

Risk Attitudes and Financial Profitability of Tomato Farmers - A Study in Bangladesh

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ABSTRACT

Purpose: Tomato production in the world has increased tremendously within last few decades. Nevertheless, tomato farmers are facing production, market, price and financial uncertainty. Management of these risks is greatly influenced by their attitudes towards risk. So, the objective of this study is to determine the risk attitude and profitability of tomato farmers in Bangladesh.

Research Method: Sixty sample respondents of tomato farmers were selected from Mymensingh district. The Safety-First principle was used to estimate risk attitude coefficient while obit regression model was utilized to estimate the factors affecting risk attitudes of tomato farmers. In addition, financial profitability was analyzed from different points of view.

Findings: Most of the tomato farmers were risk averse. Results find that only 18% of farmers were risk preferring while 42% of farmers were risk averse. Risk preferences of farmers increase with training and education while risk preference decrease with age and experience. Training and education help to understand the importance of receiving newly introduced technology, timely application of seed, irrigation and fertilizer. Education assists to earn from diversified sources that make them risk preferred. The benefit cost ratio (BCR) of tomato farming was 2.31 indicating that tomato farming is profitable.

Research Limitation: A small sample size was used for this study. Therefore, policy makers should be cautious to generalize the results to a wide context of tomato farmers in developing countries.

Originality/ Value: Productivity and profitability of tomato farmers can be improved if farmers can manage different risks and uncertainty associated with production practices.

Keywords: Farmer, Profitability, Risk attitude, Tomato

INTRODUCTION

Vegetable production in the world has achieved tremendous growth in last 50 years because of new technology adoptions such as modern production practices, new variety seeds and mechanization of farming. Vegetable production is about 290.13 million tons in 2016 (FAOSTAT, 2018). Among different vegetables, tomato captures about 60% of total fresh vegetables produced in the world. Tomato is a great source of different vitamins that reduce the risk of diseases such as gastritis, prostate, breast cancer, skin erythema and coronary heart disease (Levy and Sharoni,

2005). Apart from its nutritional significance, huge productivity of tomato is the blessing for landless farmers, laborers, distressed women of developing countries because it assists to increase income and reduce inequality (Mitra and Yunus, 2018). Bangladesh, a developing

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country, has witnessed about 6.5 times growth in tomato production after its independence. Tomato is one of the major vegetables produced in Bangladesh that occupies about 25% of total fresh vegetables produced in Bangladesh. Farming system is shifting from substantial to commercial level that is responsible for increasing tomato productivity (Mitra and Prodhan, 2018). Although tomato is known as a winter vegetable, it is also available in summer season because of the development of new varieties by Bangladesh Agricultural Research Institute (BARI) and Bangladesh Institute of Nuclear Agriculture (BINA). Tomato is the second most important vegetable export commodity after potato (ITC, 2016).

Nevertheless, tomato farmers are facing production, market, price and financial uncertainty. These uncertainties are created by weather change, disease and pest infestation, market demand, supply and price variation. Increasing supply of tomato reduces market price. Although tomato is available in summer season, its supply increases in winter. Farmers face a huge financial risk when price decreases due to increasing supply (Sharmin *et al.*, 2018). Financial profitability is greatly influenced by different risk factors. Weather in Bangladesh is changing day by day. Untimely rain, drought, prolonged summer and curtailed winter severely damage tomato productivity. Management of these risks is greatly influenced by their attitudes towards risk. Businessmen and policy makers will be benefitted if they are well acquainted with the farmer's risk attitude. Risk management practices and educational programs can be tailored according to farmer's risk attitude (Sulewski and Kloczko-Gajewska, 2014). Insurance providers, seed companies and financial institutions get benefit from farmers risk attitude when developing insurance policy and marketing new seed varieties. For example; if tomato farmers are risk lovers, they easily adopt newly introduced seed varieties. Although a new variety generally provides a huge production, these varieties may be vulnerable to diseases and pests. Risk averse farmer do not want to buy newly introduced seeds. So, seed

companies must be aware about the risk attitude of farmers. Again, risk lover farmers do not want to make insurance for their farms while risk averse farmers usually have an insurance policy (Amaefula *et al.*, 2012). Risk attitude of farmers may be influenced by different socio-economic characteristics of farmers such as age, experience, education, family members, training and extension services.

