Indian J. Fish., 73 (3): 160-169, 2026 doi:10.21077/ijf.2026.73.3.166931-16

Available online at: epubs.icar.org.in/index.php/IJF

Evaluation of the fishery module under the Farmers FIRST Project implemented by ICAR-Central Institute of Freshwater Aquaculture, Bhubaneswar, India

Neela Madhav Patnaik*, H. K. De, Usha Das, Ravi Kumar and S. K. Purbey

ICAR-Mahatma Gandhi Integrated Farming Research Institute, Motihari-845 429, Bihar, India

Abstract

The study was undertaken to evaluate the effectiveness of the Farmers FIRST project (FFP) on fish farmers in selected villages of Odisha. The FFP is implemented at ICAR-Central Institute for Freshwater Aquaculture (ICAR-CIFA), Bhubaneswar, Odisha, with the fishery module aimed at improving the livelihood of beneficiaries through participatory research and knowledge transfer. To assess the effectiveness of the fishery module of FFP, the study compared fish farmer beneficiaries with non-beneficiaries. The study was theoretically guided by the Bennett hierarchy model and employed an *ex post facto* research design involving 60 respondents comprising 30 FFP beneficiaries and 30 non-beneficiaries. An independent-sample t-test showed significant differences between among the beneficiaries and non-beneficiaries in their knowledge ($t=5.88$, $p<0.001$) and adoption ($t=3.63$, $p<0.001$) levels of scientific aquaculture management practices. More than 90% of the fish farmer beneficiaries demonstrated medium to high levels of adoption. Attitude of the beneficiaries was found to be highly favourable towards FFP activities as ascertained through weighted mean scores in terms of inputs provided (93.33%), farmer-scientist interface (92.00%) and other extension activities. Improvements were observed among beneficiaries in terms of knowledge, attitude, skills, response towards FFP activities and adoption of scientific aquaculture practices, indicating the effectiveness of the fishery module of FFP.

*Correspondence e-mail:
nmp.agriext1993@gmail.com

Keywords:
Adoption, Aquaculture extension, Beneficiary, Bennett's hierarchy model, Knowledge, Programme evaluation

Received : 20.05.2025
Accepted : 11.09.2026

Introduction

Fisheries and aquaculture play an important role in rural livelihoods by contributing to food and nutritional security, employment and income generation (Jayasankar, 2018; FAO, 2020; Tacon, 2020). In Odisha, the fisheries sector has considerable potential owing to its diverse inland water resources and favourable conditions for freshwater aquaculture (Kumar and Shivani, 2014). However, farm level productivity is often constrained by inadequate technical knowledge, limited adoption of scientific aquaculture practices, inefficient input use, disease and water quality problems, and inadequate access to timely technical guidance (Obiero *et al*., 2019; Ssekyanzi *et al*., 2022). Strengthening linkages between research institutions and farming communities is therefore essential for promoting scientific aquaculture and improving the livelihood potential of fish farming. Conventional extension approaches largely emphasise the transfer of technologies from research institutions to farmers. However, location specific production constraints require greater farmer participation in problem identification, technology assessment and field level adoption. Participatory extension facilitates two-way communication between farmers and scientists can improve access to technical knowledge and the adoption of appropriate technologies (De *et al*., 2022). In this context, the Farmer FIRST Programme (FFP) of the Indian Council of Agricultural Research (ICAR) was conceived as a farmer-centric initiative emphasising farmers' participation in problem identification, prioritisation, technology assessment and field level experimentation.

© 2026 Indian Council of Agricultural Research

The fishery module of FFP was implemented at ICAR-Central Institute for Freshwater Aquaculture (ICAR-CIFA), Bhubaneswar, to promote scientific aquaculture practices through farmer-scientist interactions, field visits, demonstrations, capacity building programmes and input support. Although FFP has been implemented across different locations and agricultural sectors, systematic evaluation of specific programme components at the individual farmer level remains important. Documentation of programme activities and outreach alone does not establish whether farmers acquired the intended knowledge or adopted recommended technologies. In particular, there is limited empirical evidence evaluating the fishery component of FFP by examining differences in knowledge and adoption between participating and non-participating fish farmers. Evidence on beneficiaries' perceptions of programme activities, perceived skills gained and future aspirations is also limited (Islam *et al*., 2015). A comprehensive evaluation is therefore necessary to understand the extent to which programme activities are associated with farmer-level outcomes and to identify areas for strengthening future interventions. Bennett's hierarchy of evaluation provides a useful framework for assessing extension programmes across progressive levels, from programme inputs and activities to participation, reaction, knowledge, attitude, skills, aspirations, adoption and outcomes (Bennett, 1976). Its application to the FFP fishery module can provide a structured assessment of both programme implementation and farmer-level responses. The present study applies this framework to evaluate the fishery module implemented by ICAR-CIFA, Bhubaneswar, and compares individual FFP beneficiaries with non-beneficiary fish farmers from nearby villages. Given the *ex post facto* and non-randomised design, the observed differences between the two groups are interpreted as associations rather than causal programme effects.

Accordingly, the study aimed to evaluate the implementation of the FFP fishery module using Bennett's hierarchy; to compare the knowledge of beneficiaries and non-beneficiaries regarding recommended scientific aquaculture practices, to compare their extent of adoption of recommended practices, and to assess beneficiaries' reactions, perceived skills, aspirations and perceived livelihood related outcomes associated with their participation in the programme. The study contributes by providing a component specific evaluation of the FFP fishery module using a hierarchical evaluation framework combined with a beneficiary and non-beneficiary comparison providing empirical evidence on observed differences in knowledge and adoption. The findings are expected to provide practical insights for improving farmer-scientist interactions, capacity building activities and technology dissemination under future FFP and similar aquaculture extension programmes.

