Knowledge Level and Extent of Adoption of Scientific Fish Farming Practices among Members of Fish Farmers Producer Organizations

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10.18805/BKAP753

ABSTRACT

Background: The study focuses on understanding the factors that influence the knowledge level and adoption of scientific fish farming practices by the members of Fish Farmers Producer Organizations (FFPOs) because they play a crucial role in the fish farming sector and have the potential to drive the adoption of scientific practices.

Methods: The research was conducted in Purba Medinipur District, West Bengal, in 2023. From four FFPOs, total 120 respondents were chosen as sample using simple random sampling. Primary data were collected through pretested structured interview schedule. Knowledge index and adoption quotient were measured to categorize the responses of the respondents. Stepwise liner regression is done for a definite conclusion.

Result: The study found that most respondents were middle-aged (68.33%), with educational attainment up to the secondary level (31.66%) and had moderate farming experience (55%). Approximately 40% of the respondents reported high utilization of information sources and highest portion attended three to four training sessions (45.83%). Regarding the level of knowledge in recommended scientific fish farming, 38.33% of the respondents fell into the medium category, followed by 34.17% who possessed a high level of knowledge. Regarding the extent of adoption of fish farming practices, 36.67% respondents reported a medium level of adoption, followed by a high level (32.5%). Furthermore, the study found that utilization of information sources (t = 4.595), risk orientation (t = 3.165) and training attended (t = 2.606) were the strongest positive predictors of respondents' knowledge levels (1% sig. level). Regarding the extent of adoption, the source of information utilization (t = 9.203), scientific orientation (t = 4.861) and education (t = 3.085) were the strongest positive predictors (1% sig. level).

Key words: Adoption, Fish farmers producer organizations (FFPOs), Fish farmers, Knowledge.

INTRODUCTION

Fish farming, an ancient occupation, serves as a rapid income booster for small-scale farmers, increasing the socioeconomic status of rural communities (Singh *et al.*, 2024). Fisheries and aquaculture have experienced significant growth in India (Mishra *et al.*, 2017) and are pivotal for food security, providing employment to millions and sustaining livelihoods nationwide (Sahoo *et al.*, 2013; Kumar *et al.*, 2024). Between 2005 and 2020, per capita fish consumption saw a significant increase of 81.43%, indicating growing demand nationwide, including among existing fish consumers (Padiyar *et al.*, 2024). Therefore, it is vital to prioritize this sector to sustainably meet the country's food requirements. However, there are notable opportunities for innovation, investment and collaboration to overcome these barriers and to promote sustainable aquaculture development. Concerted efforts are required to advocate and integrate fish-farming practices into aquaculture and fisheries (Meena *et al.*, 2024). There is substantial room to increase fish production. Enhancing fish production depends on factors such as farmers adopting recommended scientific practices and interventions, including formal financial institutional linkages, input support from the fishery department and investment in farmer skill development (Ghosh *et al.*, 2022).

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How to cite this article: Mondal, A.H., Dana, S.S., Sarkar, M.R., Kavi, S., Karjee, R. and Rej, N. (2025). Knowledge Level and Extent of Adoption of Scientific Fish Farming Practices Among Members of Fish Farmers Producer Organizations. Bhartiya Krishi Anusandhan Patrika. 40(1): 64-71. doi: 10.18805/BKAP753.

Submitted: 03-07-2024 **Accepted:** 24-12-2024 **Online:** 06-03-2025

The future of sustainable aquatic food relies heavily on successful fishery management, which is a significant hurdle for combating diseases. Recently, aquaculture has shifted from traditional, extensive methods to more intensive systems (Budakoti, 2023). Scientific fish culture integrates multiple compatible fish species, such as the Indian major carp (IMC) and exotic carp, into a single water body (Saha, 2011; Goswami, 2016). Initially relying on

