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Original Research Article



Women's participation in the aquaculture sector and its socio-economic impacts in Sadar Union of Badalgachi Upazila, Naogaon, Bangladesh

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ABSTRACT

The aim of this study was to explore women's involvement in aquaculture activities and their role in family economy, decision-making, and food security in Sadar Union of Badalgachi Upazila, Naogaon, Bangladesh. Data were collected through face-to-face interviews with 51 women (out of approximately 200 fish-culturist families) using a pretested structured questionnaire through KoBo Toolbox. The data was analyzed descriptively in MS EXCEL. The findings showed that most of the respondents were housewives (62.74%) and had less than secondary education (54.91%). Nearly 68.62% of women were actively engaged in pond monitoring, feeding, and fertilizing, and 31.38% were not, mainly due to lack of knowledge or training (81.25%). Despite their labor, they were not involved in important decision-making, including species selection, stocking, and marketing, which were taken by the male members of the family. While 60-62.5% of women received a small profit, 64.86% were unable to spend the money independently; still, 88.23% were tried to save for their future family needs. Women's involvement also contributed to diversified household nutrition, with average fish consumption of 333.55g/person/week, and partly through integrated farming (fish-vegetable) by 37.25% of the respondents. The findings suggest that women are not just occasional laborers but also an unpaid and unacknowledged second labor force, who play an essential role in the income, food security, and household resilience. The invisible role of women can be converted into economic empowerment by providing targeted training, supportive policies, and improving local infrastructure for the benefit of the households and the aquaculture industry in rural Bangladesh.

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INTRODUCTION

Despite accounting for almost half of the fisheries and aquaculture workforce worldwide, women's engagement in fisheries is still underrepresented in official statistics, and their voices are not heard in policies and decision-making processes that impact their households (Gopal *et al.*, 2020; Chambon *et al.*, 2023). This disparity between contribution and recognition is particularly high in small-scale pond culture systems in rural areas of Bangladesh, where the work of women is not recognized as productive but as a part of household activities. Globally, women are engaged in almost all parts of the aquaculture value chain, ranging from stock acquisition, pond preparation, feed-

ing the fish, processing, and local marketing and trade, but their involvement is concentrated in the unpaid, homestead-based activities, influenced by gender norms, physical restrictions, and assumptions about strength (Adam *et al.*, 2024; Njogu *et al.*, 2024). Despite women's overall positive attitude towards aquaculture as a livelihood, the gender gap remains a major restriction to their full participation in aquaculture (St. Louis & Oliveira, 2022). In the few cases where women in aquaculture have been examined in detail, they are often overlooked, undervalued, and sometimes are linked to harassment and gender-based violence, not addressed by fisheries governance (Mangubhai *et al.*, 2023; Elias *et al.*, 2024). Gender norms dictate that men take responsibility for larger value, market-

oriented activities, while women are engaged in lower profile production tasks, even in situations where their role and responsibilities in a household fishing enterprise are described as complementary (Adam *et al.*, 2025a).

Bangladesh has become one of the leading drivers of global fish production, yielding 49.15 lakh metric tons in FY 2023–24, ranking 5th in aquaculture production and 3rd in inland open-water production (DoF, 2023). Despite this growth, women's contribution in the labor market in Bangladesh is much less visible than men's, with the participation rate of labor force for women being 36.3% compared to 80.5% for men (BBS, 2022), although there is a marginal increase in the measured participation of women rural setting relative to urban setting, and rural women's work is more likely to be integrated into family farming and off-farm activities (Islam *et al.*, 2017; Bidisha *et al.*, 2022). The national statistics show that women account for 28% of the main labor force in aquaculture, 50% of pre- and post-harvest value chain activities, and 18% of the fisheries workers overall (FAO, 2022). In Bangladesh's aquaculture value chain, women's involvement in fish farming, feed preparation, and guarding ponds is relatively high, while their role in water quality management, pond preparation, disease monitoring, and marketing is limited, and their work is mostly family-based and unpaid compared to hired labor (Njogu *et al.*, 2024). The amount and nature of such participation are important not only at the household level but also at the community level. Greater participation of women in fish culture can increase the fish production, household fish consumption, food security, and create income-generating opportunities that can help reduce poverty and promote gender equality and economic empowerment (Kruijssen *et al.*, 2017; Njogu *et al.*, 2024). Besides, when women's work in the sector is not recognized in policy, and they are not trained, given credit, or given market access, the sector may be failing to make use of a large share of its own workforce and risking the food-security benefits it is supposed to bring.

