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Adoption and Farmers' Attitude of BARI Released Mustard Variety in Manikgonj District

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ABSTRACT

The study was conducted in three mustard-growing areas namely Singair, Manikgonj sadar and Ghior Upazila of Manikgonj district to assess the extent of technology adoption, relative profitability, and farmers' attitude toward BARI *Sarisha* cultivation. Total 180 randomly selected farmers were interviewed Manikgonj sadar (60), Singair (60) and Ghior (60) during the period of February to April 2012. The study revealed that adoption level of technologies in terms of input use and agronomic practices were not as most farmers did not follow the recommendations made by BARI for mustard cultivation. Similarly, the variety adoption scenario was also discouraging since only 9.5% of the farmers cultivated BARI *Sarisha*. Adoption of new mustard varieties were mostly influenced by BARI scientists, Department of Agricultural Extension (DAE) personnel and neighboring farmers. The yield of BARI *Sarisha* (1851 kg/ha) was significantly higher than that of local variety (1308 kg/ha), although it was much lower than its potential yields (2250 kg/ha). The production of BARI *Sharisha* was found profitable, since the net return and benefit cost ratio were Tk. 45,972/ha and 2:1, respectively. Farmers, who cultivated BARI *Sharisha*, received 42% higher net profit than local variety cultivator farmers. Farmers showed positive attitude towards mustard production, since nearly 27% of the adopters wanted to increase BARI *Sharisha* cultivation in the next growing season. Although mustard was a profitable crop, due to some setbacks such as scarcity and high price of fertilizers, higher price of input and lack of scientific knowledge and training, many farmers showed negative attitude towards production of BARI *Sarisha*. They experienced different constraints to mustard production. Moreover, unavailability of BARI released mustard seed was also found to be a barrier to the better adoption of improved mustard technologies in Manikgonj district.

Key words: Adoption, Technology, Profitability, Attitude, BARI

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1. INTRODUCTION

Bangladesh is an agricultural country where different kinds of crops like cereals, pulses, oilseed, vegetables and fruits are grown on a regular basis. Acute shortage of edible oil as well as industrial oils has been prevailing in Bangladesh for the last several decades. To meet up the shortage, the country has to import several thousand tons of edible oil every year spending a lot of foreign exchange.

Out of the total cropped area of 14.85 million ha, oil crops occupy about 2.36% (0.35 million ha) of the total cropped area. The total production of the country stands at 0.31 million tons. Out of oilseed cropped area, rapeseed and mustard occupies 0.24 million ha, sesame 0.039 million ha, soybean 0.03 million ha, groundnut 0.029 million ha and linseed 0.005 million ha. Out of total production, rapeseed and mustard produces 0.19 million tons, sesame produces 0.038 million tons, soybean produces 0.03 million tons, groundnut produces 0.039 million tons and linseed produces 0.003 million tons (BBS, 2009).

Mustard is an important oil seed crop of the world after soybean (FAO, 2001). In Bangladesh, it is the leading oil seed crop, covering about 80% of the total oil seed crop area and contributing to more than 60% of the total oil crop production (BBS, 2009). Bangladesh is facing a huge deficit of edible oil. In view of the importance of this crop, attention has to be given to increase its production in order to meet the huge shortage of cooking oil in the country. According to the National Nutrition Council (NNC) of Bangladesh, the Recommended Dietary Allowance (RDA) is estimated to be 6 gm oil/capita/day for a diet with 2700 Kcal (NNC, 1984). On this RDA basis, Bangladesh requires 0.29 million tons of oil equivalent to 0.8 million tons of oil seeds for nourishing her people. At present, the indigenous oil seed production is about 0.25 million tons which can cover only 40% of the domestic need (FAO, 2001).

Bangladesh is a densely populated country with limited cultivable land hence there is little scope of bringing more land under cultivation. Due to infrastructural and industrial development activities, the cultivable land is decreasing day by day. Production strategies, therefore, required to be formulated in a manner enable the farm families to increase food production. There are reasons behind the cultivation of improved mustard varieties such as higher yield, high market price, and diversified use, intermediate crop between Boro and T-Aman rice, required low inputs and low risk involvement. In this study an effort has been made to find out the constraints in order to expand mustard cultivation in Bangladesh.

Bangladesh is moving towards self-sufficiency for different agricultural commodities such as rice, wheat, and potato with certain the degree of adoption of modern technology generated by different research organizations. Bangladesh is producing about 0.55 million tons of edible oil per year as against the requirement of 1.4 million tons (Bakr & Ahmed, 2009). There has been a huge gap (60.7%) between supply and demand of edible oils, which has been met through imports incurring a huge amount of foreign exchange every year. In this context, the increase of production of oilseeds has been given priority (Mondal, 2000). If we can utilize our land towards the oilseed crops like mustard, it will save a lot of foreign currency and farmers will be more benefited by using short duration HYV mustard intermediate periods between Aman and *Boro* rice. Crop and agricultural diversification must be given priority in agricultural development strategy to achieve balanced nutrition and increasing income of the farmers.

