Adoption of Integrated Rice-Fish Farming Technology in Ebonyi State Nigeria: Perceived Effects and Constraints

Lucy A. Onoh, Charles C. Onoh, Christiana I. Agomuo, Theresa C. Ogu, Evajoy O. Onwuma

Abstract — Nigeria is facing food security crisis with growing population that is increasingly dependent on imported foods. It is the most populous nation in Africa with over 180 million people to feed. This is happening in a country that has the potential to grow highly nutritious rice through rice-fish integration with its attendant sustainable developments. This study assessed the perceived effects and constraints militating against the use of integrated rice-fish farming technology in the area. A multistage sampling technique was used in the selection of respondents. Data were collected with the use of structured questionnaire administered to 243 rice-fish farmers. The questionnaire was structured to address the objectives and hypothesis of the study. The Mean score analysis and Standard deviation were used to analyze the perceived effects and constraints militating against the use of integrated rice-fish farming technology. The Hypotheses were tested using Z- test and Analysis of variance. The results of the study revealed that the effects mostly perceived by the farmers were improved household nutrition (M=3.11) and improved family income (M=3.09). It indicated that inadequate water supply to rice-fish farms (2.5) and scarcity of inputs (M=2.1) were mostly identified as the constraints to the use of integrated rice-fish farming technology. Extension agents should intensify educational extension visits so that the farmers will have timely information about the practice. There is need for government and intervention agencies to provide agricultural inputs to the farmers to encourage them in their farming practices. They should make extension services functional and provide policies that will drive the adoption of rice-fish farming technology.

Index Terms — Agricultural technology, Barriers, Crops, Harvesting rice before fish, Stocking of carps.

I. INTRODUCTION

Any country that cannot produce food is vulnerable and at the mercy of the exporting countries trade policies. Nigeria is facing food security crisis with growing population that is increasingly dependent on imported foods. It is the most populous nation in Africa with over 170 million people to feed [1].

Nigeria is the second highest importer of rice after Philippines and spends about N1 billion a day to import polished rice of low nutritious value which has been stored for about 10 years. However, highly nutritious rice can be grown in Nigeria through rice-fish integration with its attendant sustainable developments [2].

Rice (*Oryza sativa*) is a semi-aquatic plant which belongs to the family *Poaceae*. Its origin has been traced to South-east Asia, but today it is widely grown in other parts of Asia, America, and Africa. In the South-east region of Nigeria, rice is grown mainly in Abakaliki, Bende, Eha-Amufu and Edda [3]. Its potential as a huge source of calories makes it a major food security commodity in Nigeria. Fish occupies a unique position which is the cheapest source of animal protein up to 50% of the total animal protein [4].

It is known that the coastal areas of Nigeria comprise of blackish water and mangrove swamps in the Niger Delta that is approximately 1 million hectares of these culture [5]. The potentials of aquaculture development as recorded in Asian countries, formed two thirds of world's fish production [6]. There is need to increase fish farming to bridge the gap between supply and demand as this will reduce the huge amount of money spent on importation of fish in Nigeria. Moreover, it will create a lot of jobs for the growing population in areas of production and processing.

In Nigeria integrated rice fish farming is carried out mainly at subsistence level [7]. Rice-fish culture involve stocking paddy fields main crop with fingerlings in order to obtain two crops that is, fish in addition to main crop. The strategy has been practiced for thousands of years by Asian farmers [8] and ensures a more economic utilization of land resource [9]. Integrated rice-fish culture aims to increase agricultural productivity from water, while improving the financial sustainability of investments in irrigation [10]. It is based on the affinitive relation between rice and fish and impacts tremendously on the social, economic, environmental and public health of the community [11].

