Application of Alternate Wetting and Drying (AWD) in Bangladesh Agriculture: Findings from case studies

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Abstract

Due to increasing scarcity of freshwater resources available for irrigated agriculture and escalating demand of food around the world, it will be necessary to produce more food with less water. Since, more irrigated land is devoted to rice than to any other crops in the world, wastage of water resource should be minimized (IRRI, 2003). Rice has been grown in low land areas under flooded conditions which required 3000-5000 liters of water for producing one kg rice. To address the problems of water scarcity, researchers had been looking for ways to decrease water consumption. One method to save water in irrigated rice cultivation is the intermittent drying of the rice fields instead of keeping them continuously flooded which is alternate wetting and drying irrigation (AWDI). For up scaling AWD, it is better to start with support for wider practices. Five case studies were conducted at Muktagacha, Phulpur, Trishal upazillas of Mymensingh district and Nalitabari and Nokla upazillas of Sherpur district in Bangladesh. It is seen that overall yield increased 11.7 percent by applying AWD where as it was 12.36 percent at DAE demonstration (DAE, 2010). It also can reduce irrigation use (29 to 34%) and pumping cost significantly. DAE demonstration experience through NATP showed that by using AWD, irrigation reduced 33 percent and cost reduced about 27.98 percent (DAE, 2010). BCR of applying AWD is 1.30 meaning is AWD application is beneficial for farmers. It can be concluded from FGD and IFDC's research that: AWD demonstration saved amount of water, time and labour; yield of rice is higher in AWD plot than traditional practice. Finally undertaking massive dissemination of AWD programs through DAE staffs at the field level and print and electronic media such as TV, News paper, etc. are required.

Keywords: Irrigation, water saving technology, AWD, Bangladesh

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Background of the Study: History of AWD in Bangladesh

Due to increasing scarcity of freshwater resources available for irrigated agriculture and escalating demand of food around the world, in the future, it will be necessary to produce more food with less water. Since, more irrigated land is devoted to rice than to any other crops in the world, wastage of the resource in the rice field should be minimized (IRRI, 2003).

From time immemorial, in Bangladesh rice has been grown in low land areas under flooded conditions. Rice grown under traditional practices requires between 3000-5000 litres of water for a cropping season depending on soil texture. The actual amount of water used by the farmers for land preparation and during the crop growth period is much higher than the actual field requirement. Because of this, rate of aquifer depletion has increased which results in water scarcity. To address problems of water scarcity, researchers had been looking for ways to decrease water consumption of the rice crop.

One method to save water in irrigated rice cultivation is the intermittent drying of the rice fields instead of keeping them continuously flooded. This method is referred to as alternate wetting and drying irrigation (AWDI). The first trial of AWD in Bangladesh was conducted in 2004, by BRRI and BRAC with the support from IRRI. Information about the technology was spread through workshops and seminars for NARES stuff and training of trainers was conducted with key stakeholder organizations in 2007-08. There was further testing and piloting of AWD from 2008 to 2010 and national workshop was held in 2009. The out scaling of AWD was facilitated by multistakeholder collaboration which include BRRI, IRRI, DAE and BMDA which manages deep well irrigation schemes. It also included private sectors, such as Syngenta and the NGOs IDE partnered with Katalyst and RDRS. BRRI's role was in research and training on AWD, while DAE was responsible for actual dissemination through extension activities linked with their major programs. For knowledge intensive technologies such as AWD, farmer training and group approaches were particularly useful especially FFS, which created experiential learning over time rather than in one-off training session. Support from local champions such as village chairman and representatives of local government were important. In Bangladesh the media such as radio and TV had a strong engagement from the beginning. It is difficult to get an accurate estimate of the scale of adoption. In July 2009 the secretary of Ministry of Agriculture endorsed AWD as a national program and directed the DAE to promote it to farmers nationwide.

With support from CP10 project "Developing and Disseminating Water-saving Rice Technology in South Asia" a validation trial was conducted at Madhupur farm of Bangladesh Agricultural Development Corporation (BADC) in 2005-2006 Boro seasons. This was a preliminary work and was repeated during 2006-2007 Boro seasons. This was managed in a more organized way over 1.5 acre. The yield obtained in AWD plot was 8.4 ton/ha. The information received wider publicity in the national dallies and Television. A comprehensive report on this activity was prepared by BADC, Madhupur farm. The field day received wider media publicity in Bangladesh Television. The Secretary of MoA directed four public sector organizations (BRRI, BADC, BMDA, DAE) for validation at wider scale. These organizations

prepared action plans for 2007-2008 Boro seasons reflecting higher budgetary requirement. The Ministry of Agriculture sent all these action plans to IRRI Liaison Scientist for Bangladesh for compilation. The Ministry was requested by IRRI Bangladesh Office to discuss the compilation report of the action plan. In the meeting, all organizations pointed out their fund crisis as they had no project or budget specifically for this AWD activity. Then BADC, DAE, BRRI and BMDA submit a program on AWD to MoA for funding support during 2008-2009 Boro seasons. DAE included the topic of AWD in all its routine training at CERDI and in syllabus for ATI. Initially BRRI/IRRI sent the resource persons. FoSHoL Project of IRRI, print and provide 10,000 leaflets on AWD for the four agencies and 100 pieces of perforated plastic pipe (40 cm long) to each agency. Entire activity of AWD validation was coordinated by BRAC. All agencies have to submit updated action plan for next Boro season to BARC.

IFDC has employed alternate wetting and drying (AWD) in Bangladesh funded by the U.S. Agency for International Development (USAID). To produce AWD water tubes and ensures the availability of supply, IDE and Katalyst both organizations teamed up with Hatim Company, a manufacturer of polyvinyl chloride (PVC) pipes. IDE and Katalyst also facilitated the setting up of 72 AWD demonstration plots and 22 farmers' field days in Bogra District, Bangladesh. A documentary drama video on the benefits of the safe AWD technology was shown to around 2,500 farmers. The IDE and Katalyst will continue to facilitate the promotion of AWD among farmers and widen its coverage area to other districts in Bangladesh. IFAD also focuses and providing financial support to AWD technology through its partner organizations.

