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YIELD GAP ANALYSIS AND THE FACTOR INFLUENCING Binasarisha-4 IN SOME SELECTED AREAS OF BANGLADESH

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Abstract

Binasarisha-4 is a prominent high-yielding mustard variety that plays a crucial role in the oilseed production in Bangladesh. The study was conducted in five major Binasarisha-4 growing areas of Bangladesh, namely Rangpur, Jashore, Tangail, Sirajganj and Magura district to analyze the yield gap and its influencing factors of the variety. In this paper, influencing factors of this crop were analysed by Cobb-Douglas multiple regression equation. The study found that the average yield gap I of Binasarisha-4 production was 0.08 t ha^{-1} (4.72%) and the average yield gap II was 0.20 t ha^{-1} (13.35%). Considering all, the average yield gap was 0.28 t ha^{-1} (17.46%) and much scope for yield enhancement in the variety. The coefficients for power tiller, labor, seed, urea, TSP, MoP, experience, and gypsum were found to be positively significant but farm size negatively significant. By identifying and tackling the causes of the yield gap, this study intends to maximize agricultural productivity, enhance farm incomes, and strengthen national self-sufficiency in edible oil.

Keywords: Yield gap, Cobb-Douglas multiple regression, constraints, Binasarisha-4 and Bangladesh.

Introduction

Agriculture has played a pivotal role in the sustainable growth and development of the economy of Bangladesh. Although the agricultural sector contributed only 11.30% of GDP, its importance in Bangladesh's socioeconomic development goes well beyond this indicator as 40.6% of the total workforce is employed in agriculture (BBS, 2023). Rapeseed are popularly called 'Mustard' which is a leading oilseed crop, contributing to more than 48% of the total oilseed production in Bangladesh. The most land was utilized for mustard cultivation (66.21%), followed by soybeans (11.67%), groundnuts (8.06%), sesame (6.61%), coconut (6%), linseed (1.05%), and sunflower (0.42%) (BBS, 2022). It is a cold loving crop that is grown during Rabi season.

The total area under oilseed crops is around 519.84 thousand acreages (which is 6.37% of the total area under cultivation) of land and producing about 1143 thousand tones (BBS, 2022). The total area under rape and mustard is around 383.40 thousand hectares and producing 547 thousand tones. The country is producing about 0.36 million tons of edible oil from oilseed crops per year as against the total requirement of 1.4 million tons (Mallik, 2013). Mustard is a major oilseed crop in the world, farmed in 53 countries across six continents, including India, the second largest producer after China (Boomiraj *et al.*, 2010).

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Mustard is the main oil producing crop of Bangladesh yielding 52.2% total oilseed produced from 60.3% of the total land (Huq *et al.*, 2010). The seeds contain 40-44% oil, 25% protein and 6.4% nitrogen (FAO, 2012). As a result, Bangladesh's government has prioritized agriculture in order to enhance oilseed output by providing farmers with subsidies on various inputs such as fertilizer, irrigation, and so on. Oil cake, a byproduct of mustard, is a nutritious diet for cattle and fish (Esmaeili, 2013). It is also a good organic fertilizer. It is also an effective organic fertilizer. It is a key source of cooking oil in Bangladesh, accounting for one-third of the country's edible oil requirements (Ahmed 2013). Mostly supply of oil in the market is maintained through import from abroad at the cost of huge amount of foreign exchange (Hossain *et al*., 2006).

Regarding the importance of mustard production in Bangladesh, it is vital to determine the maximum amount of mustard that may be produced per unit of land utilizing present resources. Farmers can produce more with the resources they have if they use them more efficiently. The issue is especially grave in Bangladesh, where the recommended amount per acre is rarely used for production. However, only a few systematic financial investigations of oilseed crops were conducted by private or government organizations, and they were insufficient to meet the needs of extension workers, policymakers, research people, and farmers. The present study will provide valuable information to individual farmers and researchers who will conduct further studies of a similar nature and encourage them in conducting more comprehensive and detailed investigations in this particular field of study. The objectives of the study were i) to estimate the yield gap of Binasarisha-4 among the study areas, ii) to identify the factor affecting the yield of the variety, and iii) to suggest some policy guidelines to minimize the yield gap.

