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Analysing Farmers' Perceptions of Genetically Improved G3 Rohu (*Labeo rohita*) Fish Culture in Mymensingh District, Bangladesh

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HIGHLIGHTS

- The majority of fish farmers (74.3%) had favourable and 25.7% had highly favourable perceptions toward G3 rohu culture.
- Farm size, rohu culture area, organisational participation, and extension media contact positively influenced farmers' perception.
- Household size and social mobility negatively affected perception, highlighting the need for targeted extension support.

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ABSTRACT

Growing G3 rohu (*Labeo rohita*) fish can improve nutritional stability, raise farmer incomes, boost productivity, and promote sustainable aquaculture. The study evaluated fish farmers' perceptions of G3 Rohu culture and identified the socio-economic and contextual factors influencing these perceptions. A pre-tested structured interview was conducted with 105 fish farmers, representing 50% of the total, in the Phulpur sub-district of Mymensingh district, Bangladesh, between February and May 2023. A 5-point Likert scale with 12 statements (six positive and six negative) was used to measure perceptions. Data analysis included both descriptive and inferential statistics. Results revealed that 74.3% of farmers had a favourable perception, while 25.7% reported a highly favourable perception; no respondents indicated unfavourable views. Regression analysis revealed that, among the twelve independent variables, area under fish culture, area under Rohu fish culture, organisational participation, and extension media contact significantly and positively influenced farmers' perception levels of G3 Rohu fish culture. Conversely, household size and social mobility showed negative effects. Furthermore, it is recommended that increasing organisational participation and extension services, while addressing socioeconomic hurdles, can support the widespread adoption of G3 Rohu breeds for long-term aquaculture flourishing in Bangladesh.

INTRODUCTION

In Bangladesh, the fisheries sector is crucial for economic development, contributing 2.53% to the national GDP and 22.26% to agricultural GDP, with a growth rate of 2.81% (BBS, 2024). This sector is vital for the livelihoods of over 20 million people, including 1.4 million women, who rely on it both directly and indirectly. In the fiscal year 2022-2023, fish production reached 4.92 million metric tons, contributing to an increase in per capita fish consumption to 67.8 grams per day (BBS, 2024). Bangladesh has earned global recognition as the second-largest producer of freshwater fish and the fifth-largest producer of closed-water fish farming (FAO, 2024). Among cultured species, Rohu (*Labeo rohita*) stands out as a significant freshwater carp, prized for its nutritional

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value and high consumer demand (Mehar et al., 2022). Nonetheless, traditional strains of Rohu sourced from rivers or commercial systems show considerable drawbacks, such as slow growth rates, vulnerability to diseases, and inefficient feed conversion. These limitations prolong production cycles and elevate farming costs (Mishra et al., 2017). To address these issues, significant attention has been directed towards the genetic improvement of aquaculture species, especially via selective breeding and strain improvement (Momin et al., 2024; Rej et al., 2025). In 2020 and 2021, WorldFish released Genetically Improved G3 Rohu is a major breakthrough in this field (Yeasin et al., 2022). Under local agricultural conditions, this strain, the product of selective breeding efforts, has shown the capacity to grow up to 30% quicker than standard strains (Yeasin et al., 2022). Additionally, it boasts superior feed conversion efficiency, higher survival rates, and enhanced resistance to diseases (Hamilton et al., 2022). These attributes position G3 Rohu as a promising solution for enhancing farm profitability and sustainability while addressing the increasing consumer demand for fish protein.

Despite the documented biological and economic advantages of G3 Rohu, the successful diffusion of this innovation hinges on the acceptance, awareness, and willingness of farmers to adopt it. Previous research in aquaculture has highlighted that farmers' awareness, socio-economic dynamics, and institutional backing significantly influence technology adoption (Mehar et al., 2022; Ataei et al., 2021). Nevertheless, empirical insights regarding the perceptions of Bangladeshi farmers toward G3 Rohu cultivation remain scarce. Understanding these perceptions is crucial, as technology adoption transcends mere technical considerations, encompassing behavioral and socio-economic factors as well.

The aim of this study is to ascertain the socioeconomic and contextual factors that influence fish farmers' perceptions of G3 Rohu culture. The insights derived from this research will provide valuable information for policymakers, researchers, and extension agencies, facilitating the design of effective strategies to promote the wider adoption of genetically improved fish strains. Ultimately, this will contribute to enhanced aquaculture productivity and improved livelihoods for farmers in Bangladesh.