Materials and methods

Study area and study design

The study was conducted in selected adopted villages of the Farmer FIRST Programme (FFP) implemented by ICAR-CIFA, Bhubaneswar, Odisha. The FFP was implemented in six adopted villages of the institute since 2019–20. The fishery module was implemented in four villages, namely Anthuari, Sidha Kutila, Purohitpur and Brahmanakhandi. Three villages, namely Anthuari, Purohitpur and Brahmanakhandi, were purposively selected for the study and Sidha Kutila was excluded since the fishery intervention in this village involved only community pond beneficiaries. The present study was restricted to individual fish farmer beneficiaries because the principal outcomes were assessed based on individual level knowledge and adoption of recommended scientific aquaculture practices. An *ex post facto* non-randomised research design was employed because the FFP interventions had already been implemented before the commencement of the evaluation and the beneficiaries could not be randomly assigned to the programme. For the present evaluation, multistage sampling procedure was followed starting with selection of village. Thirty individual fish farmer beneficiaries from the three selected villages were purposively selected, representing all eligible individual beneficiaries available within the selected villages. For comparison, 30 non-beneficiary fish farmers were randomly selected from nearby villages, namely Khamoga Sasan, Patapur and Kakarudrapur. Accordingly, the final sample comprised 60 respondents, including 30 FFP beneficiaries and 30 non-beneficiaries. The sampling procedure was primarily determined by the number of eligible individual beneficiaries available under the fishery module. Hence, the sample size was not based on a formal statistical power calculation. The non-beneficiary group was considered a comparison group rather than a control group because the study did not involve random allocation or baseline assessment. The two groups were compared with respect to their knowledge and adoption of recommended scientific aquaculture practices.

Data collection

Both primary and secondary data were used. Primary data comprising quantitative and qualitative information were collected from the selected respondents through a structured interview schedule, personal interviews and group discussions. Secondary information was obtained from the documents, records and reports maintained by the FFP team of ICAR-CIFA, Bhubaneswar.

Evaluation framework

The evaluation was guided by Bennett's hierarchy model (Bennett, 1976). The framework was used to organise the evaluation from programme inputs and activities through participation, reactions, knowledge, attitude, skills and aspirations, adoption of recommended practices and perceived outcomes (Fig. 1). The seven levels of the framework were operationalised according to the information available from programme records and the primary survey. Programme inputs and activities were assessed mainly from secondary records, whereas participation and beneficiary reactions were assessed through primary data. Knowledge and adoption were quantitatively assessed and compared between beneficiaries and non-beneficiaries. Attitude, perceived skills, aspirations and livelihood related outcomes were primarily assessed descriptively among beneficiaries. Since the present study followed an *ex post facto* design without baseline observations, the higher levels of Bennett's hierarchy are interpreted as post-intervention observations and beneficiary reported outcomes, rather than independently established causal programme impacts.

Measurement of knowledge

Knowledge of recommended scientific aquaculture practices was assessed using a structured knowledge schedule developed with

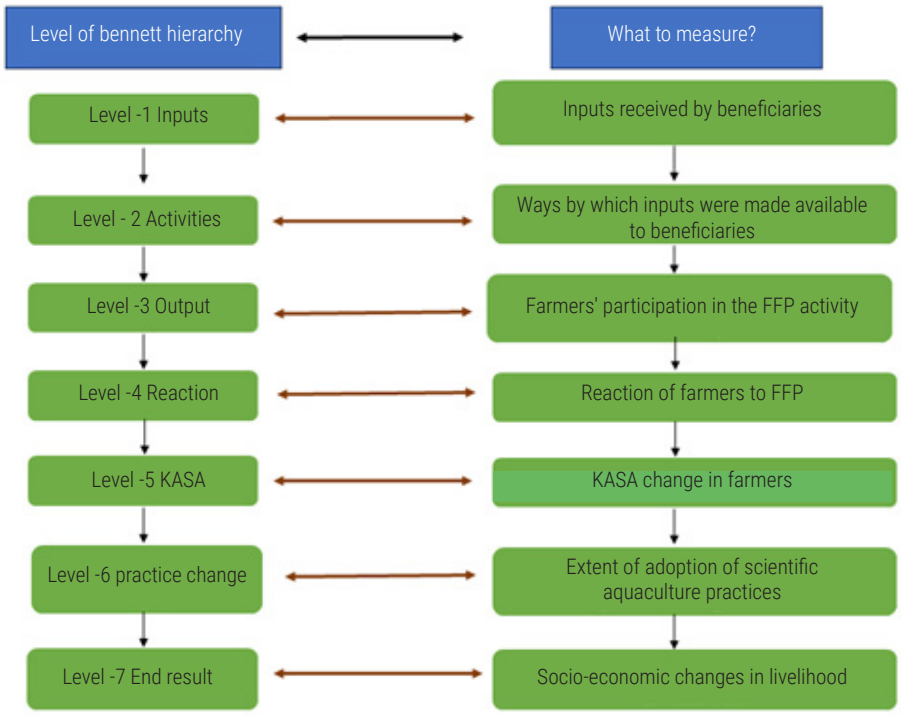

Fig. 1. Conceptual model depicting Bennett's hierarchy levels and their measurement

reference to the recommended scientific practices for fish farming promoted through ICAR-CIFA and the FFP fishery module. The schedule covered important technical practices related to pond preparation, stocking, stocking density, fertilisation, feeding, water quality management, acclimatisation, fish health and harvesting. Responses were scored according to the prescribed binary scoring procedure (know/do not know), and an overall cumulative knowledge score was obtained for each respondent. The knowledge score was subsequently used to compare the beneficiary and non-beneficiary groups. The knowledge assessment was intended to measure respondents' knowledge status at the time of investigation and not change in knowledge over time.

Measurement of adoption

The extent of adoption of recommended scientific aquaculture practices was measured using an adoption schedule covering the recommended practices relevant to fish farming under the FFP fishery module. Respondents were asked about their actual practice of the recommended technologies rather than their awareness or normative agreement with the practices.

The adoption quotient was calculated following the procedure suggested by Sengupta (1967)

$$\text{Adoption quotient} = \frac{\text{No.of scientific aquaculture practices adopted by the respondent}}{\text{Total no.of scientific aquaculture practices}} \times 100$$

The resulting adoption quotient score was used as the principal continuous measure of adoption. Respondents were subsequently classified into three adoption categories using Mean± Standard Deviation (SD) as high => (Mean+0.5 SD); medium= (Mean–0.5 SD) to (Mean+0.5 SD); low= (Mean–0.5 SD) (Balaganesh *et al*., 2020). The categorical classification was used only for descriptive interpretation, whereas the continuous adoption score was considered for categorisation.