Rice and fish are grown in the same ecosystem and both benefit from this mutuality. The rice provides the fish with a shelter as well as providing shade and thus reducing water temperature, which creates a more suitable environment. Rice fields decrease the concentrations of ammonia in the water and the total nitrogen present in the soil, contributing to the improvement of environmental conditions. Fish benefit from the herbivorous insects that can be found on the rice by having a supplementary food source. Conversely, the fish reduce insect, pests, diseases and weeds. By controlling weeds, the competition for nutrients is decreased between rice and weeds and therefore, more nutrients are available for the rice, which has a positive effect on nutrient uptake. The

Published on September 27, 2020.
Lucy A. Onoh, Department of Agricultural Extension, Federal University of Technology, Owerri, Nigeria.
(corresponding e-mail: onohamarachukwulucy@gmail.com)
Charles C. Onoh, Department of Health Services, Public Health Unit, Federal University of Technology, Owerri, Nigeria.
(e-mail: charles.onoh@futo.edu.ng)

Christiana I. Agomuo, Department of Agricultural Extension, Federal University of Technology, Owerri, Nigeria.
(e-mail: christiana.agomuo@yahoo.com)
Theresa C. Ogu, Department of Agricultural Extension, Federal University of Technology, Owerri, Nigeria.
(e-mail: romayorchris@gmail.com)
Evajoy O. Onwuma, Department of Agricultural Extension, Federal University of Technology, Owerri, Nigeria.
(e-mail: oevajoy@gmail.com)

carbon dioxide released by the fish is utilized by the rice during photosynthesis. The frequent movement by fish creates a loosening of the surface soil that causes more perfusion of oxygen by increasing the quantity of dissolved oxygen [12]. There is increase in the movement of microorganisms that produce more vital nutrients for the rice by augmenting mineralization of the organic matter. This also encourages decomposition and effectiveness of the fertilizer. This is why integrated rice-fish farming technology is desirable and needs to be adopted and sustained.

Rice-fish farming technology has a positive impact on farmers, by reducing the amount of manual labour as fish acts as weed, pest controllers and fertilizers. This has resulted in an increase in rice yields and output [13]. There is space optimization since aquaculture and agriculture are practiced in the same area. It supplements the profitability of a particular land. The landscapes created by Rice-fish farming technology could create a distinctive landscape and thus encourage [14], [15]. Rice-fish farming has tremendous impact on public health. Fish prey on the larvae of mosquitoes and thus reduce the incidence of malaria. This decreases the population of snails which harbour trematodes that cause schistosomiasis. The absence of use of pesticides helps in maintaining a clean environment and encourages biodiversity [16]. The integrated rice-fish technology depicts the highest reliability and stability indexes and is better tailored to confer positive future changes than the traditional rice monoculture [17]. An innovation may be judged based on Perceived attributes theory. It was applied to determine to what extent the technologies on improved rice processing reaches the farmers, similarly, identify rate of adoption and factors influencing the adoption of the improved rice processing technologies in the study area [18].

It is against the backdrop of the foregoing that this study sought and addressed its objectives on the perceived effects and constraints on the use of integrated rice-fish farming technology.

II. MATERIALS AND METHODS

A. Study Area

Study Area The study was conducted in Ebonyi state, Nigeria. Ebonyi state is one of the states of South East region of Nigeria. It derives its name from River Ebonyi. Ebonyi river arises from the Enugu highlands and cuts through Abakaliki. The capital and largest city in the state is Abakaliki. It has a land area of about 5,530 km² [19]. It lies within longitudes 7°30' and 8°30'E and latitudes 5°40' and 6°45' N [20]. It is bounded to the North by Benue state, to the West by Enugu state, to the East by Cross River state and to the South by Abia state. There are thirteen local government areas (LGAs) in the state namely: Abakaliki, Afikpo North, Afikpo South, Ebonyi, Ezza North, Ezza South, Ikwo, Ishielu, Ivo, Izzi, Ohaozara, Ohaukwu and Onicha. The tropical climate of the state is broadly of two seasons which are the rainy season between April and October and dry season between November and March. The temperature through the year ranges between 21 °C to 29 °C and humidity is relatively high. The annual rainfall varies from 2,000 mm in the Southern areas to 1,150 mm in the Northern areas. The