METHODOLOGY

The study was conducted in Phulpur Upazila of Mymensingh district, located in north-eastern Bangladesh, between February and May 2023. This area was purposively selected due to its prominence in aquaculture, particularly the recent expansion of Rohu (*Labeo rohita*) culture, as noted by local fisheries officers, making it an appropriate site for examining farmers' perceptions of Genetically Improved G3 Rohu.

The study population comprised all fish farmers who had experience with, or awareness of G3 Rohu culture. The help from local hatchery holders, the Upazila Fisheries Officer (UFO), and the local extension agent for fisheries (LEAF), a list of 210 growers was compiled. Fifty percent of farmers were randomly selected, following Cochran's guideline for large populations, resulting in a sample of 105 farmers (Cochran, 1977). The questionnaire and perspective statements were designed and improved after three focus group discussions (FGDs) and three key informant interviews (KIIs) with model fish farmers were carried out to uncover contextual factors. Finally, the fish farmers were interviewed in person using a pre-tested structured questionnaire.

Using the developed questionnaire, twelve socioeconomic and personal traits of farmers were measured as independent variables. A 5-point Likert scale with 12 statements, six positive and six negative, was used to evaluate perception. Response options ranged from 'strongly agree' (5) to 'strongly disagree' (1) for positive statements, with reverse scoring applied for negative statements (Podder et al., 2022; Shubham et al., 2022; Smrity et al., 2020). Each respondent's total perception score, obtained by summing scores across all statements, could range from 12 to 60.

On the other hand, the perception score for each statement was calculated by using the perception score (PS), and it was calculated by using the following formula (Smrity et al., 2020):

$$PS = P_{SA}\,x5 + P_{A}\,x4 + P_{NO}\,x3 + P_{DA}\,x2 + P_{SDA}\,x1$$

Where, PSA is the total number of responders who strongly agreed with the statement, PA is the total number of responders who concurred with the argument, PNO is the total number of responders who were undecided about the statement, PDA is the total number of responders who didn't agree with the statement, PSDA is the total number of responders who disagreed strongly with the statement. Comparably, the negative statements received the opposite score.

Finally, linear multiple regression analysis was performed to identify influential factors affecting fish farmers' perception of G3 rohu fish cultivation. A software program called SPSS (Statistical Package for the Social Sciences) was used to code, tabulate, and analyse the findings from the research.

RESULTS

Personal and socio-economic aspects of the fish farmers

Table 1 summarizes the socioeconomic attributes of fish growers. Most farmers (41.0%) are middle-aged (36–55 years), and 40.0% have only primary-level education (1–5 years). A majority (61.9%) live in medium-sized households with 5–7 members.

In terms of farm size, 81.0% operate medium-sized farms (1.01–3.00 ha), and over half (61.0%) have more than 22 years of fish farming experience. Regarding income, 59.0% belong to the medium-income group (Tk. 400,000–1,000,000). Organizational participation is low (87.6%), with 50.5% having received only 1–2 days of training. Nearly half (48.6%) have limited access to credit (up to Tk. 100,000), while 88.6% report medium contact with extension media, and 52.4% show medium social mobility.

Table 2 shows that the perception level of farmers towards G3 Rohu fish culture ranged from unfavourable to highly favourable. Farmers' perceptions of G3 Rohu fish culture ranged from favourable (74.3%) to highly favourable (25.7%), with none reporting an unfavourable opinion. Shanmuka et al. (2022) found that half of the extension (52%) workers had an unbiased perception about using social media to look for agricultural knowledge. Additionally, the results are consistent with the findings presented by Sajeev and Joshy (2024) and Podder et al. (2022).

Table 1. Personal and socio-economic features of the fish farmers

Features of farmers	Categories	Percent	Mean	SD
Age (Actual year)	Middle (36-55)	41.0	46.75	12.65
Level of education (Actual year)	Primary (1-5)	40.0	5.21	3.74
Household size (Number)	Medium (5-7)	61.9	6.05	1.89
Area under fish farming (Hectare)	Medium (1.01-3.0)	81.0	1.65	0.74
Fish farming experience (Year)	High (above 22)	61.0	20.10	8.44
Annual family income ('000' Taka)	Medium (400-1000)	59.0	633.15	282.5
Organizational participation (Scores)	Low (up to 10)	87.6	4.21	3.61
Training exposure in fish farming (Days)	Short duration (1-2)	50.5	1.83	1.54
Credit received ('000' Taka)	Low (up to 100)	48.6	83.81	75.16
Extension media contact (Scores)	Medium (15-28)	88.6	19.91	4.87
Social mobility (Scores)	Medium (11-20)	52.4	6.99	3.23

SD = Standard Deviation

Table 2. Distribution of respondents according to their perception of G3 Rohu fish culture

Categories	Number	Percent	Mean	SD
Unfavorable (12-28)	0	0		
Favorable (29-44)	78	74.3	44.43	3.30
Highly favorable (45-60)	27	25.7		
Total	105	100		

Rank order of the fish farmers' perception of G3 Rohu fish culture

Based on the perception score (PS), Table 3 evaluates fish farmers' perceptions of G3 Rohu culture, reflecting both good and negative views. According to the top-ranked statement, G3 Rohu has lower death rates and requires fewer medicines due to its resistance to common diseases. Farmers report it grows faster than traditional Rohu, reaching marketable size in 6 to 8 months, and adapts well to changes in water conditions. As a result, farmers trust this strain to be strong and profitable.

