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Household food security status and production constraints of sole fish and integrated fish-vegetable farmers in Kaduna State, Nigeria

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Abstract

The study was carried out to determine food security status of integrated fish vegetable and sole fish farmers and its determinants and describe the challenges of integrated fish – vegetable and sole fish production system in Kaduna State, Nigeria. A multi-stage sampling procedure was used to select 95 sole fish farmers and 41 integrated fish-vegetable farmers from 13 randomly selected villages in the State. Primary data were obtained through the use of a set of structured questionnaire which was administered to the selected farmers. Descriptive statistics, food security index and Probit regression model were used to analyse the data. Results established that majority of the sole and integrated fish farmers were married, male-dominated, with equal mean age of 38 years and household size of 7 persons per household respectively. Food security status of farmers revealed that more than half (52.6%) of sole fish farmers and 73.2% of integrated fish-vegetable farmers were food secure. Result of Probit regression model showed that the marginal effects of household size (-0.271), farm experience (0.006), extension contact (-0432) and cooperative membership (0.001) were statistically significant determinants of food security of sole fish farmers at a different level of probability. Likewise, the marginal effects of age of the farmers (-0.031), farming experience (0.033) and cooperative membership (-0.290) were statistically significant determinants of food security of integrated fish-vegetable production. Inadequate information and low access to improved technology and credit were the most critical constraints to integrated fish-vegetable and sole fish systems. Based on the findings of this study, there is need for farmers to form a formidable cooperative society to harness extension personnel and relevant information on inputs, credit and modern technology of integrated fish vegetable production to increase output and invariably food security

Keywords: Fish, food security, integration, vegetable, Kaduna State

INTRODUCTION

Developing countries around the world are promoting sustainable development through sustainable agricultural practices which will help in addressing socio-economic as well as environmental issues simultaneously (Walia and Navdeep, 2013). Within the broad concept of sustainable agriculture "Integrated Farming Systems (IFS)" hold a special position as it offers great efficiency in resource use, everything is utilized in this system as the by-product of one system becomes the input for another (Zira, Ja'afaru, Badejo, Ghumdia and Ali, 2015). Sustainable development in agriculture must include an integrated farming system with efficient soil, water crop and pest management practices, which are environmentally friendly and cost-effective (Oladimeji and Isah, 2019) and promotes efficient utilization of farm space for multiple productions (Eyo, Ayanda and Adelowo, 2006).

With the population of Nigeria on the increase, there is the need for a suitable agricultural system to meet the increasing demand for food, and a corresponding demand for employment opportunities that can lift people out of food insecurity and poverty. This will enable maximizing the utilization of the available limited resources without much wastage. The World Health Organization (WHO, 2017) reported that nearly 30% of the population in developing countries is currently suffering from one or more of the multiple forms of malnutrition, abject poverty and food insecurity. Thus, there is a need for environmentally friendly agricultural system that can meet this increasing demand for a job opportunity which can propel the large population of rural households out of food insecurity and poverty. One of such systems is integrated fish-vegetable production.

Nutritionally, fish is a rich source of protein, calcium, vitamin A, essential fatty acids as well as other elements. Vegetables provide the much-needed vitamins, minerals and fibre. They are important protective food and highly beneficial for the maintenance of health and prevent diseases associated with poor nutrition. They play an important strategic role in improving Nigeria's food security and nutritional status.

Integrated fish farming is a multiple land use approach in food production which combines fish culture with other agricultural production systems such as vegetable crops. It is the association of two or more separate farming systems, which become part of the whole farming system (Abiona, 2011). Low level of animal protein consumption in Nigeria as reported by the FAO in Adekunmi, Ayinde and Ajala (2017) revealed that the diet of an average Nigerian contains 20% less than the recommended FAO minimum of 53.8g per day, while the consumption of vegetables in Nigeria is generally lower than the FAO recommendation of 75 kg per year which is 206 g per day per capita (Badmus and Yekinni, 2011). According to FAO (2013), combined annual fruit and vegetable consumption in Africa is less than 100 Kg per person, which amounts 250 g per person per day.

Thus, there is the need for a suitable agricultural system to meet this increasing demand of both fish and vegetable and also maximize the utilization of the available limited resources without much wastage.

Gabriel, Akinrotimi, Bekibele, Anyanwu, and Onunkwo (2007) reviewed economic benefit and ecological efficiency of integrated fish farming in Nigeria. The study revealed that the system has ecological importance which is often overlooked by farmers which include manure loading, nutrient cycling and productive capacity of ponds, are critically analyzed. This ecological consideration is of paramount importance in integrated fish farming in that it allows recycling, and maximum utilization of resources without wastage.

