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Effectiveness of Pelleted Fish Feed on Growth Performance of Carps in Farm Ponds under Rainfed Conditions

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ABSTRACT

Aquaculture productivity in rainfed farm ponds is often constrained by poor feed quality and low feed-use efficiency, particularly in the culture of Indian major carps. The present study was undertaken to demonstrate the effectiveness of formulated pelleted fish feed on the growth performance of Indian major carps *viz.,* Catla, Rohu, and Mrigal, cultured in farm ponds under rainfed conditions in Sivaganga district, Tamil Nadu. The study was carried out in five farmer-managed ponds using slow-sinking pelleted feed over a 120-day culture period. Results revealed significantly enhanced growth rates, with average final weights of 412.4 g for Catla, 378.6 g for Rohu, and 352.7 g for Mrigal. The mean daily weight gain ranged from 2.94 g to 3.32 g, and specific growth rates (SGR) ranged between 1.52% and 1.68% per day. Feed conversion ratio (FCR) averaged 1.8, and survival rates exceeded 89%. In contrast, traditional feed (rice bran and oil cake) used in control ponds resulted in lower growth and poorer feed efficiency (FCR 2.65). Farmers reported improved fish health, ease of feeding, and greater profitability. The study affirms that formulated pelleted feed significantly improves the growth and economic viability of Indian major carps in farm ponds and is a scalable intervention for enhancing aquaculture productivity in rainfed regions.

Keywords: Farm ponds, rainfed aquaculture, fish culture, pelleted fish feed, demonstration.

INTRODUCTION

Aquaculture is a cornerstone of global food security, contributing over half of the world's fish consumption and playing a critical role in alleviating poverty and malnutrition (FAO, 2020; Vishwakarma *et al,* 2020). In India, freshwater aquaculture accounts for a substantial share of inland fish production, with Indian Major Carps *viz.,* Catla (*Catla catla*), Rohu (*Labeo rohita*), and Mrigal (*Cirrhinus mrigala*) dominating farm-level pond systems (Ayyappan and Jena, 2003). As the demand for protein-rich food rises, smallholder aquaculture has gained increasing attention as a viable livelihood option, particularly in rural areas (Debnath and Sahoo, 2020; Kumar *et al,* 2020).

In rainfed and semi-arid regions of India, water availability is highly erratic and seasonal. Here, farm ponds have emerged as a critical resource management intervention, enabling rainwater harvesting, supplemental irrigation, and allied activities like fish farming. Constructed farm ponds are small, excavated structures designed to collect surface runoff and conserve water for multipurpose use (Kumar *et al,* 2020; Srinivasarao *et al,* 2017). In addition to stabilizing agriculture, farm ponds offer an excellent opportunity for integrating fish culture, thus enhancing resource use efficiency, income diversification, and dietary nutrition in rural households (Das *et al,* 2021). Fish culture in farm ponds is especially relevant in water-scarce regions because it makes productive use of otherwise underutilized rainwater reserves. Polyculture of carps in these ponds can yield up to 3–5 t/ha/year with proper management, contributing to both income and food security. However, in many such areas, aquaculture is still practiced using traditional methods with low productivity. One of the key constraints is the continued use of traditional or farm-made feeds, typically rice bran and oil cake mixtures, that lack proper nutrient balance, resulting in poor growth rates, inefficient feed utilization, and higher organic loading in ponds (Nandeesha, 1993).

Formulated pelleted feeds, developed to meet the precise nutritional needs of fish, offer a promising solution to address these challenges. These feeds are nutritionally complete, easier to handle, reduce wastage, and support faster and more uniform

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fish growth. Their benefits such as better feed conversion ratios (FCR), enhanced survival, and reduced water quality deterioration are well established in controlled conditions (De Silva and Anderson, 1995; Tacon and De Silva, 1997). Yet, their adoption in rural pond aquaculture remains limited due to higher initial costs, lack of awareness, and inadequate field-level demonstrations. This research is designed to bridge this gap by demonstrating the application of formulated pelleted feed in small-scale farm pond aquaculture in a rainfed region of Tamil Nadu. Through comparative evaluation of carp growth and feed performance under traditional versus pelleted feeding regimes, the study aims to generate practical insights on the productivity, economic feasibility, and sustainability of improved feeding in pond-based aquaculture.

