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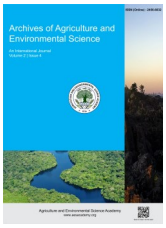

ORIGINAL RESEARCH ARTICLE

Profitability and productivity of drought tolerant *Aus* rice variety Binadhan-19 in some areas of Bangladesh

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ABSTRACT

The present study was conducted in five districts namely Mymensingh, Ranpur, Pabna, Rajshahi and Chapainwabganj in Bangladesh. The objectives of the study were i) to identify the socio-economic characteristics of Aus rice growers; ii) to estimate profitability and productivity of Binadhan-19 in the study areas; and iii) to find out the major preferences and constraints for the variety cultivation. A total of 200 farmers were randomly selected (40 from each location) to collect the data with a pre-designed questionnaire. The distribution of the farmers by age showed that the mean age for Binadhan-19 cultivated farmers was 43 years. In the study areas among the farmer 86% was educated. Farmers average experience was 20 year and income were Tk. 235066 (USD 2611.84) per year. Per hectare average yield of rice was 1.37 ton. It was estimated that, to produce one kilogram of rice, total cost incurred was Tk. 14 where per kg average selling price of rice was Tk. 17. The average gross return and gross margin of rice cultivation were found Tk. 90679 (USD 1007.54)/ha and Tk. 51290 (USD 559.88)/ha, respectively. Per hectare average net return was Tk. 2459 (USD 27.32) which was found to be highest in Chapainwabganj Tk. 29739 (USD 330.43) and lowest in Rangpur Tk. 12692 (USD 141.02) district. BCR on total cost basis was found 1.37. The highest preference was for neat rice 98% and the highest constrain said by the farmer was crop destroy by animal and bird of paddy for early ripening in Binadhan-19 cultivation.

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INTRODUCTION

In Bangladesh, Agriculture plays a leading role in the development and stability of the economy. Agriculture has been the mainstay of Bangladesh economy, contributing 13.38% to the gross domestic product (GDP) and generating employment for about 41% of total labour force (Rahman *et al.*, 2020). The population of Bangladesh will increase to 202 million by 2050 (Timsina *et al.*, UN, 2018). Therefore, the country needs to produce additional food grains by 2050 to meet the demand. Besides, a large number of studies projected that climate change is likely adversely affected on crops production in the century in Bangladesh (Kabir *et al.*, 2017). The arable land in Bangladesh is 15.92 million hectares about 60 percent of the total land area which is contributing to feed 160 million people in Bangladesh (BBS, 2020). The country has a favorable natural environment for crop production. Of the arable land, 13.39 percent is under single cropping, 25.57 percent double cropping, 11.5 percent triple cropping, 0.10 quadruple cropping and 2.86 percent currently fallow land (BBS, 2020). Rice alone constitutes about 93% of the total food grains produced annually in the country. A rising number of improved technologies/management has been developed and promoted in recent decades to address a diverse set of goals which directly benefit farmers (World Bank, 2007); these include genetic improvements (Evenson and Gollin, 2003b), irrigation management techniques (Pereira *et al.*, 2002),

improved/integrated pest management strategies (Pingali and Rosengrant, 1994; Susmita *et al.*, 2007), and climate-resilient (climate-smart) technologies (Khatri-Chhetri *et al.*, 2019). The North-West (NW) region of Bangladesh produces over 1/3 of the of the country's total rice despite covering only 23.5% of the country's total area.

Increasing agricultural productivity through the adoption and diffusion of improved agricultural technologies and practices has been considered one of the viable means for achieving economic growth and agricultural transformation in the face of natural resource scarcity and climate uncertainty in low-income countries like Nepal (Evenson and Gollin, 2003a; Gollin, 2010). To combat with future challenge of food security Bangladesh Institute of Nuclear Agriculture developed climate resilient/ drought tolerant rice variety Binadhan-19. This variety invented from drought tolerant Nerika-10 variety tree growth stops during severe drought. Again, when the favorable environment comes, it is able to give normal yield by completing the rapid increase Suitable for cultivation in Aus and Aman seasons direct planting (doubling) is suitable in rain dependent conditions all over the country including Barind and hilly areas. Irrigation water is affordable and lifespan is 95-105 days. The average yield in Aus season is 3.84 tons / ha. And maximum yield 5.0 tons / ha. Aman season average yield is 5.17 tons / ha. And maximum yield 5.5 tons / ha. yield is intricately linked with profitability, and yield gains have helped keep rice cultivation profitable, especially after 2005 in Bangladesh (Sayeed *et al.*, 2018). The rice is slender and long. Therefore, this variety can be one of the important climate resilient rice varieties to combat in future with respect to climate change.

