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Adoption Prospects and Challenges of Rice-Cum-Fish Farming Technology in the Low-Land Plains of Southern Nigeria

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Abstract

This study examined the adoption prospects and challenges of rice-cum-fish production technology among rice and fish farmers in selected states in southern Nigeria (Delta, Edo, Lagos and Ondo States). Using questionnaire, data was sought from 720 sampled rice and fish farmers in the selected States. The data were analysed using descriptive statistics, logit regression. Results showed that more than half the respondents were not aware of the rice-cum-fish technology; however, majority had a high perception of the potential benefits associated with the technology and expressed willingness to adopt it (fish farmers = 95.71%; rice farmers = 87.25%). Potential constraints to farmers' adoption of the technology included inadequate finance, lack of technical competence, perceived difficulty associated with the practice and limited land. Significant determinants of the rice farmers willingness to adopt the technology were age (b = -0.060), education (b = -0.253), income (b = -0.779), awareness of rice-cum-fish technology (b = 1.919) and perception of the technology benefits (b = 0.084). For the fish farmers, the only significant factor was farming experience (b = -0.388). Rice-cum-fish production technology, therefore, has great prospects for adoption in the study area if popularized. To enhance uptake of this technology, farmers should be trained on the rice-cum-fish production technology.

Keywords: Rice cum Fish Technology; Rice and Fish Farmers; Prospect for Adoption

1. Introduction

The practice of integrating aquaculture and agriculture, also referred to severally as Integrated Agri-Aquaculture Systems (IAAS) (Gooley and Gavine, 2003), Integrated irrigation-aquaculture (IIA) (Miller et al., 2006) or Integrated Agri-Aquaculture Systems (IAAS) (Edwards, 1998), is vital for all year-round food production where farming households face food insecurity (Tran et al., 2013). IAA includes the integration of fish, rice, vegetables, fruits, and livestock (FAO, 2001) linking aquaculture to conventional farming systems. The development of such systems, according to Gooley and Gavine (2003), Ahmed et al. (2012) and Tran et al. (2013) has been driven by different needs in different parts of the world, including a desire to improve food security on small, subsistence family farms or to minimize pollution and use valuable resources (such as water) more efficiently and effectively.

It is assumed that rice-fish farming with stocked fish also started in China. Archaeological and written records trace rice-fish culture in China over 1700 years ago and the practice may have started when fish farmers with excess fry released them in their rice fields (Li, 1992; Cai and Wang 1995). China is reported to cultivate almost one million hectares and Indonesia, 94,000ha (Ujoh et al., 2016, Lightfoot et al., 1992). Integrated irrigation-aquaculture (IIA) is only beginning in Nigeria. With poor agricultural extension services in the country, there has been little effort at increasing public awareness for viable integration of agricultural activities, even though the benefits to rural farmers, such as improved yield, water management and revenues, have been well documented during the past twenty years (Miller et al., 2006).

The potential land area that could be put under rice production in Nigeria is estimated at about 4–6 million ha, but only some 2 million ha (about

40%) are cultivated (Ujoh et al., 2016 and Miller, 2006). Rice is produced in virtually all the States of the federation (Ujoh et al., 2016). With such potential for rice production and with the present transformation of the agricultural sector against the low oil prices in the world market, the country should be self-sufficient in rice and production. Moreover, over 1.5 million ha of swamp areas in the Niger Delta show good prospects for rice–fish culture. In rice–fish culture system, fish are usually cultured within rice areas, protected from excess flooding by small dikes. The fish are cultured in rice fields either concurrently with rice or in rotation (FAO, 2017). This system of rice–fish culture is not common in Nigeria (Akegbejo et al., 2010). Rather, it is primarily the capture method that is practiced. Nevertheless, there is considerable potential for increased involvement of poor farming households in rice–fish culture in both rain fed and irrigated rice, as indicated by successful examples from such widely separated areas as Bangladesh, Madagascar and Thailand. An early review on rice-fish culture showed that by the mid-1900s it was practiced in 28 countries on six continents: Africa, Asia, Australia, Europe, North America and South America (FAO, 1957)