The constraints of AWD in Bangladesh were mainly institutional in nature. First the most common arrangement for payment of water, a fixed seasonal rate, does not provide farmers with an incentive for reducing water consumption. Pump owners do not pass on economic benefits from the saving in water and energy. Negotiating a changed arrangement would require a collective agreement of all farmers in a scheme to implement AWD. The NGO RDRS made efforts to facilitate farmer organization and influence, facilitating a farmer's forum and organizing a workshop for dialogue with pump owners. However pump owners especially those using subsidised electricity were not very willing to change. The second constraint relates to a lack of organizational capability for promoting AWD nationally in the way that NIA was able to do in the Philippines. AWD has been successfully promoted at a local level by NGOs working with the DAE, but it was not fully implemented as a national campaign.

In the search for an easy tool to signal the irrigation time, a perforated field water tube was developed which is used in AWD process. The tube is inserted into the soil 10 to 15 days after transplanting and is used to visually monitor the water table in the field. It replaced earlier method; the length of irrigation intervals used by farmers. The tube may be made out of PVC, but locally available materials, e.g. perforated soda bottles or bamboo pipes, are also suitable to measure the water depth.

AWD is a knowledge-intensive technology as it is based on the insights gained by scientists at IRRI that rice, despite being a semi-aquatic plant can tolerate reduced water supply

without suffering any negative effects. As the water level drops below soil surface, the soil is still saturated. Water is still available for the rice plant. Hence, the water level in the rice field can drop down to 15-20 cm below the soil surface without significantly affecting yield. Intervals between re-irrigation can be extended for several days. This contradicts the traditional belief that standing water is necessary at all times during rice cultivation.

Continuous flooding of rice paddies is only required up to 15 days after transplanting and during flowering. Reduced water supply at these growth stages would result in hampered plant growth and panicle development, which would result in yield losses. At the same time, expanding the aerobic conditions in the rice field two weeks after transplanting until the flowering stage can cause the growth of more weeds. It is often suggested that AWD increases the labor costs for weeding or requires the use of herbicides to control the growth of weeds. However, extra costs may be offset by an additional yield of half a ton/ha.

Farmers are currently paying an equivalent of 25 to 30% of their rice harvest for irrigation and these costs are tending to increase. This presents another factor for the economic relevance of water-saving at the farm level. Experts state that on a national level, the implementation of AWD could save costs of irrigation by lessening one-third times of irrigation number, reducing fertilizer use. AWD may also increase the concentration of essential dietary micronutrients in the grain. AWD combines the beneficial aspects of both aerobic and anaerobic cultivation. It improves water use efficiency, strengthen the root and shoot of rice plant and can improve yield by increasing the proportion of tillers that are productive. This method is very low-cost (the pipe only costs a few Taka) and saves irrigation water costs without yield loss. Justification of AWD technology is better understood and is more efficient where more frequent irrigation is needed.

However, many factors play a role in determining the success or failure of AWDI. Some of these factors can be influenced, such as irrigation infrastructure and irrigation management capacity, while others cannot be, such as rainfall and soil conditions. The increased productivity of water is likely to be the critical factor that will make farmers and officials adopt AWDI in water-scarce areas. Social changes at the level of the farmers, which may be attributed to the application of AWD, could not be observed yet. This seems related to the fact that wide-scale adoption of the technology has not happened so far. There is an assumption that a reduction of excessive consumption of irrigation water ultimately contributes to the alleviation of conflicts over scarce water resources. However, successful irrigation management with AWD and sharing of benefits from water saving will only be achieved through collective action. This requires that medium, small-scale and marginal farmers within irrigation systems establish close collaboration. Adoption levels will then increase and this will enable to social changes to be measured.

Support of the policy makers is very vital in popularizing and up scaling a technology. A constant facilitation and cooperation are needed for wider scale adoption of a technology generated by IRRI or other donor supported projects. For up scaling a technology like this, it is better to start with support for wider practice through relevant professional organizations

before organizing farmers in large scale. Experience of such organizations will have a demonstration effect.

Brief Description of the Specific Case Studies

Case I: Location: Village: Joynakanda Union: Dulla Block: Chachuya Upazilla: Muktagacha District: Mymensingh

The FGD conducted in Joynakanda including 15 farmers (i.e. farmers under AWD practices, non AWD, school teacher, and rural influential person). The SAAO helps in the selection process because he is a familiar person for his close attachment to the farmers in that locality.

The age of the household head in Joynakanda varies from 25-65 years. In this locality 50 percent of the population is men and the remaining 50 percent are women. On an average they are literate (i.e. schooling up to class 8). The people of Joynakanda mainly depend on agriculture for their livelihood. Among which 90 percent of the people are depended on agriculture for their survival and the rest are involved in business or other sources of income. For agriculture practices irrigation is utmost necessary due to inadequate rainfall farmers use irrigation throughout the rice growing seasons. About 12 STW are operating in the study area and the command area is 5-6 acres. Two types of payment in case of two STW operations are available. If the STW is electric operated then the farmer's have to pay 60 BDT/Decimal/Season, on the contrary if it is diesel operated 25 BDT/Decimal/Season together with diesel has to be paid. The irrigation is beneficial because the soil is loam soil and all the lands are medium type land.

From the output side farmers' satisfaction is moderate. In their paddy field they get 18 mounds per 30 decimal. In Jaynakanda 30 decimal is equivalent to 1 *Bigha*. Farmer's objection about the paddy price is always going on, if they have any opportunity to express their feelings, at first they touch the topics of paddy price. Now a day they get BDT 600 per mound and the price of straw is BDT 200 per *Bigha*.

Before 1996 farmer use DTW for irrigation practices. DTW was installed in 1982 in that locality. Now DTW is already extinct, farmers are habituated with STW practices since 1996. STW owners are the local people, after irrigating their own field they use STW for business purposes and their command area is 5 to 6 acre including their own land. A single STW irrigates 10-12 persons paddy field. Due to nepotism the payment system is flexible, farmers pay their irrigation charge in two installment. In most of the cases they pay the second installment after harvesting their paddy field. A general meeting with the village people especially those who are involved in farming is held to fix up the irrigation charge. They check the unit of electricity by running STW to make trial, after that the irrigation charge is fixed up. The water level is 50 feet from the surface. Irrigation water is available except March-April at that time water scarcity hampers rice field. All the STW power ranges from 3 to 6 HP.