Mustard is a short duration crop. A large area remains fallow in the *Rabi* -Fallow-Aus cropping pattern of Manikgonj district. The fallow period can be utilized for short duration mustard varieties without disturbing the existing cropping pattern. So, if mustard can be adopted in the existing cropping pattern the food deficiency can be overcome substantially. However the rate of adoption and sustainability of mustard depends largely on its economic profitability.

Bangladesh Agricultural Research Institute (BARI) with other institutes had developed a number of rapeseed and mustard varieties and disseminated in the farmers' fields through different agencies. Before releasing the technology for adoption on farmer's field, on farm trials and demonstrations are conducted to test the feasibility and suitability of the new technology. Generally, the farmers belong to field demonstration are provided free production input like seed, fertilizer, insecticides, and monitor regularly to observe agronomic practices. In spite of higher yield observed in demonstration plot, most of the farmers were found to be reluctant to adopt the new technologies in the post-demonstration period. Therefore, it was needed to take up in-depth investigation to identify the factors (e.g. social, economic, behavior, cultural, etc.) which are responsible for lower adoption rate of modern technology. If we can identify the influencing factors of new technology adoption then it will be helpful for the researchers, extension personnel and policy planners to take necessary action for strengthening the adoption of this new technology.

Comprehensive study has not yet been undertaken to identify the problems of adoption of BARI released mustard varieties at farm levels. This study provided some useful information to the producers and processors of this crop. The findings and recommendations are likely to be helpful to the policy makers and researchers engaged in improving mustard variety seed and mustard oil production, formulating price policies, evolving an efficient market structure, profitability, resource use efficiency and sound marketing system in the country. The objectives of the present study are i) to study the adoption status of BARI released mustard varieties at farm level, ii) to find out factors associated with adoption and non adoption of BARI released mustard variety at farm level, iii) to estimate relative profitability of cultivation of BARI released mustard variety.

2. METHODOLOGY

Manikgonj sadar (Jagir and Susunda union), Singair (Joimontob and Paril Nowada unions) and Ghior Upazila (Baniajuri and pukhoria union) were chosen and selected purposively as high concentrated areas of mustard production. In the next step, two villages from each of the union were selected randomly for final data collection. Then farmers were selected for interview using ***s***imple random sampling technique. Considering the limitations of time and fund, sample size of mustard farmers was fixed at 180 (60 farmers from each upazila i.e., 15 farmers from each union). Farmers were classified into two categories i.e. improved variety mustard producer and local variety producer. Data were collected during February-April 2012. Pre-testing was done before finalizing the interview schedule. Secondary data on the area and production of mustard were also used to supplement the information.

Empirical model of adoption analysis

The theoretical and empirical Probit model is discussed. Qualitative Response Models (i.e. Probit model, Logit model) have been used extensively by agricultural production and farming systems economists for studying and analyzing farmer adoption and diffusion of agricultural interventions. Probit model is based on a cumulative normal distribution function which is symmetric around zero with variance equal to 1. In Pakistan, (Malik et al., 1991) used Probit model to examine the role of credit in agricultural development and (Heisey et al., 1990) used it to identify the determinants of farmers' awareness and adoption of wheat varieties. (Traxler & Byerlee, 1992) also used this analysis to identify the characteristics of insecticide farmers.

In order to ascertain the probability of adoption of improved mustard varieties, the following empirical Probit model was carried out. The dependent variable of this model was adoption of improved mustard variety. Since the dependent variable is dichotomous, OLS cannot be used. The model is as follows:

$$A_i = \alpha + \beta_i X_i + \ldots\ldots\ldots\ldots U_i$$

Where,

Ai = Farmers adopting improved mustard varieties (if, Yes = 1; Otherwise = 0)

α = Intercept

Xi = Independent variables (Socio-economic characteristics)

Ui = Error term; and

Functional Model

$$A_i = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 \ldots\ldots\ldots\ldots U_i$$

The following independent variables were used in the model.

X_1 = Education (year of schooling)

X_2 = Experience of mustard cultivation (Year)

X_3 = Farm size (ha)

X_4 = Membership of Social Organization (Score)

X_5 = Cosmopolites of the farmers (Score)

X_6 = Extension contact (Score)

X_7 = Innovativeness (Score)

3. RESULTS AND DISCUSSION

3.1 Adoption Status of BARI Released Mustard Varieties in the Study Areas

It was reported that more than 79% of the farm households in the study areas cultivated different varieties of mustard. Among mustard growing farmers, only 9.5% farmers adopted improved mustard variety. The highest percentage of farmers in Ghior (95%) and ***Singair*** (89%) cultivated mustard, but the adoption rate of improved mustard was found lowest in these areas (Table 1). Because BARI released mustard varieties are longer in duration compare to local varieties, unavailability of BARI released mustard variety seed, lack of information access to BARI released mustard varieties, ignorance about this variety, biased to cultivate the traditional varieties. The overall adoption situation indicates the wider scope of disseminating BARI Sharisha variety in the study areas.

