



## Comparative Profitability and Impact of BINA Developed Aman Mutant Rice Binadhan-7 with Non-Mutant Variety in Bangladesh

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. 'All authors read and approved the final manuscript.*

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### **ABSTRACT**

This paper examined the cost and revenue as well as impact of mutant rice on fourteen regions of Bangladesh namely Mymensingh, Jashore, Cumilla, Bogura, Rajshahi, Sylhet, Dinajpur, Rangpur, Dhaka, Khulna, Chattogram, Rangamati, Barishal and Faridpur. A total of 560 farmers were randomly selected to fulfill the objectives where 280 farmers were mutant growers and 280 were non-mutant growers. A pre-designed interview schedule was used to collect the necessary data. Descriptive statistics, profit function and livelihood assets were used to analyze the collected data. The study revealed that total variable cost of rice cultivation was BDT.40589 and BDT.43927 per hectare for mutant and non mutant, respectively which was around 71 percent of total cost of production. On an average, the total cost of production was BDT.59584 per hectare, where 29 percent was fixed costs and 71 percent was variable cost. For Binadhan-7 cultivation per hectare

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average net return was found highest in Dinajpur region i.e. BDT.70919 and the lowest in Jashore region i.e. BDT.33703. BCR on total cost basis was found 1.90 which was the highest in Sylhet 2.56 and the lowest 1.51 in Jashore region for Binadhan-7 production. In case of non-growers BCR on total cost basis was found 1.43 which was lower than Binadhan-7 production in the study areas indicating Binadhan-7 growers earn much than the non growers. The asset pentagon approach showed that there is a noteworthy increases in capitals of sampled farm households and the highest for financial capital that was 20.05 percent and the lowest was for natural capital i. e., 5.38 percent. Among the list of preferences, the highest was 88.93 percent for short duration and it was ranked I, the lowest was high yielding i.e. 81.43 percent which was ranked as V. Among the constraints, the highest constraint reported by the farmer was labour crisis as well as high price of labour i.e. 80.71 percent and it was ranked I and the lowest ranked V was lack of quality seed at proper time i.e. 48.93 percent in Binadhan-7 cultivation. Finally it is remarked that short duration high yielding variety Binadhan-7 plays a vital role in the munga mitigation of the northern areas of Bangladesh.

*Keywords: Short duration; high yielding; aman mutant Rice; profitability and livelihood;*

## 1. INTRODUCTION

Rice is the most important and fundamental cereal food crop in Bangladesh. It dominates the crop sector of Bangladesh agriculture approximately more than 73 percent of total cropped area [1]. Bangladesh has been familiar as the fourth largest rice producer country in the world. It is a staple food for more than half of the world's population [2] and more than 95 percent of population consumes rice in Bangladesh. 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 [3]. Bangladesh is autonomous in rice [4] [5]. Production with an average per capita consumption of 134 kg per annum, compared to the world average of 57 kg per annum [6]. It is the most leading crop and produces a major distribute of farmers' income and employment [7] [8]. The fast growing population of Bangladesh puts remarkable stress on its scarce natural wealth. To feed the growing population of the country, there is an urgent need to develop more efficient and sustainable agricultural production and more unbiased distribution systems. In Bangladesh, rice is grown in three distinct seasons; namely Boro (January to June), Aus (April to August) and Aman (August to December) [9]. It is grown in four ecosystems viz., irrigated rice (Boro), rainfed or partially irrigated (transplanted Aus and Aman), rainfed upland (direct-seeded Aus), and deepwater (broadcast Aman) [10]. Aman is one of the most important crops in Bangladesh. Two types of Aman rice are grown in this country. One is called broadcast Aman which is sown in the month of mid March to mid April in the low lands and another is transplant Aman, which is planted during late June to August. At present it

is the second largest crop in the country in respect of the volume of production after boro rice. Binadhan-7 is such type of short duration (110-115 days) mutant aman rice variety which contributes significantly in changing farmer's income. It is notable that the area coverage of Aman is the largest as a single crop and boro remains the second in Bangladesh. Total aman production areas are increasing day by day after introducing of this mutant variety. In 2019-20 total area for BINA develop all rice varieties were 552483 hectare and aman varieties were 461385 hectare, in where short yielding high yielding mutant rice variety Binadhan-7 was 421080 hectare [11-12]. Specially, Binadhan-7 contributes vital role in eradiating Munga (a Bengali word that refers to the annual state of poverty and hunger, refers to two times of the year, from September to November each year (after planting aman rice) and from March-April (after planting boro rice) in Bangladesh.

Fig. 1 shows that the overall area coverage of aman mutant rice variety Binadhan-7 in 2019-20 that was 461385.10 hectare in aman season in Bangladesh, which was highest among the BINA developed varieties. Among the fourteen agricultural regions of Bangladesh containing all 64 districts the highest area was found in Jashore region (121811 hectare) and the lowest was found in Rangamati region (2551 hectare) because of hilly areas.