traditional methods, farmers now acknowledge the necessity of adopting scientific practices for optimal production (Das, 2018). The adoption of these practices among fish farmers is essential for improving productivity, reducing environmental impacts and enhancing their livelihoods of fish farmers. Knowledge is pivotal in shaping individual behaviour in this regard (Sakib *et al.*, 2014). Given these concerns, the multifaceted role of Fish Farmers Producer Organizations (FFPOs) has emerged in nurturing aquaculture and fostering the development of aquapreneurs. By raising awareness and promoting fish farming among impoverished farmers, FFPOs play a crucial role in introducing and popularizing new and improved fish-farming technologies (Singh *et al.*, 2024). FFPOs play a crucial role in facilitating the dissemination and adoption of these practices among members. To enhance the adoption of effective and efficient technologies, it is essential to evaluate the knowledge level of fish farmers (Rathore *et al.*, 2016). Knowledge entails obtaining factual information and comprehending how an innovation functions (Kumar *et al.*, 2018; Mutyaba *et al.*, 2024). Various extension programs have been implemented to raise awareness, educate and inspire farmers, farmwomen and rural youth to embrace and oversee new farming technologies in the field (Singh *et al.*, 2010). Hence, the understanding of and viewpoint regarding new technology can influence a farmer's stance (Aldosari *et al.*, 2019). Understanding the knowledge level and extent of the adoption of scientific fish farming practices within FFPOs is essential to inform targeted interventions and policy decisions aimed at promoting sustainable aquaculture development. However, only a few studies have been conducted in this regard. Keeping these facts in mind, the main objective of this study was to examine the knowledge level and extent of adoption of scientific fish farming practices among members of FFPOs.

Materials and Methods

The research was carried out in the Purba Medinipur District of West Bengal in 2023. Out of fourteen Fish Farmers Producer Organizations (FFPOs) in the district (District Controller, Food and Supply, Purba Medinipur, 2022), four were purposively selected for the study based on specific criteria: operational success of over 3 years, over 400 members and turnover exceeding Rs. 1 crore in the fiscal year 2021-2022, as verified by audit reports. The chosen FFPOs were Tamralipta Fish Producer Company Limited, Global Moyna Farmers Producer Company Limited, Divinius Farmers Producer Company Limited and Patashpur-II Farmers Producer Company Limited. Thirty respondents were selected from each FFPO, totalling 120 respondents, using a simple random sampling technique. Primary data were gathered through pre-tested semi-structured questionnaire schedule. A descriptive research design was employed in the study. Respondents' knowledge level was measured by a teacher-made knowledge test developed by Nagarajaiah (2002) with few modifications. A score of 1 and 0 was assigned for 'yes' and 'no' responses, respectively, to each statement. The raw knowledge score of each individual was then converted into a knowledge index and the respondents have been grouped on the basis of mean and standard deviation, *viz*., low (mean - SD/2), medium (between mean - SD/2 to mean + SD/2) and high (mean + SD/2).

Knowledge index (KI) =

$$\frac{\text{Number of correct responses}}{\text{Total number of knowledge items}} \times 100$$

To assess the extent of adoption regarding scientific fish farming practices, the approach outlined by Nagarajaiah (2002) was employed, with necessary adjustments. Scores of 2, 1 and 0 were assigned for 'full adoption', 'partial adoption' and 'non-adoption' of each recommended practices as proposed by Sinha and Kolte (1974) and the maximum and minimum overall adoption score a respondent could get was 34 and 0. Adoption quotients were calculated from raw adoption scores as suggested by Sengupta (1967) to gauge the overall adoption level followed by Balasubramaniam (1988).

Adoption quotient =

$$\frac{\text{Adoption score of the respondents}}{\text{Maximum adoption score one could get}} \times 100$$

After calculating the individual adoption quotient scores, respondents were grouped into three categories, using the mean and standard deviation as measures for verification.

Results and Discussion

Profile of the respondents

The study included a diverse group of participants categorized by age, education, family size, farming experience, farming area, annual income, occupation, type of culture, economic motivation, risk and scientific orientation, source of information utilization and the number of training sessions attended, as presented in Table 1. Among the respondents, 19.17% were young (up to 30 years) and 68.33% were middle-aged (30 to 60 years). The predominance of middle-aged farmers suggests a significant level of experience and exposure to fish farming (Rathore *et al.,* 2016; Goswami and Samajdar, 2016; Salam *et al*., 2020; Anna and Dinesh, 2022). Educational attainment varied, with the 31.66% had the secondary education, followed by 25.83% with middle school education and 24.16% with higher secondary education. Education plays a crucial role to tackle complex problems in farming through improved decision-making and the majority of respondents possessed at least secondary level education (Unnikrishnan and Dinesh, 2020). Regarding family size, 55.83% had small families (fewer than 5 members). A majority (55%) had moderate farming

Table 1: Respondents' profile (N = 120).

