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Profitability of Transplanted Aman rice cultivation in some selected areas of the southern part of Bangladesh

Rebeka Sultana Supti & Dr. Rokeya Begum

Abstract

The research aimed to assess the profitability of Transplanted Aman (T. Aman) rice cultivation in the southern region of Bangladesh. Specifically, it sought to identify the most successful service providers and evaluate the financial viability of T. Aman rice cultivation in the study area. Data collection involved 118 randomly selected respondents, including farmers, dealers, and marketers. The overall cost of production per hectare, as determined by primary data analysis, came to Tk. 34,869.76. Furthermore, 2,149.00 kg of T. Aman rice were produced on average per acre. The resultant Benefit Cost Ratio (BCR) of 1.26 means that for every taka invested in T. Aman production yielded Tk. 1.26 in return. Gross returns were determined to be Tk. 43,882.58, resulting in net returns of Tk. 9,013.58. The findings underscored the profitability of T. Aman rice cultivation in the southern region of Bangladesh, as evidenced by the favorable results of the cost-benefit analysis. It is recommended to utilize contemporary inputs such as high-quality seeds, fertilizers, efficient labor, power tillers, pesticides, and timely irrigation to enhance output and profitability. Timely and effective utilization of these inputs is crucial for maximizing output and profitability in T. Aman rice cultivation.

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Introduction

Rice stands as a crucial cereal crop in Bangladesh, renowned for its high productivity, nutritional value, and versatile applications (Islam et al., 2017). It contributes over 4.5% of the country's GDP and is the cornerstone of the agricultural sector, where "food security" is primarily dependent on "rice security" (BBS, 2020). Approximately 81% of all cultivated land and 80% of all irrigated land is used for rice agriculture, which provides 96% of the world's cereal supply (Alam et al., 2013). Rice has a major role in guaranteeing farmers' income and employment, with an average yearly per capita consumption of 134 kg, above the global average of 57 kg (Mottaleb et al., 2016). (Md. Abdur Rashid Sarker, 2012). In Bangladesh, rice is grown in four different ecosystems throughout three different seasons: Boro (January to June), Aus (April to August), and Aman (August to December). In spite of this, farmers' field studies have shown that present productivity is below achievable yields, specifically 8–10 t/ha during the dry season (Boro) and 5–6 t/ha during the wet season (Transplanted Aman) (Mamun, 2015). Differential management strategies between researchers and farmers contribute to this production gap. To enhance profitability and address the demand-supply disparity, this study scrutinizes rice farms' production efficiency and the economic viability of T. Aman Rice production in Bangladesh's southern region.

However, coastal regions encounter difficulties. Over the past ten years, climate change has caused an approximate 15% decline in Aman rice production (Roy et al., 2020). Reducing the yield gap and increasing efficiency are key to increasing production (Laborte et al., 2012; Mondel, 2011). Since T. Aman rice is primarily grown in coastal regions, farmer interviews were conducted to learn more about the effects of seed, fertiliser, and rural electricity management systems on hectare costs, yields, and returns. Although some studies have explored Aman rice cultivation in Bangladesh (Zakaria et al., 2014), research on Aman rice in climate-vulnerable southern regions focusing on inefficiencies, profitability, and influencing factors remains scarce.

By evaluating the profitability of T. Aman rice production and the productivity of T. Aman-producing farmers, this study aims to close this gap. The study's findings may provide valuable insights for further research and serve as a basis for addressing the yield gap through practical technologies (Roy et al., 2020). Given the vulnerability of Bangladesh's coastal population to climate change, evaluating Aman rice production effectiveness and estimating yield gaps becomes imperative. Anticipated outcomes aim to enhance individual farmers' profitability and efficiency while informing extension agents and policymakers to develop robust food security strategies. The paper's primary goals include quantifying input requirements, estimating costs and profitability across seasons, and identifying factors influencing T. Aman rice production.

