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Role of Training in Promoting Scientific Fish Farming Practices Among Farm Pond Users in Dryland Tamil Nadu

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ABSTRACT

Krishi Vigyan Kendras (KVKs) play a pivotal role in India's agricultural extension framework, especially in promoting location-specific technologies among small and marginal farmers. With the increasing relevance of farm ponds in integrated farming systems and their potential to supplement rural income, fish farming has gained prominence as a sustainable livelihood option. This study assesses the impact of KVK training programs on farmer's knowledge enhancement and their subsequent adoption of scientific fish farming practices in farm ponds. Conducted in Sivaganga District of Tamil Nadu, the study employed a mixed-methods approach, including pre- and post-training assessments, structured interviews, and an adoption index. Results revealed a statistically significant increase in farmers' knowledge levels after training. Furthermore, adoption of scientific aquaculture practices was positively influenced by knowledge gain, education level, and social participation. The findings highlight that while KVK training effectively builds knowledge and improves adoption, sustained impact requires stronger input supply systems, continuous advisory services and farmer group-based support mechanisms. The study affirms the value of targeted training interventions for enhancing aquaculture adoption in rainfed agro-ecosystems.

Keywords: Adoption, Aquaculture, Behaviour, Dryland agriculture,Fish farming, Knowledge gain, Ponds,

INTRODUCTION

The growing pressures of climate variability, declining groundwater levels, and increasing demands for water have prompted a renewed focus on farm ponds as a viable solution for water conservation and integrated farming systems. In this context, farm ponds are not only crucial for irrigation but also offer opportunities for diversified livelihoods through fish farming. Fish farming in farm ponds has emerged as a profitable and sustainable enterprise, particularly suited to small and marginal farmers who seek additional sources of income and nutrition (Debnath, 2019; Kumar *et al,* 2019). Sivaganga district, located in the southern part of Tamil Nadu, exemplifies the transformative potential of farm ponds in improving rural livelihoods. The district's agrarian economy has long been dependent on agriculture, with farmers facing challenges such as erratic rainfall and limited irrigation sources. In recent years, however, fish farming in farm ponds has emerged as a sustainable and profitable alternative, offering farmers an additional source of income and improving their resilience to climate change (Thavapalan and Sathish, 2021). The district's farmers are increasingly integrating fish farming with traditional agricultural practices to maximize resource use and improve income stability. Despite the significant potential, however, many farmers still lack the technical skills and institutional support required for scientific fish farming. Traditional practices often lead to sub-optimal production due to poor pond preparation, lack of feeding protocols, and minimal disease management. The need to bridge this knowledge and skill gap is imperative to harness the full potential of aquaculture.

In this context, Krishi Vigyan Kendras (KVKs) have played a pivotal role in addressing the knowledge gap and providing scientific training to farmers (Kumar and Kaur, 2015). KVKs, under the Indian Council of Agricultural Research (ICAR), are established as frontline institutions to transfer knowledge, technologies, and best practices in agriculture and allied sectors. In Sivaganga, KVKs have been

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instrumental in promoting fish farming by offering targeted training programs that focus on pond management, species selection, feeding practices, water quality management, and disease control. These programs aim to equip farmers with the necessary skills and knowledge to shift from traditional to scientific fish farming practices, thereby improving their productivity and profitability. However, there is limited research on their specific influence in Sivaganga district. This study aims to fill this gap by evaluating the effectiveness of KVK-led fish farming trainings on farmer's knowledge enhancement and subsequent adoption behaviour. By focusing on Sivaganga district, this research seeks to explore the unique challenges and opportunities faced by farmers in this region, while also assessing the broader implications for scaling sustainable aquaculture practices across similar rural areas in Tamil Nadu and India. The study also aims to investigate the factors that influence the adoption of fish farming practices. Ultimately, the research aims to contribute to the understanding of how extension programs can effectively bridge the knowledge gap in fish farming, thus promoting sustainable practices and improving rural livelihoods in Sivaganga and beyond.

