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# Impact of Capacity Building on Adoption of Scientific Aquaculture Practices: A Case Study from Hilly Regions of Uttarakhand, India

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## ABSTRACT

Present study was undertaken in Champawat district of Uttarakhand to evaluate the impact of training programs and on-farm demonstrations conducted during 2005 to 2020 in promoting scientific aquaculture among smallholder farmers. A comparative analysis of baseline (2005) and endline (2020) data from 90 farmers assessed changes in knowledge, adoption, and economic outcomes. Results showed significant improvements in farmers' knowledge levels, adoption of scientific practices, and fish productivity and income in intervention ponds compared to non-intervention ones. Data were analyzed using descriptive statistics and percent change methods. Mean knowledge scores across all key areas of aquaculture increased notably between 2005 and 2020. The proportion of farmers in higher knowledge categories rose substantially, while fish farming activities expanded with a 295% increase in active farmers and a 344% rise in net profit per 100 m². Technological demonstrations revealed that integrated models, particularly fish-poultry farming, delivered the highest productivity and income, highlighting the effectiveness of scientific and integrated aquaculture practices in enhancing rural livelihoods.

## Introduction

Aquaculture has emerged as one of the fastest-growing sectors in the global food industry, playing a critical role in food security, livelihood generation, and rural development. In India, the sector has witnessed tremendous growth, contributing over 1.3% to the national GDP and around 7.8% to the agricultural GDP (DAHD, 2022). With a diverse range of freshwater and brackish water resources, India is the third-largest fish producer in the world, and aquaculture constitutes over 55% of the total fish production (FAO, 2020). The hill districts of Uttarakhand, including Champawat, possess significant untapped potential for freshwater aquaculture. Despite the presence of perennial rivers, springs, and moderate temperatures suitable for cold and warm-water fish species, fish farming in this region remained underdeveloped for decades due to limited awareness, lack of technical knowledge, and poor extension services (Negi *et al.,* 2019). Traditional fish farming practices in rural Uttarakhand are often characterized by low productivity, minimal input use, and poor management of pond ecosystems. Factors such as inappropriate site selection, insufficient pre-stocking preparation, suboptimal stocking density, lack of supplementary feeding and inadequate health management contribute to lower yields and profitability (Kumar *et al.,* 2018). These challenges underscore the importance of capacity-building interventions to promote scientific aquaculture practices among smallholder and marginal farmers.

Training and demonstrations are vital tools in agricultural extension, enabling farmers to enhance their knowledge, improve skills, and adopt appropriate technologies in a practical and participatory manner. Studies have shown that structured training programs and on-farm demonstrations can significantly improve farmers' awareness and application of improved aquaculture techniques (Sarma *et al.,* 2020; Barua *et al.,* 2017).

Training, not only, imparts technical knowledge but also improves decision-making abilities and changes attitudes toward modern and sustainable practices. In this context, a series of training programs and frontline demonstrations were initiated from 2005 to 2020 in Champawat district. These interventions were aimed at promoting scientific fish farming practices, including site-specific technological models like composite fish farming, fish-poultry, fish-vegetable and fish-crop integrations.

Present study evaluates the impact of trainings and demonstrations on the knowledge levels, adoption behavior, and economic performance of fish farmers in the region. By comparing baseline (2005) and post-intervention (2020) data, the study provides insights into how sustained extension support can transform traditional aquaculture systems into profitable and sustainable enterprises in the hill regions of Uttarakhand.

The present study was undertaken to assess the improvement in the knowledge levels of fish farmers regarding scientific fish farming practices following training interventions, to evaluate changes in the adoption of improved fish farming technologies and productivity in Champawat district over a 15-year period, and to analyze the economic benefits derived from the technological interventions demonstrated by the Krishi Vigyan Kendra (KVK), with the aim of assessing their overall impact on sustainable aquaculture development and farmers' livelihoods.

## Materials and Methods

### Study Area

The study was conducted in Champawat district of Uttarakhand, India, a hilly region with substantial potential for aquaculture due to the presence of perennial water sources, suitable agro-climatic conditions, and an increasing interest among rural youth and farmers in alternative income-generating activities. The interventions and data collection were carried out from 2005 to 2020.