There are some studies on risk attitude of fruits, vegetables, crops and aquaculture farmers in the world but very few works on tomato. John *et al.*, (2016) found that inter croppers are more risk averse than the mono croppers in Nigeria. Risk attitude influences the decisions farmers make in the agricultural production process. Vassalos and Li (2016) got the finding that younger farmers with large farm size are more likely to participate in marketing contract agreements in USA. Asci *et al.*, (2014) found that growers in Florida choose field-grown tomato due to high values and risk aversion. Fakayode *et al.*, (2012) got the result that pest and disease attack, traditional methods of farming and weather dependency were the most perceived risk in Nigeria. Maintaining good relationship with traders, selling at low price due to perishability, off-farm income and selling at local market are the major risk management strategies for fruits and vegetables. Lucas and Pabuayon (2011) found that resource-poor farmers are more likely to consider rice farming as not risky. Probably, they have little to lose or gain compared to resource endowed farmers. In addition, both resources endowed and resource poor farmers think that farming is relatively risky because of the increasing price of fertilizer and environmental factors such as unfavorable weather. Farmers also found that rice and corn are relatively risky than other crops in Philippines. Lee and Cheong (2010) perceived price and production are the most significant risks. Farm management and technical measures are perceived to be more effective than other risk management strategies in Vietnam. Jin *et al.*, (2007) found that under uncertainty the traditional NPV rule for aquaculture investment decision should be

modified. As far as the author's awareness, risk attitude of tomato farmers in Bangladesh has not carried out. Therefore, the objective of this study is to determine the relationship between risk attitude and profitability of tomato farmers in a selected area of Bangladesh.

MATERIALS AND METHODS

Sampling Procedure and Data Description

Mymensingh is one of the largest districts of Dhaka division. This district covers an area of 4363.48 km² which lies between 24°15' and 25°12' of northern latitudes and between 90°04' and 90°49' of eastern longitudes. Temperature of Mymensingh is ranging from 12 to 33° C and average annual rainfall is about 2174 mm. This is a promising area of Bangladesh for tomato production that witnessed about 98% increase in the last 8 years. In 2015, about 6800 MT tomato was produced in Mymensingh (BBS, 2015-16). Two upazillas of Mymensingh district named Mymensinghsadar and Muktagacha were selected purposively based on the production of tomato. These two upazillas occupy about 60% of total tomato production of Mymensingh (District Statistics, 2013). In this study, sixty sample respondents of tomato farmers were selected from four villages namely, Uzanchahier chor, these two upazillas using stratified random sampling techniques (Figure 01). A pre-tested

interview schedule and direct interview method are used for the collection of cross-sectional data. Data is collected on input used, output produced, credit accessibility, socio-economic characteristics of farmers.

Analytical Techniques

Both inferential statistics and econometric techniques are utilized for data analysis. Inferential statistics such as mean and standard deviation are used while ordinary least squares technique is used for estimation of equations.

Estimation of Risk Attitude

The Safety-First principle is used to estimate risk attitude coefficient. Safety-First principle was first introduced by Kataoka (1963). This model was modified by Moscardi and de Janvry (1977) and utilized by Amaefula *et al.*, (2012). This principle assumes that the objective of a farmer is to minimize the probability of experiencing variability in tomato production. The Cobb-Douglas production function is used for functional analysis of the data. It is a homogeneous function that assists to measure the return to scale and interpret the elasticity coefficients. The productivity of tomato is likely to be influenced by different factors like human labor, seed, fertilizer, pesticide, irrigation etc. The empirical form of the Cobb- Douglas regression equation is as follows:



