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Profitability of Small-Scale Tomato (*Lycopersicon esculentum*) Production in Some Selected Areas in Bangladesh

Mst. Samshunnahar, Romaza Khanum* and M. Serajul Islam

Department of Agricultural Economics, Bangladesh Agricultural University, Mymensingh, Bangladesh

**Corresponding author and Email: payelsgvc@yahoo.com*

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Abstract

A study was conducted to analyze the profitability, contribution of factors in yield and socioeconomic status of small-scale tomato (*Lycopersicon esculentum*) producing farmers in some selected areas in Bangladesh. The study was based on primary data, collected from 60 farmers, selected using a multi-stage random sampling technique. The main factors of production like, seeds, human labour, tillage, fertilizer, irrigation and insecticides were considered to estimate the impacts on tomato production. Data were analyzed statistically and economically and results were mostly presented in tabular form. Amongst 3 farm size groups, small tomato farmers earned highest profit, followed by medium farmers. Gross returns per acre of small, medium and large farms were Tk. 104180, 95000 and 82600 and their corresponding net returns were Tk. 46978, 45356 and 5354, respectively. Moreover, the undiscounted benefit cost ratio of was the highest for medium farmers (1.91), followed by small farmers (1.82), while it was the lowest for large farmers (1.74). The coefficient of determinations (R^2) was about 0.694, which indicates that about 69 percent of variations of tomato production are explained by the independent variables. The result showed that human labour followed by tillage of the variables was significantly positive, which implies that various independent inputs uses had effective contribution to increase tomato production. It was therefore, observed that a considerable improvement took place to increase household income of the studied farmers and to improve the economic conditions with the introduction of small-scale commercial tomato production. The elasticity of different inputs was 0.744 which exhibited the decreasing returns to scale and farmers allocated their resources in the rational stage of production (stage-II). However, lack of quality seed was one of the major constraints in cultivation of tobacco. Effective policy and efficient extension services have therefore, to be ensured to increase income and employment opportunities of the tomato drowers.

Keywords: Tomato Production, Small Scale, Benefit Cost Ratio (BCR), Profitability

1. Introduction

Agriculture is considered the backbone of economy and contributed 19.29 percent of total GDP (BBS, 2012) in Bangladesh. It covers 8.52 million hectares of total cultivated land, where about 47.30 percent of total labor forces are directly or indirectly involved for their livelihoods. It comprises crops and vegetables, livestock, forestry and fisheries, while vegetables are the important source of income to small and marginal farmers and contributes to the nutrition of the consumer (Begum *et al*., 2011). Out of 15 vegetables, tomato (*Lycopersicon esculentum*) is

good sources of vitamin A and C, versatile and widely grown vegetable in Bangladesh (Das *et al*, 2011). It is also important in terms of area, production, yield, and commercial use, placed sixth based on total annual world production (FAO, 2011). Nowadays land area under tomato cultivation has been expanded day by day due to increasing domestic consumption of demand. It is, therefore known a profitable, less risky, relatively short production cycles, and labour intensive cash crop compared with many field crops (Islam, 2005). It produces mainly in winter month of Bangladesh. In order to demand of consumption, seed availability and high selling price, farmers are bringing more land under plough and also sowing in summer tomato. As a result, tomato was produced 255000 mt. tons in Bangladesh during the 2011-12 (BBS, 2012), while it was about 190213 mt. tons from 23817 hectares of land in 2009-10 (BBS, 2010).

Regarding increased tomato production, there were some studies (Haque, 2007; Mohiuddin *et al*., 2007; Parvej *et al*., 2010; Karim *et al*., 2009; Usman and Bakari, 2013) conducted in home and aboard. No systematic study has yet been explored in the specific area, especially in Rajshahi district which is one of the major tomatoes producing area in Bangladesh. It covers 4406 hectares of land, with about 56.67 thousand metric tons in 2010-11 (BBS, 2010). Inspite of increasing interest of producing tomato, very few systematic initiatives have been undertaken by the government and private organizations through extension workers, research personnel, NGO officials and farmers in that area. Although, farmers are allocating their cultivated land into tomato cultivation and creating commercialized farm. Considering the above facts, the present study has been under taken to identify the socioeconomic profile; to analyze the profitability of small-scale tomato production; and to determine the factors affecting yield and income. It is expected that the findings of the study will be helpful for the small scale commercial tomato farmers as well as policy makers to expand the cultivated area in respect of increasing domestic demand.

