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Research Article

Socio-economics of fish farmers as determinant of productivity in composite farming: A descriptive study in Barind region of Malda district, West Bengal

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Abstract

Composite fish farming is basically a technique of six species culture in which three each of Indian and exotic major carps (IMC) (*Labeo catla*, *Labeo rohita* and *Cirrhinus mrigala*) and (*Hypophthalmicthys molitrix*, *Ctenopharyngodon idella* and *Cyprinus carpio*), respectively are cultured together for optimum utilization of internal food resources to increase the pond productivity. The socio-economic conditions of the fish farmers engaged in composite fish farming and such conditions impacting upon the fish productivity were investigated employing an interview schedule that was properly structured following baseline data collection in Barind region, Malda district, West Bengal, India during April to September, 2021 incorporating one hundred fifty farmers as respondents. The results indicated that higher annual productivity (>5tonnes / hectare) was recorded from the farmers belonged to the middle age group. Influence of formal education and farming experience on productivity established a significant positive relationship between formal education and productivity, with the model ($y=-0.2757x2+2.8203x-0.776y$; $R^2 = 0.9542$). Additionally, greater fish farming experience correlates strongly with increased productivity, represented by $y=0.2532x+1.386y = 0.2532x + 1.386y=0.2532x+1.386$ ($R^2 = 0.9742$). Optimal production rates, exceeding 5 tonnes per hectare per year, were achieved in ponds that ranged between 0.6-1 hectare, with productivity diminishing as pond size increased beyond this range. Findings suggest that both formal education and practical experience, alongside pond size management, are critical in composite fish farming in maximizing productivity.

Keywords: Composite culture, Fish farmers, Productivity, Socio-economic profile, West Bengal

Highlights

- 78.67% farmers belonged to the middle-age category and from the joint or large family structures
- 42% farmers possess extensive experience, having been involved in fish farming for 15 years or more
- Productivity exhibited negative correlation with pond size ($y=-2.668x+9.18$, $R^2 = 0.69$)
- Principal bottlenecks in productivity were insufficient support from different Govt. organizations

INTRODUCTION

India currently ranks third among the world's largest fish-producing countries, accounting for 7.96% of global production, which totals approximately 17.45 million metric tons for the year 2022-23. It holds the fourth position in capture fisheries (both marine and inland) and is second in aquaculture production globally, contributing 10% of the world's finfish output (FAO, 2022a). Notably, aquaculture alone contributes to 76% of India's total fish production (Goswami and Zade, 2015; FAO, 2022b), accounting for 1.07% of the national GDP and 5.30% of the agriculture GDP (Ngasotter *et al.*, 2020).

Approximately 56% of the population in India are fish eaters, with per capita fish consumption of 5-6 kg/year and 8-9 kg among fish-eating individuals (Salim, 2016) whereas, the availability is 9.85 kg (Saha and Paul, 2000). Research and development efforts over the past five decades have significantly increased average fish yields in the country, making carp culture an essential economic activity (Panda, 2016).

Village-level ponds play a vital role in Indian inland freshwater aquaculture, which are primarily managed by individuals from the lower strata of rural communities (FAO, 2009). Farmers intending to maximize their income often tend to practice composite fish culture (Biswas *et al.*, 1991). Inland freshwater aquaculture production has grown by more than 10% annually over the last two decades, primarily due to the composite culture of native and exotic carp species in ponds (DOF, 2022).

West Bengal stands out as the largest fish seed-

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producing state in India and ranks second after Andhra Pradesh in table fish production, contributing approximately 21-23% of the country's inland fish production (DOF, 2022). Despite having only 7.45% of the nation's total water resources (DOF, GOWB, 2016), West Bengal accounts for about 28.57% of the country's fish food consumption (Goswami and Samajdar, 2012).

Technological advancements in production methods, investment practices, and income generation within composite fish culture are primarily determined by farmers' socioeconomic status and their engagement in development initiatives (Biswas *et al.*, 2018). However, the successful implementation of various development programs can be hindered by a lack of reliable data on the socioeconomic conditions of farmers (Biswas *et al.*, 2017). Numerous micro- and macro-level socioeconomic surveys have been conducted by different agencies and researchers across various regions in India to explore the challenges faced by the fishing community (Rao, 1986; Singh *et al.*, 2015).

