Asian Australas. J. Food Saf. Secur. 2024, 8(2), 58-66; https://doi.org/10.3329/aajfss.v8i2.77004

**Asian-Australasian Journal of Food Safety and Security**
ISSN 2523-1073 (Print) 2523-2983 (Online)
https://www.ebupress.com/journal/aajfss/

*Article*

# Profitability and technical efficiency of Binadhan-17 cultivation in the *Haor* areas of Bangladesh

Syful Islam[1,2*], Md. Habibur Rahman[1], Mohammad Rashidul Haque[1], Md. Mohsin Ali Sarkar[1,2] and Razia Sultana[1,2]

[1]Agricultural Economics Division, Bangladesh Institute of Nuclear Agriculture, Mymensingh, Bangladesh
[2]Department of Agricultural Economics, Faculty of Agricultural Economics and Rural Sociology, Bangladesh Agricultural University, Mymensingh, Bangladesh

*Corresponding author: Syful Islam, Agricultural Economics Division, Bangladesh Institute of Nuclear Agriculture, Mymensingh, Bangladesh. E-mail: bausyful07@gmail.com

Received: 08 September 2024/Accepted: 20 November 2024/Published: 25 November 2024



**Abstract:** The *Haor* region contributes approximately 20% of Bangladesh's total rice production, and this study focused on the Binadhan-17 rice variety in three key *Haor* districts including, Sunamganj, Kishoreganj, and Netrokona. The research aimed to assess the costs, returns, and technical efficiency of Binadhan-17 cultivation, surveying 180 randomly selected farmers from the region. Using a stochastic frontier production function model and descriptive statistics, the study found that the average production cost per hectare was BDT 76,863, with fixed costs accounting for 35.90% and variable costs for 64.10%. The average net return per hectare was BDT 44,289, and the Benefit-Cost Ratio (BCR) was 1.58, with Sunamganj having the highest BCR (1.62), followed by Kishoreganj (1.57) and Netrokona (1.54). Significant positive relationships were found between human labor, land preparation, and insecticide costs at the 1% level, while seed, urea, and organic manure costs were significant at the 10% level, and TSP was significant at the 5% level. Around 68.33% of farmers achieved outputs close to the maximum frontier level (91%–99%), with an average technical efficiency of 89.40%, indicating a 10.60% production loss due to inefficiency. The study also identified several challenges faced by farmers, including difficulties in obtaining timely seed and labor, limited knowledge of production technologies, high fertilizer prices, and lack of capital, offering insights for policymakers to enhance rice production in the short term.

**Keywords:** cost and return; technical efficiency; Binadhan-17; Cobb-Douglas frontier production function; constraints

## 1. Introduction

Agriculture is a significant economic sector in Bangladesh. It accounts for 11.66% of the country's GDP and employs a labor force of 45.40% (BBS, 2022; BER, 2022). Rice cultivation plays a central role in Bangladesh's agricultural sector, accounting for approximately 62.77% of the country's total cultivated land (BBS, 2019). In an average year, rice production is around 36 million tons. We need to improve our production efficiency. Production efficiency refers to how effectively they utilize various resources to maximize profit and adopt prominent production technology. It has caused policymakers to think that improvement is impossible with current outdated production technologies. The crucial problem in the agricultural sector of Bangladesh aims to increase the output per unit input used. Thus efficient use of inputs has ignored a vital role in increasing agricultural productivity.

The *Haor* region is located in the northeastern part of Bangladesh and spans across seven districts including Sunamganj, Kishoreganj, Netrokona, Sylhet, Habiganj, Maulavibazar, and Brahmanbaria (Bokhtiar *et al*., 2024). Agricultural practices in the *Haor* areas, particularly the cultivation of Boro rice, heavily rely on natural conditions. The primary challenges to modern Boro rice farming in this region include floods, hailstorms, and drought. The total cultivated land in the *Haor* districts covers approximately 1.26 million hectares, with 0.68 million hectares (around 66%) located within the *Haor* region. Of this *Haor* land, about 80% is dedicated to Boro rice cultivation, while only around 10% is utilized for T. Aman production (Ali *et al*., 2019; Hoq *et al*., 2021). Hybrid rice is also cultivated in the *Haor* region. Despite the challenges of growing a single crop and the frequent occurrence of flash floods, this area contributes approximately 20% of Bangladesh's total rice production and accounts for nearly one-fifth of the country's land area. Additionally, it serves as a source of livelihood for around 20 million people (Das and Roychoudhury, 2014).