Figure 01: Selected study areas (Mymensinghsadar and Muktagacha) in Mymensingh district

$$Y = AX_1^{\beta_1} \cdot X_2^{\beta_2} \cdot X_3^{\beta_3} \cdot X_4^{\beta_4} \cdot X_5^{\beta_5} \cdot e^u \quad (5) \quad K = \frac{1}{\theta} \left(1 - \frac{P_i X_i}{P f_i \mu y}\right) \quad (8)$$

Taking logarithm in both sides of equation (1) got the form

$$\ln Y = A + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + u \quad (6)$$

Where,

Y = Productivity of tomato per hectare;

A = Intercept;

β_1, \dots, β_5 = Partial regression coefficients;

X_1 = Quantity of labor per hectare;

X_2 = Quantity of Fertilizer per hectare;

X_3 = Cost of Irrigation per hectare

X_4 = Cost of Seed per hectare;

X_5 = Cost of Pesticide per hectare and

U = Error term.

The risk aversion coefficient for each producer is obtained from equation (5). Fertilizer is selected among other inputs in estimating risk attitude coefficient because it is the main input of tomato production. Moreover, it is the most significant input because of its importance in increasing yield of tomato. The elasticity of fertilizer which is similar to the coefficient of fertilizer in the production function is used for calculating this coefficient. Coefficient of variation of output, output and input prices are used to estimate a value of K for each farmer. The coefficient of variation of productivity (θ) is calculated from summary statistics of tomato productivity in equation (7).

$$\theta = \frac{\sigma_y}{\mu_y} \quad (7)$$

Where,

σ_y = standard deviation and

μ_y = mean yield.

The risk attitude coefficient (K) is computed in equation (8):

Where,

K = risk parameter;

θ = coefficient of variation of productivity;

P_i = Input price (fertilizer price/kg);

X_i = Input quantity (fertilizer kg/ha);

μy = mean yield (kg/ha);

f_i = elasticity of fertilizer input and

P = price of output (per kg)

The farmers are classified into four groups based on the risk parameter k following the work of Moscardi and de Janvry (1977). A farmer is risk preferring if $k < 0$, low risk averse if $0 < k < 0.4$, intermediate risk averse if $0.4 \leq k \leq 1.2$ and high risk averse if $1.2 < k < 2.0$.

Factors Determining Risk Attitude of Tomato Farmers

Tobit regression model, developed by James Tobin, is utilized to estimate the factors affecting risk attitudes of tomato farmers. This is also known as censored regression model. Several previous studies used tobit regression model for investigating the factors affecting risk attitude (Yusuf *et al.*, 2015). Risk attitude is ranged from $k < 0$ to $k < 2.0$ and this model is shown in equation (9):

$$K = \alpha_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + e \quad (9)$$

Where,

K = Risk parameter;

α_0 = Intercept;

β = Coefficient;

X_1 = Age (years);

X_2 = Education (Years of schooling);

X_3 = Family member (number);

X_4 = Experience (Years);

X_5 = Training (dummy) and

e = error term.

Risk parameter of tomato farmers is the dependent variable in the tobit regression model. Age, education, family members, training and experience are independent variables and these variables are hypothesized to have a positive influence on risk attitude of tomato farmers. In addition, STATA-14 was used for estimating Cobb-Douglas production function and tobit regression.

Profitability Analysis of Tomato Production

Return was calculated by multiplying yield with its price. The gross return was estimated as follows in equation 1:

$$\text{Gross return, GR} = \Sigma QP \quad (1)$$

Where, GR = Gross return from tomato (Tk. / hectare); Q = Quantity of the tomato; P = Average price of the tomato.

Gross margin was calculated by subtracting the total variable costs from the gross return (Sharmin *et al.*, 2018), showed in the following equation 2:

$$\text{GM} = \Sigma \text{GR} - \text{TVC} \quad (2)$$

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

Net return was calculated by deducting total costs from gross return as shown in the equation. The formula for calculating net return of tomato production is as follows in equation 3:

$$\text{Net return, NR} = \Sigma (\text{GR} - \text{TC}) \quad (3)$$

Where, GR = Gross return; and TC = Total cost.

