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Exploring the Potential and Performance of the Oilseed Mustard Variety Binasharisha-9 in Some Selected Areas of Bangladesh

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Authors' contributions

This work was carried out in collaboration among all authors. Authors RS and MHR designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors MRH, MMAS, SI and AN managed the analyses and interpretation of the study. Authors MMHT and NIT managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

The study aimed to identify the profitability of mustard variety and was conducted in three Binasarisha-9 growing areas of Bangladesh, namely Mymensingh, Sherpur and Ranpur district. In total, data were collected from randomly selected 180 farmers, 60 farmers from each area. Survey was conducted in sadar, Gouripur and Nalitabari Upazila of Rangpur, Mymensingh, and Sherpur district, respectively. From each areas 30 farmers was adopters and 30 was non-adopters. In the

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sampled areas data were collected through pre-designed interview schedule from January-March, 2019. Tabular, descriptive statistics and logit model were used to fulfill objectives.The study ascertains that mustard production is profitable. The average per hector net return was Tk. 22278.34 and profitability ratio was 1.50. Thirteen explanatory variables were performed in logit regression analysis in this study. The result of logit regression model shows that experience of household head, farm size, annual income, yield, training, and extension contact were found as positively significant and earning person, duration and weather were found as negatively significant variables in explaining the variation in Binasarisha-9 adoption of farm households. The major constraints were: About 20% mentioned about lack of training facilities and was top ranked followed by quality seed in timely (13.33%), infestation of disease (11.11%), and other (9.99%) were found among the mustard growers.

Keywords: Mustard; Binasarisha-9; profitability; logit model; cost; chi-square.

1. INTRODUCTION

Mustard (*Brassica* spp.) is one of the oldest oilseed crops of Bangladesh. Mustard, collectively known as rapeseed, has potential demand as preferred edible oil for one-thirds of the world population. Edible oils play vital roles in human nutrition by providing calories and aiding in digestion of several fat soluble vitamins, for example Vitamin A [1]. The per capita recommended dietary allowance of oil is 6 gm/day for a diet with 2700 Kcal [2]. Canada is the world's largest producer of pure mustard seed, accounting for an average 28% of the world's production followed by Nepal which grows 26%, Myanmar 13%, Ukraine 9%, Russia 7% and 3% each in China and the United States of the world mustard seed crop.

Mustard is a cold loving rabi crop grows during (October-February) usually under rainfed and low input condition in Bangladesh. 'Binasarisha-9' is one of the most important mustard crops in Bangladesh which plays a major role in supplementing the income of small and marginal farmers. Maximum seed yield of Binasarisha-9 is 2.0 tonne/ha which is higher than national average. Other improved characters are shorter plant height and black seed coat color. Binasarisha-9 was found to be moderately resistant to stem rot, tolerant to altarnaria blight and also showed lower incidence of aphid infestation than the local varieties. Each Kg of Binasarisha-9 yields 430g of mustard oil which is 10% higher compared to other local varieties. Farmers prefer this variety because it's a short duration variety (80 days) and farmers can plant Aus paddy in its place after harvesting mustard. Every year Bangladesh produces 0.22 million metric tonne of mustard oil [3]. Mustard seeds are cultivated in plenty and every year the production of mustard seed exceeds its demand [4]. All oilseed Brassicas are cultivated in about 0.31 million ha with 0.352 million tonnes production of oilseed contributing about 34.27% and 69.95% of the total oilseed production and acreage, respectively in the country with the average productivity of 1154 kg/ha [5]. Table 1 shows area and yield of mustard in different year in Bangladesh [6,7].

Table 1. Area and yield of mustard in Bangladesh

year	area(ha)	yield (kg/ha)
2013-14	287676.9	976.33
2014-15	325053.4	1105.82
2015-16	318633.6	1135.81
2016-17	336542.5	1078.2
2017-18	307641.3	1142.68
2018-19	270138.5	1154.00

Source: BBS, 2019

Fig. 1 shows yield of mustard is increasing year after year except 2016-17. Among the 6 years it was the lowest in the year 2013-14 i. e 976.33 kg/ha and it was the highest in the year 2018-19 i.e 1154 kg/ha.