Bangladesh faces resource constraints and limited efficiency in adopting new technologies. Research on inefficiency suggests that productivity can be increased by improving existing efficiency levels, even without introducing advanced technologies (Khan *et al*., 2021). Identifying and addressing efficiency gaps enables the implementation of strategies to minimize them. Productive efficiency can be categorized into three types, technical, allocative, and economic efficiency. Assessing these forms of efficiency has been a key focus of research in both developed and developing nations. This is especially important in agricultural economies of developing countries, where resources are scarce, and opportunities for adopting or developing advanced technologies are diminishing (Wakweya, 2023). Measuring efficiency is crucial for boosting productivity growth. Such studies can benefit economies by revealing how much productivity can be enhanced by focusing on efficiency improvements, which are often underutilized, while utilizing existing resources and available technologies. This approach helps guide decisions on whether to prioritize efficiency enhancements or the development of new technologies in the short term. However, by representing the production processes of sample farms in terms of input-output (production function) with a given technology, these studies cannot fully distinguish the effects of efficiency from farm-specific variations in how available technology is used, especially considering the biological nature of agricultural production (Haelermans and Ruggiero, 2013).

This research was conducted considering research questions such as, what are the costs and returns associated with its cultivation, and how economically viable is the process? How technically efficient are the farmers producing Binadhan-17, and what factors influence their efficiency levels? Which key inputs have the most significant impact on the crop’s yield in this region? How do the profitability and Benefit-Cost Ratio (BCR) of Binadhan-17 cultivation vary across different districts in the *Haor* areas? Lastly, what major challenges do farmers face in cultivating Binadhan-17, and how can these challenges be mitigated to enhance productivity? Corresponding hypotheses propose that Binadhan-17 cultivation is economically viable, with positive net returns and a BCR exceeding one, and that input costs such as labor, fertilizers, and land preparation significantly influence yield. The study also hypothesizes that farmers achieve high technical efficiency levels, influenced by attributes like age, education, and farming experience, while profitability varies across districts due to resource and management differences.

Pertaining to the enduring view in the literature that growers practicing traditional agriculture is often described as 'poor but efficient', and the focus has shifted towards increasing investments in the development of new and more productive techniques, several studies that investigated the relationship between farm size and output in Indian agriculture have been conducted since late 1950. Regional variations, together with input-output relations and enterprises, have also been taken into account since 1960. The study aimed to estimate the costs and returns of Binadhan-17 cultivation, assess the technical efficiency of its growers, and identify the major constraints to its cultivation at the farm level. The measurement of efficiency and identifying the influencing factors for growing Boro rice by the farmers of the study area various policies, like price policy, input supply policy, extension policy, and distribution policies can be adopted to augment total output.

## 2. Materials andMethods

### 2.1. Ethical approval and informed consent

This study did not require ethical approval. Informed consent was obtained from all participants before the interview.

### 2.2. Selection of the study area

The research was carried out in three major Binadhan-17 producing *Haor* areas of Bangladesh, such as Sunamganj, Kishoreganj and Netrokona districts (Figure 1).

