers who are yet to acquire the technology. The purchase price is the costs of fingerlings and the marketing costs is the costs of feeds, transportation costs and other costs as listed on Tables 3 and 4. From Table 12, it was revealed that for an average entrepreneur, the costs of feed (₦154,222.22) accounted for the largest proportion (45.4%) of the total costs of producing catfish. This is followed by costs of fingerlings (₦38,555.56) which accounted for 11.3% of the total costs of production. The labour costs and security costs accounted for 4.1% and 0.9% of the total costs respectively.

The table clearly indicates that large amount of capital is being spent by the catfish producers on the purchase of feed and fingerlings in the study area. The fixed cost of producing catfish consists of costs of some fixed assets including land acquisition, pond construction, well, pumping machine, water tank, flow through pipe, fish net, boot and plastic basin which accounted for 34.9% of the total costs. For an average producer, the Gross Margin of ₦320,563.68 and the Net Margin of ₦167,601.05 were gotten. Table 3 also revealed that the production of catfish has a Benefit Cost ratio of 1.45 which clearly shows that for every ₦1 the producers invested, ₦1.45 is realized hence, yielding a net return of 45k. This finding shows that catfish production is a profitable business in the study area. This finding is corroborated by (Olasunkanmi and Yusuf, 2014) that catfish farming is a profitable and lucrative agricultural enterprise in Nigeria. From Table 4 on the other hand, considering the catfish producers who are also processors, the costs of feeds (33.5%), fingerlings (13.6%) and costs of technology (21.8%) were a substantial proportion of the total costs from production of catfish to final processing of the catfish. Also, from Table 4, the Gross Marketing Margin of an average producer-processor was ₦2,107,369.00 while the Net Marketing Margin was ₦1,140,153.57.

Table 13 also revealed that the production-processing of catfish using an improved catfish processing technology has a Marketing Efficiency of 217.9% which shows that the producer-processors had an excess of return from their output than the expenses on their inputs. The profit/kg realized by an average catfish producer was ₦200.96/kg (Table 3) while an average producer-processor realized ₦441.82 (Table 4) from their enterprise. Thus, a difference of ₦240.86 exists between the two enterprises. This clearly shows that an average producer-processor earned an extra of ₦240.86 from further processing of the catfish produced from their farm. These findings show that production-processing of catfish using an improved processing technology is a profitable agricultural enterprise and hence, more catfish producers should be encouraged to include processing into their business as a means of forward integration. The use of improved catfish processing technology will definitely increase their income thereby reducing the incursion of middle men in the business. Adopting improved technology will also reduce post-harvest loss which will also enhance the income of the catfish producers.

Table 3: Net margin analysis of an average catfish producer for one production cycle (3-4months) in 2018

Source	Inputs	Amount (₦)	% of Total cost
Total Revenue (TR) of an average producer			
Fresh catfish		542,669.22	
Variable cost (VC) of an average producer			
	Fingerlings	38,555.56	45.4
	Fertilizer	2,138.89	
	Liming	2,061.11	
	Feed	154,222.22	11.3
	Drug	1488.89	
	Labour	18,888.89	4.1
	Transportation	2466.67	
	Electricity	1941.18	
	Security	3437.5	0.9
	Association levy	2000.00	
	Taxes	3764.71.	
Total variable cost (TVC) of an average producer		222,105.54	
Fixed cost (FC) of an average producer			
	Land acquisition	30,444.44	
	Pond construction	31,888.89	
	Water tank	3466.67	
	Well	1555.56	
	Flow through pipe	3666.67	
	Pumping machine	3333.33	
	Fish net	2116.67	
	Boot	186.67	
	Plastic basins	525.00	
Total Fixed cost(TFC) of an average producer		152,962.63	
Total Revenue (TR)		542,668.89	
Total Variable cost (TVC)		221432.22	
Total cost (TC) (TVC+TFC)		375,068.17	
Gross Margin (GM) of an average producer		320,563.68	
Net Margin (NM) of an average producer		167,601.05	
Benefit cost ratio(BCR)		1.45	
Profit/kg		200.96/kg	

Table 4: Marketing margin analysis of an average catfish producer-processor for one production cycle (2-3months) in 2018

Source	Inputs	Amount (₦)	% of Total cost
Gross returns (GR) of an average producer-processor			
Processed catfish		1,350,550.00	
Fresh catfish		640,245.00	
Revenue from smoking for others		260,274.00	
Total Gross Revenue		2,251,069.00	
Variable cost (VC) of an average producer-processor			
	Fingerlings	143,700.00	13.6
	Fertilizer	5,600.00	
	Liming	7,100.00	
	Feed	353,982.00	33.5
	Drug	5,140.00	
	Labour	19,700.00	
	Transportation	5,500.00	
	Fuel	9,500.00	
	Electricity	6,500.00	
	Security	8000.00	
	Association levy	2000.00	
	Taxes	5000.00	
	Charcoal	12500.00	
	Gas refilling	31000.00	
	Salt	3200.00	
	Soap	2000.00	
	Spicing	7000.00	
Fixed cost (FC) of an average producer-processor			
	Land acquisition	60000.00	
	Pond construction	45000.00	
	Water tank	3933.32	
	Borehole	14629.63	
	Well	1555.56	
	Flow through pipe	3666.67	
	Generator	14375.00	
	Pumping machine	3333.33	
	Fish net	2116.67	
	Boot	186.67	
	Plastic basins	525.00	
	Processing technology	37500	21.8
	Sealing machine	10,555.56	
	Mats	1354.16	
	Trays	875.00	
	Knife	1458.33	
Selling Price (SP)		2,251,069.00	
Purchase Price (PP)		143,700.00	
Marketing Cost(MC)		967,215.43	
Gross Marketing Margin (GMM)		2,107,369.00	
Net Marketing Margin (NMM)		1,140,153.57	
Marketing Efficiency (ME)		217.9%	
Profit/kg		441.82/kg	

3.3.2 T-test result showing the differences between the net margin of the producers and producer-processors using the improved catfish processing technology

T-test (Table 5) result shows that there is significant difference between the net margin of the catfish producers and producer-processors using the improved catfish processing technology. This further confirmed that the producer-processors had more net margin than the catfish producers who are non-processors.

