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Economics of Alternate Wetting and Drying Method of Irrigation: Evidences from Farm Level Study

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Abstract
Rice farmers' investment on irrigation alone accounts the lion's share of total production cost. Alternate wetting & drying (AWD) method has emerged as a new technique of irrigation in Bangladesh as water saving irrigation technique. A study was undertaken with a view to verify the differences in water delivery, energy consumption and the relative economics of AWD method and conventional irrigation practice. Data were generated through sample survey in three production environments namely Kustia, Rangpur and Feni where field experiments were conducted to validate the AWD method. Data were generated using pre-designed questionnaire. Mainly descriptive statistics and partial budgeting technique were used in analyzing the data. The analysis revealed that on an average, the sample plots under AWD method required about 30% less water in growing MV Boro rice in all the study areas compared to conventional irrigation of maintaining continuous ponding water. The use of less irrigation was associated with the reduction of irrigation cost by 12 to 15% implying a clear advantage of AWD irrigation to the resource poor farmers. Almost 80% of the sample farmers in Kustia and Rangpur opined that the use of AWD method would also be conducive to increase MV Boro yield to some extent. Partial budget analysis further implied that use of AWD method would render an eventual profit of Tk 4224/ha for adopting the newly emerged irrigation technique instead of using the conventional irrigation.

Keywords: Alternate wetting and drying, conventional irrigation, boro rice, weed infestation, partial budgeting, gross return

1. Introduction

In Bangladesh, irrigated rice (Boro) is grown in dry season, which is very much input intensive. Although, Boro covers almost 4.6 million hectares and shares about 56% of the total rice production, it is highly fertilizer and irrigation dependent. Therefore, realization of optimum yield of Boro depends highly on proper application of irrigation and fertilizer in time and in optimum quantity.

Before two decades there were abundant surface water to irrigate the field crops, but now due to many reasons this resource has become scarce and irrigation has become one of the important costly inputs. Very conventionally, rice farmers everywhere have the tendency of keeping continuous standing water in rice fields. Consequently, irrigation water had been over used which has three fold effects, e.g. (a) wastage of the scarce and vital water resource, (b) increased irrigation cost; and (c) uplifting excess underground water causing environmental degradation. Earlier studies on water management practices for rice production indicated that application of irrigation water after three days on

disappearing of standing water did not reduce rice yield in Boro season (Kashem, 2006). However, taking into consideration of all these issues, the International Rice Research Institute (IRRI) has developed a water saving technology for irrigated rice production, known as alternate wetting and drying (AWD) method, where-in irrigation water is applied to the rice fields based on plant's requirement i.e. maintaining the level of required soil moisture. In the AWD method, a perforated plastic pipe is placed in the rice field through which soil moisture could be monitored and irrigation is applied only when soil water table goes about 15 cm below the soil surface. Estimates of field experimentation indicate that, substantial amount of water could be saved through using the AWD method in Boro production. Available research findings support that about 15-20% water could be saved through the AWD method (Tuong, 2007). Research findings in Bangladesh also showed that on average 28% of irrigation water could be saved without any reduction in rice yield (Kashem, 2006, BRRI, 2007). During the Boro (2007-08) season, on-farm experiments were conducted in farmers' fields in Kustia, Rangpur and Feni by the Irrigation and Water Management (IWM) Division of BRRI to verify the earlier research findings. Considering the immense need of assessing the socio-economic issues related to application of AWD method in the farmers' fields, the present study was carried out.

Objectives of the study

The specific objectives of the study were:

i) to estimate the level of variation in the amounts of water use under farmers' practice and alternate wetting and drying method for irrigating MV Boro rice;

ii) to examine the differences in cost involvement and assess the productivity and profitability of the AWD method compared to the conventional method; and

iii) to describe farmers' perceptions on the water saving method and identify ecological nitch suitable for the new water saving irrigation technology.