state enjoys luxuriant vegetation with high forest zone (rain forest) in the south and sub-savannah forest in the northern region [20]. Ebonyi state is also known as the “salt of the nation” because of its large salt deposits. The people of Ebonyi state are predominantly farmers and traders. The main crops produced in the state are rice, yam, palm produce, cocoa, maize, groundnut, plantain, banana, cassava, melon, sugar cane, beans, varieties of fruits and vegetables. Fishing was widely carried out in Afikpo. The state has abundant mineral resources such as lead, limestone, zinc and marble and huge salt deposit in Okposi and Uburu towns. It also has numerous rice processing mills, quarry factories, fertilizer blending plants, poultry farms and one of Nigerian’s foremost cement factories formerly known as Nigerian cement company [20].

B. Sampling Techniques

Multistage sampling procedure was used to select the sample for the study. The first stage to give twenty seven (27) communities, thirdly one (1) village was randomly selected from involved the purposive selection of three (3) Local Government Areas (LGAs) from each of the three (3) agricultural zones, which is Ebonyi North, Ebonyi South Central of Enugu State where rice and fish farming are practiced, to give nine (9) LGAs (Ishielu, Ohaukwu, Izzi, Ikwo, Ezza North, Ezza South, Ohaozara, Afikpo South and Onicha). In the second based on their high rice and fish farming activities each community to give twenty seven (27) villages. In the fourth stage, nine (9) rice-fish farmers were purposively selected from village based on their practice of rice-fish farming to give a total sample size of 243 rice-fish farmers for the study [21].

TABLE 1: DISTRIBUTION OF SAMPLE FRAME

Agricultural zones	L.G.A.	Communities	Villages	No of rice-fish farmers
Ebonyi North	Ishielu	Ezeillo	Amukpa	9
		Nkalagu	Amagu	9
		Nkalagu	Imoha	9
	Ohaukwu	Effium,	Akpu	9
		Umugudu,	Azu Egu	9
		Umuezeaka	Agenyi	9
	Izzi	Ogbo-Agbaja	Ishiagu	9
		Igbeagu	Ndiagu	9
		Ndiezi	Nduogbu	9
	Ikwo	Akpan-wudele	Umuome	9
Igbudu		Echara	9	
Ebonyi Central	Ezza North	Eka-Awoke	Noyo-Alike	9
		Amazu,	Onueke	9
	Ezza South	Ekka	Ndiagu	9
		Oriuzor	Umu-Ezeali	9
		Isieke	Amuzu	9
		Abina	Amana	9
		Agalaga	Ezzama	9
		Ohaozara	Uburu	Obiozara
	Afikpo South	Okposi	Okposi-Okwu	9
		Akaeze	Umuobor	9
Ebonyi South	Onicha	Igli	Agbogo	9
		Amasiri	Amazozara	9
		Owutu Edda	Amachi	9
		Isu	Agba	9
		Shiri	Isieke	9
		Ukawu	Amaofia	9
				243

C. Data Collection

Data were collected from primary sources. Primary data were obtained from field using structured questionnaire. The

questionnaire contained questions that address the objectives and hypothesis of the study.

D. Standardization of the Data Collection Instrument

The Research instrument (structured questionnaire) was standardized to ensure that the items are valid and reliable.

E. Estimating Validity

Jury method of estimating content validity was employed to determine the adequacy of the test items. To achieve this, the research instrument was given to a team of experts from different fields of agriculture in the Federal University of Technology, Owerri who independently reviewed the items and questions on the research instrument based on their relevance and adequacy in eliciting the needed information. Questions identified to be ambiguous were reviewed.