Traditionally farmers practice 26 times irrigation in their paddy field per season. But due to AWD they save 5-6 times irrigation. AWD saves the water and ensure higher yield.

Farmers Perception about AWD

AWD is a water saving technology but it is not wide spread. Due to AWD yield increases. It helps in proper growth of paddy plant; make the plant stronger and healthier. Stagnation of water hampers the paddy; make the plant weaker which always results in lower yield. AWD reduces cost of irrigation because less water is required; as the paddy field is in dry condition for certain period pest and disease infestation is comparatively lower. Although some people mentioned about the weed germination, but they apply pesticides and insecticides so it is not a problem at all. The farmers also mentioned that it saves 5-6 times irrigation water. They think that this technology is acceptable technology. Some of the farmers are well concerned about AWD by IFDC; they also receive training offered by IFDC.

Suggestions Offered by the Farmers regarding AWD

This practice is suitable only for high and medium type land, due to stagnation of water low land is unsuitable for this kind of practices. Traditional technologies are acceptable due to farmer's orthodoxy, so people have to be informed about the advantages of AWD. Department of Agricultural Extension (DAE) can take the step to introduce AWD because they have wider coverage. Media can offer advertisement about AWD and its method of implementation or a successful case may be broadcast through TV channel for better understanding of the farmers. Government can take proper steps to implement this technology through proper channel.

Finally the FGD draws the message that, AWD is a water saving and beneficial technology and the farmers are much more interested to accept this technology but they have an appeal to the government that the electricity charge are fixed randomly without considering the unit uses, although AWD saves water but they have to pay the same irrigation charge so government can take proper steps to ensure the ultimate benefit of AWD.

Case II Location: Village: Runygao Union: 4 No. Gordan Block: Nokla Upazilla: Sherpur

The FGD conducted in Runygao including 15 farmers (i.e. farmers under AWD practices, non AWD practices, rural literate person, rural influential person and large or leading farmer). The SAAO helps in the selection process because he is a familiar person for his close attachment to the farmers in that locality.

The age of the all household heads ranges from 28-62 years. Among all people 52 percent people are women and rest of them are male. On an average all the household head has schooling upto seven or eight class. About 95 percent people are engaged in agriculture, remaining 5 percent are involved in business or other activities. In Runygao 55 STW are operating. Two types of payment in case of two STW operations are available. If the STW is

electric operated then the farmer's have to pay BDT 3000-4000/ acre, on the contrary if it is diesel operated BDT 2000/acre, together with diesel has to be paid. The irrigation is beneficial because the soil is loam soil and all the lands are medium type land.

The farmers get 22-24 mounds per 33 decimal (i.e. 33 decimal is equivalent to 1 Bigha). They get BDT 500-550 per mound and the price of straw is BDT 200 per Bigha. DTW was installed in 1973 in that locality. Now DTW is already extinct, farmers are habituated with STW practices since 1985. STW owners are the local people, after irrigating their own field they use STW for business purposes and their command area is 5 acre including their own land. A single STW irrigates 20-30 persons paddy field. The owner of the farm (i.e. the buyer) monitors their field in case of irrigation. Two-third of the STW is diesel operated and one-third is electricity operated. About 70-80 percent of command area is owned by buyers and 20-30 percent of command area is owned by seller. Due to nepotism the payment system is flexible, farmers pay their irrigation charge in two installment. In most of the cases they pay the second installment after harvesting their paddy field. All the farmers are relatives in many sides for that reason they have contact everyday about their daily requirements and farm practices. The water level is 40-50 feet from the surface. Irrigation water is available except March-April at that time water scarcity hampers rice field. All the STW power ranges from 3 to 16 HP. Traditionally farmers practice 26 times irrigation in their paddy field per season. But due to AWD they save 6-7 times irrigation. In irrigation practice load shading is the main problem although some of the farmer use AWD but due to load shading they are quite unable to irrigate their plot in the proper time. So they are in vulnerable situation to maintain the schedule time of irrigation when necessary.

Farmers Perception about AWD

AWD is a water saving technology. Due to AWD yield increases (i.e. in the study area yield increases 8 mound per Bigha). It helps in proper growth of paddy plant; make the plant stronger and healthier. Stagnation of water hampers the paddy; make the plant weaker which always results in lower yield. AWD reduces cost of irrigation because less water is required; as the paddy field is in dry condition for certain period pest and disease infestation is comparatively lower. Although some people mentioned about the weed germination, but they apply pesticides and insecticides so it is not a problem at all. The farmers also mentioned that it saves 20 percent irrigation water. They think that this technology is acceptable technology. Some of the farmers are well concerned about AWD by IFDC; they also receive training offered by IFDC.

Suggestions Offered by the Farmers regarding AWD

This practice is suitable only for high and medium type land, due to stagnation of water in low land is unsuitable for this kind of practices. Field demonstration can be introduced. Department of Agricultural Extension (DAE) can take the step to introduce AWD because they have wider coverage. Media can offer advertisement about AWD and its method of

implementation. Government can take proper step to implement this technology through proper channel.

Government can take proper steps to make it familiar up to the root level and can increase subsidy in electricity at the same time monitor the authority for proper implementation. In Bangladesh the proper distribution of government help is the main problem. After that the real benefit of AWD can be ensured.

Case III Location: Village: Uttar Kapasia Union: Jugania Upazilla: Nalitabari

The FGD conducted in Uttar Kapasia including 15 farmers (i.e. farmers under AWD practices, non AWD, school teacher, and rural influential person). The SAAO helps in the selection process because he is a familiar person for his close attachment to the farmers in that locality.

All the farmers in Uttar Kapasia are middle aged farmer (i.e. the age of the all household heads ranges from 40-50 years). Among all people 52 percent people are women and rest of them are male. On an average all the household head has schooling upto seven or eight class. About 85 percent people are engaged in agriculture, remaining 15 percent are involved in business or other activities. In Uttar Kapasia 20 STW are operating. Two types of payment in case of two STW operations are available. If the STW is electric operated then the farmer's have to pay BDT 4000-5000/ acre, on the contrary if it is diesel operated BDT 2000/acre, together with diesel has to be paid. The irrigation is beneficial because the soil is Clay loam soil and all the lands are medium type land. The farmers get 70-75 mounds per acre. They get BDT 630 per mound and the price of straw is BDT 1000 per acre.

