Uttar Pradesh Journal of Zoology

Volume 45, Issue 7, Page 99-108, 2024; Article no.UPJOZ.3349
ISSN: 0256-971X (P)

Perceptions of Farmers Regarding the Opportunities and Obstacles in Utilizing Indigenous Fish Species within Assam's Aquaculture Industry

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.56557/UPJOZ/2024/v45i73981

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://prh.mbimph.com/review-history/3349

Original Research Article

Received: 18/01/2024
Accepted: 22/03/2024
Published: 28/03/2024

ABSTRACT

Background: Assam is blessed with over 200 fish species. The perceptions of fish farmers in Nalbari and Barpeta districts of central Assam regarding the opportunities and challenges of utilizing indigenous fish species (IFS) for aquaculture have been discussed.
Methodology: Utilizing a combination of purposive and random sampling techniques, data was collected from 120 fish farmers across Barpeta and Nalbari districts. Pertinent information was gathered from fish farmers (n=240) combined in the districts of Barpeta and Nalbari. To rank the causal factors based on the responses from the respondents, subsequently calculate the Rank Based Quotient (RBQ).
Results and Discussion: High demand, market value, and potential returns as key prospects driving farmer preferences for indigenous fish species cultivation. However, high capital investment, inadequate technical support, flood, quality seed etc. were found as significant challenges in the study areas. These factors are negatively impacting farmers, hindering their ability to achieve

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anticipated fish yields and income. The study focused on addressing these challenges through integrated, multidisciplinary management plan on resource conservation together with geo-environmental, eco-biological and socio-cultural integrity.

Keywords: Indigenous fish culture; farmers' perception; management plan; Assam.

1. INTRODUCTION

Biswas et al. [1] has stated that the north eastern states of India has the repository of 265 species of indigenous ornamental fishes. Rearing and breeding of these species along with indigenous fish species (IFS have drawn the attention. Many small IFS are self-recruiting in nature. Indigenous major carps form the mainstay of the freshwater aquaculture sector of India [2]. Indigenous medium and minor carps like *Labeo gonius* and *L. bata* have been gaining prominence in the aquaculture industry of the country [3], resulting in system diversification. Indigenous fish species are naturally adapted to the local environmental conditions, including water quality, temperature, and habitat. This adaptability can contribute to better survival rates and overall success in aquaculture. Further, these species often exhibit a natural resistance to local diseases and parasites, reducing the need for extensive disease management measures in addition to offering a range of ecological, economic, and cultural benefits. However, like in other parts of the country, Indian major carps (IMC) and Chinese carps are widely preferred fish species for aquaculture in Assam. The locally available fish species, although highly preferred by the local populace, are almost entirely captured from natural waterbodies. Some of the local varieties, especially minor carps and air-breathing fishes are having very high potential as culturable species, but the growth of indigenous fish culture is far from satisfactory. An attempt has been made to address various constraints faced by the farmers of Barpeta and Nalbari Districts of Central Assam. and explore the possibilities of organizing the community by collating the 'community-expectations' from other stake holders. This may help to mobilize the community for partnership by selecting such agents as per 'community-preferences'.

2. METHODOLOGY

Study area: The data was collected from Jan 2017 to May 2020 in the two districts of Central Assam. Nalbari district is situated between 26^{o}N and 26.51^{o}N latitude and between 90^{o}E and 91.47^{o}E longitude with average rainfall of 1500mm and a subtropical climate. The latitude and longitude of Barpeta district is 26.5'N and 26^{0}51'N and between 90^{0}38'E and 91^{0} E with similar rainfall and climate to the neighbouring Nalbari district.

Research design: As the researcher did not have any direct control over the selected variables, hence, ex-post-facto research design was employed in the present study. In order to make the study more comprehensive in nature, the study covered 12 blocks, six each in Nalbari and Barpeta districts. A combination of purposive and random sampling procedures was employed for selection of blocks. The names of fish farmers and fishers from both the selected blocks were collected from the fishery officials of respective district. Farmers' perceptions of opportunities and challenges were assessed to rank the causal factors based on their responses.

