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Multifaceted Impacts of Converting Rice Fields into Fish Farming Ponds in Rural Bangladesh

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Abstract
The aim of this study is to qualitatively analyze the social, economic, and environmental impacts on adjacent rice fields and rural communities resulting from the conversion of rice fields into fish farming ponds. This research is a qualitative and descriptive field-based study conducted in selected rural areas of Jhikargacha Upazila, Jessore District, during a specific period. Data were collected through in-depth interviews with 12 rice field owners and 5 pond owners, along with field observations. The collected data were analyzed thematically. The findings reveal that farmers are increasingly shifting from rice cultivation to fish farming due to higher profitability and labor shortages. However, this conversion has caused negative consequences such as waterlogging in neighboring rice fields, crop damage, reduced soil fertility, pest infestations, and social conflicts. Additionally, the decline in agricultural production has raised concerns regarding food security. In conclusion, while converting rice fields into fish ponds is economically beneficial, its social and environmental impacts necessitate planned land use and integrated policy measures to ensure sustainable agriculture and rural development.

Keywords: rice fields, fish farming, waterlogging, canals, Bangladesh.

1. Introduction

Rice is the staple food for nearly all people in Bangladesh and plays a crucial role in the country's agricultural growth and food security [21]. However, the area under cultivation, agricultural employment, and the share of agriculture in the national GDP have been gradually declining [23]. Despite this, Bangladesh's economy remains largely agrarian, with rice cultivation historically considered the primary food crop and the main source of livelihood in rural areas. Agriculture continues to play a significant role in the country's overall economic activities [22]. In recent years, farmers in various regions of Bangladesh have increasingly shifted from rice cultivation to fish farming. This transformation from rice fields to fish ponds is not limited to agricultural production alone; it also has multifaceted impacts on rural social relations, economic structures, and the environment. Fish farming in rural Bangladesh can provide opportunities for off-farm employment and livelihood diversification, contributing to sustainable development [24]. However, unplanned pond construction often creates challenges for the cultivation of adjacent rice fields and other crops. The primary objective of this study is to qualitatively analyze the impacts of converting rice fields to fish farming on adjacent rice plots and socio-economic aspects, in order to generate evidence-based insights for rural development and sustainable land management.

2. Literature Review

Aquaculture plays a vital role globally and particularly in Bangladesh in fulfilling the demand for animal protein [1]. Over time, although the total area of agricultural land has decreased due to population growth and land scarcity, pond-based fish farming areas have increased significantly [2]. Population growth and urbanization are expected to make the food security situation even more challenging [22]. In this context, integrated rice–fish production systems are considered a sustainable alternative that can enhance productivity and income for smallholder farmers [3]. Increasing both rice and fish production is essential to meet the growing food demand in Bangladesh [4], [5]. However, farmers' lack of technical knowledge, natural disasters such as floods and droughts, and a risky environment have been identified as major barriers to the expansion of rice–fish integrated farming [4], [5]. Nevertheless, studies have shown that fish farming is more profitable than rice cultivation [6], [7], and particularly semi-intensive fish farming generates higher income than rice cultivation, leading to changes in land-use practices in many areas [8]. According to [21], although rice cultivation is profitable in Bangladesh, the rate of return is relatively lower. The potential for higher profits serves as an important incentive for farmers to change their crops and farming practices [9].

Labor shortages, rising wages, and high labor costs in rice cultivation are gradually pushing farmers towards mechanization to reduce production costs [7]. Rice cultivation is becoming increasingly risky due to climate change [24]. On the other hand, integrated rice–fish farming not only increases production but also provides opportunities for income diversification and more efficient use of land and water resources [10]. Conducting multiple production activities on the same land makes this system more profitable and economically viable compared to conventional monoculture rice farming [17].

However, research has also highlighted some negative aspects of fish farming expansion. In coastal areas, the expansion of shrimp farming has reduced total rice production and led to soil degradation, resulting in lower rice yields [11]. Several studies indicate that, compared to the financial benefits from shrimp farming, the environmental and social damages are greater, including the conversion of forests and agricultural lands, loss of

biodiversity, pollution, disease outbreaks, and increased salinity of groundwater, creating problems for both drinking water and agriculture [12], [13]. Salinity caused by shrimp farming severely affects adjacent rice fields [14].