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MATERIALS AND METHODS

Study area

The study was carried out during the post-monsoon season (October 2023 to February 2024), spanning a period of 120 days, in five selected rainfed farm ponds located in Sivaganga district, Tamil Nadu.The region is characterized by erratic rainfall, shallow groundwater, and limited irrigation options, making farm ponds a vital water resource for integrated farming activities including aquaculture.

Pond preparation, stocking and feeding

A total of five farm ponds, each with a surface area of approximately 0.1 ha and a depth of 1.5 to 2.0 m. were selected for demonstration. The ponds were de-weeded, de-silted, and limed using agricultural lime at 200 kg/ha, followed by basal fertilization with cow dung (5,000 kg/ha) two weeks before stocking. Indian Major Carp fingerlings, including Catla, Rohu, and Mrigal were stocked at a stocking density of 10,000 fingerlings per hectare, maintaining the ratio of 40:30:30 respectively. The average initial weight of the fingerlings was 12–15 g. The formulated pelleted feed used in the study was a slow-sinking, floating commercial feed with a crude protein content of 28%. Feed was applied daily at 3% of the total biomass during the initial 60 d and gradually reduced to 2% thereafter, in line with biomass assessment and seasonal feeding response.

Monitoring and data collection

Routine water quality monitoring was undertaken fortnightly using field test kits to measure temperature, pH, dissolved oxygen, and ammonia levels, ensuring optimal pond conditions. Sampling of fish was conducted at monthly intervals using cast nets to assess growth, feed intake, and health status. Final harvest was carried out after 120 d and data on average final weight, survival rate, feed conversion ratio (FCR), and biomass yield were recorded. For comparative insights, five neighbouring farm ponds using traditional feed (rice bran and oilcake mixture in 1:1 ratio) under similar environmental conditions were monitored simultaneously, though without any formal intervention.

Data analysis

Farmer perception and feedback were collected through structured interviews and focus group discussions post-harvest to evaluate the practicality, acceptance, and scalability of the technology under local rainfed farming conditions. All data were statistically analysed using descriptive statistics. Means and standard deviations were calculated for growth parameters. Paired t-tests were used to compare initial and final weights. The effectiveness of formulated feed was assessed by evaluating growth performance and feed efficiency indicators.

RESULTS AND DISCUSSION

Growth performance of carps

The feeding of formulated pelleted feed in farm ponds resulted in a substantial improvement in growth performance of Indian Major Carps (Catla, Rohu, and Mrigal) compared to control ponds managed with traditional feed. As shown in Table 1, the average final weight of Catla in demonstration ponds reached 412.4 ± 24.1 g, which was significantly higher than the 305.6 ± 21.5 g observed in control ponds. Similarly, Rohu attained a significantly higher mean final weight of 378.7 ± 20.3 g in demonstration ponds, compared to corresponding control value of 268.4 ± 18.9 g. Mrigal also showed significantly superior performance under pelleted feed, achieving 352.5 ± 19.6 g in demo ponds compared to 255.2 ± 17.4 g in control ponds. These growth rates were considerably higher than those typically reported in traditional feed-based systems and are in line with earlier findings by Limbu and Jumanne (2014), Kherwar and Bhagat (2024) and De *et al* (2021), who demonstrated improved growth in Indian major carps under semi-intensive systems using supplemental formulated feeding. The superior growth under pelleted feeding was attributable to higher digestibility, better nutrient utilization, and reduced wastage compared to

Table 1: Growth performance of carps fed formulated pelleted feed in demonstration ponds (values in mean ± SD).

Fish Species	Initial Weight (g)		Final Weight (g)		Weight Gain (g)		Daily Weight Gain (g/day)		Specific Growth Rate (%/day)		Survival Rate (%)	
	DP	CP	DP	CP	DP	CP	DP	CP	DP	CP	DP	CP
Catla	14.2 ± 1.3	14.0 ± 1.4	412.4* ± 24.1	305.6 ± 21.5	398.2 ± 23.5	291.6 ± 22.7	3.32 ± 0.16	2.43 ± 0.14	1.66 ± 0.07	1.42 ± 0.06	90.4 ± 2.3	83.7 ± 2.8
Rohu	13.6 ± 1.1	13.5 ± 1.2	378.7* ± 20.3	268.4 ± 18.9	365.1 ± 21.7	254.9 ± 19.3	3.04 ± 0.13	2.12 ± 0.12	1.58 ± 0.05	1.35 ± 0.04	88.6 ± 2.9	81.2 ± 3.1
Mrigal	12.9 ± 1.0	12.8 ± 1.1	352.5* ± 19.6	255.2 ± 17.4	339.6 ± 19.8	242.4 ± 18.1	2.83 ± 0.12	2.02 ± 0.11	1.52 ± 0.06	1.28 ± 0.05	89.3 ± 2.7	82.1 ± 2.5

DP – Demonstration Pond; CP – Control Pond
* Significant at 1% level ($p \leq 0.01$)

Table 2: Feed utilization and yield performance (values in mean ± SD).

