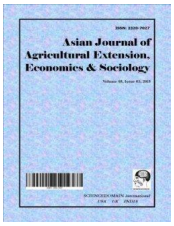

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Profitability, Inputs Influencing Yields and Constraints Faced by the Tomato (*Lycoperaicon esculentum)* Producers: An Empirical Evidence from Moulvibazar District in Bangladesh

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Authors' contributions

This work was carried out in collaboration between the authors. Authors SR and AAZ designed the study, performed the statistical analysis and wrote the final manuscript. Author SR wrote the protocol and wrote the first draft of the manuscript. Both authors read and approved the final manuscript.

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ABSTRACT

This study attempts to investigate the economics of tomato production in Moulvibazar district in Bangladesh. In this study, both economic models of description and statistical analysis were used to analyse the data. It was found that tomato cultivation was a profitable business in the study area. Per hectare production was 42.68 m. Ton. The average gross cost for tomato production was BDT. 2,80,004/ha. Per hectare gross return of small, medium and large farm was BDT. 5,62,172/ha, BDT. 5,57,908/ha and BDT. 5,44,674/ha, respectively. The overall benefit-cost ratio (undiscounted) was found 1.98. Per hectare, the benefit-cost ratio of the small, medium and large farm were 2.09, 1.99 and 1.87, respectively, which indicates that tomato production by small farm was more profitable. It was also found that the use of human labour, insecticides, fertilizer and bamboo had a

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significant impact on the gross return of tomato production. It was identified from the study that major problems faced by the farmers were: inadequate storage facilities, lack of sufficient credit supply, high interest rate, lack of human labour, inadequate supply of good quality seeds, high prices of fertilizers and insecticides, disease attacks, low price of product during harvesting, lack of marketing facilities and information. Some recommendation was made from the findings of the study, which were, institutional credit support, increase storage facilities, availability of good quality seeds, ensure fair price and control price fluctuation.

Keywords: Tomato production; profitability; inputs influencing; constraints; Kruskal-Wallis.

1. INTRODUCTION

Agriculture, the single largest sector, is the main source of income for a substantial number of people of Bangladesh, about 87% of rural households directly or indirectly depend on agriculture [1]. The national growth and development mainly depends on the development of its agriculture and farming and the overall economic growth of Bangladesh could not be achieved unless it could have achieved a breakthrough in the agricultural sector [2]. Agriculture is the highest dominating sector which is very crucial for Bangladesh economy. In fact, agriculture is the backbone of the economy of this country. This sector contributes 11.70% to Gross Domestic Product (GDP) in which 8.35% comes from crops and vegetables [3]. The overall direct contribution of the agriculture sector has decreased slightly; it has indirect contribution to the general growth of GDP. It may be noted here that, the GDP growth rate was 6.19% in fiscal year 2007-08. Vegetable is important in Bangladesh for nutrition, economy and food security [4]. Vegetables can be identified as a significant one for this economy for its noteworthy contribution (2.32% to the agricultural GDP) in raising the foreign exchange earnings and occupies an important position among the items exported from Bangladesh. Production of such high value commodity types in the country must be increased to cope with the challenges of malnutrition and low productivity. In this context, production of tomato would be able to play an important role to improve the performance along with crop diversification, particularly from the viewpoint of nutrition and profitability as it placed sixth position in terms of annual total world production [5]. Tomato (*Lycopersicon esculentum*), particular type of crop which is mostly grown in the winter season in the south-east and south-west part of Bangladesh and a good source of vitamin A and C [6]. The government of Bangladesh has been pursuing a crop diversification strategy to increase tomato cultivation to meet the demand of growing population. Among the districts of Bangladesh, Moulvibazar is renowned for agricultural activities and more than 80% families are, directly and indirectly, depending on agriculture [7]. Farmers are mainly engaged in rice cultivation, but there are also a significant portion of lands which are using for commercial tomato cultivation in small scale. So, it is essential for the researcher and the producers to know the costs and returns, their input use, contribution of key inputs in cultivating tomato in this specific study area. Almost all of the previous studies on the agricultural activities of this district are focused on rice cultivation related issues. Surprisingly, no research work has been undertaken particularly on cultivating tomato, although many studies [7,8,9,10,11,12,13,14,15,16,17] has been conducted across the country concerning tomato production and related issues. In this backdrop, the present study has been undertaken to estimate the profitability, inputs affects yields and significant constraints face by the farmers. It is expected that the study will provide policy makers, extension workers, farmers, researchers for reviewing the policy options in respect of supporting production of tomato and other competing crops for optimizing the use of scarce national resources.

