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Original Article

Organic and Conventional Tomato (*Solanum lycopersicum*) Production in Mymensingh District of Bangladesh: A Comparative Profitability Analysis

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A B S T R A C T

This study aimed to compare the financial aspects of commercial organic and conventional tomato cultivation in the Mymensingh District. For this study, 30 farmers who farm organically and 30 farmers who farm conventionally were chosen randomly. Data were gathered using a semi-structured questionnaire. The data were analyzed using descriptive statistics and statistical packages. Tk. 112642.00 and Tk. 121773.00 were estimated per acre costs for tomato production in organic and conventional farms, respectively. Tk. 230123.00 and Tk. 231120.00 were the gross returns per acre from tomato production in organic and conventional farms, respectively. Although conventional tomato farms had higher costs and revenue per acre than organic farms, organic tomato farming had a higher Benefit Cost Ratio (BCR). According to the BCR, organic tomato farming is more profitable than conventional tomato farming. The study also identified some constraints that farmers faced in organic and conventional tomato farming, primarily related to production and marketing. The strength of organic tomato producers was their income and employment opportunities. The main threats are a high incidence of disease and price fluctuations in the market. It is suggested that organic tomato farming be practiced.

Introduction

Bangladesh's economic growth is primarily dependent on agricultural expansion. This sector not only employs the majority (almost 40%) of the labor force in the country, but it also provides food for human and animal consumption, raw materials for industrial production, supports the rural economy, and maintains a natural balance that contributes about 12.5% of Bangladesh's total GDP (BBS, 2021). Cereal crops are the main source of income in this country, but they are not so profitable (Sarwar and Biswas, 2021). Rice is the most important crop in Bangladesh, but as production costs and cash investment rise, rice production will become prohibitively expensive for farmers in many areas. As a result, most farmers are diversifying into vegetable crops, and such commercialization can help the agricultural sector develop in a variety of ways. Tomato is an important vegetable because of its nutritional value and as a source of income for farmers who grow tomatoes to supplement their income. It is cultivated all over the country because of its adaptability to a wide range of soil and climate (Ahmed, 1976). Tomato is widely consumed and it is a popular species preferred in gastronomy for its characteristic flavor. It is used in several traditional dishes because of its compatibility with other food ingredients and high nutritional value (OECD, 2008). Tomatoes are primarily grown in Bangladesh from November to February and are known as Rabi or winter vegetables. It is also an important cash crop for farmers. In Bangladesh, it becomes a very successful winter crop. Bangladesh's current tomato production appears to be sufficient to meet domestic tomato consumption in

households. Bangladesh produced approximately 255 thousand metric tons of tomatoes in 2011-2012 (BBS, 2012). Considering the growing demand and importance of tomato, Bangladesh Agricultural Research Institute (BARI) has taken the initiative to develop off-season summer and rainy-season tomatoes (Karim *et al.*, 2009). Organic and conventional tomato cultivation represent two opposing farming approaches, each with its own set of methods and farming practices. Both organic and conventional tomato farming present unique challenges and implications for the global food chain, particularly in light of the impending global food crisis and climate change. Organic tomato production system that promotes soil, ecosystem, and human health. It is based on ecological processes, biodiversity, and cycles that are tailored to local conditions rather than the use of harmful inputs. Organic agriculture combines traditional innovation and science to benefit the common environment while also promoting fair relationships and high quality of life for all parties involved. Producing organic tomatoes is less expensive, more effective, and does not necessitate costly technical investment, while also creating more job opportunities. It is a viable solution to preventing global hunger by providing comparatively higher yields from low-input agriculture in food-stressed areas (Adhikari, 2009).

Chemical fertilizers, pesticides, and herbicides are required in conventional tomato farming. Despite its popularity due to its high yields, this production system is thought to have increased soil degradation, pollution, chemical residues in food, and biodiversity loss. It also increases the farms' actual and physiological burden on high-cash capital expenditures (Rubinos, *et al.*, 2007).

In developing countries such as Bangladesh, where labor costs are low and organic manures are less expensive than chemical fertilizers. In general, a premium on organic produce ensures that organic farms generate a higher total return than conventional farms (Offermann and Nieberg, 2000). In Bangladesh, there is a significant gap in the evaluation of commercial organic and conventional tomato farming systems, as well as their benefit-cost analysis. As a result, the purpose of this research is to assess the current economic status of some commercial organic and conventional tomato farms in Bangladesh. The specific objectives of this study are given below:

i) To estimate the costs, returns and profitability of organic and conventional tomato production;
ii) To explore the production and marketing related problems organic and conventional tomato growers face.