Table 5: T-test result showing the differences between the net margin of the producers and producer-processors using the improved catfish processing technology

Variable	Mean difference	Standard error difference	T-test
Net margin	34739.467***	148296.531	4.729

***significant at 1 percent

3.4 Determinants of adoption of the improved catfish processing technology in South Western Nigeria

The factors influencing the adoption of the improved catfish processing technology in the study area were examined using the logit regression model. The dependent variable is a dichotomous variable with two levels (adopted and non-adopted). The explanatory variables that were used in the model were the socio-economic characteristics of the respondents. The inclusion of the variables used in the binary logistic model was based on the approach by Budry *et al.,* (2006) and Bandara and Thiruchelvan (2008). The logit regression model selected was estimated using maximum likelihood estimation techniques and the estimates were presented in Table 6. The likelihood of the logit model indicated that the (likelihood regression) LR statistics of 78.64 was highly significant ($p < 0.001$). The Pseudo R-squared value from the model is 0.745 which shows that the variable in the model predicted 74.5% of the variability of adoption of the improved catfish processing technology in the study area. These model statistics revealed that the binary logistic model estimated in this study has strong explanatory power. Marginal effects were computed to access the effect of one-unit change in each of the significant explanatory variables on the likelihood of adopting the improved catfish processing technology.

Access to credit (0.292) predicts the likelihood of adopting the improved catfish processing technology at 5 per cent level of significance. Credit has a crucial role in improving farmer's financial decision to invest in farm activities, increasing productivity (Kohansal and Firoozzare 2013; Akudugu, 2012) and the likelihood of adopting improved technology has been associated with access to formal credit (Gunn, 2014; Adetule, 2017). The level of significance may be explainable in the fact that the producers may not necessary invest in the purchase of the improved catfish processing technology as they may depend on those that have and take their catfish produced to those that have the technology for processing and only pay for use. The marginal effect shows that the probability of the producers adopting the improved catfish processing technology if a producer had access to credit increases by 41 per cent in the absence of changes in other predictors. Furthermore, at 10 per cent level of significance, the coefficient of membership of association (0.663) was seen to be significant. Processors who are already using the improved catfish processing technology were found to be members of association necessitating the importance of association in adopting the improved technology. This is shown to positively influence the likelihood of adopting the improved catfish processing technology that if a producer belongs to association the probability of adopting the improved catfish processing technology increases by 34.6 percent. This shows that the likelihood of producers to adopt the technology would increase with increased membership of association. This is expected as it has been observed in literature the numerous benefits obtained in belonging to the different association which includes access to loan which may be used in purchasing the technology.

From Table 6, awareness (0.516) was observed to be positive and was significant at 1 percent level. This shows that awareness is an important factor as far as the adoption of the improved technology is concerned because information is seen as important tools towards increasing agricultural productivity. The marginal effect (0.021) of awareness shows that if the catfish producers are properly informed and aware of the existence and benefits of the technology, then the likelihood of such producer adopting the improved catfish processing technology will increase by 2.14 per cent. This is expected as it has been observed by Ogbona *et.al.* (2017) that the more the information received by farmers, the better the utilization of those information.

Table 6: Factors influencing the adoption of improved catfish processing technology

Explanatory variable	Coefficient	Standard error	Marginal Effect
Constant	3.145**	1.528	
Age	0.436	0.674	0.218
Gender	-0.022	0.300	0.111
Education	0.632	0.876	0.251
Years of Experience	0.901	0.341	0.021
Access to credit	0.292**	0.452	0.410
Membership of association	0.663*	0.026	0.346
Awareness	0.516***	0.047	0.021
Cost of Technology	-0.311	0.917	-0.138
Log likelihood	-61.42		
Restr. Log likelihood	-98.53		
LR statistics (10df)	78.64*		
Pseudo R^2	0.745		

*significant at 10 per cent; **significant at 5 per cent; ***significant at 1 per cent

4. Conclusion

The findings of the study showed that majority of the respondents were young adults and are still active and are also in their productive age, hence they are vibrant and energetic to carry out production and processing activities. It was also observed that the catfish producer-processors were male dominated in South Western, Nigeria. The use of charcoal powered improved catfish processing technology was common in South Western, Nigeria. The study concluded that processing of catfish by the catfish producers resulted in higher net margin than its production alone. Thus, vertical integration in catfish production-processing should be encouraged among the catfish producers since it showed a higher marketing margin compared with production of catfish only. The study concluded that factors such as access to credit, membership in association and awareness, positively and significantly influenced the adoption of the improved catfish processing technology in South Western, Nigeria. Future research can be conducted in other region in Nigeria in order to design and implement a uniform policy that will help facilitate adoption of the technology in Nigeria. In accordance with the findings of the study, the following recommendations were made: Credit facilities should be made available to the catfish producers in order to expand their catfish farm and also for them to be able to acquire the improved catfish processing technology. Catfish producers who are yet to become members of CAFAN should be encouraged to join because of the immense benefits that might accrue to them including training and access to loans among others. There is a need to increase awareness among the catfish producers on the benefits of using the improved catfish processing technology.

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