Measurement of attitude

Beneficiaries' attitude towards FFP activities and interventions was measured using statements representing different dimensions of the programme, including input support, farmer-scientist interaction, perceived livelihood benefits, sustainability and future continuation of scientific fish farming. Responses were recorded on a five-point Likert-type scale: Strongly agree=5, Agree=4, Neutral=3, Disagree=2 and Strongly disagree=1. For negatively worded statements, the scoring direction was reversed before computation. A weighted mean score was calculated for each statement using the following formula:

$$\text{Weighted mean (in \%)} = \frac{\text{Total score obtained}}{\text{Maximum obtainable score}} \times 100$$

where,

Total score obtained=Sum of scores obtained by multiplying the number of farmers choosing each weight (5, 4, 3, 2, 1)

Maximum obtainable score=Total no. of farmers in the sample multiplied by the highest weight

Assessment of perceived skills and aspirations

Perceived skills gained through participation in the FFP fishery module were assessed through open-ended questions. Beneficiaries were asked to describe the technical skills they had acquired through their association with the programme. As no objective competency test or field-based performance assessment was conducted, these responses are reported as perceived skills gained rather than objectively measured skill attainment. Similarly, beneficiaries were asked about the changes, innovations or fish-farming activities they intended to undertake in the coming years as a result of their association with FFP.

Assessment of perceived livelihood related outcomes

Livelihood related outcomes were documented through beneficiary responses concerning perceived changes in fish production, harvesting period, marketing, income generation and related aspects of fish farming. Because the study did not have baseline data or longitudinal measurements of production, costs, income and profitability, these outcomes were treated as self-reported and perceived changes. They were not used to estimate the causal economic impact of FFP.

Statistical analyses

The quantitative data were coded and analysed using IBM SPSS Statistics version 26 and Statoberry LLP platform. Descriptive statistics, including frequency, percentage, mean and standard deviation, were used to summarise the characteristics and responses of the respondents. For the comparison of knowledge and adoption quotient scores between the beneficiary and non-beneficiary groups, independent-samples t-test was used and depicted as box and beeswarm plots respectively.

Results and discussion

The findings are presented according to the seven levels of Bennett's hierarchy, progressing from programme inputs and activities to farmer reactions, knowledge, attitude, skills, aspirations, adoption and perceived livelihood related outcomes. Quantitative comparisons are restricted to knowledge and adoption, for which data were available for both beneficiaries and non-beneficiaries. The remaining levels are presented descriptively based on programme records and beneficiary responses.

Level 1: Inputs

The FFP fishery module provided beneficiaries with both material and technical inputs. Material support included fish fingerlings of Indian major carps [IMCs *viz*. *Labeo rohita* (rohu), *Catla catla* (catla) and *Cirrhinus mrigala* (mrigal)], fertilisers (single super phosphate and urea), lime and fish feed, while soil and water testing and technical advisories constituted important knowledge-based support. These inputs addressed key constraints reported by farmers, particularly limited access to quality seed, inadequate technical knowledge and poor pond management. The combination of inputs with technical guidance on balanced feeding and pond management was important, as input provision alone may not ensure appropriate technology use. The FFP approach therefore linked resource support with scientific advisories, creating an enabling environment for farmers to apply recommended aquaculture practices.

Level 2: Activities

The FFP fishery module employed a combination of farmer-scientist interfaces, stakeholder meetings, field visits, capacity building programmes and field days as major extension activities (Table 1). These activities were designed to facilitate two-way communication, strengthen farmers' technical knowledge and promote the application of scientific aquaculture practices. The farmer-scientist interface provided beneficiaries and other fish farmers with opportunities to interact directly with scientists, clarify technical doubts and obtain timely recommendations on fish production. Question-answer sessions during these interactions helped address farmers' location-specific problems and improve their understanding of recommended aquaculture practices. Stakeholder meetings were organised at the panchayat level with participation from *Gram Sabha* members, key informants, progressive farmers and farmers engaged in different livelihood enterprises. Group discussions during these meetings helped identify enterprise-specific constraints and enabled the FFP team to align interventions with farmers' needs and livelihood priorities. Field visits served both input-delivery and technical advisory functions. Project staff supplied fingerlings, feed and fertilisers and regularly monitored fish growth and health. During these visits, beneficiaries received practical guidance on acclimatisation of fingerlings, appropriate stocking density, pond fertilisation, feeding rate and schedule, and periodic fish sampling for monitoring growth and health. Thus, field visits provided opportunities for on-site learning and problem solving, rather than functioning solely as input-distribution activities. Capacity building programmes were organised at the adopted villages and KVK of ICAR-CIFA, where farmers were trained in scientific aquaculture practices and exposed to well managed demonstration ponds. These programmes complemented field level learning by providing structured technical training. Field days were also organised at the village level, bringing together scientists, project staff and farmers. These events provided an opportunity for farmers to observe the performance of recommended practices and the improved fish yield obtained by FFP beneficiaries. Such direct observation and peer interaction potentially strengthened farmers' confidence in adopting scientific aquaculture practices.

Level 3: Output

The intended output at level 3 of Bennett's hierarchy was the extent of fish farmers' participation including beneficiaries in various extension activities under the FFP. Data for four years (2019-20 to 2022-23) were compiled from secondary records maintained by ICAR-CIFA. The major extension activities included farmer-scientist interfaces, stakeholder meetings, field visits, capacity building programmes and field days, and the number of activities and participants was documented for each year (Table 1). The highest number of extension activities was recorded in 2022-23 (56), followed by 2019-20 (50), whereas fewer activities were conducted during

Table 1. Extension activities and fish farmers participation in the adopted villages as part of Farmers FIRST Program by ICAR-CIFA, Bhubaneswar

Activities/ Programs	2019-20		2020-21		2021-22		2022-23	
	No. of Programs	No. of Participants	No. of Programs	No. of Participants	No. of Programs	No. of Participants	No. of Programs	No. of Participants
Farmers-Scientists interface	9	250	4	149	4	193	6	480
Stakeholders meeting	4	180	--	--	--	--	1	60
Field visit	34	419	23	600	31	607	44	660
Capacity building programmes	3	143	4	107	3	163	3	90
Field day	--	--	4	114	9	109	2	50
Total	50	992	35	970	47	1072	56	1340

2020-21 (35) and 2021-22 (47). The relatively lower activity during the COVID-19 period can be attributed to restrictions on mobility and limitations on conducting face-to-face programmes. The subsequent increase in activities in 2022-23 indicates a restoration of field level extension engagement following the pandemic related disruptions. Across the four-year period, field visits accounted for the largest number of activities and participants, followed by farmer-scientist interfaces. The prominence of field visits indicates the emphasis placed on direct, farm level technical support and monitoring. In contrast, the highest average participation per activity was recorded for stakeholder meetings, followed closely by farmer-scientist interfaces. This suggests that these activities provided comparatively wider platforms for collective interaction, problem identification and knowledge exchange. The participation pattern indicates that FFP employed a combination of individual level technical support and group-based extension approaches.