The Benefit-Cost Ratio (BCR) is a relative measure which is used to compare benefit per unit of cost. BCR was estimated as a ratio of gross returns to total costs (Sharmin *et al.*, 2018) showed in the following equation 4:

$$\text{Benefit cost ratio, (BCR)} = \frac{\text{Gross Return}}{\text{Total Cost}} \quad (4)$$

RESULT AND DISCUSSION

Summary Statistics

Summary statistics of productivity, input used in production and socio-economic characteristics of tomato farmers are presented in Table 01. Average yield of tomato was found 21067 kg per hectare ranging from a minimum of 9000 kg to as maximum as 35000 kg. Mean yield of BARI hybrid tomato was found 32780 kg per hectare (Baree, 2012). Labor was the main input for producing tomato. Quantity of labor per hectare was 16 man days and a period of eight hours was considered as one man days. Irrigation cost was the second most important cost (Tk. 23057/ha) item of tomato farmers. Timely irrigation helps to increase tomato productivity (Djidonou *et al.*, 2013). Most of the farmers had much experience on tomato farming and they are middle aged. Result also found that farmers' family size was much higher than average family size of Bangladesh (BBS, 2015-16). Young members of the family can work as a family labor that will reduce the hired labor cost. Older farmers had a larger family size and young members of this family contributed to the farm as a labor (Peter and Susan, 2014). In addition, average education (years of schooling) of tomato farmers was 9 years. Education assists to adopt new production techniques and increase productivity.

Determination of Risk Attitude Coefficient

The Safety-First principle assumes that the farmer's objective is to minimize the probability of experiencing variability (a shortfall) in output or income below a certain initial level (Amaefula *et al.*, 2012). Assume that, first principle holds and the degree of risk aversion is derived from an observed behavior. Observed behavior can be found from the production technology of tomato farmers. The observed level of inputs use exposes the risk attitude of tomato farmers. First stage of method involves the estimation of production function that shows the direct relationship between input vector (X) and output (Y). Then the most significant input

variables are determined from the estimated function based on signs and coefficients of significant variables. Table 02 presents the estimation results from the Cobb-Douglas production function. In addition, few goodness-of-fit measures are reported. One measure is the coefficient of multiple determination (R^2). The value of R^2 is 0.79 that means 79 percent of the variation in tomato productivity is explained by the explanatory variables included in the model. A second measure is the overall fit of the estimated regression. F-value (42.9) is significant at 1 percent level of significance implies that all explanatory variables included in the model are important for explaining the variations in productivity of tomato.

Quantity of fertilizer is the most significant input with the coefficient of 0.36. In addition,

irrigation water per hectare is also significant but its coefficient is a little bit lower than fertilizer. Elasticity of scale can be calculated from the estimated coefficients. The sum of estimated coefficients for tomato farmers is 0.66 that implies farms are operating under decreasing returns to scale. Inputs used in production process can be divided into modern and traditional inputs. Modern inputs are fertilizer, irrigation and pesticide while traditional inputs are seed and labor. Modern inputs have larger share in total output elasticity. Factor share for modern and traditional inputs are 0.65 and 0.02 that shows the importance of modern inputs in production process. Alene and Manyong (2007) also found that modern inputs capture large share of output elasticity.

Table 01: Summary statistics for tomato farmers

Variable	Mean	Std. Dev.	Min	Max
Productivity (kg/ha)	21066.50	5718.07	9000.00	35000.00
Quantity of labor (man-days/ha)	16.38	9.58	5.00	45.00
Quantity of fertilizer (kg/ha)	2362.71	752.04	1100.00	3500.00
Cost of irrigation (Tk./ha)	23057.27	10014.66	10000.00	45900.00
Cost of seed (Tk./ha)	5392.78	1785.09	1600.00	7410.00
Cost of pesticides (Tk./ha)	6955.03	5102.05	1600.00	16000.00
Risk attitude parameter	0.78	1.04	-1.78	2.10
Age (Years)	41.7	16.38	20	67
Family member (No.)	5.73	1.23	3	8
Education (Year of schooling)	8.97	2.29	4	16
Experience (Years)	11.08	1.66	8	16
Training (in days)	9.67	13.23	0.00	60.00