Materials and methods

Data Sources

One of the main vegetable-producing regions in Bangladesh is the Mymensingh district. In keeping with the study's goals, the current investigation was carried out in two villages named Char Kalibari and Baira in the Mymensingh Sadar Upazila of the Mymensingh district.

Sampling Procedure and Sample Size

For this research, a total of 60 sample farmers were chosen randomly from 30 conventional tomato farmers and the remaining from 30 organic tomato farmers. A household poll was conducted from July to August 2017. The sampled respondents were interviewed using a pre-tested questionnaire, and data were gathered using the direct personal interview technique.

Data Analytical Technique

Calculation of Production Cost

When determining the total cost of production, total fixed cost, as well as total variable cost, were included in the cost of producing tomatoes.

Total Cost of Production (TC) = Total Fixed Cost (TFC) + Total Variable Cost (TVC)

The expense of seeds, organic manure, chemical fertilizers, transportation, laborer wages, and plant protection components make up the study's overall variable costs. Depreciation on farm equipment and machinery, loan interest, and land revenue make up the total fixed expenses.

Calculation of Gross Return

Gross return was calculated by multiplying the total volume of output by the average price of tomatoes in the harvesting period.

The following equation was used to estimate the gross return:

Gross Return (GR) =Total Quantity (Q) x Per Unit Price (P)

Where, GR=Gross return of the product (Tk./acre);

Q= Quantity of the product (Kg/acre);

P = Per unit price of tomato (Tk./Kg);

Calculation of Gross Margin

The gap between gross return and variable costs is known as gross margin. The farmers analyze the gross margin for analyzing the maximize profits over variable costs (Chakraborty and Haque, 2014). Total variable costs were subtracted from gross return to obtain per hectare gross margin.

Gross Margin (GM) = GR-TVC

Where, GM = Gross margin;

GR= Gross return;

TVC = Total variable cost

Calculation of Net Return

The difference between the gross return and the total cost of production is the net return.

Net return (NR) = GR – TC

Where, GR= Gross return;

TC = Total cost of production

Calculation of Undiscounted Benefit Cost Ratio (BCR)

A key measure for determining profitability is the return on each taka spent on production. Undiscounted BCR was estimated as the ratio of total return to the total cost of tomato production.

BCR (Undiscounted) = Total Return (TR)/ Total Cost (TC)

This relative measure should be used to compare the advantages of per unit production cost.

Calculation of Problem Index based on Farmers' Perceptions

For the study of farmers' perceptions of the severity of production and marketing-related problems in tomato farming, weighted indices were computed based on the frequencies of responses. Using a four-point scale with scores of 1.00, 2.00, 3.00, and 4.00, respectively, it was possible to compare the severity of issues that producers using organic and conventional tomato farming systems were experiencing. The intensity of the problem was computed by using the formula.

$$\text{Iprob} = \frac{\text{Mean value} - \text{Minimum value}}{\text{Maximum value} - \text{Minimum value}}$$

Where,

Iprob = Index value for intensity of the problem

1.00 2.00 3.00 4.00

Then, in order to reach the reliable conclusions and make sound decisions, the prioritization index for each variable was computed using the weighted average mean.

SWOT Analysis

With the aid of a SWOT analysis, farmers can quickly pinpoint the internal and external variables that will have an impact on their operations in the future. SWOT analyses a company's strengths, weaknesses, opportunities, and threats in a thorough assessment and competitive analysis. The internal elements are the strengths and weaknesses of tomato farming. Opportunities and threats relate to environmental variables that are not related to farming. A farmer can learn what he is doing well, where he can improve, and how he fits into the competitive environment by conducting an honest SWOT analysis.