DTW was installed in 1976-1986 in that locality. Now DTW is already extinct, farmers are habituated with STW practices since 1987. STW owners are the local people, after irrigating their own field they use STW for business purposes and their command area is 5 to 6 acre including their own land. A single STW irrigates 5-10 persons paddy field. One-third of the command area is owned by seller and two-third is owned by buyers. There are approximately 15 to 18 STW in Uttar Kapasia. Two part tariff contract is used for irrigation. The water level is 65-70 feet from the surface. Irrigation water is available except March-April at that time water scarcity hampers rice field. All the STW power ranges from 5 to 12 HP. Traditionally farmers practice 24-27 times irrigation in their paddy field per season. But due to AWD they save 1 to 4 times irrigation.

Farmers Perception about AWD

AWD is a water saving technology and saves one-fourth of irrigation. Due to AWD yield increases. It helps in proper growth of paddy plant; make the plant stronger and healthier. Stagnation of water hampers the paddy; make the plant weaker which always results in lower yield. AWD reduces cost of irrigation because less water is required; as the paddy field is in dry condition for certain period pest and disease infestation is comparatively lower. Although

some people mentioned about the weed germination, but they apply pesticides and insecticides so it is not a problem at all. They think that this technology is acceptable technology. Some of the farmers are well concerned about AWD by IFDC; they also receive training offered by IFDC. The non AWD practiced farmer are now interested to accept AWD technology.

Suggestions Offered by the Farmers regarding AWD

This practice is suitable for high and medium type land. Department of Agricultural Extension (DAE) can take the step to introduce AWD because they have wider coverage. Media can offer advertisement about AWD and its method of implementation. Government can take proper steps to implement this technology through proper channel. Demonstration at every villages or unions has to be introduced.

Finally government can make aware about the negative impact of using huge water and its losses in farm practice and broadcast the benefit of using AWD to motivate the farmers.

Case IV Location: village: Bakshimul union: 15 number Tarakanda union Sub-district: Tarakanda (Phulpur) District: Mymensingh

Tarakanda is a small upazilla of Mymensingh district with three block named Bakshimul , Tarakanda and Gopalpur. Bakshimul is a beautiful village under 15 no. union in Tarakanda with a very much scenic beauty. Most of the people of this village are farmer. They are mainly involved with agricultural farming and rice production. 65% of the farmers of this village are directly related to rice production and 35% of the people are related to non-farm occupation. In this village number of female member are higher than male members. We conducted our focus group discussion with 12 farmers. Their age was 28 to 62 years. Most of them are illiterate but they can sign their name. Two of them were studied upto class 8 and these two farmers were very much informative and helped us to collect first hand information. A young farmer, 31 years was too efficient about his farming and he was really an intensive farmer. The farmers were more or less small in category. Their average farm size was more or less 0.3acre to 4.0 acre (approximately). Soil of Bakshimul is mainly loam type. In some areas of Bakshimul we saw loam and clay loam type soil also.

Now we will concentrate on our study topic. It is ADW and irrigation system. The objectives of the study are to see the merit of using AWD to mitigate emissions from the irrigated boro paddy field and to suggest some policy guidelines for future development of the GW irrigation market in Bangladesh.

In our study area sources of irrigation is shallow tubewell. Here soil is loam type. Main crop is boro rice. Average yield is 5 to 8 mound approximately. Market price of per mound rice is tk.525 to tk.550. Here mainly AWD irrigation system is practiced. Boro season takes approximately 3.5 to 4 months. Farmers irrigate the field more or less 20 to 25 times in every rice season. In Bakshimul there are 150 to 200 shallow tubewell exist. Only one deep tubewell was used after the liberation war period. The owner of shallow pump rent irrigation water on

the basis of verbal contact. Borrower pays tk.400 for per 10 decimal crop field for getting irrigation water. In case of diesel machine tk.200 is paid by the borrower for irrigation water in every 10 decimal of crop land. From a 10 hp shallow pump 15 to 20 person can take water. A machine owner uses 40% of irrigation water for own and rent 60% of irrigation water. The relationship between machine owner and borrower is quite satisfactory. In some cases who borrow water does not clear their payment appropriately. For this reason a traditional Bengali program to collect their due payment. The machine owner monitors the irrigation activities twice a week.

AWD is a very much eco friendly and appropriate system of drying and wetting of crop field. This is good for crop and soil. It saves almost 20% of water. It reduces irrigation costs. It increases yield. AWD practice will help farmer by reducing costs. It will be an acceptable technology to all. It is labour saving technology also. The farmers of Bakshimul were trained from FDC and NATP and they are cordially accepting this modern technology of irrigation and ultimately they are really being benefitted from this practice.

Case V Location: Village: Boilorcharpara union, Sub-district: Trishal, District: Mymensingh

To conduct FGD on that day we reached Boilorcharpara union at 4.30 pm and continued the discussion on AWD application up to 6.30 pm. In that union the proportion of male is higher than female. Almost 70% people are directly connected with agriculture and another 30% are engaged with non-farm activities. There were 15 farmer participants who applied AWD in their crop field in boro season. Participant farmers were about 22 to 60 years old. Most of them were fifth to sixth grade passed. Almost of them were small farmers. In participating farmers highest land possessing farmer owns 4 acre land and lowest possession is 60dc.Their average land size were 2 to 2.5 acre. Soil texture is loamy here and it's a medium land area. Average depth of groundwater level is 40-45 ft from surface level in general but100ft below in dry season. In boro season they cultivate BRRI- 28 and BRRI-29 in their field. A farmer cultivates 40% of land under ownership and remaining 60% under leasing. In this union there were 10-15 STW owners and 5 DTW owner and most of the STW are operated by electricity only one is operated by diesel. By STW and DTW 10-15 acre and 30-40 acre is irrigated respectively in average. Charge of irrigation water is in fixed rate, 400-500 TK./10dc and payment is done in 3-4 installments. Whereas the unpaid portion of STW charge is cleared in Halkhata. And they kept no documentary on STW charge. One STW is used in 2-3 farmers land in average for irrigation purpose. In peak period of boro season they need 50% less water for irrigation purpose than other period.