Land-use changes have significantly increased the extent of natural wetlands; however, agricultural land and vegetative cover have decreased, and future pond construction may intensify this trend [15]. The unplanned conversion of natural wetlands into fish ponds poses serious threats to ecosystems and increases the problem of prolonged waterlogging [16]. Moreover, unplanned pond excavation for fish farming is destroying vast agricultural lands and obstructing natural water flow, creating persistent waterlogging that severely impacts farmers' livelihoods and food production [5]. Transforming rice-based farms into diversified and commercial farms incorporating fish, livestock, and poultry has increased farmers' livelihood assets and capabilities [18]. Currently, fish farming is being promoted in various regions of Bangladesh, creating new dynamism in the rural economy [20].

Various studies indicate that converting rice fields into fish ponds is bringing multidimensional changes to rural society in Bangladesh. Socially, families involved in fish farming are gradually moving away from traditional agricultural labor, reducing interest in customary agricultural social events and practices. Simultaneously, new disagreements and social inequalities are emerging around land management and resource control. Economically, fish farming generates new sources of income, but it requires comparatively higher initial investment and ongoing expenses. Nonetheless, opportunities for marketing and stable demand strengthen income streams. Environmentally, in the long term, it leads to soil fertility reduction, changes in natural water bodies and biodiversity, and introduces new challenges in irrigation and water storage management. Recent studies suggest that although the conversion of rice fields to fish farming has positively influenced farmers' income, its social and environmental impacts need to be carefully considered. For sustainable agriculture and rural development, planned land use and an integrated policy approach are essential.

Most studies on the conversion of rice fields to fish farming in Bangladesh have emphasized the profitability and production increase of fish farming. However, research on the social changes caused by this transformation—such as impacts on people's livelihoods, social relations, labor distribution, and land management—remains very limited. Similarly, although environmental changes have been discussed, their effects on farmers' daily lives and livelihoods have not been deeply analyzed. Therefore, there is a clear need for an integrated qualitative study on the social and environmental impacts of converting rice fields into fish ponds.

3. Methodology

This study employed a qualitative research approach, primarily relying on interview-based data collection. The participants included 12 neighboring rice field owners and 5 pond owners, all of whom were male. Each interview lasted between 30 to 40 minutes. During data collection, detailed notes were taken using pen and paper to document any issues encountered in the process.

3.1 Study Area

The research was conducted in selected rural areas of Jhikargacha Upazila, Jashore District, where the conversion of rice fields into fish ponds and its impacts are prominently observable.

3.2 Data Collection Methods

- Descriptive interviews with farmers and their family members to understand their experiences and perspectives.
- Field observations to directly assess agricultural practices and land conditions.
- Structured interviews with pond owners to understand fish farming management and its associated impacts.
- Additionally, various relevant research studies, articles, and literature reviews were consulted to support data analysis and thematic development.

3.3 Data Analysis

The collected data were analyzed using a thematic approach. The primary themes included: the reasons farmers convert rice fields into fish ponds, and the subsequent impacts on neighboring rice fields. Within each theme, the data were thoroughly interpreted and presented through qualitative analysis.

3.4 Key Observations

This methodology facilitated an in-depth understanding of farmers' and pond owners' experiences within the local context. The combination of direct interviews, field observations, and relevant literature review enhanced the realism and credibility of the findings. The thematic analysis allowed for an organized presentation of the data, fully aligning with the research objectives. Moreover, it enabled the identification of complex impacts related to local agriculture, environment, and social context.

4. Findings and Discussion

Why are farmers converting rice fields into fish ponds?

4.1 Higher Profit and Labor Shortage Solutions

Fish farming is considerably more profitable compared to rice cultivation, especially in the current year when rice market prices have fallen relative to the previous year. If the pond owner cultivates the fish personally, the income is significant; even if the pond is leased out, the earnings are notably higher than rice cultivation. These ponds primarily cultivate species such as pabda and tengra, which have a higher market value compared to other fish. In some cases, part of the harvest is provided to the pond owner for consumption in addition to the lease payment. These findings are consistent with previous studies [6], [7], [8].
Moreover, during certain periods of the year, rice cultivation often faces labor shortages, particularly during harvest season. By creating ponds and leasing them, farmers do not

face a shortage of labor, which aligns with earlier research [23].