MATERIALS AND METHODS

Study Area

The study was conducted in Sivaganga district, situated in the southeastern region of Tamil Nadu. Characterized by a semi-arid climate, the district experiences frequent rainfall variability and water scarcity issues, making water conservation efforts such as increasing adoption of farm pond-based interventions under government schemes such as MGNREGA and PMKSY. KVK Sivaganga conducted more than 40 structured training programs on scientific fish farming over the past five years. Using a purposive sampling technique, a total of 100 farmers who attended KVK fish farming training between 2021 and 2024 were selected.

Data Collection and Tools

Primary data were collected through structured interviews using a pre-tested questionnaire. Knowledge gain was assessed using a 20-item test covering key domains: pond preparation, stocking density, feeding regime, water quality maintenance and disease control. Adoption was measured using an adoption index, calculated as the proportion of recommended practices adopted by each respondent. Descriptive statistics summarized demographic and training participation details. A paired t-test compared pre- and post-training knowledge scores. Multiple regression was used to identify predictors of adoption behaviour.

RESULTS AND DISCUSSION

Demographic profile of respondents

Understanding the demographic characteristics of respondents is crucial for interpreting their training needs, adoption behaviour, and responsiveness to capacity-building initiatives. The study covered 100 fish farmers who participated in training programs on scientific aquaculture conducted by KVK Sivaganga between 2021 and 2024. The demographic profile included variables such as age, gender, education, landholding size, annual income, social participation and prior aquaculture experience (Table 1). The majority of respondents (46%) were in the age group of 36-50 years, followed by 32% above 50 years and 22% below 35 years. This indicates that middle-aged farmers form the core group experimenting with aquaculture, possibly due to their relatively stable resources and openness to diversifying income sources. A study by Jayanthi *et al* (2021) similarly observed that farmers in the 35–50 age range are more likely to adopt aquaculture innovations, especially in rainfed areas of Tamil Nadu. Gender-wise, 83% of the respondents were male and 17% female. The low female participation can be attributed to social norms and perceptions of aquaculture being labour-intensive, although literature suggests that women often play critical roles in feeding, pond cleaning, and harvesting when adequately supported (Rao and Devi, 2020). A significant portion of farmers (52%) had completed secondary education, followed by 30% who had completed higher secondary or college education, and 18% with only primary-level education or below. This level of literacy is crucial, as it facilitates better comprehension of technical training content and documentation processes such as input records, loan applications, and market communications.

In terms of landholding, 36% were marginal farmers (<1 ha), 44% small (1–2 ha), and 20% medium and above (>2 ha). This aligns with the broader rural demographic structure in India, where the predominance of smallholder farming is a defining characteristic (ICAR, 2021). These farmers often rely on diversified farming systems for livelihood security, and fish farming is increasingly being integrated into their farm operations. Since farm pond creation is often linked to agricultural land ownership, this distribution suggests that small and marginal farmers are actively engaging in fish farming as a secondary income source. In alignment with the findings of Kumar *et al* (2022) farm ponds in Tamil Nadu are predominantly owned by smallholders, making them a strategic target group for rural aquaculture interventions. The majority of respondents (54%) reported an annual household income below ₹1.5 lakhs, with 32% in the ₹1.5–3 lakh range. Only 14% earned above ₹3 lakhs annually. Lower-income farmers showed strong interest in aquaculture as a supplementary income source, particularly when supported by government schemes and training. About 61% of the respondents were active in community-based organizations such as Primary Cooperative Society (PCS), Farmer's Interest Groups (FIGs) or Farmer Producer Organizations (FPOs). Only 28% of the respondents had prior experience in aquaculture, while the remaining 72% were first-time adopters, primarily introduced to aquaculture through the KVK's awareness campaigns and training interventions. The findings of the study align with the trend that most farm ponds in Sivaganga were originally constructed for rainwater harvesting and irrigation, with aquaculture being introduced recently through government schemes and KVK outreach. As such, structured training and technical guidance become essential for transitioning these farmers into successful aquapreneurs. The findings underscore the importance of targeting training programs to smallholder, semi-literate, and novice fish farmers, especially in dryland districts where pond-based aquaculture is still an emerging livelihood option. These demographic insights also reinforce the need for locally contextualized, hands-on training that accommodates low prior exposure, labour availability, and educational limitations.