2. MATERIALS AND METHODS

2.1 Selection of the Study Area

The area, Kamalganj Upazila of Moulvibazar District was purposively selected for the present study. It is situated between 24.10 degree and 24.35 degree north latitude and between 90.35 degree and 91.20-degree east longitude. In order to achieve the objectives of the research, necessary data has been collected from the selected area. Considering the highest production, the present study has been conducted in two unions (Union Parishad is the smallest administrative of local government of Bangladesh) namely Alinagar and Adampur

Unions of Kamalganj Upazila of Moulvibazar District.

2.2 Selection of the Sample and Data Processing

An example of representative farms which satisfy the objectives of the study was taken into account. In this study, 50 farmers were selected randomly, among which 30 farmers from Alinagar and 20 farmers from Adampur union. Out of 50 farmers, 18 were small, 25 were medium, and 7 were large farmers by selected farmer's proportion. For validating the response of the respondent 10 key informants interview was taken separately from each union.

The relevant data from the selected farmers were collected through the face-to-face interview by the researchers themselves. The questionnaire was checked after each meeting, to ensure that information to each item had recorded correctly. In order to minimize the errors, data were collected in local unit and later those were converted into standard international units. For analysing data MS-Excel and R (version 3.4.3) has been used.

2.3 Analytical Technique

Data were carefully analysed for achieving the objectives of the study. Both tabular and statistical methods were used for data analysis. A tabular technology commonly followed to find out the crude association or difference between variables. To find out the economic performance of tomato, the simple statistical model such as the average, percentage, total cost, total return, etc. were used.

2.3.1 Gross return

$$GR_i = \sum_{i=1}^{n} QiPi$$

Where,

GR_i = Gross Return from ith product (BDT./ha); Q_i = Quantity of the ith product (Kg); P_i = Average price of the ith product (BDT.); i = 1,2,3……., n

2.3.2 Gross margin

Gross margin has given an estimate of the difference between gross return and total variable costs. That is,

$$GM = GR - TVC$$

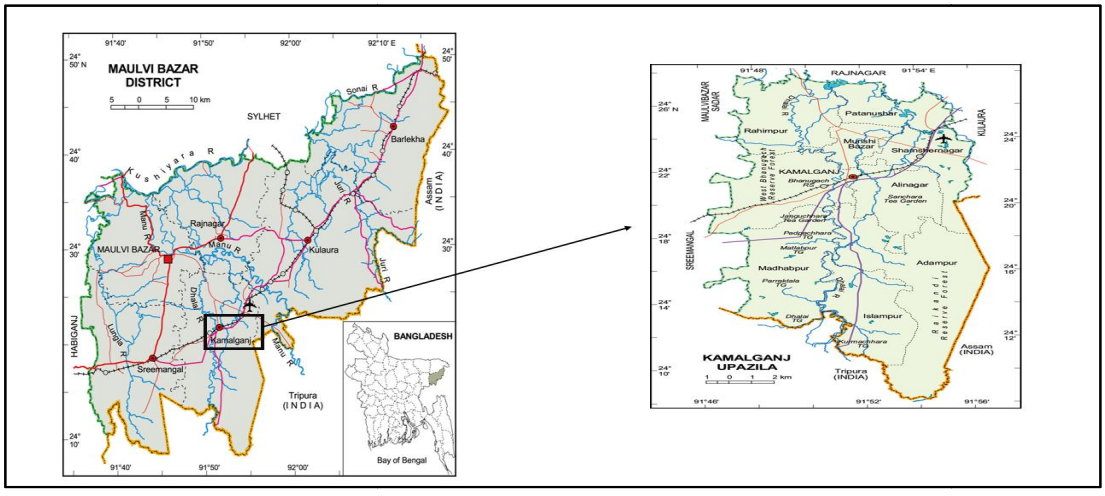
Where, GM = Gross margin; GR = Gross return; TVC = Total variable cost