The Fig. 2 shows that mostly aman rice is grown in the northern part of Bangladesh. The climate of Bangladesh is characterized by high temperatures, heavy rainfall, high humidity and fairly marked seasonal variations. More than 80 percent of the annual precipitation of the country occurs during the southwestern summer

monsoons, from June through September during which aman rice is grown. In recent years the weather pattern has been erratic, with the cool, dry season having considerably decreased- a change probably attributable to climate change (Chowdhury, I.U.A, 2015). Rainfall has statistically significant effect aman rice and also the influences of maximum temperature and

minimum temperature are more pronounced compared with that of rainfall. It implies that maximum temperature is the dominant factor in this region which increases the aman rice production significantly. So, effect of maximum temperature becoming the dominant variable continuously in the aman rice production of Bangladesh in last decade [7].

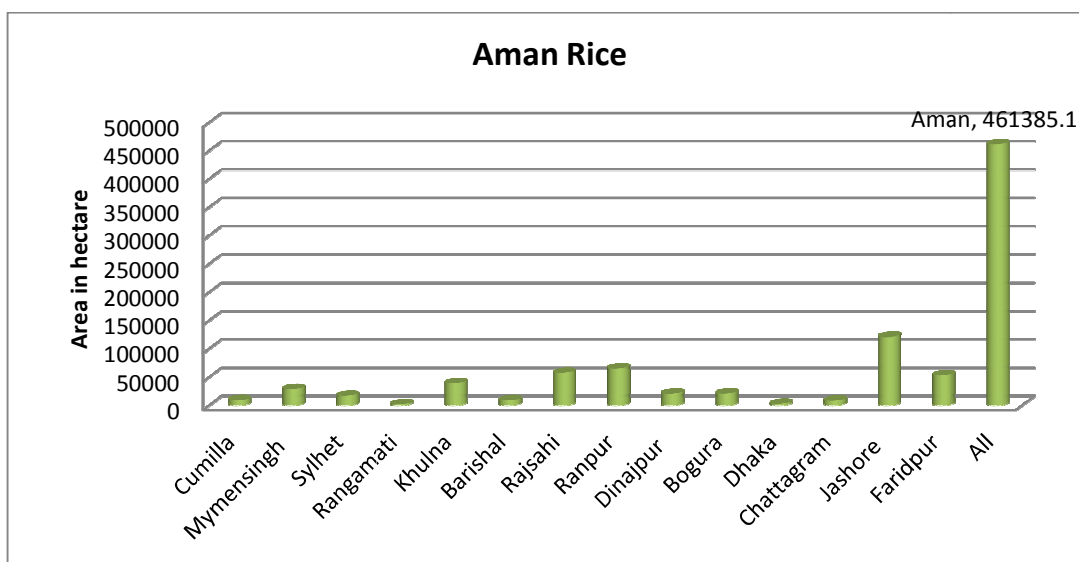


Fig. 1. Region-wise area coverage of BINA developed aman rice varieties during 2019-20



Fig. 2. Map showing the aman rice growing areas in Bangladesh.

High yielding varieties of paddy is believed to be one of the success key of increasing rice production [13]. Furthermore, Suhartatik and Makarim [14] revealed that the superior varieties have high yields because they have physiological character in accordance with its environment. On the other hand the non-mutant growers cultivated local traditional varieties (Pajam, Balam, Kataribug, Shorna) and other high yielding varieties like BR-11, Brridhan-49 in aman season.

Considering all the thing present study was undertaken to fulfill the following objectives:

- i. to compare profitability of aman mutant rice variety Binadhan-7 with the non mutant rice varieties;
- ii. to assess the impact of aman mutant rice variety cultivation on farmers livelihood pattern among the fourteen regions;
- iii. to identify preferences and constraints of aman mutant rice variety Binadhan-7 cultivation in the study areas.

## 2. METHODOLOGY

The study was conducted in fourteen agricultural regions of Bangladesh namely Mymensingh, Jashore, Cumilla, Bogura, Rajshahi, Sylhet, Dinajpur, Rangpur, Dhaka, Khulna, Chattagram, Rangamati, Barishal and Faridpur. To fulfill the objectives fourteen agricultural regions were classified as Reg-1: Cumilla region, Reg-2: Mymensingh region, Reg-3: Sylhet region, Reg-4: Rangamati hilly region, Reg-5: Khulna region, Reg-6: Barishal region, Reg-7: Rajshahi region, Reg-8: Rangpur Region, Reg-9: Dinajpur region, Reg10: Bogura region, Reg-11: Dhaka region, Reg-12:Chattagram region, Reg-13: Jashore region and Reg-14: Faridpur region. A total of 560 farmers were randomly selected to fulfill the objectives where 280 farmers were mutant growers and 280 were non- mutant growers. A pre-designed interview schedule was used to collect the necessary data. Descriptive statistics, profit function and livelihood assets were used to analyzed the collected data.

### 2.1 Profitability Study of Mutant Rice Variety Binadhan-7 Growers and Non Growers

For profitability analysis, the following equation was used.