2. Methodology

This section discusses about the selection of the area, period of the study, sampling technique and sample size, preparation of the interview schedule and data processing and analysis.

2.1. Sample technique and of sources data

The study was conducted in Rajshahi district, the Northern part of Bangladesh. A multi-stage sampling technique was applied to select the sample farmers. First, the district was purposively selected on the basis of major intensive tomato production. Then, three dominating tomato production dominated *Upazilas* were also selected purposively. Later, two villages from each *Upazila* namely Mohishalbari and Kakanhat under Godagari *Upazila*, Nijampur and Kasba of Nachole *Upazila* and Rohanpur and Alinagar of Gomastapur *Upazila* were selected randomly. Stratified random sampling method were applied for selecting the ultimate tomato producing households, assuming that this technique can provide a more accurate representation of the sample based on the characteristics used to divide the farmers into smaller groups or strata than simple random sampling. Finally, tomato cultivating farmers were selected in consultation with the Agricultural Officers of the respective *Upazilas* for conducting field survey. Tomato farmers were further categorized into three groups based on cultivable land; small farmers ($\geq$0.05 to $\leq$2.49 acres); medium farmers ($\geq$2.50 to $\leq$7.49 acres); and large farmers ($\geq$7.50 acres) for collecting data. A total of 60 farms comprising 30 small, 20 medium, and 10 large farms were finally conducted for the study. Data were collected during the month of January to February in 2014 with structured survey schedule.

Both primary and secondary data were used in the study. Several field visits were conducted face to face interviews for collecting primary information. Secondary data were also collected from different sources such as Bangladesh

Bureau of Statistics (BBS), Food and Agricultural Organization (FAO), Directorate of Agricultural Extension (DAE) and published articles for the study purpose.

2.2. Analytical technique

Both descriptive and statistical techniques were used in the present study. Descriptive techniques such as frequency distribution, percentages, summation, etc. were used to analyze the socioeconomic characteristics and constraints associated with tomato farmers. Multiple regression analysis was used to determine cost and return and to identify the impacts of independent variables (seeds, human labour, tillage, fertilizer, irrigation and insecticides etc.) on tomato production. Additionally, undiscounted benefit cost ratio (BCR) was also used to assess the economics of tomato production.

The Cobb-Douglas production function was the appropriate form of the production function for fitting agricultural production data. This model is simple to calculate and the elasticity of production can directly be obtained from the co-efficient. To determine the contribution of independent variables on tomato production, the Cobb-Douglas production function was converted into the following linear logarithmic (Double log) form;

$$lnY = lna + b_1 lnX_1 + b_2 lnX_2 + b_3 lnX_3 + b_4 lnX_4 + b_5 lnX_5 + b_6 lnX_6 + u_i$$

Where, *In* = Natural logarithm; *Y* = Gross Return (Tk/acre); X_1 = Seed cost (Tk/acre); X_2 = Human labour cost (Tk/acre); X_3 = Tillage cost (Tk/acre); X_4 = Fertilizer cost (Tk/acre); X_5 = Irrigation cost (Tk/acre); X_6 = Insecticide cost (Tk/acre); a = Constant or intercept term; $b_1, b_2, b_3, b_4, b_5, b_6$ = production coefficient of the respective input variable to be estimated; and u_i= error term.

3. Results and Discussion

The socioeconomic with a set of variables and then the results of costs, returns and profitability of tomato and finally the effect of influencing factors on economic return of tomato production are presented in the following sub-section.

3.1. Socioeconomic profile of tomato farmers

Table 1 shows the socioeconomic characteristics of respondents in the study area. The result revealed that the average male and female members were 61 and 39 percent, respectively in the farm households. It is evident that, tomato production is dominated by male counterparts. Ojo *et al* (2009) also found that tomato production is male dominated production in Niger state. More specifically, male and female members for small, medium and large farm households were 60, 63 and 61 percent and 40, 37 and 39 percent respectively. Considering all farm households, majority of male members were categorized as medium (63%) farms, while most of female members were engaged in large (39%) farms respectively. It was evident that 60 percent male and 40 percent female were categorized as small farms compare to other farms.