For instance, Mr. Azi has been engaged in large-scale rice cultivation for many years. However, during the harvesting season, a lack of sufficient local labor forces him to hire workers from other areas, which significantly increases production costs. To mitigate this additional financial burden, he has converted part of his agricultural land into fish ponds.

Similarly, other rice field owners have also dug ponds on their land due to various practical difficulties.

4.2 Vegetable Cultivation Alongside Fish Farming

In addition to fish farming, many pond owners cultivate various vegetables along the embankments of their ponds. This practice allows them to fulfill household food requirements and, in many cases, sell surplus produce in the market for additional income. *On the embankments of most ponds, various types of vegetables are seen, among which onions, eggplants, chili, and tomatoes are notable.* Which are not cultivated in waterlogged areas.

Multidimensional Impacts of Land Conversion on Farmers

4.3 Waterlogging in Adjacent Agricultural Lands

Rice cultivation requires comparatively more water, which is supplied through artificial irrigation systems and natural rainfall. While artificial irrigation depends on the farmer's management and decision-making, natural rainfall is entirely governed by environmental conditions beyond the farmer's control. During periods of excessive rainfall, existing canals and drainage channels play a crucial role in removing surplus water from rice fields, supporting agricultural production. These drainage systems exist at both private and government levels. However, in recent times, the expansion of fish farming has led to the construction of numerous ponds and enclosures, which in many cases obstruct natural and artificial drainage canals. As a result, during the rainy season, water accumulates in rice fields, creating prolonged waterlogging. This waterlogging not only reduces rice production but also causes significant difficulties for farmers during harvest. Furthermore, the management of pond water for fish harvesting, pond maintenance, or water regulation often causes water to flow into adjacent agricultural lands at inappropriate times, disrupting normal rice growth and causing both qualitative and quantitative crop losses. The impact of land conversion from rice fields to fish farming is not confined to the converted plots alone; it also causes prolonged waterlogging in surrounding agricultural lands. Ponds and tanks constructed for fish farming retain water, interfering with the natural drainage system of the land. Consequently, crop productivity declines, soil fertility decreases, and the loss of soil nutrients accelerates. Farmers must invest additional time, labor, and financial resources to make the land cultivable again. In some cases, excessive waterlogging has led to complete crop failure. Overall, unplanned pond excavation for fish farming damages agricultural land and obstructs natural water flow, creating prolonged waterlogging, as noted in previous studies [17], [19].

Several rice farmers reported that pond excavation causes waterlogging in their fields during every season, resulting in substantial crop losses. They also noted that closing drainage canals during such work exacerbates water drainage problems, increasing the extent of damage

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This situation negatively affects farmers' livelihoods and food production, posing a serious challenge for the sustainable development of the agricultural system in the long term.

4.4 Reduction in Agricultural Land Area

Despite continuous population growth in Bangladesh, the total land area has not increased. The conversion of rice fields into fish ponds has significantly reduced the availability of productive agricultural land at the local level. Land previously used for cultivating rice and other food crops is now being converted into ponds or fish tanks, thereby shrinking the area available for crop production. This trend is consistent with previous studies [2], [15]. The direct impact is on the food production capacity of farmers and local communities. Reduced crop production leads to decreased farmer income. Moreover, environmental changes in the land make cultivation more difficult than before, increasing production costs. The effects of this issue are not confined to farmers alone but extend to the broader society and economy. Reduced food production may lead to food shortages and increase reliance on imports in the future.
Overall, the trend of converting rice fields into fish farming ponds poses a significant challenge to the stability of local agricultural systems and the sustainable production of food.

4.5 Increase in Food Imports

Due to the decline in local food production, food imports are increasing to meet the needs of the large population, which continues to grow steadily. The reduction in rice production and the decreased cultivation of other crops are negatively affecting the country's food security. Consequently, dependence on foreign food sources is increasing instead of relying on domestic production. The rise in food imports is placing additional pressure on the national economy and increasing expenditure of foreign currency. Although pond owners are able to earn comparatively higher income through fish farming or leasing, a large segment of society—particularly low-income groups and those not directly involved in crop production is most adversely affected. As food prices rise in the market, these families face difficulties in purchasing sufficient food. At the same time, reduced local production is causing farmers to lose self-sufficiency.