Knowledge gain

The effectiveness of training programs largely depends on the extent to which they enhance the knowledge and skills of participants. To assess the knowledge gain among farmers trained by KVK Sivaganga, a pre- and post-training test was administered covering key domains of scientific fish farming. The test consisted of 10 multiple-choice and short-answer questions focused on pond preparation, stocking, feed management, water quality, disease control, and record keeping (Table 2). The average pre-training knowledge score across all six domains was 15.6 out of 60, indicating a low baseline understanding of scientific fish farming practices among the respondents. Following the training, the mean post-test score increased significantly to 40.4, reflecting an average knowledge gain of approximately 159%. The greatest improvement was observed in the domain of water quality management, which had the lowest initial score (mean = 2.0) but saw a dramatic increase post-training (mean = 6.7; 235% gain). This suggests that water quality concepts were previously unfamiliar but effectively conveyed during the training. This pattern mirrors the findings of Reddy *et al* (2017), who reported that farmers often exhibit lower baseline awareness in areas requiring technical precision and scientific understanding, such as nutrient management and water chemistry. Substantial gains were also noted in stocking density and feed management, two critical parameters for optimizing growth and yield in farm pond aquaculture. Even in relatively technical domains such as record keeping and disease management, where adoption is usually low due to complexity or labour demands, trainees showed significant improvement in knowledge levels. The increase in record keeping scores from 1.8 to 4.5 though modest compared to other domains, is notable considering that over 70% of respondents had no prior exposure to formal monitoring systems. These findings are in alignment with similar training impact studies by Sharma and Ghosh (2021) and Yadav *et al* (2020), which emphasize that structured, hands-on training modules particularly those delivered in local languages and with visual aids are highly effective in increasing awareness and interest in scientific aquaculture among small and marginal farmers. Furthermore, analysis across demographic segments revealed that knowledge gain was consistent across age and landholding groups, but marginally higher among those with higher education levels, indicating the importance of education in assimilating technical content. Education was positively associated with adoption levels, consistent with findings by Reddy *et al* (2019), who noted that better-educated farmers were more receptive to scientific inputs, including feed management and disease prevention.

Adoption behaviour

The adoption behaviour of farmers following training is a key indicator of the practical relevance and effectiveness of capacity-building interventions. In this study, adoption was assessed based on the implementation of six core scientific practices introduced during the KVK Sivaganga training: (i) ploughing of pond bottom (ii) recommended stocking density, (iii) use of pelleted feed, (iv) pond liming and water quality management, (v) basic disease control measures, and (vi) record keeping. Adoption was measured through field verification and structured interviews conducted 3 to 6 months post-training. The findings revealed that a substantial proportion of farmers demonstrated positive adoption behaviour. As shown in Table 3, the most widely adopted practice was maintaining appropriate stocking density (82%), followed by the use of formulated feed (75%), and pond liming for pH adjustment (65%). These practices are relatively easy to implement, require limited behavioural change, and yield visible improvements in fish growth and survival. Ploughing of the pond bottom, a recommended preparatory practice for removing toxic gases and decomposed organic matter before stocking, was adopted by 58% of the farmers. Despite being a low-cost intervention, its adoption was often constrained by labour availability or limited awareness prior to training. These results are consistent with earlier studies, which indicate that while input-based interventions are adopted readily, knowledge-intensive or management-heavy practices such as record maintenance or disease diagnosis face slower uptake (Yadav *et al,* 2020; Jayanthi *et al,* 2021).