The age structure of tomato farmers were classified into four age groups such as 18 to 24 years, 25 to 45 years, 46 to 60 years and above 60 years old. It was revealed that majority (58%) of farmers were within the age range of 26-45 years, followed by 46-60 years (21%). It was therefore, can be said that tomato production was experienced adults' farmers dominated production. Noonari *et al*. (2015) also found that about 43% conventional farmers belonged to age group above 50 years. In terms of working members of households, the most of female members were housewife while male members were engaged in different income activities such as agriculture, business and services etc. In the household level, 84 percent male working members were large farmer while only 18, 18 and 16 percent of female working members were in small, medium and large farms respectively. It was also indicated that 83 percent male and 17 percent female were contributed in household income (Table 1).

Table 1. Socioeconomic profiles of households in the study area

Variables		Small		Medium		Large		Average	
		Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)	Frequency	Percentage (%)
Sex	Male	48	60	62	63	38	61	49	61
	Female	32	40	36	37	24	39	31	39
Age distribution	18 to 25	5	17	2	10	2	20	3	16
	26 to 45	15	52	13	65	6	60	11	58
	46 to 60	7	24	4	20	2	20	4	21
	Above 60	2	7	1	5	-	-	1	5
Work involvement	Male	42	82	55	82	32	84	43	83
	Female	9	18	12	18	6	16	9	17
Family size	≤ 5		30	7	35	3	30	6	30
	6 – 8	13	43	8	40	5	50	9	45
	Above 8	8	27	5	25	2	20	5	25
Educational status	Illiterate	10	33	6	30	2	20	6	30
	Primary level	12	40	8	40	5	50	8	40
	Secondary level	8	27	4	20	3	30	5	25
	Above secondary	-	-	2	10	-	-	1	5
Occupational status	Agriculture	28	93	12	60	8	80	16	80
	Small business	2	7	6	30	2	20	3	15
	Services	-	-	2	10	-	-	1	5
Annual income	≤50000	21	70	5	25	-	-	8	32
	50001-100000	6	20	10	50	1	10	6	27
	100001-150000	3	10	3	15	6	60	4	28
	≥ 150000	-	-	2	10	3	30	2	13
	Size of land holding	1.10	70	4.04	72	7.86	82	4.33	77
Land ownership	Own	2.75	46	7.72	39	16.96	48	9.14	45
	Rented in	0.98	17	3.91	20	5.74	16	3.54	17
	Leased in	1.16	20	5.87	29	8.38	23	5.14	25
	Rented out	0.42	7	1.67	8	1.98	6	1.36	7
	Leased out	0.61	10	0.83	4	2.56	7	1.33	6
	Homestead area	0.86	18	1.92	11	2.06	7	4.84	10
	Total cultivated land	3.31	70	12.12	72	23.58	82	39.01	77

Source: Field survey, 2014

In order to find out family size, the families were classified into three groups as small (0-5), medium (6-8), and large families consisting of more than 8 members. Forty five (45) percent family was consisted with 6-8 members, only 25 percent was above 8 members (Table 1), which was greater than the national average (4.35). To examine the educational status of tomato producing farmers, four categories such as illiterate, primary (class 1-5), secondary (class 6-10), and above secondary level of education were used in the study. It was evident from the Table 1 that, most (40%) farmers have received primary education, while 30 percent of respondents were illiterate. Twenty five percent farmers have secondary level of education and only 5 percent received above secondary level education. Small farmers were more illiterate compare to others in the study area. The study revealed that about 31% of the small farmers were old age. It was therefore, evident that education was negatively correlated with age.

