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Conservation agriculture: A farm level practice in Bangladesh

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ABSTRACT

Conservation agriculture (CA) is one of the alternative practices of agricultural development in Bangladesh. In the present study is investigated to determine the extent of practice of conservation agriculture by the farmers and to explore the factors related to practice of conservation agriculture. Eighty (80) farmers of four villages of Gurudaspur upazila of Natore district, Bangladesh were interviewed. Maximum farmers belonged to medium practice of conservation agriculture while very few of them had low or high practice. Zero tillage found to be the most practiced conservation technique. Out of nine independent variables, only level of education, extension media contact and organizational participation of the farmers had showed positive significant relationship with conservation agriculture practice. Extension media contact and organizational participation influence the extent of CA practices at farmers' field as confirmed by the backward linear regression model. Growing more weeds in case of zero and/or minimum tillage and lack of available information about conservation agriculture at block level were the major problems hindering conservation agriculture practice. To popularize the CA practices, Government should organize more training and demonstration activities on CA involving block level extension workers as well as farmers plus strengthening research-extension-farmers linkage.

Key words: Conservation, Extension media contact, Medium, Weeds, Zero tillage.

INTRODUCTION

Feeding the huge population is at present the prime concern of Bangladesh. But producing quality food maintaining sustainable soil health for future generation is a possible future concern. Long term use of chemical fertilizer and pesticides without using organic fertilizer resulted soil degradation and initiate decreasing trend of soil productivity (Kafiluddin and Islam 2008). An increased cropping intensity of 1.90 (BBS, 2012) with traditional rice based cropping pattern covering most of the land (Rashid *et al.,* 2014) influence the situation further. Intensified HYV of rice and other crops cultivated to feed the huge population of the country, has led to huge amount of nutrients withdrawal from the soil (Akteruzzaman *et al.,* 2012).). The consequences of this intensified rice based agriculture on soil fertility, soil microbial activity and lastly to our environment is severe (Uddin and Dhar, 2016). So, the inclusion of conservation techniques to commercial farming is becoming popular all over the world (Johansen *et al.* 2012). Bangladesh is also trying to adopt Conservational Agriculture (CA) considering its positive impact on soil health. Already minimum tillage and other conservation techniques are practicing in the country but not on large scale (Islam *et al.* 2011). Besides, agriculture in Bangladesh employs more than 45 percent of total labour force (BBS, 2015) but labour scarcity is increasing day by day (BBS, 2015) and labour wage is also very high (Statistical Bulletin, 2013) which adds huge cost to total production budget. CA is an approach that reduces agricultural operational costs while increasing yields utilizing natural resources properly (Roy *et al*., 2009). With the practice of minimum tillage only, costs of production can be cut to large extent (Miah *et al.*, 2010).

The CA research in Bangladesh are few and previous research mainly focuses on adoption of different conservation agriculture practices (Dass, 2013). Research reports available in Bangladesh (Barma *et al.,* 2014) revealed that wheat, maize, pulses, oilseeds, jute, rice can be established and grown successfully using CA technology. Farmers are accepting the concept of CA based tillage technologies considering the advantages of higher yields, reduced cost of tillage operation, and minimum turnaround time between the crops (Hossain *et al.,* 2015).

But, practising conservation agriculture is not yet studied well. Therefore, the present study was considered and encompasses the following specific objectives: i) to determine the extent of practice of conservation agriculture by the farmers. ii) to explore the associated factors of the farmers' influencing practicing conservation agriculture iii) to identify the problems faced by the farmers in practicing conservation agriculture.

MATERIALS AND METHODS

Study area, population and sampling: The study was conducted in four villages under two unions of Gurudaspur upazila in Natore district, Bangladesh. These four villages are attributed with zero tillage, cultivation of garlic,

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onion, wheat, pulses and potato as well as practicing other CA components like permanent organic soil coverage, crop rotation, retention of crop residues, and application of FYM traditionally. Many farmers practice different components of CA traditionally in the area. About 800 farmers (those practice CA components) list were collected from Upazila Agriculture Office and considered as population of the study while 80 farmers (10 percent of the population) were selected as the sample using simple-random method. Sample farmers were interviewed using pre-tested structured questionnaire to collect the data.