Overall, this situation indicates that changes in the agricultural system are not only affecting local farming but also profoundly influencing national food policies and food security.

4.6 Creation of Habitats for Insects and Harmful Animals on Pond Embankments

The embankments of ponds constructed for fish farming are generally relatively high and wide, preventing water from reaching these areas even during the rainy season. These permanently dry and unused embankments serve as favorable habitats for various insects, rats, and snakes. Consequently, a distinct population of harmful animals develops around the ponds, posing risks to adjacent agricultural lands. During the rice maturation stage, rats and various harmful insects cause significant crop damage. Rats cut off rice panicles and often spread rapidly across the field, leading to extensive losses. Similarly, insect infestations reduce both the quality and quantity of rice, resulting in financial losses for farmers. Furthermore, the presence of snakes on pond embankments creates serious safety hazards for agricultural work. These dry embankments are ideal habitats for venomous snakes. In many cases, farmers cannot enter the fields on time due to fear of snakes, disrupting crop management. Incidents of snake bites causing injury or death among farmers in rural areas are regularly reported in both media and field observations.

For example, last year, the Russell's viper caused panic in many areas. Additionally, farmers whose agricultural land is adjacent to ponds often encounter snakes on their fields.

Overall, the creation of habitats for insects and harmful animals on pond embankments is not limited to crop losses; it also poses a serious threat to the lives and livelihoods of farmers. Therefore, environmental and agricultural safety considerations must be integrated when expanding fish farming.

4.7 Difficulty in Harvesting Crops from Fields

The construction of ponds for fish farming and the closure of drainage canals cause waterlogging or soft soil in the fields. As a result, conventional vehicles or bullock carts cannot access the rice fields, hindering timely harvesting. Farmers often have to wait for the fields to dry or hire additional labor to safely transport crops. This increases both time and cost, and in many cases, crops are damaged.

Mr. Mahi mentions that if the rice field is dry, the vehicle owner demands one rate to transport the rice home, but if the field is wet, a higher rate is charged.

Overall, this situation indicates that the expansion of fish farming directly complicates agricultural operations and places significant pressure on farmers' time, labor, and financial resources.