Identification of prospects and constraints for culture of indigenous fish species: With the assistance of fisheries specialists, a list of opportunities and challenges for fish farming with native fish was created (Table 1), and pertinent information was gathered from fish farmers (n=240) of Barpeta and Nalbari Districts.

Data analysis: The collected field data were documented in MS excel spread sheet by defining the different parameters and the data were statistically analysed by using SPSS software. In order to rank the causal factors based on the responses from the respondents and subsequently calculate the Rank Based Quotient (RBQ), farmers' perceptions of opportunities and restrictions were ascertained by Sabarathnam [4]. The differences in attitudes of farmers of the two districts, if any, were statistically (correlation, ANOVA test) examined.

3. RESULTS

Criteria of selecting indigenous fish species for aquaculture: As per farmers' perception about the prospects of selecting indigenous fish species in the Barpeta and Nalbari districts, high demand, market value and faster growth rate of target species get the top priority (Table 1).

Accordingly, *Labeo calbasu, L. gonius* and air-breathing species, *Clarias magur* and *Heteropneustes fossilis* are preferred species of farmers of the two districts. Similarly, flood, lack of technical know-how and non-availability of adequate seed are three major constraints as perceived by the farmers (Table 1).

Farmers' perception in Barpeta Nalbari Districts: According to the perception of farmers regarding the prospect of indigenous fish species for aquaculture, particulars like high demand with 94.00% RBQ score ranked I, followed by high market value with a RBQ score of 91.33% and a high return (BCR) with a RBQ score of 68.00% in Nalbari district (Table 2). On the other hand, particulars like efficient extension machinery and credit availability have the lowest RBQ score of 13.33%. Details of farmers' perception regarding the prospects of using different indigenous fish for culture in Nalbari. Market value of minor carps and air-breathing fishes and farmer's preference are found highly correlated (r = 0.94).

According to the perception of farmers regarding the prospect of using different indigenous fish species for aquaculture in Barpeta district, particulars like high demand with a RBQ score of 95.33% is ranked I, followed by high market value with a RBQ score of 94.67% and high return (BCR) with a RBQ score of 74.00%, indicating a high preference of indigenous fish species for aquaculture in the district (Table 3). On the other hand, particulars like efficient extension machinery and credit availability have the lowest RBQ score of 25.33% and 10.67% respectively and ranked VIII and IX respectively (Table 3), which indicates farmers of the district have a poor perception regarding credit availability. Selection of indigenous species based on their market value was found highly correlated (r = 0.92).

Constraints of indigenous fish culture: Regarding the constraints of using different indigenous fish species for aquaculture in Nalbari district, particulars like high capital investment with a RBQ score of 76.67% is ranked I, followed by lack of quality seed with a RBQ score of 69.50%, poor extension machinery/technical support with a RBQ score of 58.72% were identified as the most important ones as identified based on farmers' perception (Table 4). On the other hand, factors like low production with a RBQ score of 41.50% and water loss due to seepage with a RBQ score of 35.33% and are ranked lowest. In the case of Barpeta district, constraints of selecting indigenous fish species for aquaculture were found in the order of high capital investment (RBQ score 90.83%), followed by lack of scientific knowledge (RBQ score 79.72%), flood menace (RBQ score 64.44%). On the other hand, issues like labour shortage with a RBQ score of 36.78% followed by lack of suitable sites for fish farms has the lowest RBQ score of 27.39% (Table 5). Among the challenges linked to abnormally high floods, the most significant constraint was the 'loss of brood stock' (RBQ=99.1), while the least critical constraint was the 'entry of weeds/macrophytes' during floods (RBQ=25.5).

The prospects and challenges faced by the farmers of the two neighbouring districts are almost similar types and the ANOVA test revealed the differences between the two districts insignificant ($P_{0.05}$).