The duration of Tori-7, 70-75 days, BARI Sharisha-9, 80-85 days (BARI, 2001), BARI Sharisha-14, 75-80 days and BARI Sharisha-15, 80-85 days (BARI, 2011) are, respectively. It was reported by the different BARI research stations that if BARI *Sharisha* harvested 5-7 days before the maturity there exist no significant yield difference (Aziz at el., 2011). But the quality of early harvested grain differs with fully matured grain. It could be used in consumption purpose, not for seed. Bearing this in mind, the farmer can early harvest BARI *Sharisha* before transplanting of *Boro* rice and get benefit by using BARI released mustard in their existing cropping pattern.

3.2 Adopted variety and seed rate

Quality seed is prerequisite of desired yield. Seed quality is a composite of several factors such as genetical, physical, physiological and pathological purity of seed which contribute to planting value of seed. Genetical purity are trueness and pure; physical purity are free from other crop seeds, free from weed seed, free from inert matter and low moisture content; physiological quality are high germination capacity and seedling vigor; pathological purity are free from seed borne diseases (Copeland, 1988).

The level of adoption of mustard varieties was mostly depended on the dissemination process used by BARI in association with the Department of Agricultural Extension. The scientists of BARI had developed and disseminated 15 improved rapeseed and mustard varieties to the farmers since 1984. It was found that BARI *Sharisha*-14 and BARI *Sharisha*-9 were the most highly adopted varieties by the farmers. Besides, most mustard farmers of Manikgonj Sadar, Singair and Ghior used Tori-7 (67%), is presented in Table 2.

The recommended seed rate of BARI *Sharisha*-9 and BARI *Sharisha*-14 is 7.5 kg/ha. All the sampled farmers in the study areas used higher amount (15% higher) of seed

than the recommended level. Therefore, the level of adoption of seed rate was found to be very low.

3.3 Technology used and their level of adoption

Appropriate input use and time of operation are essential for achieving higher yield and economic benefit. Therefore, it is important to know the existing level of technology in terms of agronomic practices, time of operation and input use. The existing level of technology employed in the production of

October and continued up to the 1st week of December. It is revealed from (Table 2) that the highest (45%) number of farmers sown seeds during mid October to mid November followed by 33 per cent farmers sown within the 1st and 2nd week of October. The highest percentage of farmers was found in Singair upazila to sow mustard seeds during the recommended time span (mid October to mid November). The time of seed sowing was highly adopted because farmers found it convenient to sow during the available range of time.

Table 1 Per cent of households adopted BARI released mustard varieties

Study Area	Total agricultural households	Total mustard cultivated households	Households cultivated BARI mustard (%)	Households cultivated local mustard (%)
Manikgonj Sadar	419	318	13	87
Singair	275	212	11	89
Ghior	184	160	5	95
All	878	690	9.5	90.5

Source : Field survey

Table 2 Adoption of improved mustard varieties by the sample farmers.

Variety used (%) and seed rate	Singair	Manikgonj Sadar	Ghior	All area
Tori-7	31 (52)	43 (72)	47 (78)	121 (67)
BARI 15	6 (9)	3 (5)	3 (5)	12 (7)
BARI 14	13 (22)	8 (13)	6 (10)	27 (15)
BARI 9	10 (17)	6 (10)	4 (7)	20 (11)
All varieties	60 (100)	60 (100)	60 (100)	180 (100)
Seed rate (kg/ha)	7.93	8.62	8.63	8.40

Source : Field survey

Note: Figures within parentheses are percentages of total
Recommended seed rate 7-8 kg/ha (BARI, 2001).

BARI *Sharisha* variety and their level of adoption are presented in (Tables 3 and 4) below.

a) Land preparation

It includes ploughing, laddering and other operations needed to make the soil suitable for sowing seeds. The mustard farmers in the study areas ploughed their lands with the help of power tiller. The number of ploughing and laddering varied from farm to farm and location to location. On the average, 66% of the total farmers ploughed their land 4-5 times followed by 44 per cent farmers ploughed 2-3 times. The highest number of farmers at Singair and Ghior upazila ploughed their lands 4-5 times, respectively (Table 3). It is important to note that five times ploughing and laddering is recommended for mustard cultivation.

b) Sowing of seeds

Farmers in the study areas followed broadcast method for sowing mustard seed. It was started from the 1st week of

c) Irrigation

Two irrigation periods, one is after 15-20 days of seed emergence and the other is during flowering stage, are recommended for achieving higher productivity of mustard. Most sample farmers in the study areas except in Ghior upazila's farmer irrigated one time. Ghior's farmers did not irrigate their crop because of rainfall initiated in the early stage of production. On an average, 88 per cent of the total farmers did not irrigate their crop, whereas 12 per cent farmers irrigated once. Based on the adoption irrigation percentage, the higher level of adoption was found in Ghior in the application of irrigation.

