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ORIGINAL RESEARCH ARTICLE

Production and marketing system of mustard (*Brassica juncea*) in some selected areas of Bangladesh

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ABSTRACT

The paper provides an estimate of the marketing efficiency of BINA Sarisha-11, the mustard variety of *Brassica juncea*, developed by BINA and grown in Rangpur, Jamalpur, and Magura. It looks at various aspects of marketing: the cost of cultivation and returns, the identification of participants in the marketing chain, marketing costs, margins, and efficiencies at different levels. A total of 180 respondents were selected through stratified random sampling comprising 90 farmers and 90 traders. The statistical tools used included profitability and marketing efficiency models. The results showed that the cultivation of BINA Sarisha-11 was profitable as an average net return of BDT 51,291 (423.64 USD) per hectare was estimated with a benefit-cost ratio of 1.94. Marketing efficiency varied among the chains; the Farmer to Retailer to final Consumer chain was the most efficient, least costly, and had the highest producer share of 64.61%. On the contrary, longer chains were costlier and offered reduced producer shares. Farmers complained of seed unavailability, high prices of fertilizers, and lack of training, while traders complained of unstable prices and high costs of transportation as major challenges. The study identifies that there is a need for policy intervention to smoothen the marketing chains, improve access to inputs, and reduce problems related to market infrastructure. This will ensure the value chain of BINA Sarisha-11 is profitable and efficient, adding to the overall sustainability in mustard cultivation within Bangladesh.

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INTRODUCTION

Agriculture is the backbone of Bangladesh in its economic structure, livelihood, and food security of rural people. Among all the crops cultivated, mustard occupies a very important position due to its dual purpose: as an essential oilseed crop and as a source of income for countless farmers (Abrol, 2024). One of the major varieties of mustard, Binasarisha-11, has emerged as a key contributor to the agricultural economy in recent years. This variety, developed by the Bangladesh Institute of Nuclear Agriculture (BINA), is renowned for its high yield potential, disease resistance, and adaptability to the country's agro-climatic conditions. Binasarisha-11 has 1.44 ton/ha yield on the other hand binasharisha-9 is 1.41 ton/ha (Abir *et al.*, 2024). In

addition, Binasarisha-11 is medium plant height, the number of siliques per plant is 65-75 and 1000 seed weight 2.80-2.95 gram. which was released in the year 2021 and plant duration 83-87 days (BARC, 2025). Cultivation of mustard not only helps meet the domestic demand for edible oil but also reduces import dependency, saving foreign exchange in the process (Rahman *et al.*, 2024). Financial profitability analysis shows that mustard production was profitable on both variable cost and total cost basis and its benefit cost ratio (BCR) was more than one (Uddin *et al.*, 2024). Despite its potential, the journey from field to market for mustard is fraught with challenges. While the cultivation aspects of this variety of mustard have become more advanced, the same cannot be said about its marketing systems. The inefficiencies in the marketing systems related to mustard seriously detract from the financial benefits that could accrue to farmers. Problems like high transaction costs, volatility in prices, and commission agents reduce the benefit that the farmers are getting from their produce (Chaity, 2021). Addressing these inefficiencies is, therefore, vital to unlocking the full economic potential of Binasarisha-11 cultivation for ensuring sustainable livelihoods of the mustard growers in Bangladesh. The success of any agricultural venture is not only dependent on production but also on effective marketing. In the case of Binasarisha-11, the marketing process often acts as a bottleneck in the value chain. Inefficiency in marketing, such as high costs, excessive profit margins for middlemen, and low shares to producers, acts as one of the major obstacles to maximize the income of mustard farmers. Poor market access, not having information on prices on time, and exploitation by middlemen have often resulted in discouragingly low returns to farmers. At the same time, the lack of organized and appropriate market mechanisms has also widened the gaps between farm gate prices and retail prices. This is especially hurtful in countries such as Bangladesh, whose population includes predominantly small farmers who are quite sensitive to any change in the market dynamics.