Badalgachi Upazila in Naogaon district is a well-known fish-producing area, where both men and women are engaged in this sector. But no published study has been found that reports on the extent, nature, and socio-economic impacts of women's involvement in fish production at the union level in this locality. The existing literature on women-empowerment in aquaculture in Bangladesh has focused on the northwest divisions of Rangpur and Rajshahi, and on samples at the national or project level (Njogu *et al.*, 2024; Adam *et al.*, 2025a), and the Naogaon division has been studied primarily using project baseline surveys, not union-level household data (Adam *et al.*, 2025b). This means that there is limited local evidence regarding the impact of women's involvement in a specific upazila's aquaculture sector on the household level in terms of income use, decision making, and food security, which is needed before targeted interventions can be developed for this area and not extrapolated from national averages. This study was thus undertaken to assess the nature and extent of women's engagement in aquaculture-related activities in Sadar Union of Badalgachi Upazila, and how this involvement affects the household's socio-economic situation, including income utilization, decision-making, and food security.

MATERIALS AND METHODS

Study area

The study was conducted in the Sadar Union of Badalgachi Upazila, Naogaon district, Bangladesh (Figure 1).

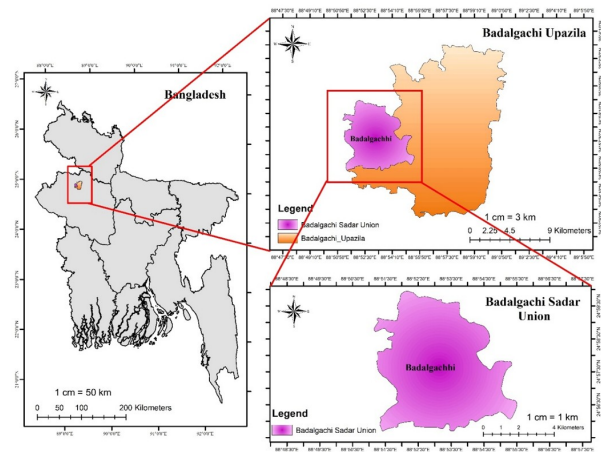


Figure 1. Map of the study area.

Sampling procedure

The sampling frame was about 200 households of fish-culturists. To select 51 respondents from this frame, simple random sampling was used, a widely used technique to select a representative sample from a defined sampling frame (Rana *et al.*, 2019).

Research instrument development

Questionnaire design

A closed-ended, structured questionnaire, widely adopted in household socio-economic surveys to reduce measurement error and standardize data collection using interviews, was the primary data collection tool (Rahman *et al.*, 2019).

Pre-testing and refinement

The designed questionnaire was pretested with 6 fishing households outside the main study villages but within the same upazila before the primary survey. This enabled us to evaluate the clarity of the questions, including correcting grammar, removing repetition, clarifying ambiguous questions, making them culturally relevant, and removing irrelevant questions (Ranganathan *et al.*, 2024). These pretested data were not counted in the final outcome. The final questionnaire was then designed in KoBoToolbox for digital use.

Language and administration

The English version questionnaire was translated into Bangla (Bengali) by the enumerator. All the interviews were done in Bengali by the enumerator. Respondents were asked to answer the questions, and when they needed clarification on any issues, it was done using standardized probing language, rather than a leading response.

Data collection procedure

Digital data collection platform

Data were collected using KoBoToolbox to reduce paper usage, double entry, and data-entry errors, and to improve field survey efficiency (Dizon *et al.*, 2022; Aryal *et al.*, 2023).