Literature review/ Related works

Bangladesh's economy is predominantly agrarian, with agriculture playing a central role in sustaining livelihoods and driving economic growth (Miah et al., 2020). Among agricultural commodities, rice production stands out as essential for maintaining food security, particularly in a country where rice is a dietary staple (Mainuddin and Kirby, 2015). Within the context of Bangladesh's agricultural landscape, Transplanted Aman (T. Aman) rice cultivation in the southern region emerges as a crucial aspect deserving further scrutiny regarding its economic viability. Numerous studies have delved into various facets of rice production, agricultural development, and food security in Bangladesh, providing valuable insights into key determinants, challenges, and opportunities in this sector. Miah, Hasan, and Uddin (2020) highlight the significance of regional growth analysis in understanding disparities and similarities in rice production environments across different regions. They stress the need for region-specific strategies to enhance productivity and ensure rice security, emphasizing the importance of tailored approaches to address local challenges. Mainuddin and Kirby (2015) project future trends in rice production and consumption, underlining the importance of sustainable agricultural practices and policy interventions to meet growing food demand amidst evolving climatic and demographic factors. Al Mamun et al. (2021) analyzes the growth and trend of rice production, advocating for targeted interventions to enhance productivity and address disparities in rice production regions, thereby contributing to overall rice security. Climate change poses significant challenges to rice cultivation in Bangladesh, as highlighted by Hasan, Sarker, and Gow (2016), who assess the impact of climate change on Aman and Boro rice yields. They emphasize the importance of developing climate-tolerant rice varieties to ensure food security, particularly in the face of changing climate conditions. Technical efficiency and production constraints are also critical considerations in rice cultivation, as explored by Islam, Hossain, and Jaim (2004). Their study provides insights into the determinants of technical efficiency and potential policy interventions to enhance rice productivity, underscoring the importance of optimizing resource use. Sultana et al. (2022) examine the yield gap, risk attitude, and poverty status of coastal climate-vulnerable Aman rice producers, emphasising the need for focused interventions to raise livelihoods and productivity in these locations. Kabir et al. (2015) present a vision for sustainable rice production, outlining strategies to achieve sustainable rice production, including genetic gain acceleration and minimizing yield gaps. Roy, Rahman, and Khan (2019) assess the inefficiency and yield gap of Aman rice production, identifying production constraints and opportunities to enhance efficiency and productivity in coastal regions. Uddin et al. (2011) contribute insights into cultivation practices and productivity factors relevant to Aman rice production, emphasizing the importance of spacing on yield and yield attributes.

While existing literature provides a comprehensive understanding of the rice production landscape in Bangladesh, there is a gap in specific research focusing on the economic viability of transplanted Aman rice cultivation in the southern regions. This study aims to address this gap by examining the nuances of transplanted methods and their impact on profitability metrics. Moreover, while previous studies have examined various aspects of rice cultivation in Bangladesh, there is limited research explicitly focusing on the financial aspects of transplanted Aman rice growth. This study bridges this gap by concentrating on economic elements specific to the transplanting procedure, such as input costs, market price, and return on investment, thereby providing practical insights to improve the economic viability of rice farming in Bangladesh's southern areas.

Materials and Methods

A multistage sampling technique was employed to choose regions where T. Aman rice is cultivated. Initially, an upazila predominantly cultivating T. Aman rice was purposively selected from Patuakhali district. Subsequently, two villages, namely Betagi and Bashbaria in Patuakhali, were randomly chosen using a simple random sampling method, considering their significant coverage of T. Aman cultivation. A total of 118 farmers engaged in T. Aman rice cultivation within these selected areas were then randomly sampled for the study.