Composite fish culture has a rich history in West Bengal and is widely practiced among fish farmers, although many tend to modify the recommended cultural practices (Biswas *et al.*, 2017). The total area available for fish farming in impounded water bodies in West Bengal is approximately 3.57 lakh hectares, which encompasses ponds (0.29 million hectares), ox-bow lakes and baors (0.042 million hectares), and reservoirs (0.027 million hectares). The area designated for commercially viable, scientific fish farming is around 0.126 million hectares (DOF, 2022). According to Pandey and Upadhyay (2012), the gap between domestic fish demand and supply persists largely due to insufficient utilization of water resources for fish production.

This study was designed to investigate the socioeconomic aspects of the fish farmers of the Barind area of Malda district, West Bengal engaged in composite fish culture. This area was specifically chosen due to its long-standing tradition and the prevalence of composite fish culture.

Table 1. Socio-personal status of the respondents

Socio-personal characteristics	Frequency (n=150)	Percentage (%)
Age groups (Years)		
Young (≤30)	21	14
Middle (>30 to 60)	118	78.67
Old (>60)	11	7.33
Family size (No. of individuals)		
Small (<5)	16	10.67
Large (>5)	134	89.33
Nature of family		
Nuclear Joint	33	22
	117	78

MATERIALS AND METHODS

Plan of work: The present study was carried out between April and September 2021, including 150 farmers as respondents. These farmers were purposively selected from the Barind region of Malda district in West Bengal. This is because, this region is known for its widespread practice of composite carp farming and its rich inland fishery resources. Furthermore, the accessibility of the study area allowed for effective data collection through personal interviews with the farmers.

In Malda district, four of the fifteen development blocks- Gazole, Bamongola, Habibpur, and Old Malda- were selected for this study based on their high concentration of composite carp farmers, representing one-third of the district's area. From this region, fifteen villages were chosen through simple random sampling, serving as the representative units for the research. Within each village, ten fish farmers were selected using a proportionate stratified random sampling method (Noor *et al* 2022), resulting in a total sample size of 150 fish farmers participating in the study.

Statistical analyses: Data were collected through structured and pretested interview schedules specifically developed for this study. Personal interviews were conducted on-site with the respondents. The analysis of the data involved calculating percentages and frequencies for each variable. To evaluate the dependency among the variables, correlation test between the parameters were applied. The degree of the correlation was determined using R^2 values.

RESULTS

Seventy-eight point six seven per cent (78.67%) of the farmers belonged to middle aged group (31 to 60 years) and primarily from joint (78%) and larger family (89.33%) (Table 1).

Although most surveyed fish farmers (59.76%) had a formal education of medium, primary, or upper primary level (Fig. 1A), they had developed significant farming experience in composite fish farming over time. The analysis revealed a positive relationship between productivity and formal education level ($R^2 = 0.7921$) (Fig. 1B), with the highest productivity