### Training and Demonstration Interventions

A total of 166 training programs and multiple On-Farm Technological Demonstrations were conducted to promote scientific fish farming practices among rural and smallholder farmers. These capacity-building initiatives focused on ten key thematic areas: Site selection and pond construction, Pre-stocking management, fish selection and identification, fish seed stocking management, manuring and liming, fish feed and feeding, water quality management, fish health management, fish harvesting and marketing, integrated fish farming systems (e.g., fish-poultry, fish-vegetable).

Trainings were typically 3–7 days in duration and involved lectures, group discussions, hands-on demonstrations, exposure visits, and distribution of extension literature in local language. Resource persons included scientists, aquaculture experts, and experienced progressive farmers. Demonstrations were conducted on farmer fields under the On-Farm Testing (OFT) and Frontline Demonstration (FLD) programs of Krishi Vigyan Kendra (KVK) and presented in Table 1 and 2.

### Sampling and Data Collection

To assess the impact of trainings and demonstrations, a comparative study design was adopted, analyzing the knowledge levels, adoption behavior, and economic outcomes of fish farmers before and after the intervention period. Baseline year (2005) data were collected from 25 fish farmers who were engaged in traditional or semi-scientific fish farming practices. End line Year (2020) data was collected from a sample of 65 trained fish farmers, who had participated in one or more training/demonstration programs during 2005–2020. Sampling was done through purposive sampling, focusing on trained and active fish farmers from the blocks of Champawat district where KVK interventions were implemented. Primary data were collected using structured interviews, knowledge assessment questionnaires, field observations and economic data sheets. Secondary data were sourced from KVK annual reports, training records, and government aquaculture statistics.

## Knowledge Assessment

Knowledge levels were assessed using a pre-tested structured questionnaire that included 30 questions, covering the ten key thematic areas mentioned above. Each correct answer was scored as 1 point, while incorrect or no answers were scored as 0.

Thus, the maximum possible score was 30 points. Based on total scores, farmers were categorized into four knowledge levels: very low: up to 15; low: 16–22; medium: 23–29; high: 30 and above.

The mean knowledge score (%) for each thematic area was calculated using the following formula:

$$\text{Mean Knowledge Score (\%)} = \frac{\text{Total Number of Correct Responses}}{\text{Total Respondents X Maximum Possible Score}} \times 100$$

## Evaluation of Economic and Technological Impact

To assess the impact on productivity and profitability, data were collected on the following indicators: Number of fish farmers and ponds, fish production per 100 m² and Gross income and net profit per 100 m². Additionally, a comparative analysis was carried out between: IP (Intervention Ponds) – where scientific methods and integrated models were adopted and NIP (Non-Intervention Ponds) – where traditional methods were continued.

**Technological models included:** Composite fish farming, fish-poultry farming, fish-vegetable farming and fish-crop farming. Yield (kg/m²) and income (Rs/m²) were calculated and compared to determine the percentage increase in productivity and income resulting from the interventions.

## Data Analysis

Data were tabulated and analyzed using descriptive statistics such as: Frequencies, percentages, mean scores and percent changes. Economic comparisons between intervention and non-intervention groups were based on yield differences and net returns. The overall impact was interpreted in terms of knowledge enhancement, adoption behavior and economic gain over the 15-year intervention period.

## Results and Discussion

## Impact of Trainings on Knowledge of Scientific Fish Farming Practices

The results of the study clearly demonstrate a considerable improvement in the knowledge levels of fish farmers in the Champawat district following a series of training programs and field-level demonstrations conducted by KVK, Lohaghat (Champawat), between 2005 and 2020.

As presented in Table 3, a total of 166 training programs were conducted across various thematic areas of fish farming. The knowledge levels of the farmers were assessed at two different time points, baseline in 2005 (N=25) and post-intervention in 2020 (N=65) based on their mean knowledge scores in 10 critical components of scientific aquaculture.

The highest increase in knowledge was recorded in pre-stocking management, where the mean knowledge score rose from 34.0% in 2005 to 81.75% in 2020, reflecting a gain of nearly 140.44%. Other significant improvements were seen in site selection and pond construction (from 50.0% to 76.31%), fish seed stocking management (from 36.0% to 74.31%), manuring and liming (from 34.0% to 66.92%), fish feed and feeding (from 30.0% to 60.46%).

Moderate improvements were observed in fish health management (from 27.6% to 47.69%), fish harvesting and marketing (from 30.4% to 46.92%).

Although the knowledge level in areas like water quality management and integrated fish farming also increased significantly (from 22.4% to 53.85% and from 20.0% to 58.46%, respectively), the overall trend shows that every aspect of fish farming benefited from targeted training interventions.