Opportunities abound for the integrated approach of rice–fish culture in Nigeria ecosystem. Nigeria has large and expansive areas of swampy landscapes and regularly flooded lowland areas that are suitable for rice–fish culture (Ezenwa, 1991). Despite the potential for rice-fish farming, rice monoculture remains the main farming system in most of the wetland areas of Nigeria (Ajala and Gana, 2015). Most of the rice–fish culture methods in Nigeria have been on experimental bases. The studies of Okoye (2004) and Yaro (2003) showed that rice-cum-fish culture system gives an increase of 10% in rice yield and increase of 54% in revenue due to inclusion of fish in the culture system. Nigerian Institute for Oceanography and Marine Research (NIOMR) has been involved in experiments focusing on rice-cum-fish farming with the intention of scaling up the technology to rice and fish farmers particularly in the coastal wetland areas of Nigeria. However, the sustainability of the technology will be based on an understanding of farmers' willingness to adopt or incorporate such a technology into their present production system and the pro-active efforts to understand potential challenges to the integration of this culture into existing farming systems. The most important research issues in the form of questions are as follows: how level of the farmers' awareness of rice-cum-fish farming technology in the study area? and what are the factors associated with the farmers' willingness, perception and potential constraints to the utilization of the rice-cum-fish technology by farmers in the study area. The specific objectives of the study are to:

Examine the socio-economic characteristics of rice and fish farmers in the study area;

Ascertain the level of the farmer's awareness of rice-cum-fish farming technology in the study area;

Determine the factors associated with the farmers' willingness to adopt rice-cum-fish farming technology;

Examine the farmer' perception of the benefits of the system; and

Identify the potential constraints to the utilization of the rice-cum-fish technology by farmers in the study area.

2. Materials and methods

The study was conducted in Delta, Edo, Lagos, and Ondo States of Nigeria which are in the South-West (Lagos and Ondo States) and South-South (Delta and Edo States) geo-political zones of the country. The total land area of the four States is about 54,419km2 distributed as follows: Delta State (17,440km2), Edo State (17,902km2), Lagos State (3,577km2) and Ondo State (15,500km2) (NPC, 2006). These States were specifically targeted for study because they were identified as the most important and promising areas for rice-fish culture, given their favourable resources and climatic conditions, such as the availability of low-lying agricultural land, warm climate, fertile soil, and cheap and abundant labour. Hydrological conditions are also favourable for rice-fish farming as this area is located within the coastal and wetlands in Nigeria (Anyanwu et al., 2007).

A multi-stage sampling technique was employed in the selection of respondents. Stage 1 involved purposive selection of 3 local government areas (LGAs), characterized by wetlands, from each State, given a total of 12 LGAs. Information on the selected LGAs was obtained from NIOMR and validated with the various State ADPs. Stage 2 involved purposive selection of 3 wetland communities per LGA to give a total of 36. In Stage 3, 20 rice and 5 fish farmers were chosen per community using snowball sampling technique. The higher proportion of rice farmers sampled in this study was because the proposed rice-cum-fish technology was primarily targeted at them. Contact with these farmers (respondents) was facilitated by personnel of the ADP and NIOMR in the four States. The total operational sample was 900. However, field response was 577 for rice farmers, which represent about 80% response rate, while 163 responses were obtained for fish farmers, representing about 91%

response rate. Need to give explanation on tools used for data collection!

Data analysed in the study were collected from primary sources (i.e. rice and fish farmers), using validated and pre-tested question instrument comprising open and close-ended questions. Descriptive statistics, Logit regression were used to analyse the data collected. Logit regression is a parametric statistic employed to analyse the relationship between one or more independent variables and a dichotomous dependent variable (Peng et al., 2002). The mathematical representation of the model is specified as: P (Yi/1-Yi) = a + b1X1 + b2X2 + …… + bnXn + e

Where

P= a dummy variable

A= the coefficient on the constant term

B= the coefficient on the independent variable(s)

X= the independent variable (s)

E= error term

Where;

Y= Willingness to adopt rice-cum-fish farming (Dummy variable: willing=1, not willing = 0)

Explanatory variables:

X1= Age (measured in years)

X2 = Education (years of formal school education)

X3 = Gender (dummy variable: male =1; female = 0)

X4 = Household size (number of people feeding from the same pot)

X5 = Farm size (measured in hectares)

X6 = Occupational status (dummy variable: full time farming = 1, part-time = 0)

X7 = Farming experience (in years)

X8 =Income (N)

X9 = Extension contact (number of contacts in last 6 months)

X10 = perception of benefits of technology (total score on perception)

X11 = awareness of any rice-cum-fish technology (aware = 1, not aware = 0)

3. Results and discussion

3.1Socio-Economic Characteristics of Rice and Fish farmers

Table 1 presents the relevant socio–economic characteristics of the rice and fish farmers. The results reveal that male dominated rice and fish production in the study area with a percentage of 71.27% and 80.98% respectively. This indicates that female participation in this enterprise was probably low**.** This result confirms the finding of Shaibu and shaibu (2017) and Olaoye et al. (2011) who reported higher participation of males in rice cultivation and raising of fish in Nigeria. The authors attributed the gender discrepancy to land rights which generally favour male, and women tendency to engage in off-farm activities like processing and marketing.