Variables	Category	Percentage (%)	Mean	Standard deviation
Age (chronological year)	Young age (Up to 30 years)	19.17	43.29	11.67
Range = 25 years to 72 years	Middle age (30 to 60 years)	68.33		
	Old age (Above 60)	12.5		
Education (class)	Up to primary (Up to 4th standard)	10.83	-	-
	Middle school (Up to 8th standard)	25.83		
	Secondary level (Up to 10th standard)	31.66		
	Higher secondary level (Up to 12th standard)	24.16		
	Graduate and above (College level and above)	7.5		
Family size (Nos. of member)	Small (Below 5)	55.83	4.84	2.25
Range = 2 to 13	Medium (Within 5 to 10)	40.83		
	Large (Above 10)	3.34		
Farming experience (year)	Short term experience (Up to 5 years)	18.33	8.82	4.93
Range = 1 year to 22 years	Moderate experience (Between 6 to 10 years)	55		
	Long term experience (Above 10 years)	26.67		
Farming area (Acre)	Marginal (Up to 2 acres)	34.16	4.05	3.36
Range = 0.1 acre to 22 acres	Small (2 to 5 acres)	44.17		
	Large (More than 5 acres)	21.67		
Annual income (Rs.) Range=	Low annual income (Rs. <1 lakh)	17.5	3.16	2.35
Rs. 20 thousand to 15 lakhs	Medium annual income (Rs. 1 lakh to 3 lakhs)	50.83		
	High annual income (Rs. >3 lakhs)	31.67		
Occupation	Aquaculture only	65.83	-	-
	Aquaculture + agriculture	18.33		
	Aquaculture + animal husbandry	8.33		
	Aquaculture + agriculture + animal husbandry	4.17		
	Ancillary fisheries activities (*e.g.*, Input supplier *etc*. through FFPO)	3.33		
Type of culture	Monoculture or Single species culture (*e.g.*, Catfish farming, shrimp farming)	11.67	-	-
	Polyculture or mixed culture Multiple species culture with other compatible species (*e.g.*, IMC with Amur carp, Tilapia, Prawns and other indigenous fish species)	55.83		
	Composite culture (IMC with exotic carp)	32.5		
Economic motivation	Low (<13.47)	18.33	17.43	3.96
	Medium (13.47 to 21.39)	50.83		
	High (>21.39)	30.83		
Risk orientation	Low (<23.79)	25	29.78	5.99
	Medium (23.79 to 35.77)	55.83		
	High (>35.77)	19.17		
Scientific orientation	Low (<32.45)	30.83	42.09	9.64
	Medium (32.45 to 51.73)	49.17		
	High (>51.73)	20		
Source of information utilization (Scoring done on the basis of regular, sometimes and never contact of each of information source)	Low (<6)	18.33	8.61	2.22
	Medium (6 to 10)	42.5		
	High (>10)	39.16		
No. of training attended	Up to 2 trainings	31.66	-	-
	3 to 4 trainings	45.83		
	5 to 6 trainings	22.5		

experience (6 to 10 years), followed by 26.67% with long-term experience (above 10 years) and 18.33% with short-term experience (up to 5 years). In terms of farming area, 44.17% had small holdings (2 to 5 acres), 34.16% had marginal holdings (up to 2 acres) and 21.67% had large holdings (more than 5 acres). The majority of respondents (50.83%) had a medium income (Rs. 1 lakh to 3 lakhs) and 31.67% had a high income (more than Rs. 3 lakhs). Aquaculture was the primary occupation for 65.83% of respondents. For the type of culture practiced, 55.83% were involved in polyculture, 32.5% in composite culture and 11.67 % in monoculture. The prevalence of polyculture and composite culture practices indicates a diversified approach to fish farming. Economic motivation varied, with 50.83% having medium motivation and 30.83% high motivation. With medium to high levels of economic motivation noted among the participants, it is evident that the potential for increased profitability from scientific fish farming practices is a compelling incentive for adoption (Swathi Lekshmi *et al.*, 2005; Goswami and Samajdar, 2016). Risk orientation was medium for 55.83% and high for 19.17%. Scientific orientation was medium for 49.17%, low for 30.83% and high for 20%. Respondents with high scientific orientation are likely more proactive in adopting innovative and scientifically proven techniques (Rathore *et al.,* 2016). Regarding the utilization of information sources, 42.5% had medium utilization and 39.16% had high utilization. In terms of training sessions attended, 45.83 % attended 3 to 4 sessions, 31.66% attended up to 2 sessions and 22.5% attended 5 to 6 sessions. The high utilization of information sources (Rathore *et al.,* 2016; Goswami and Samajdar, 2016) and participation in training sessions through FFPO platform suggested an active engagement with learning and knowledge dissemination within the community.