The equation applied for each of the selected farmers:

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

Where,

$\pi$  = Net return

$P_m$  = Price of main product per units

$Y_m$  = Total quantity of main product

$P_b$  = Price of by-product per unit

$Y_b$  = Quantity of by-product

$P_{x_i}$  = Price of ith input per unit used for rice production

$X_i$  = Quantity of the ith input used for rice production

TFC = Total fixed cost

$i = 1, 2, 3, \dots, n$  (number of input)

T

he 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).

**Benefit Cost Ratio:** The benefit cost ratio (BCR) is a relative measure which is used to compare benefit per unit of cost. Benefit-cost ratio is the ratio of present net worth of benefit and present net worth of cost. It indicates that the benefit of per unit cost at present worth.

**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 ploughing 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 family 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 their own storage. Besides, in research office and DAE office it is also available. Only few farmers purchase seed from the local market or other organization. The farmer of the study areas mainly used Binadhan-7, Pajam, Balam, BRRI-11, Shorna, etc.

**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/DAP, MoP and Sulphur in the survey area.

**Pesticide:** Pesticide mainly insecticide and fungicide was 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 (STW). 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 four months.

### 3. RESULTS AND DISCUSSION

#### 3.1 Total Cost of Production

**Variable cost:** The cost of production included all kinds of variable costs such as hired labour, land preparation, seed, fertilizers, irrigation, pesticides, etc. which was 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 BDT.40589 & BDT.43927 per hectare for mutant & non mutant, respectively which was around 71 percent of total cost of production (Table 1). The highest cost item was hired labour which accounted for about 32.91 percent for mutant rice and 30.98 percent in case of non mutant of the total cost. Cost of fertilizer accounted for 12.45 percent and 13.19 percent for mutant and non mutant rice cultivation of total cost, respectively as well as ranked second. Land preparation cost (power tiller cost) was about 12 percent for both categories of total cost and ranked third cost item for aman rice cultivation.

**Fixed cost:** Family labour and rental value of land was considered as fixed cost of production. There are 29 percent fixed costs for both category of rice production. The family labour

cost was BDT.19182 and BDT.14701 per hectare around 25 percent of the total cost in case of both categories of farmer and land use cost were accounted for BDT.2400 (4.16%) and BDT.2491 (4.05%) per hectare for mutant and non mutant rice production, respectively (Table 1).

**Total cost:** Total cost of production included variable costs and fixed costs incurred for Binadhan-7 and non-mutant varieties cultivation. On an average, per hectare total cost of production was BDT.57689 for mutant and BDT.61479 for non mutant, where 29.64 percent and 28.55 percent were fixed costs and 70.36 percent as well as 71.45 percent were variable cost, respectively (Table 1).

#### 3.2 Financial Profitability of Binadhan-7 Growers & Non Growers 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.

#### 3.3 Returns and Financial Profitability of Binadhan-7 Production

From Table 2, per hectare average yield of rice was 4.65 and 3.97 ton as well as per kg average price were about BDT.20 & BDT.19 for Binadhan-7 and non-mutant rice variety. The average yield was the highest in Dinajpur region (5.3 t/h) and it was the lowest in Rangamati region (4.0 t/h) among the 14 regions. The per hectare average net return of Binadhan-7 production and non mutant rice was found BDT.50410 and BDT.26063, respectively indicating 48.30 percent higher than the non-mutant variety cultivation in the study areas. For Binadhan-7 cultivation per hectare average net return were found in the highest in Dinajpur region BDT.70919 and the lowest in Jashore BDT.33703. BCR on total cost basis was found 1.90 which was the highest in Sylhet 2.56 and the lowest in 1.51 in Jashore region for Binadhan-7 production. In case of non growers BCR on total cost basis was found 1.43 which was lower than Binadhan-7 production in the study areas indicating Binadhan-7 growers earn much than the non growers.