2. Methodology

The study was conducted in three locations of Rangpur, Kustia and Feni where on-farm experiments were conducted on alternate wetting and drying (AWD) method of irrigation in boro rice. Data were collected through interviewing the sample farmers. Pre-structured questionnaire was used for collecting the data. The number of sample farms from each location were 29 (nine AWD users and 20 conventional irrigation users). So, in total the number of samples was 87(3x29). Although the AWD users were selected purposively, the conventional irrigation using farms were chosen following the random sampling technique. The study was carried out during Boro season, 2008. The conventional descriptive statistics were employed in analyzing the data. In order to evaluate the consequence of small change in the irrigation practice that affect only a part rather than the whole production process, partial budget analysis was carried out.

3. Empirical Results

3.1. Comparative input use level

Data on different production inputs used in the AWD and conventionally irrigated plots in different locations are presented in Table 1. Land preparation cost was higher in Feni compared to that in Kustia and Rangpur. Farmers in Kushtia applied a bit more fertilizer in seedbed and that is why, seedbed preparation cost was higher in Kustia compared to other locations. The level of fertilizer application was higher in Kustia compared to that of Rangpur and Feni. However, it was evident that the frequency of irrigation was lower in AWD plots than the conventionally irrigated plots in all the study locations. It is impressive to note that, at least three irrigations could be saved by using AWD method. This result is in consonance with the finding of an earlier study (BRRI, 2007). Number of weeding as well as total labour needed for weeding in the AWD plots was higher than in the plots with conventional method in all the locations. About six additional labour was required for weeding one hectare of land under AWD method at Rangpur (Table1). In Kustia and Feni, additional 7 and 4 labours respectively were needed for weeding the AWD plots on per hectare basis.

Table 1. Input use level for AWD plots and farmers' practice, Boro 2007-08.

Items	Kustia		Rangpur		Feni	
	AWD method	Conventional method	AWD method	Conventional method	AWD method	Conventional method
Seed (Kg/ha)	52	65	61	62	59	64
Seedbed (Tk/ha)	1776	1830	1272	1220	1345	1360
Land pre.(Tk/ha)	4930	5125	5052	4978	7945	7832
Uprooting & transplanting (No .of lab/ha)	45	47	40	41	37	37
Fertilizer (Kg/ha):						
Urea	262	273	235	264	216	246
TSP	112	107	83	60	97	85
MP	120	65	67	43	98	41
Gypsum	75	46	43	15		10
Zinc	7.5	7.7	3.3	2	1.41	1.1
Manure (Tk/ha)	1225	1280	525	765	512	686
Irrigation Number	10	15	9	12	7	10
Weeding Number	1.7	1.7	1.44	1.9	1.88	1.45
Labor for weeding (man- days/ha)	48	41	42	36	42	38
Herbicide (Tk/ha)	343	543	415	245	-	-
Insecticide (Tk/ha)	615	889	844	270	950	1086
Harvesting ,carrying &threshing (Tk/ha)	10416	10208	7171	7200	12325	12325

Source: Field Survey, 2008

3.2. Scenario of comparative cost and return

In Rangpur, Boro rice was cultivated after harvesting potato. Farmers applied higher doses of fertilizers for potato and applied lesser amount of urea in Boro rice. So, the cost of fertilizers was comparatively lower in Rangpur than in Kustia and Feni (Table 2). Both in Kustia and Rangpur irrigation cost for AWD plots was lower compared to that of conventional method. In Feni, irrigation machine was operated by electricity and irrigation charge was fixed on unit area basis. Therefore, cost of irrigation was the same in both the methods implying that number of irrigation had no effect on irrigation cost. On the other hand, in Kustia and Rangpur farmers had to supply diesel in addition to machine rent

and the machine rental rate was different for Kushtia and Rangpur. However, in Kushtia the payment for irrigation was made in kind (1.5 mounds paddy for 33 decimal of land), while in Rangpur, rice growers had to pay Tk.300 for 24 decimal of land. Since price of paddy was very high during Boro season of 2008, the machine rent in Kustia was quite high which led to higher irrigation cost (Tk12338/ha) compared to Rangpur (6572/ha).