Knowledge level and extent of adoption of recommended scientific fish farming practices among ffpo member fish farmers

The distribution of respondents by their knowledge of recommended scientific fish farming practices (Fig 1) showed that 38.33% had a medium level of knowledge followed by 34.17% with a high level and 27.5% with a low level of knowledge. A significant number of respondents exhibited medium to high levels of knowledge, indicating a robust understanding of scientific fish farming within the FFPOs (Sasmal *et al.*, 2006; Saha, 2011; Rajan *et al.*, 2013; Rathore *et al.,* 2016; Goswami and Samajdar, 2016; Yadav *et al.*, 2024). This widespread knowledge is likely facilitated by accessible training programs conducted by FFPO officials for their member, extension services and efficient use of information sources through FFPO platform and peer-to-peer learning within the community. While the prevalence of high and medium knowledge levels suggests effective dissemination of scientific practices, the presence of a smaller segment with low levels of knowledge points to a need for intensified educational support and motivation to reach less informed members. In terms of the adoption of scientific practices (Fig 2), 36.67% of respondents had a medium level of adoption, 32.5% had a high level and 30.83% had a low level of adoption. Regarding adoption of scientific practices of fish farming, a significant number of FFPO members showed medium to high levels of adoption. The finding is line with the result of Talukdar and Sontaki (2005); Pounraj and Rathakrishnan (2011); Goswami *et al.* (2012); Goswami *et al.* (2016); Saha *et al.* (2016); Das *et al.* (2018). This is influenced by strong support systems from FFPO, successful training programs and visible success stories, which highlight the tangible benefits of adopting scientific methods. However, the existence of a subset of members with low levels of adoption indicates

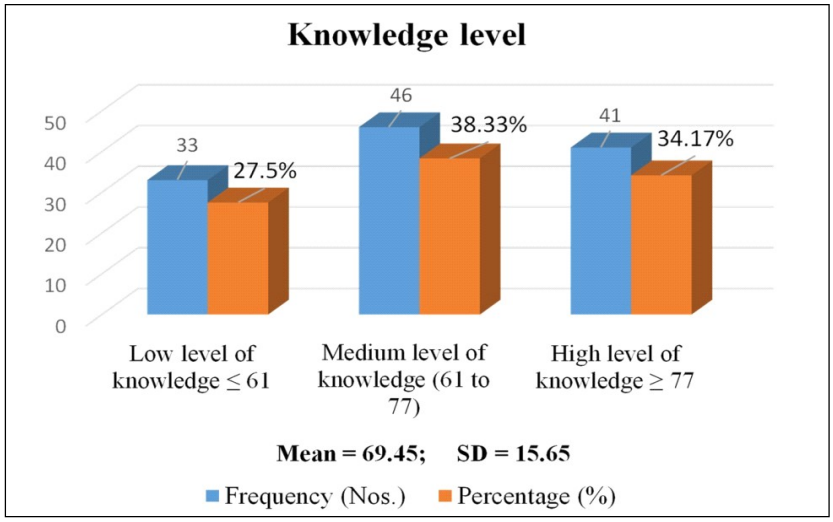


Fig 1: Distribution of respondents according to the level of knowledge for recommended scientific fish farming (N = 120).

that there are still barriers to embracing these practices fully. So, continuous education, support from FFPO officials and targeted efforts by extension agencies is essential for transitioning these members towards scientific methodologies.