Out of three types of occupation such as agriculture, small business and services, agriculture was the main dominant occupation in the study area. Irrespective of size of land holding, the overwhelming majority (80%) of respondents were agricultural farmers, where 93 percent were small farmers and only 3 percent were in services. Based on different occupational activities, it was also indicated that annual income reflects the real socioeconomic status of the respondents. The annual income levels of the farm households were categorized into four ranges, such as: below Tk. 5,00,00, Tk. 5,00,01-10,00,00, Tk. 10,00,01-15,00,00, and above Tk. 15,00,00. The results indicate that 70 percent of the respondents had less than Tk. 5, 00, 00 per annum.

Table 1 also revealed that the average land under tomato cultivation for small, medium and large farmers were 1.10, 4.04 and 7.86 acres, respectively. About 77 percent of total cultivated land was allocated to tomato cultivation in the study area while large farmers occupied 82 percent. It was further noted that majority (45%) of respondents cultivated in their own farm land and only 25 percent of farm land obtained through rented in. The highest percentage (18%) of homestead area was found for small farmers and the lowest percentage (7%) was allocated for large farmers. Finally, Table 1 indicated that 82 percent of cultivated land under large farmers where 70 percent was for small farmers.

3.2. Profitability of small-scale tomato production

3.2.1. Cost of tomato cultivation

This study estimated the cost of production on the basis of various variable inputs like seed, fertilizer, manure, human labour, pesticide, irrigation etc. Due to sources of supply, family and hired labour performed many farm activities such as land preparation, laddering, weeding, insecticide spraying and harvesting etc. It was indicated that the total cost of human labour per acre was estimated to be Tk. 27000, Tk. 22400 and Tk. 20400 for small, medium and large farmers, respectively. It was indicated that human labour cost was higher for small farmers, used more family labour in farming activities. Land preparation was the main operation for which per acre human labour cost for small farmers were also higher (Tk. 3568) compare to others.

Fertilizer (organic and inorganic) is generally used to increase tomato production. Per acre cost of organic fertilizer for small, medium and large farmers was Tk. 1488, Tk. 1886 and Tk. 3105, respectively. Per acre cost of inorganic fertilizers were Tk. 7647, Tk. 5908 and Tk. 5212 for small, medium and large farmers, respectively. This study estimated the different fertilizer costs for different tomato producing farm due to use different doses and kind of organic and inorganic fertilizer. Tampoare *et al* (2013) also supported that human labour cost was the major cost items followed by fertilizer cost. Farmers used different kinds of insecticides to keep their crop free from pests and diseases which increased production cost directly. The result showed that per acre cost of insecticides were Tk. 2130, Tk. 1894 and Tk. 3447 for small, medium and large farmers, respectively.

Table 2. Cost of tomato production (Tk/acre)

Cost items (Tk/acre)	Small farmers	Medium farmers	Large farmers	All farmers
A. Variable cost				
Labour	27000 (47)	22400 (45)	20400 (43)	23000 (45)
Draft power and power tiller	3568 (6)	3314 (7)	2851 (6)	3244 (6)
Seed	5750 (10)	6500 (13)	5550 (12)	5446 (11)
Fertilizer				
Organic	1488 (3)	1886 (4)	3105 (6)	2159 (5)
Inorganic	7647 (13)	5908 (12)	5212 (11)	6256 (12)
Pesticide	2130 (4)	1894 (4)	3447 (7)	2490 (5)
Irrigation	5436 (9)	3636 (7)	2588 (6)	3887 (8)
Total variable cost	53019 (92)	45538 (92)	43153 (91)	46482 (92)
B. Fixed cost				
Land use cost	3167 (6)	3233 (6)	3266 (7)	3222 (6)
Interest on operating capital (@11.5 for 4 months)	1016 (2)	873 (2)	827 (2)	905 (2)
Total fixed cost	4183 (8)	4106 (8)	4093 (9)	4127 (8)
Total cost (A+B)	57202 (100)	49644 (100)	47246 (100)	50609 (100)

Source: Field Survey, 2014
Note: Figure within parentheses indicate percentage of total cost

Table 3. Yield and return of tomato production in the study area

Items	Small farmers	Medium farmers	Large farmers	All farmers
Green tomato/acre (kg)	4855	4378	3892	4375
Ripe tomato/acre (kg)	354	372	238	321
Gross return/acre (Tk)	104180	95000	82600	93920
Total variable cost acre/(Tk)	53019	45538	43153	46482
Total cost/acre (Tk)	57202	49644	47246	50609
Gross margin/acre (Tk)	51161	49462	39447	47438
Net return/acre (Tk)	46978	45356	35354	43311
Benefit Cost Ratio (undiscounted)	1.82	1.91	1.74	1.85

Source: Field Survey, 2014

Irrigation was considered as the leading input of production. Optimal level of irrigation water supply increases production. The study indicated that per acre cost of irrigation for tomato production was higher (Tk. 5436) for small farmers compared to others. Generally, irrigation costs depend on well depth, delivery system, energy costs, and management capacity etc.