Farmers Perception Regarding AWD

In boro season they use STW and DTW for irrigation purpose and paid a fixed rate to the well owner and the well owners have to pay electricity bill of STW on meter reading basis. They have started the use of STW from 2006. They heard about AWD due to IFDC and DAE

and also participates some training programs on AWD. There need 1/3 times less irrigation per season than traditional practices in AWD application. Groundwater level depletion has increased year by year. So they need to lift water from more depth which causes higher irrigation cost. Most of the STW here are operated through electricity, which saves the higher diesel cost and also the electricity bill as they require less irrigation in AWD process. They said due to this process they can save water and reduce cost of irrigation and fertilizer. In AWD process there need half times less fertilizer than traditional practices (80kg/acre urea saves). Due to AWD process the proportion of productive tillers has increased and strengthens the shoot and root activity. It is easy to fertilizer spreading, harvesting as the soil are not so muddy. And finally by applying AWD technique in their field in boro season they get 1.5 times higher yield per katha than in traditional practices. So in that area farmers are very interested to adopting and applying the AWD technology.

On the other hand, they said that the labor and fertilizer cost is high (350Tk./mandays) and (1000Tk/sack) respectively. And the well owners don't reduce the water charge even though there need less electricity for less irrigation. So their production cost is increasing day by day but the selling price of rice is very low (600Tk./mound) and earn 500Tk/acre from straw. Production cost of cultivating is 3000Tk./Katha. So with this selling price it is even very hard to recover the production cost. So they claim higher selling price of rice at least 800Tk./mound and need to reduce the water charge. And due to this loss they get discouraged to produce rice in next season; only produce up to subsistence level and they also claim that non farming activities will generate more income than rice production. Through this AWD process they can reduce production cost which indirectly increases the income in boro season.

Farmers Suggestions

- Government should give more subsidy to reduce production cost;
- Electricity bill should be reduced;
- The system of fixed electricity bill well should be removed;
- They needs sufficient electricity in boro season;
- Managing large numbers of farmer groups for irrigation requires a more sophisticated organization of the irrigation management.

Non-Farmers View

Non farmers said that they can't meet up the regular family expenses due to higher price of all regular necessary commodities and only the price of rice is reasonable. From their point of view, the price of rice should not be increased. So there is conflict between farmers and non-farmers about selling price of rice.

Recommendations

- People have to understand the usefulness of AWD process;
- There need to raise awareness among people to adopt it;

- DAE has to disseminate it to farmers nationwide;
- The media such as radio and TV should telecast programs on AWD;
- There need to illustrate the actual usefulness of AWD;
- This requires close collaboration among medium, small-scale and marginal farmers within irrigation systems.

Although the respondent farmers are satisfied with AWD technique, the adoption of AWD process in this area is still in its early stages. Key organizations from public, private and the non-governmental sectors have shown high commitment in promoting AWD, taking up the new technology and disseminating it within ongoing projects and programs. But the successful spread of this technology depends on good links between the organizations that disseminates AWD efficiently and effectively among the farmers.

Results from IFDC's Field Demonstration

It is seen from Table 6 that overall yield increased 11.7 percent by applying AWD where as the yield increase of DAE demonstration plot was 12.36 percent (DAE, 2010). On the other hand number of irrigation reduced 28.6 percent and hours of irrigation reduced 34.2 percent meaning is that application of AWD can reduce irrigation use (29 to 34%) and pumping cost significantly. DAE demonstration experience through NATP showed that by using AWD, irrigation reduced 33 percent and cost reduced about 27.98 percent (DAE, 2010).

Benefit Cost Analysis of AWD Application

It is very important to see the benefit-cost analysis of AWD application in the farmers' field. They always consider the direct benefit from one technology.

It is seen from the above mentioned table 7 that the additional cost for applying AWD technique at the farmers' field is about BDT. 13000.00/ha and additional benefit from it is about BDT. 16893.00/ha. BCR of applying AWD is 1.30 meaning is AWD application is beneficial for farmers.

Concluding Remarks

Considering water use, cost and returns, it is evident AWD irrigation method is superior. It can be concluded from FGD and IFDC's research that:

1. AWD demonstration saved amount of water, time and labour.
2. Yield of rice is higher in AWD plot than traditional practice.
3. AWD method of irrigation reduced irrigation cost and cost of production.
4. It gave higher gross return and gross margin to the AWD applied farmers.

Farmers' faced some basic constraints to adopt AWD methods in their field and those are:

1. Monitoring is difficult for them.
2. Commitment from the seller is not ensured.
3. Kacha channel is a problem to control irrigation water.
4. Irrigation mainly depends on owner of the machine.
5. Insufficient supply of electricity and higher price of diesel are problems for regular supply of water.

Strategies for Scaling-up AWD Technology

1. Undertaking massive dissemination of AWD program through DAE staff at the field level.
2. Undertaking extensive program to focus AWD technology through print and electronic media such as TV, News paper, etc.
3. Undertaking extensive training and motivational program for farmers, field workers of DAE as well as owners of the machine.
4. Drawing the attention of the policy makers through workshop and seminar.

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Appendix-1: Tables of the Study

Table 1 FGD Findings at a Glance at Muktagacha

Items	Measures
Male – Female ratio	50:50 percent
Age of farmers	25-65 years old
Education level of participants	0-12
Soil type	Loam
Land type	Medium
Occupation (Agriculture)	90 percent
Occupation (Business and others)	10 percent
Number of shallow tubewells	12 STW
Command area under STW	5-6 acre
Number of users in a STW	10-12 (persons)
Irrigation cost (Diesel operated)	25 (BDT /decimal/season) + Own diesel
Irrigation cost (Electric operated)	60 (BDT /decimal/season)
Horse power of tubewell	3-6 HP
Depth of ground water level	50 feet
Output	18 mounds per 30 decimal (30 decimal= 1 Bigha)
Price of Paddy	600 BDT /mound (1 mound = 40 kg)
Price of straw	200 (BDT/ Bigha)
Traditional irrigation practiced	26 times
Irrigation saved due to AWD	5-6 times