Knowledge level predictors

The stepwise linear regression analysis identified several significant independent variables associated with the knowledge level of respondents (Table 2; N = 120). Education (β = 0.217, t = 2.588, p = 0.011), annual income (β = 0.193, t = 2.162, p = 0.033), risk orientation (β = 0.256, t = 3.165, p = 0.002), training attended (β = 0.210, t = 2.606, p = 0.010) and utilization of information sources (β = 0.354, t = 4.595, p = 0.000) showed significant positive standardized coefficients (1% significant level). Higher levels of education and income were positively associated with knowledge levels (Saha, 2011; Rajan *et al.*, 2013; Sakib *et al.*, 2014; Sarma *et al.*, 2016; Rathore *et al.*, 2016), as this might the driver of greater access to materials, training programs and scientific information regarding scientific fish farming. Participation in training sessions was positively correlated with knowledge (Rajan *et al.*, 2013; Rathore *et al.*, 2016), highlighting the importance of continuous learning and skills development in enhancing knowledge levels. The strong positive correlation between source of information utilization (Sasmal *et al.*, 2006; Saha, 2011; Rajan *et al.*, 2013; Sakib *et al.*, 2014; Rathore *et al.*, 2016) and knowledge level underscores the significance of accessing and utilizing various sources of information, such as extension services, research publications and peer networks, in expanding one's knowledge base. Conversely, age had a negative standardized coefficient (β = -0.251, t = -4.242, p = 0.000). Younger individuals being more receptive to new information (Sasmal *et al.*, 2006; Rajan *et al.*, 2013). These results indicate that higher levels of education, income, risk orientation, participation in training sessions and effective utilization of information sources are associated with increased knowledge levels. The model explained approximately 90.3% of the variation in knowledge level (adjusted R-square = 0.903).

Extent of adoption predictors

Regarding the extent of adoption of fish farming practices (Table 3). Positive predictors included education (β = 0.187, t = 3.085, p = 0.003), training attended (β = 0.172, t = 1.902, p = 0.060), scientific orientation (β = 0.489, t = 4.861, p = 0.000) and source of information utilization (β = 0.601,

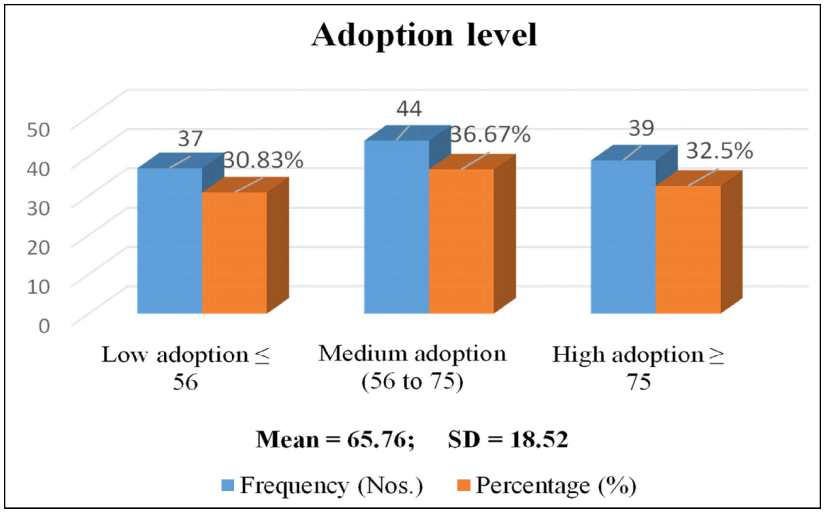


Fig 2: Respondents' distribution based on the extent of adoption of scientific fish farming practices (N = 120).

Table 2: Inspection of independent variables using stepwise linear regression with knowledge level (N=120).

Independent variable	Standardized coefficients	t value	Sig.
	Beta		
Age	-.251	-4.242	.000
Education	.217	2.588	.011
Annual income	.193	2.162	.033
Risk orientation	.256	3.165	.002
Training attended	.210	2.606	.010
Source of information utilization	.354	4.595	.000

Dependent variable: Knowledge; Adjusted R square: 0.903.

Table 3: Inspection of independent variables using stepwise linear regression with adoption extent (N=120).