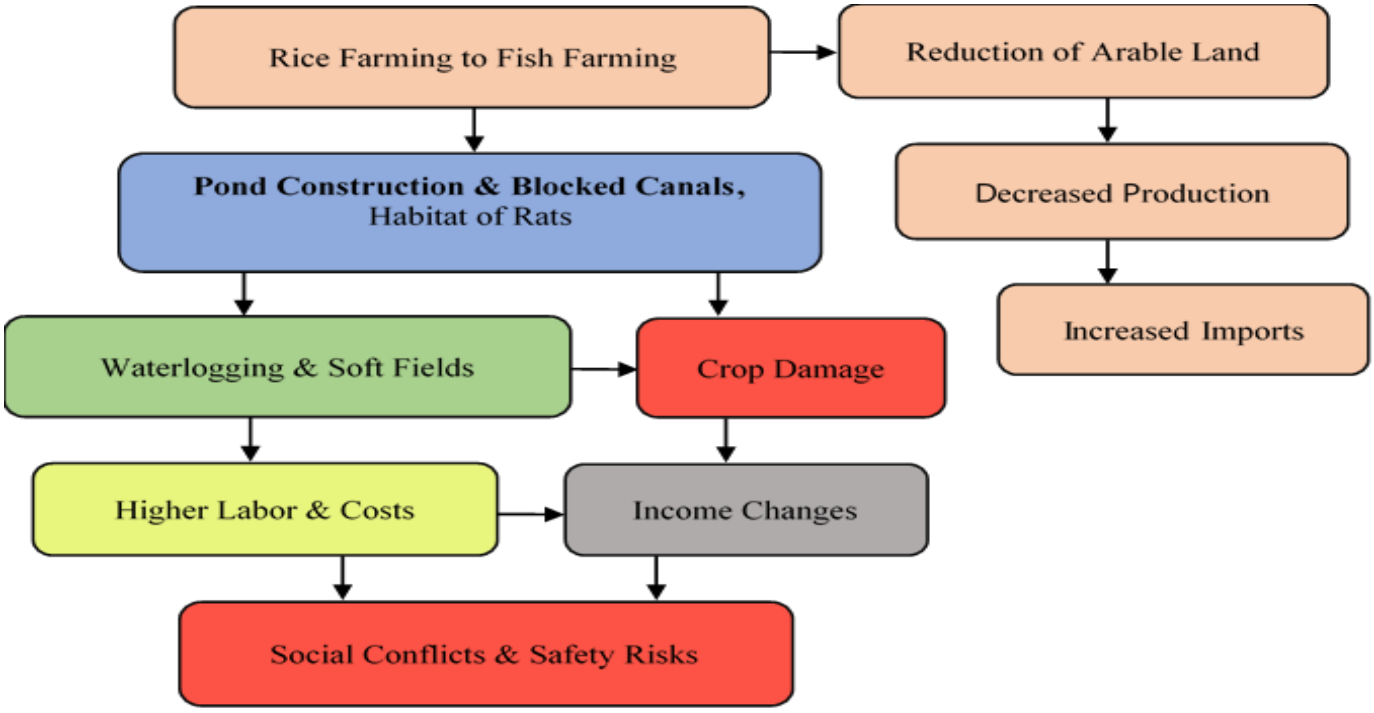
4.8 Conflicts and Clashes

Disputes occasionally arise between pond owners and crop owners over issues such as crops, water, or land use. These disagreements sometimes escalate beyond verbal arguments into conflicts and physical altercations. In such situations, local government officials, such as the chairman or members, often attempt to resolve the issues through mediation. In some cases, when the situation reaches a critical stage, intervention by the Upazila Nirbahi Officer (UNO) becomes necessary to settle the matter. Several incidents in this study illustrate such conflicts.

For example, the operation of aerators in fish ponds to supply oxygen sometimes damages pond embankments and local roads, leading to serious disputes between pond owners and residents, which are later resolved through mediation. Similarly, the closure of canals by pond owners causes damage to nearby crop fields. When local residents collectively file complaints with the administration, the authorities intervene to address the issue.

These cases demonstrate that mismanagement of ponds and crop-related land can create social conflicts and safety risks at the local level.

5. Figure 1 Problems Associated with the Conversion of Rice Fields into Fish Farming Ponds



Source: Author's own creation

This flowchart shows that the conversion from rice cultivation to fish farming leads to pond excavation, closure of canals, and the creation of rat habitats, which causes waterlogging and soft soil in adjacent fields and damages the crops. As a result, labor and costs for agricultural work increase, and farmers' income is affected. Ultimately, the impacts of these environmental and economic problems extend to the social level, creating conflicts and security risks. Moreover, the reduction in crop land affects overall production, forcing rice imports from other areas to meet the food demand of the current population.

6. Conclusion

The conversion of rice fields into fish farming ponds has brought about a multifaceted change in rural Bangladesh's agricultural system. While this transformation is economically beneficial for farmers, its social, economic, and environmental impacts are also significant. Economically, fish farming provides comparatively higher income and helps alleviate labor shortages to some extent. Many farmers earn income through pond leasing without directly using their own land. However, the social and environmental consequences cannot be overlooked. Pond excavation, canal closure, and the creation of habitats for harmful animals have reduced the productivity of adjacent rice fields and other crops. Waterlogging, soft soil, and the increased labor and costs for harvesting crops impose financial and psychological stress on farmers. Moreover, land management and resource control issues have given rise to local social conflicts, security risks, and disagreements within communities. This situation indicates that while converting rice fields to fish ponds increases income, it simultaneously places long-term pressure on agricultural sustainability, food security, and environmental balance. Therefore, planned land use, proper water management, and attention to social cohesion are essential for rural development and sustainable agriculture. Overall, this study emphasizes that the expansion of fish farming should not be guided solely by economic considerations; rather, policy-making and land management decisions must integrate its social and environmental impacts.

7. Limitations

This study was conducted using a qualitative approach, focusing on the social, economic, and environmental impacts resulting from the conversion of rice fields into fish farming ponds. As the research was carried out in a limited geographical area and involved a small number of participants, the findings may not be directly generalizable to the entire country. Furthermore, since all respondents were directly or indirectly affected by this land conversion, the collected information may be somewhat experience-based and subjective. In the future, conducting research over a larger geographical area with a greater number of participants, using quantitative or mixed-method approaches, could allow for a more comprehensive and in-depth analysis of the issue.

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