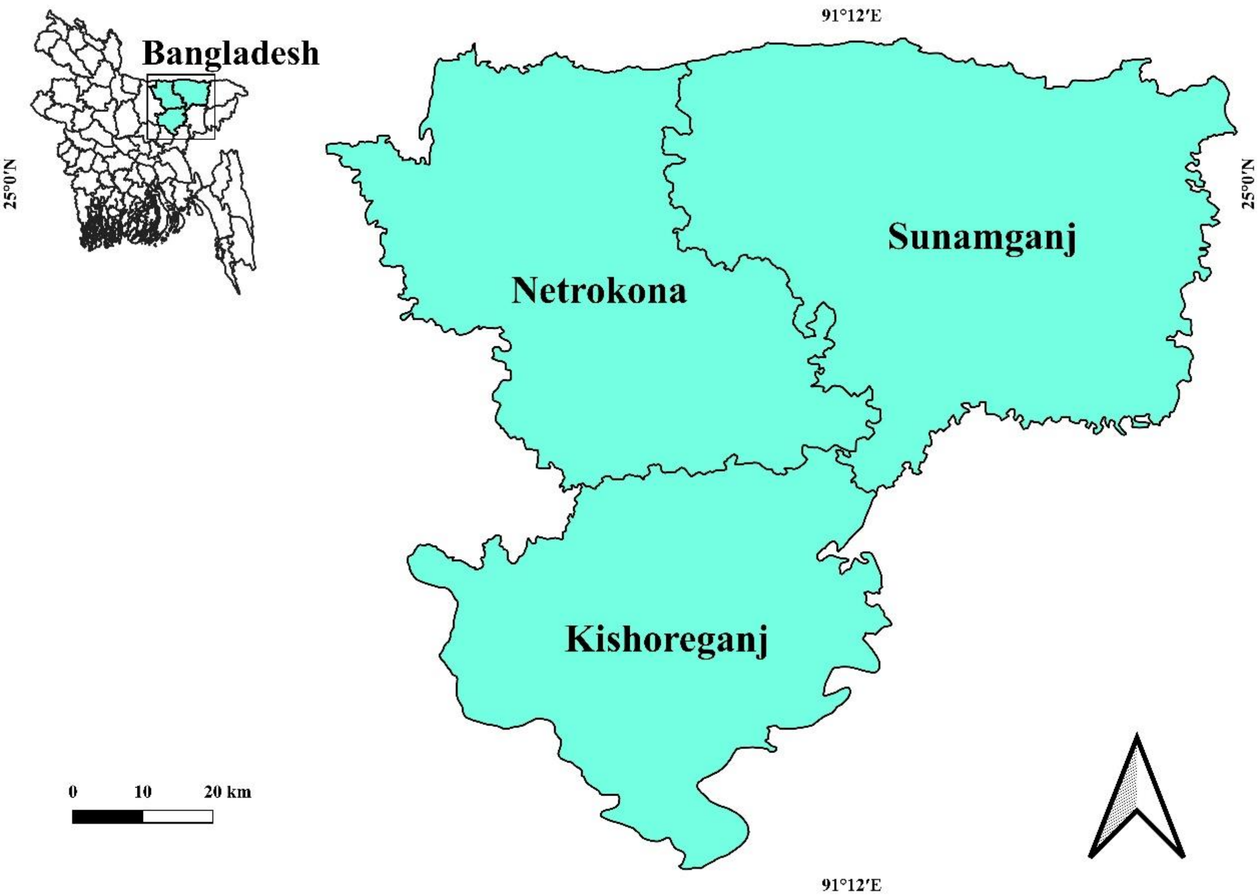


**Figure 1. Map of the selected *Haor* areas.**

### 2.3. Sampling procedure and sample size

This study employed a multistage sampling technique to ensure a representative sample from the target population (Islam *et al*., 2020). In the first stage, the study area was divided into three key districts: Sunamganj, Kishoreganj, and Netrokona. In the second stage, 60 farmers were randomly selected from each district, making up a total sample size of 180 respondents. The selection process aimed to capture a diverse range of farming practices and conditions within the *Haor* region, providing a comprehensive understanding of the factors influencing rice cultivation.

### 2.4. Data collection

The data related to the objectives of the year 2021-2022 were collected by survey method. Data were collected from Binadhan-17 growers through an interview schedule. Collected data were edited, compiled, tabulated and examined to achieve the objectives.

### 2.5. Statistical analysis

The collected data was analyzed using descriptive statistics such as averages, percentages and ratios which were used for focusing the results of the study (Islam *et al.*, 2019; Fakir *et al.*, 2021). The Stata software was used to analyze the data. The map of the study area was prepared using QGIS-3.40.0.

### 2.5.1. Profitability analysis

A detailed analysis of costs and returns were calculated on the full cost basis (Islam *et al.*, 2021; Kaysar *et al.*, 2023). The difference between the total revenue (TR) and total cost (TC) is called profitability. The profit ($\pi$) equation was used for estimating the net return.

$\pi$= total revenue (TR) – total cost (TC)

= TR - (TVC + TFC)

$$\pi = \sum Q_y . P_y + \sum Q_b . P_b - \sum_{i=1}^{n} (X_i . P_{xi}) - TFC$$

Where,

$\pi$ = Net returns (BDT $ha^{-1}$);

$Q_y$= Total amount of output (kg $ha^{-1}$);

$P_y$= Per unit prices of output (BDT $kg^{-1}$);

$Q_b$= Total amount of by-product (kg $ha^{-1}$);

$P_b$ = Per unit prices of by-product (BDT $kg^{-1}$);

$X_i$ = Quantity of $i^{th}$ inputs;

$P_{xi}$ = Per unit price of $i^{th}$ inputs;

TFC = Total fixed cost involved in Binadhan-17 production;

i = 1, 2, 3, ..., n

### 2.5.2. Technical efficiency analysis

The Stochastic frontier production function model was utilized to determine the technical efficiency of Binadhan-17 growers in the study areas (Erena *et al.*, 2021). The model function is specified as below,

$$LnY = a_0 + b_1 lnX_1 + b_2 lnX_2 + b_3 lnX_3 + b_4 lnX_4 + b_5 lnX_5 + b_6 lnX_6 + b_7 lnX_7 + b_8 lnX_8 + V_i - U_i$$

Where, Y = Output of Binadhan-17 (kg $ha^{-1}$)

$X_1$ = Quantity of human labor (man days $ha^{-1}$)

$X_2$ = Cost of power tiller (BDT $ha^{-1}$)

$X_3$ = Quantity of seed or seedlings (kg $ha^{-1}$)