Table 1. Prospects and challenges of indigenous fish culture

Sl. No.	Prospects	Challenges
1	High demand	Flood
2	High market value	Lack of scientific knowledge
3	Fast growth rate	Inadequate availability of seeds
4	Less disease-prone	Water loss due to seepage
5	High return (BCR)	High larval mortality
6	Availability of quality seed	Poor extension machinery/technical support
7	Low mortality	Feed shortage
8	High production per unit area	Low production
9	Efficient extension machinery	Fish disease
10	Credit availability	Labour shortage
11	-------	Market/transportation
12	-------	Storage issue

Table 2. Farmers' perception in selecting indigenous fish species in Nalbari district

Particulars	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5	Rank 6	Rank 7	Rank 8	Rank 9	Rank 10	RBQ score (%)	Rank
High demand	24	36									94.00	I
High market value	32	24						4			91.33	II
Fast growth rate			4	24	20	8	4				62.67	IV
Less disease-prone			4	20	12	12	12				58.67	V
High return (BCR)			24	12	12	12					68.00	III
Availability of quality seed	4		12			20	20	4			54.67	VII
Low mortality			4			4	16	36			37.33	VIII
High production per unit area	4		12	4	12	4	8	16			56.00	VI
Efficient extension machinery									20	40	13.33	IX
Credit availability									20	40	13.33	IX

Table 3. Farmers' perception of selecting indigenous fish species in Barpeta district

Particulars	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5	Rank 6	Rank 7	Rank 8	Rank 9	Rank 10	RBQ score (%)	Rank
High demand	32	28									95.33	I
High market value	28	32									94.67	II
Fast growth rate			12	20	16	8					62.00	IV
Less disease-prone				4	8	24	12	12			46.67	V
High return (BCR)			36	16	4	4					74.00	III
Availability of quality seeds			4		4	8	28	8	8		41.33	VI
Low mortality				4	4	4	12	32	4		37.33	VII
High production			12	20	12	8		8			62.00	IV
Efficient extension machinery					8			4	44	4	25.33	VIII
Credit availability									4	56	10.67	IX

Table 4. Farmers' perception of the challenges of selecting IF in Nalbari district

Particulars	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R 11	R 12	RBQ score (%)	Rank
Flood	8	12			6	4	2	6	10	6	2	4	57.22	IV
Scientific knowledge		4	12	6	4	6	4	4	2	6	8	4	51.56	VI
Availability of seed	12	8	8	10	2	4	2	2	6	2	2	2	69.50	II
Water seepage				4	4	6	8	6	6	12	14		35.33	XII
Technical support	4	8	6	14	2	4	2	2	4	4	4	6	58.72	III
High capital investment	18	10	10		8	2	2	4	2		4		76.67	I
Feed shortage	2	2	4	4	4	6	4	6	8	6	6	8	42.94	X
Low production			4	4	6	4	10	6	8	4	6	8	41.50	XI
Fish disease	4	4	6	4	8	10	4	6	4	6	2	2	56.28	V
Storage issue	2	2	4	6	6	6	8	6	4	2	4	10	47.83	IX
Labour shortage	4	4	6	4	4	2	10	2	6	6	6	6	49.06	VIII
Transportation	6	6		4	6	6	4	10		6	2	10	49.89	VII

Table 5. Farmers' perception of the challenges of selecting IFS in the Barpeta district