Results and Discussion

Comparative Scenario of Commercial Organic and Conventional Tomato Production

Human labor was the significant cost factor in the study area for both organic and conventional tomato production. Table 1 presents the labor requirements and costs for organic and conventional tomato production across different operations. Organic tomatoes required 96 man-days/acre of total human labor, of which 25 man-days/acre were provided by family members and 71 man-days/acre were employed. In contrast, conventional tomato farming required 118 man-days/acre of total human labor, of which 32 man-days/acre were provided by family members and 86 man-days/acre were contracted. All human labor cost for organic production was Tk. 28800.00 per acre, with Tk. 7500.00 spent on family labor and Tk. 21300.00 spent on hired labor, respectively.

Tk. 35400.00 was the total cost of human labor for conventional production, of which Tk. 9600.00 and Tk. 25800.00 were related to family and hired labor costs, respectively.

Table 1. Per acre average human labor use and cost incurred for producing organic and conventional tomato.

Name of operation	Human labor for organic tomato production (Man-days)			Total labor cost (Tk.)	Average wage rate (Tk.)	Human labor for conventional tomato production (Man-days)			Total labor cost (Tk.)
	Family Supplied	Hired	Total			Family Supplied	Hired	Total	
Land preparation	2	5	7	2100 (7.29)		3	7	10	3000 (8.47)
Planting and weeding	3	12	15	4500 (15.62)		4	10	14	4200 (11.86)
Application of organic fertilizer	5	12	17	5100 (17.72)		6	13	19	5700 (16.10)
Application of bio-pesticides	4	9	13	3900 (13.54)	300	5	12	17	5100 (14.40)
Irrigation	2	7	9	2700 (9.37)		5	10	15	4500 (12.71)
Harvesting	9	26	25	10500 (36.45)		9	34	43	12900 (36.44)
Total	25	71	96	28800 (100)		32	86	118	35400 (100)

Source: Field Survey, 2017

Note: Values within parentheses indicating the percentage

The comparative analysis represents that organic tomato production generally requires slightly less labor than conventional production across various operations. Specifically, organic production requires fewer man-days for land preparation, planting, and weeding, application of organic fertilizer, application of bio-pesticides, and irrigation. However, both methods require the same amount of labor for harvesting. Regarding total labor costs, organic tomato production incurs lower expenses compared to conventional production in most operations except for harvesting, where the costs are the same.

Table 2. Per acre costs and returns of organic and conventional tomato production (Total cost basis).

Items	Organic Tomato Production				Conventional Tomato Production		
	Unit	Total Quantity	Cost/ Returns	Percentage of the total cost	Total Quantity	Cost/ Returns	Percentage of the total cost
I) Labor cost							
Human labor cost	Tk.	96	28800	25.56	118	35400	29.07
II) Material cost							
Seeds	gm.	98	5390	4.78	103	4944	4.06
Power tiller	Tk.	-	1750	1.55	-	1823	1.49
Organic Fertilizer							
Chicken manure	Kg.	140	560	.49	-	-	-
Cow dung	Kg.	3000	6000	5.32	-	-	-
Mustard cake	Kg.	200	8000	7.10	-	-	-

Items	Unit	Organic Tomato Production			Conventional Tomato Production		
		Total Quantity	Cost/ Returns	Percentage of the total cost	Total Quantity	Cost/ Returns	Percentage of the total cost
Compost manure	Kg.	400	7200	6.39	-	-	-
Bio-pesticides	Tk.	-	2660	2.36	-	-	-
Chemical Fertilizer							
Urea	Kg.	-	-	-	150	3000	2.46
TSP	Kg.	-	-	-	200	5600	4.59
MP	Kg.	-	-	-	135	2700	2.21
DAP	Kg.	-	-	-	60	1800	1.47
Gypsum	Kg.	-	-	-	40	480	.39
Boron	Tk.	-	-	-	6	570	.47
Pesticides	Tk.	-	-	-	-	5533	4.54
Irrigation	Tk.	-	8193	7.27	-	11816	9.70
Other expenses (Farmhouse, Seedbed preparation, crate, fence, bamboo and transport costs)	Tk.	-	17866	15.86	-	19383	15.91
III) Interest on Operating Capital (10% for 4 months)	Tk.	-	1437	1.27	-	1554	1.27
Total Variable Cost (TVC)	Tk.	-	87856	77.99	-	94,603	77.68
Fixed cost (FC)							
IV) Depreciation (Machinery and Equipment)	Tk.	-	4000	3.55	-	4500	3.69
V) Land use cost	Tk.	-	20786	18.45	-	22670	18.61
Total Fixed Cost (TFC)	Tk.	-	24786	22.00	-	27170	22.31
A) Gross cost (I+II+III+IV+V)	Tk.	-	112642	100	-	121773	100
B) Total Return	Tk.	-	230123	-	-	231120	-
C) Gross margin (Total return – Total variable cost)	Tk.	-	142267	-	-	136517	-
D) Net return (B-A)	Tk.	-	117481	-	-	109347	-
E) BCR (B/A)	-	-	2.04	-	-	1.89	-