Table 02: Estimates of Cobb-Douglas production function

Variables (per hectare)	Coefficient	Std. Err.	t	P-value
Quantity of labor (x1)	-0.01	0.03	-0.47	0.63
Quantity of fertilizer (x2)	0.36**	0.15	2.37	0.02
Cost of irrigation (x3)	0.29**	0.11	2.57	0.01
Cost of seed (x4)	0.03	0.04	0.9	0.37
Cost of pesticides (x5)	0.00	0.08	-0.05	0.96
Constant	4.05***	0.51	7.93	0.00
R^2	0.79			
Adjusted R^2	0.78			
F-value	42.9***			0.00
Returns to scale	0.66			
Factor shares (Traditional inputs)	0.02			
Factor shares (Modern inputs)	0.65			

***, **, * represent significant at 1%, 5% and 10% level

The elasticity of quantity of fertilizer (x_2), coefficient of variation (θ), output price per kg and factor price per kg are utilized in determining the risk attitude coefficient. The risk attitude coefficient is specific for each farmer. In Figure 02, the calculated coefficients were classified into four groups based on their risk attitudes named risk preferring, low risk averse, intermediate risk averse and high risk averse. Results find that only 18% farmers are risk preferring while 42% farmers are risk averse. Therefore, most of the farmers are not interested to take risk. Because of their risk averseness, they may not easily accept newly introduced technology such as hybrid seeds or machinery. Amaefula *et al.*, (2012) found the similar result for poultry birds.

Determinants of risk attitude of tomato farmers

Risk attitude of tomato farmers are affected by different socioeconomic factors such as age, education, experience, training and family size. Age, education and training are significant at 1% while experience is significant at 10% (Table 03). Negative coefficient of education (-0.04) shows the negative effect of education on the risk preference of tomato farmers. That is the higher the years of schooling, the lower is the incidence of risk averseness. Educated farmers can easily attend any kind of training programs and workshops. They can understand the importance of receiving newly introduced technology. Moreover, educated farmers can earn from diversified sources that assist farmers to adopt newly invented technology. Amaefula

et al., (2012) found the opposite result. In addition, training programs is negatively related with farmers' risk attitude coefficients. Negative coefficient (-0.05) means the higher the training received, the lower the risk averseness. Different government and non-government organizations arrange training for tomato farmers. Training on tomato farming introduces the farmers with new variety seeds, pesticides and machinery (Schreinemachers *et al.*, 2016). Furthermore, farmers become aware about the timing of input application that reduces the production risk. Therefore, training facility increases the risk preference.

Positive coefficient of Age (0.02) implies that risk aversion increases with the age of tomato farmers. Generally, aged farmers are risk averse. They are not interested to adopt new farming techniques with associated risk (Albert and Duffy, 2012). Amaefula *et al.*, (2012) found similar result. In addition, tomato farmers' experience has positive relation with farmers' risk attitude that is shown by the positive coefficient (0.03). So, risk aversion of tomato farmers increases with their experience. Sometimes, experienced farmers apply their own experience in their farm instead of receiving new farming techniques. They think that modern technology may not congenial for tomato farming. Amaefula *et al.*, (2012) found the similar result. In addition, family size is positively related with risk attitude coefficient but it is insignificant.