Particulars	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R 11	R 12	RBQ score (%)	Rank
Flood	28		6		2	2	2				6	14	64.44	III
Scientific knowledge	6	18	18	6	2	2	4		4				79.72	II
Availability of seed		2			8	8	10	8	8	8	4	4	41.06	IX
Water seepage			2		2		8	4	2	10	16	16	23.89	XII
Technical support	2	2	10	14	12	10	2				2	6	63.89	IV
High capital investment	24	20	8	2	6								90.83	I
Feed shortage		2	2	2	4	2	12	10	12	4	8	2	41.50	VIII
Low production		4	4	16	10	8	8	6			2	2	62.22	V
Fish disease		4	4	6	4	6		12	8	12	2	2	45.06	VII
Storage issue						8	4	8	8	16	10	6	27.39	XI
Labour shortage			2	4	2	6	6	4	16	4	10	6	36.78	X
Transportation		8	4	10	8	8	4	8	2	6		2	58.22	VI

4. DISCUSSION

Rural development strategies are the various forms of empowerment [5]. Policies should reflect the strengths of public extension, private firms and NGOs to serve the needs of farmers in developing countries [6]. Strengthening thecommunity is needed to make them equals in partnership arrangements [7]. There is a need to upgrade local leadership in terms of culture of enterprise and innovative action [8]. This may facilitate collaboration between the public and private sectors for restoring communities [9]. There is also a need to create synergy between the private sector, cooperatives, and government institutions in reaching out tonew technologies [10]. However, it is also difficult to organize a community [11]. To organize the poor, providing knowledge of the markets through PPCP is important [12]. However, private companies lack presence in many rural areas, though company-community partnership has been initiated in forestry [13].

Precaution on diversification of the local fish fauna is needed for the reasons of prevention of transit of new diseases, parasites and possible effect on the local ecosystem and local gene pool. Integrated aquaculture (in addition to conventional poultry, piggery, rice) with local aquatic vegetation, plants can also offer a solution to conserving many aquatic plants, but it needs standardization of rearing protocol and also economic viability of the species to be cultured. Traditionally practised aquaculture diversification can also uphold local tradition, customs, rituals of these communities in the midst of cultural harmony without harming the aquatic environment [14]. Kim et al. [15] have also shown that aquaculture diversification may have biological value by virtue of species diversification and rotation in ponds to recover from unfavourable changes arising because repeated culture of single species helps in optimal utilization of farms with equitable utilization of the farm space and resources and more efficient way of using available resources. Social benefits that can be derived from diversification in the regions include nutritional input, its cultural importance to folklore, custom and ritual. Economic benefits like creation of alternate commodities, medicine value, risk reduction and chances of reducing diseases are also obtainable from freshwater diversification as stated by Kumar et al. [16].

RBQ methodology is one of the most commonly used tools in fisheries science for prospects and constraint analysis [17,18,19]. In the present study, parameters like high demand with a RBQ score of 95.33% is ranked I, followed by high market value with a RBQ score of 94.67% and a high return (BCR) with a RBQ score of 74.00%, as per the perception of farmers in Barpeta district. On the other hand, particulars like efficient extension machinery and credit availability have the lowest RBQ score of 25.33% and 10.67% respectively and ranks VIII and IX respectively. While in the case of Nalbari district, particulars like high demand with 94.00% RBQ score ranked I, followed by high market value with a RBQ score of 91.33% and a high return (BCR) with a RBQ score of 68.00% as per the perception of farmers. On the other hand, particulars like efficient extension machinery and credit availability have the lowest RBQ score of 13.33%.

Indian major carps, particularly rohu followed by catla and mrigal are the most widely cultured fish species in the country [2]. The prospects of high consumer demand and better market price of Indian major carps [20] has facilitated their widespread culture. Semi-intensive farming of indigenous carps is the most prevalent system of farming in India. Prospect in the form of high return associated with carp culture as demonstrated by Sindhu et al. [21] and it has led to better adoption of this culture technology. Therefore, farmers need to invest every year in introducing composite fish culture(CFC) and it can be maintained in a small pond having a water depth of 1m during the dry session. Small indigenous fish species (SIFS) offers great potential to supplement valued protein and micronutrient for mass rural poor people [22]. Study of the districts has also shown that fishing pressure has increased on indigenous fish species for local and international demand and trade. Technical know-how on these species is limited. There is a poor monitoring and legal framework for reducing destruction of breeding grounds. A support system with science-based knowledge on habitat, food and feeding habits, reproductive biology, larval development for these fishes is required [22,23].