2.3.3 Net return

The following equation was used to determine the net return of tomato production.

$$\prod = P_Y Y - \sum_{i=1}^{n}(\mathrm{Pxi}Xi) - \mathrm{TFC}$$

Where, $\prod$ = Net return (BDT./acre); $P_{Y=}$ Per unit price of the product (BDT./kg); Y = Quantity of the production per acre (kg); Px_i = Per unit price of i^{th} inputs (BDT.); X_i = Quantity of the i^{th} inputs per acre (Kg.); i = 1,2,3……. ,n (number of variable);



Map 1.
Source: www.banglapedia.org

2.3.4 Benefit Cost Ratio (BCR)

The BCR was estimated as a ratio of gross returns and gross costs. The formula of calculating BCR (undiscounted) is shown below:

Benefit cost ratio = Gross benefit / Gross cost

2.4 Statistical Technique

The Cobb-Douglas model [18] for tomato production respondents was specified as:

$$Y = aX_1b_1\ X_2b_2\ X_3b_3\ X_4b_4\ x_5b_5\ X_6b_6\ X_7b_7\ X_8b_8\ X_9b_9$$

The Multiple Regression model in logarithm form may be expressed as:

$$\ln Y = \ln a + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + b_6 \ln X_6 + b_7 \ln X_7 + b_8 \ln X_8 + b_9 \ln X_9 + U$$

Where,

Y= gross return (BDT./ha); X_1= human labour cost (BDT./ha); X_2= power tiller cost (BDT./ha); X_3= seed cost (BDT./ha); X_4= insecticides cost (BDT./ha); X_5= fertilizer cost (BDT./ha) ; X_6= irrigation cost (BDT./ha); X_7 = bamboo cost (BDT./ha); X_8 = poly bag cost (BDT./ha); X_9 = land use cost (BDT./ha); a= constant/intercept; $b_1, b_2, \ldots\ldots b_8$ = coefficients of respective variables; U = error term; and ln = natural logarithm

2.5 Kruskal-Wallis Test

Kruskal-Wallis ranking analysis was used to assess farmer's perception on major problems which faced by farmers to cultivate tomato. This tool was used to measure the responses gathered from farmer's perception on major problems which faced by farmers to cultivate tomato. [19] used Kruskal-Wallis One Way Analysis of Variance (ANOVA) by Ranks to assign priorities to identified constraints to Apiculture.

The equation for estimating the ranks is outlined thus

$$H = \frac{12}{N+1} \sum_{i=1}^{ni} \frac{1}{ni} \frac{[Ri - ni(N+1)2}{2}$$

Where R_i, is the sum of the ranks assigned to observation in the ith sample and $\frac{ni(N+1)}{2}$, the expected sum of ranks for the ith treatment [20].

3. RESULTS AND DISCUSSION

3.1 Cost and Returns of Tomato Cultivation

The study estimated the cost of production and return on the basis of different variable inputs used. The major costs associate with the tomato cultivation were labour, power tiller fertilizer, polybag, insecticides, bamboo, irrigation and land use cost. Laborers required for different farm operations like land preparation, seedling, weeding, application of fertilizer, irrigation, insecticide application, harvesting and carrying, etc. It occupies a large portion of total cost of production. In the study area, the wage rate varied from BDT. 240 to BDT. 280 per man-day depending on the time and availability of day labour. The average rate was BDT. 260 per man-day. The amount of human labour used for tomato cultivation was 306 man-days per hectare resulting a cost of BDT. 79590 which were 28.42% of total production cost by all farm categories (Table 1). The total average costs of labour were BDT. 79690, BDT. 79820 and BDT. 81900 represent 28.63%, 28.50%, 28.14% of total cost for small, medium and large farms respectively. Large farmers spent more on human labor compared to small and medium farmers because large farmers had adequate fund to hire labour for the production process of tomato. Balanced application of fertilizer is important for proper growth of the plants and it ensure the maximum yields.