There are many studies regarding the profitability of mustard production in different region of Bangladesh. Unfortunately, not many studies are found to estimate the profitability of Binasarisha-9 and factors affecting the adoption of this variety altogether in the context of Bangladesh. In the body of literature, some researchers have conducted different study on economic assessments such as profitability, gross margin of mustard inBangladesh [8-15]. Few of them have concentrated sporadically on the adoption practices and cultivation of oilseeds in Bangladesh [16,17].

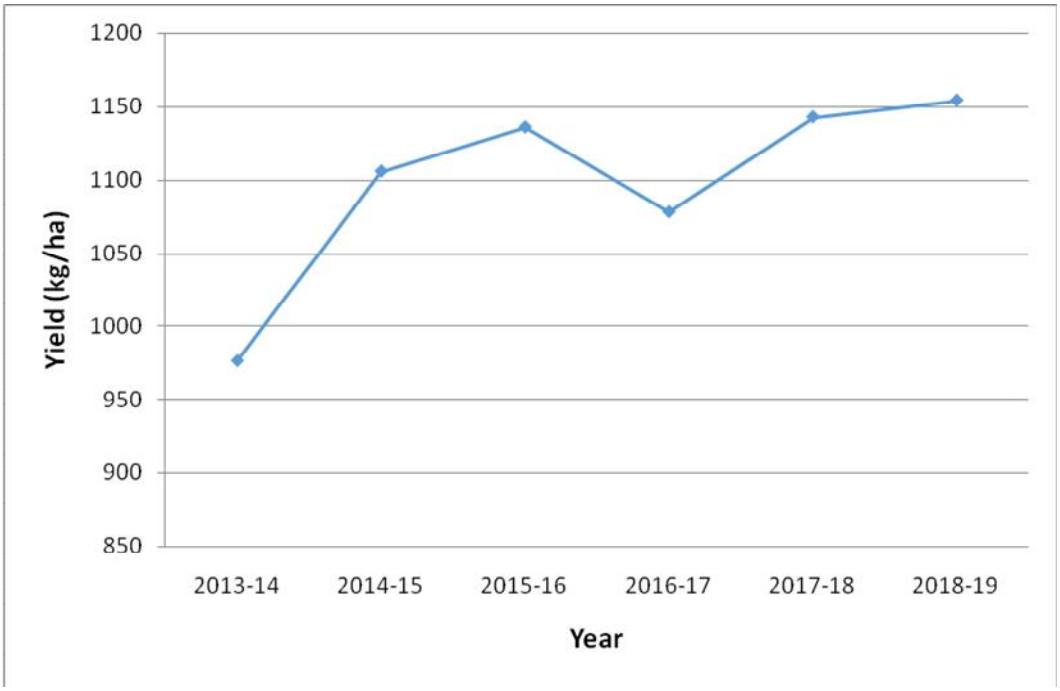

Fig. 1. Yield of mustard at different year in Bangladesh

Similar study was conducted by Huq et al. (2007) [18] which focuses on measurement of technical efficiency whereas [19] analysed the constraints of production and marketing of mustard in country. Another study examined rainfall variability and its impact on mustard production [20]. However, the estimation of profitability, comparative advantages, and problems and prospects of lentil and mustard production in Bangladesh has been received less attention. From that pursuit, this study could be one of the comprehensives ones due. In addition, this study aims to cover the existing gap in the literature about the prospects mustard production in Bangladesh.

Mustard is a cold loving rabi crop grows during (October-February) usually under rainfed and Based on the following background, this study's objectives were (i) to estimate the profitability of Binasarisha-9; (ii) to determine factors affecting the adoption of the variety, and (iii) to identify constrains and problem of the variety cultivation. Therefore, it is expected that findings of the study will provide some important guidelines to the producers, future researchers and policy makers to formulating appropriate policies for increasing the mustard production in Bangladesh.

2. MATERIALS AND METHODS

2.1 Financial Profitability of Binasarisha-9 Cultivation

Financial profitability is a major criterion to make decision for producing any crop at farm level. It has been measured based on net return, gross margin and ratio of return to total cost. Financial profitability has been calculated using the farm survey data of Binasarisha-9.

2.2 Estimation of Financial Profitability

Profitability analysis of Binasarisha-9 has been determined based on net return analysis. To determine the net returns from Binasarisha-9 production, gross costs (variable and fixed cost) were deducted from gross returns. For this purpose, the following equation was used [21].