Materials and Methods

The study was conducted in five major Binasarisha-4 growing areas in Bangladesh, namely Rangpur, Sirajganj, Jashore, Tangail and Magura (Fig. 1). Data were collected from a randomly selected sample of 200 farmers, with 40 participants from each of these locations, using a pre-designed questionnaire. The collected data were analyzed by using tabular and statistical methods.

In this study, the concept of yield gap as proposed by Zandstra *et al.* (1981) was used. The total yield gap can be divided into two parts i.e. Yield gap I and Yield gap II. Yield Gap I refers to the difference between the yield research station and the potential farmers' yield obtained at demonstration plots. On the other hand, Yield Gap II reflects the impacts of biophysical and socio-economic constraints, is the difference between the yield obtained at the potential farmers and the actual yield obtained on farmers' fields. The yield gaps were estimated as follows:

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

Where,

Y_R is the yield of research stations,
Y_p is the yield of potential farmers, and
Y_F is the yield of the actual farm.

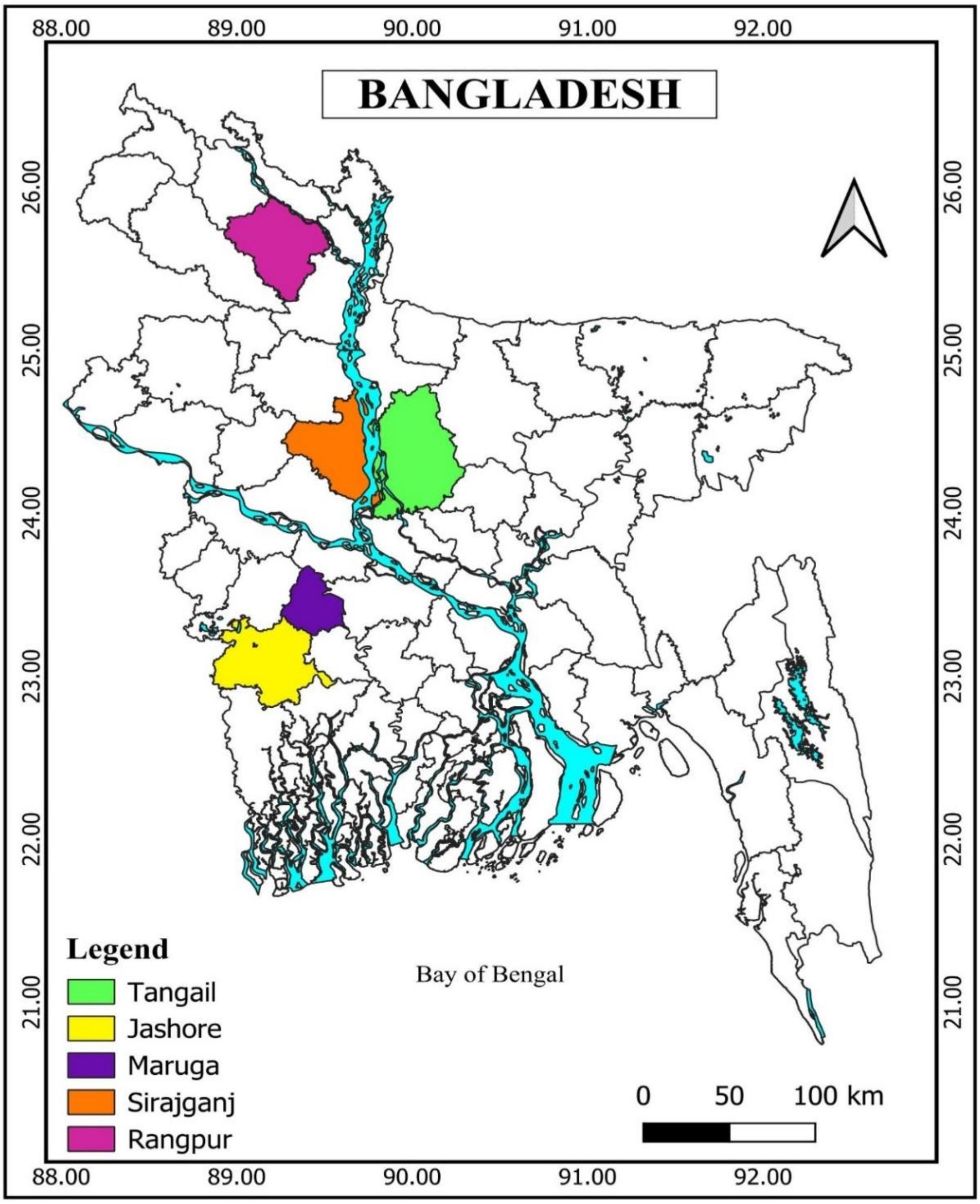

Fig. 1. Map of the study locations.

Source: Authors production by QGIS software, 2025.

The production of Binasarisha-4 is likely to be influenced by different factors, such as seed, chemical fertilizer, etc. (Coelli *et al.*, 1996; and Sharif *et al.*, 1996). The following Cobb-Douglas type production function was used to estimate the parameters. The functional form of the Cobb-Douglas multiple regression equation was as follows:

