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A CLIMATE RESILIENT MANAGEMENT PRACTICE IN RICE FARMING: ADOPTION OF ALTERNATE WETTING AND DRYING IN BANGLADESH

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A B S T R A C T

The aims of the study were to investigate the adoption status of alternate wetting and drying (AWD), finding out the reasons that affect in adoption of AWD and exploring the problems in practicing AWD at farm level. Data were collected from farmers of selected two villages named Noyanagar and Dhinagar of Jhilim union under Sadar upazila (sub-district) of Chapai Nawabganj district during August 2016. Randomly chosen 80 (40 adopters and 40 non-adopters of AWD) rice farmers were the sample drawn from a population of 600 rice farmers. For collecting quantitative and qualitative data both structured questionnaire and checklists were used. In the study area the level of adoption was at satisfactory level due to the scarcity of water especially in Boro seasons although the technique of AWD was not practiced properly. Majority (80%) of the AWD adopters received preliminary information on this technology mainly from grassroots level extension officers of DAE. Yet, more than half (60%) of the respondents did not receive any training on AWD. This is why a good number of the AWD practicing farmers (45%) had low knowledge on the technology which lowered the rate of adoption. According to the majority of the adopter farmers (92%), main reason of adoption of this technology was for saving irrigation cost. On the other hand, mismatching of existing irrigation scheme with AWD was the major barrier for the adoption according to 98% of the farmers. The existing pattern of irrigation scheme created major problems for practicing AWD as perceived by the farmers (80%). Therefore, the policy maker may rethink on the irrigation policy to rearrange this irrigation scheme. Besides, proper motivational activities should be launched by the different GOs and NGOs in collaboration with DAE to increase the rate of adoption of this water saving technology.

Keywords: Adoption, AWD, rice farming, climate-smart practice

INTRODUCTION

The Rice is the major staple food of Bangladesh which requires a lot of irrigation water for production. Irrigation water in Bangladesh is becoming increasingly scarce. To fulfill the food demand of a rapidly growing population amidst this increasing water scarcity, more efficient water management practices - water-saving technologies - are required. On the global average 3400 liters of water are used to grow one kilogram of rice (Hoekstra, 2008), which makes rice a very water-intensive crop. As a consequence, Bangladeshi rice growing farmers have to cope with unreliable irrigation water supply, either deriving from the physical unavailability of surface and groundwater resources, or caused by insufficient electricity or fuel supply for pumping. In order to address farmers' needs to save water, energy and fuel in irrigated rice, the International Rice Research Institute (IRRI) has developed the Alternate Wetting and Drying technology, which has been introduced in Bangladesh in 2004. Alternate Wetting and Drying (AWD) is a water-saving technology that lowland (paddy) rice farmers can apply to reduce their water use in irrigated fields.

In Bangladesh, the production of dry season irrigated rice has a predominant importance for national food security. Approximately 55% of the country's rice production is grown during the dry Boro season (Risingbd, 2014) and most of those are irrigated using groundwater resources which lowers the water table. So, the decrease of groundwater levels, falling at the rate of 0.1-0.5 metre/year has been clearly linked to the

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intensive abstraction of groundwater due to dry season rice farming (Shamsudduha *et al.,* 2009). Farmers are currently paying an equivalent of 25-30% of their rice harvest for irrigation and these costs are tending to increase (Sattar *et al.,* 2009). This is 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 for irrigation of up to 4568.4 million BDT in electricity or 6382.8 million BDT in fuel or 30.0 liter diesel/ha (Miah *et al.,* 2009).

AWD can increase rice yield by approximately 10% relative to permanent flooding (Price *et al.,* 2013). It can increase the nutritional status and decrease toxic elements such as cadmium that can be problematic in rice. Evidence is also increasing that AWD may boost concentrations of essential nutrients, particularly zinc, in harvested rice (Price *et al.,* 2013).