Source: Field Survey, 2015

Table 2 FGD Findings at a Glance at Nakla

Items	Measures
Male – Female ratio	52:48 percent
Age of farmers	28-62 years old
Education level of participants	0-11
Soil type	Loam
Land type	Medium
Occupation (Agriculture)	95 percent
Occupation (Business and others)	5 percent
Number of shallow tubewells	55 STW
Command area owned by sellers	20-30 percent
Command area owned by buyers	70-80 percent
Number of users in a STW	7-8 (persons)
Irrigation cost (Diesel operated)	2000 (BDT acre/season) + Own diesel (2/3 diesel operated)
Irrigation cost (Electric operated)	3000-4000 (BDT acre/season) (1/3 electric operated)
Horse power of tubewell	3-16 HP
Depth of ground water level	40-50 feet
Output	22-24 mounds/ 33 decimal (33 decimal= 1 Bigha)
Price of Paddy	500-550 BDT/mound (1 mound = 40 kg)
Price of straw	200 (BDT./ Bigha)
Traditional irrigation practiced	26 times
Irrigation saved due to AWD	6-7 times

Source: Field Survey, 2015

Table 3 FGD Findings at a Glance at Nalitabari

Items	Measures
Male – Female ratio	52:48 percent
Age of farmers	40-50 years old
Education level of participants	5-6
Soil type	Clay loam
Land type	Medium
Occupation (Agriculture)	85 percent
Occupation (Business and others)	15 percent
Number of shallow tubewells	20 STW
Command area owned by sellers	1/3
Command area owned by buyers	2/3
Number of users in a STW	5-10 (persons)
Irrigation cost (Diesel operated)	2000 (BDT./acre/season) + Own diesel
Irrigation cost (Electric operated)	4000-5000 (BDT /acre/season)
Horse power of tubewell	5-12 HP
Depth of ground water level	65-70 feet
Output	70-75 mounds/ acre
Price of Paddy	630 BDT /mound (1 mound = 40 kg)
Price of straw	1000 (BDT/acre)
Traditional irrigation practiced	24-27 times
Irrigation saved due to AWD	1-4 times

Source: Field Survey, 2015

Table 4 FGD Findings at a Glance at Tarakanda (Phulpur)

Items	Measures
Male – Female ratio	49-51 Percent
Age of farmers	28 - 62 years old
Soil type	Clay loam
Land type	Medium
Number of shallow tubewells	150-200 STW
Command area owned by sellers	60 percent
Command area owned by buyers	40 percent
Number of users in a STW	15-20 (persons)
Irrigation cost (Diesel operated)	200 (BDT/ 10 decimal /season) + Own diesel
Irrigation cost (Electric operated)	400 (BDT /10 decimal /season)
Horse power of tubewell	10 HP
Output	5 to 8 mounds
Price of Paddy	525-550 BDT /mound (1 mound = 40 kg)
Traditional irrigation practiced	20 - 25 times
Irrigation saved due to AWD	20 percent

Source: Field Survey, 2015

Table 5 FGD Findings at a Glance at Trishal

Items	Measures
Male – Female ratio	51:49 (percent)
Age of farmers	22-60 years old
Education level of participants	Fifth- Sixth Grade
Soil type	Loam
Land type	Medium
Average land size	2-2.5 acre
Owner's land in a command area	40%
User's land in a command area	60%
Number of shallow tubewells	10-15(persons)
Command area under STW	10-15 acre
Number of users in a STW	10-12 (persons)
Area operated by DTW	30-40 acre
Irrigation cost	5500 BDT/ha
Labor cost	350 BDT Man-day
Fertilizer cost	1000 BDT/sack
Major rice variety	BRRI-28, BRRI-29
Depth of ground water level	90-100 feet
Average yield in boro rice	5928 – 7904 Kg/ha

Source: Field Survey, 2015

Table 6 AWD demonstration results in Mymensingh and Sherpur region

District	Upazila	Yield (kg/ha)		Frequency of irrigation (no.)		Time of irrigation (hrs/ha)	
		AWD Plot	Farmers' Plot	AWD Plot	Farmers' Plot	AWD Plot	Farmers' Plot
Mymensingh	Muktagacha	6142 (5.7)	5810	8	12	98.8	118.7
	Phulpur	5139 (16.4)	4417	11	16	84.0	133.4
	Trishal	7308 (19.3)	6128	6	10	14.8	24.7
Average		6183 (12.7)	5488	8 (38.5)	13	64.2 (27.8)	88.9
Sherpur	Nakla	6233 (12.2)	5554	12	17	66.7	86.5
	Nalitabari	6280 (7.9)	5818	11	17	81.5	153.2
Average		6257 (10.0)	5686	12 (29.4)	17	71.6 (39.6)	118.6
Average figure of Mymensingh and Sherpur		6207 (11.7)	5558	10 (28.6)	14	66.7 (34.2)	101.3

Figures in the parentheses indicate percentage change.

Source: IFDC 2015 (Accelerating Agriculture Productivity Improvement, Quarterly Progress Report, April-June 2015, submitted to USAID-Bangladesh, IFDC, Muscle Shoals, Alabama 35662, USA.

Table 7 Benefit and cost of applying AWD at the farmers' field

Sl. No.	Cost and benefit items	Cost and benefit (BDT./ha)
1.	Additional cost for perforated pipe/bottle	1400.00
2.	Additional labour cost for irrigation and other management	5000.00
3.	Additional cost for weeding (Herbicides)	5600.00
A	Total additional cost for applying AWD	13000.00
4.	Monetary benefit from yield increase (11.7%)	10893.00
5.	Monetary benefit from reduced irrigation (30%)	6000.00
B	Total additional benefit for applying AWD	16893.00
6.	Benefit cost ratio for applying AWD (B/A)	1.30

Source: Author's calculation based on FGD at the village level

Table 8 AWD demonstration results in Mymensingh and Sherpur region

District	Upazila	Yield (kg/decimal)	Frequency of irrigation (no.)		Irrigation cost	
		AWD Plot	AWD Plot	Farmers' Plot	Diesel operated	Electricity operated
Mymensingh	Muktagacha	22.39	20 times	26 times	25 (BDT /decimal/season) + Own diesel	20 (BDT/decimal/ season + Unit electricity cost 60 (BDT /decimal/season)
	Tarakanda	24.26	20 times	26 times	20 (BDT/decimal /season) + Own diesel	40 (BDT/decimal /season)
	Trishal	28.00	13 times	18 times		50 (BDT/ decimal/season
Sherpur	Nakla	26.01	19 times	26 times	20 (BDT/decimal/ season) + Own diesel	30-40 (BDT/ decimal/season)
	Nalitabari	27.06	18 times	25 times	20 (BDT/decimal/ season) + Own diesel	40-50 (BDT /decimal/season)