$X_4$ = Quantity of Urea (kg $ha^{-1}$)

$X_5$ = Quantity of TSP (kg $ha^{-1}$)

$X_6$ = Cost of irrigation (BDT $ha^{-1}$)

$X_7$ = Quantity of organic manure used (kg $ha^{-1}$)

$X_8$ = Cost of insecticide (BDT $ha^{-1}$)

$a_0$ = Constant

$b_i$ = Parameters

ln = Natural logarithm

$V_i$ and $U_i$ = $V_i$ is normally distributed two sided random error and $U_i$ is a non-negative variable, due to technical inefficiency in production;

i = 1, 2, 3, ........., 8

The model for technical inefficiency effects within the stochastic frontier equation for $U_i$ is expressed as (Jack, 2013),

$$U_i = \gamma_0 + \gamma_1 Z_1 + \gamma_2 Z_2 + \gamma_3 Z_3 + \gamma_4 Z_4 + \gamma_5 Z_5 + w_i$$

Where,

$Z_1$ = age of the selected growers (years)

$Z_2$ = education (years)

$Z_3$ = farming experience of the selected farmers (years)

$Z_4$ = farm size (decimal)

$Z_5$ = training (training receives ‘1’ for yes, ‘0’ for otherwise)

$w_i$ = The classical disturbance term is assumed to be independently distributed, originating from the truncation of a normal distribution with a mean of zero and an unknown variance, $\gamma^2$.

## 3. Results and Discussion

### 3.1. Cost of Binadhan-17 cultivation

The variable costs for cultivating Binadhan-17 included hired labor, land preparation, seeds, manure, fertilizers, irrigation, and pesticides, among other inputs. The value of family-supplied labor and other inputs was considered part of the fixed cost (Islam *et al*., 2018). The total variable cost of cultivating Binadhan-17 was BDT 49,269 per hectare, representing 64.10% of the overall production cost. Within the variable costs, hired labor accounted for the largest share (33%), followed by fertilizers (12.65%), power tiller use (8.47%), and irrigation costs (5.01%). Family labor and land use costs were classified as fixed costs, with the total fixed cost for Binadhan-17 cultivation averaging BDT 27,594 per hectare. Family labor and land use contributed BDT 15,476 and BDT 12,118 per hectare, respectively, comprising 20.13% and 15.77% of the total cost (Table 1). Analyzing both variable and fixed costs, the average total production cost for Binadhan-17 was BDT 76,863 per hectare, with fixed costs making up 35.90% and variable costs 64.10% (Table 1). The highest total cost was observed in Kishoreganj (BDT 79,224 per hectare), followed by Sunamganj (BDT 75,767) and Netrokona (BDT 75,599).

The results of the cost analysis for Binadhan-17 cultivation highlight the significant share of variable costs, which constitute 64.10% of the total production cost. Hired labor emerged as the largest contributor to variable costs, followed by fertilizers, power tiller use, and irrigation, which emphasizes the labor-intensive nature of rice cultivation in the *Haor* region. The high proportion of variable costs suggests that improving the efficiency of these inputs, particularly labor and fertilizers, could enhance cost-effectiveness and productivity (Sujan *et al*., 2017; Rahaman *et al*., 2022). On the other hand, fixed costs, including family labor and land use, accounted for 35.90% of the total production cost. The relatively high contribution of family labor and land use indicates that while these costs are not as flexible, they still play a crucial role in determining overall production expenses. The total cost of production varied across the three districts, with Kishoreganj having the highest total cost, which could be attributed to factors such as higher labor or input costs in that region. Sunamganj and Netrokona followed, with slightly lower production costs (Hoq *et al*., 2021).

**Table 1. Cost of Binadhan-17 cultivation in the study areas.**

| Cost component | Cost of production (BDT/hectare) | | | | % of all areas |
|---|---|---|---|---|---|
| | Sunamganj | Kishoreganj | Netrokona | Average | |
| **(A) Variable cost** | **46897** | **52272** | **48640** | **49269** | **64.10** |
| Hired labor (man days) | 24404 | 27859 | 24732 | 25665 | 33.39 |
| Power tiller | 6410 | 6817 | 6298 | 6508 | 8.47 |
| Seed | 1037 | 973 | 908 | 973 | 1.27 |
| Fertilizers | 8947 | 10208 | 10018 | 9724 | 12.65 |
| Urea | 2519 | 2393 | 2267 | 2393 | 3.11 |
| TSP | 2779 | 2864 | 2408 | 2684 | 3.49 |
| MP | 630 | 652 | 703 | 662 | 0.86 |
| Gypsum | 356 | 402 | 385 | 381 | 0.50 |
| Zinc | 440 | 418 | 550 | 469 | 0.61 |
| Cow dung | 2223 | 3479 | 3705 | 3136 | 4.08 |
| Pesticides | 1112 | 1267 | 1324 | 1234 | 1.61 |
| Irrigation | 3557 | 3964 | 4035 | 3852 | 5.01 |
| Int. on operating capital | 1430 | 1184 | 1325 | 1313 | 1.71 |
| **(B) Fixed cost** | **28870** | **26952** | **26959** | **27594** | **35.90** |
| Family labor | 16269 | 15001 | 15158 | 15476 | 20.13 |
| Land use cost | 12601 | 11951 | 11801 | 12118 | 15.77 |
| **Total cost (A+B)** | **75767** | **79224** | **75599** | **76863** | **100.00** |