**Table 1. Per hectare cost of mutant rice variety Binadhan-7 and non-mutant rice production in Bangladesh**

Study Areas	Type		Power tiller (BDT./ha)	Seed (BDT./ha)	Fertilizers/manure (BDT./ha)	Pesticides (BDT./ha)	Irrigation charge (BDT./ha)	Variable Cost (including IOC) (BDT./ha)	Land use cost (BDT./ha)	Fixed Cost (BDT./ha)	Total Cost (BDT./ha)									
	Human Labour (BDT./ha)	Hired labour (Family labour)																		
	Mutant	Non mutant	Mutant	Non mutant	Mutant	Non mutant	Mutant	Non mutant	Mutant	Non mutant	Mutant	Non mutant	Mutant	Non mutant	Mutant	Non mutant	Mutant	Non mutant	Mutant	Non mutant
Mymensingh	28036 (14626)	27177 (15654)	627 4	380 5	139 1	1945	4188 (803)	5555 (862)	163 5	15 12	3322	350 5	4609 2	448 34	2247	2665	168 73	183 19	6296 6	631 52
Jashore	24384 (15214)	23176 (12875)	684 0	707 3	178 7	1651	5368 (2588)	8604 (987)	310 4	28 22	3953	296 4	4861 5	478 39	1971	1446	171 85	143 21	6580 0	621 61
Cumilla	24928 (13849)	25863 (14369)	727 6	759 9	147 0	1181	9793 (740)	10537 (998)	227 2	43 23	3877	572 5	5087 5	568 25	1936	1776	157 85	161 45	6666 0	729 70
Rajshahi	21262 (11812)	22914 (12730)	787 5	881 5	179 1	2383	8121 (954)	9352 (1007)	255 3	27 59	4398	729 6	4743 0	550 71	2170	2280	139 83	150 10	6141 3	700 81
Bogura	23515 (10364)	23515 (9745)	758 5	800 33	250 1	1723	9221 (1355)	8252 (825)	220 7	24 40	1096	711 8	4796 3	463 96	1809	2297	148 73	120 42	6283 6	584 38
Sylhet	12968 (7205)	18654 (10364)	793 7	840 2	182 6	2216	7835 (298)	8487 (603)	198 0	30 00	256	664 8	3442 6	484 99	2147	2296	935 1	126 59	4377 7	611 58
Dinajpur	16524 (9180)	9541 (17177)	656 5	744 9	151 6	1894	6246 (783)	9184 (1744)	119 0	25 83	1341	637 0	3563 8	392 11	2256	2059	114 36	192 37	4707 4	584 48
Rangpur	15822 (16352)	15851 (16452)	711 2	731 3	269 0	2267	7924 (1606)	9286 (1833)	321 33	18 33	204	211	3620 9	391 67	5138	6046	214 90	224 98	5769 9	616 65

<b>Dhaka</b>	18031 (15468)	20229 (14296)	613 3	726 2	176 3	1998	7031 (1139)	7829 (1448)	159 2	16 02	358	340	3658 1	413 13	2472	2469	179 39	167 65	5452 0	580 78
<b>Khulna</b>	22314 (14534)	23321 (16182)	718 6	714 6	204 7	2276	6897 (1491)	7996 (1300)	200 7	23 06	466	482	4303 8	454 93	2538	2483	170 72	186 64	6011 0	641 57

Study Areas	Type		Human Labour (BDT./ha)		Power tiller (BDT./ha)		Seed (BDT./ha)		Fertilizers/manure (BDT./ha)		Pesticides (BDT./ha)		Irrigation charge (BDT./ha)		Variable Cost (including IOC) (BDT./ha)		Land use cost (BDT./ha)		Fixed Cost (BDT./ha)		Total Cost (BDT./ha)	
	Hired labour (Family labour)																					
	Mutant	Non mutant	Mutant	Non mutant	Mutant	Non mutant	Mutant	Non mutant	Mutant	Non mutant	Mutant	Non mutant	Mutant	Non mutant	Mutant	Non mutant	Mutant	Non mutant	Mutant	Non mutant	Mutant	Non mutant
<b>Chattagram</b>	17826 (20536)	19241 (17321)	704 2	703 7	244 0	2401	7745 (1120)	7741 (1367)	204 5	25 85	898	1006	3969 7	4199 2	2547 95	24	230 82	198 16	6278 0	618 08		
<b>Rangamati</b>	12041 (16652)	13040 (17440)	703 7	793 1	226 8	2243	4407 (1350)	4618 (1454)	205 1	22 90	501	525	3009 6	3257 7	2298 78	24	189 49	199 18	4904 5	524 95		
<b>Barishal</b>	16087 (18383)	17523 (17071)	748 8	752 2	178 5	2131	8707 (1323)	7990 (1331)	219 6	29 28	400	491	3855 0	4050 8	1993 89	19	203 76	190 60	5892 6	595 68		
<b>Faridpur</b>	12028 (18936)	12545 (19182)	718 1	765 1	219 8	2131	7033 (946)	8107 (890)	271 1	26 22	564	593	3303 0	3524 7	2072 98	20	210 08	212 79	5403 7	565 27		
<b>All</b>	18983 (19182)	19044 (14701)	710 9	736 0	196 2	2031	7180 (1178)	8110 (1189)	199 0	25 43	1537	3105	4058 9	4392 7	2400 91	24	171 00	175 52	5768 9	614 79		
<b>%</b>	32.91 (25.48)	30.98 (24.50)	12.3 2	11.9 7	3.40 3.30	3.30	12.45 (2.04)	13.19 (1.93)	3.45 4.1	4.1 4	2.66	5.05	70.3 6	71.4 5	4.16 5	4.0	29.6 4	28.5 5	100. 00	100. 00		