The equation has been applied for each of the selected farmers:

$$\pi = P_m Y_m + P_b Y_b - \sum (P_{x_i} X_i) - TFC$$

Where,

π = Net return
Pm = Price of main product per units

Ym = Total quantity of main product
P_b = Price of by-product per unit
Y_b = Quantity of by-product
Px_i = Price of ith input per unit used for mustard production
X_i = Quantity of the ith input used for mustard production
TFC = Total fixed cost
i = 1, 2, 3.....n (number of input)

The estimation of Interest on operating capital (IOC) was as follows:

Interest on OC = AI × i × t

Where, AI = (Total investment)/2; I = Rate of interest per annum (%); and t = Period of mustard production (in month).

To measure the financial profitability two types of cost were estimated, cost items identified for the study were as follows:

2.2.1 Variable costs

Cost of human labour is one of the major cost components in the production process. Generally cost of hired labour required for different operations such as land preparation, sowing, weeding, fertilizer and pesticide application, irrigation, harvesting etc. are included as variable cost. Besides, for land preparation power tiller cost was estimated, which was used by farmer on contract basis and in cash. Cost of material inputs in the production process, farmers use different types of material inputs such as seeds, fertilizers, pesticides, irrigation, cow dung etc. The inputs can be supplied from home/own sources and purchased from the markets. Both own and purchased was considered in the study.Interest on operating capital was determined for three months production period; hence, at the rate of 11 percent per annum was used for calculating interest on operating capital was computed.

2.2.2 Fixed cost

Family labour cost was estimated. Cash rental value of land has been used for cost of land use.

2.2.3 Gross return

Per hectare gross return was calculated by multiplying the total amount of product and byproduct by their respective per unit prices.

2.2.4 Net return

Net return was calculated by deducting the total production cost from the total return or gross return. That is, Net return = Total return – Total production cost.

2.2.5 Gross margin

Gross margin is defined as the difference between gross return and variable costs. Generally, farmers want maximum return over variable cost of production. The argument for using the gross margin analysis is that the farmers are interested to get returns over variable cost. Gross margin was calculated on TVC basis. Per hectare gross margin was obtained by subtracting variable costs from gross return. That is, Gross margin = Gross return – Variable cost [22,23].

2.2.6 Measure of production performance by efficiency

As a measure of performance, efficiency ratio, profitability ratio is specified as follows [24]:

i. Efficiency ratio (ER) = TR/TC
ii. Profitability ratio (PR) = π/TC

2.3 Determination of Factor Affecting to Adoption of the Variety

The logit regression model was used to determine the factors affecting the adoption of the variety. The logit regression model is one of the binary choice regression model in which a dichotomous regression variable is considered as the dependent variable. When the dependent variable is binary, the linear probability model (LPM), logit and probit can be used [25,26]. Logit model have been widely used in order to explore the factors affecting farmers' decision in adoption studies [27,28,29,30]. The general logistic model expresses a qualitative dependent variable as a function of several independent variables, both qualitative and quantitative. The implicit form of the model was as follows:

$$Z_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \beta_{12} X_{12} + \beta_{13} X_{13} + U_i$$

In order to obtain the Zi there need a dichotomous response variable, if the dependent variable is 1 then the farmer is adopter of the variety otherwise zero.

Measurement of dependent and explanatory variables were given in Chart 2.

Chart 1. The independent variables were captured as

X_1=Age of the respondent (Year)	X_8= Availability of Seed
X_2=Gender	X_9=Yield (Kg)
X_3= Education (Year of Schooling)	X_{10}=Duration (Days)
X_4= Farmers experience in farming (years)	X_{11}= Training
X_5= Earning person (no. /household)	X_{12}=Extension Contact
X_6=Annual income	X_{13}= Weather
X_7= Farm size (hectare)	