The average yield of Binadhan-17 was 5,877 kg per hectare. Sunamganj recorded the highest yield at 6,053 kg per hectare, followed by Kishoreganj at 5,903 kg per hectare and Netrokona at 5,676 kg per hectare. The gross margin based on variable costs was BDT 71,883 per hectare, with Sunamganj having the highest gross margin (BDT 75,767 $ha^{-1}$), followed by Kishoreganj (BDT 72,294 $ha^{-1}$) and Netrokona (BDT 67,863 $ha^{-1}$). The average net return was BDT 44,289 per hectare, with Sunamganj achieving the highest net return (BDT 46,621 $ha^{-1}$), followed by Kishoreganj (BDT 45,342 $ha^{-1}$) and Netrokona (BDT 40,904 $ha^{-1}$). The BCR was estimated at 1.58, with the highest BCR recorded in Sunamganj (1.62), followed by Kishoreganj (1.57) and Netrokona (1.54) (Table 2). The results of this study indicate that the cultivation of Binadhan-17 in the *Haor* region is relatively profitable, with consistent yields observed across the districts, although Sunamganj stands out in terms of yield, gross margin, net return, and Benefit-Cost Ratio. The average yield of the rice variety suggests it performs well under the conditions in the *Haor* region. However, Sunamganj's yield surpasses the other districts, highlighting more favorable growing conditions in this area. Similarly, the gross margin and net return were highest in Sunamganj, suggesting that farmers in this district managed to generate more income relative to their production costs (Bairagi *et al*., 2021). The BCR across all districts indicates that, on average, Binadhan-17 cultivation is economically viable, with farmers earning more than they are spending. Sunamganj's higher BCR further reinforces the economic viability of rice cultivation in this district, which may point to more efficient resource utilization and management practices. Although Kishoreganj and Netrokona showed slightly lower BCR values, they still demonstrate positive returns, meaning that Binadhan-17 is still a viable option for farmers in these districts, even with some challenges (Zaman *et al*., 2022; Sarkar *et al*., 2024).

**Table 2. Profitability of Binadhan-17 cultivation in different locations.**

| Type | Study areas | | | All average |
|---|---|---|---|---|
| | Sunamganj | Kishoreganj | Netrokona | |
| Yield from Binadhan-17 (kg ha$^{-1}$) | 6053 | 5903 | 5676 | 5877 |
| Return from Binadhan-17 (BDT ha$^{-1}$) | 116460 | 119000 | 111653 | 115705 |
| Return from straw (BDT ha$^{-1}$) | 5928 | 5565 | 4850 | 5448 |
| Total return (BDT ha$^{-1}$) | 122388 | 124565 | 116503 | 121152 |
| Total variable cost (BDT ha$^{-1}$) | 46897 | 52272 | 48640 | 49269 |
| Total cost (BDT ha$^{-1}$) | 75767 | 79224 | 75599 | 76863 |
| Gross margin (BDT ha$^{-1}$) | 75491 | 72294 | 67863 | 71883 |
| Net return (BDT ha$^{-1}$) | 46621 | 45342 | 40904 | 44289 |
| Rate of return (BCR) | 1.62 | 1.57 | 1.54 | 1.58 |

### 3.2. Technical efficiency of Binadhan-17 farmers

The stochastic frontier model includes key variable inputs such as human labor, land preparation, seeds, urea, TSP (triple super phosphate), irrigation, organic manure, and insecticide costs. In addition, the inefficiency model incorporates socio-economic factors like age, experience, education, and farm size. Most parameters were found to be statistically significant and positive (Table 3). Specifically, the coefficients for human labor, land preparation, and insecticide costs were positive and significant at the 1% level, while the coefficients for seed, urea, and organic manure were positive but significant at the 10% level. The coefficient for TSP was also positive, significant at the 5% level. However, irrigation costs showed a negative and statistically insignificant relationship with Binadhan-17 production. The estimated output elasticities with respect to human labor, land preparation, seed, urea, TSP, organic manure, and insecticides were positive, with values of 0.423, 0.082, 0.181, 0.402, 0.101, and 0.215, respectively. This suggests that increases in these variables would lead to significant positive changes in Binadhan-17 production. For example, a 1% increase in human labor, land preparation, seed, urea, TSP, organic manure, or insecticide inputs is expected to result in yield increases of 0.423%, 0.082%, 0.181%, 0.402%, 0.101%, and 0.215% per hectare, respectively. The variance was significantly different from zero, indicating that the model's distributional assumptions were valid and that the model fit the data appropriately.