In addition to the prospects, aquaculture of indigenous fishes do come with certain constraints and both these aspects need to be identified for sustaining the growth of the sector. Farmers' and fishers' perception has been used by numerous researchers [18,24,25] to identify

the prospects and constraints associated with different aspects of fisheries and aquaculture to arrive at meaningful conclusions.Vignesh et al. [17] studied the constraints associated with Indian major carp seed farmers of Thanjavur district of Tamil Nadu and reported that farmers encountered a primary constraint of insufficient availability of high-quality carp seeds, with subsequent challenges including a shortage of water supply and the elevated cost of supplementary feed. These various constraints are negatively impacting farmers, hindering their ability to achieve anticipated fish yields and income. Bhattacharjya et al. [19] studied the constraints of extreme climatic events on fish seed production in Assam. They studied the primary challenges faced by fish seed producers in the region due to these extreme climatic events, drawing on field studies conducted in 27 randomly selected fish seed production farms across three districts in the Lower Brahmaputra Valley Zone of Assam, India. Rank Based Quotient values were computed based on the ranks assigned by fish seed producers to prioritize the identified constraints. During the studied period, it is seen that RBQ stands by 69.50 and seeds of indigenous fish species is acting as a major constrain in culture practice. Study of Barat et al. [26] has revealed that there are lower genetic diversity and significant genetic differentiation among magur (*Clarias magur*) population. Such studies for other ichthyospecies are important for management and conservation purposes, as populations are dwindling day to day due to habitat degradation, over exploitation, indiscriminate use of agricultural pesticides and introduction of competitor exotic species and packages of practice are yet to the reach of small and marginal farmers. Mashahary et al. [27] studied the fish diversity status in Kokrajhar,an adjacent district of the study area in Assam state, India where it was found that 5,3,and 1 species are near threatened, vulnerable and endangeredrespectively, as per the IUCN Red list database and opined for urgent need of sustainable development of fisheries and aquaculture as demand of these locally captured fisheries are high in the area and possibility of extinction is high.

Floods caused by overflow of the Brahmaputra and its tributaries, happen to be an age-old problem in the state of Assam. Flood during monsoons, causes havoc among fish farmers as it results in the escapement of fishes from their confinements and leads to severe economic losses and is a major hurdle against successful fish farming in the state [28]. In the study and rest of the Assam state, floods are characterized by their substantial magnitude, frequent occurrences, and widespread devastation, particularly during the monsoon season. A study conducted by Hoilenting & Sharma [29] examined the economic losses in fisheries due to floods that occurred in 2017. They found that the fishery sector suffered direct losses, including fish loss, damage to pond dykes and embankments, stock damages, and more, due to flooding and associated water inundation in ponds and fish farms. On average, ₹55,461 (60%) of the losses were incurred in fish, followed by damages or losses in pond dykes or embankments, amounting to ₹20,908 (22.64%) in a one-acre pond. Constraints associated with drought-like situations ranged from relatively less significant issues like 'low milt production of male brood fishes' with the lowest value (12.5) to the overarching constraint of 'inadequate water depth in fish ponds' during pre-monsoon and prolonged dry spells (RBQ=100.0).

