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PROFITABILITY AND YIELD RESPONSE OF GARLIC BASED CROPPING SYSTEMS IN CHALAN BEEL AREA OF BANGLADESH

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Abstract

Garlic (*Allium sativum*) is one of the most extensively grown spice crops in Bangladesh. The garlic- based cropping pattern is gaining recognition as an effective and sustainable agricultural practice. This system maximizes land utilization, enhances soil fertility, and boosts farmers' economic returns. This paper examines the benefits, challenges, and best practices for adopting the garlic based cropping sequence in the Chalan Beel area. The cost of production method was applied to calculate the data. A comparative analysis of existing and improved cropping patterns in medium high land (CP-1) and medium low land (CP-2) highlights significant economic and yield benefits from incorporating garlic-based systems. In CP-1, replacing lentil with Garlic and adopting a high-yielding rice variety increases the total net income from Tk. 75,660 to Tk. 3,02,094, while the BCR rises from 1.16 to 1.74. In CP-2, replacing the fallow period with Garlic and substituting Boro rice with watermelon increase the total net income of Tk. 3,76,664, with an improved BCR of 1.89. The findings underscore the economic viability of garlic-based cropping patterns in enhancing profitability and optimizing land use efficiency. This study assesses the agronomic, economic advantages and offers recommendations for its successful implementation. This cropping pattern seems to be efficient and profitable system for this region.

Keywords: Garlic, mungbean, watermelon, Chalan Beel, sustainable agriculture, crop rotation, soil fertility, farm profitability.

Introduction

Garlic (*Allium sativum*) is one of the most extensively grown spice crops in Bangladesh. It is a lucrative cash crop with the potential to greatly enhance farmers' earnings, owing to its high yield potential and strong market demand (Ansary *et al*., 2020). Agricultural profitability depends on effective cropping systems that maximize yield, maintain soil health, and optimize resource use. The garlic based cropping pattern is a promising approach in regions with favorable agro-climatic conditions. The Chalan Beel region of Bangladesh is an essential agro-ecological zone known for its diverse cropping systems. Chalan Beel, the largest inland wetland in Bangladesh, supports a significant portion of the country's agricultural economy. Farmers in this region traditionally cultivate

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aman rice during the monsoon season. This pattern ensures continuous land utilization while balancing soil nutrient cycles and increasing farmer incomes. Garlic cultivation has become a significant agricultural activity in the Chalan Beel region, encompassing parts of Pabna, Natore, and Sirajganj districts. In recent years, farmers have increasingly turned to garlic farming due to its profitability and the favorable conditions of the region's silt-mixed soil. Garlic is an essential component of Bangladeshi cuisine and has high economic and medicinal value. The Chalan Beel area, spanning multiple districts, provides an ideal environment for garlic cultivation due to its alluvial soil and favorable climatic conditions. A study by Haque *et al.* (2013) analyzed the profitability of garlic cultivation in selected areas of Bangladesh. The research found that per bigha costs of garlic cultivation were Tk. 65,493 on a full cost basis, with major expenses attributed to human labor (30%) and seed (25%). The average yield was 6.15 metric tons per hectare, resulting in a net return of Tk. 56,914 per hectare and a benefit-cost ratio of 1.87. The study also identified challenges such as the non-availability of high-yielding variety (HYV) seeds, lack of technical knowledge, pest infestations, and low market prices during peak seasons. Additionally, a study by Hossain *et al.* (2013) evaluated the performance of high-yielding garlic varieties at two locations in Bangladesh. The research found that in Kurigram, 'BARI Roshun-2' yielded 8.11 and 8.04 t/ha over two successive years, while in Bogra, 'BAU Roshun-2' yielded 12.01 and 11.82 t/ha during the same period. These varieties also provided higher gross returns and gross margins compared to local varieties. Another research by Kaysar *et al.* (2023) focused on the adoption and profitability of BARI-released garlic varieties. The study revealed that 'BARI Roshun-2' had the highest adoption rate among farmers (45%), while 'BARI Roshun-1' had a 14.67% adoption rate. No adoption of 'BARI Roshun-3' and 'BARI Roshun-4' was observed in the study areas. Farmers preferred 'BARI Roshun-2' and 'BARI Roshun-1' due to their higher yield, greater profitability, and reduced susceptibility to pests. Key constraints identified included low market prices during peak seasons, non-availability of improved seeds, unfavorable weather conditions, and lack of technical knowledge. Garlic, often known as the "stinking rose," holds a significant position among the spices cultivated in Bangladesh (Upadhyay, 2017). Celebrated for its unique flavor and wide-ranging culinary and medicinal applications, garlic has become a key component of the country's spice industry, consistently ranking among the top in production (Afrad and Akter, 2020; Akhter *et al.*, 2016; Ambiara *et al.*, 2016; Islam and Monjil, 2016; Khan *et al.*, 2017; Paswan *et al.*, 2021; Rana *et al.*, 2021; Sabur and Molla, 1993). However, despite its widespread cultivation, domestic production remains insufficient to meet the growing local demand, necessitating imports from international markets (Begum and D'Haese, 2010; Kotler and Gertner, 2002).

