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PROFITABILITY AND YIELD GAP ANALYSIS OF Binadhan-14 IN SOME SELECTED AREAS OF BANGLADESH

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Abstract

The aim of this study was to estimate the profitability and yield gap of Binadhan-14. The study was conducted in Mymensingh, Jamalpur, Rangpur and Sunamganj districts of Bangladesh. Data were collected using a simple random sampling technique from 200 Binadhan-14 cultivating farmers. Data were collected from October-November, 2021. Descriptive statistics as well as Stochastic Frontier model were used to achieve the objectives. The average actual farmer's yield of Binadhan-14 was 5.11 t ha^{-1}. BCR was estimated at 1.53 implying that the Binadhan-14 cultivation at farm level was profitable. The estimated average yield gap-I was 0.43 t ha^{-1} (6.95 %.) and average yield gap-II was 0.71 t ha^{-1} (12.10 %.). The average yield gap was 1.14 t ha^{-1} (19.05%). The regression coefficients for power tiller, human labor, fertilizers, irrigation, wedding, insecticides and seed under all areas were positive and significant at 1%, 5% and 10% level. Farmers' characteristics like age, farming experience and agricultural training found negatively related to their yield gap of the Binadhan-14. The government should realize that yield gap exists in rice crops of Bangladesh and, therefore, explore the scope to increase production as well as productivity of rice by narrowing the yield gap and thereby ensure food security.

Key words: Binadhan-14, Profitability, Yield gap, Cobb-Douglas production function

Introduction

Agriculture contributes about 11.38% to the gross domestic product (GDP) (BBS, 2022). Bangladesh agriculture suffers from several issues, such as limited and scattered land holdings, natural hazards, increasing temperatures, irregular and unpredictable rainfall, winter shortening, rising sea level, rice mono-cropping, and low profitability in rice cultivation (Mondal *et al.*, 2012). Paddy crop is cultivated in a wide range of environments characterized by different temperatures, climates, and soil-water conditions (Basavaraj *et al.*, 2020). Rice production is marginally profitable in Bangladesh. Nevertheless, the country already attained rice self-sufficiency (Jalilov *et al.*, 2019). It is one of the dominant cereal dietary items of almost 15 million farm families (BBS, 2015) in Bangladesh. It provides one-sixth of rural household income, half of the rural employment (nearly 48%), two-thirds of per capita daily calorie intake, and half of per capita daily protein intake (Rahman *et al*, 2016). About 81 percent of the total cropped area and over 80 percent of the total irrigated area is planted to rice. Approximately 96 percent share of the total cereal supply comes from rice alone (Alam *et al*, 2013).

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Rice is the single crop which plays the most important contribution to GDP, income and employment generation and meets the challenges to self-sufficiency in food production (Hasnain *et al,* 2015). Bangladesh is autonomous in rice (Mainuddin *et al,* 2015, Timsina *et al,* 2018). Production with an average per capita consumption of 134 kg per annum, compared to the world average of 57 kg per annum (Mottaleb *et al,* 2016). It is the most leading crop and produces a major distribute of farmers' income and employment (Sarker *et al,* 2012 and Alam *et al,* 2016). Food self-sufficiency mostly depends on rice production. The total contribution of the rice production is about 70 percent of the total agricultural contribution to GDP. Thus, it is often argued that self-sufficiency in food might be attained by enhancing the overall productivity of rice (Chowdhury, 2013). Considering the food habit of the people of Bangladesh, 'rice security' should also address the 'nutrition security'. In this country, rice is not only the carbohydrate-supplying food, but also the major provider of protein, micronutrients, and health benefits. Antioxidants supplied by rice contribute to relieving oxidative stress, and preventing cancer, cardiovascular problems and complications of diabetes (Shozib *et al,* 2020). Rice is the main cereal crop grown in three different seasons, namely *Aus*, *Aman* and *Boro* in Bangladesh which covers 74.85% of the total cultivable area (BBS, 2017).