The bottom three ranked statements reveal key issues regarding G3 Rohu. Farmers note that its cultivation requires advanced techniques, like pond management, which may be challenging for smallholders. Additionally, concerns about the high cost of fingerlings and consumer hesitancy around genetic manipulation pose significant obstacles. Overall, while farmers recognize the biological and economic benefits of G3 Rohu, they remain worried about practical implementation and market acceptance.

Factors influencing farmers' perceptions of G3 Rohu culture

Based on the data in Table 4, the R value was 0.873 and R^2 was 0.763, with an F-value of 24.643 that was statistically significant at the 0.1% level. The multicollinearity analysis, using the Variance Inflation Factor (VIF), showed maximum and minimum VIF values of 7.270 and 1.254, respectively. According to Shrestha (1983), VIFs between 1 and 5 suggest moderate correlation among variables, 5 to 10 indicate non-severe multicollinearity, and values above 10 point to severe

Table 3. Rank order of the fish farmers' perception of G3 Rohu culture

Statements	No. of Respondents					PS	RO
	SA	A	NO	DA	SD		
G3 Rohu exhibits improved resistance to common diseases and infections, leading to lower mortality rates and reduced reliance on medication. (+)	51	54	0	0	0	471	1
G3 Rohu exhibits enhanced adaptability to fluctuating water conditions, such as tolerating lower oxygen levels, wider temperature variations, and even slightly acidic or alkaline water. (+)	45	60	0	0	0	465	2
The genetically improved G3 Rohu grows faster than traditional Rohu, reaching 1 kg in just 6-8 months under optimal conditions instead of 10-12 months, enabling more fish to reach harvest size more quickly. (+)	44	61	0	0	0	464	3
The Genetically Improved G3 Rohu strain exhibits a lower mortality rate than traditional local Rohu varieties	35	70	0	0	0	455	4
G3 Rohu requires less feed to attain the same weight as traditional Rohu, reducing feed costs and enhancing farming profitability. (+)	32	73	0	0	0	452	5
G3 Rohu has better meat texture and taste, making the fish more desirable for consumers and increasing market value. (+)	19	86	0	0	0	439	6
For G3 production, fish farmers must rely on specific hatcheries for quality fingerlings. (-)	10	76	2	17	0	394	7
G3 Rohu fingerlings may be in short supply, especially in remote areas. (-)	6	50	7	42	0	335	8
Fish farmers may face difficulty getting a premium price if buyers do not recognize the strain's value.	1	59	4	41	0	335	9
The higher cost of G3 Rohu fingerlings increases the investment for farming. (-)	0	55	0	50	0	320	10
Consumers are hesitant to embrace G3 Rohu fish because of concerns about genetic modification. (-)	1	25	8	71	0	359	11
G3 Rohu requires more specific or advanced farming practices, such as feeding strategies, monitoring systems, or more sophisticated pond management, compared to traditional Rohu. (-)	0	22	10	73	0	366	12

SA = strongly agree, A = agree, NO = no opinion, DA = disagree, SD = strongly disagree, RO = rank order

Table 4. Summary of multiple linear regression analysis explaining farmers' perceptions of G3 Rohu culture

Variables	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
(Constant)	36.555	1.964		18.612	.000		
Age	-0.034	0.064	-0.132	-0.535	0.594	0.343	3.425
Level of Education	0.072	0.069	0.082	1.047	0.298	0.420	2.378
Household size	-1.058	0.160	-0.608	-6.590	0.000	0.303	3.300
Fish farming experience	0.162	0.083	0.413	1.959	0.053	0.158	7.270
Area under fish culture	1.494	0.745	0.336	2.006	0.048	0.192	2.862
Area under rohu fish culture	1.087	1.310	0.671	8.466	0.000	0.411	2.435
Annual family income	-0.005	0.003	-0.363	-1.963	0.053	0.875	1.293
Credit received	0.000	0.003	-0.007	-0.108	0.914	0.569	1.756
Training exposure in fish culture	0.088	0.152	0.041	0.579	0.564	0.514	1.944
Organizational participation	0.267	0.053	0.292	5.034	0.000	0.767	1.304
Social mobility	-0.318	0.107	-0.312	-2.981	0.004	0.236	4.241
Extension media contact	0.373	0.039	0.550	9.679	0.000	0.798	1.254

N = 105, R = 0.873, R^2 = 0.763, Adjusted R^2 = 0.732, F-value = 24.643

multicollinearity. Hence, no severe multicollinearity was identified in the model.