The pressing need for the removal of marketing inefficiency in the mustard sector therefore calls for the testing of existing marketing chains for Binasarisha-11. Identification of the weak links in these chains would, therefore, enable one to suggest specific interventions that could be used to improve marketing efficiency and hence farmers' profitability. In the absence of such efforts, the potential benefits of growing high-yielding varieties like Binasarisha-11 may not materialize, thus keeping rural farming communities in a vicious cycle of low income and limited economic growth. This research work, therefore, attempts to estimate the marketing efficiency of Binasarisha-11 across different marketing chains in Bangladesh and finally come up with strategies that maximize the economic returns of the farmers through pricing at a level that gives a fair share and equitable benefit in the value chain. The present study is delimited to an in-depth study of the marketing chains of Binasarisha-11 in Bangladesh. It does not deal with the agronomic practices, production technologies, and post-harvest techniques of processing, but it puts greater emphasis on economics regarding marketing alone.

The importance of the present study lies in the fact that it can bring a sea change in the marketing of Binasarisha-11 and, by extension, other agricultural commodities in Bangladesh. Increased efficiency in marketing for farmers means more income, less dependence on exploitative intermediaries, and enhanced bargaining power. Identification of the causes of inefficiency and their correction through this research can lead to more equitable and sustainable value chains. From a policy perspective, the findings of the study can be used as an important input in the design of interventions aimed at enhancing market transparency, reducing transaction costs, and improving the overall competitiveness of the mustard sector. Policymakers can use this information to develop policies that enhance farmer cooperatives, improve access to market information, and promote direct marketing channels. In addition, the study is also in line with the general national goals of poverty reduction, rural development, and agricultural modernization.

MATERIALS AND METHODS

Selection of study area

The study was conducted in key mustard-growing regions of Bangladesh, specifically targeting areas where Binasarisha-11 is predominantly cultivated. The selection of the study areas was guided by their significance in mustard production, accessibility, and the presence of diverse marketing channels. Regions such as Magura, Rangpur and Jamalpur were chosen as they represent the major mustard-producing hubs in the country (Figure 1). These areas also exhibit variations in market infrastructure, transportation networks, and trading practices, making them ideal for analyzing marketing efficiency.

Selection of sample and sampling technique

A stratified random sampling technique was used for the selection of district and market for collection of data. A list of Binasarisha-11 farmers from each district obtained from BINA. In order to capture the marketing chain, the key intermediaries were identified; these include wholesalers, retailers, commission agents, stockiest and processors.

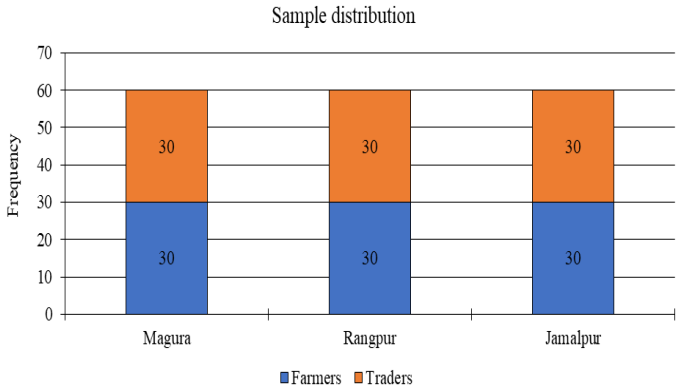

Figure 1. *Sample distribution of the study.*

Data collection

The collection of data was done through both primary and secondary sources to ensure robustness and accuracy. Pre-tested, semi-structured questionnaires were used for the collection of primary data from farmers and market actors. Collected information included production volume, marketing costs, price realization, and the role of intermediaries. We also used published reports and statistics from Bangladesh Bureau of Statistics, DAM, and Bangladesh Institute of Nuclear Agriculture. All the respondents gave their consent before providing the information and the research is ethically cleared. The respondents were assured that the information obtained from them would be treated as confidential, and data were anonymized to protect their identity. Participation in this study was completely voluntary, and respondents could withdraw at any stage.