Bangladesh Institute of nuclear agriculture (BINA) developed Binadhan-14 is a late transplanting potential *Boro* or Braus rice variety which contributes significantly in changing farmer's income and employment generation to meets the challenges of self-sufficiency in food production. Binadhan-14 variety allows *Boro* rice transplantation even up to last week of March and produces average yield of 6.9 t ha-^{1} in 105-125 days under proper management practices.

This variety allows of any duration in the cropping pattern of short duration T. *Aman* rice mustard/rapeseed-*Boro* rice keeping the *Boro* yield unaffected. It has long-fine grains with palatable to eat. This variety contributes significantly in increasing area under mustard/rapeseed, pulses, potato and even winter vegetables.

There are some studies about the profitability of rice production in Bangladesh (Anik 2003, Ismail *et al,* 2010; Khan 2005, Mondal 2005, Tasnoova *et al.* 2006, Rahman *et al*, 2015, Noonari *et al*, 2015, Islam *et al*, 2017 and Bwala *et al*, 2018). The present study not only analyses the profitability but also identify yield gap, factors affecting gross return and to suggest some policy guidelines to minimize the yield gap about Binadhan-14 production. Therefore, the findings of this study would guide the policy makers in designing policies that can contribute to the measures needed to improve the nation's potential for food production efficiently. The specific objectives of the study were (i) to estimate the costs and return of Binadhan-14 cultivation in the study areas; (ii) to determine the yield gap of Binadhan-14; (iii) to identify the factors affecting the yield gap of Binadhan-14 and (iv) to suggest some policy guidelines to minimize the yield gap.

Materials and Methods

Selection of the study area, sample size and sampling technique

This study was conducted in the four districts namely Mymensingh, Jamalpur, Rangpur and Sunamganj in Bangladesh. A total of 200 Binadhan-14 farmers taking 50 farmers from each district were randomly selected with the help of Department of Agricultural Extension (DAE) personnel for interview. Field investigators under the direct supervision of the researchers collected field level cross sectional data using pre-tested interview schedule.

Method of data collection and period of study

Data for the present study were collected from sample Binadhan-14 farmers through face-to-face interview method using a pre-tested interview schedule. Field level primary data were collected by the researcher with the help of trained enumerators for the period of October-November, 2021.

Analytical techniques

Collected data were edited, summarized, tabulated and analyzed to fulfill the objectives of the study. The data were analyzed with the help of suitable statistical measures as frequencies, percentages, mean and standard deviation. Descriptive statistics were used to analyze and compare the socioeconomic characteristics. The total cost was composed of total variable costs (TVC) and total fixed costs (TFC). The gross return (GR) was computed as total mustard output multiplied by the market price of Binadhan-14. Gross margin (GM) was defined as GR-TVC, whereas the net return (NR) was defined as GR-TC. Finally, the Benefit Cost Ratio (BCR) was computed as GR/TC.

In the study, the concept of yield gap as suggested by Zandstra *et al.* (1981) was used. Total yield gap can be decomposed into two parts i.e. Yield gap I and Yield gap II. Yield Gap I refer to the difference between research station's yield and potential farm yield obtained at demonstration plots, while Yield Gap II, reflecting the effects of biophysical and socio-economic constraints, was the difference between yield obtained at the nearest potential plot and actual yield obtained on farmer's fields. The yield gaps were estimated as follows:

$$\text{Yield Gap I} = [(Y_R - Y_P)/Y_R] \times 100$$
$$\text{Yield Gap II} = [(Y_P - Y_F)/Y_P] \times 100$$

Where,

Y_R is the research station yield,
Y_P is the potential farm yield, and
Y_F is the actual farm/farmers' yield.