Although AWD is a very eco-friendly and economical technology for sustainable agricultural development, the rate of adoption of this practice in our country is very low. Fixed-irrigation rate arrangements between water sellers and farmers, non-availability of water on needed schedules, and lack of understanding of AWD are considered as the major constraints in the wide scale adoption (Kürschner *et al.,* 2010). The following specific objectives were formulated for the proper direction of the study:

- To determine the adoption status of AWD in rice farming;
- To find out the reasons that affect adoption of AWD at farmers' level; and
- To explore the problems of rice farmers in practicing AWD at farm level.

METHODOLOGY

This study was conducted in two villages named Noyanagar and Dhinagar of Jhilim union, at Sadar upazila (sub-district) under district of Chapai Nawabganj district of Bangladesh. The villages were selected as the study area purposively considering the objectives of the research. Rice farmers of the study villages were the target population of this study. The total number of farmers was 200 at Nawanagar, out of which 20 percent were selected as sample. On the other hand, in case of Dhinagar total number farmers were 400. Among which 10 percent of the total population were selected as the sample. Hence, the sample of the study constitutes 80.

According to the relevant research area, the researcher selected some associated issues of adoption of AWD after a thorough literature review, consultation with a number of key-informants like area under rice and AWD, access to irrigation water, sources and cost of irrigation, source of information on AWD, knowledge on irrigation and AWD, training exposure etc. These issues were measured by direct questions with percentages and frequency count. Besides these the reasons and problems those associated with the adoption of AWD were also measured in the same way.

Both qualitative and quantitative methods of data collection were employed. A personal interview schedule (structured questionnaire) was used to collect data from the selected respondents under the sample of the study. Besides the questionnaire survey, qualitative methods such as focus group discussion was used for the collection of necessary information from the respondents. The data were collected from 10th to 30th August 2016. The Statistical Package for Social Sciences was used to perform data analysis.

FINDINGS AND DISCUSSION

Area under rice cultivation and AWD: Farmers' area under rice cultivation as well as area under AWD was observed to understand the actual status of AWD practice in rice area. The area under rice cultivation and alternate wetting and drying (AWD) is presented in Table 1.

Table 1. Farmers' area under rice cultivation and AWD.

Area under rice cultivation and AWD	Observed range (hectare)	Mean		Standard deviation	
		Adopter	Non-adopter	Adopter	Non-adopter
Land area under rice cultivation	0.13 – 13.30	1.50	1.91	2.23	1.33
Area under AWD practice	0.13 – 6.65	0.89	0.00	1.106	0.00

It was observed that the non-adopters had more average area under rice cultivation than the AWD adopter farmers. On the other hand, adoption of AWD in terms of possible land coverage was calculated as 26.023% which means around 26% of rice cultivable land came under AWD practice. The farmers practiced this technology almost without knowing it properly due to the scarcity of water. There was a substantial demand for AWD as a water- and energy saving technology for rice cultivation in the dry season. Actual adoption of AWD, however, is strongly determined by factors, either external or internal, which influence the local irrigation systems. Overall, the survey confirmed that the mass uptake of the technology has not yet occurred.

Adoption of AWD in different seasons: It was observed that none of the farmer adopted AWD by using magic water pipe (magic pipe/pani pipe). Farmers' also reported that they followed water conservation technique of AWD on the basis of their understanding of the condition of soil water moisture content (Figure 1).