F. Estimating Reliability

Test re-test method was used to establish the ability of the measurement scale to maintain a consistent result when applied to the same sample. To achieve this, the Likert scales for the objectives were first administered to 20 farmers who did not form part of the study but had similar attributes with the sample. After 14 days interval, the same measurement scales were administered to the same group of farmers. Data from their two responses were correlated to obtain correlation coefficient values of ($r = 0.82$) and ($r = 0.89$) for Objective II. The r – value showed that the measurement scales were 82% and 89% reliable.

G. Measurement of Variables

Objective 1: To ascertain the perceived effects of use of rice-fish farming technologies, the farmers were asked to indicate on a 4-point Likert-type rating scale of:

Strongly agree (SA) = 4
Agree (A) = 3
Disagree (DA) = 2
Strongly disagree (DS) = 1

To obtain the mean:

$$\bar{X} = \frac{SA + A + DA + SA}{4} = \frac{4 + 3 + 2 + 1}{4} = 2.5$$

Decision rule: Any mean score greater than or equal to 2.50 was adjudged “agreed” while any mean score less than 2.50 was adjudged “disagree”.

Objective 2: The constraints militating against farmers’ use of integrated rice-fish farming technology. This was measured using a 3-point Likert-type rating scale of: Very Serious (VS) = 3, Serious (S) = 2, Not serious (NS) = 1.

The mean computation for the constraint was achieved using the formula:

$$\bar{X} = \frac{\sum fx}{n}$$

$\bar{X}$ – the value by which the constraint militating against the use of the rice-fish farming technology was adjudged.

f – Frequency of response in each column.

x – Nominal value of the rating scale of response option (3, 2, 1).

$\sum fx$ – Sum of the frequency of the constraints militating against the adoption of rice-fish farming technology.

n – Sample size.

The mean of the scaling statement was found by dividing the sum of the rating scales by the number of scales. Thus:

$$\frac{VS + S + NS}{3} = \frac{3 + 2 + 1}{3} = 2.0$$

Decision Rule: Items with mean score greater or equal to 2.0 ($\bar{X} \geq 2.0$) were taken as “Constraint”. While items with mean score less than 2.0 ($\bar{X} < 2.0$) were taken as “Not Constraint”.

H. Method of Data Analysis

The Mean score analysis and Standard deviation were used to achieve objectives 1 and 2. Hypothesis I was tested using Z- test to determine the difference in the level of use of rice-fish farming technology between male and female farmers. Hypothesis II was tested using Analysis of variance (ANOVA) to determine the statistical mean difference among the three agricultural zones in Ebonyi State.

Hypothesis I

Hypothesis I was tested at $P \leq 0.05$ using Z-test. The Z-ratio is expressed mathematically:

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

where

Z – the value by which the statistical difference between male and female farmers in their level of use of the technologies was adjudged.

$\bar{X}_1$ – Mean of male farmers.

$\bar{X}_2$ – Mean of female farmers.

σ_1 – Variance of male farmers.

σ_2 – Variance of female farmers.

n_1 – Number of male farmers.

n_2 – Number of female farmers.

Hypothesis II

Hypothesis II was tested using Analysis of variance (ANOVA).

The ANOVA is implicitly expressed thus:

$$F = \frac{MSSB}{MSSW} = \frac{SSB(n - K)}{SSW(K - 1)}$$

where:

F – the value by which the statistical mean differences among the three agricultural zones were judged.

SSB – Sum of squared deviations between the mean of use of integrated rice-fish farming technology by farmers in the 3 agricultural zones of Ebonyi state.

SSW – Sum of squared deviation within the mean of use of integration rice-farming technology by farmers in the 3 agricultural zones of Ebonyi State.

$\bar{x}$ – grand mean of the use of integrated rice-fish farming technology of farmers in the 3 agricultural zones of Ebonyi State.

x_{ij} – nth of the use of integrated rice-fish farming.

n_j – sample size of respondents from j agricultural zone.

n – number of observations from the 3 agricultural zones.
 k – number of agricultural zones of the state.