Table 2: Comparative cost and return (Tk/ha) for Boro production under AWD and conventional irrigation method

Cost Items	Kustia		Rangpur		Feni	
	AWD method	Conventional method	AWD method	Conventional method	AWD method	Conventional method
Seed and seedbed	3336	3455	3102	2770	3115	3084
Land preparation	4930	5125	5052	4978	7945	7832
Pre-harvest labour cost	11670	10950	10746	10019	17731	16624
Fertilizers	9758	7800	6025	5073	8423	6330
Mannure	1225	1280	525	765	512	686
Irrigation	12338	14059	6572	7792	6774	6774
Herbicide	343	543	415	245	-	-
Insecticide	615	889	844	270	950	1086
Post harvest labour cost	10416	10208	7171	7200	12325	12325
Interest on operating capital (5 month @10%)	1138	1131	843	815	1204	1140
Total variable cost	55769	55440	41295	39924	58979	55881
Rental value of land	18302	18302	20916	20916	18216	18216
Total cost of production	74071	73742	62211	60840	77195	74097
Yield (t/ha)	5.63	5.25	5.65	5.36	5.57	5.48
Gross return	112028	100723	105162	104917	104912	98992
Paddy	102748	91875	101789	101402	101652	95900
Straw	9280	8848	3373	3515	3260	3092
Unit cost of production	13.16	14.05	11.01	11.35	13.86	13.52

Source: Field Survey, 20083.3 Differences in number and amounts of irrigation between AWD and conventional method

Table 3. Differences in irrigation between AWD and conventional method.

Items	Kustia		Rangpur		Feni	
	AWD method	Conventional method	AWD method	Conventional method	AWD method	Conventional method
No. of irrigation	10(33)	15	9	12(33)	7(30)	10
Diesel requirement (Lit/ha)	99	148	89	119	-	-
Diesel cost (Tk/.ha)	4158(33)	6216	3582(25)	4790	-	-
Machine rent (Tk/ha)	8180	7843	2990	3002	-	-
Total cost (Tk/ha)	12338	14059	6572	7792	6774	6774

Figures in parentheses indicate percent decrease

Source: Field Survey, 2008

Table 4. Results of the test of significance between AWD and conventional irrigation methods.

Items	AWD method	Conventional method	Mean difference	t-statistics	P = (T<t)
Number of irrigation	9	13	4	5.7428	0.001
Diesel requirement (Lit/ha)	92	133	41	6.242	0.000
Machine rent (Tk/ha)	5957	5880	77	0.028	0.001

Source: Field Survey, 2008

The differences in irrigation between AWD plots and conventional practice is showed in Table 3. It was evident that in terms of number of irrigation there was moderate saving in applying irrigation water under AWD method in all the locations. In other words, the frequency of irrigation for the plots with conventional method was about 33% higher than that of AWD method. In Kustia and Rangpur, irrigation machines were operated by diesel and the savings in diesel under AWD method ranged from 30 - 33%. In Feni, irrigation cost was same for both the methods. However, test of significance was carried out to determine the level of significance between two irrigation methods. In case of both number of irrigation and diesel requirement between AWD and conventional method, the differences were statistically significant. (Table 4 and fig.1).

3.3. Partial budget analysis

Partial budget analysis was done to assess the break down of economic advantage of alternate wetting and drying technology over the conventional irrigation method. However, in exercising the partial budgeting technique, the average cost of irrigation for all three locations was taken into consideration. Results of partial budget analysis indicated that Boro rice growers could earn additional benefit of Tk 4224/ha by adopting AWD method instead of using the conventional irrigation (Table 5).