The results of the multiple linear regression analysis showed that the following twelve independent variables, area under fish culture, area under Rohu culture, organizational participation, and extension media contact, had a positive and significant impact on farmers' perceptions of G3 Rohu culture. However, there were negative effects on household size and social mobility.

DISCUSSION

The findings of this study reveal that farmers in Mymensingh generally hold highly favorable perceptions of G3 Rohu culture, with none reporting unfavorable views. This widespread acceptance underscores the recognition of G3 Rohu's biological and economic advantages, including higher disease resistance, faster growth, and adaptability to diverse water conditions. These findings are in line with earlier studies that demonstrated positive farmer attitudes toward innovative agricultural and aquaculture practices (Smrity et al., 2020). The rank order analysis further highlights the primary drivers of positive perceptions. Farmers identified disease resistance and reduced input costs as the most important advantages, consistent with the economic rationale for adopting improved strains. Similarly, faster growth and better adaptability to environmental fluctuations were strongly valued, reflecting the high production risks fish farmers typically face. These advantages build confidence in the strain's profitability and resilience, encouraging adoption.

However, concerns about the higher cost of fingerlings, reliance on specific hatcheries, and the need for advanced management practices suggest barriers to scaling adoption, particularly for smallholders with limited resources. Such reservations are consistent with broader evidence that technological innovations often face challenges of affordability, accessibility, and consumer acceptance (Podder et al., 2022; Shanmuka et al., 2022). The results of the multiple linear regression analysis show that fish farmers' opinions about G3 Rohu farming are greatly influenced by a number of important parameters. Notably, household size has a negative relationship with perception levels, suggesting that larger households face heightened financial and resource constraints. This limitation likely restricts their capacity to invest in or explore new technologies like the G3 Rohu culture (Riley, 2024). Similar conclusions have been drawn by Hoque et al. (2022) and Islam and Sarker (2024), highlighting the significant connection between household size and farmers' attitudes towards aquaculture innovations.

Conversely, the area dedicated to fish culture exhibits a significant positive relationship with perception. Farmers who allocate larger areas for fish farming tend to have more favorable views of G3 Rohu, possibly due to increased resource availability and an openness to adopting innovations that improve productivity (Giller et al., 2021). This finding is supported by Ramos et al. (2015) and Kumar et al. (2018). Additionally, organizational participation positively impacts perception. Farmers involved in cooperatives or community groups typically demonstrate higher awareness and more favorable views of G3 Rohu culture. Such engagement provides access to training and peer learning opportunities (Valleala et al., 2015).

Lastly, extension media contact has a significant and positive correlation with perception levels. Farmers with regular interactions with extension services gain enhanced technical understanding and awareness of the G3 Rohu culture. Extension services are crucial for providing timely information and guidance, thus encouraging improved fish variety adoption (Norton & Alwang, 2020; Jarh et al., 2024). Overall, these findings underscore the importance of household dynamics, resource allocation, community involvement, and extension services in shaping perceptions towards aquaculture practices.

CONCLUSION

A major cultivated species in Bangladesh is the Rohu, and the fishing industry is vital to the economy and food security of the country. However, traditional strains face growth and disease limitations, prompting the introduction of genetically improved G3 Rohu. This study finds that all surveyed fish farmers hold a

favorable perception of G3 Rohu, driven by its faster growth, improved disease resistance, and adaptability to diverse water conditions. As per regression results, household size, fish culture area, organisational membership, mobility in society, and extension media interaction all have a substantial influence on these perceptions. Positive experiences and access to technical knowledge, particularly through extension services and farmer organisations, strengthen adoption potential. These results highlight that targeted training, strengthening farmer networks, and expanding extension outreach can accelerate the uptake of G3 Rohu. Encouraging this superior strain could increase farm profitability, lower production risks, and support the long-term growth of the aquaculture industry in Bangladesh.

DECLARATIONS

Ethics approval and informed consent: Informed consent was sought from the respondents for the study.

Competing interest: The Authors have no competing interests.

Conflict of interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The authors declare that during the preparation of this work, they thoroughly reviewed, revised, and edited the content as needed. The authors take full responsibility for the final content of this publication.

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