Research article

Financial and factor demand analysis of broiler production in Bangladesh

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ABSTRACT

Financial and factor demand analysis of broiler production has been estimated in this paper using a farm survey data of 210 farmers from four major broiler producing areas (i.e., Dhaka, Rajshahi, Mymensingh and Chittagong) of Bangladesh. Findings showed that broiler farming incurred most of its cost from its operating input, mainly feed. Broiler farming was financially profitable, but the performance of Mymensingh division was comparatively low, arising from a high unit cost of production and low unit price selling than the others. The net return was highest in Dhaka division, while Rajshahi division showed the highest ratio in returns on investment. However, in terms of cost (variable) and net return of broiler farming, no significant difference among the study areas was observed. The value of own price elasticity for feed, chick price, and labour price were negative and inelastic, which were -0.00249, -0.05718, and -0.13101, respectively. Besides, a complementary relationship was found between feed and day-old chick and feed and labour while day-old chick and labour were substitutes. The study also revealed that cross price elasticity was highly inelastic, and changes in the prices of inputs did not result in massive changes in the quantity demanded of other inputs for broiler farming.

1. Introduction

Livestock is one of the crucial sectors in the national economy and significantly contributes to agriculture and the gross national product of Bangladesh. The agricultural sector contributes 10.67% of the GDP, whereas the livestock and poultry sub-sector contributes 1.53% (BER, 2018). Furthermore, it is pivotal for the rural economic system as maximum households in Bangladesh are directly or indirectly involved in livestock farming. The poultry industry is one of the significant livestock sub-sectors committed to supplying animal protein in eggs and protein at a low price to the nation (Das et al., 2008). It also plays a vital role in reducing malnutrition and fostering the nation's agricultural sector (Silva and Rankin, 2014). Thus, the poultry industry can attain the Sustainable Development Goals (SDGs) by reducing malnutrition and promoting better health for Bangladesh. Poultry farming is currently contributing to the employment sector by creating more than 6 million jobs by direct, indirect employment, including support services (Ansarey, 2012). Also, the poultry sector has proved an attractive investment opportunity sector in Bangladesh (Hamid et al., 2017). Thus, the number of poultry farmers on a commercial basis is being increased in Bangladesh, which is regularly expanding. For instance, in 2008–2009, the poultry population of Bangladesh was 2626.28 lakh, which was increased to 3379.98 lakh in

2017-18 (DLS, 2018). Nonetheless, bird rearing is mostly substance practice, but poultry is largely commercially produced in Bangladesh. Poultry meat, especially from broiler, is superior to other types of meat available for human consumption since it is tender, palatable, and easily digestible. Interestingly, a broiler requires less capital, and it has a shorter life cycle in production than other meat-producing animals (Jabbar and Green, 1983). Besides, broiler meat can rapidly and efficiently fulfil the shortage of protein requirements as it can be produced within a short time compared to that of other animals (Mbuza et al., 2017). The demand for broiler meat has been rising daily as most people, irrespective of caste and religion, prefer chicken (Hossain et al., 2011). The percentage of broiler consumption in Bangladesh accounted for 40% of the total meat consumed in 2018, and per capita broiler meat consumption is 6.3 kg per year, which is expected to reach around 7 kg in 2020 (WPSA-BB, 2018). Thus, to meet the future growing demand for broiler meat in Bangladesh, broiler farms must operate sustainably and efficiently to maintain sustainable profitability in this industry and encourage future investment in this sector.

Even though studies (such as; Akter et al., 2015; Chowdhury and Chowdhury, 2015; Hassan, 2018; Islam et al., 2010; Kawsar et al., 2013; Rana et al., 2012, etc.) have proved that broiler production is a profitable farming practice in Bangladesh, relevant issues such as production

accessibility, sustainability, and non-optimal resource utilization may exist. Moreover, these factors regarding poultry farming can vary from one area to others and a small margin between cost and revenue forced the farmers to accept relatively small profits (Abdurofi et al., 2017). Furthermore, the outlook on net returns is not promising for the new investment in this sector, thus deterring the new investment (Rahman et al., 2003). Hassan (2018) found that because of high per unit cost and increased management cost, in the long run, small farms experience less efficiency than large farms in Bangladesh. Many researchers found that the relatively higher cost of broiler feed is a major cause for less performance of the industry (Chanjula and Pattamarakha, 2002; Elsedig et al., 2015). The benefits from broiler production depended on supplying the birds with the highest possible quality of feed. Simultaneously, the scarcity of raw materials was one of the significant problems for feed mills operation, which influenced poultry feed price and quality (Haque et al., 2016). Kawsar et al. (2013) found that feed conversion ratio was considered an important factor for determining the farm profitability, which resulted from the quality of chicks and feed and the broiler farm's management techniques. To ensure a continuous and sustainable supply and consumption of broiler meat in Bangladesh, the factors that heighten the profitability of broiler farming must be scrutinized.