III. RESULTS AND DISCUSSION

A. Farmers perceived effects of use of integrated rice-fish farming technology on farmers

Table 2 shows the distribution of farmers by their perceived effects of use of integrated rice-fish farming technologies on farmers. The table reveals that the farmers perceived the following as the positive effects of use of rice-fish farming technologies in the area: improved household nutrition ($M=3.11$), improved family income ($M=3.09$), improved standard of living ($M=3.08$), increased provision of food and fish ($M=3.02$), improved environmental conservation and friendliness ($M=2.99$), provision of employment ($M=2.96$) and, improved household assets ($M=2.85$). Fish supplies quality protein needed for the replacement of worn out tissues in the body while rice which is a staple crop in Nigeria supplies energy in form of calories to the farmers for healthy living. The sale of produce from the rice-fish farming enriches the farmers' purse by providing him/her income upon the sale of the produce. With increase in income the standard of living becomes adequately improved; the farmer will be able to pay his/her bills, buy materials, clothing, and shelter, among other needs.

B. Constraints to the level of use of integrated rice – fish farming technology

Table 3 shows the distribution of integrated rice-fish farmers by constraints to the level of use of integrated rice – fish farming. The result indicated that inadequate water supply to rice-fish farms (2.5), scarcity of inputs ($M=2.1$), dearth of information ($M=2.1$) and lack of finance ($M=2.0$) were identified as constraints to the level of use of integrated rice-fish farming technology. The results are in line with the findings of [22] that identified them among militating factors of the level of use of aquaculture technology by fish farmers. Also [7], explained that contrary to the general expectation that lack of finance constrain the use of rice-fish farming technology, as often witnessed with other technologies, the problem with the novel practice is largely lack of information on its practice. However, unavailability of markets to sell farm produce and buy inputs ($M=1.9$), inadequate transportation to convey farm produce ($M=1.8$), problem of leaking ponds ($M=1.7$), inability of farmers to interpret technology due to illiteracy ($M=1.2$) and time consuming nature of the practice ($M=1.1$) were perceived as not constraints to the level of use of rice-fish farming technology in the study area. Again, the result conforms to the views of [7], which [considered every other factor less problematic besides information access on rice-fish farming. The average standard deviation value was low ($SD = 0.3$) and thus implied that the farmers were unanimous in their perception on the constraints.

TABLE 2: DISTRIBUTION OF FARMERS BY PERCEIVED EFFECTS OF USE OF INTEGRATED RICE-FISH FARMING TECHNOLOGY

Effects	SA	A	D	SD	$\bar{X}$	R
Increase of provision of food/fish	90	100	20	33	3.02	Agree
Provision of employment	80	103	30	30	2.96	Agree
Improved family income	98	95	25	25	3.09	Agree
Improved household assets	80	90	30	43	2.85	Agree
Improved standard of living	102	80	40	21	3.08	Agree
Improved household healthcare	40	32	88	83	2.12	Disagree
Improved household nutrition	105	80	40	15	3.11	Agree
Improve environmental conservation/friendliness	93	85	35	30	2.99	Agree

$\bar{X} \geq 2.50$ implies "agree".
 $\bar{X} < 2.50$ implies "disagree".

TABLE 3: DISTRIBUTION OF FARMERS BY PERCEIVED CONSTRAINTS TO THE LEVEL OF USE OF INTEGRATED RICE – FISH FARMING TECHNOLOGY

Constraints	Very serious	Serious	Not serious	Mean	SD	Remark
Scarcity of inputs	99	81	63	2.1	0.3	Constraint
Lack of finance	74	68	101	2	0.1	Constraint
Practice is time consuming	3	19	221	1.1	0.2	Not constraint
Illiteracy among farmers	14	22	207	1.2	0.2	Not constraint
Dearth of information	88	97	58	2.1	0.3	Constraint
Unavailability of markets	73	66	104	1.9	0.3	Not constraint
Transportation problem	56	73	114	1.8	0.4	Not constraint
Shortage of labour	41	96	106	1.7	0.6	Not constraint
Inadequate water supply	144	77	22	2.5	0.2	Constraint
Problem of leaking ponds	22	149	72	1.8	0.3	Not constraint
Scarcity of land	53	64	126	1.7	0.3	Not constraint

$M \geq 2.0$ (Constraint); $M < 2.0$ (Not constraint).

