# Adoption of Integrated Rice-fish Farming Technology in Ebonyi State Nigeria: Sources of Information and Level of Use

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*Authors' contributions*

*This work was carried out in collaboration among all authors. Author LAO designed the study, carried out field visits, wrote the protocol and the first draft of the manuscript. Author CCO provided guidance on literature search, data management and computational aspects. Authors CIA and TCO participated in the literature search and data collection. Author EOO participated in the field visits and documentation. Author FCA confirmed the accuracy of the results and served as the overall supervisor. All authors read and approved the final manuscript.*

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## ABSTRACT

**Background:** Integrated rice-fish farming is one of the most viable, reliable and profitable of any farming enterprise. It contributes immensely to the economic empowerment of many families especially in the rural communities. It enables the farmer to be productive all year round and fully maximize its production.
**Aim:** To identify the sources of information available to farmers on integrated rice-fish farming and assess the level of use of integrated rice-fish farming technologies by the farmers in the study area.
**Study Design:** This was a cross-sectional study. 243 farmers were assessed to ascertain their sources of information and level of use of integrated rice-fish farming technologies in the study area.

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**Methodology:** Primary data were obtained from the field using structured questionnaire. The questionnaire contained questions that address the objectives of the study. Farmers were asked to identify the sources of information and the level of use of integrated rice-fish technology on a 4-Likert scale.

**Results:** The result revealed that 78.2% of the farmers got information on integrated rice-fish farming technology using phone, 75.0% said they heard about it on radio, 70.0% got theirs from friends /relatives while 67.9% indicated getting their information from co-operatives. It revealed that the farmers used the following technologies: use of net guard (M = 3.17) skills in harvesting of fish before rice (M=3.17) stocking of carp fish (M=3.09) use of organic fertilizers (M=3.05) transplanting the rice seedling (M=2.95) and use of pest and disease resistant varieties (M=2.85), while technologies like use of bamboo guard (M=1.97) skills in harvesting of rice before fish (M=1.96) stocking of tilapia fish (M=1.93) construction of trenches (M=1,88) and use of terracing (M=1.86) are not used.

**Conclusion:** Most of the farmers (78.2%) got their information from the electronic media such as mobile phones and radio. Use of net guard (M= 3.17) skills in harvesting of fish before the rice (M= 3.17), stocking of carp fish (M= 3.09) and use of organic fertilizers (M= 3.05) were the technologies mostly used by the farmers.

**Recommendations:** For effective communication and information dissemination to be sustained on rice-fish farming, the Federal and State governments should support the farmers by providing mobile phones and radios because farmers will always prefer information channels that are cheaper, accessible and convenient.

## 1. INTRODUCTION

Fish occupies a unique position which is the cheapest source of animal protein making 50% of the total animal protein [1]. Fisheries guarantee direct and indirect employment opportunities, with up to 1.6 million artisanal fishermen in the primary sector and some 200,000 workers employed in the aquaculture sub-sector. Fish plays important roles in Nigeria economy. Fish is available to Nigerians in fresh, smoked, dried or frozen forms with no religious bias compared to pork or beef. 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. It is a cereal which has become a food of considerable strategic importance in many rapidly growing African cities, where its consumption among urban and rural poor households has increased considerably. In the South-east region of Nigeria, rice is grown mainly in Abakaliki, Bende, Eha-Amufu and Edda [2]. Its potential as a huge source of calories makes it a major food security commodity in Nigeria.

Adoption is defined in different ways by various authors. [3] defines adoption as the integration of a new technology into existing practice and is usually proceeded by a period of 'trying' and some degree of adaptation. The relative speed with which farmers adopt an innovation, has as one of its pillars, the element of 'time', and intensity of adoption refers to the level of use of a given technology in any time period [4].

The acceptance of a new idea is a complex process. It involves a sequence of thoughts and actions above which people have limited knowledge. The major concern of extension is to narrow the gap between diffusion and adoption. Adoption therefore refers to the final decisions by farmers to put into a new idea or an innovation [5]. The meaning of adoption implies that the adopter is satisfied with innovation. The complex process involved is usually referred to as adoption process it has been defined by Rogers (2003) as a mental process, which an individual passes through from the time he hears of the new idea and the time he finally accepts it. [6] went further to say that an innovation or idea may be rejected at any stage in the adoption process or even after adoption use after previously adopting is referred to as rejection or abandoned adoption [7].