Adoption behaviour was also influenced by farmer's exposure, education, and support mechanisms. Farmers who were part of Primary Cooperative Societies (FPCs) or Farmers' Interest Groups (FIGs) and had higher post-training knowledge scores were significantly more likely to adopt multiple practices. This aligns with the findings of Reddy *et al* (2019), who reported that social participation and information retention were key drivers of aquaculture technology adoption. Moreover, first-time fish farmers showed a preference for practices that minimized risk and did not require recurring expenditure. For instance, stocking density adjustments and liming were preferred over continuous use of commercial feed or water quality testing kits. The study also revealed that 68% of respondents qualified as high adopters (implementing four or more practices), while 32% were low adopters (one to three practices). Qualitative feedback indicated that high adopters were motivated by observed benefits in productivity, peer influence, and confidence built during hands-on training sessions. In contrast, low adopters cited barriers such as unavailability of inputs (e.g., feed and seed), lack of technical support post-training, and risk aversion as reasons for partial adoption. This behavioural segmentation echoes the diffusion of innovation theory (Rogers, 2003), which suggests that early adopters are typically more informed, socially connected, and receptive to technical support, while others require repeated exposure and institutional support to change practices. Overall, the adoption behaviour observed among KVK-trained farmers in Sivaganga reflects a promising shift towards scientific fish farming in rainfed regions. However, sustaining and scaling adoption will require follow-up extension support, timely input supply, and clustering of farmers to encourage peer learning and market linkages. Structured follow-through by KVKs, convergence with line departments, and field-based demonstrations are therefore critical to reinforcing adoption behaviour beyond the training phase.

Determinants of Adoption

Adoption of scientific fish farming practices among farmers trained by KVK Sivaganga was influenced by a combination of individual, socio-economic, and institutional factors. While the training resulted in substantial knowledge enhancement, the translation of knowledge into practice varied across respondents. A multiple linear regression analysis was conducted to assess the influence of farmer characteristics on the extent of adoption of scientific fish farming practices, using the number of practices adopted (ranging from 0 to 6) as the dependent variable. The model revealed that several factors had statistically significant effects on adoption levels, with an overall R^2 of 0.61, indicating that 61% of the variation in adoption behaviour was explained by the selected independent variables (Table 4). The analysis revealed that knowledge gain had a strong positive influence ($\beta = 0.11$; $p = 0.007$), suggesting that for every one-point increase in the post-training knowledge score, the number of practices adopted increased by 0.11. This reinforces the critical role of well-designed training in translating awareness into action. This finding aligns with earlier studies which affirm that targeted training significantly influences adoption behaviour when the content is practical, locally contextualized, and reinforced through demonstrations (Jayanthi *et al,* 2021; Sharma and Ghosh, 2021). Education level also significantly influenced adoption ($\beta = 0.24$; $p = 0.009$), indicating that farmers with higher levels of formal education were better positioned to understand and apply technical recommendations such as optimal stocking density, water quality testing, and formulated feed use. This supports previous observations by Reddy *et al* (2019), who noted that educational attainment positively correlates with technology adoption in aquaculture.

Annual income was also found to significantly influence adoption behaviour ($\beta = 0.31$; $p = 0.029$). Farmers with higher annual incomes were more likely to adopt a greater number of scientific practices, likely

Table 1. Demographic Profile of Respondents (n = 100)

Sr. No.	Parameter	Category	Percentage (%)
A.	Age	Below 35	22
		36–50	46
		Above 50	32
B.	Gender	Male	83
		Female	17
C.	Education	Primary or below	18
		Secondary	52
		Higher Secondary and above	30
D.	Landholding	Marginal (<1 ha)	36
		Small (1–2 ha)	44
		Medium (>2 ha)	20
E.	Annual Income	Below ₹1.5 lakhs	54
		₹1.5 – ₹3.0 lakhs	32
		Above ₹3.0 lakhs	14
F.	Social Participation	Member of PCS/FIG/FPO	61
		No participation	39
G.	Prior aquaculture experience	Yes (1–3 years)	28
		No	72
H.	Type of pond	Farm pond (rainfed/seasonal)	100

Table 2. Mean Knowledge Scores Before and After Training (n = 100)

Sr. No.	Knowledge Domain	Max. Score	Pre-Training Mean	Post-Training Mean	% Increase
1.	Pond preparation and liming	10	3.1	7.4	138.7*
2.	Stocking density and species mix	10	2.9	7.1	144.8*
3.	Use of formulated feed	10	3.3	7.8	136.4*
4.	Water quality management	10	2.0	6.7	235.0*
5.	Disease identification and control	10	2.5	6.9	176.0*
6.	Record keeping and monitoring	10	1.8	4.5	150.0*
7.	Overall Knowledge Score	60	15.6	40.4	159.0*