Age is an important socio-economic characteristic because it affects productivity, output and adoption of innovation. Overall, over 80% of each respondent group was less than 50 years with a mean age distribution of about 40 and 43 years for the fish and rice farmers respectively. This implies that fish and rice farmers in the study area were relatively young, within their active age and can cope with the labour demand associated with the enterprises or their integration. Similar finding was reported by Olaoye et al., (2011); Orebiyi et al., (2011) and Olaoye (2010) that most fisher folk were in their economic active age cadre and possess the physical stamina to undertake production task associated with the fishing enterprise.

Married respondents dominated fish (85.89%) and rice (85.64%) production in the study area. These suggest that respondents' involvement in the enterprises was to better cater for their families. These results agree with that of Shaibu and Shaibu (2017) who noted that most rice farmers were married. Most of the fish (94.5%) and rice (96.3%) farmers had same level of formal education. The highest proportion of the fish farmers (43.56%) had secondary education while about 30% each of the rice farmers had primary and secondary education. The fact that most respondents had formal education may promote adoption of rice-cum-fish production technology.

Farmers with 1-10 years of farming experiences were in the majority among the fish (44.17%) and rice (46.68%) farmers in the study area. The average farming experience ranged from 13 years (fish farmers) to 14 (rice farmers) years. These years of experience may motivate the farmers to attempt something new such as rice-cum-fish production system, to exploit the potentials of agricultural diversification and enhance household income (Kumolu-Johnson and Ndemle, 2010). Size of farm determines the scale of production in agriculture; the result shows the farm size for the rice farmers. The highest proportion of rice farmers operated on less than one hectare of farmland (41.11%), with the average being 2.52ha. Similar findings were reported by Jamiu et al., (2016) that most rice farmers in Kogi State were small-scale operating 1-1.3ha. Such small size may encourage the farmers to adopt the rice-cum-fish technology as a strategy to boost their income level.

Table 1. Socio-economic characteristics of respondents

Characteristics	Fish farmer (n=163)		Rice farmer (n =557)	
	Freq	Percentage	Freq	Percentage
Gender				
Female	31	19.02	160	28.73
Male	132	80.98	397	71.27
Age range (years)				
<= 30	40	24.54	80	14.36
31 – 40	40	24.54	154	27.65
41 – 50	60	36.81	219	39.32
51 – 60	19	11.66	75	13.46
61+	4	2.45	29	5.21
Marital Status				
Single	23	14.11	77	13.82
Married	140	85.89	477	85.64
Widow(er)			3	0.54
Educational level				
No formal education	9	5.52	22	3.95
Adult education	10	6.13	10	1.8
Primary education	34	20.86	176	31.6
Secondary education	71	43.56	170	30.52
Diploma/ NCE	24	14.72	64	11.5
University	15	9.2	115	20.65
Household size				
1-4	38	23.31	136	24.42
5-8	68	41.72	225	40.39
9-12	24	14.72	99	17.77
>12	33	20.25	97	17.42
Experience (years)				
≤ 10	72	44.17	260	46.68
11 – 20	62	38.04	193	34.65
21 – 30	27	16.56	66	11.85
31 – 40	2	1.23	27	4.85
≥ 41	0	0	11	1.97
Source of land				
Purchased	26	15.95	79	14.18
Rented	84	51.53	267	47.94
Inherited	47	28.83	204	36.62
Others	6	3.68	7	1.26
Farm Size (ha)				
1 & below			229	41.11
1.1-2.0			115	20.65
2.1-3.0			34	6.1
3.1-4.0			40	7.18
>4.0			139	24.96
Income (monthly)				
<50,000	14	8.59	39	7
50,000-250,000	67	41.1	320	57.45
>250,000	82	50.31	198	35.55