Level 4: Reaction

Farmers' reactions to the FFP fishery module were assessed through open ended questions concerning their motivation for joining the programme, satisfaction with its activities, and suggestions for improvement. The responses indicated that access to updated technical knowledge and quality aquaculture inputs from ICAR-CIFA were the major motivations for participating in FFP. The potential to increase fish production and farm income was another important consideration. A section of the beneficiaries reported that their ponds had remained underutilised because of limited access to quality fish fingerlings and inadequate motivation or technical guidance. Their association with FFP, combined with input support and regular technical follow-up, enabled them to utilise these ponds more productively. The beneficiaries expressed high satisfaction with both tangible and knowledge-based support provided under the programme. Fish fingerlings, feed and other inputs, along with technical guidance on scientific aquaculture practices, were perceived as useful for improving fish farming activities and strengthening aquaculture as an income generating enterprise. These responses suggest that the FFP approach addressed both resource constraints and knowledge gaps faced by participating fish farmers. Regarding programme improvement, beneficiaries suggested increasing the quantity of fish seed supplied and, consequently, stocking density. However, the FFP technical team clarified that stocking density should be determined according to pond area, fingerling size and recommended production norms, and that indiscriminate increases in stocking density could adversely affect fish growth and pond health. This interaction highlights the importance of farmer–scientist dialogue in balancing farmers' production aspirations with scientifically recommended aquaculture practices.

Level 5: Knowledge, Attitude, Skills and Aspiration (KASA)

Knowledge of farmers on scientific aquaculture practices

Beneficiaries demonstrated relatively higher knowledge across all ten recommended practices (Table 2). Knowledge was particularly high for careful transportation and gradual acclimatisation of seed (100%), pond water filling after manuring (100%), pre-stocking water quality monitoring (90%), harvesting (90%) and feeding twice daily (86.67%). Among non-beneficiaries, knowledge was also moderate to high, but generally lower than that of beneficiaries. For example, knowledge of pre-stocking water quality monitoring was 56.67% among non-beneficiaries compared with 90% among beneficiaries, while knowledge of acclimatisation was 63.33% compared with 100%, respectively. A study by Saha (2011) among fish farmers of Tripura revealed that farmers were quite knowledgeable about liming, manuring, control of aquatic weeds, controlling predators, recommended size of fish while stocking, use of supplementary feeds and appropriate fish size at harvest. Alternatively, study by Ssekyanzi *et al*. (2023) revealed that majority (75%) of fish farmers in Rwenzori Region of Uganda did not know the importance of regularly testing water quality in their fish farming facilities. It was observed that, relatively high knowledge among beneficiaries in the study area of Odisha may be linked to their repeated exposure to field visits, training and farmer-scientist interactions with FFP. However, the presence of substantial knowledge among non-beneficiaries indicates that aquaculture information was also available through other extension agencies, probable spillover effects due to proximity with FFP villages, farming experience and informal information networks through famer led extension. This is important because the observed advantage of beneficiaries should not be interpreted as evidence that FFP was the sole source of their knowledge. On the contrary, a study by Bhatt and Patel (2018) found that the fish farmers of Kheda District, Gujarat, had low knowledge levels on the recommended aquaculture practices related to pond management, health management, weed control and stocking.

Knowledge level of beneficiaries and non-beneficiaries on scientific aquaculture practices

A significant difference was observed between beneficiaries and non-beneficiaries in overall knowledge scores ($t=5.88$, $p<0.001$) (Fig. 2). The finding indicates a clear association between FFP participation and higher knowledge levels. Nevertheless, because the study lacked baseline observations and random allocation, the

Table 2. Knowledge of fish farmers on scientific aquaculture practices

Scientific aquaculture practices	Beneficiaries (n=30)	Non-beneficiaries (n=30)
After manuring, the pond should be filled with water up to a 2.0-2.5 m level	30 (100.00)	16 (53.33)
Lime is applied uniformly after 4-5 days of filling water to adjust the alkalinity and pH	20 (66.67)	18 (60.00)
Knowledge of any one method for eradication of undesirable fishes from pond a. Mahua oil cake @1000 kg acre^{-1} m^{-1} water depth b. Bleaching powder (20% chlorine) @200 kg acre^{-1} m^{-1} c. Urea @40 kg acre^{-1} m^{-1} water depth followed by bleaching powder (20% chlorine) @70 kg acre^{-1} m^{-1} water depth after 18 h	23 (76.67)	19 (63.33)
Post-stocking fertilisation for continuous and sustained availability of nutrients for plankton growth	20 (66.67)	20 (66.67)
Water quality should be monitored before stocking to ensure that it meets the required standards for carp seed growth	27 (90.00)	17 (56.67)
Weight of seed should also be taken into consideration while selecting seed for stocking.	21 (70.00)	18 (60.00)
Seed should be transported carefully to the farm and acclimatised to the farm conditions gradually	30 (100.00)	19 (63.33)
Fish sampling (20-25 fish) should be carried out every month for estimation of average body weight.	24 (80.00)	17 (56.67)
Fishes are to be fed twice a day (half in the morning and the other half in the evening)	26 (86.67)	19 (63.33)
Partial/Complete harvesting is done during the early hours of the day	27 (90.00)	19 (63.33)