Source: Field Survey, 2021

**Table 2. Per hectare return of mutant rice variety Binadhan-7 and non-mutant rice production**

Study areas	Type		Price (BDT./kg)		Return from paddy (BDT./ha.)		Return from straw (BDT./ha.)		Total return (BDT./ha.)		Total variable cost (BDT./ha.)		Total Cost (BDT./ha.)		Net return (BDT./ha.)		BCR	
	Yield (Kg./ha.)		Mutant	Non mutant	Mutant	Non mutant	Mutant	Non mutant	Mutant	Non mutant	Mutant	Non mutant	Mutant	Non mutant	Mutant	Non mutant	Mutant	Non mutant
	Mutant	Non mutant	Mutant	Non mutant	Mutant	Non mutant	Mutant	Non mutant	Mutant	Non mutant	Mutant	Non mutant	Mutant	Non mutant	Mutant	Non mutant	Mutant	Non mutant
<b>Mymensingh</b>	4893	4018	21	19	102762	76351	10559	6031	113321	82382	46092	44834	62966	63152	50355	19229	1.80	1.30
<b>Jashore</b>	4023	3008	21	19	84491	57152	15012	13060	99503	70212	48615	47839	65800	62161	33703	8052	1.51	1.13
<b>Cumilla</b>	4756	3998	21	20	99880	79963	15277	12115	115156	92078	50874	56825	66660	72970	48497	19108	1.73	1.26
<b>Rajshahi</b>	5203	4324	21	20	109270	86474	15470	12098	124740	98573	47430	55071	61413	70081	63328	28492	2.03	1.41
<b>Bogura</b>	5022	4082	20	19	100431	77557	15799	12834	116230	90391	47963	46396	62836	58438	53394	31953	1.85	1.55
<b>Sylhet</b>	4991	4190	20	20	99827	83805	12422	10036	112249	93841	34426	48499	43777	61158	68472	32683	2.56	1.53
<b>Dinajpur</b>	5275	4782	18	19	100228	86067	17765	11659	117993	97726	35638	39211	47074	58448	70919	39278	2.51	1.67
<b>Rangpur</b>	5050	4305	19	18	95959	77491	10803	9467	106761	86958	36209	39167	57699	61665	49063	25293	1.85	1.41
<b>Dhaka</b>	4380	3979	21	19	91982	75599	11423	10070	103404	85670	36581	41313	54520	58078	48885	27592	1.90	1.48
<b>Khulna</b>	4128	3769	21	20	86683	75377	10711	12321	97393	87698	43038	45493	60110	64157	37283	23541	1.62	1.37
<b>Chattagram</b>	4349	3812	20	19	86975	72430	11826	9341	98802	81770	39697	41992	62780	61808	36022	19963	1.57	1.32
<b>Rangamati</b>	4012	3406	21	21	84248	71530	10039	6041	94288	77571	30096	32577	49045	52495	45243	25077	1.92	1.48
<b>Barishal</b>	4526	3898	20	20	90523	77952	16086	10523	106610	88475	38550	40508	58926	59568	47684	28907	1.81	1.49
<b>Faridpur</b>	4567	3985	21	20	95910	79690	11028	12545	106938	92236	33030	35247	54037	56527	52900	35709	1.98	1.63
<b>All</b>	4655	3968	20	19	94941	76960	13500	10347	108440	93885	40589	43069	57689	61747	50410	26063	1.90	1.43

Source: Field Survey, 2021



### 3.4 Livelihood Changes for Mutant Rice Variety Binadhan-7 Cultivation

Demographic characteristics of the mutant rice variety Binadhan-7 growers and non-growers:

The demographic characteristics of the rice farmers were presented and discussed according to their age, sex, education, household size, years of farming experience and farm size. The distribution of the farmers by age showed that the mean age for Binadhan-7 cultivated farmers was 45 years. Among the farmer 92 percent was educated which was categories as illiterate, primary, secondary, higher secondary and above. In the study areas, the average experience of farmers was 21.38 years and income was BDT. 242134 per year (Table 3).

### 3.5 Livelihoods

A livelihood is the set of capabilities, assets and activities that furnish the means for people to meet their basic needs and support their well being. The building of livelihoods reflects and seeks to fulfill both material and experiential needs. Livelihoods are not simply a localized phenomenon, but connected by environmental, economic, political and cultural process to wider national, regional and global arenas. In these guidelines, "livelihood" does not just mean the activities that people carry out to earn a living. It means all the different elements that contribute to or affect their ability to ensure a living for themselves and their household. This includes:

- the assets that the household owns or is able to gain access to-human, natural, social, financial and physical capital;
- the activities that allow the household to use those assets to satisfy basic needs;

- the different factors that the household itself may not be able to control directly, like the seasons, natural disasters or economic trends, that affect its vulnerability;
- Policies, institutions and processes that may help them or make it more difficult for them, to achieve an adequate livelihood.

#### 3.5.1 Impact on livelihood pattern of the mutant farmer

The members of a household combine their capabilities, skills and knowledge with the different resources at their disposal to create activities that will enable them to achieve the best possible livelihood for themselves and the household as a whole: Everything that goes towards creating that livelihood can be thought of as a livelihood asset [10]. The livelihood framework identifies five core assets or capital upon which livelihoods are built. Increasing access which can take the form of ownership or the right to use to these assets is a primary concern for Department for International Development in its support of livelihoods and poverty elimination. These assets can be divided into five different "types" shown in Fig. 2.