** Differences statistically significant at $p < 0.01$ level (Paired t-test).*

Table 3. Adoption of Scientific Fish Farming Practices among Trained Farmers (n = 100)

Sr. No.	Scientific Practice Adopted	Number of Adopters	Adoption Rate (%)
1.	Ploughing of pond bottom before stocking	58	58
2.	Stocking at recommended density (1000–1500/pond)	82	82
3.	Use of formulated/pelleted feed	75	75
4.	Pond liming and pH adjustment	65	65
5.	Disease prevention ($KMnO_4$, salt, etc.)	41	41
6.	Record keeping (stocking, feed, harvest data)	31	31

Overall high adopters (≥4 practices adopted): 68 farmers (68%)

Overall Low adopters (≤3 practices adopted): 32 farmers (32%)

due to better financial capacity to procure inputs such as pelleted feed, liming materials, and basic diagnostic tools. Although KVK training made low-cost alternatives available, certain practices especially those requiring recurring investment or labour remained more accessible to better-off households. This aligns with the findings of Yadav *et al* (2020), who observed that resource-endowed farmers tend to adopt a broader range of aquaculture innovations, particularly when those innovations require upfront financial commitment. However, it is worth noting that despite income disparities, a considerable number of low-income farmers adopted key practices when training was backed by demonstrations and peer encouragement, indicating that knowledge and confidence can partially offset financial constraints.

Table 4. Linear Regression for Factors Influencing Adoption (n = 100)

Sr. No.	Independent Variable	Regression Coefficient (β)	Standard Error	t-value	p-value
1.	Education level (years)	0.24	0.09	2.67	0.009*
2.	Annual income (₹ lakhs)	0.31	0.14	2.21	0.029*
3.	Landholding size (hectares)	0.18	0.12	1.50	0.137
4.	Knowledge gain (score 0–60)	0.11	0.04	2.75	0.007*
5.	Social participation (Yes=1)	0.88	0.35	2.51	0.014*
6.	Prior aquaculture experience	0.69	0.28	2.46	0.016*
7.	Age (years)	-0.02	0.02	-1.20	0.234

**Significant at 1% level ($P \leq 0.001$)*

$R^2 = 0.61$

Table 5. Constraints to Adoption of Scientific Fish Farming Practices (n = 100)

Sr. No.	Constraint Identified	No. of Respondents	Percentage (%)	Rank
1.	Non-availability of quality fish seed locally	78	78	I
2.	High cost or non availability of pelleted feed	64	64	II
3.	Lack of technical guidance after training	57	57	III
4.	Difficulty in maintaining records	52	52	IV
5.	Inadequate access to water testing or health kits	45	45	V
6.	Labour constraints for pond preparation or maintenance	38	38	VI
7.	Fear of crop loss due to disease or pond drying	35	35	VII

Social participation emerged as another key determinant (β = 0.88; p = 0.014), with members of PCSs, FIGs or FPOs adopting nearly one additional practice compared to non-members. This finding is consistent with earlier studies (Reddy *et al,* 2019; Rao and Devi, 2020) which highlighted the role of community-based institutions in facilitating technology diffusion through exposure to peer learning, collective decision-making, and shared access to inputs and markets. Prior aquaculture experience also significantly influenced adoption (β = 0.69; p = 0.016), as those with even limited exposure were more confident and better equipped to integrate new practices into their existing farm routines. On the other hand, variables such as landholding size and age did not significantly affect adoption levels, suggesting that adoption is not necessarily dependent on farm size or the farmer's age, but rather on training effectiveness, motivation, and support systems. This supports the diffusion theory proposed by Rogers (2003), where adoption depends more on awareness, perceived utility, and social learning than on traditional metrics of farm size or age. Overall, the findings suggest that enhancing farmer knowledge, strengthening local institutions, and facilitating access to inputs and peer support networks are key strategies for promoting widespread adoption of scientific fish farming practices in farm ponds.