Parameter	Demonstration Pond	Control Pond
Feed Conversion Ratio (FCR)	1.80* ± 0.12	2.65 ± 0.15
Total Biomass Yield (kg/ha)	2,980* ± 125	2,120 ± 105
Net Biomass Gain (kg/ha)	2,690* ± 110	1,820 ± 95
Feed Applied (kg/ha)	4,840 ± 160	4,820 ± 170

* Significant at 1% level ($p \leq 0.01$)

Table 3: Average water quality parameters observed during the study

Parameter	Demonstration Pond	Control Pond
Temperature (°C)	26.0 – 30.5	26.2 – 30.7
pH	7.2 – 8.1	7.0 – 8.4
Dissolved Oxygen (mg/L)	5.4 – 6.8	4.6 – 5.9
Total Ammonia (mg/L)	0.02 – 0.06	0.05 – 0.12

traditional feed inputs such as rice bran and oil cake mixtures (Ali and Jauncey, 2004; Hasan *et al,* 2007). Furthermore, survival rates were consistently higher in demonstration ponds, averaging 90.4 ± 2.3% in Catla, 88.6 ± 2.9% in Rohu, and 89.3 ± 2.7% in Mrigal, compared to 83.7 ± 2.8%, 81.2 ± 3.1%, and 82.1 ± 2.5% respectively in control ponds. This improvement suggests that pelleted feed not only accelerates growth but also contributes to improved pond health and reduced stress on fish stocks. These findings are consistent with earlier studies which have demonstrated that the use of formulated feeds enhances both growth and survival of carps under semi-intensive and farm pond conditions (Hasan and New, 2013 and Ramakrishna *et al,* 2013).

Feed utilization efficiency

Feed utilization efficiency is a critical determinant of aquaculture profitability, and in the present study, a significant improvement was observed in demonstration ponds fed with formulated pelleted feed compared to control ponds fed with traditional mixtures. As presented in Table 2, the FCR in demonstration ponds was 1.80 ± 0.12, which was significantly lower than the 2.65 ± 0.15 recorded in control ponds, establishing the superior efficiency of pelleted feed. Similarly, total biomass yield in demonstration ponds averaged 2,980 ± 125 kg/ha, which was significantly higher than the 2,120 ± 105 kg/ha achieved in control ponds. The net biomass gain followed the same trend, with demonstration ponds recording significantly higher value of 2,690 ± 110 kg/ha compared to only 1,820 ± 95 kg/ha in control ponds. Interestingly, the feed applied did not vary much between demonstration ponds and control ponds, highlighting that the improved results in demo ponds were due to enhanced feed efficiency rather than greater input use. The markedly lower FCR and higher

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Table 4: Farmer Feedback and Field Validation on use of Pelleted Feed

Parameter	Observation / Response	**Farmer Agreement (%)*
Ease of feed application	Uniform pellet size and ease of broadcasting improved feeding convenience	100%
Perceived fish growth rate	Faster growth observed compared to traditional feed	100%
Feed wastage	Significantly reduced due to better feed stability and targeted consumption	90%
Water quality maintenance	Water remained clearer; reduced organic waste accumulation	80%
Fish health and survival	Higher survival rate and improved fish appearance	100%
Profitability perception	Increased yield and income over previous practice	100%
Willingness to continue with pelleted feed	Farmers willing to adopt pelleted feed in future cycles	100%
Willingness to recommend to others	Positive; most participants shared experience with peer farmers	90%
Need for continued support	Requested training and input facilitation for wider adoption	80%

* Percentage reflects farmers who responded positively out of five demonstration participants.

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biomass production under pelleted feed align with findings reported by Manivannan and Saravaran (2012), Mocanu *et al* (2015), Sharma *et al* (2022) and Manam (2024), who emphasized that balanced feeds improve nutrient assimilation, reduce wastage, and enhance productivity in carp polyculture. These results reinforce the notion that nutritionally balanced pelleted feeds are not only biologically superior but also economically advantageous, as they optimize input utilization without increasing feed costs.