C. Hypothesis testing

Hypothesis I: There is no significant difference in the level of use of integrated rice-fish farming technology between male and female farmers in the study area

Result in Table 4 showed that the mean difference in the level of use of integrated rice fish farming technology between male and female farmers in the study area was 1.109. The test produced a Z-value of 1.47 which was not significant when compared with the critical Z-value of 1.96 at 5%

probability level of significance for a two tailed test. Hence, since Z-calculated ($Z\text{-cal}=1.47$) was less than Z-tabulated ($Z\text{-tab}=1.96$), the hypothesis which states that there is no significant difference in the level of use of integrated rice fish farming technology between male and female farmers in the study area was therefore accepted. This result suggests that the farmers across gender are the same in the level of use of integrated rice-fish farming technologies and thus confirmed the earlier results of this study which indicated that the farmers poorly utilized the practice. [14], [15] have noted that when the awareness of a technology is generally low in a location the level of use is bound to suffer. Unfortunately, lack of use of a useful technology entails a huge loss for the farmer as the potentials inherent in such technology, largely elude the farmers. The implication of the above result is that, since the males and females do not differ in their level of use of the technologies, equal opportunities should be given to them in terms of access to extension information, access to loan or grants, inputs and other incentives that enhance productivity.

TABLE 4: Z-TEST OF SIGNIFICANT DIFFERENCE IN THE LEVEL OF USE OF INTEGRATED RICE FISH FARMING TECHNOLOGY BETWEEN MALE AND FEMALE FARMERS IN THE STUDY AREA

Variables	N	Mean	Standard deviation	Z-cal.	Z-tab	Decision
Male	165	48.116	8.114	1.47	1.96	The null hypothesis is accepted
Female	78	49.225	9.431			

Hypothesis II: There is no significant difference in the level of use of integrated rice-fish farming technology among farmers in the 3 agricultural zones of Ebonyi State

Result in Table 5 shows the test of Analysis of Variance (ANOVA) carried out to ascertain whether there are significant differences in the level of use of integrated rice-fish farming technologies among farmers in the 3 agricultural zones of Ebonyi State. The test produced an F-value of 1.19 which was less than the tabulated F-value of 1.94 and P-value of 12.10 which exceeded the 0.05 significant value benchmark ($P<0.05$). Hence, the hypothesis which states that there are no significant differences in the level of use of integrated rice-fish farming among farmers in the 3 agricultural zones of Ebonyi State is therefore accepted, implying that the farmers in the three agricultural zones were at the same level of use of technology. This could be due to fact that they operate within the same ecological conditions and socio-cultural environment.

TABLE 5: ANALYSIS OF VARIANCE (ANOVA) ON THE SIGNIFICANT DIFFERENCES IN THE LEVEL OF USE OF RICE-FISH FARMING TECHNOLOGY AMONG FARMERS IN THE 3 AGRICULTURAL ZONES OF EBONYI STATE

	Sum of Squares	DF	Mean Square	F-CAL	F-tab	Decision
Between Groups	11.111	240	6.75	1.19	1.94	Null accepted
Within Groups	11.214	3	6.11			
Total	0.103	243	24.86			

IV. CONCLUSION

This study has demonstrated that the rice-fish farming technologies had effects on the farmers' productivity. Inadequate water supply, scarcity of inputs and dearth of information constituted constraints to the level of use of rice-fish farming technology by the farmers. No significant difference existed between male and female farmers in their level of use of the technologies and there were no significant differences in the level of use of the technologies among farmers in the 3 agricultural zones of Ebonyi State.