Analytical techniques

The collected data were analyzed using Stata software. Descriptive statistics, profitability model and marketing efficiency model was used in analyzing the collected data.

Profitability analysis

The following conventional profit equation (Sarkar *et al.*, 2023) was applied to examine farmer's profitability level of the mustard producing farms in the study areas.

Net profit, $\pi = \Sigma PmQm + \Sigma PfQf - \Sigma (Pxi\ Xi) - TFC$

Where, π = Net profit/Net returns from mustard farming (Tk./ha); Pm = Per unit price of mustard (Tk./kg); Qm= Total quantity of the mustard production (kg/ha); Qf = Per unit price of other relevant mustard (Tk./kg); Pf = Total quantity of other relevant mustard (kg/ha); Pxi = Per unit price of i^{th} inputs (Tk.); TFC = Total fixed cost (Tk.); and Xi = Quantity of the i^{th} inputs (kg/ha). Labor, land preparation, seeds, fertilizers, micronutrients, insecticides, pesticides, and irrigation, harvesting, and caring costs are the components of total variable cost. On the other hand, land use cost and interest on operating capital are the components of total fixed cost. Gross margin is the difference between gross return and total variable costs, i.e., GM = GR - TVC. The net return is then calculated as the difference between the total return and all costs, variable and fixed, i.e., NR = TR - TC (Haque *et al.*, 2016).

Marketing efficiency

Efficient marketing plays an important role in increasing the producer's share in consumer's taka and maintains the measure of increased production. Three indicators were used for measuring efficiency in different marketing chains. These indicators are (i) marketing cost; (ii) marketing margin and (iii) Percentage of producer's share of Binasarisha-11.

Marketing cost: The total marketing cost was determined by the following formula (Islam *et al.*, 2017):

$Tc = Cp + \Sigma Mci$

Where, Tc= Total cost of marketing, Cp= Producer cost of marketing and Mci= Marketing cost by the i^{th} trader

Marketing margin: The absolute margin of the middleman, wholesaler, trader and retailers were determined by the following formula:

MM=SP-PP

Where, MM= Marketing margin, SP= Selling price, PP= Purchase price

The cost of marketing was calculated and the low-cost marketing chain was ranked I and that which was the highest cost as the last. The same approach was followed in ranking the margin of middlemen in each chain.

Producer's share: The producer's share (Yu, 2018) was calculated by the following formula and the chain which was highest producer's share was ranked (I) and first and vice-versa.

Percentage of producers' share = $(PP_i/PR_i) \times 100$

Where, PP_i= Producer's share in the ith chain, PR_i= Average price at the retail level in each chain, i= Number of chains (i=1, 2....., n)

Marketing efficiency: Four methods like i) Shepherd Method ii) Acharya & Agarwal Method iii) Composite Index Method and iv) Marketing Efficiency Index Method are usually used to calculate the marketing efficiency (Mgale & Yunxian, 2020; Areal *et al.*, 2018; Kashyap *et al.*, 2013). quintal of Binasarisha-11 was calculated and these were assigned rHowever, Composite Index method was followed to estimate marketing efficiency for the present study. As per this method, the percentage of producer's price, marketing cost, marketing margin and marketing profit/ gross margin per anks. Total scores were found by adding the respective ranks in each chain. The mean scores were calculated for each chain. Where the mean score was less, it was efficient chain.