$$Y = AX_1^{\beta 1}X_2^{\beta 2}\ldots\ldots\ldots\ldots\ldots\ldots X_n^{\beta n}e^{ui}$$

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

$$\ln Y = \sigma + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + \beta_7 \ln X_7 + \beta_8 \ln X_8 + \beta_9 \ln X_9 + \beta_{10} \ln X_{10} + u_i$$

Where,

Y = Yield (kg ha^{-1})
X_1 = Number of power tiller
X_2 = Number of labor
X_3 = Amount of seed (kg ha^{-1})
X_4 = Amount of urea (kg ha^{-1})
X_5 = Amount of TSP (kg ha^{-1})
X_6 = Amount of MoP (kg ha^{-1})
X_7 = Amount of gypsum (kg ha^{-1})
X_8 = Amount of Zn (kg ha^{-1})
X_9 = Soil fertility
X_{10} = Farm size
X_{11} = Experience
σ= constant value
$\beta_1, \beta_2 \ldots\ldots\ldots\ldots \beta_{11}$= Co-efficient of the respective variables and
u_i = Error term.

Results and Discussion

Yield gap of Binasharisha-4 cultivation

Binasharisha-4 stands out as a significant variety within the oilseed sector in Bangladesh, particularly for its high yield and cultivation during the Rabi season (Islam *et al*., 2018). Its adoption has been instrumental in increasing domestic oilseed production and reducing reliance on imports (Rahman *et al*., 2016; and Dutta *et al*., 2016). However, despite its potential, the actual yields achieved by farmers often fall significantly short of its attainable yield under optimal management practices.

The study showed that the farmers' highest yield of Binasarisha-4 was obtained from Magura (1.46 t ha^{-1}) followed by Jashore (1.38 t ha^{-1}), Sirajganj (1.26 t ha^{-1}), Rangpur (1.20 t ha^{-1}), and Tangail (1.17 t ha^{-1}) district.

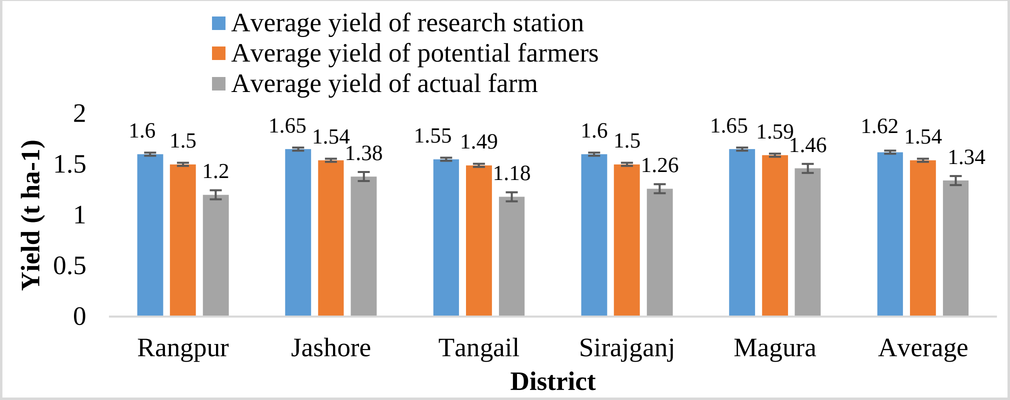

Fig. 2. Estimated yield of Binasharisha-4 in different locations.