V. RECOMMENDATIONS

There is need for government and intervention agencies to provide agricultural inputs to the farmers to encourage them in their farming practices. This can be done in the form of subsidy, credit facilities and grants to the farmers. Dearth of information is one of the problems that is facing the farmers in rice-fish farming technologies. Extension agents should help to bridge the gap through intensive educational extension visits so that the farmers will have timely information about the practice. They should mount aggressive awareness campaign in the area to enable more farmers embrace the practice of rice- fish farming in the state.

REFERENCES

- [1] A. G. Coche, (2008). Fish culture in rice fields: a World-wide synthesis. *Hydrobiologia* 30 (1): 1-14.
- [2] S. B Cohen, (1998) "Abakaliki " The Columbia Gazetteer of the World. New York.
- [3] K. H. Dang, J. C. Verdegem, R. Le Dyong, and D. C. Little, (2007). Integrated fresh water aquaculture, crop and livestock production in Mekong Delta, Vietnam, Determinants and role of the pond. *Agricultural systems*, 2, May 2007 94:445-458
- [4] O. O. Eliot, (2002): Biological observation of some species used for aquaculture in Nigeria FAO) CFA Symposium on Aquaculture in Africa, Accra, Ghana.
- [5] F.A.O., (2015). Growing lowland rice; a production hand book Africa Rice Centre (WARDA). <http://www.warda.org>.
- [6] T. B. Gurung, and S. K. Wagle, (2005). Revisiting underlying ecological principles of rice-fish integrated farming for environmental, economical and social benefits. *Our Nature*, 3(1):1-12.
- [7] H. Josupeit, (2008). The economic and social effects of the fishing industry. FAO fish circ. 314.Rev. 1.Pp 6.9.
- [8] U. Khumairoh, E. A. Lantinga, R. P. Schulte, D. Suprayogo, and J. C. Groot, (2018). Complex rice systems to improve rice yield and yield stability in the face of variable weather conditions. *Scientific reports*, 8(1), 14746.
- [9] Y. Koseki, (2014). Column: Rice-Fish Culture: The Contemporary Significance of a Traditional Practice. In *Social-Ecological Restoration in Paddy-Dominated Landscapes* (pp. 165-172). Springer, Tokyo.
- [10] J. Lu, and X. Li, (2006). Review of rice-fish-farming systems in China—one of the globally important ingenious agricultural heritage systems (GIAHS). *Aquaculture*, 260(1-4), 106-113.
- [11] P. K. Nayak, A. K. Nayak, B. B. Panda, B. Lal, P. Gautam, A. Poonam, and N. N. Jambhulkar, (2018). Ecological mechanism and diversity in the rice-based integrated farming system. *Ecological Indicators*, 91, 359-375.
- [12] C. J. Nnaji, F. C. Okoye, and J. O. Ogunesye, (2003). Integrated fish farming practices with special reference to combination rates production figures and economics evaluation. In A. A. Eyo, J. O. Ayanda (eds) *Conference proceeding of fisheries society of Nigeria (FISON) Owerri 8th-12th December, 2003*, PP 173-178.
- [13] I. Nwachukwu, and R. Onuegbu, (2007). Adoption of Aquaculture Technology by Fish Farmers in Imo State of Nigeria. *The Journal of Technology Studies* 33(1) DOI: 10.21061/jots.v33i1.a.8.
- [14] I. Nwachukwu, (2003). *Agricultural communication: Principle and practice*. Umuahia: Lamb House Publishers