In Nigeria, sole fish and integrated fish farming has been reported in many states of the federation in which a sizeable number of fish farmers integrate poultry, piggery or livestock with fish production, while integrated fish cum crop production is on the rise also in several states (Aquaculture and Inland Fisheries project, AIFP, 2005; Akpabio and Inyang, 2007; Zira *et al.,* 2015; Malgwi, Mailumo and Akpoko, 2017). However, most empirical studies on sole fish and integrated fish-vegetable farming in Kaduna State (Issa, Abdulazeez, Kezi, Dare and Umar, 2014; Amin, 2015; Malgwi *et al.,* 2017; Ijah, Oladele, Ishola, Ayodele, Yahaya, Omodona, and Olukotun, 2020) dwelled on profitability and efficiency of fish production. There has been little information on the analysis of integrated fish – vegetable production on farmers' food security in Kaduna state, Nigeria. Thus, the findings of this research will provide relevant information on the basic information of status of food security among sole fish and integrated fish-vegetable farmers.

It is on this basis that the following objectives were addressed by this study:

I. Determine the food security status of sole fish and integrated fish - vegetable farmers.
ii. Examine the determinants of food security status of sole fish and integrated fish - vegetable farmers.
iii. Examine the challenges of integrated fish – vegetable production system.

Materials and methods

Study area

The study was conducted in Kaduna State which has four 23 Local Government Areas (LGAs) and (4) Agricultural Development Program (ADP) zones. The agricultural zones include Maigana, Lere, Samaru and Brini Gwari zones (Kaduna Agricultural Development Agency, KADA, 2018). The State lies between Latitudes 9° 00'N and 11⁰ 30'N and Longitudes 6° 00'E and 9° 10'E of the prime meridian (KADA, 2018). Kaduna State has a projected population of 9,268,346 persons in 2021 at an annual growth rate of 3.2 per cent with a landmass of about 48,000 square kilometres. The state is endowed with vast lands, the presence of freshwater bodies and favourable climatic conditions, with rainfall between 1837 mm and 3236 mm. The temperature ranges from 18 ^{0}C to 26 ^{0}C during rainy season and from 32 ^{0}C to 39 ^{0}C in the dry season (Yunusa, Yusuf, Zahraddeen and Abdussalam, 2017, KADA, 2018). The physical properties of the soil in the study area are moderately good and allow continuous cropping of a wide variety of vegetable crops such as spinach, cabbage, onion, green beans, tomatoes, cucumber, eggplants, lettuce, pumpkin, pepper, and carrots.

Sampling procedure and sample size

A pilot survey of existing fish farms and integrated fish-vegetable farmers was conducted in Kaduna State in 2019. This formed the basis for the sample frame employed in the study. A multi-stage stratified sampling procedure was used to select integrated fish farmers for this study. The purposive selection of Maigana agricultural zone out of the four zones in the state was done based on the predominance of vegetable and fish production and their integration. The second stage involved the random selection of three LGAs in the selected agricultural zones. These include Giwa, Kudan and Sabon-gari LGAs. Fifty percent (50%) of villages that are predominantly engaging in integrated fish-vegetable farming were chosen in the three LGAs. This translates to four villages in Giwa LGA, five villages from Kudana LGA and finally, 4 villages from Sabon-gari LGA. The list of integrated fish-vegetable farmers in each village was compiled with assistance of the Agricultural Extension Units of the Local Government Areas and the sole fish marketers using snowball sampling technique. All the farmers identified in the 13 villages during the pilot survey constituted the sample size of the study, hence, the sample size was stratified to 95 sole fish farmers and 41 integrated fish-vegetable farmers.

Data collection

Primary data was used for this study. The data were obtained in 2019 through the use of a structured questionnaire which was administered to the selected fish, and fish-vegetable integrated farmers in the study area.

Analytical techniques

The data collected were analyzed using descriptive statistics such as the mean, frequency distribution, standard deviation, coefficient of variation and percentages. Inferential statistics used in data analysis include food security index and Probit regression model. The food security line used was based on the daily recommended level of calories and protein, which are 2260 Kcal and 65 g respectively. To generate food security indices, the nutrient content of the food items consumed were used to derive calorie availability in equation 1.

Food Security Index (Zi) =

$$\frac{\text{Household Daily per Capita Protein Consumed } (X)}{\text{Household Daily per Capita Calorie protein required } (Y)} \quad \ldots\ldots(1)$$

For a household to be food secured, *Zi* must be greater than or equal to 1 (*Zi*> 1). If *Zi* is less than 1 (*Zi*< 1), the household is food insecure.