In the 2024-2025 season, the Department of Agricultural Extension (DAE) reported that approximately 39,604 hectares across eight districts have been dedicated to garlic cultivation. Notably, Natore accounts for 18,200 hectares, Pabna for 9,632 hectares, and Sirajganj for 900 hectares. The cost of cultivating garlic on one bigha of land is estimated to be around Tk 53,000, up from Tk 42,000 in previous years. Despite the increased costs,

farmers remain optimistic due to the potential for high yields and profits. A successful harvest can yield about 25-30 maunds of garlic per bigha, with a market value ranging from Tk 6,000 to Tk 7,000 per maunds. The Chalan Beel area contributes significantly to the national garlic output. Farmers in this region typically grow garlic during the Rabi season (winter) when the weather conditions are most suitable. The major varieties cultivated include local and improved strains that offer better yields and disease resistance. Small-scale farmers dominate garlic production, using traditional farming techniques. This study revealed that the profitable cropping pattern in Chalan Beel region. Besides, the study highlights the productivity and profitability of garlic-based cropping pattern. This article uphold the current status of garlic production in Chalan Beel areas which emphasizing its economic significance and potential strategies to improve cropping intensity.

Materials and Methods

Farmer's typically planting garlic after harvesting Aman paddy, utilizing the residual moisture in the soil. The cultivation process involves minimal tillage, where garlic cloves are planted in rows in the muddy soil and then covered with rice straw. This method allows for harvesting. The study was conducted in Hoybotpur and Patpara Borobil villages of upazilas namely Natore Sadar and Gurudaspur within the Chalan Beel region, focusing on soil fertility, yield performance, and economic feasibility.

Aman Rice (July–November): Aman rice, a rain-fed crop, is cultivated during the monsoon season. Aman rice (transplanted during June-July) thrives in the monsoon-fed waterlogged conditions of Chalan Beel. Farmers use both traditional and high-yielding varieties (HYVs) to optimize production. It prepares the soil by adding organic matter and residue, which benefits the following crops. Harvesting occurs in November-December, making the land available for garlic cultivation. Binadhan-17 a short duration aman rice variety and laxmidigha a local Bona aman rice variety were used to these cropping pattern experiment.

Garlic (November–March): After harvesting Aman rice, garlic is planted. Garlic is planted immediately after Aman rice harvest (December-January) and grows well in the residual soil moisture. Proper land preparation, organic fertilizers, and timely irrigation enhance yield and bulb quality. The crop was harvested in March-April, allowing for the introduction of mungbean. Dhaka-1 and Italy were two garlic varieties.

Mungbean and water melon (March–June): Mungbean is grown as a short-duration pulse crop (April-June) cultivated in medium high land, utilizing residual soil nutrients and minimal irrigation. The variety name was Binamoog-8. Farmers can sell mungbean at competitive market prices, increasing overall farm profitability. On the other hand water melon cultivated in Medium low land and variety name RJ Dragon which provide visible net income to the farmer's.

Data collection:

Sampling procedure:

The research was undertaken in two distinct Upazilas of Bangladesh (Fig. 1). Data were collected from two Upazilas namely Natore Sadar and Gurudaspur. Within each of these Upazilas, a careful selection process was employed. The unit area for each farmer's was 33 decimal (1 bigha) from each Upazilas purposively selected in close collaboration with Department of Agricultural Extension (DAE) personnel and garlic farmers. The data were collected and recorded from two years.