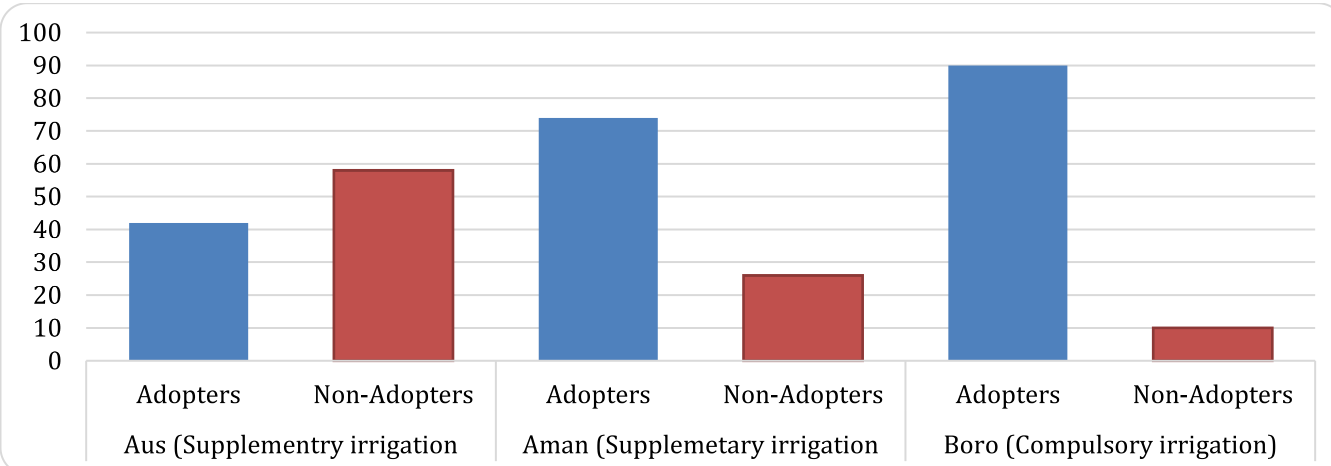

Figure1. Adoption of AWD by the farmers in different rice seasons.

Figure 1 shows that level of adoption was satisfactory in the study area. It was especially highest (90%) in Boro season (November to May)– the most water scarce season, while it was lowest in the case of Aus (supplementary irrigation.) However, it is needed to mention that farmers had relatively low awareness on AWD technology. Majority of the farmers either heard of the technology in some training or discussion meeting or from the SAAOs during discussion of farm and home visit. Only few farmers reported that they knew about the magic pipe, which is the key for getting benefits of AWD practice, while no such pumps are available in the locality. Therefore, majority of the adopters had not clear idea about the practice of AWD and there remains ample opportunity to popularize the technology among farmers if DAE initiates appropriate extension programs on it.

Access to irrigation water: Access to irrigation water in the study area is a crucial issue for adopting a water saving technology like AWD. The issue has been checked from different perspectives and seasons of rice production. The results may be seen in the Table 2.

Table 2. Extent of availability of irrigation water for the respondents.

Rice types	Percent of farmers opined on extent of availability					
	Sufficiently available		Partially available		Not available	
	Adopter	Non-adopter	Adopter	Non-adopter	Adopter	Non-adopter
Aus (supplementary irrigation)	37.5	22.5	17.5	22.5	45.0	55.0
Aman (supplementary irrigation)	57.5	60.0	40.0	37.5	2.5	2.5
Boro (compulsory irrigation)	75.0	70.0	20.0	27.5	5.0	2.5

Data presented in the Table 2 clearly show that there is unavailability of water for irrigation in the area mainly for Aus rice. Therefore, the farmers did not and could not cultivate Aus rice in Kharip 1 season (November to May), while many of them were engaged in low water requiring crops like pulses and oilseeds. On the other hand, no such problem was identified for the other two rice seasons. Findings are similar to those of Kürschner *et al.* (2010) where they unveiled that 82% confirmed that water scarcity occurs during the Boro season. The problem of water scarcity is particularly severe in Rajshahi Division where groundwater shortages as their main problem of irrigation. Of the farmers in Rajshahi, 84% used supplementary irrigation in this Aman season, which usually indicated sufficient rainfall, while only 27% of the Rangpur farmers irrigated during Aman. In normal years, water scarcity does not occur until the onset of the dry Boro season in December.

Sources and cost of irrigation: Farmers got water for irrigation from different sources. Therefore, irrigation cost was a major factor for crop production of the study area which might lead to the adoption of AWD for reducing the cost. Sources of irrigation water and cost of irrigation per hectare land are shown in Table 3.

Table 3. Sources and cost of irrigation for the respondent.