The Probit regression model was used to achieve the determinants of food security status of sole fish and integrated fish–vegetable producers in the study area.

Implicitly;

$$Y_i = X_i\beta + \varepsilon_i \quad \ldots\ldots(2)$$

Where: $Y = 1$ if $1 \leq Z < \infty$ (Food secure)
$Y = 0$ if $0 < Z < 1$ (Food insecure)

Explicitly;

$$Yi = \beta o + \beta_1 X_1 + \ldots + \beta_9 X_9 + \mu \ldots\ldots 3$$

X_1 = age of household head (years); X_2 = education level of household head (years); X_3 = household size (number of person); X_4 = farm size (ha); X_5 = number of extension visit; X_6 = amount of credit obtained (₦); X_7 = non-farm income (₦); X_8 = household farm income (₦) and X_9 = dependency ratio (number of non-income earners in a house divide by income earners in the household).

Results and discussion

Table 1 showed that the two production systems, fish farming and integrated fish-vegetable farming (93.7 and 87.8 % respectively) were dominated by male folk. This implies that the male folks still play dominant roles in either sole or integrated fish-vegetable farming in the study area. It is generally believed that males are often more energetic and could readily avail themselves for energy-demanding tasks such as required in sole fish and integrated fish-vegetable farming activities. This result is in line with the assertion of Olawumi, Dipeolu, and Bamiro (2010) and Oladimeji, Abdulsalam, Mani, Ajao and Galadima (2017) that fisheries activities are mostly dominated by men in Nigeria. The importance of marital status on agricultural production is associated with the supply of agricultural family labour. Results in Table 1 revealed that 95 and 100% of fish and fish integrated farmers respectively were married.

Age is an important variable that may has influence on the decision-making process of farmers concerning the decision to adopt improved fish farming technologies and other production-related decisions such as fish farming integration (Awoyemi, 2011). The result in Table 1 reveals that over 90% of both groups are below 50 years of age. The average age of 38 years for both fish and integrated fish-vegetable farmers were within the productive age range of 21-50 years. This will enable them to withstand the rigorous nature of fish farming activities. Furthermore, the coefficient of variation of age for sole fish (17.2%) and integrated fish-vegetable (17.1%) farmers was low which indicate that the age gap of each of the two groups were low. This finding is similar to that of Olawumi *et al.* (2010), Awoyemi, (2011), Olaoye, Ashley-Dejo, Fakoya, Ikenweiwe, Alegbeleye, Ashaolu, and Adelaja (2013) and Oladimeji *et al.* (2017) who observed that youth constitute the majority of the fish farmers in Nigeria and are more flexible to new ideas and risk, hence are expected to adopt innovations more readily than older farmers.

The result of the household size presented in Table 1 established that 44.2% and 53.67% of the fish and integrated fish-vegetable farmers had a household size of 4-6 persons with an average household size of 7 persons for households of both production systems. The estimated coefficient of variation for fish farmers is 45.9% while for integrated fish farmers is 56.8%. This implies that there is a high level of variation in the household size within groups. This large household size depicts common characteristics of rural households particularly in Northern Nigeria where polygamy is mostly practised and family labour is also utilized for farming activities (Hussaini, 2019). This finding is in line with Oladimeji *et al*. (2017) who opined that most fish farmers had a mean household size of 7 persons in Kwara State, Nigeria.

Table 1 showed the distribution of farming experience of both fish and fish-vegetable integrated farmers. Fish farming experience shows that the mean experience of 12 and 11 years for integrated fish-vegetable and sole fish production respectively. This is an indication that some of the respondents are new in the enterprise. The coefficient of variation of farming experience in sole fish (46.9%) and integrated farmers (44.1%) indicate a wide variation in their experience in the two enterprises. Fishery experience of a farmer determines his ability to make effective farm management decisions, not only adhering to aquaculture practices but also concerning input combination or resource allocation. This result is consistent with Olaoye *et al.* (2013) that respondents with the highest number of years of experience perhaps have good skills and better approaches to the fish farming business.

The ultimate aim of extension services is to enhance farmers' ability to efficiently utilize resources through the adoption of new and improved methods used in production instead of using traditional methods which are inefficient, resulting to low yield. Moreover, 80% of fish farmers and 70.7% fish-vegetable farmers had no contact with extension agents. According to Oladimeji, Abdulsalam, Damisa and Sidi (2013), extension service is very essential to the improvement of farm productivity and efficiency among farmers. The estimated coefficient of variation for extension contact is 40.1 and 26.6 % for sole fish and integrated fish-vegetable farmers respectively. This implies a low level of variation in the extension contact for integrated fish-vegetable farmers.