The average yield of Binasarisha-4 at the farmers' level was 1.34 t ha^{-1} (Fig. 2). It was also found that the average research station's highest yield of Binasarisha-4 was 1.62 t ha^{-1}. The average yield of potential farm was 1.54 t ha^{-1}.

Table 1. Estimated yield gap of Binasarisha-4 in different locations

Particular	Unit	Rangpur	Jashore	Tangail	Sirajganj	Magura	Average
Yield gap I	t ha^{-1}	0.10	0.11	0.07	0.10	0.06	0.08
	(%)	(6.25)	(6.67)	(3.87)	(6.25)	(3.64)	(4.72)
Yield gap II	t ha^{-1}	0.30	0.16	0.32	0.24	0.13	0.20
	(%)	(20.00)	(10.39)	(21.48)	(16.00)	(8.18)	(13.35)
Total yield gap	t ha^{-1}	0.40	0.27	0.38	0.34	0.19	0.28
	(%)	(25.00)	(16.36)	(24.52)	(21.25)	(11.52)	(17.46)

Source: Authors' own calculation

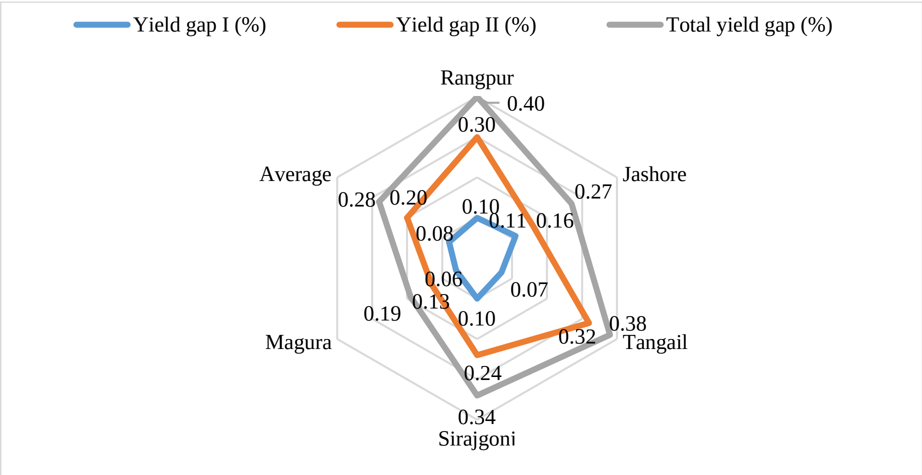

Fig. 3. Estimated yield gap of Binasharisha-4 in different locations.

As seen from Fig. 3, the estimated average yield gap I was 0.08 t ha^{-1} (4.72%) and average yield gap II was 0.20 t ha^{-1} (13.35%). The lowest gap was 0.19 t ha^{-1} (11.52%) observed in Magura district and it was the highest 0.40 t ha^{-1} (25.00%) in case of Rangpur district. Considering all, the average yield gap was 0.28 t ha^{-1} (17.46%) and much scope for yield enhancement in the variety. This finding is supported by Sarkar *et al*. (2022) where the authors found the average yield gap of mustard production was 0.25 t ha^{-1} (16.47%).

Factors influencing the yield of Binasarisha-4

By acknowledging the importance of Binasarisha-4 and the potential losses incurred due to the yield gap, there needs to be a comprehensive determination of its influencing factors. Ultimately, addressing this yield gap holds the key to unlocking the full potential of Binasarisha-4 and contributing significantly to the sustainable growth and development of the agricultural sector of Bangladesh, particularly within the oilseed sub-sector.

In Table 2, the district-wise farmers have to maintain according to the recommended dose to some extent but on average, the farmers among the study areas did not consider the recommended doses of seed rate, fertilizer and seedling age. The average seed rate was 7.06 Kg ha^{-1}, urea 209.56 Kg ha^{-1}, MoP 78.77 Kg ha^{-1}, TSP 164.03 Kg ha^{-1} and seedling age 4.35 days, respectively, indicating that they are either below or range the recommendation.