Statistical Analysis

The production of Binadhan-14 is likely to be influenced by different factors, such as, seed, labor, power tiller, chemical fertilizer, irrigation, weeding, insecticides, etc. The following Cobb-Douglas type production function was used to estimate the parameters. The functional form of the Cobb- Douglas multiple regression equation was as follows:

$$Y= AX_1^{b1} X_2^{b2} \ldots\ldots\ldots\ldots X_n^{bn} e^{ui}$$

The production function was converted to logarithmic form so that it could be solved by least square method i.e.

$$\ln Y= a + b_1 \ln X_1 + \ldots\ldots\ldots\ldots + b_n \ln X_n + e^{ui}$$

The empirical production function was the following:

$$\ln Y= a + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + b_6 \ln X_6 + b_7 \ln X_7 + b_8 \ln X_8 + b_9 \ln X_9 + b_{10} \ln X_{10} + b_{11} \ln X_{11} + b_{12} \ln X_{12} +Ui$$

Where,

ln = Natural logarithm;
Y = Yield (kg ha^{1});
X_1 = Power tiller cost (Tk ha^{1});
X_2 = Human labor cost (Mandays ha^{1});
X_3 = Seed cost (kg ha^{1});
X_4 = Fertilizer cost (kg ha^{1});
X_5 = Irrigation cost (Tk ha^{1});
X_6 = Weeding cost (Tk ha^{1});
X_7 = Insecticides cost (Tk ha^{1});
X_8 = Age;
X_9 = Education;
X_{10} = Farm size;
X_{11} = Farming experience; and
X_{12} = Agricultural training

a = Constant value
b_1 b_2 .... b_{12} = Co-efficient of the respective variables and U_i = Error term.

Results and Discussion

Financial profitability of Binadhan-14 cultivation

The cost of Binadhan-14 production, gross return, gross margin, net return and the benefit cost ratio (BCR) for Binadhan-14 cultivation are being discussed in the following sections.

Cost of Binadhan-14 cultivation

The cost of human labour, land preparation, power tiller, seed, fertilizers, pesticides and irrigation were taken into consideration, while calculating cost of Binadhan-14 production. Beside this, interest on operating capital was also considered as the cost of Binadhan-14 production. Total cost consists of variable cost and fixed cost that covered 71.8% and 28.2% of total cost for Binadhan-14 production.

The average costs of Binadhan-14 cultivation were Tk. 80111 ha^{-1} and Tk. 57519 ha^{-1} on full cost and cash cost basis, respectively. Table 1 represents that 50.2% of total cost was incurred for human labour hiring purpose which was nearly similar to Rahaman *et al.* (2018) where the authors found that 49.89% of total cost was considered for labour cost. The highest production cost was for human labour (50.2%), followed by irrigation (12.2%), land use (8.3%) and power tiller (7.8%). The cost of Binadhan-14 cultivation was found highest in Rangpur (Tk. 84328.73 ha^{-1}) followed by that in Mymensingh (Tk. 82675 ha^{-1}), Jamalpur (Tk. 77095 ha^{-1}) and Sunamganj (Tk. 76348 ha^{-1}), respectively.

Table 1. Per hectare cost of Binadhan-14 production in different locations

Cost Component	Cost of production (Tk ha^{-1})				All	% of
	Mymensingh	Jamalpur	Rangpur	Sunamganj	areas	total cost
A) Variable Cost	59054	56698	60077	54248	57519	71.8
Hired labour (Man days)	23676	24342	25065	23945	24257	30.2
Power tiller	6521	5525	7010	5828	6221	7.8
Seed	2404	2203	2122	2523	2313	2.8
Fertilizers:						
Urea	2370	2233	2571	2628	2450	3.0
TSP	2429	2655	2416	2810	2577	3.2
MP	1657	1821	1880	2024	1845	2.3
Gypsum	682	634	551	493	590	0.7
Zinc Sulphate	913	980	828	774	874	1.0
Cow dung	3625	2563	3512	2836	3134	3.9
Pesticides	2297	1853	2210	2019	2095	2.6
Irrigation	10896	10654	10198	7274	9755	12.2
Int. on operating capital	1580	1231	1710	1090	1403	1.7
(B) Fixed Cost	23621	20396	24251	22099	22592	28.2
Family labour	16784	13895	17323	15724	15931	19.9
Land use cost	6836	6501	6928	6375	6660	8.3
Total Cost (A+B)	**82675**	**77095**	**84328**	**76348**	**80111**	**100.0**

Source: Field survey, 2021

Return from Binadhan-14 production

The average return from Binadhan-14 production in different locations is shown in table 2. The average yield of Binadhan-14 was 5108 kg ha^{-1}. The yield was highest at Jamalpur (5340 kg ha^{-1}) followed by Mymensingh (5120 kg ha^{-1}), Sumanganj (5050 kg ha^{-1})

and Rangpur (4920 kg ha^{-1}). The total return from Binadhan-14 production consists of the values of Binadhan-14 and straw.