## Shift in Knowledge Categories among Fish Farmers

The categorization of farmers based on their cumulative knowledge scores of scientific fish farming practices (Table 4) revealed a marked shift in the knowledge distribution between 2005 and 2020. In 2005, 32% of the farmers fell under the very low knowledge category (score ≤15), which declined to 7.69% by 2020. Farmers in the low knowledge category (score 16–22) decreased from 36% to 23.08%. A significant improvement was seen in the medium knowledge group (score 23–29), which increased from 24% to 43.08%. Notably, the high knowledge category (score ≥30) increased from only 8% in 2005 to 26.15% in 2020, indicating that more than a quarter of the trained farmers reached an advanced understanding of scientific fish farming practices. This progression confirms the effectiveness of continuous training and extension interventions in building the knowledge base and technical capacity of farmers in rural hill regions.

## Expansion of Fish Farming Activities in Champawat District

The long-term impact of KVK interventions was also observed in the scaling up of fish farming activities at the district level. As shown in Table 5, between 2005 and 2020. The number of active fish farmers increased from 55 to 218, marking a growth of 295.36%. The number of fish ponds rose from 58 to 235, an increase of 305.17%. Average fish production per 100 m² increased from 20 kg to 36 kg, indicating a yield improvement of 80.00%. Correspondingly, the average gross income rose from Rs. 2,200 to Rs. 7,200 per 100 m², a gain of 227.27%. Most notably, the net profit per 100 m² increased from Rs. 900 to Rs. 4,000, which represents a 344.44% increase, reflecting improved input efficiency and better technical management. These results suggest that trainings and demonstrations not only improved farmers' knowledge but also translated into higher productivity and enhanced profitability.

## Performance of Technological Demonstrations

The comparative analysis of production and income levels between intervention ponds (IP) and non-intervention ponds (NIP) is presented in Table 6, which highlights the effectiveness of technological interventions under different integrated fish farming models.

**a. Composite Fish Farming:** Intervention ponds recorded a fish yield of 61.34 kg, compared to 27.82 kg in non-intervention ponds, an increase of 120.49%. The net income from intervention ponds was Rs. 7046.20, whereas it was only Rs. 2808.00 in non-intervention ponds, an increase of 150.93%. The production efficiency was also higher at 0.41 kg/m² in intervention ponds compared to 0.18 kg/m² in NIP.

**b. Fish-Poultry Integration:** This system yielded 65.49 kg of fish and 77.35 kg of poultry meat from 250 m² area. The net income from this model was Rs. 17,344.20, and the combined productivity was 0.95 kg/m², the highest among all systems evaluated.

**c. Fish-Vegetable Integration**: Fish production reached 62.68 kg, while vegetables yielded 598 kg from 350 m². This model provided a net income of Rs. 13,461.40, with a total productivity of 1.89 kg/m².

**d. Fish-Crop Integration:** This model yielded 59.80 kg of fish and 50.10 kg of crops, resulting in a net income of Rs. 7,264.40 and a combined productivity of 0.31 kg/m². Among the integrated systems, fish-poultry farming emerged as the most productive and profitable model, followed by fish-vegetable farming, demonstrating the potential of integrated models in maximizing resource use and ensuring economic sustainability for smallholders.

The present study highlights the transformational role of structured capacity-building interventions in improving the knowledge, adoption, and economic returns of fish farming in the hilly region of Champawat district, Uttarakhand. Over the 15-year period (2005–2020), the results indicate that trainings and demonstrations by Krishi Vigyan Kendra (KVK), Lohaghat, significantly enhanced farmers' knowledge, encouraged the adoption of scientific aquaculture practices, and increased the scale and profitability of fish production in the region.

## Knowledge Enhancement through Trainings

The data in Table 3 show a substantial increase in farmers' knowledge across all thematic areas of fish farming. The mean knowledge score in pre-stocking management increased from 34.0% to 81.75%, the highest gain observed. This underscores the importance of understanding water preparation, liming, manuring, and pond management as foundational practices in aquaculture. Similar findings were reported by *Mishra et* *al.,* (2017), who emphasized that technical knowledge in pond preparation and pre-stocking care is crucial for successful fish farming. Training on site selection and pond construction also showed significant improvement (from 50.0% to 76.31%), indicating that farmers are better equipped to plan, design, and construct ponds that support optimal fish growth. According to Suresh and Manjunatha (2014), the quality of pond construction directly affects water retention and fish productivity. Gains were also made in critical areas like fish feed and feeding (60.46%) and fish seed stocking management (74.31%). These aspects are essential for reducing mortality and improving feed conversion ratios (FCR). Farmers often lack access to knowledge about the appropriate species composition, stocking density, and feeding schedules, issues that are well-addressed through systematic training (Sharma *et al.,* 2016). However, fish health management and marketing knowledge, while improved, still lag behind in relative terms (47.69% and 46.92% respectively). These areas may require further targeted interventions, especially with emerging concerns around fish disease outbreaks and fluctuating market access in hill districts.