Source: Field Survey, 2017

Analysis in Table 2 indicates that organic tomato production incurs a lower total cost of production compared to conventional tomato production. The organic tomato production has lower labor costs, with a percentage of 25.56% of the total cost, while conventional production has a higher percentage of 29.07%. In terms of material costs, organic production has higher costs due to the use of organic fertilizers and bio-pesticides, but the total variable cost for organic production is slightly lower at 77.99% compared to 77.68% for conventional production.

When considering the fixed costs, organic production has lower depreciation costs (3.55% compared to 3.69% in conventional) and land use costs (18.45% compared to 18.61% in conventional). As a result, the gross cost of organic production is 112,642 Tk., while conventional production incurs a slightly higher gross cost of 121,773 Tk. In terms of the comparative cost of production, the table highlights that organic production can be more cost-effective due to lower labor costs and slightly lower total variable costs.

Table 2 also shows that organic tomato production generates a higher total return compared to conventional tomato production. Organic production yields a total return of 230,123 Tk., while conventional production yields a slightly lower total return of 231,120 Tk. When considering the gross margin, organic production has a gross margin of 142,267 Tk., whereas conventional production has a slightly lower gross margin of 136,517 Tk.

The net return for organic production is 117,481 Tk., indicating the profit generated after deducting all costs. On the other hand, conventional production yields a net return of 109,347 Tk.

The benefit-cost ratio (BCR), which measures the return on investment, is 2.04 for organic production and 1.89 for conventional production. This implies that for every unit of cost incurred, organic production generates a higher return compared to conventional production.

Comparative Profitability of Organic and Conventional Tomato Production

The overall comparative profitability analysis of organic and conventional tomato production is summarized in Table 3. The analysis shows that organic tomato production yields 5,490 kg, while conventional tomato production yields a higher quantity of 7,410 kg. Organic tomato production incurs a total cost of 112,642 Tk., while conventional tomato production has a slightly higher total cost of 121,773 Tk.

Table 3. Comparative picture of per acre organic and conventional tomato production.

Particulars	Organic Tomato Production	Conventional Tomato Production
A) Cost (Tk.) Total cost basis	112642	121773
B) Yield (Kg.)	5490	7410
C) Gross return (Tk.)	230123	231120
D) Gross margin	142267	136517
E) Net return (Tk.)	117481	109347
F) Undiscounted Benefit Cost Ratio (BCR) Total cost basis	2.04	1.89

Source: Field Survey, 2017

The gross return, which represents the total revenue generated from tomato sales, is 230,123 Tk. for organic production and 231,120 Tk. for conventional production. This indicates that conventional production has a slightly higher gross return. The gross margin, which is the difference between the gross return and the total cost, is 142,267 Tk. for organic production and 136,517 Tk. for

conventional production. This implies that organic production has a higher gross margin, indicating a greater profitability per unit of cost. The net return, which represents the profit after deducting the total cost from the gross return, is 117,481 Tk. for organic production and 109,347 Tk. for conventional production. This suggests that organic production generates a higher net return compared to conventional production. The undiscounted Benefit Cost Ratio (BCR) compares the total cost to the gross return. For organic production, the BCR is 2.04, indicating that for every unit of cost, there is a return of 2.04 units. For conventional production, the BCR is 1.89, indicating a slightly lower return per unit of cost. These findings align with a previous study by Hajong *et al.* (2018), supporting the profitability analysis. Zaman *et al.* (2006) also found the BCR of summer tomato production is 3.2 in Jamalpur district which also supported the findings. In summary, the analysis suggests that organic tomato production generally yields higher profitability and returns compared to conventional tomato production.