Farmers' decisions about whether and how to adopt new technology are conditioned by the dynamic interaction between characteristics of the technology itself and the array of conditions and circumstances [3]. Decisions are often the

result of a comparison of the uncertain benefits of the new invention with the uncertain costs of adopting it [8]. An understanding of the factors influencing this choice is essential both for economists studying the determinants of growth and for the generators and disseminators of such technologies [8].

Integrated rice-fish farming is one of the most viable, reliable and profitable of any farming enterprise. It contributes immensely to the economic empowerment of many families especially in the rural communities [9,10].

The Rice-fish farming technological package is comprised of the following components: use of terracing, trench construction, bamboo guard construction, use of net guard, fingerling stocking, use of pesticides, use of resistant varieties of rice and supplies of fish, use of organic and inorganic fertilizers, rice-fish harvesting, rice seedling transplanting [11]. It enables the farmer to be productive all year round and fully maximize its production. Integrated rice-fish farming is one of the most viable, reliable and profitable of any farming enterprise. It contributes immensely to the economic empowerment of many families especially in the rural communities.

In this practice, rice and fish are raised side by side in separate compartment using the same water or an alternating system that is really a type of rotation culture, but distinct enough to warrant a separate section [12]. Fishes are usually cultured within rice areas protected from excess flooding by small dikes. Fishes are cultured in rice paddies either concurrently with rice or in rotation. It can optimize resource utilization through the complementary use of land and water. While rice constitutes a major staple food and carbohydrate, source of calories, fish on the other hand, are rich in micro-nutrients and vitamins and thus human nutrition can be greatly improved through fish consumption, intensification, profitability and productivity.

Ecologically, integrated rice-fish farming improves soil fertility by increasing the availability of nitrogen and phosphorus to the soil. The natural aggregation of fish in rice field would inspire the combination of rice farming with fish to increase productivity [13]. Integrated rice-fish farming offers contribution to food, income and nutrition especially in form of carbohydrate and animal protein [14].

Benefits of rice-fish culture include reduction in the use of chemical fertilizer and the recycling of the nutrients by the fish through feeding and deposition of faeces in the soil. This increases the uptake of nutrient such as phosphorus and nitrogen by the rice and also contributes to improved use of land. Other gains from rice-fish integration include an increase in income from the production of both fish and rice. Fish culture can be extensive or semi-extensive. Earthen pond fish culture is the most suitable integrated aquaculture system because of the natural ecosystem that can conveniently accommodate both crop and livestock production [15].

Hunger and malnutrition remain amongst the most devastating problems facing the world poor and needy today [16]. The most reliable source of protein for man is fish, yet millions who depend on this are faced with scarcity [17]. With the population of Nigeria on the rise, there is a corresponding demand for fish consumption [18]. Thus there is the need for suitable agricultural system to meet the increasing demand for food and also maximize the utilization of the available limited resources without much waste. Integrated rice-fish farming fits exactly into this [19]. These gaps could be closed through researches that are aimed at the provision of effective communication, greater awareness, wide popularization on the sources of information and level of use of rice-fish technologies.

## 2. METHODOLOGY

### 2.1 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 Aboine. Aboine 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 $km^2$ [20]. 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 [21].

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. The animals reared include grass cutters, poultry, goats, pigs and cattle. Fishing is widely carried out in Afikpo. The state has abundant mineral resources such as lead, limestone, zinc and marble and the huge salt deposit at the 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, Nkalagu [20].

## 2.2 Sampling Techniques

Multistage sampling procedure was used to select the sample for the study. The first stage 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 to give twenty seven (27) communities, thirdly one (1) village was randomly selected from 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 [22].

**Table 1. Distribution of sample frame**

| Agricultural zones | L.G.A. | Communities | Villages | No of rice-fish farmers |
|---|---|---|---|---|
| Ebonyi North | Ishielu | Ezeillo | Amukpa | 9.0 |
| | | Nkalagu | Amagu | 9.0 |
| | | Nkalagu | Imoha | 9.0 |
| | Ohaukwu | Effium, | Akpu | 9.0 |
| | | Umugudu, | Azu Egu | 9.0 |
| | | Umuezeaka | Agenyi | 9.0 |
| | Izzi | Ogbo-Agbaja | Ishiagu | 9.0 |
| | | Igbeagu | Ndiagu | 9.0 |
| | | Ndiezi | Nduogbu | 9.0 |
| Ebonyi Central | Ikwo | Akpan-wudele | Umuome | 9.0 |
| | | Igbudu | Echara | 9.0 |
| | | Eka-Awoke | Noyo-Alike | 9.0 |
| | Ezza North | Amazu, | Onueke | 9.0 |
| | | Ekka | Ndiagu | 9.0 |
| | | Oriuzor | Umu-Ezeali | 9.0 |
| | Ezza South | Isieke | Amuzu | 9.0 |
| | | Abina | Amana | 9.0 |
| | | Agalaga | Ezzama | 9.0 |
| Ebonyi South | Ohaozara | Uburu | Obiozara | 9.0 |
| | | Okposi | Okposi-Okwu, | 9.0 |
| | | Akaeze | Umuobor | 9.0 |
| | Afikpo South | Igli | Agbogo | 9.0 |
| | | Amasiri | Amaozara | 9.0 |
| | | Owutu Edda | Amachi | 9.0 |
| | Onicha | Isu | Agba | 9.0 |
| | | Shiri | Isieke | 9.0 |
| | | Ukawu | Amaofia | 9.0 |
| | | | | 243 |