d) Weeding

Except for Manikgonj sadar upazila, some sample farmers in the study areas weeded their crop one times. Weeding was done mainly by utilizing human labor. 92 per cent of the total farmers performed no weeding in their field. The lower level of adoption was recorded in providing weeding to mustard crop (Table 3).

e) Insect-pest control

Aphid is one of the most harmful insects for mustard. 28 per cent of total mustard farmers used pesticides (i.e. Ripcord) to control insects like aphid and cutworm. The highest number of 42 % farmers in Manikgonj Sadar was reported to apply pesticides in controlling aphid during the month of January. On the other hand, only 19% and 20% farmers of Ghior and Singair, respectively used pesticide in their field. Low levels of adoption occurred while in applying pesticides to control insect-pest infestation which was found in study areas.

Table 3 Technology used in mustard production and their level of adoption.

Technology	Singair	Manikgonj Sadar	Ghior	All area
Sample size	60	60	60	180
Plowing and laddering				
Below the Recommended (2-3)	27 (45)	29 (48)	24(40)	80 (44)
Recommended (4-5)	33 (55)	31 (52)	36 (60)	100 (66)
Above the Recommended (>5)	--	--	--	--
Sowing time				
1st Oct.- Mid Oct. (Before)	15 (25)	20 (33)	24 (40)	59 (33)
Mid Oct.- Mid Nov. (Recommended)	36 (60)	28 (47)	18 (30)	82 (45)
Mid Nov.-1st Dec. (After)	9 (15)	12 (20)	18 (30)	39 (22)
Irrigation provided				
Not provided	59 (98)	57 (95)	45 (75)	161(88)
1 No.	1 (2)	3 (5)	15 (25)	19 (12)
Weeding				
Not weeded	53 (88)	60 (100)	56 (93)	169 (92)
One time	7 (12)	--	4 (7)	11(8)
Pest control				
Do not use pesticides	48 (80)	35 (58)	49 (81)	132 (72)
Use pesticides	12 (20)	25 (42)	11 (19)	48 (28)

Source : Field survey

Note: (i) Recommended ploughing and harrowing- 5 Nos. (BARI, 2001).

Table 4 Manure and fertilizer use and their farm level adoption in BARI *Sharisha* cultivation.
(Figure in kg/ha)

Manure and Fertilizer	Singair	Manikgonj sadar	Ghior	All area
Manure	5574(8)	2306.1(14)	2093.2(4)	3278.9(26)
Urea	194.7 (60)	206.3 (60)	220.8 (60)	207.3(180)
TSP	145.2 (54)	176.9 (43)	158.1 (50)	158.8(147)
MP	75.1 (56)	68.6 (51)	82.3 (59)	75.7(166)
DAP	101.9(8)	209.6(21)	172.1(13)	177.5(42)
Gypsum	87.3 (23)	100.3 (26)	107.4 (16)	97.5(65)
Zinc oxide	8.6 (7)	12.4 (8)	8.1 (5)	10.12(19)
Boric acid	4.5 (11)	6.5 (5)	8.7 (9)	7.1(18)

Source: Field survey

Note: Figures within parentheses are the number of fertilizer-using farmers.

Table 5 Recommended fertilizer use in their farm level in the study areas.
(Figure in kg/ha)

Fertilizer dose	Singair			Manikgonj Sadar			Ghior			All Areas		
	Urea	TSP	Gypsum	Urea	TSP	Gypsum	Urea	TSP	Gypsum	Urea	TSP	Gypsum
Below the Recommendation	36 (60)	42 (70)	19 (32)	30 (50)	38 (63)	37 (62)	18 (30)	36 (60)	23 (37)	84 (46)	116 (63)	79 (44)
Recommended	12 (20)	10 (16)	25 (42)	19 (32)	9 (15)	14 (23)	37 (60)	12 (20)	20 (33)	68 (37)	31 (17)	59 (33)
Above the Recommendation	12 (20)	8 (14)	16 (27)	11 (18)	13 (22)	9 (15)	5 (8)	12 (20)	17 (28)	28 (17)	35 (20)	42 (23)

Source : Field survey

Note: (i) Recommended average fertilizer dose (kg/ha) for BARI *Sharisha* 9: Urea-225, TSP-160, MP- 77, Gypsum-135, Zinc oxaid-5 and Boric acid-11; and for BARI *Sharisha* 14: Urea-275, TSP-175, MP- 92, gypsum-165, Zinc oxaid-5 and Boric acid-11 (BARI *Sharisha* 9 and11, 2001).

Table 6 Influence of different personnel regarding cultivation of BARI *Sharisha*.

Personnel	Manikgonj Sadar	Singair	Ghior	All area
Family member	10 (17)	9 (15)	9 (15)	28 (15)
Neighbouring farmer	7 (11)	11(19)	10 (17)	28(15)
Sub-Assistant Agri. Officer	28(47)	16 (26)	13 (22)	57 (32)
BARI Scientists/Agri. Officer	15 (25)	24 (40)	28 (56)	67 (38)
All type	60 (100)	60 (100)	60 (100)	180 (100)

Source: Field survey
Note: Figures within parentheses are percentages of total

Table 7 Maximum likelihood estimates of variable determining adoption of BARI released mustard variety among respondent farmer.