Selection and measurement of dependent and independent variables: Extent of practicing conservation agriculture was the dependent variable of the study. It was measured based on 8 components of conservation agriculture. The components are - Zero tillage, Minimum tillage, Crop residues retention, Permanent organic soil coverage, Crop rotation, Practice of FYM, Practice of green manure and Practice of vermi-compost. Farmers' opinion for each component was measured using a 4-point rating scale. This type of scale was used by Roy (2013). Weights of responses were: 3 for regularly, 2 for occasionally, 1 for rarely and 0 for not at all. Farmers' age, level of education, family size, farm size, farming experience; annual family income, extension media contact and organizational participation were the independent variables assuming that these variables might affect the practicing conservation agriculture. These variables were measured using appropriate scales and scoring system. Both descriptive and inferential statistical analyses were used.

RESULTS AND DISCUSSION

Selected characteristics of the farmers: The salient features of farmers' characteristics have been shown in the following Table 1. The majority of the farmers surveyed reported being within the ages of 18 to 50 (81%). Similar findings were found regarding age by Uddin *et al.* (2017a). The farmers on average completed about six years of schooling and similar findings were found by Dev (2015). The literacy rate (60 percent) found in this study was similar to the national literacy rate of 61.5% reported by Khatun and Miwa (2016)

Table 1: Salient features of the selected characteristics of the CA practicing farmers

Characteristics	Scoring system	Range		Respondent Categories	Respondent's Percentage (n=80)	Mean	SD*
		Possible	Observed				
Age	Years	Unknown	22-70	Young (18-35)	35.0	42.14	10.52
				Middle age (36-50)	46.2		
				Old (Above 50)	18.8		
Level of education	Years of schooling	Unknown	0-18	Illiterate(0)	15.0		
				Can sign only(0.5)	25.0	5.44	5.01
				Primary (1-5)	13.8		
				Secondary (6-10)	35.0		
				Higher secondary (11-12)	6.2		
				Above Higher secondary (Above 12)	5.0		
Family size	No. of members	Unknown	2-16	Small (up to 4)	47.5	5.04	2.05
				Medium (5-6)	42.5		
				Large (Above 6)	10.0		
Farm size	Hectares	Unknown	0.134-4.34	Landless (<0.02 ha)	0	0.7835	0.6498
				Marginal (0.02-0.2 ha)	5.0		
				Small (0.21-1.0 ha)	73.8		
				Medium (1.01-3.0 ha)	20.0		
				Large (Above 3.0 ha)	1.2		
Farming experience	Years	Unknown	5-55	Low (up to 20) years	51.2	23.00	11.61
				Medium (21-40) years	45.0		
				High (Above 40) years	3.8		
Annul family income	'000' Tk.	Unknown	95-1500	Low (up to 100)	1.2	364.83	236.54
				Medium (101-500)	81.2		
				High (above 500)	17.5		
Extension media contact	Scale score	0-33	2-23	Low (1 to 11)	73.8	9.65	4.41
				Medium (12-22)	25.0		
				High (above 22)	1.2		
Organizational participation	Scale score	Unknown	0-34	No participation (0)	43.8		
				Low (1-11)	36.2	5.14	7.65
				Medium (12-22)	16.2		
				High (above 22)	3.8		

SD = Standard Deviation

Source: Field survey data, 2016

and also found by the Khan (2015). Besides, the average family size of the farmers reported to be 5.04, which is relatively more than national average of 4.50 (HIES, 2010). The average farm size for the farmers surveyed was 0.784 hectare that was slightly more than the national average farm sized of 0.6 hectare. The average annual income of the farmers' in the study area was BDT 364830 ($4560.38 US), which is more than the average of household income BDT 1, 37,748 ($1721 US) (HIES, 2010). The similar findings found in the study conducted by Haq (2016).

On average the farmers have about 23 years farming experiences. It shows that farmers have sufficient experience with the farming activities. The highest proportion of the respondents (98.8%) stated low to medium extension services contact. So, the information seeking tendency of the farmers seem to be low to medium and similar trend founded by Miah *et al.* (2016). Almost half of the respondents (44 %) had no participation with organizations and rest had participation.

Data presented in the Table 1 indicate that less than half of the farmers were received training while more than half did not receive training. Farmers who received training could employ their skills to tackle various uncertain circumstances.

Extent of practicing conservation agriculture by the farmers: The possible score of extent of practicing CA components could range from 0 to 24. The observed practice score ranged from 8-17 with an average of 12.69 and standard deviation 1.83. Based on the possible practice score, the farmers were classified into the three categories as shown in the following Table 2

Data furnished in Table 2 indicates that the majority (96.25 per cent) of the farmers had medium practice of CA components. But, it seems that worldwide the practice of CA was on the lower side of around 10 per cent farmers only (Willer *et al.,* 2008). So, this might be because some specific techniques are practiced extensively at field level which contribute to the score. Analysis of eight selected components of conservation agriculture will clear the picture. Rank orders of these components are summarize in the Table 3 according to mean value.