## Shifts in Knowledge Categories and Adoption Levels

The movement of farmers from very low and low knowledge categories in 2005 to medium and high knowledge levels in 2020 (Table 4) demonstrates the cumulative impact of long-term extension education. In 2020, over 69% of farmers had moderate to high knowledge, compared to only 32% in 2005. This progression is in line with the Knowledge-Attitude-Practice (KAP) model, which posits that enhanced knowledge leads to attitudinal change and eventually, behavioral adoption (Rogers, 2003). Similar adoption curves have been observed in other KVK-led aquaculture programs across India (Panda *et al.,* 2016; Jena, 2018).

## Demonstrated Technologies and Economic Benefits

The impact of demonstration plots is particularly evident in the yield and income data (Table 6). In composite fish farming, the adoption of improved stocking, feeding, and pond management practices resulted in 120.49% higher fish production and 150.93% higher net income over farmers' traditional methods. This reaffirms findings by Barman *et al.,* (2015), who reported similar gains from composite fish culture in eastern India. Integrated fish farming systems performed even better. Among these, fish-poultry farming yielded 65.49 kg fish, 77.35 kg poultry meat, and net returns of Rs. 17,344.20 per 100 m², making it the most profitable model. The synergy between poultry droppings (as natural manure) and fish nutrition is well-documented to enhance pond fertility and reduce input costs (Nandeesha, 2002). Fish-vegetable farming also proved efficient, especially in areas with access to irrigation from pond water, contributing 598 kg of vegetables and Rs. 13,461.40 net income. Even fish-crop farming, while slightly less profitable, provided multi-commodity output and income diversification. These integrated systems are particularly suitable for smallholder and marginal farmers in hilly terrains, where land fragmentation limits mono-cropping. According to Das *et al.,* (2017), integrated farming enhances resource-use efficiency and supports year-round income.

## Expansion in Scale and Economic Returns at District Level

The overall district-level impact as presented in Table 5 is noteworthy. The number of fish farmers increased by 295.36%, and the number of ponds increased by 305.17%, suggesting that KVK's efforts translated into actual expansion of aquaculture infrastructure. Average fish production rose from 20 to 36 kg/100 m², and net profit increased by 344.44%, confirming that trained farmers could sustainably intensify production.

These trends align with Rao *et al.,* (2013), who observed similar regional scale-up of fish farming in Andhra Pradesh following intensive training-cum-demonstration programs. The Champawat experience also echoes the findings of Singh & Gupta (2019) who emphasized that long-term hand-holding and field-level demonstration are essential for successful aquaculture extension in hilly states like Uttarakhand and Himachal Pradesh.

## Key Drivers and Barriers to Adoption

Feedback from participating farmers during the study indicated that major drivers of adoption included improved profitability, reduced mortality due to better water quality and health management, year-round income through integrated systems, access to inputs and regular hand-holding from KVK experts.

**Table.1** Details of Technological demonstrations conducted at farmers fields

| Fish Poultry farming | |
|---|---|
| **Number of demonstration units** | 10 |
| **Fish farming** | Same as in composite fish farming practice in Intervention ponds |
| **Number of poultry birds** | 25 each in two crops in a year |
| **Poultry breed** | Cari Devendra, RIR, Kadaknath |
| **Fish vegetable farming** | |
| **Number of demonstration units** | 10 |
| **Fish farming** | Same as in composite fish farming practice in Intervention ponds |
| **Number of poultry birds** | 25 each in two crops in a year |
| **Crop area** | 200 $m^2$ |
| **Crop grown** | First crop (March-September) Capsicum var. California wonder<br>Second crop (September-January) cauliflower var. Snow crown |
| **Fish crop farming** | |
| **Number of demonstration units** | 10 |
| **Fish farming** | Same as in composite fish farming practice in Intervention ponds |
| **Crop area** | 200 $m^2$ |
| **Crop grown** | First crop (June-October) Soybean var. PS1092<br>Second crop(October-May) Wheat var. UP2572 |