Field data collection protocol

The respondents were questioned face-to-face using the questionnaire to get insight into the difficulties faced by the female labor force, their socio-economic status, production methods, their knowledge of fish culture and related problems, and their social status in the community.

Inclusion-exclusion criteria

The respondents were those aged eighteen (18) years or older who owned a fish pond or engaged in any aquaculture activity and who gave voluntary informed consent. The respondents who were not directly or indirectly involved in any fish culture or aquaculture activity, or were not available or unwilling to participate in the interview process, or were incapable or absent during the survey period, were excluded.

Data analysis

After the field data collection was done, the raw data were downloaded from KoBoToolbox to Microsoft Excel (.xlsx) for processing and analysis (Aryal *et al.*, 2023). To ensure data integrity and accuracy, the data were systematically cleaned in multiple stages, such as identifying missing values, detecting outliers, performing consistency checks, and screening for duplicate entries, prior to analysis. The data were verified, coded, and translated to international units for data comparability and consistency, tabulated, and analyzed descriptively using MS Excel (Yamwembo, 2026) to determine the key findings on women's involvement in the aquaculture sector.

Ethical consent

All respondents gave informed verbal permission after explaining the study's purpose, its voluntary nature, and the confidentiality of their responses.

RESULTS AND DISCUSSION

Demographic information of the participants

The ages of all the respondents ranged from 20 to 60. Most of the participants (33.33%) were 31-40 years old, with the next highest group (29.41%) being 41-50 years old, with 15.69% of the participants being 51-60 years old, and 21.57% being 20-30 years old. So, most working women in this study were between 31 and 50 years old (62.74%). This age distribution is consistent with Mengo *et al.* (2023) and Olaniyi *et al.* (2025), who similarly found that most woman workers in aquaculture fell in the 31-50 and 31-40 age groups, respectively, in their study; a likely explanation is that women in this age range are past the heaviest years of young child-rearing yet still they are capable of performing the regular, hands-on pond work required by aquaculture. The study revealed that 98.04% of the respondents were housewives, while 1.96% were students. The majority (54.91%) had education below the secondary level (mainly classes 5 to 8), 19.61% had primary-level education,

13.72% had completed secondary level, and 11.76% had no institutional education, but could sign their own names. This is similar to what Adam *et al.* (2025b) also found: most of the respondents they surveyed were below the primary or secondary school level, which is likely to be related to the phenomenon of early marriage and domestic duties (Laksono *et al.*, 2021), which limit girls' education and their full participation in aquaculture in rural fish-farming communities. Most of the respondents' families earn their primary livelihoods from agriculture and aquaculture, with 69% of participating families making a living entirely from aquaculture; 25% of families depend on both aquaculture and agriculture, and about 6% depend on aquaculture and other activities like tailoring, auto-rickshaw driving, day labor, or grocery shop. A majority of participants (52.94%) were categorized as poor, and 29.42% of participants were categorized as lower-middle class, 11.76% of participants were categorized as middle class, and 5.88% of participants were categorized as higher-middle class by well-being status. This high concentration of poverty is reflected in the nature of women's roles in aquaculture, as described below: they are limited, informal, and largely unpaid, which limits the income women can earn from their work, even when they do much of it.

Women's participation in the aquaculture sector

The study revealed that 68.62% of the respondents are involved in various activities related to aquaculture in the study area, such as regular monitoring, feeding, weeding, fertilizing, and observing the fish growth, behavior, and water conditions, whereas 31.38% of the women who have ponds are not involved in fish culture or aquaculture-related activities (Table 1). The primary reasons cited by non-involved were that there was enough manpower elsewhere in the household (18.75%) and that they were not knowledgeable or trained (81.25%), suggesting that the limiting factor for wider involvement is not willingness, but lack of knowledge or training. In this study, 64.71% of engaged women have knowledge of fish culture, and 43.14% have been trained (Figure 2). The major culture systems they participate in are mixed carp culture (34.28%), catfish culture (22.85%), pangus monoculture (5.71%), and carp-pangus mixed culture (37.14%). Even with this level of involvement, these women are not engaged in decision-making on species selection, stocking rate and density, harvesting, or market selling, and never directly involved in profit-management decisions. These decisions are usually made by the husband, the eldest son, or other male family members of the household.