## 2.3 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 hypotheses of the study.

## 2.4 Standardization of the Data Collection Instrument

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

### 2.4.1 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.

### 2.4.2 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 objectives II was 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.

## 2.5 Measurement of Variables

**Objective 1:** To identify the sources of information on integrated rice-fish farming, the farmers were asked to indicate from a list of options, the sources they obtain information on rice-fish farming technology.

**Objective 2:** To examine the level of use of integrated rice-fish farming technology in the study area, the farmers were asked to indicate on a 4-point Likert-type rating scale of:

Used to a very large extent (TVLE) = 4
Used to a large extent = (TLE) = 3
Used to a little extent = (TLiE) = 2
Used to no extent = (TNE) = 1

The mean computation for the level of use was achieved using the formular:

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

Where:

$\bar{X}$ = The value by which the mean score of the rice-fish farming technology use was adjudged

$f$ = Frequency of responses in each column

$x$ = Nominal value of the rating scale of response option (4, 3, 2, 1)

$\sum fx$ = Sum of the frequency of rice-fish farming technology components

$n$ = Sample size

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

$$= \frac{TVLE + TLE + TLiE + TNE}{4}$$
$$= \frac{4 + 3 + 2 + 1}{4}$$
$$= \frac{10}{4}$$
$$= 2,5$$

**Decision Rule:** Technologies with mean score equal to or greater than 2.50 were adjudged to be used while technologies with mean scores less than 2.50 were adjudged not to be used.

**The following null hypotheses were tested:**

**Ho$_1$:** There is no significant difference in the level of use of integrated rice-fish farming technology by male and female farmers in the study area.

**Hypothesis I:** Hypothesis I was tested at P<0.05 using Z-test. The Z-ratio is expressed mathematically:

$$Z = \frac{\bar{X_1} - \bar{X_2}}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}}$$

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

Where: $\overline{X_1}$ = Mean of male farmers
$\overline{X_2}$ = Mean of female farmers
$S_1$ = Variance of male farmers
$S_2$ = Variance of female farmers
$n_1$ = Number of male farmers
$n_2$ = Number of female farmers

**Ho$_2$:** There is no significant difference in the level of use of integrated rice fish farming technology between the 3 agricultural zones of Ebonyi State.

**Hypothesis II:** Hypothesis II was tested using Analysis of variance (ANOVA)

The ANOVA is implicitly expressed thus;

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

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.

x = grand mean of the use of integrated rice-fish farming technology of farmers in the 3 agricultural zones of Ebonyi State.

xij = nth of the use of integrated rice-fish farming

nj = 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

## 2.6 Method of Data Analysis

Descriptive and inferential statistical tools were used in achieving the objectives of the study. For instance, frequency distribution and percentage were used to achieve objective I. While mean score analysis and standard deviation were used to achieve objective II. 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.

## 3. RESULTS AND DISCUSSION

### 3.1 Sources of Information on Integrated Rice – Fish Farming Technology

Table 2 is the distribution by information sources on integrated rice – fish farming. The result revealed that 78.2% of the farmers got information on integrated rice-fish farming technology using phone, 75.0% said they heard about it on radio, 70.0% got theirs from friends /relatives while 67.9% indicated getting their information from co-operatives. Therefore, most of the farmers got their information using their phones and through the radio. [23,24] in their findings on farmers' information sources corroborated this result. They found non- human channels like phones, radio, and human channels like, friends/relatives and co-operatives. The implication of this result curtails that for effective information dissemination on a rice- fish farming, mobile phone, radio, friends/relatives, co-operatives, channels should be used. This, according to [23] is because farmers will always prefer information channels that are cheaper, accessible and convenient for them.