MATERIALS AND METHODS

The study was conducted in five districts of Bangladesh. These were Mymensingh, Ranpur, Pabna, Rajshahi and Chapainwabganj. The areas were selected purposively where Binadhan-19 growing farmers were available. In total 200 farmers were randomly selected (40 from each location) to fulfill the objectives. The primary data were collected in the year 2019-20 on the respondent's socioeconomic characteristics such as age, education, family size, farm size, and literacy level as well as the rice farming practices. In the sampled areas data were collected through pre-designed interview schedule. Tabular, descriptive statistics were used to complete the study. Profitability analysis of Binadhan-19 has been determined on the basis of net return analysis. To determine the net returns from Binadhan-19 production, gross costs (variable and fixed cost) were deducted from gross returns. Gross returns (GR) are the total market value of main and by product of each enterprise. The gross return is calculated by multiplying the total volume of production of an enterprise by the average farm gate price of that product and by product at harvesting period. For this purpose, the following equation was used (Dillion and Hardaker, 1993).

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

$$\pi = Pm^{*} Ym + Pb^{*} Yb - \Sigma (Pxi^{*} Xi) - TFC$$

Where, π = Net return; Pm = Price of main product per units
Ym = Total quantity of main product; Pb = Price of by-product per unit; Yb = Quantity of by-product; Pxi = Price of ith input per unit used for Binadhan-19 production; Xi = Quantity of the ith input used for Binadhan-19 production
TFC = Total fixed cost
i = 1, 2, 3.....n (number of input)

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

$$\text{Interest on OC} = AI \times i \times t$$

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

Land preparation

Land preparation included, ploughing, laddering, pit preparation and other activities needed to make the soil suitable for plantation of seedling. In the study areas, all the farmers ploughed their land with the help of power tiller and tractor and the number of ploughings varied from farm to farm.

Human labour

Human labour is one of the most important components for crop cultivation. Machine power could not replace human labour fully for cultivation till now in our country. Farmers used both families supplied and hired labour. Family labour includes the operator himself and other working member of the family, while the hired labour includes permanent hired labour, labour employed on monthly contract basis, casual labour and labour employed on the other contract basis.

Seed

Most of the farmers collect seeds from research office and DAE. Only a few farmers purchase seed from the local market or other organization.

Fertilizer

Proper use of fertilizer can enhance agricultural production largely and help to retain or improve soil fertility. The sample farmers used four kinds of chemical fertilizers namely; Urea, TSP, MoP and Sulphur in the survey area.

Pesticide

Pesticide mainly insecticide and fungicide were used by most of the sample farmers and applied to survey plot with different rates. The cost of pesticide was computed based on the price that the farmers have actually paid.

Irrigation

Farmers in the study areas used irrigation water in their plot from shallow tube well (SRW). Very few farmers followed deep irrigation method for irrigation purpose.

Land rent

Land rent is one of the biggest fixed cost items for the production process. Rental value of land was estimated for the cropping period at the rate prevailing in the study area. In this analysis, cropping period was considered as 4 months that varied from crop to crop.

RESULTS AND DISCUSSION

Demographic characteristics of the Binadhan-19 cultivated farmers

The demographic characteristics of the rice farmers were presented and discussed according to their age, sex, education, marital status, household size, years of farming experience and farm size (Table 1). The distribution of the farmers by age showed that the mean age for Binadhan-19 cultivated farmers was 38 years (Razia, *et al*. 2021). This implies that the rice farming populations were still within their productive age and can still engage efficiently in rice production. Rice farming is a labour-intensive occupation and exerts energy for land preparation, nursery, planting, weeding and harvesting. The average age of Binadhan-19 producing farmers was 38. The findings are similar to those of Nwaobiala and Adesope (2013) who found out that the mean age of upland rice farmers and swamp rice farmers in Ebonyi State were 37.3 years and 39.2 years, respectively. This is encouraging as an active age implies increased productivity and enables the farmers engage in other value adding activities like rice processing. Among the farmer 86% was educated which was categories as illiterate, Primary, Secondary, Higher secondary and above. In the study areas Farmers average experience was 20 year and income were Tk. 235066 (USD 2611.84) per year.