In both the districts, high capital investment is the major constraint facing fish farmers. High input costs, particularly feed, which alone constitutes around 60% of the total production (operational) cost in aquaculture systems [30] is one of the major factors behind high capital investment. Further, in terms of fixed or capital costs, new pond construction requires very high investments, leading to high capital investments. Lack of quality seed is one of the major factors affecting the fisheries and aquaculture sector of the country in general and Assam in particular. The production of high-quality fish seeds, particularly for carps, is crucial as carp culture constitutes a cornerstone in Indian aquaculture. Regrettably, the absence of genetic enhancement has led to the generation that is not bold/of sub standard quality seeds in numerous fish hatcheries of the countries [31]. Poor extension machinery is another major constraint commonly faced by farmers. A study conducted among fish farmers of Khowai district, Tripura reflected the existence of poor extension machinery. The results of the Rank Based Quotient (RBQ), supported by additional inquiries, indicated that the extension machinery suffered from inefficient implementation, delayed departmental proceedings, and lack of timeliness in providing inputs [18]. Khanal et al. [32] in their study on two districts of Nepal revealed climate change, technical constraints like disease outbreaks, undesirable quality of seeds (i.e. fry,

hatchlings, and fingerlings), water temperature fluctuations, high cost inputs(i.e. feeds, seeds, and other accessories), lack of storage facilities, improper government regulation and market management; diversified socio-economic and consumer behaviour, small-sized farm holding by majority of the farmers, price fluctuations, improper knowledge of fish cultivation among fish farmers etc. are some of the constraints faced by the fish farmers. Modern aquaculture technology will eventually check the price drop and will enhance variability for consumers. The lack of an adequate cold chain and distribution system for fish as a perishable product affects availability and marketing.

Lack of knowledge on scientific fish farming, which is an indirect reflection of poor extension mechanism, is a major constraint on the growth of fisheries and aquaculture sector of the country. Knowledge constitutes a fundamental aspect of an individual's behavior, and a profound understanding of scientific fish culture plays a pivotal role in embracing technological advancements in the field, which influences fish production. Goswami & Samajdar [33] reported that the majority of fish farmers (50.8%) in Dakshin Dinajpur district, West Bengal, one of the leading fish producing states of the country, exhibited a moderate level of knowledge concerning scientific fish culture practices. The adoption behaviour of composite fish culture practices was studied by Goswami et al. [34] and established that it is positively influenced by factors like extension participation, economic motivation, scientific orientation and knowledge of fish farmers, and negatively by their age. The study recommended that efforts should be made by extension agencies through their various programmes to highlight the economic benefits of composite fish farming to promote large-scale adoption of this technology. They opined that study tours, exposure visits, participation in fairs and exhibitions could be the ideal methods for promoting adoption of composite fish culture.

Perception of farmers is also an important factor in determining the growth of aquaculture in a given area. In this context, Shackleton et al. [35] conceptualized 6 dimensional aspects for synthesizing and understanding the main factors that influence people's perception, which shall be helpful in guiding research goals, facilitating dialogue, negotiation, policy formulation and governance. Feed shortage is ranked as X and VIII in the perceived constrains for using different indigenous species. Rola & Hasan [36] reported that traditional farmers can easily recognize the importance of commercial feeding, though its high cost per unit and limited technical know-how discourage them frompurchasing this type of feed while effective disease control, better farm management and improved quality fry may act as enabling factors for positive attitude. It is observed that easy access to capital, capacity building mechanisms for fish farmers and action-oriented research are prerequisites for better use of commercial feed and increased stocks on the farm land. The Haribhanga wetlands in Assam have seen an improvement in fish production and productivity as a direct result of the implementation of CIFRI technology [37], which also helped to increase the household income of fishermen and the security of their means of subsistence.

5. CONCLUSION

Policy framework and extension work for bringing this under need-based culture system to marginal and small farmers,as double cropping pattern to reduce risk factors, enhancing food security, sound economic return and employment is the need of the hour. To take advantage of economies of scale, small farmers need to be organized into associations, or “clusters” (FAO, 2010). The unified goal for fishers and fish farmers is to organize the primary stakeholders. Accordingly, there is a need to focus on community organizations for fishers as well as for fish farmers. They may be further empowered to choose the input and marketing agents as per their preferences. This may be further facilitated to develop partnerships with public and private organizations for better livelihood and environmental security. Such a framework for developing PPCP is envisaged by integrating stakeholders to sustain resources and livelihood.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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