$R = (R_i/N_i)$

Where, R_i= Total value of ranks of all indicators (i_1, i_2 and i_3), Ni= Number of indicators

RESULTS AND DISCUSSION

The trend of mustard cultivation in Bangladesh (Figure 2), starting from 2008-09 up to 2022-23, is a general upward graph in both area and production. While the area has increased from 578 thousand acres to 947 thousand acres, production has also increased from 203 thousand metric tons to 547 thousand

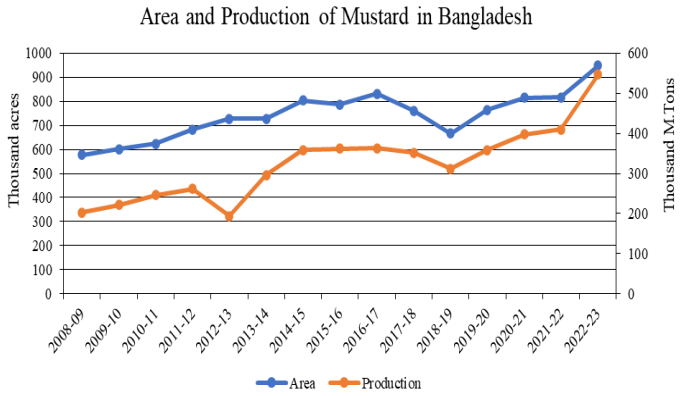

Figure 2. *Area and Production of Mustard in Bangladesh.*

metric tons. Though, there had been some ups and downs, but the general rising trend in productivity reflected improvement in agronomic practices and better seed varieties. While major leaps in the production of this crop in recent years, mainly from 2021-22 to 2022-23, show improvements in mustard farming and its potentiality within the nation (BBS, 2023).

Cost and return estimation

The cost of human labor, power tiller, seed, fertilizers, pesticides and irrigation were taken into consideration, while calculating cost of Binasarisha-11 cultivation. Beside this, interest on operating capital was also considered as the cost of Binasarisha-11 cultivation. Total cost consists of variable cost and fixed cost that covered 83.5% and 16.5% of total cost for Binasarisha-11 cultivation. The average costs of Binasarisha-11 cultivation were BDT 55290 and BDT 36670 per hectare on full cost and cash cost basis, respectively. The highest production cost was for hired labour (20.9%) followed by family labour (18.1%), land preparation/power tiller (15.8 %) and land use cost (15.5%). The cost of Binasarisha-11 cultivation was found highest in Magura (BDT 57568/ha) followed by that in Jamalpur (BDT 54541/ha) and Rangpur (BDT 53763/ha), respectively (Table 1). On the other hand, the average yield of Binasarisha-11 was 1576 kg/ha. The yield was highest in Rangpur (1715 kg/ha) followed by Jamalpur (1692 kg/ha) and Magura (1320 kg/ha). The average gross margin was found BDT 51291/ha on variable cost basis. Gross margin was highest in Rangpur (BDT 71541/ha) followed by Jamalpur (BDT 67583/ha) and Magura (BDT 42128/ha), respectively. The average net return per hectare was BDT 51291. The net return was highest in Rangpur (BDT 62857/ha) followed by Jamalpur (BDT 58823/ha) and Magura (BDT 32192/ha), respectively. Benefit cost ratio was assessed at 1.94 and 2.31on full cost and variable cost basis implying that the Binasarisha-11 cultivation at farm level was profitable. The average yield of Binasarisha-9 is 1.40 ton per ha. The average net return per hectare was BDT 22278.34. Besides, the highest net return was obtained in Rangpur (BDT 30334.53 per ha) followed by Sherpur (BDT 20771.68 per ha) and Mymensingh (BDT 16519.40 per ha), respectively (BINA, 2024). It means that, net return is almost doubled in Binasarisha-11 compare to Binasharisha-9 and one study shows that, the mustard production was profitable in both cases such as variable cost and total cost basis, where BCR was more than one (Uddin *et al.*, 2024).

Table 1. Per hectare cost and return of Binasarisha-11.