Pattern of input use

Pattern of input use for Binadhan-19 cultivation: Farmers in the study areas used various inputs for Binadhan-19 cultivation. Farmers used on an average 126 man-days per hectare of total human labour for Binadhan -19 cultivation where family labour was 57 man-days and hired labour was 69 man-days. On an average, they sowed 37 kg seed per hectare of land. They applied Urea at the rate of 111 kg/ha, TSP 119 kg/ha, and MoP 86 kg/ha. It was observed that among the chemical fertilizer, farmers used highest amount of TSP for the studied districts (Razia *et al*., 2021) (Table 2 and Figure 1).

Cost of cultivation

Total cost of production

Variable cost: The cost of production included all kinds of variable costs such as hired labour, land preparation, seed, manure, fertilizers, irrigation, pesticides, etc. used for the production of rice. Both cash expenses and imputed value of family supplied inputs were included in the variable cost. The study revealed that total variable cost of rice cultivation was Tk. 39389 (USD 437.65) per hectare which was 60% of total cost of production (Table 3). The highest cost item was human labour which accounted for about 49 % of the total cost. Cost of land preparation and land use cost accounted for about 11% of total cost and ranked second cost item

Fixed cost: Family labour and rental value of land was considered as fixed cost of production. The family labour and land use cost were Tk. 19161(USD 212.90) and Tk. 7536 (USD 83.73) per hectare which was accounted for about 29% and 11 % of total cost respectively (Table 3).

Table 1. Socio-demographic profile of the selected rice farmer's during 2019.

Variables	Mean values
Age (years)	38
Educational Status (%)	86
No education	20
Illiterate	20
Primary	17
Secondary	20
Higher Secondary	21
Above	2
Family size (no.)	6
Male	3
Female	3
Income (Tk/year)	235066
Total land size (hectare)	99
Land under Binadhan-19 cultivation	25
Farming experience (years)	20
Farming as a single occupation	99
Farming+ business	27
Farming+ job	11
Farming + others	24
Training or extension services (%)	20
Received	20
Did not receive	80

Table 2. Level of major input use pattern of Binadhan-19 cultivation in the study areas.

Particulars	Districts					
	Mymensingh	Ranpur	Pabna	Rajshahi	Chapainwabganj	All
Human labour (man-days)	127	131	133	121	121	126
Hired	59	75	85	75	52	69
Family	68	56	48	46	69	57
Seed (kg/ha)	36	34	40	37	38	37
Urea	126	122	99	114	96	111
TSP	106	123	99	151	118	119
MoP	84	83	57	113	94	86

Table 3. Per hectare cost of Binadhan-19 in the study areas (Tk/ha).

Particulars	Districts						
	Mymensingh	Ranpur	Pabna	Rajshahi	Chapainwabganj	All	%
Variable Cost							
Cost of land preparation	6213	6503	6974	8067	8150.63	7181	11
Hired labor	10490	13322	15564	16554	10272	13240	20
Seed	1794	1513	2612	1946	2141	2001	3
Cowdung	2582	2468	1500	5824	3569	1188	6
Urea	2248	1970	1750	1839	1591	1879	3
TSP	3118	3092	2841	4038	3207.34	3259	5
MoP	1384	2220	1239	2018	1154.17	1603	2
Sulphar	111	212	446	636	506	382	1
Cost of irrigation	4019	4604	2186	1190	1033	2606	4
Cost of insecticide	2062	2608	1500	3621	2215	2401	4
Sub-total	34021	38512	36612	45733	33839.14	38743	59
Interest on operating capital	567	642	610	762	564	646	10
Total variable cost	34588	39154	37222	46495	34403	39389	60
Fixed Cost							
Family labor	18461	17684	12931	19024	27708	19161	29
Land use cost	6955	8778	6680	7879	7392	7536	11
Total fixed cost	25416	26462	19611	26903	35100	26698	40
Total cost	**60004**	**65616**	**56833**	**75432**	**72553**	**66087**	**100**