Table 2. Input–use pattern of Binasarisha-4 growing farmers (Kg ha^{-1})

Factors	Seed	Urea	MoP	TSP	Gypsum	$ZnSO_4$
Recommendation	7.41	197-247	74-86	148-173	123-148	5
Rangpur	7.11	223.91	82.40	165.32	139.46	4.72
Sirajganj	6.96	199.96	73.51	160.62	127.35	4.10
Jashore	7.30	209.25	75.26	170.36	141.56	4.07
Tangail	6.22	198.26	77.37	151.46	130.22	3.85
Magura	7.38	216.46	85.33	172.41	137.18	4.36
Average	7.06	209.56	78.77	164.03	135.15	4.35

Other factors that were also responsible for the yield of Binasarisha-4 are described in Table 3. On average, 67% used power tiller more than two times, 69% irrigated their lands 1-2 times and 64% weeded their lands 1 time and 58 % sprayed pesticide and insecticide to control disease and insects.

In Table 4, the contribution of specified factors affecting the production of Binasarisha-4 could be seen from the estimation of a regression equation (Islam *et al.,* 2019; Huq *et al.,* 2007; Hossain *et al.,* 2013; and Seyoum *et al.,* 1998). Very few farmers used Sulphur and manure, so this was not included in the equation. The result showed that a few coefficients do not have the expected sign. However, the coefficients for seed, urea, MoP, and TSP were found to be positively significant at 1% level. On the other hand, power tiller, labor, and experience were found to be positively but farm size negatively significant at 10% level. Gypsum was found to be positively significant at 10% level. The positive sign indicated that using more of these inputs in Binasarisha-4 production could increase the yield to some extent. The negative sign of farm size indicate that yield was not achieved according to the farm size.

Table 3. Input–use pattern of Binasarisha-4 growing area

Factors	Rangpur	Sirajganj	Jashore	Tangail	Magura	Average
Power tiller (%)						
One times	5	-	10	15	5	8
Two times	20	20	20	25	28	25
More than 2	75	80	70	60	67	67
Irrigation (%)						
No irrigation	35	26	32	44	17	31
Irrigation (1-2)	65	74	68	56	83	69
Weeding (%)						
No Weeding	41	37	49	34	19	36
Weeding (1)	59	63	51	66	81	64
Pesticide and insecticide (%)	62	47	65	41	76	58

Table 4. Factor influencing the production for Binasarisha-4 cultivation in the study areas

Item	Co-efficient	t-value	P>t-value
Intercept	3.703	8.96	0.000
Power tiller (X_1)	0.063**	1.98	0.050
Labor (X_2)	0.101**	2.00	0.048
Seed (X_3)	0.363***	4.02	0.000
Urea (X_4)	0.129***	2.91	0.000
TSP (X_5)	0.145***	0.027	0.000
MoP (X_6)	0.098***	0.81	0.000
Gypsum (X_7)	0.001*	1.80	0.072
Zn (X_8)	-0.032	2.15	0.415
Soil fertility (X_9)	0.074	1.00	0.319
Farm size (X_{10})	-0.083*	-1.78	0.077
Experience (X_{11})	0.138**	1.38	0.028

Note: '*' '**' and '***' indicate significant at 10%, 5% and 1% level.

Constraints of Binasarisha-4 cultivation

The constraints of Binasarisha-4 cultivation represent a missed opportunity for maximizing agricultural productivity, enhancing farmers' incomes, and bolstering national food security, particularly in the context of edible oil. Understanding the magnitude of this yield gap is the first crucial step towards identifying the constraints hindering optimal production. Farmers were facing some constraints in cultivating of Binasarisha-4. Major constraints mentioned by the farmers and the yields of Binasarisha-4 below the potential level are described in Table 5.