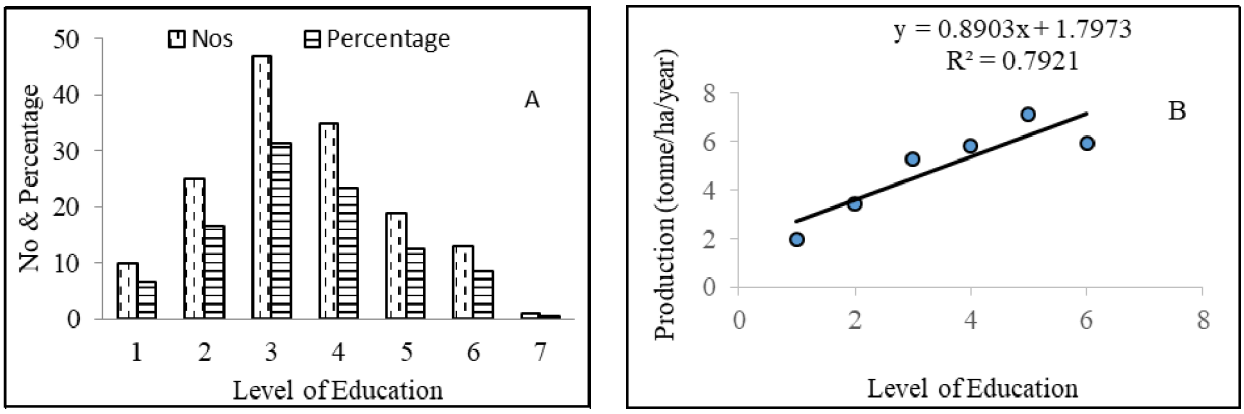

Fig. 1. Educational standards of the farmers(A); illiterate (1), functionally literate (2), primary (3), secondary (4)upto higher secondary (5), graduates (6) and above (7) and fitted relationship between educational level and average fish production(B); illiterate (1), functionally literate (2), primary (3), secondary (4) up to higher secondary (5), graduates (6) and above (7).

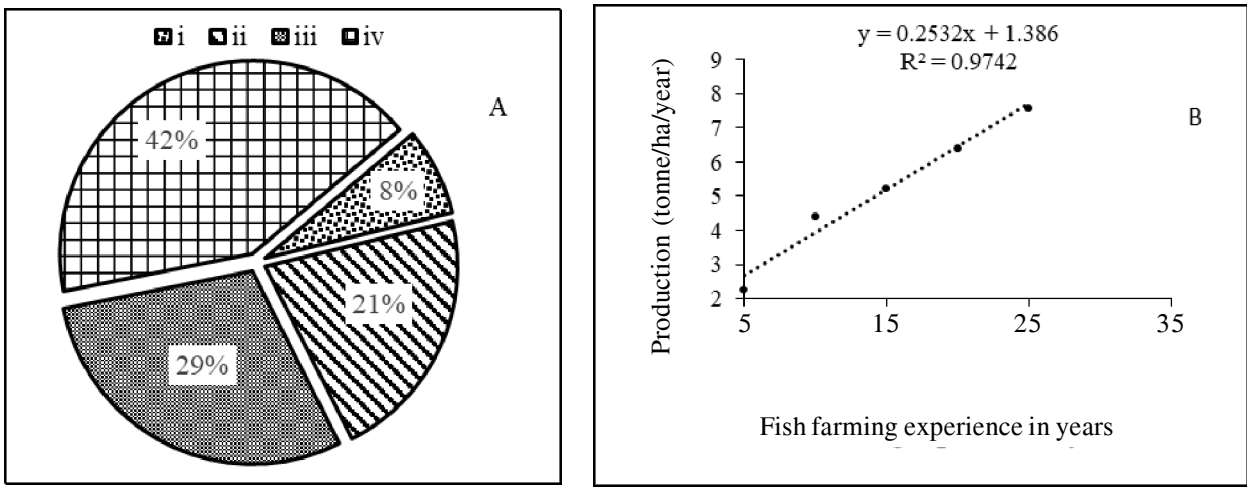

Fig. 2. Experience of the respondents in composite fish farming (A); and fitted relationship between experience and average fish production(B); i) very low (<5 years) , ii) low (≤10 years), iii) medium (≤15 years), iv) high (>15 years).