Table 2. Distribution of respondents by contact with extension agent

Level	Fish farmer		Rice farmer	
	Frequency	Percentage	Frequency	Percentage
No contact	27	16.56	253	45.42
Once	36	22.09	86	15.44
Twice	94	57.67	180	32.32
>Twice	6	3.68	38	6.82
Total	163	100.00	557	100.00

Household size is a strong determinant of family labour availability for agricultural production in rural areas. Majority of the fish (41.72%) and rice (40.39%) farmers had a household size comprising 5 to 8 members with an average of 8 each. This suggests that the respondents had large family size. This finding supports the preponderance of large family sizes among the rural inhabitants (Kumolu-Johnson and Ndemle, 2010). Such large size offers some advantages such as the respondent's access to free and/or cheap labour to assist in the enterprise (Shaibu and Shaibu, 2017).

Majority of the fish farmers (50.31%) earned above N250,000 monthly while majority of the rice farmers (57.45%) earned N50,000 - N250,000 monthly. The mean income was N184,386.5 and N134,784.56 for the fish and rice farmers respectively. The findings suggest that monthly income from rice and fish farming is considerable enough to support their households. Furthermore, this income level may empower the farmers to adopt the proposed rice-cum-fish production technology, since its adoption will require some additional capital investment. Studies by Awotide et al. (2011) and Adewuyi et al. (2010) have revealed an average annual income of N190,661.50 and N320,650 for rice and fish farmers respectively.

3.2 Respondents' contact with Extension Agents

Table 2 reveals that majority of the fish farmers (57.67%) have had two contacts with extension agents in the last six months, while the highest proportion of the rice farmers (45.42%) claimed to have had no contact with the agents in the last six months. The general result suggests a low contact of the agricultural extension service with fish and rice farmers in the study area. This was because the farmer agent contact level was lower than the T & V system recommended fortnightly visits between extension agents and farmers. This has implications on the farmers' adoption of recommended farm technologies. Contact with extension agents positively influences farmers' adoption of improved technologies.

3.3 Farmers' awareness of rice-cum-fish production technology

Table 3 presents the results on farmers' awareness of rice-cum-fish production technology in the study area. The result shows that less than 50% of the farmers (48.47% of fish farmers, 43.27% of rice farmers) were aware of the technology. Being aware should hopefully, serve as a motivation to at least give the technology a trial, compared to those who are not aware at all. Awareness of a technology has been described as having positive influence on its adoption by farmers (Olumba and Rahji, 2014).

Table 3. Awareness of rice-cum-fish technology

	Fish farmer		Rice farmer	
	%	Frequency	%	Frequency
Aware	79	48.47	241	43.27
Not aware	84	51.53	316	56.73
Total	163	100.00	557	100.00

3.4 Willingness to adopt rice-cum-fish production technology

Fig. 1 reveals that most of the respondents (fish farmers = 95.71%; rice farmers = 87.25%) were willing to adopt the rice-cum-fish production technology. Further probe of those who expressed willingness to adopt the technology indicated the following factors as being the motivations for their decision: need to diversify income, overall reduction in production cost particularly of land rental since same land will be used to engage in more than one enterprise, being ecologically sound i.e. reduction in use of fertilizers and the recycling of nutrients by the fish through feeding and depositing of faeces in the soil. This increases nutrients (phosphorus and nitrogen) uptake by the rice; and contributes to improved use of land.

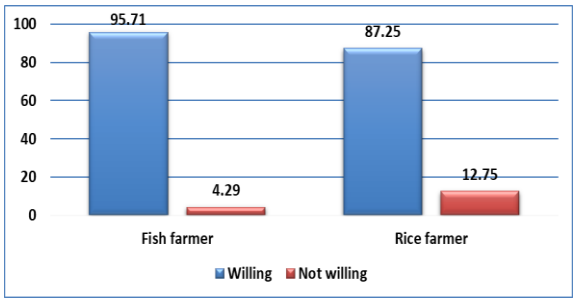

Figure 3: Farmers' willingness to adopt rice-cum-fish technology (%)

3.5 Constraints to adoption of rice-cum-fish production technology

The study probed the respondents who indicated unwillingness to practice the rice-cum-fish production technology, reasons for their decision. The factors mentioned by fish farmers are noted as follows:

Fear of not getting improved varieties/seeds for planting;

Perceived difficulty that may be associated with practicing the technology;

Lack of technical know-how or the competency to manage such combined production system;

Inadequate capital: some respondents felt they lacked the additional finance to undertake the extra or additional enterprise.

