Does diversification of rice based systems always lead to gender equity? A case from Bangladesh

Kamala Gurung[1], Humnath Bhandari[1]

Rice and fish are the staple food of more than 150 million people in Bangladesh. Rice is the dominant crop, which occupies more than three-fourths of the country's cultivated area. Almost 15 million farm families grow rice. Both men and women contribute labor to rice farming, which is labor-intensive but labor participation varies by sex, depending upon geographic region and socioeconomic groups. Despite its significant contribution to rural livelihoods, rice-based farming systems have been diversifying and changing in Bangladesh, Commercial aquaculture farming (CAF) has been expanding in rice fields over the past two decades. Moreover, traditional subsistence-type backward fish ponds are also converting into CAF. These transformations may have affected livelihood options, gender roles and responsibilities, and access to production resources. The objective of this paper is to examine transformation in rice-based agricultural systems and derive implications of CAF on gender roles and relations and household food security. The primary data was collected from 10 villages of three districts of Bangladesh and analyzed for this purpose. The conversion of rice to CAF disproportionately benefitted upper-middle class and rich farm households, with significantly lower labor requirement for CAF than rice farming. CAF has threatened the household food allocation and created greater income inequality in society. The transformation has decreased the workload of women as compared to rice cultivation, but women's access to and control over agricultural products have declined. They have become more dependent on their husband's income and have lesser control over income use. With the promotion of women-friendly mechanization, diversifying rice-based

[1]*International Rice Research Institute (IRRI), Social Sciences Division, Dhaka, Bangladesh.*

farming systems could be effective interventions to make rice-based farming more profitable. Equitable access to credit to poor and medium farmers, including women, could make them engage in CAF.

Key words: rice, commercial aquaculture, cropping-system, gender, Bangladesh.

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1. INTRODUCTION

Rice and fish are the staple food of more than 150 million people in Bangladesh. Rice, the foremost crop in the country is grown on about 12 million ha, accounting for more than three-fourths of the total cropped area. Rice provides half of agricultural GDP, one-sixth of rural household income, half of rural employment, two-thirds of per capita daily calorie intake, and half of per capita daily protein intake. Over the past three decades, paddy rice production has more than doubled, from 21 million t in 1980 to 48 million t in 2010. This substantial increase in rice production played an important role in improving the food security and livelihood of the people of Bangladesh. Almost all of the 15 million farm families in the country grow rice. Both men and women contribute their labor to rice farming, which is labor-intensive. However, labor participation varies by sex, depending on the geographical regions and socioeconomic groups.

Despite its significant contribution to rural livelihood, rice-based farming systems have been diversifying and changing in Bangladesh. Monoculture commercial aquaculture farming (CAF) particularly fish, shrimp, and prawn farming has been expanding in rice fields over the past decades. Moreover, traditional subsistence-type backyard fish ponds are also converting into CAF. Shrimp and prawn production takes place mainly in south and southwestern Bangladesh in converted rice fields. These transformations may have affected livelihood options, gender roles and responsibilities, and access to resources (e.g., credit).

A number of studies have documented positive and negative implications of commercial aquaculture intervention in the rural communities. The majority of these studies have explicitly

addressed the opportunities generated and livelihoods improvement through the intervention (Alauddin et al., 1995; Mondal, 2008; Joffree et. al., 2010; & Primavera 1997). However, the existing studies have not provided evidence-based results in terms of changes and impacts of the commercial aquaculture intervention on income distribution across the socio-economic groups, and gender roles and relations in Bangladesh, although there are a number of predictions made by some researchers (Dehadrai, 1992; & Kusakabe, 2003). For instance, Dehadrai (1992) stated that the aquaculture in the rice field may save the time that men and women spend in fish culture, although this effect is somewhat counterbalanced by the extra work needed for the rice and fish management. Similarly, enterprise activities such as fish farming experienced around the world, particularly by women, are more likely to increase women's social and economic empowerment (Kusakabe, 2002; Dehadrai, 1992; & Primayera 1992). Thus, there is a need to assess the implications of the present changing pattern of rice based agricultural systems into commercial aquaculture farming.

In order to examine transformation in rice-based agricultural systems and derive implications of CAF, there are three key specific research questions formulated, which are; i) Have the agricultural land use practices changed over time? If so, how these changes have affected the household food security and sources of livelihoods of the various socio-economic groups? ii) Has the commercial fish farming affected the gender roles and relations in terms of their labor and resource allocation? and iii) What are the driving forces of increasing commercial fish farming into the rice fields?

The conceptual framework of this study (Fig 1) is developed on the notions of alternative livelihood option, gender roles and relation in order to deepen the understanding of the transformation in rice-based agricultural systems and derive implications of the commercial

aquaculture intervention (CAF). This framework is contextualized commercial aquaculture farming system and it's implications through empirical evidence-based study mainly at the intra-household level.

2. METHODOLOGY

Based on the objectives of the study, three districts-(Khulna, Sathkhira and Mymensingh were purposively selected since commercial aquaculture has been initiated/emerged in these districts over the past decades. Ten villages were purposively selected from the three districts. Among the 10 villages, seven villages are mostly dominated by commercial aquaculture farming systems and three villages with mostly dominated by rice farming systems. 40 sample households were randomly selected from each village. Thus, a total of 400 households were included in the surveys (Table 1).