Sources of irrigation water	AWD Adopters		Non-Adopters	
	Percent of user	Average cost/ha (Tk)	Percent of user	Average cost/ha (Tk)
BMDA scheme	100.0	13,825	95.0	12,814
Personal shallow tube well	2.5	2,632	0	0
Water bought from other's shallow tube well	5.0	7,519	0	0
Water bought from other deep tube well	2.5	11,278	0	0
Other sources	10.0	3,383	7.5	7,867
Average per capita irrigation cost	-	12,097	-	12,540

Data presented in Table 3 indicate that almost all of the farmers use irrigation water from BMDA scheme. In the study area BMDA provides irrigation by its Deep Tube well (DTW). It should be mentioned that the calculation was done only for Boro season. In Aman season, when ground water level is increased, the irrigation cost falls significantly (average BMDA supply cost ranges from Tk. 3,000 to 5,000 depending on land). As the irrigation cost is a major factor of rice production cost (mainly for Boro rice), there remains a good scope to introduce AWD among the farmers.

The largest water and energy saving potential benefits were expected with DTW and larger STW–based irrigation systems. All famers from a command area (mostly served by one tube) would be required to practice AWD and perform irrigation at the same time. This has not been observed in the field. The conditions for practicing AWD are determined by the diverse features of STW and DTW-based irrigation systems, which vary significantly from one location to another. This includes, for example, regulations of payments, decision-making among users within a command area, the type of organizational arrangement, and the magnitude including the number of water users. Farmers got very upset due to constant electricity shortages, which led to irrigation failures, exposing their fields to risk of a complete harvest loss. It is assumed that especially in large DTW schemes, the number of conflicts over water-related issues can only decrease if enough farmers implement this technology, reducing the overall demand within the scheme.

Sources of information on AWD: The AWD adopter farmers were asked to indicate their sources of information on AWD that shaped their knowledge and awareness on the technology. The result is presented in Figure 2.

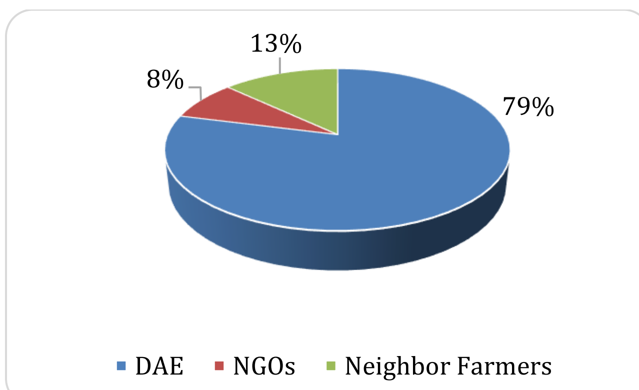

Figure 2. Sources of information on AWD.

It is an important finding that an overwhelming majority (80%) of the AWD adopters confirmed that they received preliminary and vital information on AWD mainly from grassroots level extension staff of the Department of Agricultural Extension (DAE). The other mentionable source is neighbouring farmers (12.5%) and rest of the farmers (7.5%) of them got AWD information from different NGOs.

DAE had been promoting dissemination of AWD through its regular extension programs and a number of projects. Usually the SAAOs tried to motivate farmers to follow this practice as observed by personal visit and communication with the field level extension officers. Training and demonstration were being provided to the farmers through a number of projects. The DAE emphasizes the AWD for its dissemination to the farmers. In case of any demonstration on rice, AWD has been preferably used for water management if found feasible.

Farmers' knowledge on AWD: AWD adopter farmers' knowledge on the technology was measured by using a small knowledge scale. The scale had five items on various aspects of the technology and the possible score could range from 0 to 10. Based on the knowledge score, the farmers were divided into three categories as shown in Figure 3.