Membership of cooperatives influences the adoption of improved technologies resulting in higher productivity and poverty alleviation. The result revealed that 90.5% of fish farmers and 80.5% of integrated fish-vegetable farmers in the study area do not participate in any cooperative association. The average years of membership of the cooperative society were four and three for fish and integrated fish-vegetable farmers, respectively. The likely effect of this result is that most of the farmers in the study area may not enjoy the assumed benefits accrued to co-operative societies through a pooling of resources together for a better expansion, efficiency and effective management of resources and profit maximization.

Food security status of sole fish farmers

Food security status of farmers in the study area is presented in Table 2. The result revealed that 52.6% of sole fish farmers and (73.2%) of integrated fish-vegetable farmers were food secure. This implies that the large percentages of integrated fish-vegetable farmers are more secured compared to sole fish farmers. The mean food security index for sole fish and integrated farmers were 1.31 and 1.84 respectively. The food surplus implies that on average the food secure sole fish farmers consumed 0.31 Kcals more than their daily calorie requirements whilst integrated fish-vegetable farmers consumed 0.84 Kcals over their daily calorie requirements. The higher differences observed in fish –vegetable farmers compared to sole fish farmers could be attributed to the availability of both fish and variety of vegetable which could readily be consumed or sold to purchase other food items and condiments for household consumption.

The food insecurity gaps among fish and integrated fish-vegetable farmers were also found to be 0.26 and 0.14 respectively. The food insecurity gap implies that on average the food insecure farmers consumed 0.26 and 0.14 Kcals less than their daily calorie requirements for fish and fish-vegetable farmers, respectively.

Determinants of food security of integrated fish-vegetable farmers

The estimated parameters of the Probit model, including the coefficients, standard error, t-values and marginal effect are presented in Table 3.

The result showed that the marginal effects of age of the farmers (-0.031), farming experience (0.033) and cooperative (-0.290) were determinants of food security of integrated fish-vegetable production.

Age was statistically significant at the 10% level and had a negative marginal effect (-0.031) on the level of food security of the integrated fish-vegetable farmers' households. The marginal effect shows that the increase in the age of the farmers reduces the probability of being food secured by 0.031Kcals. Thus, the higher the age of the farmers, the lower the food security level; as their household size might be large and decrease in ability to earn income. This finding is comparable with study of Awotide *et al*. (2010) who opined that young farmers with better education and exposure to new ideas are more likely to participate in any developmental programmes and bear more risk than older farmers.

The marginal effects of fish farming experience (0.033) had a direct relationship with food security and statistically significant at 10% level, thus suggesting that the higher the experience in fish farming, the higher they are food secured. The farming experience shows that farmers will be able to make a sound decision as regards resources allocation and management of their fish and fish-vegetable farms.

Membership of cooperative marginal effects (-0.290) had an inverse relationship with food security and statistically significant at 5% level of probability. This suggests that the lower the years spent as a member of a cooperative association, the higher they are food insecure. The effect of this result is that most of the fish farmers in the study area may not be enjoying the assumed benefits accrued to co-operative societies through a pooling of resources together for a better expansion, efficiency and effective management of resources and profit maximization. This finding is in contrast with Odebiyi (2010) who found that cooperative groups ensure that their members derive benefits from the groups such as they could not derive individually.

Constraints to integrated fish-vegetable production system

Table 4 shows the challenges encountered in the course of producing sole fish and integrated fish-vegetable production in the study area.

Inadequate information on improved technology

This was ranked first from both production systems as the major constraints to production. About (90.5%) of sole fish farmers and (87.8%) of integrated fish-vegetable farmers attest to this fact that inadequate information on improved technology is the major constraint to production.

Low access to improve technology

This was rank second for both production systems as the major challenges militating against their production. About (61.1%) of sole fish farmers and (78%) of integrated fish-vegetable farmers complain about low access to improv technology. This may be because modern equipment is costly and the fish farmers lack the necessary finance to purchase them.

Poor access to credit

Poor access to credit was ranked third for sole fish farming and integrated fish-vegetable production. Credit is a very strong factor that is needed to acquire or develop any enterprise; its availability could determine the extent of production capacity. This finding is corroborated with the findings of Oladimeji *et al.* (2013) that credit is an important input for expansion of aquaculture/agriculture and this could have a prospect in improving the productivity of farmers and contributing to uplifting the livelihoods of disadvantaged rural farming communities.

Conclusion and recommendation

Based on the finding of this study, it was concluded that integrated fish-vegetable farmers are better food secure compared to sole fish farmers. The determinants of food security among sole fish farms were household size, farming experience, extension contact and membership of cooperative while variables such as age, farming experience and cooperative society determined food security status of integrated fish farmers. The most critical constraint for the two systems was inadequate information and low access to improve fish farming technology in the study area.