**Table.2** Details of Technological demonstrations on Composite fish farming conducted at farmers fields

| DETAILS | Intervention ponds | Non-Intervention ponds |
|---|---|---|
| **Pond size ($m^2$)** | 100 | 100 |
| **Number of ponds** | 10 | 10 |
| **Fish seed density (No/100 $m^2$)** | 300 | 700 |
| **Fish seed size (cm)** | 10-12 | 2-3 |
| **Species ratio (S:G:C)** | 30:40:30 | 40:30:30 |
| **Time of stocking** | March | July |
| **Harvesting period (months)** | 12 | 12 |
| **Fish feeding** | Pelleted floating fish feeding, twice daily @ 1-3% body weight | Traditional feed, household waste |

**Table.3** Impact of trainings on knowledge level of fish farmers regarding different aspects of scientific fish farming

| S.l. | Aspects | Trainings organized during 2005-2020 (No.) | Mean knowledge score | | | |
|---|---|---|---|---|---|---|
| | | | Year 2005(N=25) | | Year 2020(N=65) | |
| | | | No. | % | No. | % |
| 1 | Site selection and pond construction | 12 | 12.5 | 50.0 | 49.6 | 76.31 |
| 2 | Pre-stocking management | 16 | 8.5 | 34.0 | 53.14 | 81.75 |
| 3 | Fish selection & identification | 18 | 10.0 | 40.0 | 35.7 | 54.92 |
| 4 | Fish seed stocking management | 18 | 9.0 | 36.0 | 48.3 | 74.31 |
| 5 | Manuring & liming | 16 | 8.5 | 34.0 | 43.5 | 66.92 |
| 6 | Fish feed and feeding | 20 | 7.2 | 30.0 | 39.3 | 60.46 |
| 7 | Water quality management | 17 | 5.6 | 22.4 | 35.0 | 53.85 |
| 8 | Fish health management | 12 | 6.9 | 27.6 | 31.0 | 47.69 |
| 9 | Fish harvesting and marketing | 17 | 7.6 | 30.4 | 30.5 | 46.92 |
| 10 | Integrated fish farming | 20 | 5.0 | 20.0 | 38.0 | 58.46 |
| | Total | 166 | | | | |

**Table.4** Distribution of respondents based on their knowledge level on scientific fish farming

| Category | Year 2005 (N=25) | | Year 2020 (N=65) | |
|---|---|---|---|---|
| | No. | % | No. | % |
| **Very low (up to 15 score)** | 08 | 32.0 | 05 | 7.69 |
| **Low (16-22 score)** | 09 | 36.0 | 15 | 23.08 |
| **Medium (23-29 score)** | 06 | 24.0 | 28 | 43.08 |
| **High (30 or above score)** | 02 | 08.0 | 17 | 26.15 |

**Table.5** Impact of trainings and demonstrations on fish farming in district Champawat

| | Year 2005 | Year 2020 | Percent change |
|---|---|---|---|
| **Number of fish farmers** | 55 | 218 | 295.36 |
| **Number of fish ponds** | 58 | 235 | 305.17 |
| **Average fish production (Kg/100 $m^2$)** | 20 | 36 | 80.00 |
| **Average gross income (Rs/100 $m^2$)** | 2200 | 7200 | 227.27 |
| **Average net profit (Rs/100 $m^2$)** | 900 | 4000 | 344.44 |

**Table.6** Production and income in different technological demonstrations.

| Technological interventions | Total Area ($m^2$) | Production (Kg) | | | | | Net Income (Rs) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | IP | NIP | % increase of fish production over NIP | Total Production ($Kg/m^2$) | | IP | NIP | % increase over NIP | Income ($Rs/m^2$) | |
| | | | | | IP | NIP | | | | IP | NIP |
| **Composite Fish farming** | 150 | Fish- 61.34 | Fish- 27.82 | 120.49 | 0.41 | 0.18 | 7046.20 | 2808.00 | 150.93 | 46.97 | 18.72 |
| **Fish-poultry farming** | 250 | Fish- 65.49 Poultry meat- 77.35 | - | 135.41 | 0.95 | - | 17344.20 | - | 517.67 | 69.38 | - |
| **Fish-vegetable farming** | 350 | Fish- 62.68 Vegetable- 598 | - | 125.31 | 1.89 | - | 13461.40 | - | 379.39 | 38.46 | - |
| **Fish-crop farming** | 350 | Fish- 59.80 Crop- 50.10 | - | 114.95 | 0.31 | - | 7264.40 | - | 158.70 | 20.75 | - |

IP- Intervention ponds
NIP- Non-Intervention ponds

However, constraints were also reported, such as Limited availability of quality fish seed, High initial cost for integrated farming units, Lack of cold chain and market linkages in remote areas, dependency on seasonal rainfall in some locations.