Independent variable	Standardized coefficients	t value	Sig.
	Beta		
Age	-.116	-2.551	.012
Education	.187	3.085	.003
Farming experience	-.270	-4.321	.000
Training attended	.172	1.902	.060
Source of information utilization	.601	9.203	.000
Risk orientation	-.136	-2.023	.045
Scientific orientation	.489	4.861	.000
Occupation	-.206	-4.768	.000

Dependent variable: Adoption; Adjusted R square: 0.951.

t = 9.203, p = 0.000). However, age negatively influenced adoption (β = -0.116, t = -2.551, p = 0.012). Farming experience (β = -0.270, t = -4.321, p = 0.000), risk orientation (β = -0.136, t = -2.023, p = 0.045) and occupation (β = -0.206, t = -4.768, p = 0.000) were also negative predictors. This model explained approximately 95.1% of the variation in the extent of adoption (adjusted R-square = 0.951) (1% significant level). The negative association between farming experience and adoption extent (contrary with the findings of Swathi Lekshmi *et al.*, 2005; Pounraj and Rathakrishnan, 2011; Das *et al.*, 2018; Aswathy and Imelda, 2020) suggests that respondents with less experience in fish farming were more inclined to adopt newer, more scientifically advanced practices. Utilization of information sources, educational status, exposure to training and risk orientation were also strong predictors of extent of adoption highlights the crucial role of access to information regarding scientific fish farming and willingness to take calculated risks in driving the adoption of these practices (Sasmal *et al.*, 2006, Pounraj and Rathakrishnan, 2011; Goswami, 2012; Goswami *et al.*, 2012; Sakib *et al.*, 2014; Aswathy and Imelda, 2020).

CONCLUSION

The study showed that members of Fish Farmers Producer Organizations (FFPOs) exhibited a medium to high level of adoption of recommended fish farming practices and possessed notable knowledge regarding these practices. However, a significant number of respondents still lagged behind so, concerted educational efforts, proper motivation and continuous support are essential. There is also need for more need-based training programs supported by the fishery department, along with greater financial stability for both fish farmers and the FFPO body. It concludes that more capacity-building programs, connections with fellow farmers and proper dissemination of farming-related information are crucial for improving farming status. Overall, the findings suggest that promoting education, training, access to information and fostering a supportive environment for innovation are vital for enhancing both knowledge and adoption levels within the fish farming community. These efforts are essential for the sustainable growth and resilience of the fish farming sector, which might applicable in all fisheries cluster region for upliftment of livelihood of the fish farmers.

ACKNOWLEDGEMENT

The author is thankful to all resource persons as well as all respondents and also expresses gratitude to the West Bengal University of Animal and Fishery Sciences, which provided the necessary resources and support for conducting this research.

Author's contribution

Conceptualization and designing of the research work (Abdul Hannan Mondal, Shyam Sundar Dana); Execution of field/lab experiments and data collection (Abdul Hannan Mondal); Analysis of data and interpretation (Abdul Hannan Mondal, Sindhu Kavi); Preparation of manuscript (Abdul Hannan Mondal, Moumita Ray Sarkar).

Data availability statement

The corresponding author has access to the study's raw data.

Ethical statement

The paper reflects the author's research and analysis in a truthful manner. This work has not been published previously elsewhere.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article. No funding or sponsorship influenced the design of the study, data collection, analysis, decision to publish, or preparation of the manuscript.

REFERENCES

Aldosari, F., Al Shunaifi, M.S., Ullah, M.A., Muddassir, M., Noor, M.A. (2019). Farmers' perceptions regarding the use of information and communication technology (ICT) in Khyber Pakhtunkhwa, Northern Pakistan. Journal of the Saudi Society of Agricultural Sciences. 18: 211-217.

Anna, A.T. and Dinesh, K. (2022). Socio-economic prospects and major constraints of vannamei shrimp farming in Kerala. Journal of Extension Education. 34: 6750-6758.

Aswathy, N. and Imelda, J. (2020). Logit analysis of the factors affecting cage fish farming adoption decisions in the Southwest coast of India. Current Journal of Applied Science and Technology. 39: 29-34.