Figures in the parentheses indicate percentage

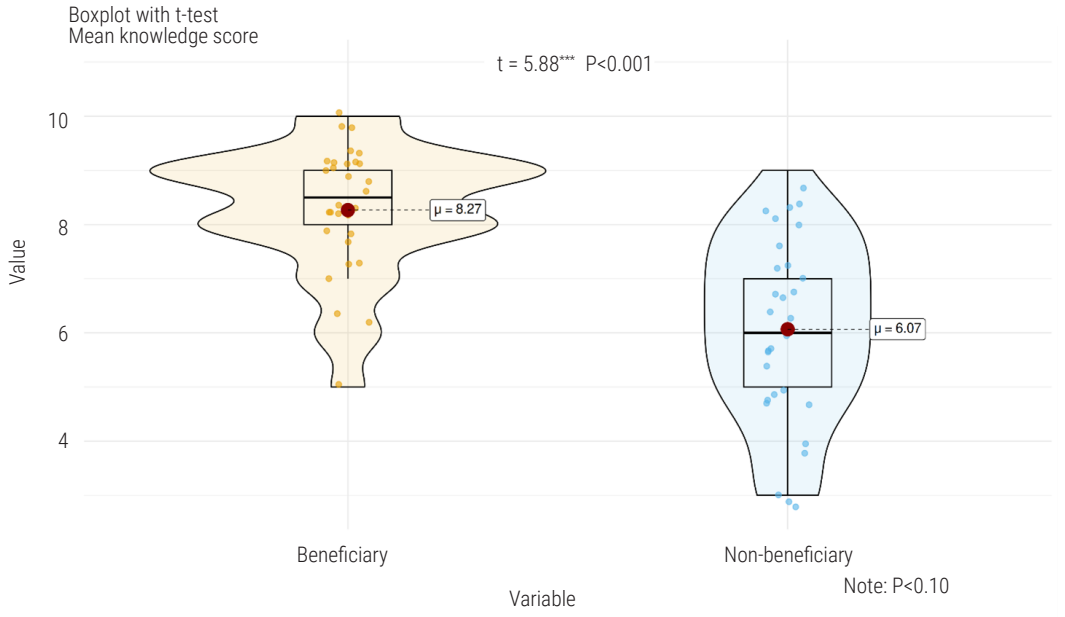

Fig. 2. Box plot depicting Knowledge level on scientific aquaculture practices

difference cannot be interpreted as a causal change attributable exclusively to FFP.

Attitude of beneficiaries towards FFP activities of ICAR-CIFA

The Beneficiaries expressed a generally favourable attitude towards the activities and interventions implemented under the FFP fishery module (Table 3). More than 90% of the respondents expressed favourable responses regarding the inputs provided (93.33%), farmer–scientist interface (92.00%) and the contribution of FFP towards sustainable livelihood (91.33%). These responses indicate that beneficiaries valued both the material support and technical interaction provided through the programme. Regarding relations between beneficiaries and non-beneficiaries, 81.33% of the respondents reported that they had not experienced any conflict. The limited occurrence of conflict may be associated with the participatory approach adopted during beneficiary selection, which involved interaction with different village stakeholders. Only four beneficiaries reported minor disagreements with non-beneficiaries. According to the respondents, such perceptions emerged after non-beneficiaries observed the comparatively better production achieved by some FFP beneficiaries. However,

Table 3. Attitude of fishery beneficiaries towards FFP of ICAR-CIFA, Bhubaneswar (n=30)

Scientific aquaculture practices	Beneficiaries (n=30)	Non-beneficiaries (n=30)
Water up to 2.0- 2.5 m level filled in the pond after manuring	27 (90.00)	11 (36.67)
Applying lime in powder form @ 80 kg acre^{-1} (200 kg ha^{-1}) uniformly after 4-5 days of filling water	20 (66.67)	9 (30.00)
Any one method adopted for eradication of undesirable fishes from pond a. MOC @1000 kg acre^{-1} m^{-1} water depth b. Bleaching powder (20% chlorine) @200 kg acre^{-1} m^{-1} c. Urea @40 kg acre^{-1} m^{-1} water depth followed by bleaching powder (20% chlorine) @70 kg acre^{-1} m^{-1} water depth after 18 h	21 (70.00)	7 (23.33)
Post-stocking fertilisation is carried out with alternate weekly application of manure (0.5 t cow dung per ha-m) and inorganic fertilisers (10 kg urea and 15 kg SSP per ha-m)	18 (60.00)	10 (33.33)
Water quality testing is done before stocking	24 (80.00)	8 (26.67)
Weight of the seed is taken into consideration while selecting the seed for stocking	15 (50.00)	15 (50.00)
Seed is transported carefully to the farm and acclimatised to the farm conditions gradually	23 (76.67)	15 (50.00)
Fish sampling every month for estimation of average body weight	16 (53.33)	7 (23.33)
Fishes are fed twice a day	19 (63.33)	11 (36.67)
Partial/complete harvesting is done during the early hours of the day	24 (80.00)	17 (56.67)

Figures in parentheses indicate percentage
[2,3,4] Items marked with (–) were negatively worded and were reverse-scored before calculation of the weighted score.

this finding is based on beneficiaries' perceptions and should not be interpreted as evidence of a direct behavioural effect of the programme. A majority of respondents (64%) disagreed with the statement that beneficiaries would become helpless after the withdrawal of handholding support from ICAR-CIFA. Farmers indicated that the technical knowledge and scientific aquaculture practices acquired through FFP could help them continue fish farming independently. Nevertheless, some beneficiaries (<30%) expressed concerns regarding future investment requirements and profitability after the completion of FFP support. To address such concerns, beneficiaries were encouraged to consider group-based fish farming in community ponds as an alternative for sharing labour requirements and reducing individual production risks. The beneficiaries (53%) also generally disagreed with the statement that farmers would revert to traditional fish farming after completion of the programme. Respondents reported that their exposure to scientific aquaculture practices had increased their awareness of the potential for higher production and marketable surplus compared with their earlier low-input practices. This suggests that the programme may have contributed to greater appreciation of scientific fish farming practices among participating farmers, although the cross-sectional design does not permit attribution of this attitudinal change solely to FFP. An important aspect of the programme was the horizontal dissemination of aquaculture knowledge. About 88.67% of beneficiaries reported sharing information or practices with other farmers. Such farmer-to-farmer communication indicates the potential for wider diffusion of aquaculture technologies beyond direct beneficiaries.