Data were collected and analyzed using the Q^2 method comprising qualitative and quantitative techniques. Qualitative data were collected through multi-participatory research techniques such as self-evaluation for access to and control over resources, timeline of land-use system, and well-being ranking. Farm households were classified into four socioeconomic groups based on wealth ranking criteria identified by the farmers (Table 2). The analysis is disaggregated by socio-economic groups and gender. For analysis, data collected through household surveys were processed using the "SPSS" computer software package and disaggregated by socio-economic groups and gender analysis, which is depending on the specific objective. The data are presented as percentages and proportions in tables and figures that are further analyzed in the various sections of this research. Lorenz curve analysis also used to measure the income inequality distribution in the household for instance, with and without

commercial aquaculture farming households and illustrates the extent that income is distributed unequally in a particular community.

3. RESULTS AND DICUSSION

3.1 Farmland ownership

The ownership of farmland continues to bring high status, wealth, and prestige in rural areas, and is still considered an important component of the well-being of contemporary rural livelihood. In order to stratify households by economic category, a well-being ranking method was conducted during the group discussions in the 10 research sites. Households were classified into rich, upper-medium, lower-medium, and poor groups according to the size of farm holdings and also engagement of non-farm-related activities. This was followed by a formal household survey to determine the land owned by different socio-economic groups.

The empirical evidence from the 10 villages reveals that the average land owned is 0.49 ha, with the rich and upper-medium-class households owning a significantly larger land area than the poor and lower-medium-class households. The average farm size among sample households was 0.43 ha, ranging from 0.07 ha for the poor to 1.43 ha for the rich households (Table 3). This indicates that rich households have sufficient agricultural production to secure their livelihoods throughout the year. Rich households have more leased-out farmland (0.62 ha) than leased-in farmland (0.39 ha). During the focus group discussion, women farmers expressed that the trend of leasing out farmland has been increasing because (a) women farmers cannot cultivate all of their farmland because of out-migration of their male family members and (b) finding laborers in the village is difficult. In contrast, upper-medium-class households have leased-in farmland of about 0.22 ha, which is higher than leased-out farm land (0.19 ha). This evidence suggests that

the upper-medium-class households meet their livelihood through land tenancy and engaging in agriculture as an enterprise. The group discussions and the direct field observations revealed that such enterprise and land tenancy is common in the CAF system.

Lower-medium-class and poor households also leased-out their land. Households in these categories are compelled to lease/mortgage out their piece of land because their lands are surrounded by neighboring large shrimp/fish farms. Moreover, crop cultivation is not suitable because of water logging and high salinity. Often, farmers are under pressure to lease out their land by influential people. Because of the lack of access to credit/loan services, they are not able to establish their own aquaculture enterprise.

3.2 Trend in agricultural land-use pattern

The information on the trend in agriculture land-use pattern was mainly gathered through focus group discussions with key informants. The "agricultural land-use" calendar from 1970 to 2011 was used in 10 research villages. The major land-use categories in the sample villages are: (a) rice (local and HYV); (b) commercial aquaculture; (c) seasonal fallow land; and (d) legumes, jute, and others (e.g., vegetables, oil seeds, and wheat).

Until the 1990s, local varieties of rice occupied a relatively large proportion of the total cropping area (Fig 2). However, this has drastically decreased from 33% in 1971-80 to 17% in 2006-11. In contrast, the area under high-yielding varieties (HYVs) of rice increased significantly from 1% in 1980-90 to 25% in 2006-11. Local rice varieties dominate the *aman* season, whereas HYVs dominate the *boro* season. Because of short-duration HYVs for the *boro* season, the seasonal fallow land has drastically decreased from 50% to 20% over the past three

decades. These findings are consistent with farmers' views on changes in land-use patterns in research sites.

Commercial aquaculture, particularly shrimp/prawn farming, did not exist in research study sites before the 1990s. Mostly homestead fishpond culture was practiced for household consumption and as small-scale enterprises. However, CAF has remarkably increased after the 1990s because of the high demand for shrimp and fish in the international market (Fig 2). Out of the total 400 sample households, 36% own fishponds. Farmers' perception on the increasing trend of commercial aquaculture evidently correlates with the number of fishponds constructed by sample households from 1968 to 2011 (Fig 3). Figure 3 shows that a large number of fishponds have been constructed after year 2000. The average area of a pond ranges from 0.03 ha/hh to 4.68 ha/hh (household survey 2011). The rapid growth in the number of ponds in recent years reveals that small aquaculture farming has been moving toward CAF. CAF is a monoculture system characterized by high capital, high input, and high yield.

3.3 Comparison of costs and returns of rice and commercial aquaculture farming

This study explored why farmers are shifting from rice farming to monoculture CAF. The main driving factors are: (a) economic benefit from rice cultivation is less, (b) there is labor shortage for rice production; and (c) labor cost and input cost of rice production is high. About 68% of the households responded that rice production is less profitable than CAF. During the group discussion, the group of male farmers reported that CAF gives quick and direct cash benefits with lesser workload than rice cultivation. Despite higher capital investment, the large profit from CAF motivates farmers to engage in it (see labor section for details).