- [15] I. L. Nwaogazie, (2018) Personal Communication, Centre for Occupational Health, Safety and Environment, Institute of Petroleum Studies, University of Port Harcourt, Nigeria.
- [16] B. O. Omitoyin, (2007). Introduction to Fish farming in Nigeria. Ibadan University Press. University of Ibadan.
- [17] R. U. Onyeneke, (2017). Developments adoption of improved technologies in rice production in Imo State, Nigeria. *African Journal of Agricultural Research*. Vol. 12(11): 888-896.
- [18] J. N. Orji. Political Organisation in Nigeria since the last Stone age: History of the Igbo people. New York. 2011.
- [19] F. T. Ujoh, F. Ujo, I. Kile, (2016). Integrated Production of Rice and Fish: Toward a Sustainable Agriculture Approach. *Journal of Scientific Research and Reports*. 10(6): 1-9.
- [20] M. M. J. Vincke, (2009). Fish culture in rice fields: its status and future role in pillar TVA and Dill WA (eds). *Advances in Aquaculture*. Fishing News Book Ltd. Farnham. Survey, England PP.208-223
- [21] Q. Wariboo, and N. Ezenwa (2001). Keynote address, proceedings, conference of the fisheries society of Nigeria.
- [22] J. Xie, L. Hu, J. Tang, X. Wu, N. Li, Y. Yuan, and X. Chen, (2011). Better root development of the rice. Ecological mechanisms underlying the sustainability of the agricultural heritage rice–fish co-culture system. *Proceedings of the National Academy of Science*.

Theresa Celestine Ogu is a Principal Agricultural Superintendent II at the Department of Agricultural Extension, Federal University of Technology, Owerri, Nigeria. She holds a HND in Agricultural Extension and Management from Federal College of Agriculture, Ishiagu, Ebonyi State, Nigeria. Mrs. Ogu has her pet project in Farm Management

Evajoy Ogechi Onwuma obtained a Bachelor degree in Agricultural Extension from Federal University of Technology, Owerri, Nigeria. She is a Senior Farm Officer at the Department of Agricultural Extension, Federal University of Technology, Owerri, Nigeria. Presently, Mrs. Onwuma is a Postgraduate Student at the Department of Agricultural Economics, Extension and Rural Development, Imo State University, Owerri, Nigeria.

Lucy Amarachukwu Onoh holds a Bachelor's and Master's degrees in Agricultural Extension at the Federal University of Technology, Owerri, Nigeria. She is a Senior Farm Officer and teaches Dry season vegetable production techniques and Agricultural extension teaching methods to students of the School of Agriculture and Agricultural Technology. Mrs. Onoh is a researcher in Rural Development and

Sociology.

Charles Chukwuemeka Onoh obtained a Bachelor of Science and MBBS degrees from the prestigious University of Nigeria, Nsukka. He also has Master of Science degrees in Pharmacology & Therapeutics and Occupational Health, Safety & Environment from Nnamdi Azikiwe University, Awka and University of Port Harcourt, Nigeria respectively. He completed a doctorate degree programme in Occupational Health

& Safety in 2017.

He is well experienced in Therapeutics, Disease modelling and Clinical e-health. He is a resource person for so many institutions including College of Medicine, Madonna University, Port Harcourt, Department of Gender & Global Health, Institute of Women, Gender and Development Studies, Department of Public Health and Department of Environmental Health Science, Federal University of Technology, Owerri, Nigeria.

Dr. Onoh is a TETfund scholar and has developed a Computer Software for the Assessment of Cardiometabolic diseases. Currently, he is working on the Application of Smart devices in medical surveillance and agricultural technologies of public health concern.

Christiana Ihuoma Agomou is a Principal Agricultural Superintendent at the Department of Agricultural Extension, Federal University of Technology, Owerri, Nigeria. She obtained a HND in Agricultural Extension and Farm Management from Federal College of Agriculture, Umuahia, a PGD in Forestry and Environmental Management from Michael Okpara University of Agriculture, Umuahia, Nigeria and an

M.Sc in Agricultural Extension from Imo State University, Owerri, Nigeria.

Mrs. Agomuo is a Ph.D and TETfund scholar.