The average gross margin was found in Tk. 64970 ha^{-1} on variable cost basis. Gross margin was highest in Sunamgnaj (Tk. 71902 ha^{-1}) followed by Jamalpur (Tk. 64516 ha^{-1}), Mymensingh (Tk. 61888 ha^{-1}) and Rangpur (Tk. 61575 ha^{-1}), respectively. The average net return was Tk. 42378 ha^{-1}. The net return was highest in Sunamgnaj (Tk. 49803 ha^{-1}) followed by Jamalpur (Tk. 44119 ha^{-1}), Mymensingh (Tk. 38267 ha^{-1}) and Rangpur (Tk. 37324 ha^{-1}), respectively. Benefit cost ratio was estimated at 1.53 and 2.13 on full cost and variable cost basis implying that the Binadhan-14 cultivation at farmers' level was profitable. This finding is supported by Sarkar *et al*. (2022) where the authors found *Boro* rice production was profitable.

Table 2. Profitability of Binadhan-14 cultivation in different location

Type	Study areas				All areas
	Mymensingh	Jamalpur	Rangpur	Sunamganj	
Yield from Binadhan-14 (Kg ha^{-1})	5120	5340	4920	5050	5108
Return from Binadhan-14 (Tk. ha^{-1})	116750	117764	117598	122486	118650
Return from straw (Tk. ha^{-1})	4192	3450	4054	3665	3840
Total return (Tk. ha^{-1})	120943	121214	121652	126151	122490
Total variable cost (Tk. ha^{-1})	59054	56698	60077	54248	57519
Total cost (Tk. ha^{-1})	82675	77095	84328	76348	80111
Gross margin (Tk. ha^{-1})	61888	64516	61575	71902	64970
Net return (Tk. ha^{-1})	38267	44119	37324	49803	42378
Benefit Cost Ratio (BCR)					
BCR on full cost	1.46	1.57	1.44	1.65	1.53
BCR on variable cost	2.05	2.14	2.02	2.33	2.13

Source: Field survey, 2021

Yield gap of Binadhan-14 production

The results showed that the actual farmers level highest yield was obtained from Jamalpur (5.34 t ha^{-1}) followed by Mymensingh (5.12 t ha^{-1}), Sunamganj (5.05 t ha^{-1}) and Rangpur (4.92 t ha^{-1}) district, respectively. At farmers' level, the average actual farmers' yield of Binadhan-14 was 5.11 t ha^{-1} (Table 3). The estimated average yield gap-I was 0.43 t ha^{-1} (6.95%) and average yield gap-II was 0.71 t ha^{-1} (12.10%). The lowest gap was 1.04 t ha^{-1} (16.82%) observed in Jamalpur district and it was the highest 1.20 t ha^{-1} (20.08%) in case of Sunamganj district. Considering all, the average total yield gap was 1.14 t ha^{-1} (19.05 %) and much opportunity for yield improvement in the variety. This result is supported by sultana *et al*. (2019).