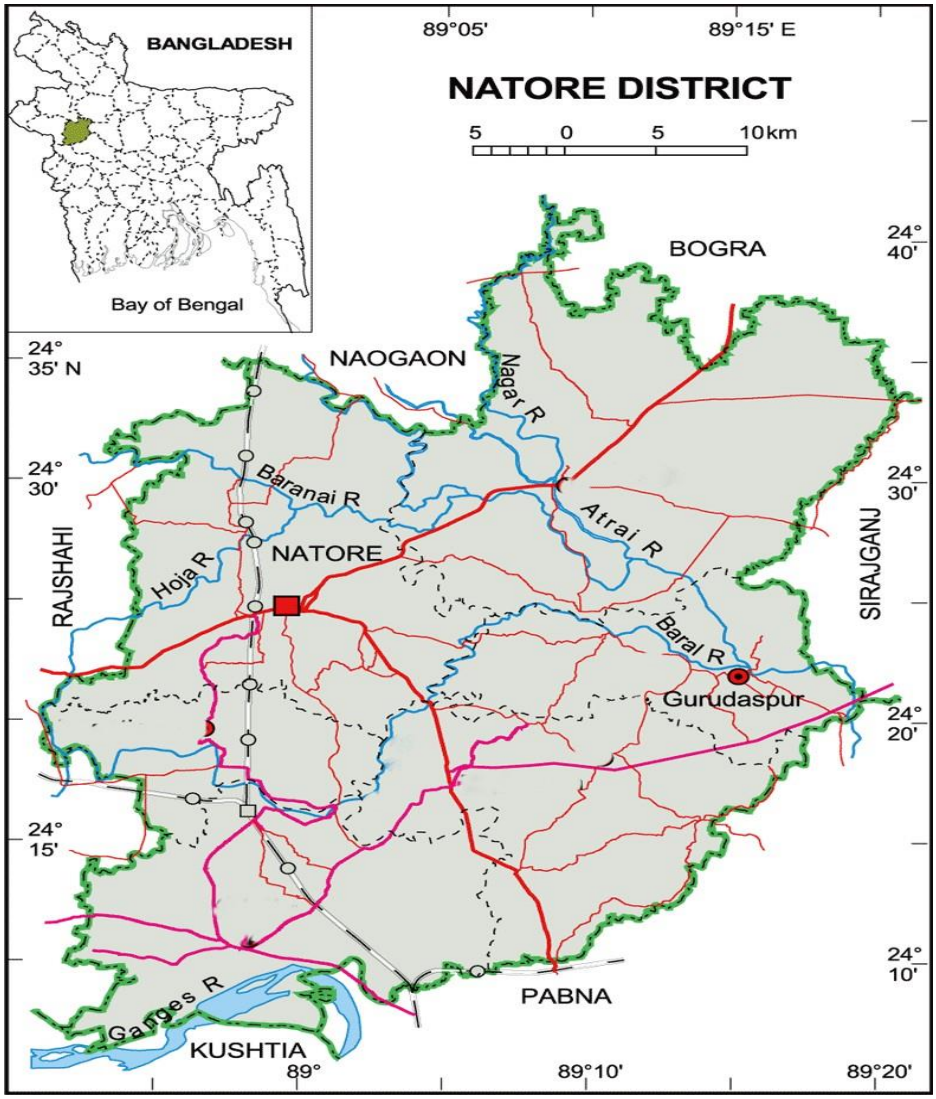

Fig. 1. Data were collected from upazilas of Natore sadar and Gurudaspur, Natore.