This asset can provide a useful starting point for household livelihood analysis, as it encourages investigators to take into account all the different kinds of assets and resources that are likely to play a role in household livelihood. In the past, development workers often tended to focus very much on the physical capital, the financial capital and the human capital. But very often people's access to natural capital and the key role of the social capital of households has not been properly taken into account. Using this pentagon as guide can help investigators to get a more complete picture of the household and its livelihood assets.

**Table 3. Socio-demographic profile of the Binadhan-7 growers and non-growers**

SI no.	Variables	Mean values
1.	Age (years)	45
2.	Gender (Male %)	95
3.	Educational qualification (%)	92
4.	Family size (no.)	6
	• Male	3
	• Female	3
5.	Income (BDT/year)	242134.20
6.	Educated person (no.)	3
7.	Earning Person (no.)	2
8.	Land size (hectare)	124.21
9.	Land under Binadhan-7 cultivation (hectare) (%)	34.58 (27.84)
10.	Farming experience (years)	21.38

Source: Field Survey, 2021.

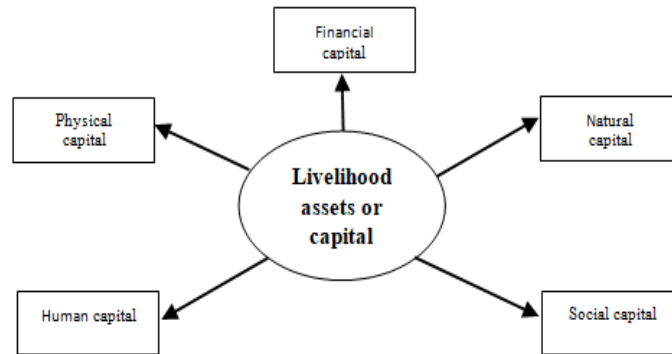


Fig. 2. Different types of assets

Table 5. Livelihood changes for cultivation of mutant rice variety Binadhan-7 in study areas

Item	Present (%)	12 Years Ago (%)	Differences (%)
<b>Home type</b>			
• Mud build	4 (1.43)	38 (13.57)	34 (12.14)
• Tin shade	56 (20)	189 (67)	133 (47)
• Half building	168 (60)	43 (15.36)	125 (44.64)
• Building	52 (18.57)	10 (3.57)	42 (15)
No of livestock & poultry increases	47 (16.79)	24 (8.57)	23 (8.21)
Tubewell	264 (94.29)	242 (86.43)	22 (7.86)
Source of drinking water (Pond, river)	20 (7.14)	35 (12.50)	15 (5.35)
Number of tree increases	238 (85)	112 (40)	126 (45)
<b>Sanitation</b>			
• Mud build	1 (0.36)	24 (8.57)	23 (8.21)
• Tinshade	38 (13.57)	156 (55.71)	118 (42.14)
• Half building	212 (75.71)	95 (33.93)	117 (41.79)
• Building	29 (10.36)	5 (1.79)	24 (8.57)
Food security increases	243 (86.79)	112 (40.00)	131 (46.79)
Health condition increases	234 (83.57)	109 (38.93)	125 (44.64)
<b>Road</b>			
• Paved road	7 (2.50)	74 (26.43)	67 (23.92)
• Raw road	50 (17.86)	155 (55.36)	105 (37.50)
• Brick	223 (79.64)	51 (18.21)	172 (61.43)
Electricity connection (PDB, Palli biddut, Solar)	279 (99.64)	170 (60.71)	109 (38.93)
Social communication (Mobile/Internet)	276 (98.57)	79 (28.21)	197 (70.36)
Recreation(TV/Radio)	272 (97.14)	146 (52.14)	126 (45)
Agricultural industrialization	259 (92.50)	8 (2.86)	251 (89.64)
Women empowerment increases	268 (95.71)	120 (42.86)	148 (52.86)
Women and child death rate decreases	114 (40.71)	71 (25.36)	43 (15.36)

Source: Field Survey, 2021

The asset pentagon approach showed that there is a noteworthy improvement based on different capitals (namely, human capital, social capital, natural capital, physical capital and financial capital) of farm households adopting mutant rice variety in comparison to non-mutant variety. Fig. 3 represents the changing nature of different capitals which reveals that the farmers cultivating had a positive impact on farm households' livelihood patterns in comparison to farmers with non-mutant growers. Increases in capitals of

sampled farm households were the highest for financial capital that was 20.05 % and the lowest was for natural capital i. e. 5.38%.

From Table 5, it was observed that livelihood of Binadhan-7 growers was changed from 12 years before, because Binadhan-7 was developed in 2007. In case of home type, the highest differences were seen in Tin-shade building that was 47% and the lowest was mud build 12.14%.