The results in the Table 3 indicates that CA practicing farmers mainly followed the zero tillage, permanent organic soil coverage and crop residues retention respectively. Application of green manure is least practiced. The zero tillage seems to be the most popular CA practice in the studied area. Traditional agriculture even modern agriculture required more energy, machineries, labor and time for tillage operation that contributes to higher cost of production. But, zero tillage and other components conservation agriculture mainly focuses on disturbing the soil to lowest possible amount. In turn, this requires less inputs considering the soil management like labor or other machineries. This might be influencing the farmers more to use different conservation agriculture practices. Previous studies also suggests that, farmers adopt retention of crop residues, crop rotation and less soil alteration (zero and minimum tillage) more than other practices (Uddin *et al*., 2017b) and also practiced highly in Bangladesh (Akteruzzaman *et al.,* 2012).

Relationship between the selected characteristics of the farmers and extent of

Practice of conservation agriculture: Pearson's product moment coefficient of correlation (r) was computed and compared with relevant tabulated values with 78 degrees of freedom at the designated level of probability in order to determine whether the relationship between the concerned variables were significant or not. The results of correlation analysis between the concerned variables have been presented in Table 4.

Table 2: Distribution of the farmers according to their practice of CA components

Range		Categories	Farmers		Mean	SD
Possible	Observed		Number	Percent		
0-24	8-17	Low (up to 8)	2	2.5	12.69	1.83
		Medium (9-16)	77	96.25		
		High (17 and above)	1	1.25		
		Total	80	100.0		

Table 3: Rank order of the components of the conservation agriculture

Components	Extent of practice				Mean	Rank order
	Regularly	Occasionally	Rarely	Not at all		
Zero tillage	72	7	1	0	2.89	**1**
Permanent organic soil coverage	70	6	0	4	2.78	2
Crop residues retention	59	16	3	3	2.65	3
Crop rotation	26	53	1	0	2.31	4
Practice of FYM	26	17	9	28	1.51	5
Minimum tillage(strip, ridge and reduced)	1	3	8	68	.21	6
Practice of vermicompost	1	5	2	72	.15	7
Practice of green manure	0	0	6	74	.07	8

Table 4: Correlation between selected characteristics of CA practicing farmers and extent of CA practice (N=80)

Selected personal socioeconomic characteristics	Correlation co-efficient (r) with 78 df	Tabulated values (r) significant at(78 df)	
		0.05	0.01
Age	-.068		
Education	**.276***		
Family size	.037		
Farm size	.025		
Farming experience	-.173	0.220	0.286
Annual family income	.146		
Extension media contact	**.423****		
Organizational participation	**.394****		

* Correlation is significant at the 0.05 level (2-tailed).
** Correlation is significant at the 0.01 level (2-tailed).

Out of 8 independent variables, education, extension media contract, and organization participation correlated positively with the extent of practice of conservation agriculture. The findings revealed that extension media contact has the strongest relationship with the practice of conservation agriculture. This might be due to the cause that, people with low farm size as observed here feel at risk to try out new things like conservation agriculture. So they need some assurance to give trial to some unconventional practices. When their extension media contact increases they get that assertion from different extension agent. Organizational participation also plays similar kind of role like extension media contact. Being a member of an organization, a farmer can get support from peer members of that organization and can also learn from them about the benefits of conservational agriculture. It is quite common that education increase farmers' knowledge as well as change their attitudes towards new staffs.

Econometric estimation on identifying the factors affecting the practice of Conservation Agriculture: A backward multiple linear regression analysis was employed to see the contribution level of all the variables to the extent of practice of conservational agriculture. It is clear from table 5 that all the correlated variables in total accounted for 22.9 per cent of the total variation.

In the first model (Table 5), it was observed that the three variables i.e. organizational participation, education and extension media contract contribute 22.9 per cent of total variation. But the variable education had no signification contribution and thus deleted in the second model. Education contribute 1.3 per cent on the total variation. This might be because in some cases less formally educated person become more positive person for his experience in farming.