Statistical analysis

After the end of each crop's harvest, data were collected on yield and yield attributes, gross return, total variable cost, gross margin and BCR. Primary data encompassing aspects such as farm households, land usage, cropping patterns, adoption rates, input utilization, farm production, grading, packaging, transportation, marketing costs, and cultivation challenges, were estimated for calculating the cost of production with the two farmers. Data were collected through field observations, farmer interviews, and experimental plots. Key parameters such as yield, input costs, and net income were analyzed. Descriptive statistics, employing various statistical tools such as means, percentages, and ratios, were employed to present the study's findings. The profitability of garlic based cropping pattern was assessed through the examination of gross returns, gross margins, and the benefit-cost ratio. Additionally, the total cost estimation incorporated the consideration of opportunity costs associated with family-provided labor. Land use costs were computed based on the annual lease value of the land (Haque *et al.*, 2013; Islam *et al.*, 2016; Meena *et al.*, 2013).

Profitability analysis:

Combining cost of production with BCR in crops Production:

A. Input cost:

- **Non-material input cost:**
  Such as preparation of seedling nursery bed, uprooting seedling, ploughing, laddering, irrigation, harvesting, carrying, threshing, drying cost etc.
- **Material input cost:**
  Such as seed, fertilizer, pesticide, miscellaneous.

Total input cost = Non-material input cost + Material input cost

B. Overhead cost:

I. Interest on total input cost @12 Taka/annum for 6 months
II. Interest on the value of land @12 Taka/annum for 1 year
III. Miscellaneous overhead cost at 5% Taka/annum for

Total cost of production (TC) = Total input cost + Overhead cost

C. Gross income/return

I. Product
II. By product

Net income/ Profit = Gross income - Total cost of production

Benefit Cost Ratio = Gross income ÷ Total cost of production

If BCR <1, the production is not profitable. If BCR >1, the production is profitable.

Results and Discussion

Economic analysis included data collection on prices and quantities of inputs used and output produced (seed, straw, byproducts etc.). The inputs used included seed, fertilizer, labor and pesticides. The output and inputs were valued at market prices. Results were used to count net income and benefit cost ratio of crops. Net income was computed as the difference between management cost and gross margin.

Table 1. Cropping Pattern-1(CP_1): Medium high land

Parameters	Existing cropping pattern			Improved cropping pattern		
Crops	T. Aman	Lentil	Mungbean	T. Aman	Garlic	Mungbean
Variety	Shampa Katari	Binamoshur-5	Binamoog-8	Binadhan-17	Dhaka-1	Binamoog-8
Yield (t ha^{-1})	5.00	1.49	1.79	6.00	8.34	1.64
Gross income (Tk ha^{-1})	2,10,000	1,63,900	1,74,330	2,22,000	5,42,360	1,74,330
TC (Tkha^{-1})	1,82,450	1,46,090	1,44,030	1,82,450	3,10,116	1,44,030
Net income (Tk ha^{1})	27,550	17,810	30,300	39,550	2,32,244	30,300
Total Profit (Tk ha^{-1})	75,660			3,02,094		
BCR (Whole pattern)	1.16			1.74		

Price: Shampakatari 40 Tk/kg, Lentil 110 Tk/kg, Mungben 8=90 Tk/kg, Aman rice 30 Tk/kg, Garlic 70 Tk/kg

Table 2. Cropping Pattern-2(CP_2): Medium low land

Parameters	Existing cropping pattern			Improved cropping pattern		
Crops	Broadcast aman	Fallow	Boro	Broadcast aman	Garlic	Watermelon
Variety	Laxmidigha	-	BRRI dhan29	Laxmidigha	Italy	RJ Dragon
Yield (t ha^{-1}, Fruits No./ha)	2.08	-	7.75	1.93	7.45	2980
Gross income(Tk ha^{-1})	93,800	-	2,62,000	74,795	4,84,250	2,38,400
TC (Tkha^{-1})	40,975	-	2,14,056	48,475	2,60,556	1,11,750
Net income(Tk ha^{1})	52,825	-	47,944	26,320	2,23,694	1,26,650
Total Profit (Tk ha^{-1})	1,00,769			3,76,664		
BCR	1.40			1.89		

Price: Laxmidigha 40 Tk/kg, BRRI dhan29 30 Tk/kg, Garlic 70 Tk/kg, Watermelon 80 taka/piece

From the comparative analysis of the existing and improved cropping patterns in medium high land (CP-1) and Medium low land (CP-2) reveals significant economic and yield benefits from the improved systems.