The second highest cost of production is associated with fertilizer cost. Urea, TSP, MoP, Gypsum and Boron are the main fertilizers for tomato production. Among the three farmers fertilizer cost is higher for large farmer and lowest is for small farmers. Total variable cost was estimated as BDT. 196082, BDT. 205890/ha and BDT. 216162/ha for small, medium and large farmers separately. The study showed that land use cost per hectare for all farmers was BDT.70474 for tomato cultivation which occupied 26.40% of total cost of tomato production (Table 1). In case of farm categories, it was highest in large farms (BDT. 71270/ha) than that of small farms (BDT. 69494/ha) and medium farms (BDT. 70658/ha). Total gross cost was BDT. 291034/ha for large farmers and BDT. 268844/ha for small farmers. Gross returns was BDT. 562172/ha, BDT. 557908/ha and BDT. 544674/ha respectively for small, medium and large farmers. Net return was calculated by deducting gross cost from total return. Per hectare net return of

Table 1. Cost and return of tomato production (BDT/ha)

Items	Total Cost and Return (BDT./ha)	Total Cost and Return (BDT./ha)	Total Cost and Return (BDT./ha)	Total Cost and Return (BDT./ha)
	Small	Medium	Large	Average
A. Gross return				
Main product	562172	557908	544674	554918
B. Variable cost				
Total labour	76960	79820	81900	79560
Power tiller	11565	11942	13255	12254
Seeds	9841	10825	11219	10628
Fertilizer:				
Urea	7500	7900	8600	8000
TSP	7504	7756	8260	7840
MP	7710	8070	8520	8100
Gypsum	2315	2396	2639	2450
Boron	2800	3200	3600	3200
Subtotal	27829	29322	31619	29590
Insecticides	23010	24117	26385	24504
Bamboo	36275	37647	38614	37512
Polybag	2442	2644	2850	2645
Irrigation	8160	9573	10320	9351
Total variable cost	196082	205890	216162	206045
C. Fixed cost				
Interest on operating Capital(10% for 4 months)	3268	3431	3602	3434
Land use cost	69494	70658	71270	70474
Total fixed cost	72762	74089	74872	73908
D. Gross cost (B+C)	268844	279979	291034	279952
E. Gross margin (A-B)	366090	352018	328512	348873
F. Net return (A-D)	293328	277929	253640	274966
G. Benefit cost ratio (A/D) (Undiscounted)	2.09	1.99	1.87	1.98

*Source: field Survey, 2017; *83.70 Taka= 1 USD (23 May 2018, Bangladesh Bank)*

tomato production under small, medium and large farmers were BDT. 293328/ha, BDT. 277929/ha and BDT. 253640/ha, respectively, which indicates that net return was the highest in small farmers than medium and large farmers. Per hectare net returns of tomato for all categories of farmers was estimated at BDT. 274914/ha. An undiscounted benefit cost ratio (BCR) is a relative measure, which is used to compare benefit per unit of cost. The benefit cost ratio (BCR) was calculated as a ratio of gross returns and gross costs. The BCR of tomato farm was greater than one indicating that tomato farming was profitable. In all farm categories, the highest BCR was revealed small farm holder (2.09) than the medium farm holder (1.99) and large farm holder (1.87). This indicates that small farm holder earned comparatively higher from tomato cultivation as compared to large and medium farm holder. The BCR of tomato for all categories of farms was 1.98.

3.2 Effects of Inputs on Production

To determine the effects of variable inputs, several production function models can be used. The Multiple Regression model was chosen because of its superior properties, particularly in explaining agricultural production behavior. Another special advantage of using Multiple Regression model was that the regression under OLS in logarithm yields coefficients which represents partial elasticity of production and it is simple to calculate and the elasticity of production can directly be obtained from the coefficients.