Cost component	Cost of production (Tk./hectare)				% of total cost
	Magura	Rangpur	Jamalpur	All area	
(A)Total Variable Cost	47632	45079	45781	46164	83.5
Hired labor cost	12461	10980	11244	11562	20.9
Family labor cost	8255	10844	10988	10029	18.1
Land preparation/Power tiller	9576	8454	8110	8713	15.8
Seed	810	758	725	764	1.4
Fertilizers					
Urea	3453	3002	3466	3307	6.0
TSP	3524	3280	3387	3397	6.1
MP	1407	884	687	993	1.8
Zink Sulphate	1445	1352	1177	1325	2.4
Boron	2706	2482	2852	2680	4.8
Pesticides	1480	1082	960	1174	2.1
Irrigation	2515	1961	2185	2220	4.0
(B) Total Fixed Cost	9936	8683	8760	9127	16.5
Int. on operating capital	556	538	510	535	1.0
Land use cost	9380	8145	8250	8592	15.5
Total Cost (A+B)	57568	53763	54541	55290	100.0
Yield from Binasarisha-11 (Kg/ha.)	1320	1715	1692	1576	
Total return (Tk./ha)	89760	116620	113364	106581	
Total variable cost (Tk./ha)	47632	45079	45781	46164	
Gross margin (Tk./ha)	42128	71541	67583	60417	
Net return (Tk./ha)	32192	62857	58823	51291	
Benefit Cost Ratio (BCR)					
BCR on full cost	1.56	2.17	2.08	1.94	
BCR on variable cost	1.88	2.59	2.48	2.31	

Like as in case of Binasarisha-4, The average net return per hectare was Tk. 29113.30. The net return was highest in Magura (Tk. 33060.19/ha) followed by Kushtia (Tk. 32195.20/ha), Jashore (Tk. 28227.04/ha) and Faridpur (Tk. 22970.78/ha), respectively as reported earlier by Sarkar *et al.* (2020). Similarly, Uddin *et al.* (2024) reported the farmers' perception and financial profitability of mustard production in Bangladesh.

Identification of marketing actors and cost

Agricultural markets involve a number of intermediaries along the path from farm to consumer and play a vital role in the distribution and sale of the products. A number of important marketing chains were identified in the study areas, each having its particular sequence of stakeholders. Faria, Bepari, and Arathdar intermediaries are crucial in facilitating the movement of goods from farmers to the ultimate consumers. They provide essential services: aggregation, storage, transportation, and access to the market. The literature states that such market intermediaries reduce transaction costs and market inefficiencies, hence benefiting both the producer and the consumer. The marketing chain for mustard is given in figure 3 and from table 2,

Figure 3. Marketing chain showing various subchains.

The per quintal (100 kg) marketing cost of Binasarisha-11 of different actors like Faria for BDT 188, Bepari for BDT 277, Arathdar for BDT 258, Stockist for BDT 1123, Paiker for BDT 430 and Retailer for BDT 253 in all areas. Marketing cost of stockist was the highest among the intermediaries. The other cost items of the actors were loading, unloading, packaging, Arathdar commission, khajna (market tax) etc. The cost varied from area to area depending on coverage of distance (Table 3). The results of this study are in accordance with Sarkar *et al.* (2023) who suggested the profitability and marketing system of Binachinabadam-8 in some selected northern char areas of Bangladesh.

Marketing cost at different levels of marketing chain

Chain-wise marketing cost per quintal is shown in Table 3. It was observed that Chain-i incurred the highest marketing cost BDT 1330 followed by Chain-ii BDT 1188, Chain-iii BDT 1123 and Chain-iv BDT 675. Lowest marketing cost was found in Chain-v and it was BDT 440. Highest numbers of intermediaries were involved in Chain-i which was the main reasons for higher marketing cost. Farmers' share in consumer prices of Binasarisha-11 in different marketing chains was the highest in Chain-v followed by Chain-iv, Chain-iii and Chain-ii and was lowest in Chain-i. It indicated that if farmers would sell their mustard through Farmer-Retailer-Consumer, they would be most benefited. Unnecessary marketing tiers develops when there is market imperfection or producer-seller are unorganized and while there is lack of market information or the cost of gathering information is high. It reveals if farmers' sell their mustard through Farmer-Faria-Arathdar- Paiker-Stockist-Millier-Consumer, the marketing cost becomes high (Chain-i). On the other hand, if farmer sell their product through Chian-v (Farmer -Retailer-Consumer) then the marketing cost is the lowest. The

Table 2. Marketing cost of different actors involved in the chain (Tk./100 kg).