The study also investigated the hypothesis that CAF is more profitable than rice production (Table 4). The net return from CAF is about US$2,245/ha/year, which is 3.6 times higher than that from rice production in three seasons. On the other hand, the total cost of three seasons' rice production ($2,284/ha/year) is higher than the cost of aquaculture farming ($2,117/ha/year). For CAF, the variable cost ($1,650/ha/year) is much higher than the fixed cost ($467/ha/year), which comprises mainly of fish feed and labor cost for feeding and looking after the ponds. The fixed cost for aquaculture is significantly higher than that for rice production. In case of rice production, labor cost is higher than other cost inputs. Among the three seasons, both costs ($1,062/ha/year) and returns ($503/ha/year) from *boro* rice production are higher than the other two seasons' rice production; whereas, the return of *aus* rice production is negative ($–33/ha/year).

Both the male and female participants also expressed that CAF is profitable, but it requires a huge capital investment, for which they had to make loans. As a result, they suffer from mental stress, worrying about how they can repay their debts, which have to be paid on a quarterly basis. Women farmers expressed that the adoption of CAF has unintended effects on intra-household food allocation. Households who were rice self-sufficient before shifting to CAF become rice-deficient after the shift. This is because their rice land was converted to aquaculture, resulting in less rice production. Consequently, they are more dependent on the market for their daily food consumption and they are more vulnerable to increasing rice prices. Women from households who converted to CAF and also leased-out farmlands, further expressed that, in the past, households stocked rice for a whole year and women could make decisions on its use for family consumption. But now, they are more dependent on the market and on their husbands to

secure food (e.g., rice, pulses, and vegetables) to feed their families, since financial resources are controlled by the men.

3.4 Livelihood diversification

Farm activities were, and still are, the primary source of income to ensure household food security for families who belong to the rich and upper-medium class. Farmers from these groups reported that farm income still is a more important livelihood source for their family than income from non-farm activities, even after the adoption of CAF (Table 5).

For the lower-medium class and poor households who operate limited lands, farm (e.g., wage labor) and non-farm activities are the primary sources of livelihood. The share of non-farm income is higher for these households. Out of the total household income, the share of non-farm activities is 64% and 54% for lower-medium-class and poor households, respectively (Table 5). Majority of the lower-medium-class and poor households who were engaged in seasonal off-farm activities, are now forced to engage in non-farm activities (e.g., pulling rickshaws, driving vans and) to sustain their income. The result also indicates that income sources are more diversified for poor and lower-medium-class households than for the upper-medium class and the rich. The commonly held perception that market-led activities will create employment in the community is not true here, because CAF requires much less labor than crop cultivation. The group discussion also revealed that most of the large fishponds in each village were operated by outsiders. Therefore, the extra income from CAF is not benefiting local communities.

This study also disaggregates different sources of income, which are crop, aquaculture, livestock, wage labor, services, and remittance (national and international). Results revealed that, before converting to CAF, the income of rich and upper-medium-class households came largely

from crop production. However, the major source of income now shifted to aquaculture, which was not an important source earlier. The share of aquaculture to total household income is 27% and 50% for the upper-medium-class and rich households, respectively. Household income from non-farm activities, such as small shops, services, and remittances, is relatively small.

Poor households have lost their traditionally dominant farm labor occupation mainly from crop production. Today, their income sources are more diversified and they are now engaged in non-farm-related activities such as daily labor in the market and pulling or driving rickshaws as the main sources of income. This can be partly attributed to the push factor, wherein they lose employment in the farm because of reduced crop farming and lower employment opportunities in aquaculture in the village. This clearly indicates that CAF has changed the sources of livelihood across various socio-economic groups and created greater income inequality among farming households.

3.5 Unequal income distribution

The disparity in income distribution was further investigated by analyzing the hypothesis that the adoption of CAF increases income inequality in society. This was analyzed by comparing the income distribution among households with and without commercial aquaculture. Gini coefficient and Lorenz curve were used to measure income distribution and inequality. Table 8 shows that the Gini coefficient for households without aquaculture is smaller (0.35) than that for households with aquaculture (0.48). Likewise, the Lorenz cure area for households without aquaculture is smaller than that for households with aquaculture (Fig 4). Both the Gini coefficients and the Lorenz curves indicate that households without CAF have a lower degree of income inequality than those with CAF. This implies that adoption of CAF increases income

inequality in society. Above findings clearly indicated that rich and upper-medium-class households are mainly engaged in CAF and hence, CAF benefitted higher-income households. On the other hand, the poor and lower-medium-class households were less involved in CAF. These households expressed that CAF requires a large amount of capital and credit. They neither have the assets nor the access to credit to invest on it. This has led to income inequality within the society.

It was found that credit is one of the main determinants of adopting CAF. The sources of credit are from commercial banks, non-government organizations (NGOs), money lenders, and other informal sources (relatives and friends) (Table 7). Table 7 shows that 99 of the sample households from different socio-economic groups reported that they were able to access credit from various sources.

NGOs were the dominant sources of credit as mentioned by the women from all the socio-economic groups. Findings also show that households avail of credit more than once from different NGOs. The amount of credit taken varies significantly across socio-economic groups. The average amount borrowed is significantly lower for poor households ($207) than rich ones ($595). The data further show that poor and lower-medium-class households, including women, were not able to access credit from banks. Only the rich and upper-medium-class households have accessed loans from banks. The amount of credit taken from the bank is much higher and the interest rate is much lower (about 11.5%) than other sources. These findings are consistent with poor farmers' revelation that the amount of credit they receive is not enough for aquaculture investment. Therefore, CAF benefits more the upper-medium and rich farming households, which comprise a smaller proportion of farming communities.