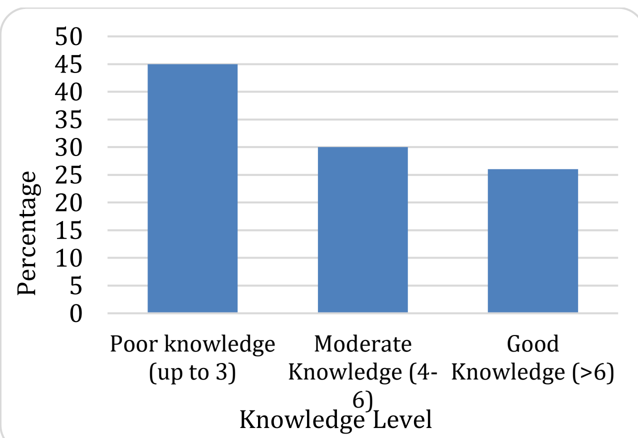

Figure 3. Distribution of farmers based on their knowledge on AWD.

Figure 3 shows that around half (45%) of the AWD practicing farmers had poor knowledge on AWD while only one-fourth (26%) of them had good knowledge and 30% of them had moderate knowledge on AWD.

Kürschner *et al.* (2010) observed in his study that most organizations were limited by the capacity and capability of well-trained extension staff considering that AWD is a knowledge-intensive technology. This was partly attributed to inadequate training received from within their organizations. As a consequence, training of farmers was reported to lack quality and to insufficiently transfer the knowledge on AWD to farmers. The approaches used by the different organizations, though often addressing groups of farmers, did not sufficiently address farmers from the same command area, or take into account the specific and varying features of the local irrigation systems. Therefore, it may be concluded that appropriate steps and programs on awareness and motivation towards AWD is instrumental for its widespread adoption among farmers.

Training on AWD: The training received score of the respondents ranged from 0-15 days, the average being 1.45 days and standard deviation 3.071. Based on the training received scores, the respondents were classified into four categories shown in the Figure 4.

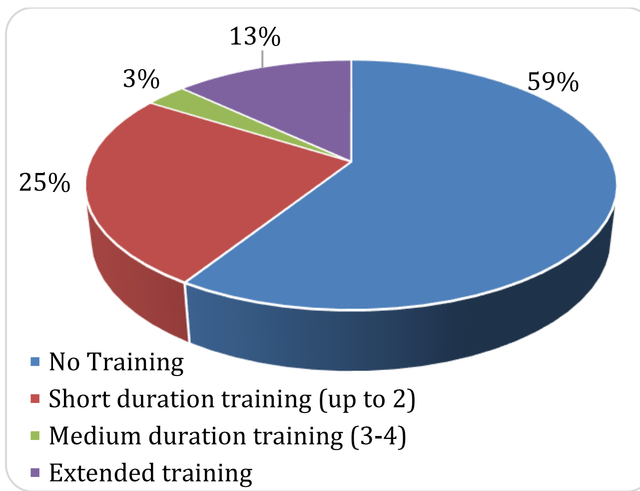

Figure 4. Distribution of the adopter farmers according to their training on AWD.

It is interesting to note that less than half of the adopters received some sorts of training on AWD, while no non-adopters received any training on the technology. As the maximum farmers had no training, their efficacy in this practice may consequently be below the standard level and most of them practiced this technology without knowing it properly.

Reasons for adoption of AWD: The reasons for adoption of AWD are an important issue for any future extension program towards farmers' motivation. A simple presentation of the reasons is made in the Table 4.

Table 4. Reasons for adoption of AWD according to the farmers.

Reasons for adoption of AWD	Percent of respondents*	Rank order
AWD reduces irrigation costs	92.5	1
It saves water	90.0	2
It is an easy technology to understand	75.0	3
There is no complexity in practicing AWD	70.0	4
It increases crop production	67.5	5
It is an environment friendly technology	67	6
It is a low cost technology	61.0	7
Materials for practicing AWD are locally available/ can be made easily	60.0	8
It helps in sustainable water resources management	57.5	9

*Multiple responses included.