Table 1. Among all of the respondents, the women's participation rate in fish culture.

Participation Status	Percentage (%)	Mode	Percentage (%)
Active	68.62	Regular	77.14
		Irregular	22.86
No Participation	31.38	-	-

From this, it can be concluded that the aquaculture activities of women in the study area are not regarded as a contribution to the household's profit-making activities but rather as support for the male members of the household. The same trend is evident in fish marketing, where women are rarely involved beyond the farm gate, in part due to social norms that constrain women's mobility (Njogu *et al.*, 2024). This constraint is even stronger at the local level; in Naogaon Sadar, some women

are involved in fish cutting as a livelihood activity at the local market, but this is not observed in the study union at all. Similarly, women's participation in fish feed and aqua-medicine dealership, fish product or value-added product business, and technical support services is not observed, as 92.15% of the respondents felt that these activities are mainly for men. These local patterns reflect the results of other parts of Bangladesh. Nationally, women are more engaged in feed

preparation (72%), feeding (66%), and guarding ponds (47%), and only about 10% in water quality management, pond excavation, disease checking, and fish marketing (Njogu *et al.*, 2024). Similarly, Chakma & Ruba (2021) reported that women's activities in rural Bangladesh, including pond drying, feeding, feed preparation, fertilization, liming, pond supervision, fry release, stocking, and pond medication, are carried out by women. These findings collectively illustrate the overall picture of women's involvement in the aquaculture value chain in Bangladesh, where women are engaged in nearly all value chain activities but are more likely to be engaged in specific activities influenced by gender norms, assumptions about physical strength, and domestic responsibilities.

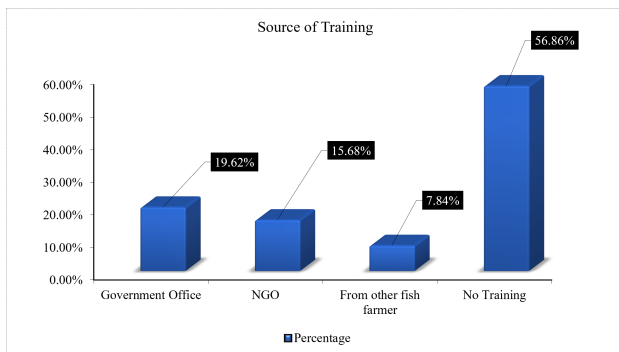


Figure 2. Source of training about fish culture.

In line with the present findings, women's involvement in aquaculture in the country is generally low, and they are engaged as unpaid family laborers rather than paid laborers (Njogu *et al.*, 2024). This is consistent with the fact that women's involvement in aquaculture is largely confined to the homestead due to limited mobility, which constrains their access to training, markets, and off-farm aquaculture activities (Choudhury *et al.*, 2025). As stated by Choudhury *et al.* (2025), in Bangladesh, aquaculture is considered a male-dominated sector, yet women's participation remains considerable, a finding that conforms to the present study. This pattern is a part of an ongoing pattern of unrecognized phenomena found in the wider literature. Women's roles in fisheries have been reported as under-recognized, under-researched, and male-dominated (Kusakabe & Thongprasert, 2022), and recent research on gender-based violence in fisheries governance has also indicated the lack of recognition of women's full range of roles and vulnerabilities (Mangubhai *et al.*, 2023). Gender based restrictions on women's roles have also been observed outside Bangladesh as well. In fishing and farming communities, men and women are typically assigned complementary but unequal roles shaped by prevailing gender norms (Adam *et al.*, 2024; Mohamed *et al.*, 2026). A recent study of the aquaculture value chain in Nigeria confirms that these gender norms continue to contribute to significant gender inequalities in asset value, wages, and profits, despite the relatively high participation of women in household-level decision-making (Adam *et al.*, 2025a). Overall, this study shows that women's primary role in aquaculture remains limited to informal, part-time, and flexible household production activities, carried out close to home and centered on childcare and domestic chores (Mengo *et al.*, 2023; Salazar *et al.*, 2023).