Inadequate land space to accommodate the combined enterprise.

On the part of the rice farmers who were unwilling to practice this technology, the factors/possible constraints mentioned include:

Perceived difficulty in managing the integrated enterprise. Some of the respondents felt such an integrated enterprise will be too burdensome for them manage;

Lack of technical know-how: some of the respondents expressed the concern that they do not have the skill to or the know-how of undertaken such a business enterprise (i. e. rice-cum-fish production system)

Financial constraints: some believed that incorporating fish into their rice paddies will unnecessarily increase their production cost, and this they felt will not be able to afford given their limited ability to credit;

No sufficient land to practice. Some respondents noted that their land size was rather too small to combine or integrate with fishery in a profitable manner.

3.6 Farmers' Perception of Rice-cum-Fish Production Technology

Table 4 presents the results of the respondents' perception of rice-cum-fish production technology in the study area.

The result shows that the addition to income was the major consideration of both the fish (mean = 3.56) and rice (mean = 3.15). Other major considerations included the belief that the system was feasible (fish farmers = 3.35; rice farmers = 2.97) and the simplicity of the practice/system (fish farmers = 3.33; rice farmers = 2.94).

3.7 Relationship between farmers' socio-economic characteristics and willingness to adopt rice-cum-fish technology

Logit regression was used to estimate the relationship between the respondents' socio-economic characteristics and their willingness to adopt the proposed rice-cum-fish technology. The result is presented in Table 5.

The coefficient of determination for both models (rice farmers = 0.655; fish farmers = 0.221) implies that the independent variables explained 22.1% and 65.5% of the variation of the rice and fish farmers willingness to adopt the production technology. The goodness-of-fit test result for the rice farmers ($\chi2 = 375.56$; $p > 0.050$) and fish farmers ($\chi2 = 125.83$; $p > 0.050$) were not significant, implying that the model are a good representation of real-life data. The likelihood ratio test results for the rice farmers data (chi square = 69.819) and the fish farmers data (Chi square = 35.476) were significant at the 5% level, implying that the model independent variables had a significant effect on the dependent variable.

The negative coefficient for age (b = -0.060) and odd ratio (OR) of 1.06 (1/0.942) means that younger rice farmers are 6% more likely to adopt rice-cum-fish technology when compared to older farmers. Younger farmers are said to be more open to new ideas and willing to take risk such as engaging in new ventures compared to older farmers, who are described as being more conservative and unwilling to try out new ideas (Onemolease and Alakpa, 2009).

The result for education is negative (b = -0.253), and with an OR of 1.29 (1/ 0.776), it means less educated rice farmers were 29% more likely to adopt the rice-cum-fish technology relative to the more educated farmers. This finding is contrary to expectation. It is possible that the more educated rice farmers have other economic ventures i.e. are part-time farmers, while the less educated may be more dependent on rice farming as a major means of livelihood, and therefore more interested in any farm innovation that will help boost income. Significant positive correlations between education and innovativeness among farmers have been reported by Apata et al. (2010) and Onemolease and Alakpa (2009).The coefficient for household size was positive (b = 0.449), and its OR of 1.57 implies that farmers with larger families are 56.7% more likely to adopt the rice-cum-fish technology compared to farmers with lesser family size. The farmers may also want to adopt this technology because they realize that they will make more money which they can use to cater for their larger family.

The coefficient for income was negative (b = -0.779) with an OR of 2.18 (1/0.59), which means that farmers with lower income were two times more likely to adopt the rice-cum-fish technology compared to farmers with higher income. This result is unexpected, since positive correlation has been reported between income and farm innovation adoption. An explanation for this could be that rice farmers with less income are desperate to enhance their economic livelihood and therefore more interested in a production technology that will boost income. The wealthy farmers may also adopt a 'wait-and-see' attitude because of the risk associated with a new technology.

The coefficient for awareness was positive (b = 1.919), and with an OR of 6.82, it means farmers who were aware of the technology were about seven times more likely to adopt it than those who are not aware. This result is in line with expectation as other studies have reported positive correlation between

farmers' awareness and the adoption of technology (Olumba and Rahj, 2014). The coefficient for the perception of the technology benefit was also positive (b= 0.084) with an OR of 1.09, implying that rice farmers with a higher benefit perception were 9% more likely to adopt the rice-cum-fish technology.