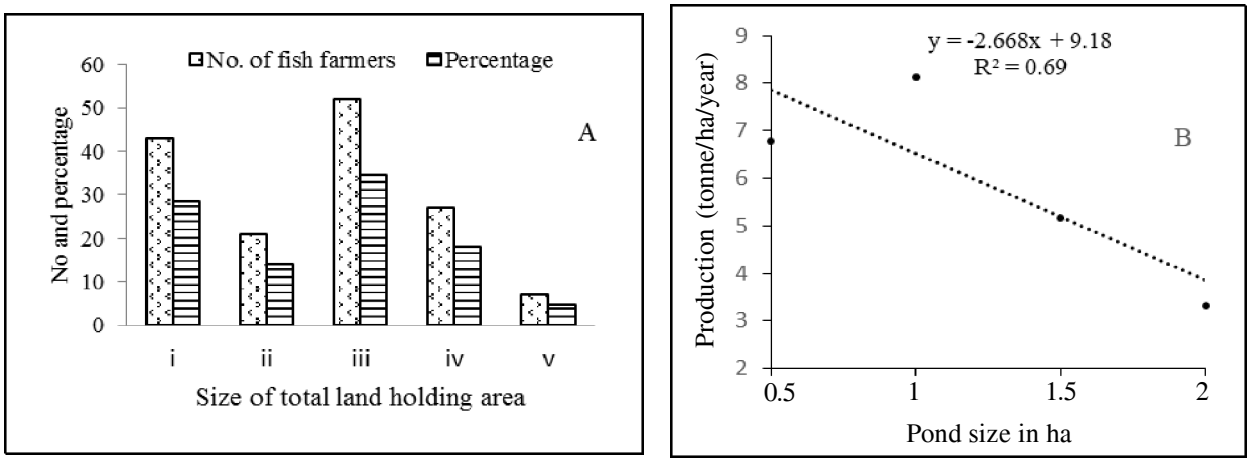

Fig. 3. Pond size (A) and the correlation between pond size and fish production (B); ≤0.5 ha (i), ≥0.6-1 ha (ii), 1.1-1.5 ha (iii), 1.6-2 ha (iv),>2 ha (v).

recorded in this study (6.57 tonnes per hectare per year) attributed to a farmer with a graduate education. It is noteworthy that 66.4% of the farmers lacked formal training in composite fish farming (Table 2).

Most of the farmers of Barind region was recorded with high level of experience; 42% with ≥15 years and farmers with ≤5 years' experience were very low (7.33%). Therefore, it was clear that the surveyed fishermen were highly skilled because of their vast experience ($y = 0.2532x + 1.386$; $R^2 = 0.9742$) in fish farming over the years (Fig. 2 A and B)

Pond size plays a discernible role in aquaculture, influencing factors such as input usage, technology adoption, production levels, and farmer income. In this study, 60% of farmers managed ponds with an area of up to 1 hectare (Fig. 3A), where they achieved fish production exceeding 5 tonnes per hectare per year, particularly in ponds sized between 0.6 and 1 hectare. Overall, productivity tended to decrease ($y = -2.668x + 9.18$; $R^2 = 0.69$) as pond size increased (Fig. 3B).

For more than 65.33% of fish farmers, composite fish farming emerged as the principal source of livelihood, while the rest supplemented their income through raising carp seed (fry and fingerlings), agriculture, or animal husbandry. Regarding pond ownership, only 24.67% of farmers cultivated fish solely in their family ponds, 34% used a combination of owned and leased ponds, and 41.33% relied exclusively on leased in ponds for composite fish culture (Table 2).

Farmers engaged in composite carp farming reported multiple challenges. A significant portion (51.99%) pointed to insufficient support from government organizations as the main barrier. Additionally, 16.67% highlighted issues with accessing quality fish feed, and 12.67% faced challenges obtaining high-quality fish seed (fingerlings). Difficulties in securing bank loans impacted 10.67% of farmers, while climate change, lack of disease diagnostic facilities (4.67%), and transportation issues (3.33%) were also noted as key concerns (Fig. 4A).

Farmers identified several needs to improve productivity: 27.33% highlighted bank financing as essential for growth, and 17.33% expressed the need for greater government support through fisheries schemes. Furthermore, 24% emphasized the need for high-quality feed, 14.67% for superior seed, 6.67% for better marketing channels, 5.33% for water and soil quality analyses, and 3.67% for disease diagnostics (Fig. 4B).