3.6 Comparison of labor allocation by gender between rice production and commercial aquaculture farming

The labor requirement for *boro* rice cultivation is higher than that for CAF (Tables 9 and 10). This finding is consistent with the discussions among farmers that higher labor and input costs and shortage of labor are the major reasons for converting from rice farming to CAF. The major supply of labor (62%) in rice production comes from hired workers than from family members (Table 8). Male family members contribute about 26% of the total labor used in rice production, compared to 6% performed by female family members. Although women's contributions to rice production are quite low compared to that of men, they are mainly responsible for postharvest activities (e.g., drying, storage, and seed selection). Aside from these, they spend at least two or three hours a day cooking lunch and snacks for the family and hired workers. These non-economic activities are not counted in production and postharvest activities.

Crop establishment, particularly transplanting (51.1 days/ha), and harvesting and threshing (55.1days/ha) are the most labor-intensive rice cultivation activities (Table 8). Labor demands for these activities are supplied mainly by hired male labor. The total labor requirement for land preparation is relatively small (19.3 days/ha), which is largely because of the use of machines in land preparation. An earlier study conducted by Ahmed (2001) indicated the high use of labor inputs (72.4 days/ha) during land preparation for rice planting, which used to continue for about a month.

For CAF, family male labor is significantly higher than hired labor, which is in contrast to rice production (Table 9). Out of 152.6 of the total labor days/ha/year spent on aquaculture (e.g., fish, shrimp, and prawn) farming, only 34% come from hired male labor and the rest is

provided by family labor. This indicates that the shift from rice to CAF reduces overall farm employment opportunities and, more importantly, off-farm employment opportunities for the poor. As stated earlier, rich and upper-medium-class households are actively engaged in aquaculture management and production because this is a lucrative business. However, women's labor contribution in CAF is much lower compared to that in rice production. Although women contribute to almost all activities, more on fish feeding, their contributions are quite low (4.2 days/ha/year). During the group discussions, women farmers expressed that although their workload has been reduced because of CAF, they are also not able to use their saved time for other productive activities.

Within CAF activities, dikes/refuse preparation (74.8 days /ha/year) and guarding the fishpond from thieves (74.6 days /ha/years) are the most labor-intensive activities. Dikes/refuse preparation is carried out at the beginning of the pond establishment and the dike structure may work for several years, although it requires repair and maintenance every year. These activities are mostly done by hired labor. Because of the high risk of losing the fish from thieves, male members of farming households or hired workers provide security for the fishponds.

3.7 Gender-differentiated access to and control of commercial aquaculture farming and rice-related activities

This section presents the self-evaluated ratings of women's access to and control over the resources used in CAF and rice cultivation (Fig 5). Women's access to and control over resources vary depending on particular rice and aquaculture resources and activities. Discussing all activities is beyond the scope of this paper. Only selective activities are discussed and presented.

Rice varieties and commercial aquaculture farming

Information about the involvement of men and women in the decision-making process regarding selection of rice varieties and CAF was collected based on two questions: (1) who selects rice varieties to be grown? and (2) who decides to adopt commercial aquaculture? Findings reveal that women have limited influence on decision-making about CAF (Fig 5). Both men and women reported that men are more experienced and knowledgeable on the business aspect of CAF and hence, they are the major decision-makers. During group discussions, women expressed that men consult them at the initial stage, but that they are completely excluded in later stages.

Women expressed that, although they don't have access to seed from markets or information on rice varieties, they are more involved in the decision-making process of rice varietal selection at the household level. Women have average influence on decision-making about rice varieties selection (Fig 4). They reported that, although they are involved in the seed selection process, their husbands make the decision on what new rice varieties to grow on their farms.

Marketing rice and commercial aquaculture products

Women from different socio-economic groups are concerned over their access to resources (e.g., rice) even for the daily household consumption, although their labor has been decreased. They are now more dependent on the market and their husbands to purchase the food (rice) for the household. Women are not aware of the exact income from fish/shrimp farming since the men deal with the traders. They further expressed that, before, they had access to fish/shrimp any time for household consumption. However, after shifting to CAF, they have to

wait for the harvesting period or they have to ask their husbands even for household consumption of fish/shrimp. This has a negative impact on household nutrition. On the other hand, the women said that they had more access to and control over crop products at the household level when they were cultivating crops. As stated earlier, traders used to come to the village to purchase grain, such as rice, which had allowed them to know how much money they were getting from selling rice grains; also, women had influence on the amount of grains to be sold. Despite their involvement in decision-making and access to both crop and small fishpond culture, earlier resources continue to be controlled by their male counterparts (Fig 5). The shift from crop production to CAF has increased social conflicts in the community. Poor households are especially forced to give their land for CAF due to pressure from the community.