It is evident from Table 4 that reducing cost of irrigation was the key reason for adoption of AWD. Some other reasons are also related to this important reason. The other issues are its simplicity and availability of the materials needed. Most of the farmers experienced the seasonal shortages of water that forced them to practice this technology. This "forced AWD" practice had given them the chance to observe the effects of less water, which helped to adopt this technology. This technology effectively reduces the amount of irrigation water needed per season, thereby decreasing the labour and time input needed for irrigation service. Consequently, AWD lowers farmers' cost for production of rice.

Reasons for non-adoption of AWD: The non-adopter farmers were asked to indicate reasons for their non-adoption of a water saving technology like AWD and a simple open-ended question was used for this. The results are presented in the Table 5.

Table 5. Reasons for non-adoption of AWD.

Reasons for non-adoption of AWD	Percent of respondents*	Rank order
Existing irrigation scheme does not match with AWD technology	97.5	1
Lack of awareness and understanding	90.0	2
Lack of proper extension work (motivational campaign, demonstration, field days, discussion etc.)	87.5	3
Used to practice drying by general understanding	55.0	4
Lack of monitoring by extension agency	42.5	5
Lack of understanding on reliability of the practice	25.0	6
Seems a complex technology	5.0	7
Irregular water supply and uncertainty	4.0	8

*Multiple responses included.

Data presented in Table 5 indicate very important ground reality about the adoption of AWD. That is the existing irrigation scheme operated by BMDA (in the study area) or private operator in other areas of the country is the key reason for non-adoption of the practice. Farmers got very upset due to constant improper services of BMDA, which led to irrigation failures, exposing their fields to risk of a complete harvest loss. Other important reasons included lack of awareness campaign and support service by extension agencies, in particular DAE.

Problems Faced by the Farmers in Practicing AWD: The AWD adopter farmers were asked to indicate the problems they faced in practicing the technology. There were several problems found in the survey area that acted as the barrier for the adoption of AWD. The summary of the results could be seen in Table 6.

Table 6. Problems faced by the farmers in practicing AWD.

Problems faced by the farmers	% of respondents*	Rank order
Ongoing irrigation scheme by service providers (which does not match the technology)	80.0	1
Lack of motivation and advisory service	65.0	2
Insufficient information	57.5	3
Lack of training	55.0	4
Lack of adequate water supply in time	40.0	5
Complexity in preparing and using magic pipe	35.0	6

*Multiple responses included.

Data presented in Table 6 revealed that the major problem lied on existing irrigation system as provided by service providers. Due to the fixed rate and sequential pattern of irrigation scheme, the farmers do not take risk of receiving less water than the farmers who are not practicing AWD because of the fact that they have to pay same amount of money in either case of water use. The other problems are information and motivational types of problems which come under the jurisdiction of extension agencies.

CONCLUSION AND RECOMMENDATIONS

The findings indicate that the level of adoption was satisfactory in the study area due to the scarcity of water especially in Boro seasons without following the technique of AWD practice properly. So, it may be concluded that the adopter farmers had vague idea about the practice in the study area and they perceived risk of a new technology or might result from structural problems in the irrigation systems. The majority (80%) of the AWD adopters received preliminary and vital information on the technology mainly from grassroots level extension officers of DAE as the findings indicated. Moreover, about half (45%) of the AWD practicing farmers had low knowledge on the technology. So, the other relevant organizations had improper and low contact with the farmers about this technology. The main reasons for adoption of AWD were that it required low use and low cost for irrigation. Therefore, there remains huge opportunity to increase the adoption rate of this water saving technology by rearranging the irrigation scheme.

The main reasons for non-adoption of AWD were that the existing irrigation scheme did not match with AWD technology as well as the lack of awareness of farmers on advantages of this practice. So, there remains huge opportunity to rethink about the national policy of irrigation scheme and to increase the adoption rate of this water saving technology by the farmers. The major problem lied on existing irrigation system as provided by service providers. Almost all of the farmers use irrigation water from irrigation scheme which provides irrigation with a fixed supply cost. So, it may be concluded that due to the fixed rate and sequential pattern of irrigation scheme, the farmers did not take risk of receiving less water than the farmers who were not practicing AWD. The fact is that they had to pay same amount of money in either case of water use.

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