Also, the following recommendations were made:

(I) Sole fish farmers should be encouraged to practice integrated fish-vegetable farming to enhance increased output and improved food security status;

(ii) There is need for strengthening extension contact to encourage integrated fish-vegetable production instead of sole fish production. This will allow for better performance and more efficient utilization of limited resources thus a greater output to enhance food security.

(iii) Farmers should mandatorily through ADPs and Local Government Areas (LGAs), form a functioning and formidable cooperative to harness the opportunity of economic of scale in inputs, output, and extension training.

(iv) Access to formal credit through Bank of Agriculture (BOA) and other financial institutions and informal credit from their cooperative and non-governmental organization will enhance access to improved technology and inputs and invariably increase output and food security.

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Table 1: Descriptive statistics of the households' variables used in Probit regression model

Variable	Fish	Integrated fish farmers	Mean	CV	F	%	Mean	CV
Male	89	93.7			36	87.8		
Female	6	6.3			5	12.2		
Marital status								
Married	90	95.0			41	100		
Single	5	5.0			-	-		
Age (years)								
20-29	12	12.63	38	17.2	4	9.76	38	17.1
30-39	41	43.16			16	39.02		
40-49	35	36.84			18	43.90		
50-59	7	7.37			3	7.32		
Household size								
1-3	13	13.68	7	45.9	3	7.32	7	56.8
4-6	42	44.21			22	53.67		
7-9	26	27.37			8	19.51		
10-45	14	14.74			8	1.52		
Experience (yrs)								
1-5	12	12.63	12	46.9	5	12.20	11	44.1
6-10	43	45.26			20	48.78		
11-15	17	17.89			10	24.39		
16-20	23	24.21			6	14.64		
Extension								
Access	19	20	2.74	40.1	12	29.27	2.17	26.6
No access	76	80			29	70.73		
Cooperative								
Member	9	9.47	3.8	39.2	8	19.51	3.0	43.6
Non-member	86	90.53			33	80.49		

Source: Field survey, 2019

Table 2: Food Security Status of Sole Fish and Fish-vegetable Farmers

Parameters	Sole fish farmers		Integrated fish farmers	
	Food secure	Food ins.	Food secure	Food ins.
Percentage of households	52.6	47.4	73.2	26.8
Number of households	50	45	30	11
Mean food security index	1.31	0.74	1.84	0.86
Standard deviation	0.77	0.24	0.56	0.44
Food insecurity gap/surplus	0.31	0.26	0.84	0.14
Per capita daily calorie	1989.4		2120.6	

Source: Data analysis, 2019

Table 3: Determinants of food security of integrated fish -vegetable farmers

	Sole fish			Integrated fish		
Variables	ME	**SE**	**Z**	ME	**SE**	**Z**
Sex	0.005	0.213	1.32	-0.333	0.188	-1.52
Age	0.328	0.005	1.05	-0.031*	0.444	-1.77
Household size	0.217***	0.196	3.14	-0.015	0.071	-0.52
Education	0.216	0.116	0.95	-0.205	0.291	-1.78
Farming experience	0.006**	0.342	2.21	0.033*	0.022	1.53
Farm size	-	-	-	-0.028	0.378	-0.19
Extension contact	-0.432**	0.224	-2.21	-0.255	0.443	-1.45
Cooperative membership	0.001***	0.004	-2.65	-0.290**	0.344	-2.14
Constant	0.009*	0.005	1.87	5.079***	1.895	2.68
Log likelihood	-62.97			-21.03		
No. of observation	95			41		
LR chi^2 (8)	33.01			14.55		
Prob> Chi^2	0.000			0.000		
Marginal effects after probit y= effects (predict)	0.653			0.551		

Source: Data analysis, 2019: *** = P<0.01, **= P<0.05, ** = P<0.10; ME denote marginal effects

Table 4: Challenges of the Sole fish and integrated fish -vegetable production systems

	Sole fish n= 95			Fish-vegetable n=41		
Constraints	**F**	**%**	**Rank**	**F**	**%**	**Rank**
inadequate information on improved technology	86	90.5	1st	36	87.8	1st
Low access to improve technology	74	78.0	2nd	25	61.1	2nd
Access to credit	31	32.6	3rd	15	36.6	4th
Scarcity of water	6	6.3	4th	1	2.4	5th
High cost of juvenile	3	3.2	5th	1	2.4	5th
High cost of improved seed	-	-	-	16	39.0	3rd

Source: Field survey, 2019; * denote multiple responses allowed