Women's contribution to the family economy through the aquaculture sector

Women's primary source of income in aquaculture is from the sale of fish from their household ponds at the market,

which is primarily done by male family members. This aligns with the broader picture of the aquaculture value chain in Bangladesh, where the majority of employment opportunities in aquaculture are created for men, and women's employment is relatively low (Ali *et al.*, 2026). In general, women find it hard to earn the same profits as men in aquaculture activities (Adam *et al.*, 2025a), 60% of the women involved and 62.5% of the non-involved women said sometimes they received very little profit from their male counterparts, but not on a regular basis, while 64.86% of women could not spend the money on their own in this study. Interestingly, about 62.85% of women engaged in the sector reported that they sometimes sold part of their fish locally and saved the earnings for future use. The distribution of the profit money women receive (Figure 3) indicates that women invest almost all of the money they control in their family treatment, food, children's education, and other family purposes, including in case of hard times. Similarly, Harper *et al.* (2020) identified gender inequalities in household spending, with women's income being used disproportionately for household provisioning and children's health and education. Interestingly, despite this restricted discretionary control, approximately 88.23% of women still manage to save a portion of their earnings for future use, a good sign of financial discipline under such limited circumstances. Although these women do not have much autonomy over their spending, they are eager to invest in their children's schooling and in family emergencies, benefiting their families and communities. More broadly, women's participation in aquaculture can have a good impact on women's autonomy and household decision making: In Bangladesh, women's involvement in the formal aquaculture industry has been a significant contributor to empowerment, including the ability to make economic decisions and to exercise control over household resources (Shanta *et al.*, 2025), although the present findings suggest this empowerment effect is partial and uneven where women's labor is unpaid and family-based rather than remunerated.

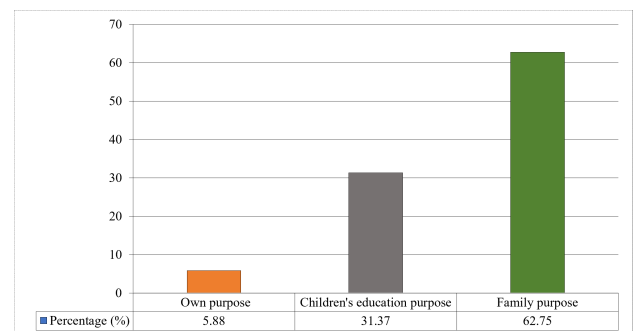


Figure 3. Expenditure rate of the profit money and the source of expenditure.

Women's contribution to family nutrition and food security

In this study, most respondents were lower-middle-class or poor, and, by their own accounts, buying nutritious food for their families is challenging given high market prices, so most households rely heavily on food collected from their own yards and ponds. About 60.78% of women catch fish from their own ponds as their primary source of protein (Table 2), particularly among poorer households, who catch fish when they need it and cook it for their families themselves. The average number of family members in the study is 4, the average number of days consumed fish per week is 4, and the average consumption of fish per family member per week is

333.55 g. The findings by Harper *et al.* (2020) and Hossain *et al.* (2024) confirm that women's participation in aquaculture contributes to higher productivity, profitability, and household nutritional security, aligning with the present study, in which fish caught by women are used directly to feed their own families. To meet additional nutritional needs, 37.25% of the women respondents are practicing integrated aquaculture, that is, cultivation of vegetables in and around the ponds with fish. This sub-sector is completely managed by women respondents themselves who grow seasonal vegetables along the pond embankments to get a healthy source of food for daily use. Haobijam & Ghosh (2023) indicates this type of integrated aquaculture as a tool to meet the increasing demand for fish and vegetables, enhance income stability, diversify food production, and boost nutrition and food security, noting that women's often-unseen role in this sub-sector directly contributes to the dietary diversity and nutritional intake of their families, especially for vulnerable populations like pregnant women, lactating mothers, and children. This study confirms the assertion of Orkoh & Hatab (2025) that women's equal and productive involvement in fisheries and aquaculture plays an important role in the nutrition and living standard of the household, because the data clearly indicate that women involved in aquaculture contribute significantly towards the nutrition of their family members.