Table 3. Estimated yield gap of Binadhan-14 in different areas

Particular	Mymensingh	Jamalpur	Rangpur	Sunamganj	Average
Average research station yield (Y_R), t ha^{-1}	6.30	6.38	6.05	6.25	6.25
Average potential farmers yield (Y_P), t ha^{-1}	5.75	6.12	5.53	5.85	5.81
Average actual farmers yield (Y_F), t ha^{-1}	5.12	5.34	4.92	5.05	5.11
Yield gap I (%)	0.55 (8.73)	0.26 (4.08)	0.52 (8.60)	0.40 (6.40)	0.43 (6.95)
Yield gap II (%)	0.63 (10.96)	0.78 (12.75)	0.61 (11.03)	0.80 (13.68)	0.71 (12.10)
Total yield gap (%)	1.18 (19.69)	1.04 (16.82)	1.13 (19.63)	1.20 (20.08)	1.14 (19.05)

Source: Field survey, 2021

Major factors that influencing the yield of Binadhan-14

The district wise farmers have to maintain according to recommended dose in some extant but in average. The farmers among the study areas did not consider the recommended doses of seed rate and fertilizers. The average seed rate was 31.56 kg ha^{-1}, Urea 207.23 kg ha^{-1}, TSP 87.74 kg ha^{-1}, MoP 129.92 kg ha^{-1}, Zypsum 59.06 kg ha^{-1} and ZnSO4 7.23 kg ha^{-1} respectively, indicating that they are either below or above the recommendation (Table 4).

Table 4. Input–use pattern of Binadhan-14 growing farmers

Factors	Seed (kg ha^{-1})	Urea (kg ha^{-1})	TSP (kg ha^{-1})	MoP (kg ha^{-1})	Zypsum (kg ha^{-1})	$ZnSO_4$ (kg ha^{-1})
Recommended	25-30	220-260	100-125	140-180	65-80	7-8
Mymensingh	32.31	212.44	93.26	142.14	68.29	7.55
Jamalpur	28.65	175.25	88.41	138.54	63.45	8.10
Rangpur	30.74	224.36	72.98	126.35	55.14	6.85
Sunamganj	34.52	216.85	96.32	112.63	49.37	6.40
Average	31.56	207.23	87.74	129.92	59.06	7.23

Source: Field survey, 2021

Other factors which were also responsible in the yield of Binadhan-14 are described in Table 5. In average 55.86% farmers used power tiller more than three times, 74.94% farmers irrigated their land more than three times, 66.39% farmers weeded their land 2 times and 94.56% farmers spray pesticide and insecticide to control disease and insect in the study area.

Table 5. Input–use pattern of Binadhan-14 growing areas

Factors	Mymensingh	Jamalpur	Rangpur	Sunamganj	Average
Power tiller (%)					
Two times	6.50	5.21	1.88	2.51	4.03
Three times	41.52	40.55	32.89	45.52	40.12
More than 3	51.98	54.24	65.23	51.97	55.86
Irrigation (%)					
Two times	3.54	5.65	2.02	1.28	3.12
Three times	20.14	28.80	16.42	22.40	21.94
More than 3	76.32	65.55	81.56	76.32	74.94
Weeding (%)					
Weeding 1	32.01	37.12	23.44	41.87	33.61
Weeding 2	67.99	62.88	76.56	58.13	66.39
Pesticide & insecticide (%)	98.25	92.65	99.05	88.28	94.56

Source: Field survey, 2021

Factors affecting gross return of Binadhan-14

To determine the effects of the explanatory variables, linear and Cobb-Douglas model were initially estimated for Binadhan-14 production. Some of the key variables are explained below.

The contribution of specified factors affecting production of Binadhan-14 could be seen from the estimation of regression equation in Table 6. The regression coefficients for power tiller, human labor, fertilizers and irrigation for Binadhan-14 for all areas were positive and significant at 1% level. On the other hand, coefficients for wedding and insecticides were found to be positively significant at 5% level and coefficient of seed was positively significant at 10% level for all areas. The positive sign indicated that using more of these inputs in Binadhan-14 production could increase the yield to some extent.

The regression coefficients for age, farming experience and agricultural training for all areas had negative but significant relationship at 5% and 10% level, respectively. For all areas, the regression coefficient of farm size was positive but not significant. In case of education under all areas, the regression coefficient was negative and not significant. Age, farming experience and agricultural training influenced the yield gap of Binadhan-14 negatively i.e. with the increase of age, farming experience and agricultural training yield gap of Binadhan-14 will be decreased.