Production and Marketing Problems of Organic and Conventional Tomato Growers

According to the findings of the study, the most serious problem in organic and conventional tomato farms in the study area was a high incidence of disease and insect pests. This was observed due to a lack of knowledge about disease identification (Karim *et al.*, 2009). The availability of fertilizer and manures was the second most important issue for organic tomato farms, while quality seed materials were a major issue for conventional tomato farms.

Table 4. Production and market related problems of commercial organic and conventional tomato growers in Mymensingh district.

Problems	Organic tomato		Conventional tomato	
	Index value	Rank	Index value	Rank
Production related				
1. Quality seed materials	0.20	3	0.45	2
2. Availability of fertilizer and manure	0.21	2	0.06	6
3. Disease-specific biological and chemical pesticides	0.15	6	0.26	3
4. Irrigation water and facility	0.17	4	0.1	5
5. Labor availability	0.06	7	0.03	7
6. Disease and pest problem	0.56	1	0.65	1
7. Soil fertility	0.16	5	0.15	4
Market related				
1. Transportation and road	0.15	7	0.21	8
2. Price information	0.26	3	0.23	7
3. Market price instability	0.66	1	0.55	1
4. Market availability	0.18	6	0.38	4
5. Assurance of getting income	0.27	2	0.43	3
6. Price stability of inputs	0.06	9	0.26	6
7. Premium price of produce in the local market	0.25	4	0.33	5
8. High profit by middleman	0.21	5	0.44	2
9. Storage facility	0.1	8	0.01	9

Source: Field survey, 2017

Note: Scale value range from 1.00 to 4.00, where 1.00= little bit, 2.00= Moderate, 3.00= Serious, and 4.00= most serious problem at all.

In terms of marketing, the most serious problem that organic and conventional tomato producers faced was a lack of market price stability for tomato production. The second major market-related issue was ensuring that organic tomato farmers received income from the market while conventional tomato farmers earned a high profit from the middleman. Mohiuddin *et al.* (2007) and Haque *et al.* (2012) also identified some major problems in tomato production like non-availability of high-yielding tomato variety seeds at the proper time, lack of technical knowledge, lack of storage facilities, infestation of insects and diseases etc.

Table 5. SWOT Analysis of Tomato Production in the Study Area.

Strengths	**Weaknesses**
• Tomato cultivation in the Mymensingh district is profitable. Organic tomato cultivation is more profitable although its yield (per acre) is comparatively lower than conventional tomato farming. • Better income for farmers. • Better employment opportunities.	• Lack of appropriate crop varieties, poor quality seeds, and fertilizers. • High market margin by the middlemen. • Lack of adequate farmer knowledge.
Opportunities	**Threats**
• Shifting subsistence to commercial production. • Use of organic manures to lower disturb the environment. • A large number of farmers are shifting from conventional farming to organic tomato farming. • Health-conscious people always demanded organic tomatoes than conventional growing tomatoes.	• High incidence of disease and pests requiring high use of pesticides leads to high production costs. • Highly fluctuation in market prices of tomatoes as well as input materials. • Lack of water and irrigation facility.

The SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis identifies the sector's strengths and failures while also identifying limiting factors. According to Table 5, organic tomato production provides better income and employment opportunities, whereas middlemen play a negative role for producers. The threats to organic tomato production include a high incidence of disease and a high fluctuation in market price. In terms of health, there are still opportunities.

Conclusion

The current study was undertaken with the goal of evaluating the comparative profitability of organic and conventional tomato production by analyzing the costs and returns in order to generate new information that may be useful to producers as well as policymakers. Both organic and conventional tomato farming is a profitable and successful agro-business in the Mymensingh district. However, organic tomato farming is more profitable than conventional tomato farming. Although considering the profitability and SWOT analysis, tomato production is a profitable venture in the study area, both organic and conventional tomato growers face some production and marketing challenges. The most significant problem for both types of farms is the high incidence of disease and insect pests, highlighting the need for improved disease identification and management practices. Market-related issues include market price instability, ensuring income for organic tomato farmers, and the high-profit margin taken by middlemen. To address these challenges and capitalize on opportunities, it is crucial to improve disease management practices, enhance the availability of quality inputs, promote knowledge sharing among farmers, and establish better market linkages. Furthermore, efforts should

be made to reduce the influence of middlemen, invest in research and development for improved crop varieties, and focus on sustainable practices such as organic manure usage. By addressing these issues, the tomato production sector in the study area can achieve greater profitability and sustainability.

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