Analytical Technique:

A combination of quantitative and descriptive statistical methods were used to analyse the gathered data. The socioeconomic characteristics of the survey respondents were presented using descriptive statistics, which included metrics like minimum, maximum, mean, and percentages. Use of the profit function was made for the mathematical analysis. This required figuring out a number of financial metrics to evaluate the Transplanted Aman rice farming's profitability. Key metrics included gross return, which represents the total revenue generated from the sale of rice; gross margin, indicating the difference between total revenue and total variable costs; net return, which accounts for total revenue minus total variable and fixed costs; and the benefit-cost ratio (BCR), which compares the benefits of the rice cultivation to its costs. These metrics provide insights into the financial viability and efficiency of the T. Aman rice production.

Gross return: The entire amount of rice produced multiplied by the price per unit that the farmers were paid yielded the gross return. According to Dillon (1993), this computation included both the primary product and any related byproduct.

Gross Return = Σ (Q x P) Where Q = Output quantity; and P = Output price.

Gross margin: is used to describe the difference between the overall amount of money earned and the variable expenditures spent on a specific project.

Gross Margin = Gross return − Total variable cost

Net return: After subtracting all costs—both fixed and variable—from gross return, net return was calculated.

Net return, $\pi = \Sigma P_yQ_y - \Sigma (P_{xi} X_i) - TFC$. In this case, TFC refers for total fixed costs in Tk, i ranges from 1 to n, denoting the number of inputs, Py stands for the output's per unit price, Qy is the total quantity of output, Pxi is the input's per unit price, and Xi is the input's quantity.

Benefit-cost ratio (BCR): Acts as a comparison measure by assessing the return on investment per unit of expense. By expressing them as a ratio, it quantifies the link between gross profits and gross costs. The following formula can be used to get the BCR (undiscounted):

Benefit-cost ratio = Gross benefit ÷ Gross cost

Empirical Technique:

To evaluate the level of technical efficiency, functional analysis was used, with the Cobb-Douglas Stochastic Frontier Production Function. The stochastic frontier's functional form can be represented as follows:

$Y = \beta 0\ X1^{\beta 1}\ X2^{\beta 2} \ldots\ldots\ldots X6^{\beta 6}\ e^{Vi-Ui}$

The above function is the linearized double-log form:

$\ln Y = \ln\beta 0 + \beta 1\ln X1 + \beta 2\ln X2 + \beta 3\ln X3 + \beta 4\ln X4 + \beta 5\ln X5 + Vi-Ui$

Where,

Y = Output (kg/ha); X1 = Human labour (man days/ha); X2 = Land preparation cost (Tk./ha); X3= Seed (Kg/ha); X4 = Fertilizer (kg/ha); X5 = Cost of insecticide (Tk./ha)

The stochastic production frontier equation's account of the technical inefficiency effects is defined by

$Ui = \delta 0 + \delta 1Z1 + \delta 2Z2 + \delta 3Z3 + \delta 4Z4 + \delta 5Z5 + Wi$

Where, Z1…….. Z6 are explanatory variables.

The equation can be written as:

$Ui = \delta 0 + \delta 1$ T. Aman farming experience + $\delta 2$ Education + $\delta 3$ Contact with AEO+$\delta 4$ Training + $\delta 5$ Credit service + Wi

U is a one-sided technical inefficiency effect under the control of the farmer with a positive half normal distribution $\{Ui \sim |N(0, \sigma u2)|\}$, and V is a two-sided uniform random variable beyond the control of the farmer with a N (0, σv2) distribution. where Wi is a uniform random variable with two sides. W is a positive half-normal distributed unobservable random variable. Using STATA software, the model was calculated concurrently.

Results and Discussion:

The potential for economic growth solely through enhanced utilization of existing resources reaches a limit once an efficient production technology is attained. Consequently, the pursuit of increased output solely through efficiency improvements cannot be sustained indefinitely, as the frontier output level is eventually reached under perfect technical efficiency conditions.

Hence, alternative growth strategies must be considered when increasing output solely through resource efficiency is no longer feasible. The adoption of modern agricultural technology to augment output per unit of input represents one such strategy.