Perceived skills and aspirations of beneficiaries

The skills acquired by beneficiaries through their association with the FFP fishery module were assessed using open-ended questions. The responses indicated that beneficiaries had developed a better understanding of scientific fish rearing practices across different stages of production, from pre-stocking to harvesting. The major skills reported included pond preparation, appropriate stocking density and pond fertilisation. Beneficiaries also reported learning to adjust feeding according to the growth stage of fish and to undertake periodic fish sampling to monitor growth and identify health-related problems. Another important area of learning was water quality management. Beneficiaries recognised the importance of regular water testing and maintaining suitable levels of pH, dissolved oxygen and alkalinity for healthy fish growth and reducing mortality.

The future aspirations of beneficiaries were assessed through an open-ended question on the changes or innovative practices they intended to undertake following their association with FFP. The responses reflected an interest in commercialisation, enterprise diversification and greater value realisation from fish farming. Several beneficiaries expressed an intention to undertake group based fish rearing and direct marketing to strengthen their bargaining position and reduce dependence on intermediaries. A section of the farmers proposed integrating fish farming with other enterprises, such as vegetable cultivation, fruit trees and poultry, indicating an interest in diversified and integrated farming systems. A few beneficiaries also expressed interest in fish seed rearing, which they perceived as a potentially more remunerative enterprise. The presence of several fish markets in Khordha District and the technical support available from ICAR-CIFA were identified as key factors encouraging these aspirations.

Level 6: Extent of adoption

The extent of adoption of the scientific aquaculture practices by the beneficiaries against the non-beneficiaries was the basis on which level-6 of practice change was analysed.

Adoption of scientific aquaculture practices among the fishery respondents

The adoption pattern presented in Table 4 shows a clear difference between FFP beneficiaries and non-beneficiaries across several recommended scientific aquaculture practices. The highest

proportion of beneficiaries (90%) followed the recommended pond water level after manuring, compared with only 36.67% of non-beneficiaries. Similarly, more than 70% of beneficiaries had adopted practices such as eradication of weeds and predatory fish, water quality testing, acclimatisation of fingerlings and recommended harvesting procedures. Liming was adopted by 66.67% of beneficiaries, which is broadly comparable with the findings of Uttej *et al.* (2023). The relatively higher adoption among beneficiaries may be associated with their repeated exposure to technical guidance, field demonstrations, input support and farmer–scientist interactions under FFP. Practices such as water quality testing and fish sampling require specific technical knowledge and access to appropriate guidance; these were adopted by 80% and 53.33% of beneficiaries, respectively, but remained considerably lower among non-beneficiaries. Similar adoption of water quality and fish health monitoring practices has been reported by Abraham *et al.* (2010), who found that 52–59% of farmers in West Bengal and Andhra Pradesh monitored water quality and fish health at fortnightly intervals. For eradication of undesirable fish, beneficiaries reported the use of mahua oil cake (MOC), bleaching powder or urea in recommended quantities. In contrast, most practices among non-beneficiaries recorded adoption levels below 30%. Daily feeding was reported by 63.33% of beneficiaries compared with 36.67% of non-beneficiaries, although the corresponding proportion reported by Dubey *et al.* (2016) was lower (22%). The comparatively low adoption among non-beneficiaries, despite their reasonable knowledge of several practices, suggests that knowledge alone may not necessarily translate into practice. However, Islam *et al.* (2024) reported in their study from Bangladesh that knowledge about fish farming has a positive linear relationship with adoption. Input costs, labour requirements, pond preparation expenses, climatic risks and concerns regarding fish mortality may constrain adoption. This is consistent with Ananth *et al.* (2014), who reported continued reliance on traditional fish farming practices among farmers in Khordha, Odisha.

Categorisation of fishery respondents based on adoption quotient

Based on the adoption quotient and mean ± standard deviation criteria (Table 5), beneficiaries were predominantly classified as medium adopters (73.34%), followed by high (23.33%) adopters, while only 3.33% were categorised as low adopters. Among non-beneficiaries, 56.67% belonged to the medium adoption category, while none were classified as high adopters. Thus, beneficiaries were predominantly medium-to-high adopters, whereas non-beneficiaries were concentrated in the low-to-medium categories. Study by Islam *et al.* (2024) revealed that about 80% of the fish farmers were in medium to high level category in adopting fish farming technologies in rural Bangladesh. The categorisation reflects the observed adoption status at the time of the study and does not independently establish that the programme caused the difference. The present findings are broadly comparable with Uttej *et al.* (2023), who reported that 48.33% of fish farmers had a medium level of adoption, followed by high (38.33%) and low (13.34%) adoption levels.

Table 4. Adoption of scientific aquaculture practices among the fishery respondents

Scientific aquaculture practices	Beneficiaries (n=30)	Non-beneficiaries (n=30)
Water up to 2.0- 2.5 m level filled in the pond after manuring	27 (90.00)	11 (36.67)
Water up to 2.0- 2.5 m level filled in the pond after manuring	20 (66.67)	9 (30.00)
Any one method adopted for eradication of undesirable fishes from pond	21 (70.00)	7 (23.33)
a. MOC @1000 kg acre^{-1} m^{-1} water dept		
b. Bleaching powder (20% chlorine) @200 kg acre^{-1} m^{-1}		
c. Urea @40 kg acre^{-1} m^{-1} water depth followed by bleaching powder (20% chlorine) @70 kg acre^{-1} m^{-1} water depth after 18 h		
Post-stocking fertilisation is carried out with alternate weekly application of manure (0.5 t cow dung per ha-m) and inorganic fertilisers (10 kg urea and 15 kg SSP per ha-m)	18 (60.00)	10 (33.33)
Water quality testing is done before stocking	24 (80.00)	8 (26.67)
Weight of the seed is taken into consideration while selecting the seed for stocking	15 (50.00)	15 (50.00)
Seed is transported carefully to the farm and acclimatised to the farm conditions gradually	23 (76.67)	15 (50.00)
Fish sampling every month for estimation of average body weight.	16 (53.33)	7 (23.33)
Fishes are fed twice a day	19 (63.33)	11 (36.67)
Partial/complete harvesting is done during the early hours of the day	24 (80.00)	17 (56.67)