Credit and investment in commercial aquaculture farming

With the introduction of CAF, large amounts of loans for investment in aquaculture have significantly increased, and these loans are generally obtained from banks which require collateral. Since women do not own any assets, they are automatically deprived of the opportunity to borrow from formal banking institutions. However, a big change has happened in Bangladesh in terms of giving women access to micro-credit (Table 7). Many NGOs, such as the Grameen Bank, BRAC, etc., have opened opportunities for poor women by providing them micro-credit without collateral for income-generating activities. Studies have shown that women have higher repayment rates than men. However, the amount of loans borrowed by women is limited to small enterprises rather than agri-business ventures such as CAF, which requires huge investment and land as collateral.

4. CONCLUSIONS

The main objective of this research was to assess the implications of the shift from rice monoculture and small fishpond farming into CAF on the livelihood and intra-household food security, and also on gender roles and relations. The shift to CAF has changed the sources of livelihood across various socio-economic groups. The main drivers leading to CAF are: less profit from rice cultivation, labor shortage, and high labor cost of rice production. Although women's workload has been reduced in CAF, they are still not able to use their saved time in other productive economic activities because of the lack of other income-generating opportunities.

CAF is significantly more profitable than rice farming. CAF is mainly adopted by higher-income bracket households because of the high capital requirements for initial investment and business operation. Therefore, CAF has disproportionately benefitted the higher-income bracket households, thereby increasing income inequality in the society. However, CAF has also threatened the household food allocation of "self-sufficient rice producers," making them market-dependent. CAF may also not necessarily continue to be profitable in the future because of market uncertainty and risk factor, such as that already seen in the sharp decline in fish/shrimp farming. In contrast, farming households among the lower-income bracket have lost their traditional off-farm-related activities. Thus, their major sources of income are derived from non-farm-related activities because farm labor employment opportunities are significantly lower in CAF than in rice production. The study further shows that gender roles and relations have been changed along with the introduction of CAF at the intra-household level. Although the workloads have decreased, women's access to and control over the crop products at the household level have declined after shifting to CAF. Women are concerned over their loss of

access to resource allocation even for daily household consumption. They are now more dependent on the market and on their husbands in purchasing food (rice) for household consumption.

Some policy implications could be derived from this study for long-term sustainable household food security. First, food security is the primary objective of rural households and hence, rice farming is inevitable, although there has been an increasing trend of adopting CAF. Therefore, in view of labor shortage and male out-migration, women-friendly mechanization for transplanting and harvesting is urgently needed to promote rice cultivation. These machines could be effectively and efficiently used by women's groups acting as service providers to generate income. Second, diversifying rice-based farming systems (e.g., inter-cropping system, improved cropping system) with vegetables, legumes, and lentils could be effective risk-management strategies for sustainable agriculture-based enterprises, which could benefit women and poor farmers. Third, due to limited access to credit or availability of small credit, the poor and the lower-medium-class households, including women, have not benefited from CAF unlike households that are better-off. Therefore, equitable and easy access to low-interest agricultural credit, provision of credit without collateral, and training are likely to benefit women and poor farmers with CAF and reduce income inequality.

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Table 1: Sampling design of the study

Dominant farming systems	Districts & Villages			Sample household (no.)[1]
	Mymensingh	*Khulna*	*Sathkhira*	
Rice cultivation	Boalmara	Mailara	-	80
Commercial aquaculture (shrimp & white fish)	Nishaigunj	Paikgacha, Surkhali	Govindakatti	160
Emerging fingerlings & table fish	Noldnigi, Pachashi	-	-	80
Rice and aquaculture (one season rice and other season shrimp/white fish)	-	-	Porandhaha, Sahara	80
Total	**10 villages from three districts**			**400**

[1] Forty households were surveyed in each village.

Table 2: List of indicators identified by the participants for different socio-economic groups.

Socio-economic group			
Rich	**Upper -Medium**	**Lower -Medium**	**Poor**
• Own about 3.24 to 4.05 ha of agricultural land •Engage as fish dealers or cultivators of large size of fish •Own brick houses •Household members have high educational level •Engage in government services (i.e., teacher, government agencies) and also judges in the village	• Own about 1.6 to 2.4 ha of agricultural land •Own good clay protected houses with roofs of iron sheets •Engage in fish dealers or cultivate own medium-size fishes •Involved in government or non-government organizations •Household members hold a educational qualifications	• Own a small amount of agricultural land • Involved in vegetable growing • Loan for household expenditure •Do the work themselves and sometimes for others •Have small houses with roof of corrugated iron sheets •Work for garment factories	•No agricultural landholdings or own only traditional thatched cottage •Food deficit for the whole year •Livelihood depend on wage labor on a daily basis (e.g., pulling rickshaws, driving vans, catching fish) •Loan from NGOs •Earn from farm labor and catching fish • May cultivate others' land

Source: Group discussion, 2011-12.

Table 3: Total land owned and operated by different socio-economic groups among sample households in Bangladesh (ha).

Landholding	Poor	Lower-medium	Upper-medium	Rich	Total
Land own	0.09	0.18	0.61	1.81	0.49
Farm size	0.07	0.22	0.56	1.43	0.43
Leased-in land	0.06	0.13	0.22	0.39	0.17
Leased-out land	0.03	0.04	0.19	0.62	0.16

Note: Land-owned = homestead + own cultivated + rented-out
Farm size = own cultivated + rented-in
Source: Field survey 2011-12

Table 4: Average costs and returns of aquaculture and rice cultivation in sample households in Bangladesh, 2011-12 (US$/ha/year).