Table 1 presents an analysis showing that, at the 1 percent level, human labour has a positive and statistically significant influence. With a coefficient of 0.73, assuming all other variables stay constant, a 1 percent increase in the cost of labour leads to a comparable 0.73 percent increase in the yield of T. Aman rice. Similarly, at the 1 percent level, the cost of land preparation shows a positive and substantial influence (coefficient of 0.26). This implies that, all other things being equal, a 1% increase in extra land preparation costs results in a 0.26 percent increase in T. Aman rice output. On the other hand, a negative influence with a significance level of 10% is shown in the seed cost. Holding all other variables equal, a 1 percent increase in seed quantity results in a 0.22 percent drop in T. Aman rice output (coefficient of -0.22). This suggests that using too much seed reduces the production of T. Aman rice. With a coefficient of 0.49, fertiliser cost shows a positive and substantial influence at the 1 percent level. If all other conditions stay the same, a one percent increase in fertiliser quantity results in a 0.49 percent increase in T. Aman rice production. Additionally, at the five percent level, the expense of insecticides has a favourable and considerable influence on T. Aman output. With a coefficient showing that, on the assumption that other variables stay constant, a 1% increase in pesticide expenditure leads to a 0.15 percent increase in T. Aman rice yield.

According to the technical inefficiency effect model shown in Table 1, training and education have negative coefficients. The negative coefficient for education indicates that educated farmers are generally more technically efficient than their less educated colleagues, even if the education coefficient lacks statistical significance. On the other hand, farmer training appears to help reduce technical inefficiency based on the negative and significant (at the 5 percent level) training coefficient. The fact that the experience, credit, and extension service coefficients are positive, however, suggests that these variables have little bearing on the technical inefficiency in T. Aman production. However, the extension service coefficient is significant at the 10 percent level, indicating that it has no discernible effect on the technical inefficiency of T. Aman production.

Table 1: Presents the parameter estimates for the Cobb-Douglas Stochastic Frontier Production Function and the Technical Inefficiency Model applied to T. Aman rice farmers.

Variable	Co-efficient	P value	Parameter
Stochastic Frontier			
Constant	-0.37	0.72	β0
Human Labor (X1)	.73***	0	β1
Land Preparation (X2)	.26***	0.001	β2
Seed (X3)	-.22*	0.076	β3
Fertilizer (X4)	.49***	0	β4
Insecticide (X5)	.15**	0.026	β5
Inefficiency Model			
Constant	-1.39*	0.102	δ0
Experience (Z1)	0.012	0.395	δ1
Education (Z2)	-0.06	0.265	δ2
Extension Service (Z3)	1.02*	0.057	δ3
Training (Z4)	-1.34**	0.013	δ4
Credit Service (Z5)	0.13	0.793	δ5

Source: Field survey, 2019

Profitability of T. Aman Production

Variable Costs:

Cost of Land Preparation

Land preparation stands as a crucial element in the production process, encompassing activities such as plowing, laddering, and other tasks essential for preparing the soil for T. Aman cultivation. In the case of T. Aman production, three tillers were required for land preparation, with each tiller costing Tk. 150. As a result, it was calculated that the average cost of preparing land for T. Aman cultivation was Tk. 4981.53 per hectare, or 14.29 percent of the overall cost (see Table 2).

Cost of Human Labor

The cost of labour for humans makes up a sizable amount of total manufacturing costs. It is a crucial and widely used input in the production process of T. Aman, being necessary for a number of processes including as preparing the soil, planting, weeding, applying fertiliser and insecticides, irrigation, harvesting, transporting, threshing, cleaning, drying, and storing. With an average salary cost of Tk. 500 per man-day, 65 man-days of labour were needed per hectare in the context of T. Aman production. As a result, it was calculated that the overall cost of labour was Tk. 21,751, or 62.37 percent of the entire cost of production (see Table 2).

Cost of Seed:

The price of seed varied greatly according to its availability and quality. According to Table 2, the anticipated total cost of seed per hectare for T. Aman cultivation was Tk. 1980, or 5.68 percent of the overall cost of production.