Figures in the parentheses indicate percentage

Table 5. Distribution of fishery respondents based on adoption quotient

Distribution of respondents on adoption quotient scores (Mean ± SD)		Beneficiary (n=30)		Non-beneficiary (n=30)	
		Frequency	Percentage	Frequency	Percentage
<42.18	(Low)	3	10.00	19	63.34
42.18–61.82	(Medium)	10	33.33	10	33.33
>61.82	(High)	17	56.67	1	3.33

Mean=52.00; SD = 19.64

Test of hypothesis on adoption of scientific aquaculture practices

An independent comparison of adoption scores was conducted to examine whether the observed difference between the two groups was statistically significant. The analysis revealed a significant difference in adoption between beneficiaries and non-beneficiaries (t=3.63, p<0.001; Fig. 3), indicating that FFP beneficiaries had significantly higher adoption scores than non-beneficiaries. The result provides quantitative evidence of an association between participation in the FFP fishery module and higher adoption of recommended scientific aquaculture practices. The finding is consistent with the descriptive adoption patterns presented in Table 4 and the adoption quotient based distribution in Table 5. However, given the purposive selection of beneficiaries, non-randomised design and absence of baseline observations, the statistical difference should not be interpreted as a causal estimate of programme impact.

Level 7: Perceived end result outcomes

Livelihood changes due to FFP of ICAR-CIFA among the beneficiary fish farmers are the intended objective for which the project was carried out. To evaluate the changes in livelihood is a macro-objective which includes several micro-objectives as indicators like production, productivity, income levels, participation, financial and nutritional security. The farmer beneficiaries involved in the fishery module of ICAR-CIFA FFP have realised a positive change in their livelihood. The farmer beneficiaries in the fishery module stated that previously they had ponds largely unutilised, or simply fish was cultivated for household purposes with very little quantity sold in the market. But after receiving the inputs from ICAR-CIFA, they learned a lot of scientific aquaculture practices. The attitude of farmers towards fishery was positive, considering the economic benefits and rejuvenated interest as indicated by improved knowledge and adoption rates. A study by Chandegara *et al.* (2024) found that the economic security of fish farmers was higher than that of dairy farmers in Tripura due to higher average annual income of fish farmers' households.

A farmer beneficiary associated with FFP narrated the following case with the research team:

"*An old and traditional farmer was sceptical of fishery and was having a small pond cultivating fish for household purposes. His family was not supportive of his endeavour of fish farming as an enterprise. Following his association with the FFP fishery module, he received fish fingerlings and adopted scientific aquaculture practices. The subsequent harvest from his small pond exceeded the family's expectations, leading to appreciation and greater support for fish farming. The improved production also renewed the family's interest in fishery as a livelihood activity. The case illustrates the principle of "seeing is believing" where visible improvements in fish production helped change family perceptions and encouraged greater participation in fish farming*".

The fish farmers stated that the yield from their ponds hardly totaled to 4-5 quintals per acre on average, with the first netting often carried out only after three years. But after joining the FFP, they learnt better management practices of carp farming. Now the FFP farmers are getting yields in the range of 10-12 quintals per acre, which is more than double what they were achieving from their ponds previously. Similar result was observed in the study by De *et al.* (2022) in the district of Jagatsinghpur, Odisha where the fish yield ranged from 0.77-6.2 t ha^{-1} with an average of 2.57 t ha^{-1} equivalent to 10.28 quintals per acre. Even the harvest period has decreased drastically, which is around 10-11 months. Farmers who adopted scientific aquaculture practices and taking good care of their pond were able to obtain their first harvest of table size fish within 6 months. The farmers sold the fish directly to traders at the pond site, receiving ₹140-160 per kg. Among Indian major carps (IMCs),

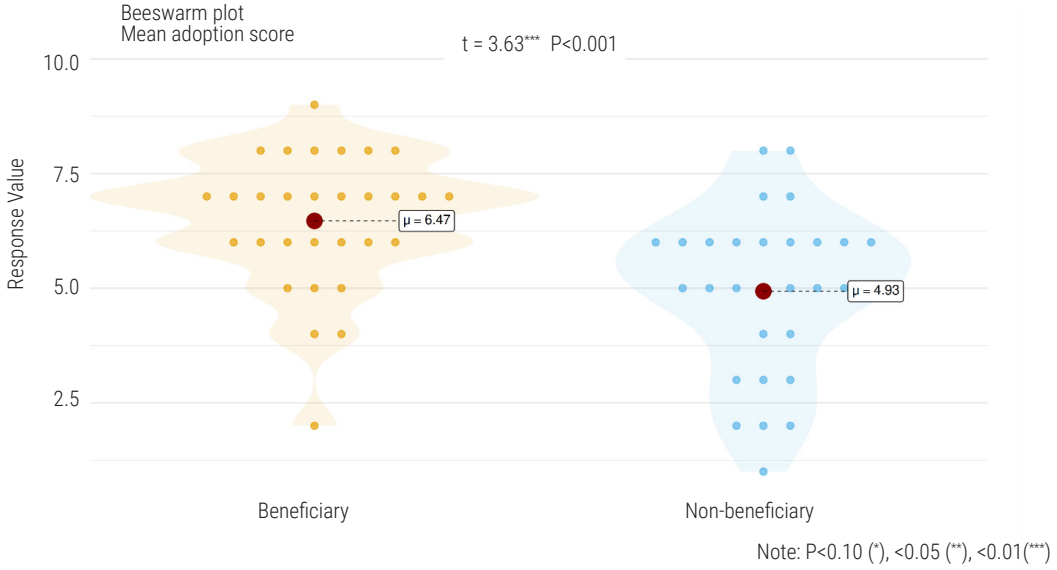

Fig. 3. Beeswarm plot depicting adoption level on scientific aquaculture practices

rohu fetched the highest price. The traders also bore the cost of the transporting the fish from the pond to the market yard. In addition to changes in livelihood outcomes such as production and profitability, farmers reported positive change in several non-tangible aspects. Their participation in extension activities increased, their standard of living changed positively, and their interest in fisheries gained momentum. It is important to state that the study has some limitations. Information on livelihood related outcomes, including changes in production, was partly based on farmers' recall and self-reported experiences rather than longitudinal farm records. Future evaluations should therefore use larger samples, collect baseline and follow-up data, incorporate objective records of production and income, and use appropriate quasi-experimental methods to generate stronger evidence of programme effects.