Water quality parameters

The water quality parameters recorded during the demonstration indicated favourable conditions for carp culture in both demonstration and control ponds, but with notable differences in stability and nutrient load (Table 3). The water temperature remained within the optimal range of 26.0–30.5 °C in demonstration ponds and 26.2–30.7 °C in control ponds, suggesting that feeding practices had minimal effect on thermal regimes. However, dissolved oxygen (DO) levels were significantly higher in demonstration ponds (5.4–6.8 mg/L) compared to control ponds (4.6–5.9 mg/L), reflecting the reduced organic load and lower decomposition associated with pelleted feed. The pH values in both systems remained within the suitable range for carps (7.0–8.4), though control ponds showed slightly greater fluctuations, which can be attributed to nutrient enrichment and algal blooms from uneaten feed. Total ammonia concentration was substantially lower in demonstration ponds (0.02–0.06 mg/L) than in control ponds (0.05–0.12 mg/L), indicating improved nitrogen utilization and reduced waste accumulation under pelleted feeding. These results are consistent with earlier reports that formulated pelleted feeds enhance water quality by reducing nutrient leaching and feed wastage (Tacon and De Silva, 1997; Hasan *et al*, 2007). Improved DO levels and lower ammonia concentration in pelleted feed systems also create a healthier pond environment, directly contributing to better survival and growth performance of cultured carps. Additionally, the use of pelleted feeds reduced nutrient leaching in pond systems, which is particularly critical under rainfed conditions where water renewal is limited (Tacon and De Silva, 1997; Hasan *et al*, 2007). The stability of key parameters such as DO and ammonia throughout the culture cycle also contributed to improved survival and fish health in demonstration ponds. These findings reinforce the role of nutritionally balanced and water-stable formulated feeds as a sustainable tool for maintaining water quality in rainfed aquaculture systems.

Farmer response and field validation

The field validation and farmer feedback revealed highly positive perceptions of the formulated pelleted feed technology (Table 4). All participating

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farmers (100%) reported that the uniform pellet size and ease of broadcasting greatly simplified feed application compared to traditional mixtures. Farmers unanimously observed faster fish growth under pelleted feeding, corroborating the quantitative growth data presented earlier. A majority (90%) confirmed that feed wastage was significantly reduced, consistent with the higher feed utilization efficiency demonstrated in the trial ponds. In terms of environmental impact, 80% of farmers perceived better water clarity and reduced organic accumulation, aligning with the recorded lower ammonia concentrations and higher dissolved oxygen levels in demonstration ponds. Moreover, farmers consistently (100%) noted healthier fish, improved survival rates, and better external appearance, echoing findings from previous participatory demonstrations where pelleted feeds enhanced stock performance (Shukla *et al,* 2023).

The economic impact was equally well recognized. All farmers agreed that profitability increased relative to their previous practices, largely due to higher biomass yield and improved benefit–cost ratio. Importantly, every farmer expressed willingness to continue using pelleted feed in future production cycles, and 90% indicated they had already shared their experiences with peers, suggesting strong potential for horizontal dissemination of the technology. However, 80% of respondents emphasized the need for continued technical support and input facilitation, underscoring the role of extension agencies in scaling adoption. These observations validate the scientific findings of this study while also highlighting that farmer acceptance is strongly influenced by ease of use, visible productivity gains, and economic returns. Similar conclusions have been drawn in participatory aquaculture trials across India and Southeast Asia, where farmer adoption was driven by direct field-level benefits and extension support (Hasan *et al,* 2007).

CONCLUSION

The present study clearly established the superiority of formulated pelleted feeds over traditional feeding practices in carp culture under farm pond conditions in rainfed areas. The use of pelleted feed significantly enhanced growth performance of catla, rohu, and mrigal, as reflected in higher daily weight gain, specific growth rate, and survival rates compared to control ponds. Feed utilization efficiency improved markedly, with lower feed conversion ratios and higher net biomass yield, demonstrating the economic viability of this technology. Improved water quality parameters in demonstration ponds, particularly higher dissolved oxygen and lower ammonia levels, further highlighted the ecological benefits of pelleted feeding. Importantly, farmer response validated the scientific findings, with overwhelming acceptance of the technology due to ease of feed application, visible improvements in growth and profitability, and willingness to adopt and disseminate the practice in future cycles. These results underscore the potential of formulated pelleted feeds as a sustainable, farmer-friendly intervention for enhancing fish production in farm ponds, thereby contributing to livelihood security and nutritional improvement in rainfed regions.

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