Table 5. Major constraints of Binasarisha-4 cultivation

Sl. No.	Particulars	Rangpur	Sirajganj	Jashore	Tangail	Magura	Average
1.	Adulterated inputs (seed, fertilizer, pesticides)	36.5	41.2	54.4	46.1	45.5	44.7
2.	Rainfall during harvesting time	35.3	61.1	27.7	25.5	36.2	37.2
3.	Lack of credit facilities	29.9	24.2	53.6	25.8	32.3	33.2
4.	Inadequate labour during harvesting time	47.3	28.8	38.5	66.5	42.5	42.9
5.	Lack of training on oilseed cultivation	10.0	17.1	26.3	20.0	13.0	17.3
6.	Others*	9.0	13.1	8.3	5.5	9.0	8.9

* Infestation of insects, imbalanced use of fertilizer, natural calamities, etc.

Some policy guidelines to reduce the Yield Gap

A multifaceted policy strategy is required to increase Binasarisha-4 agriculture productivity and profitability while also reducing the existing yield gap. Addressing the highlighted obstacles will enable smallholder farmers to produce higher and more consistent harvests.

For agricultural inputs (seeds, fertilizers, and pesticides), establish a national system of quality control like certification and enforce it strictly. This includes routine checks of input suppliers, harsh sanctions for selling tainted goods, and an open complaints procedure for farmers. Access to certified, high-quality inputs maximize the carrying capacity of the Binasarisha-4 variety and lowers yield losses due to inferior input performance by promoting healthier plant growth, improved crop establishment, and efficient pest/disease control. Encourage climate-resilient technologies to be developed and adopted. By allowing for staggered harvesting, the different maturity phases of the Binasarisha-4 cultivars lower the chance of extensive damage from unexpected rainfall. Invest in and support post-harvest drying and storage facilities at the local level, and issue timely and targeted weather advisories. Reducing post-harvest losses brought on by unfavorable weather conditions immediately raises the marketable yield, hence reducing the difference between what is produced in the field and what is marketed.

Increase access to inexpensive and flexible agricultural finance facilities designed exclusively for oilseed cultivation. This includes simplifying loan application processes, lowering collateral requirements for smallholder farmers, and encouraging microfinance institutions to expand into distant areas. Introduce credit-plus services, which combine credit and technological advice. Adequate and timely credit allows farmers to invest in optimal inputs, labor, and relevant technology all of which are critical for timely operations and maximum yield potential. Encouraging and supporting the use of small-scale, appropriate mechanization for harvesting Binasarisha-4, particularly in labor-scarce areas. Inspire the creation of agricultural cooperatives or labor-sharing groups to improve workforce deployment during peak seasons. Investing in training programs for rural youth to operate and maintain agricultural machines. Timely harvesting reduces shattering losses and quality deterioration, both of which contribute significantly to the yield gap. Mechanization can also increase efficiency and cut production costs.

Implementing thorough and practical training programs to improve Binasarisha-4 production methods, such as correct soil preparation, nutrient management (balanced fertilizer use), integrated pest management (IPM) tactics, and post-harvest handling. Use farmer field schools, demonstration plots, and digital extension services to ensure broad outreach and hands-on learning. Increased knowledge and skills allow farmers to adopt best practices, maximize resource use, and efficiently manage pests and diseases, resulting in increased yields and crop quality. Develop and disseminate early warning systems for natural disasters affecting oilseed agriculture. Promote crop insurance plans with low rates and quick claim resolution. Encouraging crop diversity and farm-level livelihood initiatives to increase resilience to individual crop failures. Proactive measures and safety nets mitigate the destructive impact of unforeseen catastrophes, protecting farmers' investments and minimizing severe yield losses caused by natural disasters.

By systematically addressing these obstacles through targeted policy interventions, Bangladesh can dramatically minimize the yield gap in Binasarisha-4 agriculture, resulting in greater production, improved farmer livelihoods, and increased food security.

Conclusion

Reducing yield gap or increasing the yield of Binasarisha-4 as well as oil crop productivity is urgent for the economic growth and development for Bangladesh. The study found that in Bangladesh, we are losing 0.28 t ha^{-1} (17.46%) yield of Binasarisha-4. If we could reduce these gaps, our total production per year would be increased, which would support in achieving oil consumption by reducing import as well as enhance the economic growth of Bangladesh.

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