Cost component	Faria	Bepari	Arathdar	Stockist	Paiker	Retailer
Transportation cost	46	69	15	15	54	46
Godown cost	-	-	105	115	-	-
Wastage cost	-	18	19	719	136	91
Packaging cost	15	21	24	28	16	15
Loading cost	14	10	-	-	14	-
Unloading cost	38	17	13	12	12	13
Toll cost	13	24	10	10	21	8
Labor cost	15	61	10	10	38	26
Dying cost	-	-	-	79	-	-
Commission cost	24	25	-	-	32	-
Entertainment cost	13	15	17	22	22	15
Electricity cost	-	-	8	12	15	15
Generator cost	-	-	1	1		-
Accountant cost	-	-	14	15	14	-
Store cost	-	-	-	61	41	-
Cleaner cost	-	-	2	3	2	1
Mobile cost	11	17	18	20	12	24
Total	188	277	258	1123	430	253

Table 3. Marketing cost of Binasarisha-11 for different marketing chain (Tk./100 kg).

Cost component	Chain-i	Chain-ii	Chain-iii	Chain-iv	Chain-v
Transportation cost	182	174	171	172	110
Godown cost	52	51	50	24	8
Wastage cost	527	428	381	125	81
Packaging cost	44	41	40	32	14
Loading cost	67	66	64	55	51
Unloading cost	44	41	42	31	28
Toll cost	18	16	14	11	8
Labor cost	26	23	24	21	10
Dying cost	110	105	101	15	5
Commission cost	68	65	68	62	35
Entertainment cost	72	71	62	40	31
Electricity cost	19	15	17	16	12
Generator cost	8	8	7		
Accountant cost	14	12	12	5	2
Store cost	9	8	7	6	2
Cleaner cost	4	3	3	2	1
Mobile cost	66	61	60	58	42
Total cost	1330	1188	1123	675	440
Farmers price (Tk./100 kg)	6800	6910	6925	6960	6990
Consumer/retail price (Tk./100 kg)	10730	10873	10805	10814	10818
Percentage of farmers share (%)	63.37 (5)	63.55 (4)	64.09 (3)	65.36 (2)	65.61 (1)
Marketing margin	3930 (4)	3963 (5)	3880 (3)	3854 (2)	3828 (1)
Marketing cost	1330 (5)	1188 (4)	1123 (3)	675 (2)	440 (1)
*() indicates Rank					

Table 4. Marketing margin of different stages of marketing chain (Tk./100 kg).

Cost component	Faria	Bepari	Arathdar	Stockist	Paiker	Retailer
A. Average sales price	7100	7440	7470	8750	7520	7530
B. Average purchase price	6800	6950	6980	6600	6900	6910
C. Gross margin (A-B)	300	490	490	2150	620	620
D. Marketing cost	188	277	258	1123	430	253
E. Marketing Margin (C-D)	112	213	232	1027	191	367

Table 5. Major problems to Binasarisha-11 cultivation and Marketing.

Problem (%)		Magura	Rangpur	Jamalpur	All area	Rank
Producer	1. Unavailability of seeds	85	92	89	89	1
	2. Lack of training	81	75	79	78	2
	3. High price of fertilizer	54	48	51	51	3
	4. Lack of capital	28	37	31	32	4
	5. Lack of technical know-how	22	18	20	20	5
Traders	1. Unstable price	92	85	85	87	1
	2. High transportation cost	81	72	74	76	2
	3. Lack of market facilities	55	71	79	68	3
	4. Lack of capital	41	65	47	51	4