### 3.2 Farmers' Level of Use of Integrated Rice – Fish Farming Technology

Table 3 is the distribution of farmers by level of use of integrated rice-fish farming technology. It revealed that the farmers used the following technologies: use of net guard (M = 3.17) skills in harvesting of fish before rice (M=3.17) stocking of carp fish (M=3.09) use of organic fertilizers (M=3.05) transplanting the rice seedling (M=2.95) and use of pest and disease resistant varieties (M=2.85) while technologies like use of bamboo guard (M=1.97) skills in harvesting of rice before fish (M=1.96) stocking of tilapia fish (M=1.93) construction of trenches (M=1,88) and use of terracing (M=1.86) are not used. This result is a confirmation of what [25] reported in his work on principles of integrated agriculture.

That net guard, harvesting of fish before rice, stocking of carp fish and use of organic fertilizers, transplanting the rice seedling and use of pest and disease resistant varieties are often cheaper to use because most of the materials and practices are bountifully available in the famer's locality, while the practices are often

50

considered less technical and easily replicable in the farmers context and location.

**Table 2. Distribution of farmers by information sources on integrated rice – fish farming**

| Information sources | *Frequency | Percentage (%) |
|---|---|---|
| Radio | 180 | 75.0 |
| Television | 120 | 49.4 |
| Newspaper | 80 | 33.3 |
| Meeting | 160 | 65.8 |
| Friends/relatives | 170 | 70.0 |
| Phone | 190 | 78.2 |
| Contact farmers | 110 | 45.3 |
| Agricultural show | 70 | 28.8 |
| Co-operative | 165 | 67.9 |
| Extension agent | 85 | 35.0 |

*Multiple responses*

It could be inferred therefore that materials and practices that are relatively and less technical to use attract family interest. Good practices on the other hand, enable the farmers minimize cost of producing rice and fish and by so doing maximize profit.

### 3.2.1 Hypothesis testing

**Hypothhesis 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-cal =1.47) was less than Z-tabulated (Z-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. [23,26] 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 no 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 3. Distribution of farmers by their level of use of integrated rice-fish farming technology**

| Technologies | TVLE(4) | TLE (3) | TLE (2) | TNE (1) | $\bar{X}$ | Remark |
|---|---|---|---|---|---|---|
| Use of terracing | 20 | 300 | 90 | 103 | 1.86 | Not Used |
| Construction of trenches | 25 | 20 | 100 | 98 | 1.88 | Not Used |
| Use of bamboo guard | 30 | 25 | 95 | 93 | 1.97 | Not Used |
| Use of net guard | 108 | 80 | 40 | 18 | 3.17 | Used |
| Stocking of Tilapia fish | 29 | 18 | 102 | 94 | 1.93 | Not Used |
| Stocking of carp fish | 95 | 103 | 34 | 28 | 3.09 | Used |
| Use of pests and disease resistant varieties | 80 | 90 | 30 | 43 | 2.85 | Used |
| Use of organic fertilizer | 97 | 88 | 32 | 26 | 3.05 | Used |
| Skills in harvesting rice before fish | 32 | 18 | 102 | 91 | 1.96 | Not Used |
| Skills in harvesting fish before rice | 109 | 80 | 40 | 14 | 3.17 | Used |
| Transplanting of rice seedling. | 90 | 85 | 35 | 33 | 2.95 | Used |

$\bar{X}$ ≥ 2.50 implies "Used" $\bar{X}$ < 2.50 implies to "Not Used"

**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 | | | |

**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 | | | |

**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.

## 4. CONCLUSION

This Study has demonstrated that most. of the farmers (78.2%) got their information from the electronic media mainly from mobile phones and radios and human channels like friends, relatives and cooperatives also contributed to the sources of information. The use of net guard (M= 3.17) skills in harvesting of fish before the rice (M= 3.17), stocking of carp fish (M= 3.09) and use of organic fertilizers (M= 3.05) were the technologies mostly used by the farmers. Inadequate water supply on rice-fish farmers (M= 2.5) constituted a constraint on the level of use of rice-fish farming technology. No significant difference exists between male and female farmers in their level of use of the technologies. Also there were no significant differences in the level of use of the technologies among farmers in the three agricultural zones of Ebonyi State.

## 5. RECOMMENDATIONS

Based on the study, the following recommendations were made:

i. The Federal and State governments should make policies that will facilitate effective communication, information dissemination and sustainability.

ii. Dearth of information is one of the problems that is facing the farmers in rice and fish farming technologies. Extension agents should help to bridge the gap through intensive educational extension visit so that the farmers will have timely information about the practice.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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