Constraints to adoption

Despite significant improvements in knowledge and motivation through KVK training, several constraints continued to hinder the full adoption of scientific fish farming practices among trained farmers. Identifying and understanding these barriers is essential to designing more responsive and inclusive extension interventions. To capture these constraints, respondents were asked to indicate the major challenges they faced in adopting the recommended practices. Multiple responses were permitted, and constraints were ranked based on their frequency of mention. The results are presented in Table 5. The most pressing constraint reported by respondents was the non-availability of quality fish seed in local markets (78%). Many farmers had to depend on distant hatcheries, which increased transport costs, delayed stocking, and in some cases resulted in poor survival due to stress or poor acclimatization. This finding resonates with prior reports from dryland districts of Tamil Nadu, where input supply chains remain underdeveloped (Jayanthi *et al,* 2021). The high cost and inconsistent availability of pelleted feed (64%) also emerged as a major hurdle. Although farmers understood the benefits of formulated feed from training sessions, many reverted to traditional feeding methods (e.g., rice bran, groundnut cake) due to cost considerations. As observed by Kumar *et al* (2022), feed-related constraints are among the most cited deterrents to scientific aquaculture adoption in smallholder systems.

Lack of post-training technical support was reported by over half the respondents (57%). While initial training enhanced their knowledge and confidence, many farmers felt the need for continued guidance during implementation, especially in diagnosing fish health issues or managing water quality. This highlights the need for follow-up visits, helplines, or community-based para-extension models to sustain adoption. Another prominent constraint was difficulty in record keeping (52%). Many farmers, particularly those with lower literacy levels, found it hard to maintain daily records on feed, stocking, mortality, or sales. Without visual or digital aids, this practice remained underutilized, despite being emphasized during training. In addition, inadequate access to water testing kits or disease diagnostic tools (45%) and labour constraints (38%) affected farmers' ability to consistently apply practices like liming, pond bottom ploughing, and health monitoring. A section of farmers (35%) also expressed fear of crop failure due to unpredictable water availability or fish mortality, which discouraged them from adopting new practices fully or investing heavily. These constraints reflect the broader challenges of promoting aquaculture in rainfed, resource-constrained settings. While training builds knowledge, actual adoption is mediated by structural and service delivery issues. Similar findings have been reported by Reddy *et al* (2019) and Yadav *et al* (2020), who emphasized that convergence with input supply schemes, decentralized diagnostic services, and market linkages are crucial for scaling aquaculture technologies. Addressing these constraints calls for a multi-pronged strategy. First, strengthening local hatcheries and input shops can ensure timely availability of seed and feed. Second, establishing farmer field schools or model ponds with regular demonstrations can provide ongoing technical support. Third, introducing simplified record-keeping templates or mobile-based apps can improve management tracking, especially among semi-literate farmers. Finally, promoting group-based input procurement and marketing through PCSs or FIGs can reduce costs and risks, thereby encouraging sustained adoption.

CONCLUSION

The present study highlighted the positive impact of KVK Sivaganga's training programs on enhancing farmer's knowledge and adoption of scientific fish farming practices in farm ponds. To improve the scalability and sustainability of scientific fish farming in farm ponds, a comprehensive approach is essential. Strengthening the local supply chain for inputs such as seed and feed can help reduce dependency on distant markets and ensure timely availability. Furthermore, establishing mechanisms for post-training extension support through helplines, field visits, or mobile-based advisories can help farmers make informed decisions during critical stages of pond management. Encouraging group-based aquaculture through Primary Cooperative Societies or Farmer's Interest Groups can reduce costs, enhance peer learning, and create platforms for collective action. Simplifying record-keeping tools, especially through the use of visual templates or mobile applications in the local language, could improve compliance and farm management efficiency. Demonstrating low-cost, climate-resilient pond management techniques, such as seasonal ploughing, liming, and polyculture models, can also enhance farmer confidence and minimize risks in rainfed areas. Lastly, convergence with ongoing government schemes such as MGNREGA or fisheries department programs can provide necessary financial and infrastructure support to resource-poor farmers.

In conclusion, the training imparted by KVK Sivaganga has proven to be an effective strategy in promoting scientific aquaculture among small and marginal farmers. Nonetheless, the long-term success of such interventions hinges on their integration with input delivery systems, continuous extension services, and supportive policy frameworks. Strengthening these complementary elements will be critical in transforming farm pond aquaculture into a viable and scalable livelihood option in dryland districts of Tamil Nadu.

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