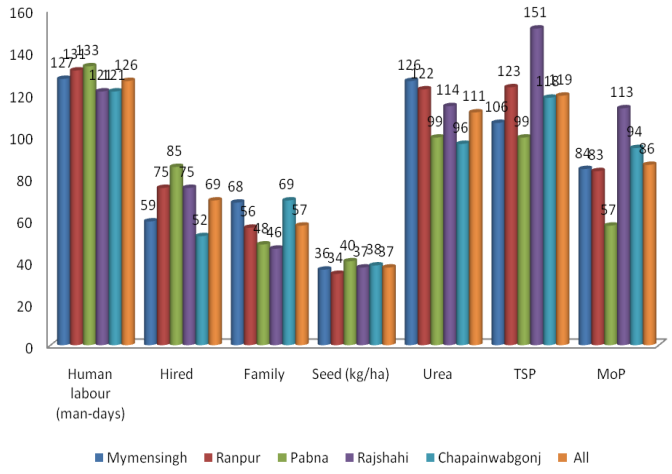

Figure 1. *Bar diagram showing input level of Binadhan-19 cultivation.*

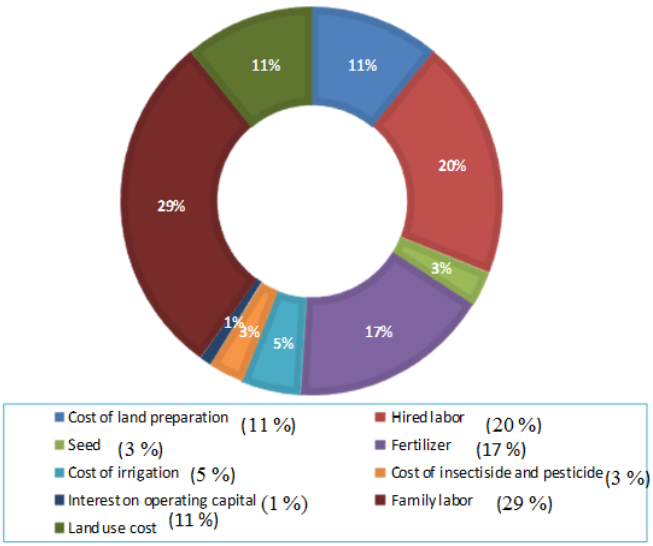

Figure 2. *Share of cost (%) of Binadhan-19 production.*

Total cost: Total cost of production included variable costs and fixed costs incurred for Binadhan-19 cultivation. On an average, the total cost of production was Tk. 66087(USD 734.30) per hectare where 40% was fixed costs and 60% was variable cost (Table 3 and Figure 2).

Financial Profitability of Binadhan-19 in the study areas

Financial profitability (FP) is based on calculation of market prices of inputs and outputs that farmers actually pay or receive for producing a crop, along with the quantities used of each. Farmers allocate land and other resources in the production of different crops on the basis of relative financial profitability.

Returns and financial profitability of Binadhan-19

Per hectare average yield of rice was 4.70 ton and per kg average price was about Tk. 17. The per kg cost of production was Tk. 13. The average gross return and gross margin of rice cultivation were found Tk. 90679/ha and Tk. 51290/ha respectively. Per hectare average net return was Tk. 24591 (USD 273.23) which was found to be highest in Chapainwabganj Tk. 29,739 (USD 330.43) followed by Mymensingh Tk. 29216 (USD 324.62), Pabna Tk. 27538 (USD 305.97), Rajshahi Tk. 22680 (USD 252) and Rangpur Tk. 12692 (USD 141.02). BCR on total cost basis was found 1.37 which was the highest in Mymensingh 1.49 and less in Rangpur districts 1.19. It was estimated that, to produce one kilogram of rice, total cost incurred Tk. 14 (Table 4).

Preferences and major constraints to Binadhan-19 Cultivation

Binadhan-19 is a profitable crop in the study areas. Farmers prefer this variety for various reasons. Major of these are shown in the Table 5. Among the list the highest preferences were for neat rice 98% and it was the lowest for easy to harvest i.e., 82%. Among the constraints the highest constrain said by the farmer was crop destroy by animal and bird of paddy and it was 81% and the lowest was disease and pest infestation i.e., 54% in Binadhan-19 cultivation (Table 5 and Figure 3).

Table 4. Per hectare return (Tk/ha) of Binadhan-19 in the study areas.

Particulars	Districts					
	Mymensingh	Ranpur	Pabna	Rajshahi	Chapainwabganj	All
Yield (kg/ha)	4506	5050	4445	4652	4902	4711
Price (Tk./kg)	17	13	17	19	19	17
Return from Binadhan-19	76602	65650	75565	88388	93138	80087
Return from by-product	12618	12658	8806	9724	9154	10592
Gross Return	89220	78308	84371	98112	102292	90679
Total variable cost (TVC)	34588.02	39154	37222	48529	37453	39389
Total cost (TC)	60004	65616	56833	75432	72553	66088
Gross Margin	54631.98	39154	47149	49583	64839	51290
Net Return	29216	12692	27538	22680	29739	24591
BCR over total cost	1.49	1.19	1.48	1.31	1.41	1.37
Cost of production (Tk./kg)	**13**	**13**	**13**	**16**	**14**	**14**