For producing tomato, different types of variables were employed by the sample farmers. Estimated values of coefficient and related statistics of the Multiple Regression models are presented in Table 2. It can be observed from the Table 2 that, eight significant variables were taken into consideration in the production

functions for tomato production. The coefficient of variable X_1 (human labour cost) was 0.536 in tomato production and significant at 5% level with the positive sign, and it is supported by samshunnahar et al. [7] who also showed that human labour cost was significant at 5%. This implies that keeping other things constant, 1% increase in human labour cost, would lead to a rise in gross return by 0.536% (Table 2). It has happened as we know that tomato production is highly labour intensive and continuous supervision is needed to get maximum production. At the same time, the estimated value of the coefficient of the variable X_2 (Power tiller cost) was 0.164 with a positive sign and statistically insignificant. Seed is an essential input for maximum yield. High-quality seed costs more and increases the yield, but a seed with low quality may reduce the average yield of tomato production. In the study, the estimated coefficient of seed cost was 0.318 with a negative sign, and it is also statistically insignificant. Which is the evidence of the inverse relationship between seed cost and yield of tomato? The regression coefficient of insecticides was 0.734, and like the seed, it has a negative sign, but it is significant at 1% level. So 1% increase in pesticides cost, keeping other factors constant, would result in a decrease the gross returns by 0.734%. Also, the negative value of pesticides price indicates the excess use of insecticides. With 1% level of significance, the estimated coefficient of fertilizer was 0.684. Since the sign is positive, it suggests that 1% increase in fertilizer cost, keeping other inputs constant, would increase the gross returns by 0.684%. The possible causes of the positive sign might be the wrong use of fertilizer in tomato production. The coefficient of variable irrigation cost and the bamboo cost was 0.295, and 0.408 with positive sign Bamboo cost was statistically significant at 10% level which indicates that keeping other inputs constant, gross return would be increased by 0.408% if 1% bamboo cost had been raised.

Both the cost of polybag and land use cost was insignificant and it implies that increase or decrease of polybag cost and land use cost will not affect the yield of tomato. The coefficient of determination (R^2) is a summary that tells how well the sample regression line fit with the data. An important property of R^2 is that it is a non-decreasing function of the number of explanatory variables present in the model, as the number of regressor increases, R^2 almost invariably increases and never decreases. The coefficient of determination (R^2) was 0.418, which explained that about 42% of the variation in gross return was explained by the independent variables included in the model. The value of adjusted R^2 is 0.305 for tomato production. It indicates that after taking into account the degrees of freedom, the included explanatory variables in the model explained about 31% of the variations in the depended variables. About 31% of the variation in gross return from tomato production is explained by the explanatory variables included in the model with all degrees of freedom, and remaining 69% of the variation in the gross return of tomato production was unexplained. The F - value of the equation is 3.688 was highly

Table 2. Coefficient and related statistics of multiple regression models

Explanatory variables	Tomato		
	Estimated coefficient	Standard errors	t-values
Intercepts	1.871	3.102	0.603
Human labour	0.536**	0.258	2.079
Power tiller	0.164	0.224	0.730
Seed	- 0.318	0.254	-1.297
Insecticides	- 0.734***	0.248	-2.955
Fertilizer	0.684***	0.213	3.211
Irrigation	0.295	0.292	1.010
Bamboo	0.408*	0.227	1.797
Polybag	-0.430	0.197	-0.220
Land use cost	-0.376	0.254	1.306
R^2	0.418		
Adjusted R^2	0.305		
F- value	3.688 ***		
Returns to scale $\sum b_i$	2.1		

Source: Field Survey, 2017

*Note: *** Significant at 1% level, ** Significant at 5% level, * Significant at 10% level*

significant at 1% level of significance implying that all the included explanatory variables were important for explaining the variation in returns of tomato production.

3.3 Problems and Constraints of Tomato Production

In the study areas tomato farmers faced a number of problems. It was observed that problems and constraints faced by tomato farmers were not identical and the problems were differed from farmer to farmer. These problems and constraints affect tomato production as well as profitability. The reasons behind the facing of constraints are that most of the farmers are not literate and they do not know the modern technologies which can help to avoid the constraints. From the perception of the respondent and key informant, the most burning problems of growing tomato were lack of sufficient credit supply, high interest rate, low price of product during harvesting, lack of storage facilities, good quality seed, human labour, suitable marketing facilities, grading knowledge, high price of seeds, fertilizers and insecticides, dominance of intermediaries, disease attacks, loss of production due to theft, burden of old debt and natural calamity. The farmer's perception on major problems were summarized by using Kruskal-Wallis One Way Analysis of Variance (ANOVA) by ranks, the major problems as perceived by the farmers were ranked from 01-14. With 01 and 14 representing the highest and lowest ranked problem, respectively is as shown by Table 3.