Balasubramaniam, S. (1988). Analysis of technology transfer effectiveness in inland fish farming. [Doctoral dissertation, Tamil Nadu Agricultural University, Coimbatore].

Biswajit Goswami, B.G. (2012). Factors affecting attitude of fish farmers towards scientific fish culture in West Bengal. Indian Research Journal of Extension Education. 12: 44.

Budakoti, S.B. (2023). A review on disease management in inland fisheries of India. Annals of Science and Allied Research. 1. doi: https://doi.org/10.5281/zenodo.10811110.

Meena, D.K., Das, B.K., Das, A.K., Sahoo, A.K. (2024). 13th Indian fisheries and aquaculture forum focuses on natural farming solutions: A promising path towards sustainable fish production. International Aquatic Research. 16: 1-6.

Das, S., Dana, S.S., Sarkar, M.R., Bandyopadhyay, U.K. (2018). Factors associated with the adoption behaviour of beneficiaries of fish farmers development agency (FFDA) regarding recommended scientific fish culture practices in West Bengal, India. Journal of Crop and Weed. 14: 169-173.

District Controller, Food and Supply, Purba Medinipur, (2022). West Bengal, Memo No. 1310(4)/DCM/Purba/2022.

Ghosh, S., Baidya, A., Ghosh, B.D., Sahu, N.C., Rahaman, F.H., Das, A.K., Das, K.S. (2022). Socioeconomic study of traditional fish farmers and trained farmers in the Indian Sundarbans ecosystem. Aquatic Ecosystem Health and Management. 25: 63-72.

Goswami, B. (2016). Factors affecting attitude of fish farmers towards scientific fish culture in West Bengal. Indian Research Journal of Extension Education. 12: 44-50.

Goswami, B. and Samajdar, T. (2016). Knowledge of fish growers about fish culture practices. Indian Research Journal of Extension Education. 11: 25-30.

Goswami, B., Mukhopadhyay, S.B., Dana, S.S. (2012). A study on factors influencing the adoption behaviour of fish farmers with special reference to scientific fish culture in West Bengal, India. International Journal of Bio-resource and Stress Management. 3: 362-367.

Goswami, B., Ziauddin, G., Datta, S.N. (2016). Adoption behaviour of fish farmers in relation to scientific fish culture practices in West Bengal. Indian Research Journal of Extension Education. 10: 24-28.

Kumar, G., Engle, C., Tucker, C. (2018). Factors driving aquaculture technology adoption. Journal of the World Aquaculture Society. 49: 447-476.

Kumar, V., Chauhan, J.K., Upadhayay, A.D., Pal, P., Lahiri, B., Ghosh, A., Singh, J.Y., Chandegara, A.K. (2024). Assessment of training effectiveness for fish farmers of Tripura. Indian Research Journal of Extension Education. 24.

Meena, S.L., Lakhera, J.P., Sharma, K.C., Johri, S.K. (2012). Knowledge level and adoption pattern of rice production technology among farmers. Rajasthan Journal of Extension Education. 20: 133-137.

Mishra, S.S., Rakesh, D., Dhiman, M., Choudhary, P., Debbarma, J., Sahoo, S.N., Mishra, C.K. (2017). Present status of fish disease management in freshwater aquaculture in India: State-of-the-art-review. Journal of Aquaculture and Fisheries. 1: 14.

Mutyaba, J.L., Ngigi, M.W., Ayuya, O.I. (2024). Determinants of knowledge, attitude and perception towards cage fish farming technologies among smallholder farmers in Uganda. Cogent Food and Agriculture. 10: 2313252.

Nagarajaiah, C. S. (2002). A Study on Knowledge, Attitude and Extent of Adoption of Composite Fish Cuture Practices in Southern Karnataka [Doctoral dissertation, Central Institute of Fisheries Education, Versova, Mumbai].

Noman, M., Kazmi, S. S. U. H., Saqib, H. S. A., Fiaz, U., Pastorino, P., Barcelò, D., Tayyab, M., Liu, W., Wang, Z., Yaseen, Z. M. (2024). Harnessing probiotics and prebiotics as eco-friendly solution for cleaner shrimp aquaculture production: A state of the art scientific consensus. Science of the Total Environment. 169921. doi: 10.1016/j.scitotenv. 2024.169921.