Cost and return items	Aquaculture	*Aus* rice	*Aman* rice	*Boro* rice
Total fixed costs (TFC)	467	55	179	219
Total variable cost (TVC)	1,650	546	442	842
Total cost (TC = TFC + TVC)	**2,117**	**601**	**621**	**1,062**
Gross revenue (GR)	4,362	568	781	1,565
Net revenue (NR = GR - TC)	**2,245**	**–33**	**160**	**503**
Benefit-cost ratio	2.1	0.9	1.3	1.5

Note: Official exchange rate for 2011 is used here: US$1 = 74 Taka
Aquaculture includes fishpond, shrimp, prawn, and fingerlings.
Source: Field survey, 2011-12.

Table 5: Percentage distribution of household income from various sources in sample households in Bangladesh, 2011-12 (N = 400).

Income source	Poor	Lower-medium	Upper-medium	Rich
Farm income	**46**	**36**	**58**	**73**
Rice	3	10	11	10
Non-rice crop	2	2	4	2

Aquaculture	1	3	27	50
Livestock	7	10	7	3
Wage labor	31	10	2	0
Land rent	2	2	7	8
Non-farm income	**54**	**64**	**42**	**27**
Business	11	21	14	13
Services	19	26	19	10
Remittance	3	5	6	4
Wage labor	20	12	4	0
All sources (US$/hh/year)	**923**	**1,300**	**1,909**	**4,631**

Note: Exchange rate used, US$1 = 74 Taka.
Source: Field survey, 2011-12

Table 6: Gini coefficients for measuring income distribution and inequality among sample households in Bangladesh, with and without aquaculture.

Households	Gini coefficient (index)
With aquaculture	0.48
Without aquaculture	0.35

Data source: Household survey 2011-12.

Table 7: Access to credit by different socio-economic groups among sample households in Bangladesh, 2011-12.

Sources of credit	Socioeconomic group				
	Rich	**Upper-medium**	**Lower-medium**	**Poor**	**Total**
Commercial banks	6	7	1	1	15
NGOs	16	30	17	10	73
Money lenders	0	3	1	2	6
Others (relatives and friends)	0	4	1	0	5
Sample size	22	44	20	13	**99**

Source: Field survey, 2011-12.

Table 8: Labor use in *boro* rice cultivation by gender and by source of labor among sample households in Bangladesh (days/ha).

Rice operations	Family labor			Hired labor	Total
	Male	Female	Joint		
Land preparation	8.15	0.3	0.7	10.1	19.8
Sowing/seed-bed preparation	4.0	0	0.7	2.5	7.2
Transplanting	8.9	0.5	1.7	40	51.1
Fertilizer application	5.2	0.0	0.0	0.7	6.2
Weeding	9.1	1.5	1.2	20.0	31.9
Harvesting and threshing	11.1	1.0	2.7	40.0	55.1
Stocking/storage	2.2	7.4	4	4.0	17.5
All operations	***48.5***	***10.7***	***11.3***	***117.7***	***188.8***
Percentage of total	**26**	**6**	**6**	**62**	**100**

Source: Field survey, boro season, 2011-12.

Table 9: Comparison of labor use in commercial aquaculture farming (CAF) by gender and source of labor among sample households in Bangladesh (days/ha).

Fish-related activities	Family labor			Hired labor	Total
	Male	Female	Joint		
Labor for pond construction					
Dikes/refuge preparation	8.7	1.5	1.5	63.5	74.8
Labor for operation and management					
Fingerling collection	7.7	0.3	0.5	1.5	9.6
Fish feeding	29.7	2.5	1.0	12.8	45.9
Fish harvesting	13.1	0.7	0.3	14.1	27.9
Security guard for fishpond	43.4	0.7	0.7	23.7	74.6
Total labor for operation and management	**93.8**	**4.2**	**2.5**	**52.1**	**152.6**
Percentage of total	**61**	**3**	**2**	**34**	**100**

Source: Field survey, 2011-12.

Note: This data was collected throughout the year.