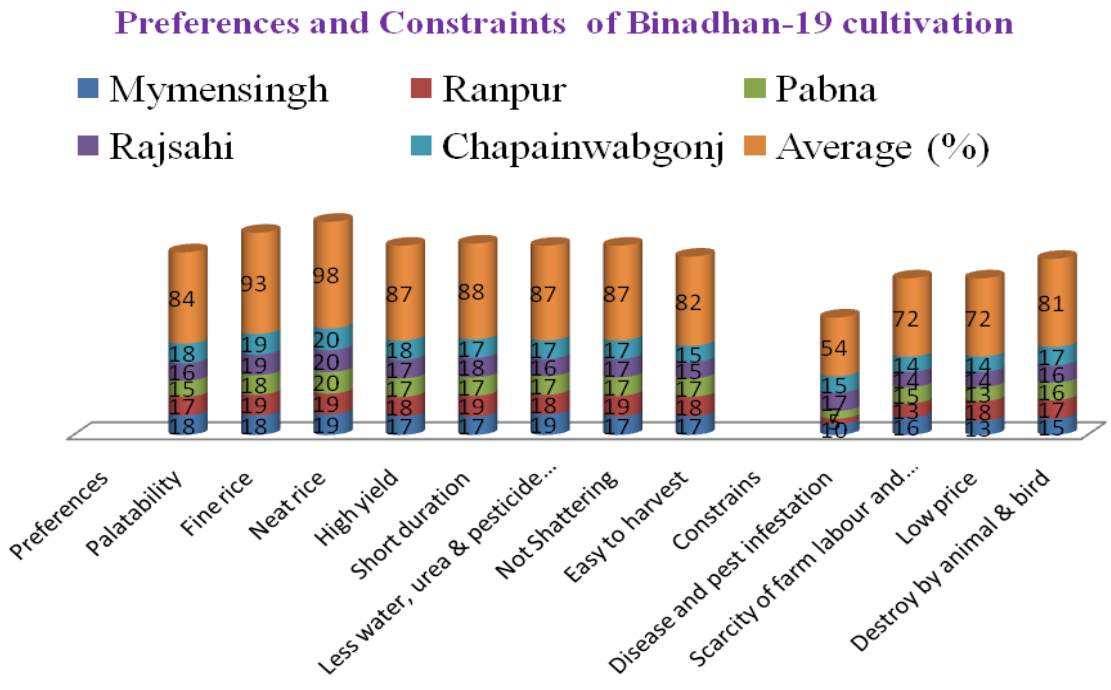

Figure 3. *Preferences and constrains of Binadhan-19 cultivation.*

Table 5. Major Preferences and constrains of Binadhan-19 under different districts.

Particulars	Districts					
	Mymensingh	Ranpur	Pabna	Rajsahi	Chapainwabganj	Average (%)
Preferences						
Palatability	18	17	15	16	18	84
Fine rice	18	19	18	19	19	93
Neat rice	19	19	20	20	20	98
High yield	17	18	17	17	18	87
Short duration	17	19	17	18	17	88
Less water, urea & pesticide require	19	18	17	16	17	87
Not Shattering	17	19	17	17	17	87
Easy to harvest	17	18	17	15	15	82
Constrains						
Disease and pest infestation	10	5	7	17	15	54
Scarcity of farm labour and high wage rate	16	13	15	14	14	72
Low price	13	18	13	14	14	72
Destroy by animal & bird	15	17	16	16	17	81

Conclusion

The cultivation of Binadhan-19 production is profitable. Farmers in the study areas used various inputs for Binadhan-19 cultivation. The average age of Binadhan-19 producing farmers was 38. Among the farmer 86% was educated which was categories as illiterate, Primary, Secondary, Higher secondary and above. In the study areas Farmers average experience was 20 year and income were Tk. 235066 (USD 2611.84) per year. Per hectare average net return was Tk. 24591 (USD 273.23) which was found to be highest in Chapainwabganj Tk. 29,739 (USD 330.43) followed by Mymensingh Tk. 29216 (USD 324.62), Pabna Tk. 27538 (USD 305.97), Rajshahi Tk. 22680 (USD 252) and Rangpur Tk. 12692 (USD 141.02). BCR on total cost basis was found 1.37 which was the highest in Mymensingh 1.49 and the lowest in Rangpur districts 1.19. Among the list the highest preferences were for neat rice 98% and it was the lowest for easy to harvest i.e., 82%. Among the constraints the highest constrain said by the farmer was crop destroy by animal & bird of paddy and it was 81% and the lowest was disease and pest infestation i.e., 54% in Binadhan-19 cultivation. Therefore, to combat with future challenges more areas should be brought under this variety cultivation for Aus season.

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