Table 2. Socio-economic profile of the respondents

Socio-economic profile	Frequency (n=150)	Percentage (%)
Occupation		
Main	98	65.33
Secondary	52	34.67
Ownership of fish ponds		
Own	37	24.67
Leased in	62	41.33
Owned and leased in	51	34
Professional training		
Trained	61	40.67
Non-trained	89	59.33
Annual income (Rs.)		
≤1 Lac	43	28.67
>1-2 Lac	94	62.67
>2 Lac	13	8.66

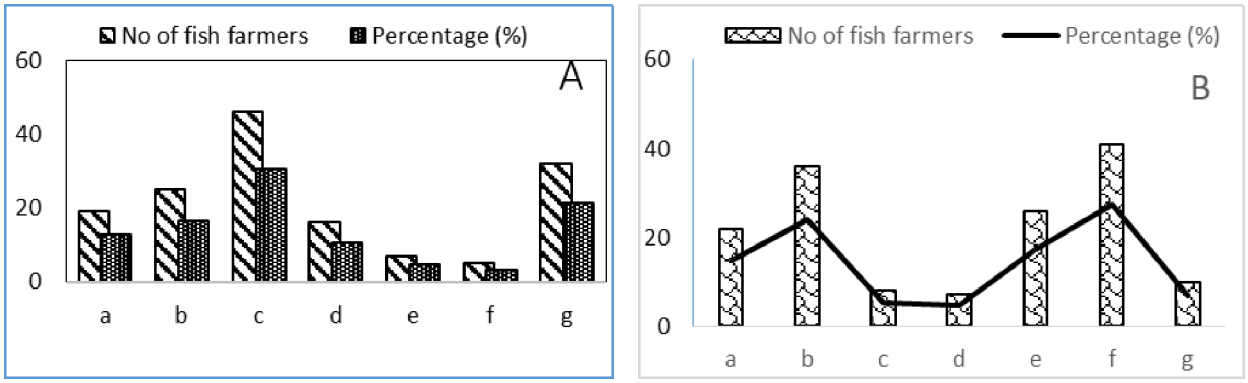

Fig. 4. Problem of the farmers (A); quality of seed (a), feed (b), bank loan (c), weather change (d), disease diagnosis (e), transportation (f), support from local govt. organization (g) and need of the farmers (B); good quality seed (a), good quality feed (b), water and soil quality analyses (c), disease management (d), support ~~of~~ from local govt. organization (e), bank loan (f), marketing channel (g) during fish culture

DISCUSSION

The results clearly established that middle aged fish farmers mostly from the large sized (≥5). Joint family dominated in the composite carp farming sector where farmers belonged to the middle age group achieved average higher productivity (>5tonnes/ hectare/year). Adewuyi *et al.* (2010), Moni and Khan (2014) and Biswas *et al.* (2018) also reported such dominance of middle-aged farmers in the polyculture of carps. As majority of farmers were having experience in fish farming of >15 years which shown to positively influence productivity (Fig. 3). Dey *et al.* (2005) and Biswas *et al.* (2018) also observed experience as an important factor influencing production in carp farming. In Malda region, just 40.67% of farmers had training in fish culture, underscoring the need for targeted professional training to enhance their knowledge and adopt modern, scientific fish farming practices. Biswas *et al.* (2018) reported positive correlation between productivity and training levels of the fish farmers of West Bengal.

According to Mkoka (2007), business potential alone does not guarantee successful harvests if farmers lack technical skills. Pond size is also critical in aquaculture, as it significantly impacts input utilization, technology adoption, production levels, and income generation for farmers (Singh *et al.*, 2015). In this study, productivity decreased with larger pond sizes (Fig. 4), potentially due to the improved management control possible in smaller to medium-sized ponds commonly used in carp culture. This highlights the importance of manageable pond sizes for efficient production and effective resource management. The FAO (2009) similarly reported that smaller ponds allow for more effective management. In this study, the majority of farmers (65.33%) relied on full-time fish farming, indicating that composite carp culture has become a vital livelihood source in these districts. Syandri *et al.* (2015) also found full-time fish culture as the primary occupation for most farmers (71.66%). Despite limited education, financial constraints, and minimal technical support from external agencies, farmers have leveraged their extensive experience to achieve a productivity level of 5 tonnes per hectare per year. This underscores the resilience and adaptability of the fish farming communities in sustaining production and livelihood.

Conflict of interest: Authors have no conflict of interest in this study.

Data availability statement: The data will be available from the corresponding author (AM) upon reasonable request; solely to be used for academic purposes.

Author's contribution: AM: Involved in investigation, data generation, preparing original draft; SKD: Engaged in conceptualization, data curation, supervision and final editing.

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