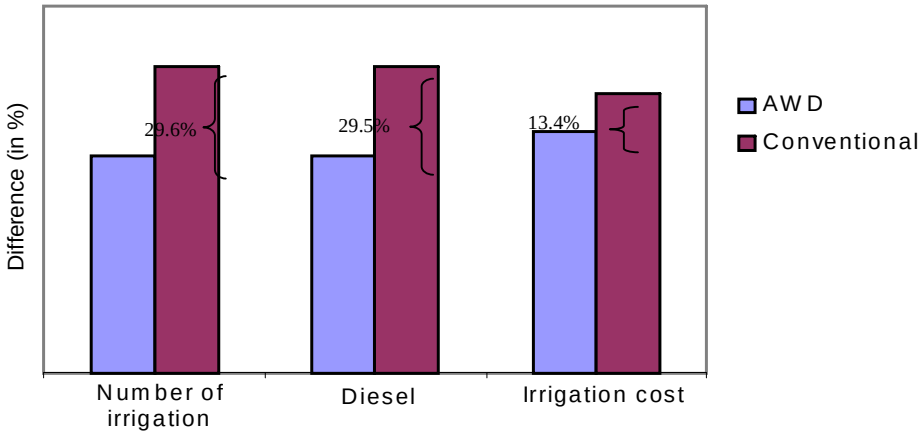

Fig. 1: Differences in irrigation, fuel requirement & cost involvement between AWD and conventional irrigation

Table 5. Partial budgeting for AWD method versus conventional method of irrigation.

Items	Debit (Tk/ha)	Items	Credit (Tk/ha)
	AWD method		Conventional method
A. Cost of production using AWD method	52,014	**A.** Cost saving for not practicing conventional method	50,415
B. Revenue forgone for not practicing conventional method	101,544	**B.** Revenue earned from using AWD method	1,07,367
C. Profit/loss	+ 4,224	**C.** Profit/loss	-
D. Total	1,57,782		1,57,782

Source: Field Survey, 2008

3.4. Farmers' perceptions on AWD method

Farmers' perception on the use of AWD method was assessed and the relevant information are presented in Table 6. It is indeed impressive that, 100% respondent of Kustia and Rangpur opined their idea in favour of the proposition that AWD method saves water leading to reduction in irrigation cost. As discussed in the earlier section that, in Feni the payment for irrigation is usually done on a piece meal rate (i.e. on contractual basis of per unit of land irrigated) under which there was no effect of volume of irrigation on the cost/payment. Therefore, in case of Feni farmers had limited scope of choice and thus they abstained from any comment. Nevertheless, in all the study areas , the sample farmers agreed-upon the consensus that the plots irrigated with AWD method had a bit higher infestation of weeds which involved little more weeding cost in producing MV Boro.

Table 6. Farmers' perceptions on AWD method of irrigation.

Stated perceptions	% respondent opined		
	Kustia	Rangpur	Feni
Save water	100	100	80
Reduce irrigation cost	100	100	-
Increase yield	76	68	50
High weed infestation	100	100	90
Increase weeding cost	96	92	80

Source: Field Survey, 2008

4. Conclusion

In all the study areas, sample plots under AWD method required about 30% less amount of water) in growing MV Boro rice. The use of less irrigation further resulted in the reduction of cost to a substantive level with an exception for the sample farms of Feni. In Feni area, irrigation cost was paid on a contractual basis, where volume of irrigation has no effect on the payment as irrigation cost. However, in the areas where irrigation machine is operated using diesel, the cost of irrigation could be reduced by adopting AWD method without any other intervention. About 80% of the sample farmers in Kustia and Rangpur opined that the use of AWD method would also be conducive to increase MV Boro yield to some extent. The use of AWD method would render an eventual profit of Tk 4224 per hectare instead of using the conventional irrigation. The AWD method may therefore, be widely disseminated for cost saving and profitable boro rice cultivation in the areas where MV rice is profusely grown under irrigated condition.

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