These findings underscore the importance of strengthening input supply chains, institutional credit, and market infrastructure to support the expansion of scientific fish farming practices.

In conclusion, the 15-year intervention (2005–2020) by KVK Lohaghat significantly improved fish farmers' knowledge, practices, and profitability in Champawat district. Training and demonstrations led to notable gains in key aquaculture areas, with a 140% increase in pre-stocking knowledge and a 344% rise in net profit. The number of farmers and fish ponds tripled, and integrated models especially fish-poultry proved highly productive and profitable. While progress is clear, challenges like limited quality seed, high input costs, and poor market infrastructure remain. Continued support and policy interventions are essential to sustain and scale these outcomes.

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## Author Contributions

V. K. Singh: Investigation, formal analysis, writing—original draft. V. Gupta: Validation, methodology, writing—reviewing.

## Data Availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

## Declarations

**Ethical Approval** Not applicable.

**Consent to Participate** Not applicable.

**Consent to Publish** Not applicable.

**Conflict of Interest** The authors declare no competing interests.

## References

Barua, P., Borah, B.C. and Das, S.K. (2017) Impact of training and demonstration on adoption of scientific fish farming practices in Assam. *Journal of Krishi Vigyan.* 6(1): 104–107.

Barman, B.K. and Karim, M. (2015). Impacts of improved aquaculture technologies in rural livelihoods. *Aquaculture Reports* 2: 82–90.

DAHD, (2022). Handbook on Fisheries Statistics. Department of Animal Husbandry and Dairying, Ministry of Fisheries, Government of India.

Das, P.C., Jena, J.K. and Mishra, B. (2017). Integrated Fish Farming Systems in India: Strategies for Sustainable Growth. ICAR-CIFA, Bhubaneswar.

FAO. (2020). The State of World Fisheries and Aquaculture 2020. Rome: Food and Agriculture Organization of the United Nations.

Jena, J.K. (2018). Developing Integrated Aquaculture Systems for Smallholders. ICAR-CIFA Bulletin.

Kumar, V., Singh, P.K. and Pandey R.K (2018). Constraints in adoption of scientific fish farming practices in India. *International Journal of Fisheries and Aquatic Studies.* 6(3): 12–16.

Mishra, S. and Das, A. (2017). Effect of extension training on adoption of fish farming practices in Odisha. *Journal of Extension Education* 29(2): 5984–5990.

Nandeesha, M.C. (2002). Integrated fish farming systems in India. FAO Aquaculture Newsletter 31: 18–20.

Negi, D.S., Joshi, P. and Pant K. (2019). Prospects and challenges of aquaculture in hill regions of Uttarakhand. *Indian Farming* 69(12): 37–40.

Panda, D. Rout, S. and Nayak, P. (2016). Livelihood improvement through integrated fish farming systems in tribal regions of Odisha. *Agriculture Update* 11(1): 1–6.

Rao, V.V. Reddy, A.R and Kumar, K.S. (2013) Role of trainings in adoption of scientific aquaculture practices. *Journal of Rural Development* 32(4): 445–453.

Rogers, E.M. (2003). Diffusion of Innovations. (5th ed.). Free Press.

Sharma, A., Singh, D. Verma, A. (2016) Knowledge and adoption level of farmers towards aquaculture practices in northern India. *Fishery Technology* 54(3): 177–183.

Sarma, P.K., Kalita, P. Saikia, P. (2020) Training needs and impact assessment of fish farmers in Assam. *Journal of Extension Education* 31(2): 51–57.

Singh, R. and Gupta, N. (2019) Extension strategies for sustainable aquaculture in hilly regions. *Indian Journal of Extension Education* 55(2): 55–60.

Suresh, A. and Manjunatha, A.V. (2014) Impact of training on fish farmers in Karnataka. *International Journal of Fisheries and Aquatic Studies* 1(6): 45–50.

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