Cropping pattern-1 (CP-1: medium high land)

In the existing pattern, the cultivation of T. Aman, lentil and Mungbean results in a total gross margin of Tk. 75,660 with a Benefit-Cost Ratio (BCR) of 1.16. However, the improved pattern, which replaces lentil by Garlic and introduces a higher-yielding rice variety (Binadhan-17), significantly enhances profitability. Higher yield and return from Garlic (yield: 8.34 t ha^{-1}, gross return: Tk. 5,42,360), which substantially increases revenue. The total gross margin increases to Tk. 3,02,094, and the BCR rises to 1.74.

Cropping pattern-2 (CP-2: medium low land)

The existing pattern consists of Broadcast aman – Fallow – Boro, leading to a total gross margin of Tk. 1,00,769 and a BCR of 1.40. In contrast, the improved cropping pattern, which replaces Fallow with Garlic and Boro with Watermelon, garlic makes it a more profitable alternative to a fallow period. Significantly boosts the total gross margin to Tk. 3,76,664, with a BCR of 1.89.

Potentiality and constraints to garlic cultivation

The potential profitability of garlic cultivation, farmers in the study areas encountered a range of challenges throughout the production process. Garlic cultivation in the Chalan Beel area (a low-lying wetland region in Bangladesh) has both potential and challenges due to its unique geographical and climatic conditions. The alluvial soil of Chalan Beel is highly fertile, which is beneficial for garlic growth. It thrives in a cool, dry climate. The beel area dries up in winter, providing a suitable window for cultivation. It is in high demand in Bangladesh, making it a profitable crop. It requires about 5-6 months to mature, which aligns with the dry period in Chalan Beel. Farmers can cultivate garlic after the monsoon season before the next rice cycle. Agricultural extension programs promote crop diversification, which can encourage garlic farming. Garlic cultivation in Chalan Beel is feasible during the dry season with proper planning, drainage, and technical support. Encouraging farmers with training, improved seed varieties, and market access can enhance production and profitability.

The findings revealed that many farmers identified the low market price of garlic during peak season as their biggest hurdle. This issue was further aggravated by significant yearly fluctuations in garlic prices, leading to substantial financial losses. Farmers attributed the declining prices to the large influx of imported garlic into local markets. Additionally, many farmers reported difficulties in accessing improved garlic varieties and adequate storage facilities in their local areas. Moreover, some growers found other crops to be more financially lucrative than garlic, contributing to a decline in its cultivation. Other notable constraints included unfavorable weather conditions, limited access to technical knowledge, a lack of institutional loans, and insufficient guidance and support from local administrative bodies (Fakir *et al.*, 2021; Hoque *et al.*, 2022). These challenges illustrate the complex nature of the difficulties faced by garlic farmers, spanning market-related concerns, competition from alternative crops, and structural as well as knowledge-based limitations. Addressing these issues is essential to ensuring the sustainability and profitability of garlic cultivation in the region.

Conclusion

The findings of this study underscore the significant economic advantages of integrating garlic into existing cropping patterns in the Chalan Beel region of Bangladesh. Comparative analysis between the existing and improved cropping patterns reveals that

garlic based cropping pattern substantially enhances both yield and profitability. The improved cropping pattern in medium high land achieved a highest gross margin with a benefit-cost ratio (BCR) of 1.74 compared to the existing pattern. Similarly in Medium low land, the improved system resulted in a highest gross margin and BCR significantly surpassing the existing system. These results highlight the potential of garlic-based cropping systems in optimizing land use efficiency, increasing farmer incomes, and promoting sustainable agricultural practices in the Chalan Beel region. Despite its high profitability, challenges such as the unavailability of high-yielding garlic varieties, pest infestations, market price fluctuations, and a lack of technical knowledge remain key constraints. Addressing these limitations through improved seed availability, farmer training programs, and market interventions can further enhance the viability and scalability of garlic cultivation.

The study reinforces the importance of strategic cropping pattern modifications in ensuring higher economic returns and better resource utilization. The incorporation of garlic, a high-value cash crop, into traditional farming systems not only increases agricultural profitability but also contributes to food security and rural development. Future research should focus on varietal improvements, climate resilience strategies, and policy interventions to further support garlic farmers in Bangladesh.

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Data availability

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

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