Explanatory variables	Coefficients	Standard Error	z-statistic	Probability (P>z)
Constant	-5.2408***	0.9858	-5.32	0.000
Education(X1)	-0.1225***	0.0386	-3.17	0.002
Experience(X2)	-0.0123	0.0133	-0.93	0.353
Farm size(X3)	-0.0005	0.0009	-0.66	0.512
Membership(X4)	0.3703***	0.1345	2.75	0.006
Cosmopoliteness(X5)	0.6268***	0.1294	4.84	0.000
Extension contact(X6)	0.0524	0.0454	1.15	0.248
Innovativeness(X7)	0.5614***	0.1508	3.72	0.000

Source : Field survey
Note: No. of observation=180; LR Chi-square (7) =132.10;
Log likelihood=-47.818752;***Coefficient Significant at 1% Level.

Table 8 Marginal effect after probit.

Explanatory variables	dy/dx	Standard Error	z-statistic	Probability (P>z)
Education (X1)	-0.0317***	0.0103	-3.07	0.002
Experience (X2)	-0.0032	0.0034	-0.94	0.347
Farm size (X3)	-0.0001	0.0002	-065	0.515
Membership (X4)	0.0960***	0.0390	2.46	0.010
Cosmopoliteness (X5)	0.1625***	0.0327	4.96	0.000
Extension contact (X6)	0.0136	0.0118	1.15	0.252
Innovativeness (X7)	0.1455***	0.0384	3.78	0.000

Source : Field survey
Note: ***Coefficient Significant at 1% Level.

Table 9 Returns from different mustard varieties.

Output	Local (Tori-7)	BARI *Sharisha*-15	BARI *Sharisha*-14	BARI *Sharisha*-9
Yield (kg/ha)	1308	1790	1907	1857
Price (Tk./kg)	41	45	49	43
Return from main product (Tk./ha)	53628	80550	93443	79851
Return from bi-product (Tk./ha)	3097	3738	3374	3462
Total return (Tk./ha)	56725	84288	96817	83313

Source : Field survey

Table. 10 Profitability of different BARI *Sharisha* and local mustard production.

Cost and return	Local Variety (Tori-7)	BARI Sarisa-15	BARI Sarisa-14	BARI Sarisa-9
A. Total cost	36468	38857	41585	46057
Variable cost (VC)	20317	23550	23188	27464
Fixed cost (FC)	16151	15307	18397	18593
B. Total return	56725	84288	96817	83313
Return from mustard	53628	80550	93443	79851
Return from straw	3097	3738	3374	3462
C. Gross margin (B-VC)	36408	60738	73629	55849
D. Net return (B-A)	20257	45431	51858	37256
E. Rate of return (BCR)				
BCR on full cost	1.6	2.2	2.3	1.8
BCR on variable cost	2.8	3.5	4.1	3.0

Source : Field survey

Table 11 Profitability of BARI *Sharisha* and local mustard production.
(Figure in Tk/ha)

Cost and return	BARI *Sharisha*	Local mustard	Mean difference	P(T<=t) value
A. Total cost	42167	36468	5699***	0.0023
Variable cost (VC)	24735	20317	4418***	0.0053
Fixed cost (FC)	17432	16151	1241	0.1125
B. Total return	88139	56725	31414***	0.0000
Return from mustard	84615	53628	30987***	0.0000
Return from straw	3524	3097	427***	0.0027
C. Gross margin (B-VC)	63404	36408	26996***	0.0000
D. Net return (B-A)	45972	20257	25715***	0.0000
E. Rate of return (BCR)				
BCR on full cost	2.1	1.6	0.5***	0.0000
BCR on variable cost	3.6	2.8	0.8***	0.0000

Source : Field survey
Note: '***'; '**' and '*' indicate significant at 1%; 5% and 10% level, respectively.

Table 12 Productivity of different mustard varieties and their yield advantages over local cultivar.
(in kg/ha)

Mustard variety	Singair	Manikgonj sadar	Ghior	All area
HYV mustard	1822.6	1890.2	1848.3	1861.5
BARI *Sharisha* 15	1547.8	1837.7	1853.1	1790.1
BARI *Sharisha* 14	1866.8	1960.2	1842.6	1906.4
BARI *Sharisha* 9	1901.0	1830.5	--	1857.1
All HYV mustard	1822.6	1890.2	1848.3	1861.5
Local mustard	1237.5	1347.2	1346.2	1307.8
Mean difference	585.1***	543.0***	502.1***	553.7***
P(T<=t) value	0.0000	0.0000	0.0000	0.0000
% higher yield over local	47.2%	40.3%	37.2%	42.3%