Padiyar, P.A., Dubey, S.K., Bayan, B., Mohan, C.V., Belton, B., Jena, J., Susheela, M., Murthy, L.N., Karthikeyan, M., Murthy, C.K. (2024). Fish consumption in India: Patterns and trends. New Delhi, India: WorldFish.

Pounraj, A. and Rathakrishnan, T. (2011). Adoption behaviour of fish farmers in critical inland fish culture technologies in Tamil Nadu. Madras Agricultural Journal. 98(7-9): 286-290.

Rajan, P., Dubey, M.K., Singh, S.R.K., Khan, M.A. (2013). Factors affecting knowledge of fish farmers regarding fish production technology. Fish Farming. 9: 10-00.

Rathore, S., Raghuwanshi, S., Bisht, K., Singh, S.P. (2016). Knowledge level of farmers on fish production technology in Tikamgarh district of Madhya Pradesh. Journal of Progressive Agriculture. 7: 50-53.

Saha, B. (2011). Knowledge level of the fish farmers in Tripura regarding scientific fish production practices. Journal of Community Mobilization and Sustainable Development. 6: 82-88.

Saha, B., De, H.K., Dana, S.S., Saha, S., Basu, K. (2016). Adoption gap in scientific fish production practices among fish farmers in Tripura. Journal of Aquaculture. pp 41-51.

Sahoo, P.K., Mohanty, J., Garnayak, S.K., Mohanty, B.R., Kar, B., Jena, J., Prasanth, H. (2013). Genetic diversity and species identification of Argulus parasites collected from major aquaculture regions of India using RAPD PCR. Aquaculture Research. 44: 220-230.

Sakib, M.H., Afrad, M.S., Prodhan, F.A. (2014). Farmers' knowledge on aquaculture practices in Bogra District of Bangladesh. International Journal of Agricultural Extension. 2: 121-127.

Salam, M.A., Hussain, S.M., Oinam, G., Debnath, B. (2020). Perceived constraints of fish farmers in adoption of scientific fish farming in Manipur. Journal of Krishi Vigya. 9: 231-235.

Sarma, H., Talukdar, R.K., Mishra, P. (2016). Impact of training on knowledge level of integrated rice-fish farming practices. Indian Research Journal of Extension Education. 13: 35-38.

Sasmal, S., Patra, H.K., Sarkar, J.D. (2006). Knowledge and adoption gap among the fish farmers regarding composite fish culture technology. Plant Archives. 6: 133-138.

Sengupta, J. (1967). A simple adoption scale for selection of farmers for high yielding varieties programme on rice. Indian Journal of Extension Education. 3: 107-15.

Singh, K., Peshin, R., Saini, S.K. (2010). Evaluation of the agricultural vocational training programmes conducted by the Krishi Vigyan Kendras (Farm Science Centres) in Indian Punjab. Journal of Agriculture and Rural Development in the Tropics and Subtropics. 111: 65-77.

Singh, S.K., Dubey, S.K., Yadav, S., Singh, R. (2024). Fish farming an ocean of opportunity for enhanced income and livelihood. Indian Farming. 74: 30-31.

Sinha, P.R.R. and Kolte, N.V. (1974). Adult education in relation to agricultural development - An evaluation study of a development block in Andhra Pradesh, report of a research project initiated by UNESCO.

Swathi Lekshmi, P.S., Chandrakandan, K., Kumaran, M., Balasubramani, N. (2005). Socio-economic profile of shrimp farmers and its influence on the extent of adoption of shrimp culture technologies. Fishery Technology. 42: 225-230.

Talukdar, P.K. and Sontaki, B.S. (2005). Correlates of adoption of composite fish culture practices by fish farmers of Assam, India. The Journal of Agricultural Sciences. 1: 12-18.

Unnikrishnan, K.V. and Dinesh, K. (2020). Socio-economic analysis of brackishwater cage culture in Kerala. Journal of Extension Education. 32: 6500-6507.

Yadav, S.K., Dahiya, T., Kanaujiya, S., Pathak, A., Pal, B.K., Yadav, S.L. (2024). Assessment of aquaculture knowledge among fish farmers in Hisar District, Haryana. Journal of Experimental Zoology India. 27(1).