data reveals that the highest marketing margin in Chain-ii and the lowest in Chain-v. The efficiency of different marketing chains was drawn as the basis of ranks of different performance indicators in different chains using composite index formula. The performance indicators revealed that the chain-v is more efficient than that of other chains. In case of Marketing margin, this is the difference between what is paid by the consumer and what is received by the producer. It was revealed from the study that the net margin of the actors like Faria for BDT 112, Bepari for BDT 213, Arathdar for BDT 232, Stockist for BDT 1027, Paiker for BDT 191 and Retailer for BDT 367 per 100 kg. Among the intermediaries the stockiest added highest margin followed by Retailer, Arathdar, Bepari, Paiker and Faria (Table 4). Similarly, Kumar *et al.* (2022). Reported the constraints in production and marketing of rapeseed & mustard and chickpea in Haryana.

Major problems to Binasarisha-11 production and marketing identified by the traders

Binasarisha-11 is a profitable oilseed variety in the study area. The farmers in the study areas faced some problems to Binasarisha-11 cultivation. The first ranked problem was unavailability of seeds (89%) in the all areas. Other problems were lack of training (78%), high price of fertilizer (51%), lack of capital (32%) and lack of technical know-how (20%). The traders or intermediaries were faces different marketing problems during their business. Eighty-seven percent farmers were suffered unstable price during their business. Seventy-six percent farmers had to paid high charge for transportation followed by lack of market facilities (68%) and lack of capital (51%) (Table 5). Kumar *et al.* (2022), reported in their study that, marketing constraints were wide fluctuation in prices 72.50 per cent followed by remunerative prices 61.67 per cent. The findings are in agreement of Rahman *et al.* (2024) who also reported the marketing strategies for mustard.

Conclusion and recommendations

Cultivation and marketing of Binasarisha-11 therefore play a critical role in improving the livelihoods of mustard growers in Bangladesh as it provides tremendous economic benefits for the growers. Economic analysis of Binasharisha-11 production reveals that masters is highly profitable crop item among other crops because benefit cost ratio is 1.94 overall which is ranges from 1.56 to 2.17 among three districts and net return also vary from BDT 32192 to BDT 62857 per ha. On the other hand, in case of channel V, which is lower chain and easy to transfer main product farmer to consumer is less costly than others. The dominant intermediaries, lack of market information, and improper infrastructure keep the possibilities of fair prices beyond the reach of most farmers. All these drawbacks translate into less income for producers, thereby restricted opportunities for making investments in improved cultivation practices and technologies. Further, marketing efficiency was found to vary substantially between regions and channels of different categories, and interventions were needed in terms of that. Addressing these inefficiencies is not only crucial to improving the economic returns for farmers but also to the sustainability of mustard cultivation in Bangladesh. Smoothening of marketing chains and ensuring transparency will help narrow the gap between farm gate and consumer prices, thereby empowering farmers and fostering rural economic development. This is why we can encourage the creation and strengthening of farmer cooperatives to allow for collective bargaining and a reduction in reliance on middlemen. Train members of the cooperatives on market management, price negotiation, and financial literacy. Invest in rural market facilities' development, including storage, transportation, and communication networks to reduce post-harvest losses and transaction costs. This may include the encouragement of direct marketing channels, such as farmer's markets and contract farming arrangements, which reduce the presence of middlemen in the chain. In so doing, all stakeholders may work together toward increasing the marketing efficiency of Binasarisha-11 for increased economic gain by the mustard farmers and toward ensuring sustainable agricultural development in Bangladesh.

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I confirm that anyone listed under the Acknowledgements section of the manuscript has been informed of their inclusion and approve this.

DECLARATIONS

Author contribution statement: Conceptualization, MRH, MHR, MMAS, MMH and MSP; methodology, MRH, MMAS; software and formal analysis, MRH, MMAS; validation, MHR investigation, MHR; data curation, MRH, MMAS and MMH; original draft preparation, MMH, MMAS, RS and SI; review and editing, MSP; visualization, MMH; project administration, MHR; funding acquisition, MRH and MMAS. All authors have read and agreed to the published version of the manuscript.

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