The evaluation of the fishery module under the Farmer FIRST Programme (FFP), using Bennett's hierarchy, indicated favourable programme-level outcomes among participating fish farmers. FFP beneficiaries demonstrated significantly higher levels of knowledge and adoption of recommended scientific aquaculture practices than non-beneficiaries. Beneficiaries also reported favourable perceptions towards input support and farmer-scientist interactions along with perceived improvements in scientific fish farming skills, particularly in pond preparation, stocking, feeding, fish sampling and water quality management. The study highlights the importance of continued farmer-scientist interaction, practical demonstrations, capacity building initiatives and continued technical support in promoting the adoption of scientific aquaculture practices. For future implementation and evaluation, ICAR institutes, KVKs and state fisheries agencies may consider systematic baseline assessments, periodic monitoring of adoption and production indicators, stronger documentation of farmer-level exposure to programme activities, and long term follow-up. Such measures would strengthen future evaluations and generate more robust evidence on the sustainability and economic outcomes of FFP interventions.

Acknowledgements

The authors acknowledge the valuable information provided by the fish farmers in the study area and the FFP team members of ICAR-CIFA, Bhubaneswar. The authors also acknowledge the support of the Directors of ICAR-NAARM, Hyderabad, ICAR-MGIFRI, Motihari and ICAR-CIFA, Bhubaneswar, in facilitating the research.

References

Abraham, T. J., Sil, S. K. and Vineetha, P. 2010. A comparative study of the aquaculture practices adopted by fish farmers in Andhra Pradesh and West Bengal. *Indian J. Fish.*, 57(3): 41-48.

Ananth, P. N., Sahoo, P. R., Dash, A. K., Pati, B. K., Jayasankar, P. and Singh, S. R. K. 2014. A study on community-based aquaculture promoted by KVK-Khordha, Odisha, India. *Cur. World Env.*, 9(3): 947. https://doi.org/10.12944/CWE.9.3.47.

Balaganesh, G., Malhotra, R., Sendhil, R., Sirohi, S., Maiti, S., Ponnusamy, K., and Sharma, A. K. 2020. Development of composite vulnerability index and district level mapping of climate change induced drought in Tamil Nadu, India. *Ecol. Indi.*, 113: 106197.

Bennett, C. F. 1976. *Analysing impacts of extension programs*. US Department of Agriculture Extension Service, No. ESC 575, Washington D.C., USA.

Bhatt, J. H., and Patel, G. G. 2018. Knowledge level of fish farmers regarding freshwater aquaculture. *Gujarat J. Ext. Edu.*, 29(2): 257-260.

Chandegara, A. K., Chauhan, J. K., Upadhyay, A. U., Lahiri, B., Pandey, D. K., Pal, P., and Reena, H. 2024. A comparative analysis of livelihood security among fish and dairy farmers in Tripura, India. *Indian J. Fish.*, 71(1): 135-143. https://doi.org/10.21077/ijf.2024.71.1.141127-16.

De, H. K., Iyemperumal, S., Das, M. K., Sahoo, P. K., Das, P. C., Sarkar, S. and Rath, D. P. 2022. Impact of Farmer FIRST project on livelihood of farmers. *Indian J. of Ext. Edu.*, 58(1):180-182. https://doi.org/10.48165/IJEE.2022.58135.

Dubey, S. K., Chand, B. K., Trivedi, R. K., Mandal, B. and Rout, S. K. 2016. Evaluation on the prevailing aquaculture practices in the Indian Sundarban delta: An insight analysis. *J. Food, Ag. Env.*, 14(2): 133-141.

FAO 2020. The State of world fisheries and aquaculture 2020: Sustainability in action. Food and Agriculture Organisation of the United Nations, Rome, Italy, 244 p. https://doi.org/10.4060 /ca9229en.

Islam, A. H. M. S., Barman, B. K. and Murshed-e-Jahan, K. 2015. Adoption and impact of integrated rice–fish farming system in Bangladesh. *Aquaculture*, 447: 76-85. https://doi.org/ 10.1016/j.aquaculture.2015.01.006.

Islam, S., Haider, S., Sayadat, N. and Rahman, S. 2024. Adoption of modern aquaculture technologies in fish farming: The case of rural Bangladesh. *World Dev. Sust.*, 5: 100192. https://doi.org/10.1016/j.wds.2024.100192.

Jayasankar, P. 2018. Present status of freshwater aquaculture in India-A review. *Indian J. Fish.,* 65(4): 157–165. https://doi.org/10.21077/ijf.2018.65.4.81300-20.

Kumar, S. T., and Shivani, P. 2014. Marine fisheries; its current status, sustainable management and socio-economic status of the marine fishers of Odisha, through Indian marine policy: A case study. *Res. J. Animal, Vet. Fish. Sci.*, 2(7): 10-19.

Obiero, K. O., Waidbacher, H., Nyawanda, B. O., Munguti, J. M., Manyala, J. O. and Kaunda-Arara, B. 2019. Predicting uptake of aquaculture technologies among smallholder fish farmers in Kenya. *Aquac. Int.*, 27(6):1689-1707. https://doi.org/10.1007/s10499-019-00423-0.

Saha, B. 2011. Knowledge level of the fish farmers in Tripura regarding scientific fish production practices. *J. Com. Mob. Sust. Dev.*, 6(1): 82-88.

Sengupta, T. 1967. A simple adoption scale used for farmers for high yielding varieties programme in rice. *Indian J. Ext. Edu*., 3 (3): 107-115.

Ssekyanzi, A., Nevejan, N., Kabbiri, R., Wesana, J. and Stappen, G. V. 2022. Knowledge, attitudes and practices of fish farmers regarding water quality and its management in the Rwenzori region of Uganda. *Water*, 15(1): 42. https://doi.org/10.3390/w15010042.

Tacon, A. G. 2020. Trends in global aquaculture and aquafeed production: 2000-2017. *Rev. Fish. Sci. Aquac.,* 28(1): 43-56. https://doi.org/10.1080/23308249.2019.1649634.

Uttej, D., Sailaja, A., Savitha, B., Sagar, G. E., Meena, A. and Rajani, V. 2023. Adoption of scientific practices in fish farming in Telangana State, India. *Int. J. Env. Cli. Cha.*, 13(8): 1733-1740. https://doi.org/10.9734/ijecc/2023/v13i82126.