Coefficient of multiple determinations (R^2)

The coefficient of multiple determination (R^2) tells how well the sample regression line fits the data. It is evident from Table 6 that the values of R^2 were 0.782, 0.891, 0.761 and 0.885 for Mymensingh, Jamalpur, Rangpur and Sunamagnj districts, respectively. This means that around 78, 89, 76 & 89 percent of the variations in gross return for Binadhan-14, respectively were explained by the independent variables included in the model. The value of R^2 under all areas was 0.830 means that 83 percent of the variations in gross return was explained by the independent variables included in the model.

Table 6. Estimated values of regression co-efficient and related statistics of Cobb-Douglas production function for Binadhan-14 production

Explanatory variables	Study areas								All areas	
	Mymensingh		Jamalpur		Rangpur		Sunamganj			
	Co-efficient	T-value	Co-efficient	T-value	Co-efficient	T-value	Co-efficient	T-value	Co-efficient	T-value
Intercept	2.211*** (0.811)	4.330	3.610*** (1.421)	4.480	4.630*** (0.510)	8.482	4.237*** (1.126)	6.450	3.320*** (1.140)	6.652
Power tiller (X_1)	0.218** (0.012)	1.646	0.214*** (0.084)	3.214	0.312*** (0.082)	2.615	0.011** (0.012)	1.650	0.284*** (0.073)	4.206
Human labor (X_2)	0.097** (0.081)	1.510	0.220** (0.141)	2.396	0.218*** (0.091)	2.251	0.224*** (0.088)	3.513	0.217*** (0.074)	4.521
Seed (X_3)	0.612* (0.132)	7.210	0.312* (0.092)	3.312	0.141* (0.080)	2.210	0.512** (0.204)	3.159	0.171* (0.131)	2.640
Fertilizer (X_4)	0.227** (0.062)	4.413	0.232** (0.090)	2.241	0.204*** (0.082)	2.530	0.056** (0.120)	2.322	0.410*** (0.160)	3.441
Irrigation (X_5)	0.023*** (0.310)	0.510	0.055** (0.042)	1.180	0.086*** (0.072)	2.272	0.420** (0.311)	3.722	0.051*** (0.640)	2.281
Weeding (X_6)	0.090** (0.080)	1.820	0.282* (0.131)	3.536	0.125** (0.091)	2.141	0.214* (0.088)	3.213	0.242** (0.070)	4.810
Insecticides (X_7)	0.251** (0.128)	3.219	0.180* (0.121)	1.510	0.174** (0.161)	1.441	0.461* (0.160)	4.886	0.311** (0.180)	3.510
Age (X_8)	-0.322** (0.081)	2.925	0.254** (0.112)	3.121	-0.310* (0.080)	3.524	-0.287** (0.068)	3.122	-0.382** (0.091)	2.421
Education (X_9)	-0.064 (0.061)	2.317	-0.096 (0.081)	1.311	-0.126 (0.210)	1.286	-0.023 (0.311)	0.886	-0.097 (0.080)	1.826
Farm size (X_{10})	0.020 (0.281)	1.654	0.140 (0.080)	2.216	0.125 (0.091)	2.112	0.052 (0.041)	1.281	0.023 (0.212)	1.210
Farming experience (X_{11})	0.538* (0.214)	3.519	-0.314** (0.082)	2.812	-0.650* (0.252)	3.658	-0.850** (0.312)	4.151	-0.554** (0.212)	4.811
Agricultural training (X_{12})	0.244* (0.90)	2.281	-0.121* (0.180)	2.151	-0.207* (0.080)	3.511	-0.165* (0.160)	1.821	-0.105* (0.091)	2.120
Coefficient of multiple determination (R^2)	0.782		0.891		0.761		0.885		0.830	
F-value	8.510***		9.467***		8.536***		10.431***		9.236***	
Returns to scale	1.028		1.065		1.038		1.049		1.045	

Source: Field survey, 2021

Note: '***' '**' '*' indicate significant at 1%, 5% and 10% level. (Figures in the parentheses indicates the standard errors)

F-value

The F-values of Mymensingh, Jamalpur, Rangpur and Sunamagnj districts were 8.510, 9.467, 8.536 and 10.431 which were highly significant at 1% level of probability implying that all the explanatory variables were important for explaining the variations in gross returns of the Binadhan-14 variety in the study area (Table 6). The F-values of all areas were 9.236 which was highly significant at 1% level of probability implying that all the explanatory variables was important for explaining the variations in gross returns of the Binadhan-14.