For the fish farmers, only one variable (i.e. farming experience) was significant and negative (b = -0.388), which implies that fish farmers with less farming experience were more willing to adopt the rice cum fish production technology compared to those with longer experience. An explanation for this result could be that farmers with longer farming experience are older and may be reluctant to try or implement new practices. This agrees with the assertions of Shaibu and Shaibu (2017) that older farmers are generally described as being more conservative towards new technologies/ideas. However, other studies have shown that years of farming experiences were significant and positively correlated with adoption of improved technologies (Kumolu-Johnson and Ndemle, 2010).

The result for contact with extension agents, for both the rice (b = 0.141) and fish (b = 0.117) farmers, were positive though not significant. The positive effect suggests that contact with extension workers may likely encourage farmers to consider adopting rice-cum-fish production technology. The result agrees with other studies which have reported the positive impact of farmers contact with agricultural extension agents on their adoption of new technologies (Shaibu and Shaibu, 2017; Onemolease and Alakpa, 2009).

Table 4. Farmers' perception of rice-cum-fish production technology

Items	Fish farmer		Rice farmer	
	Mean	SD	Mean	SD
It will make a major addition to my current income	3.56	.79	3.15	1.09
The practice will work well	3.35	.95	2.97	1.03
The practice is simple	3.33	1.20	2.94	1.05
This system of farming helps reduce labour cost since the same labour is used for both rice and fish farming.	2.75	1.07	2.52	1.06
It is a better way of making better use of the same land for two farming activities i. e. rice and fish farming	2.80	1.04	2.43	1.09
Engaging in this system will enhance my family welfare	2.77	1.10	2.42	1.09
The government should encourage farmers to go into this system of rice/fish farming	2.80	1.26	2.32	1.29
I will encourage others to try this new system	2.45	.88	2.27	.88

*Agreed (mean > 2.50)

Table 5. Relationship between farmers' socio-economic characteristics and willingness to adopt rice-cum-fish production technology (Logit regression)

	Rice Farmers			Fish farmers		
Parameter	Coefficient (b)	t value	Odd Ratio	Coefficient b	t value	Odd Ratio
Constant	4.616	4.261		19.141	0.002	
Sex	-0.045	0.136	0.956	-5.224	0.003	0.005
Age	-0.06*	3.593	0.942	0.099	0.902	1.104
Educational level	-0.253*	3.182	0.776	-0.675	1.203	0.509
Household size	0.449*	2.563	1.567	1.432	1.696	4.188
Farming experience	-0.008	0.51	0.992	-0.388*	2.088	0.678
Size of plot/farm	-0.026	1.548	0.975			
Extension contact	0.141	1.333	1.151	0.117	1.08	1.124
Income (monthly)	-0.779*	2.881	0.459	3.059	1.799	21.31
Awareness of rice-cum-fish technology	1.919*	5.059	6.817	0.972	0.003	2.643
Perception of benefit of technology	0.084*	2.917	1.088	0.227	1.000	1.254
Model Statistics						
Likelihood Ratio Chi-Square	69.819; df = 10; P<0.050			35.476; (df = 9; P<0.050)		
Goodness-of-fit (Chi-Square)	375.569 (df=389; P>0.050)			125.83; df = 108; P>0.050)		
Coefficient of determination	0.655			0.221		

4. Conclusions and recommendations

The study explored the feasibility of rice and fish farmers embracing the practice of rice-cum-fish production system. The results of the study have revealed a relatively lower awareness of this technology among both the rice and fish farmers in the study area. This indicates that this technology is new to the majority of the farmers. Thus, any intervention efforts must devote attention to enlightening the farmers of the existence of such a technology. There was a very high readiness among both the fish and rice farmers to adopt the proposed technology. An implication of this is that any programme aimed at promoting the technology will likely be successful, since the farmers are favourably disposed to the practice. But the adoption decision of the farmers, the study revealed, was influenced by their socio-economic characteristics such as age, education, income, awareness of the technology existence.

The study recommends that farmers should be exposed to training on the rice-cum-fish production technology. This will increase awareness to practice the technology; also, to address the fear of inadequate capital, farmers should be linked to credit sources from which they can access fund to implement the recommended technology. There is need to also educate the farmers on the capital or investment required for such a venture.

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