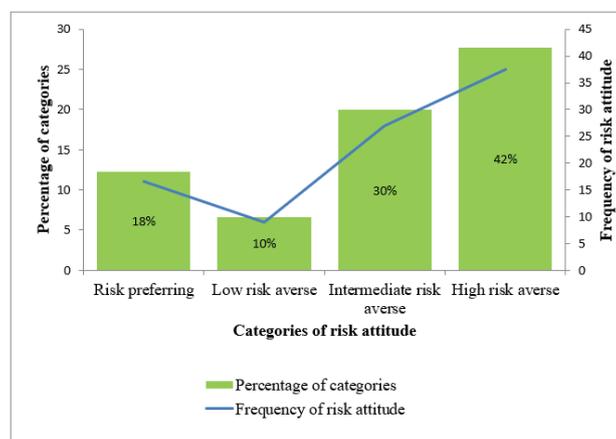


Figure 02: Distribution of risk attitudes coefficient

Table 03: Influence of socio-economic characteristics on risk attitude

Variables	Coef.	Std. Err.	t	P-value
Age	0.02	0.01	3.12	0.00
Family member	0.03	0.04	0.72	0.47
Education	-0.04	0.02	-2.6	0.01
Experience	0.03	0.02	1.73	0.08
Training	-0.05	0.00	-10.77	0.00
Constant	0.38	0.40	0.94	0.34
LR chi2				177.12
Prob> chi2				0.00

Table 04: Financial profitability of tomato farmers (per hectare)

Items	Value of cost and return	Percentage	
		Based on total cost	Based on variable cost
Variable cost			
Seed cost	5392.78	2.36	5.43
Human Labour cost	26354.9	11.55	26.5
Land preparation cost	5237.512	2.29	5.27
Irrigation cost	23057.3	10.11	23.2
Fertilizer cost	9733.134	4.26	9.80
Manure cost	3804.22	1.66	3.83
Pesticide cost	6955.03	3.05	7.01
Loading and transportation	18723.46	8.21	18.86
Total variable cost	99258.34	43.52	100
Rent on land	98800	43.32	
Depreciation of fixed assets	30000	13.15	
Total Fixed cost	128800	56.47	
Total cost of production	228058.30	100	
Returns			
Gross Return (GR)	526663.80		
Gross margin(GM)	427405.50		
Net return(NR)	298605.50		
Benefit cost ratio(BCR)	2.31		

Source: Field survey, 2017

Financial Profitability of Tomato Production

This study also focused on the financial profitability analysis of tomato farmers. All costs and returns were calculated for the duration of one year operation. The cost of using variable inputs and fixed inputs were calculated. Variable inputs were human labor, seed, fertilizer, manure, land preparation, pesticide, irrigation, loading and transportation cost while fixed inputs were depreciation of fixed assets, rent on land. Table 04 revealed that the total variable cost of tomato cultivation was Tk. 99258.34 per hectare which was 36.41 percent of total cost

of tomato production. Fixed cost of production was slightly higher than the total variable cost which was 47.25 percent of total cost of tomato production. Among the different cost items, labor and irrigation cost were the major variable cost items which accounted for about 26.55 and 23.22 percent of the total variable cost. Average gross return of tomato production was Tk. 526663.80 per hectare while gross margin was observed to be Tk. 427405.50. The benefit cost ratio (BCR) of tomato farming was 2.31 indicating that tomato farming is profitable. Karim *et al.*, (2009) found that benefit cost ratio for small, medium and large farmers was 4.22,

4.16 and 4.19 respectively. Kushwaha *et al.*, (2018); Parvin (2017) and Samshunnahar *et al.*, (2016) also found the similar result. So, tomato cultivation is profitable.

CONCLUSION

This study examines tomato farmers' attitudes towards risk and its determinants. About 42% tomato farmers are high risk averse. They are not interested to take risk in tomato production. Moreover, tomato farmers risk attitude is influenced by different socioeconomic factors. Risk preferences of farmers increase with training and education while risk preference decrease with age and experience. As tomato farmers are risk averse, seed marketing companies should be careful before marketing new variety seeds. Although crop insurance is not practiced in large scale, insurance companies can formulate new policies. Tomato farmers may be interested to open a crop insurance policy. Moreover, machinery importers need to be more aware about the farmers risk attitude. Education of tomato farmers should be ensured. Already government of Bangladesh has taken many steps to increase farmers' education.

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Further steps are needed to be taken for increasing farmers' education and their risk preference. Training facility for farmers should be enhanced. Availability of quality training for tomato farmers increases their risk preference. Agriculture officers can encourage aged farmers to receive new technology that reduces farmers' risk aversion. In addition, tomato farming in the selected area of Bangladesh is profitable. This study will enrich the literature of risk aversion and help to enhance productivity and profitability of tomato in Bangladesh.

Data Availability Statement

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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