Chart 2. Measurements of dependent and explanatory variables

Variable	Type	Measurement
Dependent variable	Dummy	1 if farmer has adopted, otherwise 0
Explanatory Variable		
X_1=Age	Continuous	Age of the Household head (years)
X_2=Gender	Dummy	1 if household respondentwas male, otherwise 0
X_3= Education	Continuous	Formal education of the respondent (years ofschooling)
X_4= Experience in farming	Continuous	Farming experiences of the respondents(years)
X_5= Earning person	Continuous	Number of active (aged 15–60 yrs) members in the family(persons)
X_6=Annual income	Continuous	Amount of money earned by the family members in a year('000 BDT)
X_7= Farm size	Continuous	Amount of land under mustard cultivation (ha)
X_8= Availability of Seed	Continuous	Seed used by farmers
X_9=Yield	Continuous	Yield obtained by farmers in kg
X_{10}=Duration (Days)	Continuous	No of days required for harvest
X_{11}= Training	Dummy	if received=1; otherwise=0
X_{12}=Extension Contact	Dummy	1 indicates having extension contact and 0 otherwise
X_{13}=Weather or climate	Dummy	if favorable=1; otherwise=0

3. RESULTS AND DISCUSSION

3.1 Cost of Production of Binasarisha-9

The average cost of production of Binasarisha-9 was Tk. 44126.98per hectare with an average yield was1.4 tha^{-1}which indicate to a production cost of Tk.32.16/kg. For Binasarisha-9 production the variable cost and fixed cost covered 62.91% and 37.09% of total cost, respectively. The major production cost was for human labour (35.80%), followed by land use (22.13%), fertilizer cost (22.06%), power tiller (12.73%), and irrigation (4.24%). The cost of Binasarisha-9 cultivation was found highest in Rangpur (Tk. 47971.59/ha) followed by that in Mymensingh (Tk. 42692.19/ha), Sherpur(Tk. 41717.16/ha) respectively (Table-2).

3.2 Return from Binasarisha-9 Production

The average return from Binasarisha-9 production in different locations is shown in Table 3. The highest yield was found at Rangpur (1497.24 kg /ha) followed by Sherpur(1328.11 kg /ha) and Mymensingh (1291.25 kg/ha). The average selling price of Binasarisha-9 was Tk.45.15/kg. The highest price of Binasarisha-9was found in Rangpur (Tk. 49.16/kg) and the lowest found in Mymensingh district (Tk. 42.10/kg). The average gross margin was found Tk. 38646.44 on variable cost basis. Gross margin was highest in Rangpur (Tk. 46386.35/ha) followed by Sherpur(Tk. 36156.171/ha), and Mymensingh (Tk. 34187.43/ha) respectively. The average net return per hectare was Tk. 22278.34. The net return was highest in Ranpur (Tk. 30334.53/ha) followed by Sherpur(Tk. 20771.68/ha), and Mymensingh (Tk. 16519.40/ha) respectively.

3.3 Measure of Production Performance (Profitability and Efficiencies)

3.3.1 Profitability ratio

The computed production profitability ratio as presented in Table 3 for Mymensing, Sherpur and Ranpurfarmers were 0.39, 0.50 and 0.63 respectively. This means that for every Tk. invested by Binasarisha-9 farmers, each gained Tk. 0.39, 0.50 and 0.63 respectively

in the study area. Thus, Binasarisha -9 were confirm to be profitable in conformity with the earlier findings under cost and return analysis.

3.3.2 Efficiency ratio

The estimated efficiency ratios for Mymensing, Sherpur and Ranpurfarmers were 1.40, 1.49 and 1.63 respectively which are greater than unity and is an indication that their operations were efficient. However, the efficiency of Rangpur farmers was higher than those of Mymensing, Sherpur farmers, indicating that Binasarisha -9 had a positive impact on the farmers in the study area (Table 3).

3.4 Logit Analysis for Factor Affecting the Adoption of the Variety

An important purpose of this study was to explore the important factors that influence farmers' decisions to adopt Binasarisha-9. Thirteen explanatory variables were performed in logit regression analysis in this study (Table 4). In this study, the result of test of multi-colinearity assures that such problem does not exist.The outcomes of the model were as follows.