Note: '***' indicates significant at 1% level. Source : Field survey

Table 13 Comparative profitability of BARI *Sharisha* and other *Rabi* crops in the study area.(Tk/ha)

Cost and return	BARI *Sharisha*	Cabbage	Carrot	Cauliflower	Maize	Onion
A. Cost of cultivation (Tk/ha)						
Full cost	42167	108783	149503	142152	89934	155167
Variable cost (VC)	24735	94115	126937	117494	70271	133180
B. Total return(Tk/ha)	88139	201982	270258	221995	164185	245626
C. Gross margin (B-VC)	63404	107867	143321	104501	93914	112446
D. Net return (B-A)	45972	93199	120755	79843	74251	90459
E. Rate of return (BCR)						
BCR on full cost	2.1	1.9	1.8	1.5	1.8	1.5
BCR on variable cost	3.6	2.1	2.1	1.8	2.3	1.8

Source : Field survey

Table 14 Willingness to increase mustard cultivation for the next year.

Type of reason	% of responded farmers			
	Singair	Manikgonj Sadar	Ghior	All area
Sample size	60	60	60	180
A. Adaptor willingness				
1. Willing to increase	33	27	20	26.7
2. Not willing to increase	67	73	80	73.3
3. Amount of area increase (ha)	0.08	0.05	0.04	0.05

Source: Field survey

Table 15 Reasons for increasing mustard cultivation for the next year.

Type of reason	% of responded farmers			
	Singair	Manikgonj Sadar	Ghior	All area
Sample size	60	60	60	180
A. Reason to increase				
1. Profitable crop	16.7	37.5	30.8	28.3
2. Short duration crop	33.3	12.5	15.4	18.4
3. Less production cost	19.6	24.3	26..8	23.2
4. Higher yield	11.1	12.5	13.5	12.3
5. Meeting household demand	11.2	12.5	11.5	11.7
6. Money received from mustard can be used for Boro production	11.1	12.5	15.4	13.0
7. Others	5.6	6.3	7.7	6.5

Source: Field survey

Table 16 Reason for not increasing mustard cultivation for the next year.

Type of reason	% of responded farmers			
	Singair	Manikgonj Sadar	Ghior	All area
Sample size	60	60	60	180
A. Reason to not increase				
1. Lack of enough land for mustard cultivation	35.0	31.9	40.4	35.7
3. Lack of HYV mustard seed	25.0	27.4	26.7	26.5
2. Low profit compared to its competitive crops	12.5	18.2	14.9	15.2
4. Boro rice cultivation become late due to mustard cultivation	27.5	22.7	22.8	24.3

Source: Field survey

Table17 Facilities demanded for increasing mustard cultivation in selected area.

Type of reason	% of responded farmers			
	Sigair	Manikgonj Sadar	Ghior	All area
Sample size	60	60	60	180
A. Facility				
1. Availability of HYV mustard seed	40.7	42.5	42.4	41.8
2. Timely supply and lower price of fertilizers	15.6	16.5	15.2	15.7
3. Required more land for mustard cultivation	12.5	13.5	9.1	11.7
4. Training on mustard production	15.6	16.0	18.2	16.6
5. Credit facility	9.4	7.5	9.1	8.6
6. Other facilities	6.2	5.0	6.1	5.7

Source: Field survey

3.4 Use of manure and fertilizer

Use of manure and fertilizers by sample farmers varied from location to location. All the sample farmers in the study areas used cow dung as manure. On an average, the manure using farmers applied 3.2 ton of cow dung per hectare for mustard cultivation. The study revealed that farmers often did not follow recommended dose for applying fertilizers. They tended to either use fertilizers in excess or in very small quantities. All the sample farmers applied Urea, Triple Super Phosphate, Murat of Potash, gypsum and boric acid in lower quantity compared to their recommended doses. Only zinc oxide and Diammonium phosphate was applied in excess quantity than its recommended dose (Table 4). However, the uses of Urea, TSP, and Gypsum fertilizers tended to its optimum level resulting the adoption percentage 37, 17 and 33 per cent, respectively for these fertilizers (Table 5).

3.5 Personnel influencing the adoption of BARI *Sharisha*

The study found that persons from different organizations principally influenced farmers to cultivate BARI *Sharisha* in the study areas. The highest percentage (38% of total) of mustard farmers was influenced by BARI scientists and Agriculture Officer to adopt BARI *Sharisha*. The level of influence of Sub Assistant Agricultural Officer in adopting BARI *Sharisha* was about 32 per cent. The level of influence of both neighboring farmer and family member in adopting BARI *Sharisha* was reported to be more or less same BARI *Sharisha* in Manikgonj Sadar, Singair and Ghior upazilas (Table 6).