The results from the stochastic frontier analysis show that human labor, land preparation, seed, urea, TSP, organic manure, and insecticides positively impact Binadhan-17 production. Among these, human labor had the most significant effect. In contrast, irrigation costs were found to have a negative and insignificant impact on rice yields. The positive elasticities suggest that small increases in these inputs could lead to higher yields, with human labor contributing the most to productivity growth. The model's fit was confirmed by the significant variance, indicating the validity of the assumptions. This suggests that optimizing input use, especially human labor and land preparation, can significantly improve productivity in the *Haor* regions (Rahman *et al*., 2012).

**Table 3. Maximum likelihood estimates the production function for Binadhan-17 cultivation.**

| Independent variables | Parameters | Co-efficient | SE | T- ratio |
|---|---|---|---|---|
| Constant | $a_0$ | 3.3674* | 0.377 | 4.120 |
| Human labour (man-days ha$^{-1}$) | $b_1$ | 0.423*** | 0.070 | 6.080 |
| Land preparation (BDT ha$^{-1}$) | $b_2$ | 0.082*** | 0.076 | 1.060 |
| Seed (kg ha$^{-1}$) | $b_3$ | 0.181* | 0.077 | 2.350 |
| Urea (kg ha$^{-1}$) | $b_4$ | 0.402* | 0.066 | 6.090 |
| TSP (kg ha$^{-1}$) | $b_5$ | 0.101** | 0.068 | 1.470 |
| Irrigation (BDT ha$^{-1}$) | $b_6$ | -0.113 | 0.069 | -1.620 |
| Organic manure (kg ha$^{-1}$) | $b_7$ | 0.126* | 0.039 | 3.240 |
| Insecticides (BDT ha$^{-1}$) | $b_8$ | 0.215*** | 0.076 | 2.82 |
| Sigma-squared | $\sigma^2$ | 0.023 | 0.003 | 0.294 |
| Gamma | $\gamma$ | 0.151 | 0.010 | 2.186 |
| Lambda | $\lambda$ | 1.357 | 0.009 | 2.506 |
| Log likelihood function | | 58.90 | | |

(Note: ***, ** and * indicate the significant at 1%, 5% and 10% level of probability, respectively); SE=standard error

The technical inefficiency model's estimated coefficients, revealed that factors such as the age, education, and farming experience of the farmers had a negative and statistically significant impact on technical inefficiency at the 1% level (Table 4). This indicates that as farmers' age, education, and experience increased, technical inefficiency in Binadhan-17 production decreased. On the other hand, while the coefficient for farm size and training was positive, it was not statistically significant. The results suggest that farmers' age, education, and farming experience significantly reduce technical inefficiency in Binadhan-17 production. As these factors increase, farmers become more efficient in resource use and decision-making. However, farm size and training, while positively associated with efficiency, did not show a significant impact (Ali *et al*., 2022).

**Table 4. Maximum likelihood estimates of the technical inefficiency model for Binadhan-17.**

| Independent variables | Para-meters | Co-efficient | SE | T- ratio |
|---|---|---|---|---|
| Constant | $\gamma_0$ | 0.244** | 0.029 | 4.255 |
| Age (years) | $\gamma_1$ | -0.013*** | 0.005 | -1.466 |
| Education (years ) | $\gamma_2$ | -0.064*** | 0.009 | -2.572 |
| Farming experience (years) | $\gamma_3$ | -0.047*** | 0.028 | -1.124 |
| Farm size (decimal) | $\gamma_4$ | 0.009 | 0.015 | 0.431 |
| Training (dummy) | $\gamma_5$ | 0.333 | 0.079 | 4.107 |
| Gamma | $\gamma$ | 0.595** | 0.042 | 5.822 |
| Log likelihood function | | 62.31 | | |

(Note: ***, ** and * represents the significant at the 1%, 5% and 10% level, respectively); SE=standard error; Likelihood-ratio test: sigma_u=0: chibar$^2$(01) = 0.00 Prob>=chibar$^2$ = 1.000

Around 68.33% of farmers achieved outputs that were close to the maximum possible level, with efficiency ranging from 91% to 99%. The average technical efficiency of Binadhan-17 producers was 89.40%, implying a production loss of 10.60% due to inefficiencies. This means that, on average, the farmers were 10.60% below the optimal production frontier (Table 5). The results show that most farmers were able to produce near-maximal output, but on average, technical inefficiency led to a production loss of over 10%. This gap suggests that improvements in resource utilization, access to better farming techniques, and training could help reduce inefficiencies. Addressing these factors would enhance productivity and profitability, particularly in regions where efficiency is lower (Felix *et al*., 2021; Endalew *et al*., 2023).