Fig 1: Conceptual framework of this study

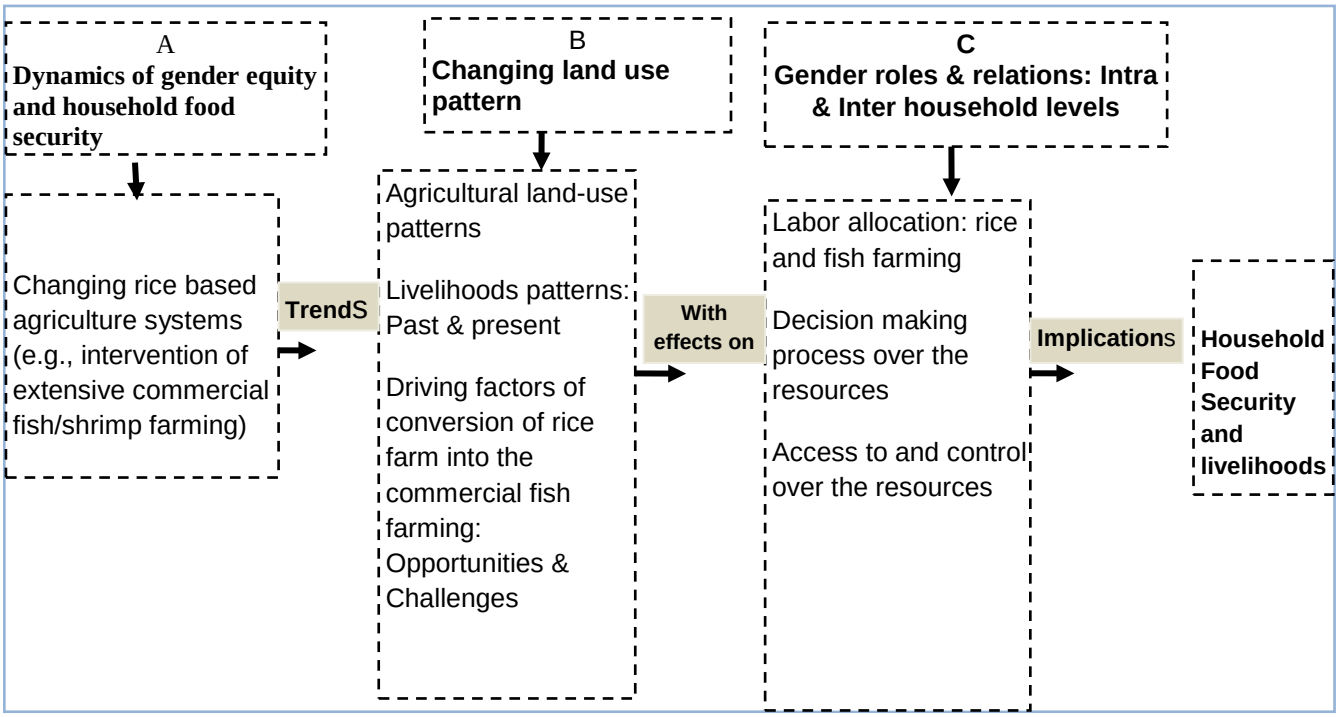
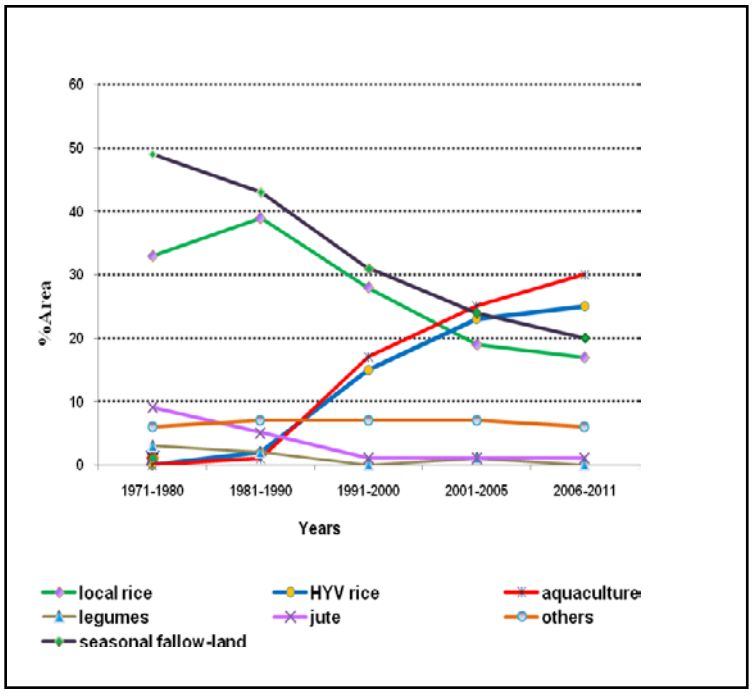


Fig 2: Farmers' perception about land-use changes from 1971 to 2001 (%).



Source: Key informant group discussion, 2011-12.

Fig 3: Number of ponds constructed by sample households in Bangladesh, 1968-2011.