3.6 Determinant of Adopting BARI released mustard variety

The adoption of BARI released mustard variety was likely to be influenced by different socio-economic factors. At first ten variables such as age, education level, farm size, extension contact, membership with social organization, contact with mass media, experience in mustard cultivation, training received, cosmopoliteness and innovativeness of the respondent farmers were hypothesized to be major determinants of adopting BARI released mustard variety in the study areas. After testing the level of significance, seven variables were finally included in the model. Table 7 showed that education, farm size and experience had negative influences whereas Societal membership, Cosmopoliteness, extension contact and innovativeness had positive influences on the adoption of BARI released mustard variety in the study areas.

Generally, positive correlation exists between the levels of education and adoption. (Miah & Alam 2008) found that there is a strong positive relationship between the levels of education and adoption. In this study, the coefficient of education level was negative and highly significant at 1% level. It showed that low level educated farmers adopted BARI released mustard variety than higher educated farmer (Table 7).

Marginal effects are popular in some disciplines (e.g. Economics) because they often provide a good approximation to the amount of change in Y that will be produced by one unit change in X (Cameron & Trivedi, 2009).

Marginal coefficient indicated that if level of education increased by 100%, the probability of adopting BARI released mustard decreased at 3.1% (Table.8). Educated farmer in the study areas showed negative attitude toward adoption of improved mustard variety. Rather they used short duration local variety that might be due to avoid risk in *Boro* cultivation.

It was observed that the respondent farmers, who were involved with different social organizations like farmer's co-operative society, IPM club, youth development society, School/ Madrasa/ mosque managing committee, Union council member, were adopted BARI released mustard variety more than the farmers who were less involved with such social organizations (Table.8). Probit estimate showed that there was a positive and significant relationship between BARI released mustard variety adoption and involvement with society. The probability of adopting BARI released mustard variety increases by 9.6% if the respondent farmers' involvement increases by 100% (Table 8).

The coefficient of cosmopoliteness and innovativeness were positive and highly significant at 1% level. It showed that highly cosmopolite and innovative farmers had higher adoption tendency towards HYV mustard than the

noncosmopolite and laggard farmers (Table 8). Marginal coefficient indicated that if the level of cosmopoliteness and innovativeness increased 100% the probability of adopting HYV mustard increased by at 16.2% and 14.5%, respectively (Table 8).

3.7 Yield and gross return

The performance of HYV mustard production in terms of profitability and economic return compared to Local (Tori-7) variety are presented in this section (Table 9). The oil contains of Tori-7 was 40-42%, BARI *Sharish*-9 was 40-42% (BARI, 2001) and both BARI *Sharisha*-14 and BARI Sharisha-15 were 40-45% (BARI, 2011). The price of BARI *Sharisha* was higher due to high percentage of oil contain, color, shape, size than local variety. The performance of BARI *Sharisha*-14 productivity as well as price was higher compared to other improved varieties due to high percentage of oil contain.

The yield of mustard were found 1307 kg/ha in Tori-7, 1790 kg/ha in BARI *Sharisha*-15, 1907 kg/ha in BARI *Sharisha*-14 and 1857 kg/ha in BARI *Sharisha*-9. Return was calculated by multiplying yield with its price per kilogram and adding the price of by product. The average gross return of different mustard varieties were estimated at Tk. 56725/ha for Tori-7, Tk.84288/ha for BARI *Sharisha*-15, Tk.96817/ha for BARI *Sharisha*-14, Tk.83313/ha for BARI *Sharisha*-9, respectively. The gross return was higher for BARI *Sharisha*-14 due to higher yield (Table 9).

3.8 Benefit cost ratio

Benefit cost ratio (BCR) considering total cost of production and total return is presented in Table 10. Return over per Taka investment or BCR (undiscounted) was calculated as a ratio of gross return to total cost. It was observed that overall BCR was 1.6 in Tori-7, 2.2 in BARI Sharisha-15, 2.3 in BARI Sharisha-14, 1.8 in BARI Sharisha-9, respectively (Table 10).

3.9 Profitability of BARI *Sharisha* Production

a) Return from mustard production

The average gross margins of different varieties of mustard production were found to be Tk. 63404/ha in BARI *Sharisha* and Tk. 36408 in local variety, respectively (Table 11). Net return was calculated by deducting gross cost from gross return. The net returns of improved and local mustard varieties production were found to be Tk. 45972/ha and Tk. 20257/ha, respectively. The BCR of improved BARI *Sharisha* was calculated as 2.2 which was much higher than that of local variety mustard due to higher yield and gross return. The mean difference of total return, net return, rate of return (BCR) was found significant at 1% level (Table 11).

b) Productivity of different mustard varieties

The average yield from mustard production in different locations is shown in Table 12. The average yield of HYV mustard is 1861.5kg/ha, which was significantly higher (42.3%) than that of local variety (Tori-7).