**Table 5. Technical efficiency of Binadhan-17 growers in the study areas.**

| Technical efficiency (%) | Farmers (frequency) | Total farmers (%) |
|---|---|---|
| 71-80 | 9 | 5.00 |
| 81-90 | 48 | 26.67 |
| 91-99 | 123 | 68.33 |
| Mean efficiency | 89.40% | |
| Maximum | 97% | |
| Minimum | 74% | |

### 3.3. Key constraints to Binadhan-17 Cultivation

Binadhan-17 is a profitable crop in the studied areas. However, farmers faced various constraints in cultivating Binadhan-17 (Islam *et al.*, 2016; Hoque *et al.*, 2022). In Table 6, about 68% of farmers opined timely non-availability of good seeds was a first ranked problem of Binadhan-17 cultivation. Other constraints were lack of knowledge about recommended production technology (62%), non-availability of sufficient labor in time (49%), high price and adulteration in fertilizer (42%) and lack of capital (39%).

**Table 6. Key constraints to Binadhan-17 cultivation in the study areas.**

| No. | Constraints | Farmers' responded (%) | | | | Rank |
|---|---|---|---|---|---|---|
| | | Sunamganj | Kishoreganj | Netrokona | All | |
| 1 | Timely non-availability of good seed | 63 | 75 | 66 | 68 | I |
| 2 | Lack of knowledge about recommended production technology | 55 | 61 | 70 | 62 | II |
| 3 | Non-availability of sufficient labor | 44 | 57 | 48 | 49 | III |
| 4 | High price and adulteration in fertilizer | 38 | 46 | 42 | 42 | IV |
| 5 | Lack of capital | 34 | 48 | 37 | 39 | V |

## 4. Conclusions

The cultivation of Binadhan-17 in the study areas proved to be economically beneficial. Farmers who planted Binadhan-17 observed substantial returns on their investments. Their yields increased notably due to investments in key inputs such as human labor, land preparation, seeds, urea, TSP, and organic manure, all of which significantly and positively influenced productivity. About 68.33% of the farmers attained a technical efficiency level of 89.40%, suggesting room for further improvement in productivity through enhancing factors like age, education, and farming experience.


## Acknowledgements

This study is acknowledged to the entire respondent for their sincere cooperation. It also shows the gratitude to the government which helps with revenue funding for conducting the study.


## Data availability

The data used to support the findings of this study are included in the article.

## Conflict of interest

None to declare.

## Authors' contribution

Conceptualization: Syful Islam; Methodology: Syful Islam. Data collection and formal analysis: Syful Islam; Writing - original draft preparation: Syful Islam; Writing - review and editing: Syful Islam; Md. Habibur Rahman; Mohammad Rashidul Haque; Md. Mohsin Ali Sarkar; Razia Sultana. All authors have read and approved the final manuscript.

## References


Ali S, M Murtaza, W Ahmad, N Bibi, A Khan and J Khan, 2022. Does education and farming experience affect technical efficiency of rice crop growers? Evidence from Khyber Pakhtunkhwa, Pakistan. Sarhad J. Agric., 38: 1147-1159.

Ali S, MA Kashem and MA Aziz, 2019. Agro-economic performance of boro rice cultivation at farmers' level of *Haor* area in Bangladesh. Int. J. Agric. Environ. Food Sci., 3: 78-82.

Bairagi S, H Bhandari, KS Das and S Mohanty, 2021. Flood-tolerant rice improves climate resilience, profitability, and household consumption in Bangladesh. Food Pol., 105: 102183.

BBS, 2019. Yearbook of agricultural statistics of Bangladesh. Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Dhaka.

BBS, 2022. Yearbook of agricultural statistics of Bangladesh. Bangladesh Bureau of Statistics, Statistics Division, Ministry of Planning, Dhaka.

BER, 2022. Bangladesh economic review; Finance Division, Ministry of Finance, Government of Peoples' Republic of Bangladesh, Dhaka.

Bokhtiar SM, MJ Islam, S Samsuzzaman, M Jahiruddin, GM Panaullah, MA Salam and MA Hossain, 2024. Constraints and opportunities of agricultural development in *Haor* ecosystem of Bangladesh. Ecologies, 5: 256-278.

Das K and A Roychoudhury, 2014. Reactive oxygen species (ROS) and response of antioxidants as ROS-scavengers during environmental stress in plants. Front. Environ. Sci., 2: 53.