Table 2. Source of fish for consumption.

Source of fish	Percentage (%)
Own pond	60.78
Market	17.65
Both	21.57

Limitations of the study

This study comprises a small sample size (51), and the respondents were from one union, the outcomes of this study cannot be generalized to other unions or other parts of Bangladesh. No statistical tests were carried out for data analysis other than descriptive (only in MS Excel), thus limiting the conclusions about the implications of observed differences among the subgroups. Additionally, the data were self-reported by women at a single time point, did not include data for male household members, and did not account for seasonal changes in aquaculture activity and income. Further studies on larger multi-union samples using statistical analyses and data from both spouses across different seasons are recommended to validate and extend these findings.

Conclusion

The result of this study indicates that women of Sadar Union of Badalgachi Upazila are not only occasional participants in fish production but also play a significant role in the fish production of their households. Their contribution is not only in terms of labor, but also in terms of household welfare, because the profit money they do have is overwhelmingly spent on family food, emergencies, and children's education, and they still save for their future hardship, despite this limited financial autonomy. Meanwhile, their fish yields in their ponds and their combined pond-vegetable growing also directly contribute to the food security and nutrition of their families, particularly for poor families. Despite the high contribution, underdeveloped local infrastructure and institutions constrain the role of women; there is no fish processing plant, cold storage, feed mill, agro-group, or value-added feed processing zone that women could expand their role into, and women are also not provided with

a supportive working environment, access to training is limited, and there is gender bias. To overcome these limitations, it will take more than one step. Legislation should be strengthened to ensure women are free of violence and discrimination and to create a safer and more supportive working environment for women in the sector. There is a need to increase training and education on new fish-culture technologies, resource management, and basic business skills, and policies that recognize and appreciate women's contributions to fish culture and enable women to participate equally in household and community decision-making. Women's access to financial services, better quality inputs (fish seed and feed), and better technology to enhance their efficiency should also be strengthened, and local infrastructure should also be enhanced (fish storage facilities, fish processing facilities, feed mills, agro-groups) to enable women to go beyond the homestead level and gain bigger benefits from the work they do. In the community, various awareness-creation programs are essential to change people's attitudes towards women's roles in aquaculture, and sensitization of people on the importance of their roles in family and community welfare is also very important. Finally, a study like this, covering only one union, is not adequate to provide a full picture of women's participation in the aquaculture sector in Bangladesh. Additional studies need to be conducted in more areas. When combined, these targeted interventions help transform the current invisible role of women to a more visible and empowering role in economic development, food security, and social equity in this union and other rural fishing communities in Bangladesh.

DECLARATIONS

Authors' contribution statement: Conceptualization: M.K.I. and R.A.; Methodology: M.K.I. and R.A.; Software and validation: M.K.I. and R.A.; Formal analysis: M.K.I.; Investigation: R.A.; Resources: R.A.; Data curation: M.K.I. and R.A.; Writing-original draft preparation: M.K.I.; Writing- review and editing: M.K.I.; Visualization: M.K.I.; Supervision: M.K.I. and R.A. All authors have read and agreed to the published version of the manuscript.

Conflict of interest: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Ethical approval: This study did not involve any invasive procedures, biomedical sampling, or experimentation on humans or animals; it was based solely on a structured questionnaire survey. Prior to data collection, voluntary informed consent was obtained from all respondents after explaining the purpose of the study, the voluntary nature of participation, and the confidentiality of their responses.

Consent for publication: All co-authors gave their consent to publish.

Data availability: All publishable data used are published within the manuscript. The remaining data is not applicable to share to maintain respondent confidentiality.

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