Finally the overall observation was due to differences in soil quality, quantity and price shifts of inputs used, other factors, production cost were different for different farmers. To estimate the gross cost, all variable and fixed inputs cost were considered. It was found that the highest and lowest per acre gross costs incurred for small and large farmers tomato production, respectively.

3.2.2. Returns of tomato cultivation

Return was calculated by multiplying yield with its price. The gross income mostly varied with the variation of variable costs of the farms. In the study, variable costs were directly associated with farms income which was varied with the variation of farmer sizes. Return per acre tomato cultivation is presented in Table 3. The average gross returns per acre were Tk. 104180, Tk. 95000 and Tk. 82600, for small, medium and large farmers, respectively. Gross margin was estimated by deducting total variable cost from gross return. The results indicated that per acre gross margin was higher (Tk. 51161) for small farmers.

The net returns of per acre tomato were Tk. 46978, Tk. 45356 and Tk. 35354 for small, medium and large farmers, respectively. Benefit cost ratio (BCR) was a relative measure, which was used to compare benefit per unit of cost. Per acre Benefit Cost Ratio (BCR) were estimated 1.82, 1.91 and 1.74 for small, medium and large farmers. The result also indicated that, small farmer's return was higher than the medium and large farmers. It was evident from the results that tomato production was a profitable business for small farmers than medium and large farmers.

3.3. Effect of influencing factors on economic return of tomato production

For producing tomato, different types of variable inputs were selected. Considering the importance of factors affecting in tomato production, six variables such as seeds, human labour, tillage, fertilizer, irrigation and insecticides were considered as explanatory inputs. The study estimated the values of co-efficient and related statistics of Cobb-Douglas production function are presented in Table 4. It was therefore, assumed that these inputs have positive influence in tomato production. The individual effects of these inputs on the dependent variables can be explained to a certain degree by multiple regression analysis.

Human labour coefficient implied that it had a significant contribution to increase of farms return. The coefficient of human labour was 0.03 and significant at 5 percent level. It indicates that keeping other factors constant, an increase in 1 percent of money spent on human labour would increase the returns of tomato production by 0.03 percent. Farmers are rational in using this input and could have better return by increasing this input because this was statistically significant. In case of irrigation cost, the regression coefficient was 0.056 which was negative sign and significant at 10 percent level. It implies that 1 percent increase of irrigation cost keeping other factors constant, would decrease the gross return by 0.056 percent (Table 4). That means the more irrigation under production the lower would be the profitability of tomato production because of possible economic returns to scale. The results also indicated that with an additional tillage, profitability would increase by 0.168 though the contribution on production was insignificant. The possible cause of this insignificancy might be the irrational use of fertilizer for producing tomato.

The result further indicated that the coefficient of multiple determinations (R^2) was 0.694, which implied about 69 percent of variations of gross return was explained. The F-value (20.045) was significant at 1 percent profitability level implying that the variation in gross return depends mainly upon the explanatory variables included in the model. The summation of elasticity of different inputs for tomato was 0.744 which was less than one. It implies that the production function exhibited decreasing returns to scale. In this case, if all the inputs specified in the respective production function were increased by 1 percent, farm income would have

been increased by 0.744 percent and farmers have allocated their resources in the rational stage of production (stage-II). It also revealed that the inclusion of the variables were important for explaining the variation in average annual return.