Endalew B, M Aynalem, A Anteneh and H Mossie, 2023. Sources of wheat production technical inefficiency among smallholder farmers in Northwestern Ethiopia: Beta regression approach. Cogent Econ. Fin., 11: 2208895.

Erena OT, MM Kalko and SA Debele, 2021. Technical efficiency, technological progress and productivity growth of large and medium manufacturing industries in Ethiopia: a data envelopment analysis. Cog. Econ. Fin., 9: 1997160.

Fakir AA, S Islam, MS Islam, MA Hoque and NI Toma, 2021. Adequacy, utilization and repayment of society for social service credit on poor women of Mymensingh district in Bangladesh. Asian Australas. J. Food Saf. Secur., 5: 1-10.

Felix KT, PN Kumar and S Arivarasan, 2021. Technical-and-allocative inefficiency index of Indian sugarcane farms- A primal system approach. Environ. Sust. Indic., 11: 100133.

Haelermans C and J Ruggiero, 2013. Estimating technical and allocative efficiency in the public sector: a nonparametric analysis of Dutch schools. European J. Operat. Res., 227: 174-181.

Hoq MS, MT Uddin, SK Raha and MI Hossain, 2021. Welfare impact of market participation: The case of rice farmers from wetland ecosystem in Bangladesh. Environ. Chall., 5: 100292.

Hoque MA, S Islam, MS Islam, MI Kaysar and AA Fakir, 2022. Effects of diverse land tenant types on agricultural credit receipt and its utilization: a case study from Mymensingh district of Bangladesh. Asian Australas. J. Food Saf. Secur., 6: 18-26.

Islam S, MC Chanda, MR Haque, R Sultana and M Yunus, 2016. Profitability and yield gap between research station and farm level of Binamoog-8. Asian J. Med. Biol. Res., 2*: 685-688.*

Islam S, MH Rahman, MR Haque and MMA Sarkar, 2018. Potential productivity and yield gap of Binasoybean-2 in the research station and farm level. Saudi J. Bus. Man. Stud., 3: 1361-1365

Islam S, MH Rahman, MR Haque and MMA Sarkar, 2019. Factors affecting gross return of Binadhan-11 produced at different districts of Bangladesh. Haya Saudi J. Life Sci., 4: 241-244.

Islam S, MH Rahman, MR Haque, MMA Sarkar and R Sultana, 2020. Technology adoption and profitability of BINA released lentil variety Binamasur-5 in Bangladesh. South Asian J. Soc. Stud. Econ., 8: 46-53.

Islam S, MH Rahman, MR Haque, MMA Sarkar and R Sultana, 2021. An economic study on sesame variety Binatil-3 in some selected areas of Bangladesh. IOSR J. Agric. Vet. Sci., 14: 21-26.

Jack BK, 2013. Market inefficiencies and the adoption of agricultural technologies in developing countries. UC Berkeley: Center for Effective Global Action, USA.

Kaysar MI, S Islam, MS Islam, M Islam, NB Atiq and S Sarker, 2023. Adoption and profitability of BARI released garlic varieties in Bangladesh: a farm level study. Asian Australas. J. Food Saf. Secur., 7: 73-90.

Khan MA, Begum R, Nielsen R and Hoff A, 2021. Production risk, technical efficiency, and input use nexus: lessons from Bangladesh aquaculture. J. World Aqua. Soc., 52: 57-72.

Rahaman MS, MAR Sarkar, MC Rahman, L Deb, MM Rashid, MS Reza and MAB Siddique, 2022. Profitability analysis of paddy production in different seasons in Bangladesh: insights from the *Haor*. Int. J. Agric. Environ. Food Sci., 6: 327-339.

Rahman K, M Mia and M Bhuiyan, 2012. A stochastic frontier approach to model technical efficiency of rice farmers in Bangladesh: an empirical analysis. The Agriculturists, 10: 9-19.

Sarkar MMA, MH Rahman, MR Haque and S Islam, 2024. Economic study of Binadhan-22 production in some selected areas of Bangladesh. Bangladesh J. Nucl. Agric., 38: 81-91.

Sujan MHK, I Faijul, MJ Azad and JR Shah, 2017. Financial profitability and resource use efficiency of boro rice cultivation in some selected area of Bangladesh. African J. Agric. Res., 12: 2404-2411.

Wakweya RB, 2023. Challenges and prospects of adopting climate-smart agricultural practices and technologies: implications for food security. J. Agric. Food Res., 14: 100698.

Zaman MR, T Aker and NI Nishat, 2022. Comparative profitability of the modern and traditional variety of T. Aman rice in Mymensingh district of Bangladesh. Int. J. Sust. Agric. Res., 9: 55-67.