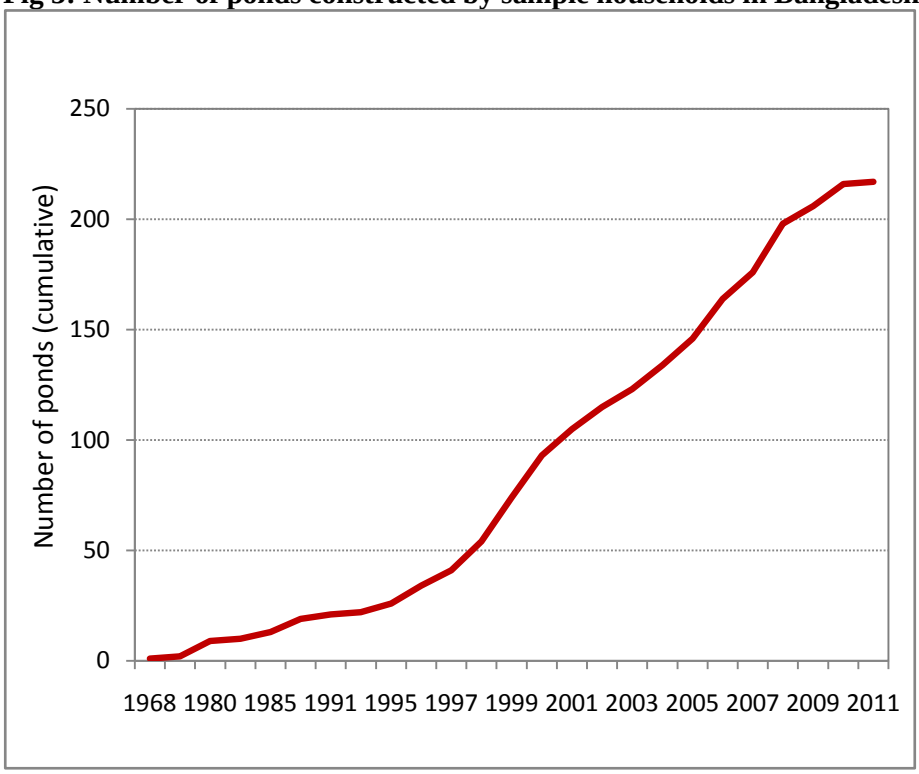


Fig 4: Lorenz curves for measuring income distribution and inequality with and without commercial aquaculture farming among sample households in Bangladesh, 2011-12.

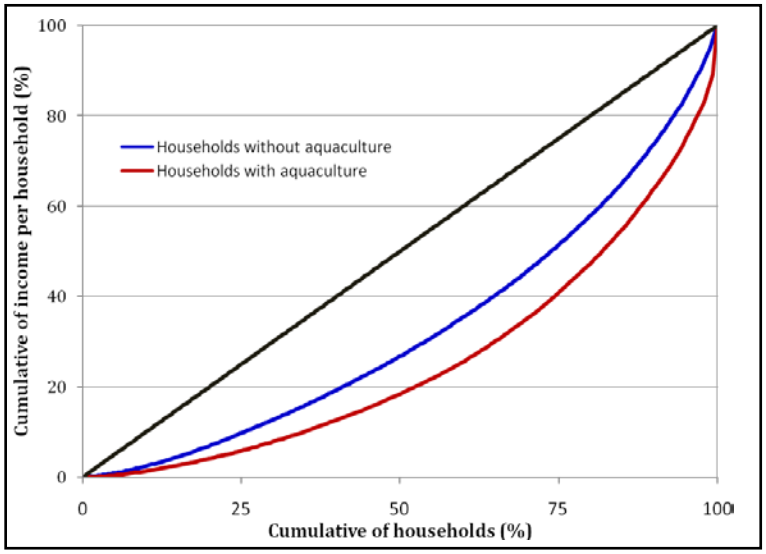
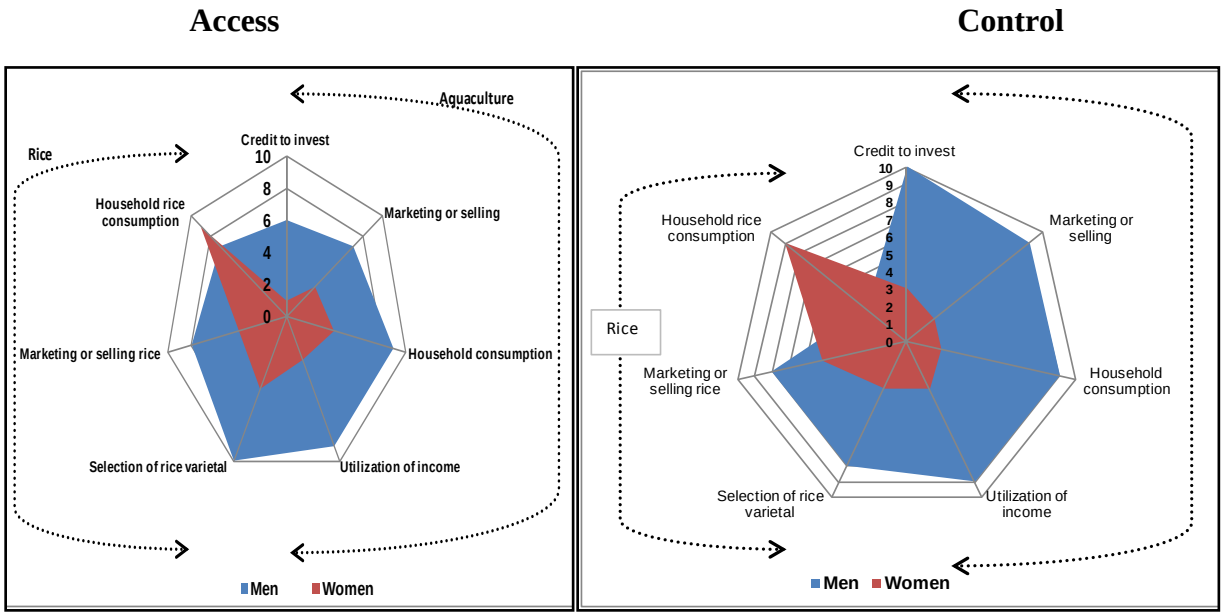


Fig 5: Comparison of self-evaluated score of access to and control over commercial aquaculture farming and rice-related activities by gender.



Note: 0 to 2= no, 3 to 5= limited, 6 to 7 = average, 8 to 10 = strong. Source: Group discussion, 2011-12.