**Table 6. Distribution of respondents according to Preferences in Binadhan-7 Cultivation**

<b>Preferences</b>					
<b>Item</b>	<b>Short duration</b>	<b>High yielding</b>	<b>Income increases</b>	<b>Create employment Opportunity</b>	<b>Reduce Poverty</b>
<b>Study areas</b>					
Mymensingh	20	17	19	19	20
Jashore	20	15	19	19	19
Cumilla	19	16	20	20	20
Rajshahi	17	14	17	17	16
Bogura	16	16	20	20	20
Sylhet	15	18	19	18	17
Dinajpur	14	17	19	18	20
Rangpur	19	15	20	19	20
Dhaka	18	18	15	17	19
Khulna	19	16	13	14	13
Chattagram	16	15	12	12	14
Rangamati	18	16	13	13	15
Barishal	19	17	18	20	18
Faridpur	19	18	16	18	17
%	88.93	81.43	85.71	87.14	88.57
Rank	I	V	IV	III	II

Source: Field Survey, 2021

**Table 7. Distribution of respondents according to constraints to Binadhan-7 Cultivation**

<b>Type</b>	<b>Constraints</b>				
	<b>Lack of quality Seed</b>	<b>Labour crisis &amp; high price of labour</b>	<b>Marketing Problem</b>	<b>Lack of Godown</b>	<b>Destroy by bird</b>
<b>Study areas</b>					
Mymensingh	7	10	5	12	12
Jashore	14	14	17	10	16
Cumilla	7	17	9	17	19
Rajshahi	13	16	7	10	17
Bogura	12	18	9	16	8
Sylhet	10	16	13	11	16
Dinajpur	7	15	10	14	13
Rangpur	8	16	12	15	14
Dhaka	11	18	18	19	11
Khulna	9	17	18	17	17
Chattagram	7	16	18	16	16
Rangamati	10	18	19	14	14
Barishal	12	17	15	10	10
Faridpur	10	18	19	14	4
%	48.93	80.71	67.50	69.64	66.79
Rank	V	I	III	II	IV

Source: Field Survey, 2021

Both the livestock & poultry rearing and drinking water through tube well were increased by 8%. At present, the number of trees cultivation per households increased by 45% from 12 years before. The study revealed that road condition also changed in the study areas. It was the highest for brick road i.e 61.43% than 12 years ago. In case of sanitation, the highest percentage change was seen in half building and tin shade 42% and the lowest was in mud built 8.21%. Food security & health condition was increase by 46.79% and 44.64 %, respectively, in the study areas. Electricity connection, Social

communication (Mobile/Internet), Recreation (TV/Radio), Agricultural industrialization was increased by 38.93%, 70.36%, 45% and 89.64%, respectively. In case of women empowerment it was increased by 52.86 % and women and child death rate was decreased by 15.36 %.

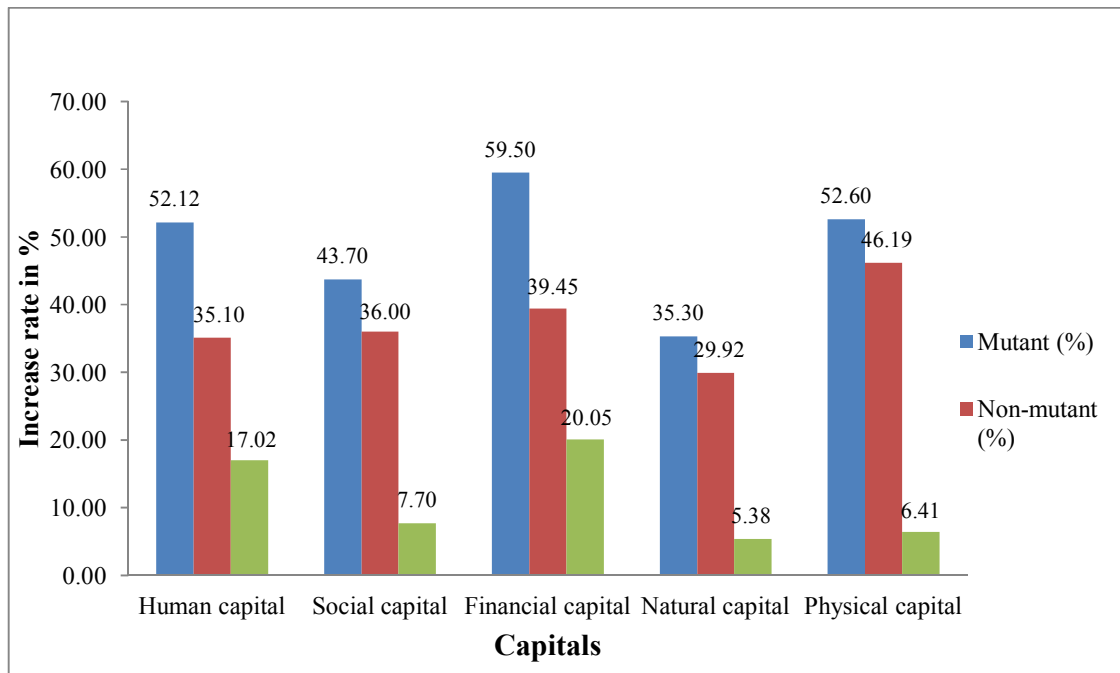
### 3.5.2 Preferences and major constraints to mutant rice variety binadhan-7 cultivation