The mean difference yield of BARI *Sharisha* was highest in Singair(47.2 %), followed by Manikgonj sadar(40.3%) and Ghior(37.2%) and significant at 1% level. The average yield received much higher than national average of 335.8 kg/ha (BBS, 2009).

c) Comparative Profitability of Mustard Cultivation

It has already been found that mustard cultivation is a profitable crop at farm level. When its profitability is compared with other competing crops, the study found that mustard production is not as profitable as the production of some competing crops like carrot, cauliflower, cabbage, maize and onion (Table13). Its net profit ranked 6th position among six competing crops. On the other hand, it ranked first position if the rate of return on investment (BCR) is taken into consideration.

d) Willingness to Increase Mustard Cultivation

The adopting farmers were asked to mention the possibility of expanding their cultivated area for improved mustard production. About 73% adopters indicated that they would not increase mustard area for BARI *Sharisha* production in the coming year. Among all mustard farmers, Singair's farmers showed the highest (33%) and Ghior's farmers showed the lowest (20%) level of interest in increasing their mustard area in the next year. The average amount of land availability for HYV mustard production was 0.05 ha (Table 14). Although mustard is a profitable crop, the percentage of farmers willing to cultivate mustard variety in the years to come is still low. Because, the farmers of the study areas were not shown any interest to cultivate BARI released variety, relaxed in adopting new technology and felt risk about hamper of *Boro* rice cultivation.

e) Reason for increasing mustard cultivation

The adopting farmers mentioned that they would expand their mustard areas for the next year because, mustard was a profitable crop (28.3%), its production required less cost (23.2%) and produced higher yield (12.2%). About 18.4% farmers mentioned mustard as a short duration crop; they were able to cultivate *Boro* rice after harvesting of mustard. A good number of adopters also wanted to increase mustard area for the next year to meet up their household demand and for its multi-purpose uses. Some adopters recognized mustard as cash crop because they could utilize the money that received from the sale of mustard for *Boro* or other crop production (Table 15).

f) Reason for not increasing mustard cultivation

Some of the adopters (73% of the total adopters) mentioned various reasons for not expanding their mustard area for the next year. One of important reasons was lack of enough land, as they need to grow other crops and lack of HYV seed. Some adopters also mentioned lower profit than other competing crops (e.g. lentil, vegetables, etc), and *Boro*

cultivation became delay due to mustard cultivation as their constraints for not expanding their mustard area for the next year (Table 16).

g) Facilities demanded for expanding mustard cultivation
The sample farmers mentioned some facilities that need to be created for them to expand their mustard areas in the near future. All of their demanded needs are presented in Table 17.

The important resource improvements raised by mustard growers were availability of HYV mustard seed, timely supply and lower price of fertilizers, provision of training on mustard production, and the assurance of credit facility. About 11.7% sample farmers wanted to expand mustard cultivation for the next year if they can manage more cultivable land from other farmers through lease or mortgage (Table 17).

4. RECOMMENDATIONS

Findings of the study ensured that the newly released mustard varieties were still new commodity to most of the farmers in the study areas. In this gloomy situation, special attention should be given in the following areas:

1. Although BARI released mustard cultivation is a profitable enterprise to the respondent farmers, they are still reluctant to increase its cultivation due to many reasons. Therefore, Government should take necessary steps in creating awareness of the farmer so that they can understand the cultivation of BARI *Sharisha* is not a problem for *Boro* rice cultivation, and can earn more benefit from cultivating it in their existing cropping patterns.
2. Financial support from Government may be provided for the demonstration of BARI released mustard varieties, hand-on training of the farmers and extension personnel, and provide input subsidy.
3. Government should take immediate steps to make improved BARI released mustard seed timely available to the farmers. Nevertheless, Government may encourage private seed companies to come forward for producing and distributing BARI released mustard seed at farm level.
4. The availability of fertilizer and their low prices plays an important role in increasing crop production which ultimately influences higher adoption of improved technologies including improved variety. Therefore, Government should take rational policy towards fertilizer distribution and it's pricing.
5. In many cases, poor farmers cannot spend more on sufficient inputs in crop production due to inadequate working capital. As a result, they cannot get desired yield due to use of lower amount of inputs. Therefore, Government may provide credit with low interest rate to the enthusiastic poor farmers.

5. CONCLUSION

It was concluded from the discussion hitherto that BARI released mustard is a profitable crop and it is well fitted with existing cropping patterns. However, the study showed a gloomy picture about the level of adoption of BARI released variety which was only 9.5%. The highly adopted varieties were BARI *Sharisha*-9 and BARI *Sharisha*-14. The overall adoption situation indicated a wider scope of disseminating BARI *Sharisha* in the study areas. The adoption of BARI released mustard variety was significantly influenced by different socio-economic factors such as societal membership, cosmopoliteness, and innovativeness of the farmer.

Financial analysis revealed that mustard cultivation was a profitable crop at farm level. When the profitability of mustard was compared with other competing crops, its production was not as profitable as the production of other competing crops like carrot, cauliflower, cabbage, maize and onion. Although the BCR of mustard cultivation is the highest, its net profit stands 6th position among competing crops.

Finally, the farmers in the study areas encountered various problems during mustard cultivation. The major problems were lack of HYV seed, high price of inputs, lack of technical know-how, lack of fertilizer, and dearth of adequate capital.

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