Lack of storage facilities (mean 493.15) was the most substantial problem in the study areas. Most of the farmers use the traditional way of storage facilities which are not scientific and do not ensure long time preservation. The key informants claimed that no government initiatives have taken to ensure storage facilities shortly. Price of the product during harvesting (mean 492.50) was the second highest constraints faced by the respondents. As they have no storage facilities and in the peak, season production is highest, they face excessive supply effect which reduces the price. Respondent said that sometimes they are to sale per kg tomato at take 2-3. High-interest rate (mean 483.66), lack of sufficient credit supply (mean 480.40), lack of good quality seed (mean 476.50), shortage of human labour (mean 469.50) were the highest ranked problems as perceived by the respondents while dominance of intermediaries (mean226.50), disease attacks (mean 221.50), burden of old debt (mean 191.80), natural calamity (mean 177.54) were perceived as the lowest ranked problems by the respondents. But, the key informants have said that natural disaster was one of the prominent issues as most of the crops damaged during imbalance situation of nature. The table also showed that all of the issues in the production of tomato respondents were significant at all levels and that they are statistically different from one another.

Table 3. Summary of Kruskal-Wallis test for major problems faced by farmer

Problem	Mean	Rank
Lack of sufficient credit supply	480.40	4
High interest rate	483.66	3
Lack of good quality seed	476.50	5
Low price of product during harvesting	492.50	2
Lack of storage facilities	493.15	1
Lack of human labour	469.50	6
Lack of suitable marketing facilities	451.43	7
Lack of grading knowledge	248.33	8
High price of seeds, fertilizers and insecticides	227.54	10
Dominance of intermediaries	226.50	11
Disease attacks	221.50	12
Loss of production due to theft	240.05	9
Burden of old debt	191.80	13
Natural calamity	177.54	14
Chi-square	293.60	293.60
Degree of freedom	13	13
Asymp. Sig.	0.000	0.000

Source: Field Survey, 2017; 01-14: Highest to Lowest

4. LIMITATION OF THE STUDY

The size of the sample taken may not be adequate due to resources and time constraints. It became difficult to contact farmers because of peak season of tomato transplanting. Most of the tomato producers do not keep any records of their cost and return. As a result, the accuracy and reliability of data entirely depend on their memory and sincerity. Since the area coverage is limited for the research site with the tiny size of sample producers, the inferences drawn from the research may not be taken as a generalization for other areas of the country.

5. CONCLUSION AND RECOMMENDATION

Nowadays, tomato is a leading staple and cash crop and the farmers of Bangladesh are earning higher profit from tomato production. Using modern inputs and production technology are being very determinant and essential factors for the tomato farmers. If these facilities can be made available to farmers in time, yield and production of tomato may be increased which can help the farmers to increase income and improve their well-being conditions. This study found that due to lack of labour, low price during the harvest season, lack of storage facilities, availability of capital and high-interest rate of credit etc., were the basic short-coming of production and hampering the increasing of tomato production in the study area. It confirms another vital reason is that available resources and appropriate technology is limited. The institutional and infrastructural support, efficient use of modern techniques and better management of land will help to increase the tomato production. We also found some inputs which have a statistically significant impact on average yields which are human labour, fertilizer use, insecticides use and bamboo. So, efficient utilization of labour use, proper use of fertilizer and insecticides need to be ensured to optimize yield. It can be concluded from the results of the present study that considerable scope exists in the study area to increase the productivity of tomato as well as for increasing income, employment and nutritional status of the farmers. This study revealed that tomato growing was more profitable than other cash crops.

Several policy recommendations might emerge from the results of this research. Regular and adequate supply of quality seed, fertilizer and insecticides should be ensured with reasonable cost. Government and associated agents should take immediate steps to set up scientific storage facilities in these areas and take stringent actions to stable price fluctuation.

CONSENT

As per international standard or university standard written participants' consent has been collected and preserved by the authors.

ETHICAL APPROVAL

It is not applicable.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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