Appendix-2

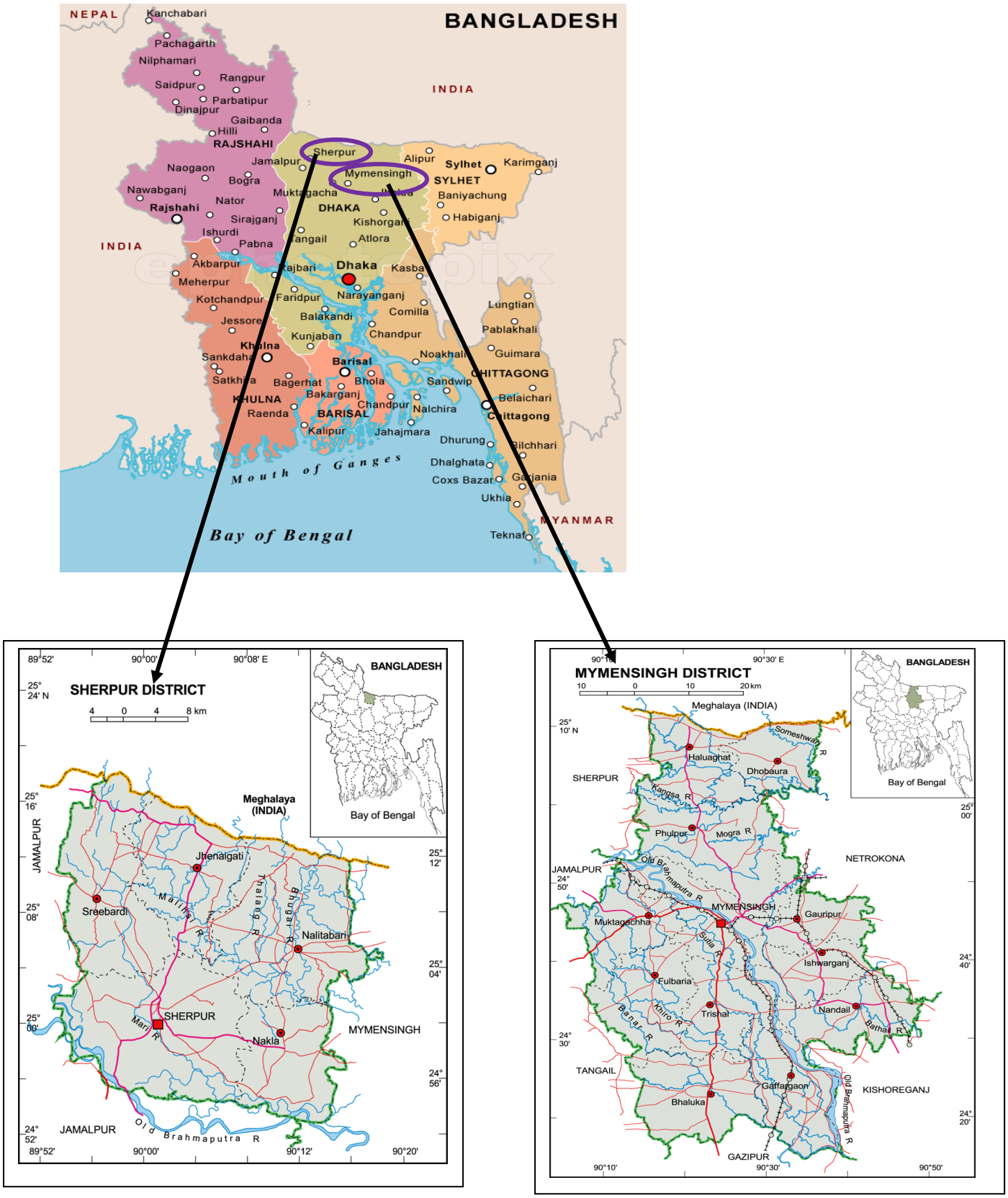

Figure: Map showing the selected Districts

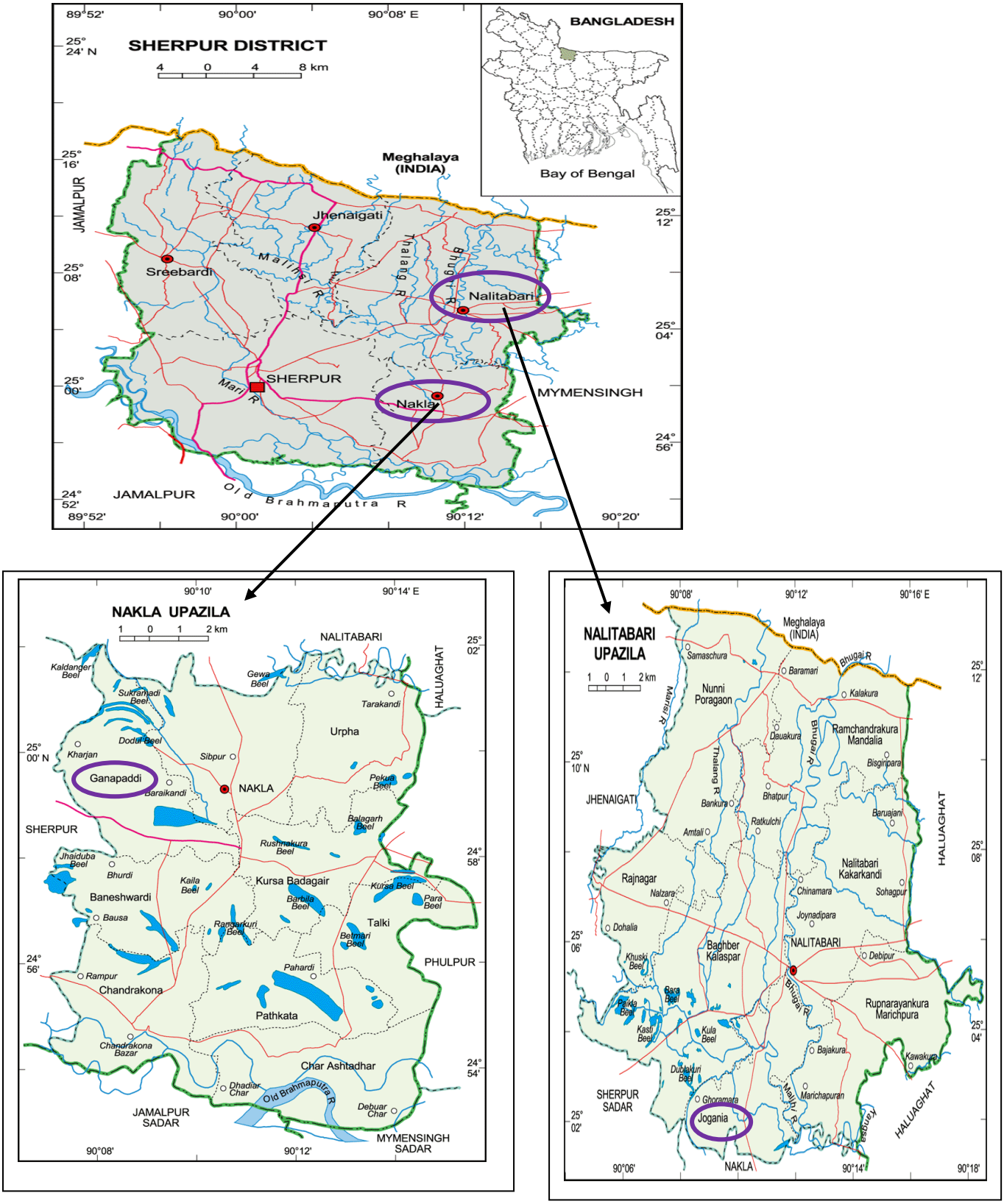

Figure: Map showing the selected Upazilas in Sherpur district

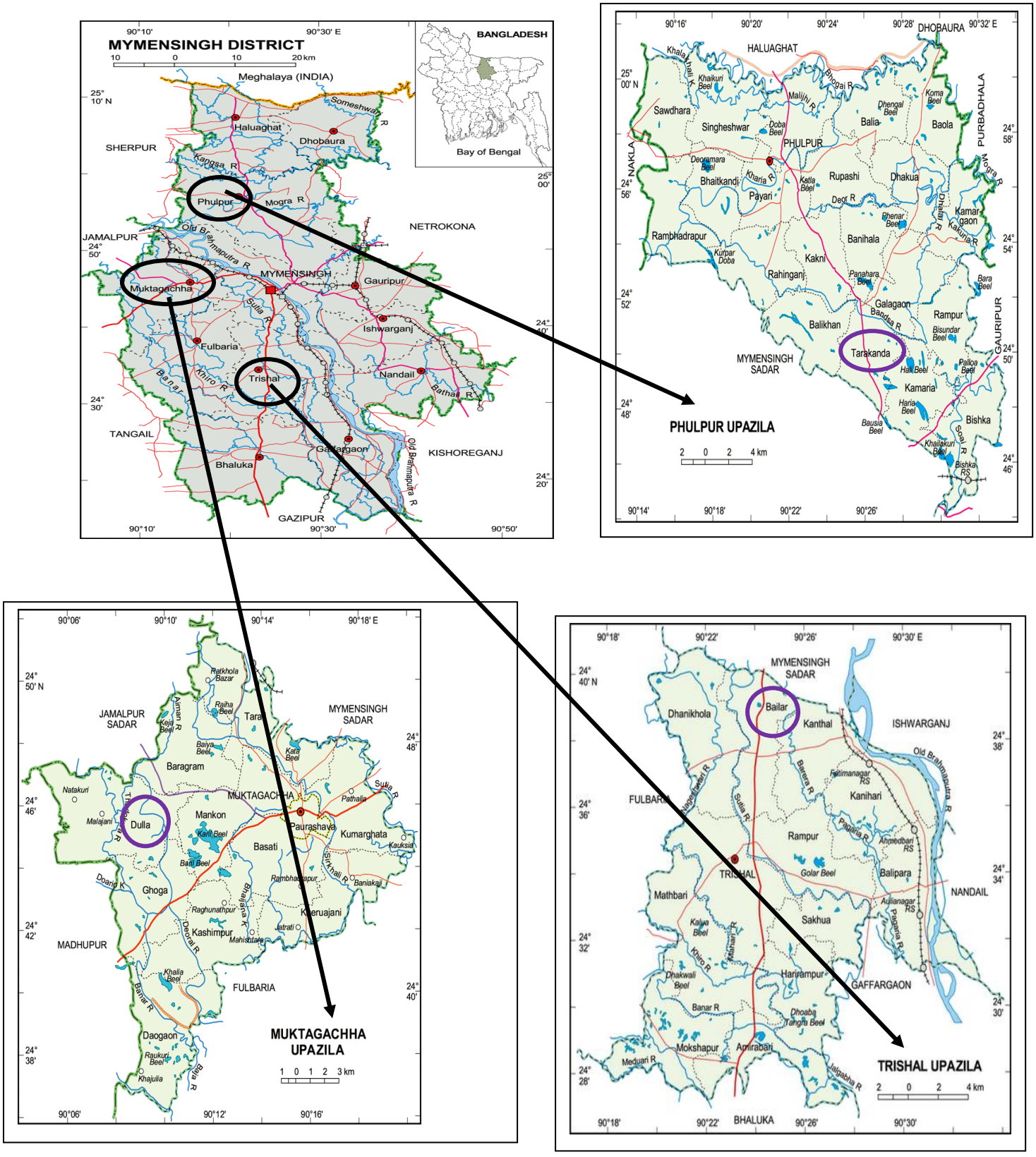

Figure: Map showing the selected Upazilas in Mymensingh district

Appendix-3

FGD Photo Gallery

Pictorial view of FGD at Muktagacha in Mymensingh

Pictorial view of FGD at Nakla in Sherpur

Pictorial view of FGD at Nalitabari in Sherpur


Pictorial view of FGD at Phulpur in Mymensingh


Pictorial view of FGD at Trishal in Mymensingh