Return to Scale

The summation of the entire production coefficient indicates return to scale. The sum of elasticity coefficients were 1.028, 1.065, 1.038 and 1.049 in case of Binadhan-14 meaning increasing returns to scale (Table 6). This means that, 1 percent increase in all inputs simultaneously would result on average 1.028, 1.065, 1.038 and 1.049 percent increase in gross return of Binadhan-14. The coefficients of under all areas was 1.045 means that 1 percent increase in all inputs simultaneously would result on average 1.045 percent increase in gross return of Binadhan-14 in the study areas. This value being greater than 1 means that the farmers are operating at the region of increasing return to scale. More clearly, the farmers still have the scope to allocate more inputs in their rice field as it will generate a higher return than production cost.

Problems and Challenges

Farmers faced several problems and challenges when they produced *Boro* rice in the study area. Some of the major problems and challenges are pointed out below:

Unavailability of quality seed: Adequate amount of high-yielding variety (HYV) seeds were not available in the study area. Because of the scarcity of quality seeds, farmers could not produce the desired amount of output at that season.

Higher input prices: In the study area, the prices of different agricultural inputs like fertilizer, pesticides, seeds, hired labor, etc. were very high, that’s why all the farmers could not afford an adequate amount of input at a higher price.

Lack of hired labor: Although the price of hired labor was very high during the period of rice farming, still there was a lack of the required amount of hired labor.

Lack of proper training: Farmers did not get any proper agricultural training which could enhance them to produce a larger amount of rice yield.

Natural calamities: Farmers faced heavy storms of Baishakh like ‘Kalbaishakhi’ during the period of *Boro* rice farming which caused lower per bigha rice yield. Farmers also faced some other natural calamities during that period.

Policy guidelines to reduce the yield gap

Yield gaps caused by biological, socio-economic and institutional constraints can be effectively addressed through an integrated crop management (1CM) practice. Transfer of the practices through extension agents could effectively help farmers minimize yield gaps. Timely supply of inputs plays an important role in the productivity of crops and minimizing yield gaps. Farmers need adequate amounts of quality inputs at the right time to obtain high yields. Therefore, farmers need to be supported by adequate and timely supply of credit to narrow yield gaps. The support of research and extension is necessary for narrowing yield gaps. The researcher should understand farmers' constraints to high productivity and accordingly develop integrated technological package (appropriate variety, timely planting, fertilizer, irrigation and pest management) for farmers to minimize the gaps. The extension service should at the same time make sure that the farmers apply accurately and scientifically the recommended technological packages in field through effective training, demonstrations, field visits, monitoring, motivation, awareness, etc. to achieve the high yield.

Conclusion

Binadhan-14 production is profitable in the study area. The average yield was 5.11 t ha^{-1} and average net return was Tk. 42378 ha^{-1}. BCR on full cost was 1.53. Therefore, Binadhan-14 growers received high return on its investment. In the study area, the average total yield gap was 1.14 t ha^{-1} (19.05%). That means we are losing 1.14 t ha^{-1} yield of Binadhan-14 in *Boro* season. If we could reduce yield gaps, our rice production per year will be increased and farmers as well as the country will be benefitted. All of the factors namely, power tiller, human labour, seed, fertilizer, irrigation, insecticides, age, education, farm size, farming experience and agricultural training are very important for Binadhan-14 cultivation. There is a need of proper guide to farmers about Binadhan-14 production management practices in the study areas.

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