Farmers prefer this variety for various reasons such as short duration, high yielding, earliness,

Table 8. Major technical information to Binadhan-7 Cultivation

Type	Study areas													%	Rank	
	Mymensingh	Jashore	Cumilla	Rajshahi	Bogura	Sylhet	Dinajpur	Rangpur	Dhaka	Khulna	Chattagram	Rangamatiari	Barishal			Faridpur
<b>Technical/ Other Information</b>																
Get information about this variety from DAE & Research station	18	17	17	16	16	17	14	18	19	19	14	8	19	20	82.86	I
Type of information/Support																
• Training	17	10	16	14	12	14	13	15	8	15	12	16	4	8	62.14	V
• Suggestions	19	14	17	15	15	16	15	17	12	5	8	18	13	12	70.00	III
• Seed support	10	8	12	7	9	8	7	8	5	0	0	0	5	4	29.64	VIII
• Rice used for family purpose	10	6	8	9	7	6	9	9	10	9	16	13	14	14	50.00	VII
Taste good to eat Binadhan-7	11	12	14	17	20	14	13	18	9	9	10	10	9	16	65.00	IV
Selling paddy at market	14	15	11	14	10	9	12	18	18	20	16	18	15	18	74.29	II
Cultivate other BINA's variety rather than Binadhan-7	12	11	16	14	13	10	11	13	6	0	9	5	18	8	52.14	VI

Source: Field Survey, 2021.



**Fig. 3. Increases in capitals of sampled farm households in the 14 study areas**

cropping intensity increase, four cropping pattern (Binadhan-7-potato/ mustard/ vegetables-Boro-Aus). They can include rabi crops like mustard, potato, wheat, different vegetables in their cropping pattern that leads to increase income as well as employment and reduce poverty. Major of these preferences are shown in the Table 6. Among the list the highest preferences was 88.93% for short duration and it was ranked I, the lowest was high yielding i.e. 81.43% which was ranked as V.

Among the constraints, the highest constraint reported by the farmer was labour crisis as well as high price of labour (80.71%) and it was ranked I and the lowest ranked V was lack of quality seed at proper time (48.93 %) in Binadhan-7 cultivation (Table 7).

From the Table 8, we found that 82.86% respondents got information about this variety cultivation from research office and DAE. There were 62.14% growers who received training, 70% got suggestions from different Agricultural officers, and 29.64% receive seed support indicating 70.36 % of seed used from their previous harvest. Farmer harvested paddy within 110-115 days and 50% of that were used for family consumption and the rest were sold by them. The study found that, 74.29% paddy was sold by the growers in the market, 65% growers

noticed about good taste to eat the rice, 52.14% cultivated other BINA developed variety rather than Binadhan-7 in aforesaid locations.

#### 4. CONCLUSIONS AND RECOMMENDATION

Cultivation of mutant rice variety Binadhan-7 is highly profitable among the study areas and that is increasing day by day [11]. Net return was the highest in Dinajpur region, a northern part of Bangladesh. It brought 48.30% higher income than the non-mutant variety cultivation in the study areas. Farmers are happy to cultivate Binadhan-7 for the special characteristics of this variety such as-short duration, HYV, early cutting and increasing the number of crop in their pattern i.e. Binasarisha (mustard), potato, Binarosun (garlic), Binamorich (Chilli), Binatomato etc. Now in a year, they can cultivate four crops so that they can earn more money which stabilizes their income and secured food. Their livelihood also changes within 12 years. The asset pentagon approach showed that there is a noteworthy improvement based on different capitals (namely, human capital, social capital, natural capital, physical capital and financial capital) of farm households adopting mutant rice variety in comparison to non-mutant variety. On the other hand, the non-mutant growers are not growing

mutant varieties like Binadhan-7 because of non availability of quality seed, extension weakness, lack of training, reluctant to adopt new variety and farmers willingness to the traditional variety cultivation for their own consumption. Some of the farmers are also cultivating other mutant varieties such as Binasail, Binadhan-9, Binadhan-13, Binadhan-19 and Binadhan-22. Finally it is remarked that short duration high yielding variety Binadhan-7 plays a vital role in the munga mitigation of the northern areas of Bangladesh for early ripening or cutting character. In this case, as there is an advantage for the BINA developed HYVs like Binadhan-7 over the other HYVs because of their shorter duration and introducing opportunities four cropping pattern then it seems to be needed to estimate the value of the additional crop in future study. So, Government of Bangladesh and donor agencies can invest more for more research and extension of the short duration mutant rice variety to achieve food security as well as sustainable development goal (SDG).

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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