Table 2. Per hectare cost of Binasarisha-9 production in different locations

Cost Component	Cost of production (Tk/hectare)			
	Mymensing	**Sherpur**	**Rangpur**	**All area**
Variable Cost	25024.2	26332.67	31919.77	27758.88(62.91)
Hired labour (Man days)	7762.5	9033.61	10129	8975.034(20.33)
Power tiller	4656.25	5907.56	6289.32	5617.71(12.73)
Seed	735	508.4	856.58	699.99 (1.58)
Fertilizers	8928	9287.599	10991.66	9735.754(22.06)
Urea	1688.25	1893.95	2486.96	2023.053
TSP	2217.5	2951.26	3873.09	3013.95
MP	1044.75	1314.28	1677.94	1345.66
Gypsum	490.00	355.00	484.88	443.29
Cow dung	3487.50	2773.11	2468.79	2909.80
Pesticides	118.75	58.82	1052.84	410.136(0.92)
Irrigation	2417.5	1109.24	2082.25	1869.66(4.24)
Int. on operating capital	406.20	427.44	518.13	450.59(1.38)
Fixed Cost	17668	15384.5	16051.82	16368.11(14.95)
Family labour	7788.00	6739.50	5269.70	6599.07
Land use cost	9880.00	8645.00	10782.12	9769.04(22.13)
Total Cost	42692.2	41717.16	47971.59	44126.98

Source: Field Survey, 2019; Note: Bracketed figures indicate the percentage of total cost

Table 3. Profitability of Binasarisha-9 cultivation in different locations

Type	Study areas			
	Mymensingh	**Sherpur**	**Rangpur**	**All area**
Yield from Binasarisha-9(Kg/ha.)	1291.25	1328.11	1497.24	1372.2
Price Tk/ kg	42.10	44.19	49.16	45.15
Return from Binasarisha-9 (Tk./ha)	54361.63	58689.19	73604.32	61954.83
Return from straw (Tk./ha)	4850.00	3799.66	4701.80	4450.49
Total Return (Tk./ha)	59211.63	62488.84	78306.12	66405.32
Total variable cost (Tk./ha)	25024.2	26332.67	31919.77	27758.88
Total Cost (Tk./ha)	42692.2	41717.16	47971.59	44126.98
Gross Margin (Tk./ha)	34187.43	36156.171	46386.35	38646.44
Net Return (Tk./ha)	16519.40	20771.68	30334.53	22278.34
Profitability ratio	0.39	0.50	0.63	0.50
Efficiency ratio	1.40	1.49	1.63	1.50

Source: Field Survey, 2019

Table 4. Estimates of the logistic regression of determinants of adopt Binasarisha-9 of farm households

Variable	Co-efficient (β)	Standard error (S.E.)	Level of significance (Sig.)	Exponential of coefficient or odds ratio Exp(β)
Age (X_1)	0.024	0.016	0.125	1.024
Gender(X_2)	-0.543	1.322	0.681	0.581
Exp(X_3)	0.038**	0.018	0.041	1.038
Education(X_4)	-0.057	0.122	0.643	0.945
Earning Persons(X_5)	-0.599**	0.238	0.012	0.550
Income(X_6)	0.000**	0.000	0.029	1.000
Farm size(X_7)	0.013*	0.008	0.088	1.014
Availability of seed(X_8)	0.171	0.371	0.645	1.187
Yield(X_9)	0.004**	0.002	0.050	1.004
Duration(X_{10})	-0.113***	0.030	0.000	0.893
Training(X_{11})	1.235**	0.540	0.022	3.439
Excon($X1_2$)	1.006*	0.626	0.100	2.733
Weather(X_{13})	-1.404**	0.624	0.025	0.246

*Source: Field Survey, 2019; *, **, and *** indicate significance levels of 10%, 5%, and 1%, respectively*

3.4.1 Age of household

The expected effect of this variable (Age of household) on Binasarisha-9 has a positive coefficient but it was insignificant. So, it has a minor impact on adopting the variety.

3.4.2 Gender

The expected effect of this variable has a negative coefficient but it was insignificant. So, it has a minor impact on adopting the variety.

3.4.3 Experience

Experience of farming has a positive coefficient which was 0.038and it was significant. One unit increase in the farming will increase the log odds ratio of adopting the variety by 1.038.

3.4.4 Education level

The expected effect of this variable on Binasarisha-9 has a negative coefficient but it was insignificant. So, it has a minor impact on adopting the variety.

3.4.5 Earning person

Earning person of sample family has a negative coefficient which was 0.599and it was significant. One unit increase the no. of earning person will decrease the log odds ratio of adopting the variety by 0.550.

3.4.6 Annual income

This result implies that the higher the household farm income, greater the probability of adopting the variety. One-unit increase in the level of farm income will increase the log odds ratio of adopting the variety by 1.0. [31].