Table 4. Estimated values of coefficients and related statistics of tomato production

Explanatory variables	Estimated Coefficient	Standard Error
Intercepts	5.257	0.768
Seed cost (X_1)	0.026**	0.092
Human labour (X_2)	0.03**	0.093
Tillage cost (X_3)	0.168	0.165
Fertilizer cost (X_4)	0.574	0.136
Irrigation cost (X_5)	-0.056*	0.104
Insecticide cost (X_6)	0.003***	0.136
R^2	0.694	-
F-value	20.045	-
Returns to scale ($\sum b_i$)	0.744	-

Source: Field survey, 2014
Note: *** Significant at 1 percent level, ** Significant at 5 percent level, * Significant at 10 percent level

Table 5. Identifying some major problems and constrains of producing tomato in the study area

Major problems and constrains	Percentage (%) of farmers reported			
	Small	Medium	Large	All
Production related problems				
Lack of adequate knowledge in farming	73	68	42	61
High price of seed	60	52	43	52
Lack of quality seed	65	78	68	70
Lack of capital	55	46	50	50
High cost of irrigation	44	60	52	52
Seasonal labour shortage and high wage rate	50	40	45	45
Non-availability of spray machine	15	20	18	18
Attacked by pest and diseases	55	60	68	61
Marketing problems				
High price of inputs	58	52	56	55
Low price of output at harvesting period	56	50	62	56
High transportation cost	60	68	65	64
Administrative problems				
Special loan	60	55	25	47
Lack of training and extension services	56	53	68	59

Source: Field survey, 2014

3.4. Problems and constraints of tomato production

Although tomato production was identified to be a profitable vegetable, there were several problems to its higher production, marketing and administration related. The respondents were asked to give their opinion regarding eight economic and technical related problems. Table 5 revealed that lack of quality seed was one of the most important limitations in producing tomato. About 70 percent tomato farmers reported that they were cheated by buying costly but less quality seeds from local market or seed dealers. It was evident that advanced agricultural technologies had not been properly introduced. As a result, a large number of farmers have not had adequate knowledge of applying proper doses and methods in producing tomato. Table 5 showed 61 percent tomato farmers were encountered for both lack of adequate knowledge in farming and attacked by pest and diseases.

In case of marketing problems, 64 percent farmers complained about high transportation cost as a challenge. To minimize transportation cost, farmers always try to sell their product at farm gate. At the harvesting period, large amount of tomato were sold to meet their various obligations as household expenditure and repayment of loan. Because of large amount of supply in harvesting time, they get very low selling price. It was therefore, shown from Table 5 that 56 percent tomato farmers expected a fair price and storage facility at that period.

In terms of administration problems, 59 percent farmers reported that due to lack of training and extension services from the concerned department, they failed to apply the modern method of tomato cultivation. It was also mentioned in Table 5 that more loan was needed to increase tomato production in the study area.

4. Conclusions

The socioeconomic conditions of three categories of sample households were considered composition of family size and household earning members, educational status, occupational status, land ownership pattern, income level and sources of income of the sample farmers. It was noted that as a whole 80 percent of the farmers were engaged in agriculture as their main occupation, and only 17 and 3 percent of the farmers were engaged in agriculture cum business and services. In the study, costs and returns were assessed to find out the net returns from tomato production of all categories of farmers. Based on the goodness of fit test (F-value), Cob-Douglas production function model was the best fitted and significantly affected by the resources on gross returns for the study. For all the enterprises seven explanatory variables were taken into account to explain variations in production. In the study areas selected tomato farmers faced various types of problems like, lack of capital, inadequate supply of good quality seeds, unavailability and high price of insecticides, high price of fertilizers, loss of production due to theft, inadequate storage facilities, lack of marketing facilities, lack of market information etc.

However, tomato was found to be an important, leading, and higher profitable vegetable in the study areas. There were some constraints which have hampered the tomato production. If modern inputs and production technologies were available in time, yield and production of tomato would have been increased as well as income, improved livelihood and nutritional status of rural people would have been changed. It is therefore, recommended that irrigation facilities, effective policy and efficient extension services have to be ensured to increase income and employment opportunities of the tomato farmers. It is also recommended to bring more fellow land under tomato cultivation in the study areas. Due to increased domestic consumption of tomato as human food, the present and future potential market should be established through a well-planned tomato production program at national level.

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