In the second model, organizational participation and extension media contact entered and accounted for 21.6 per cent of the total influence on practicing conservation agriculture. Both the variable have the similar type of influence on extent of practice. In both the cases, farmers get exposure to other people and can learn about conservation agriculture from them. Traditional farmers always believe what they see and they influence others to take any new decision. When they understand the benefits of conservation agriculture learning from different extension agents and also watch other peer farmers apply the techniques; they also get motivated.

The first model (Table 6) was not accepted as education was not significant to practicing conservation agriculture. So, the second model was found to be more significant and contribute substantially to the dependent variable.

The following predicted equation (i) was developed using the results found in the Table 6.

Extent of practice of CA= 11.220 + (0.123) × Extension media contact + (0.055) × Organizational participation……..……..... (i)

The equation shows the probability of practicing conservation agriculture. We can interpret that if one unit of these aforementioned variables increases then the probability of practicing conservation agriculture will be increased at 0.123 and 0.055 for extension media contact and organizational participation respectively.

Table 5. Model summary of Backward multiple linear regression analysis showing contribution of the selected characteristics to the practice of conservation agriculture using probability of F to remove >= 0.10

Variables entered in the model	Coefficient of determination	Multiple R^2	Change in R^2	Variance explained (%)	F Change	Sig. level of F change
a	.478	.229	.229	22.9	7.506	.000
b	.465	.216	-.013	21.6	1.255	.266

a.Predictors: (Constant), Organizational participation, Education, Extension media contract
b. Predictors: (Constant), Organizational participation, Extension media contract

Table 6: Backward multiple linear regression model showing coefficients of dependent variable with the contributing characters

Model		Coefficients[a]				
		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	11.139	.465		23.954	.000
	Education	.044	.040	.122	1.120	.266
	Extension media contract	.108	.052	.260	2.078	.041
	Organizational participation	.052	.029	.216	1.770	.081
2	(Constant)	11.220	.460		24.388	.000
	Extension media contract	.123	.050	.295	2.437	.017
	Organizational participation	.055	.029	.230	1.901	.061

a. Dependent Variable: Conservation Agriculture practice

Table 7: Rank order of the problems faced by the farmers practicing CA

Problems	Extent of problem				Computed score	Rank order
	High	Moderate	Low	Total		
Grow more weeds in case of zero/minimum tillage	62	18	0	80	222	1
Lack of available information about CA at block level	34	41	4	79	188	2
Poor research – extension – farmers linkage	18	54	7	79	169	3
Lack of training on CA	19	43	18	80	161	4
Inadequate credit support by the financial institutions such as bank/NGOs/other agencies	27	27	22	76	157	5
Lack of technical knowledge of the Farmers on CA	5	61	11	77	148	6
The perception of farmers about Crop rotation is not positive	0	14	44	58	72	7
Due to CA scarcity of animal feed increases	6	12	7	25	49	8
Low production at minimum tillage	3	7	12	22	35	9
Due to CA Scarcity of cooking fuel increases	0	3	11	14	17	10

Problems faced by the farmers in practicing CA components: For farmer's problems of practicing CA components, the researcher used 10 common problem items relevant to CA practice. In respect of each item, each farmer was asked to indicate the intensity of problem by indicating in favour of any of the four responses as high, moderate, low and not at all.

The problems identified by the farmers are listed below according to their importance in the Table 7.

The information presented in Table 7 showed that 'Grow more weeds in case of zero/minimum tillage' cause most hindrance in practicing CA components. While 'CA Scarcity because of cooking fuel demand' were the last ranked problem. It is quite usual that if soil stay undisturbed before plantation, different weed seed will remain and infest the crops intensively. Sometimes weeding gets more laborious for weed sensitive crops. As a new practice in Bangladesh, block level extension workers also have first-hand knowledge on CA. If farmers face complex problems, it gets tough for the extension workers to provide appropriate solutions. Also, high quality research on conservation agriculture in Bangladeshi conditions is very rare and information flow related to the farmers is very weak. This keep farmers in dark from practicing CA.

CONCLUSION AND RECOMMENDATIONS

Farmers are interested practicing CA components like zero tillage, permanent organic soil coverage and crop residues retention. Extension media contact increases the outlook of the farmers to practice CA components effectively and efficiently. The involvement of farmers in diversified organizations help in interacting with other people which might increases practice of CA. It also enhances interaction among the farmers which might influence the efficient use of available resources to adopt CA. If research institutes can develop CA techniques these solve the high weed problem, it will be easy to motivate farmers to use CA. Other problems should be addressed by the concerned extension service providers to improve the practicing of CA.

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