Cost of Urea:

Farmers used a variety of fertilisers in the research region, using 41 kg of urea per acre on average. An estimated Tk. 818 was spent on urea per acre, or 2.35 percent of the total cost of production (see to Table 2).

Cost of TSP:

With an average application of 77 kg per hectare, Triple Super Phosphate (TSP) fertilisers were applied at a rate almost twice as high as urea fertilisers among the different types of fertilisers used. Table 2 shows that the average cost of TSP was Tk. 1605, or 4.60 percent of the overall cost of manufacturing.

Cost of MoP:

It was found that the rate at which Muriate of Potash (MoP), weighing 21 kg per acre, was applied was less than that of other fertilisers. According to Table 2, the projected cost of MoP per acre was Tk. 411, or 1.18 percent of the total cost of production.

Table 2: Cost of T. Aman Production (Per Hectare)

Items of Cost	**Quantity (kg/ha)**	**Rate (Tk./Kg)**	**Cost (Tk./Ha)**	**% of Total Cost**
Land preparation	3	150	4981.53	14.29
Seed			1980	5.68
Human labor	65	500	21751	62.37
TSP	77	30	1605	4.6
Urea	41	20	818	2.35
MoP	21	20	411	1.18
Cost of Insecticides			1596	4.58
A. Total Operating Cost (TOC)			**33142**	**95.05**
Interest on operating capital @ of 10% for months			1104.73	3.17
B. Total Variable Cost (TVC)			**34246**	**98.21**
Rental value of land			623.03	1.78
C. Total Fixed Cost (TFC)			**623.03**	**1.78**
D. Total cost (B+C)			**34869.76**	**100**

Source: Field Survey, 2019

*"Number of tillers per hectare" and "Tk. per tiller" are the units used to indicate the quantity and rate of land preparation, respectively. Likewise, "man-days per hectare" and "Tk. per man-day" are the units used to indicate the amount and pace of human labour, respectively.

Cost of Insecticides:
To keep pests and illnesses away from their crops, farmers used a variety of insecticides. As indicated in Table 2, the average cost of pesticides for the production of T. Aman was found to be Tk. 1596, or 4.58 percent of the overall cost of production.
Interest on Operating Capital:
It's important to keep in mind that the interest on operating capital was determined by factoring in all operational costs incurred during T. Aman's production period. The interest on operating capital for the production of T. Aman was determined to be Tk. 1104.73 per hectare, or 3.17 percent of the total cost of production, as Table 2 illustrates.
Total Variable Cost:
Therefore, it is clear from the numerous cost components discussed above that the overall variable cost of producing rice was Tk. 34246 per hectare, or 98.21 percent of the total cost of production (as shown in Table 2).
Fixed Cost:
Rental Value of Land
The opportunity cost of using each hectare of land for the three-month cropping period was taken into account when calculating the rental value of the land. The cost of using the land was determined by taking its cash rental value. The land usage cost was calculated to be Tk. 623.03 per hectare, or 1.78 percent of the total production cost, based on the data gathered from T. Aman rice producers (as reported in Table 2).
Total Cost (TC) of T. Aman rice Production:
The sum of the expenses for both fixed and variable inputs was used to determine the total cost (TC) of rice production in T. Aman. As indicated in Table 2, the total cost per hectare of rice production in the current study was found to be Tk. 34869.76.

Return of T. Aman Production:
Gross Return
Table 7.2 provides specifics about T. Aman rice cultivation's return per hectare. The entire quantity of the primary product multiplied by its corresponding per-unit price was used to calculate the gross return per hectare. The table shows that the average price per kilogramme of T. Aman was Tk. 17.5, and the average production per hectare was 2149 kg. Furthermore, the 2149 kg byproduct had a Tk. 2.98 value. Thus, by adding the values of the rice's primary product and byproduct, the gross return per hectare was calculated to be Tk. 43882.58 (as given in Table 3).
Gross Margin
The entire variable cost was deducted from the gross return to get the gross margin, which is the difference between the gross return and variable cost. Based on the data, Tk. 9636.58 per hectare was found to be the gross margin (see Table 3).
Net Return
By deducting the entire cost of production from the gross return, the net return—also known as profit—was calculated. The net return was calculated to be Tk. 9013.58 per acre based on the data that was available.