3.4.7 Farm size

It has a positive coefficient which was 0.013 and it was significant. One unit increase in the size will increase the log odds ratio of adopting the variety by 1.014.

3.4.8 Availability of seed

The expected effect of this variable on Binasarisha-9 has a positive coefficient but it was insignificant. So, it has a minor impact on adopting the variety.

3.4.9 Yield

The coefficient of yield of farmer was 0.04 and it was significant at 5% probability level. The estimated value means that if one unit increase of the variable will increase the log odds ratio of adopting the variety by 1.004.

3.4.10 Duration

Table 4, indicates that the coefficient of duration of the variety was -0.113 and it was significant at 1% probability level. One unit increase of duration of the variety will decrease the log odds ratio of adopting the variety by 0.893 while holding all other variables in the model constant.

3.4.11 Training

The coefficient of training of farmer was 1.235 and it was significant at 5% probability level. The estimated value means that if one unit increase of the variable will increase the log odds ratio of adopting the variety by 3.439.

3.4.12 Extension contact

Table 4 depicts that the coefficient of extension contact was 1.006. The estimated value means that farmers' adoption is 2.733units higher in case of having extension contact compared to other condition while holding all other variables in the model constant.

3.4.13 Weather

Weather of the study areas had a negative coefficient which was 1.404 and it was significant at 5 % level of probability. One unit increase in the vector will decrease the log odds ratio of adopting the variety by 0.246.

3.5 Test of Model Fit

Let Null Hypothesis H_0 : Model fit correctly
Alternative hypothesis H_0: does not fit

Chi-square or Hosmer and Lemeshow Test was done to justify whether the model is good fitted or not (Table-5). The value of this tese statistic is 5.127 and the p-value (given by spss) is 0.744 which is greater than 0.05, so we do not reject the null hypothesis and conclude that the model adequately fits the data.

3.6 Measures of the Proportion of Variation Explained

SPSS gives two variations on this, Cox and Snell's R^2 and Nagelkerke's adjusted R^2. Cox and Snell's R^2 has the disadvantage that for discrete models (such as logistic regression) it may not achieve the maximum value of one, even when the model predicts all the outcomes perfectly. Nagelkerke's adjusted R^2 is an improvement over Cox and Snell's R^2 and can attain a value of one when the model predicts the data perfectly (Table 6)

Table 5. Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	5.127	8	.744

Source: Field Survey, 2019

Table 6. Model Summary

Step	-2 Log likelihood	Cox & Snell R Square	Nagelkerke R Square
1	174.735[a]	.336	.494

Source: Field Survey, 2019

3.7 Problems and Constraints to Binasarisha-9 Cultivation in the Study Areas

The data presented in Table 7 indicated the major problems face by Binasarisha-9 growing farmers in the study areas. About 20% mentioned lack of training facilities and was top ranked followed by quality seed in timely (13.33%), Infestation of disease (11.11%), and other (9.99%) were found among the mustard growers.

Some of the respondent farmers mentioned few constraints that were: farmer need cash money for increase the number of crops in a year including Binasarisha-9. Availability of cultivable land and more extension contact were also demanded by the farmers in expanding this variety.

Table 7. Major Problems to Binasarisha-9 cultivation in the study areas

Type of problem	% of farmers respondent				
	Mymensingh	Sherpur	Rangpur	All area	Rank
Availability of quality seed	10	16.66	13.33	13.33	2
Lack of training	20	16.66	23.33	19.99	1
Infestation of disease	16.66	10	6.66	11.11	3
Others*	6.66	10	13.33	9.99	4

*Source: Field Survey, 2019; *Scarcity of labour, adulteration of fertilizer, High price of fertilizer, Soil fertility degradation, higher price of ploughing, storage facility*

4. CONCLUSION

Binasarisha-9 production in the study areas is profitable. The average net return per hectare was Tk. 22278.34. Farmer gets good yield i.e 1.4 t/h (average) by cultivation of the variety and also large amount of substitute. The result of logit regression model shows that experience of household head, farm size, annual income, yield, training, and extension contact were found as positively significant and earning person, duration and weather were found as negatively significant variables in explaining the variation in Binasarisha-9 adoption of farm households. By include this short duration variety (85 days) in cropping pattern as well minimize those constraints farmer of our country also become benefited.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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