Table 3: Cost and Return of T. Aman Rice Production (Per Hectare)

Measuring Criteria	**Rate (Tk/Ha)**	**Quantity (Kg/Ha)**	**Cost (Tk/Ha)**
Main Product Value	17.5	2149	37607.5
By Product Value	2.92	2149	6275.08
Gross Return (GR)			43882.58
Total Variable Cost (TVC)			34246
Total Cost (TC)			34869.76
Gross Margin (GR-TVC)			9636.58
Net Return (GR-TC)			9013.58
BCR (undiscounted)(GR/TC)			**1.26**

Source: Field survey, 2019

Benefit Cost Ratio (Undiscounted)

A relative metric used to compare benefits per unit of cost is the benefit-cost ratio, or BCR. The BCR in this investigation was found to be 1.26. This suggests that the return on investment for T. Aman rice production is Tk. 1.26 for every taka invested. It is clear from the BCR of 1.26 that T. Aman rice production is profitable in Bangladesh. This ratio indicates a positive economic outcome since it shows that the benefits of producing rice from T. Aman outweigh the costs involved.

Problems and Constraints of T. Aman Production by no. of Farmers

As shown in Table 4, this study also found a number of issues and limitations related to T. Aman rice growing. In Bangladesh, farmers faced a variety of social, cultural, economical, and technical obstacles when growing T. Aman rice. The low cost of output stood out among these difficulties as a key restriction in the research domain. A lack of operational capital, expensive inputs, high-quality seed costs, a labour shortage, insufficient extension services, and exposure to natural disasters were some of the other significant issues. Significant obstacles for T. Aman farmers in the research region are presented by these limitations.

It will take coordinated efforts from the public and commercial sectors to address these issues. To enable increased T. Aman rice production, steps should be taken to mitigate or resolve these issues. Stakeholders can help increase the profitability and productivity of T. Aman farming in the area by addressing these barriers.

Table 4: Problems and Constraints of T. Aman Cultivation by No. of Farmers

Name of the problem	Rank	Number	Percent
Low price of Rice	1	115	97.46
High Labor cost	2	112	94.92
The high price of other input	3	111	94.07
Natural disaster	4	107	90.6
Pest and Disease Attack	5	102	86.44
Lack of quality seed	6	56	47.46
Lack of operating capital	7	51	43.22
Lack of extension services	8	36	30.51
Lack of scientific knowledge	9	S2	18.64

Concluding Remarks

Despite the climatic challenges faced in the endangered coastal areas of Bangladesh, Aman rice cultivation remains a profitable agribusiness venture. While the region generally has lower yield potential, its natural conditions are conducive to rice cultivation. However, constraints such as salinity intrusion, tidal surge, waterlogging, irregular rainfall, and temperature variations persist, impacting yields. Nonetheless, by enhancing farmers' technical knowledge and providing training programs focused on optimal input utilization, rice production can be improved. Emphasizing training programs and making extension services more accessible can lead to higher yields in rice production. Evidence suggests that high yields are achievable in the study area with proper management and training tailored to address farmers' challenges, needs, goals, and available resources. The talk focuses on the different cost elements, input application dosages, yields, and returns per hectare in T. Aman rice farming. Efficient use of contemporary inputs including seeds, fertilisers, labour, power tillers, pesticides, and irrigation is crucial because of its labor-intensive nature. Using these inputs efficiently and on time is essential to raising output and profitability. We might tentatively conclude that T. Aman rice agriculture is lucrative in light of these arguments.

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