The available literature review suggests that there are a large number of studies (such as Khan and Afzal, 2018; Abdurofi et al., 2017; Akter et al., 2015; Chowdhury and Chowdhury, 2015; Kawsar et al., 2013; Rana et al., 2012, etc.) conducted on profitability analysis of broiler farming. Most of these research analyzed the profitability only in a single area and not in different regions of a country except Abdurofi et al. (2017). Even the study coverage, as well as the sample size, was limited in these studies. As far as researcher's knowledge is concerned, no study has been found that has compared the existing financial condition of farmers, total net income, the marginal cost of production, input-output ratio of broiler production, and elasticity of input demand in different divisions of Bangladesh. Therefore, this study was undertaken to fill up the research gap. A very few studies (Grisley and Gitu, 1985; Garcia and Randall, 1994; Islam and Islam, 2010; Rana et al., 2021) were found that examined the input demand and elasticity of substitution. However, the nature of the responsiveness of broiler farmers to changes in input prices is not known at all. This information is essential because of the expected volatile business in the broiler sector necessitated mainly by the high cost of production. So, a factor demand analysis aimed at suggesting the effect of different cost items in broiler production is essential for newcomers and policy formulation in Bangladesh.

Given this backdrop, the present study explicitly addressed the critical research gap in knowledge on the farm-level financial condition and nature of responsiveness of the broiler farmers to input price changes, which will enable the formulation of policies appropriate for promoting the broiler sector. Specifically, the study aims to: (i) assess existing financial conditions of farmers, total net income, the marginal cost of production and the input-output ratio of broiler farming and (ii) estimate the elasticity of substitution and elasticity of demand for broiler farming in Bangladesh.

2. Materials and methods

2.1. Data and the study area

Primary data have been used in the study, and purposively selected four different broiler producing areas viz—Dhaka, Rajshahi, Chittagong, and Mymensingh, covering four divisions of Bangladesh. Many broiler farms exist in those areas, and the availability of data on broiler operations has made the researchers to choose these divisions as the study areas. A total of 210 farmers were selected randomly based on data available in the study areas. The primary data were collected by personal interview method via a questionnaire that had been pretested and improved before actual interviews. The data collection process covered two months period from August to September 2019. The collected data were analyzed and summarized to fulfil the objectives set for the study.

2.2. Analytical techniques

Both descriptive and statistical techniques were used to achieve the primary objectives of the study. Descriptive statistics were used to represent the socioeconomic characteristics of the respondents, which provide summary data, including education level, the age of farmers, working experience, the scale of broiler business, and source of capital. Two main analytical tools were used to address the objectives such as (a) farm budgetary technique to find the cost of production, farmers financial condition, input-output ration and total net income of producing broiler at the farm level, and (b) translog cost function to estimate input demand and elasticity of substitution of production at the farmer level. The details are as follows:

2.3. Farm budgetary technique

This research used farm budgetary techniques to compute financial indicators such as variable cost, net return, and input-output ratio by following Abdurofi et al. (2017). Besides these calculations, feed conversion ratio is also used by researchers for comparing the farm profitability. Farmers always operate farms in an efficient way for keeping the feed conversion ratio as lower as possible. Feed conversion ratio (FCR) has been estimated by using the following formula (Abdurofi et al., 2017) with the equation number (1):

Feed Conversion Rate equation:

$$\frac{Total\ Feed\ (kg)}{Total\ Weight\ (kg)} = FCR \tag{1}$$

If the FCR is 2, it implies that 2 kg feed is converted into 1 kg meat by farm management and technology.

Furthermore, a one-way ANOVA test compares the costs and returns of broiler farming among the study areas.

2.4. Translog cost function

Translog cost function analysis was used to investigate the effect of inputs on the cost of broiler production. Duality in production economics has enabled for estimating the cost function parameter and rely on the production function information by linking cost and production function relationships. However, cost function commonly used for estimating the elasticity of substitution and input demand elasticities (Binswanger, 1974; Lopez, 1988; Ray; Akridge and Hertel, 1986; Paul, 1987; Capalbo and Antle, 1988). The elasticities are calculated from the cost function to estimate the change in input demand from the change in the input prices. This estimation can be used as a basis to understand the behaviour of input in broiler production. The choice of cost function over production function can be attributed to several reasons. First of all, for an estimation equation, imposing homogeneity of degree one is a necessary condition in the production process (Binswanger, 1974). Regardless of the homogeneous properties in the production function, the cost function usually is homogeneous to price. Increasing the price of a product will increase production cost, not the ratio of the factors. The translog cost function method deals conveniently with neutral and non-neutral efficiency differences and economies of scale among observational scales (Christensen et al., 1971). Finally, the presence of high multicollinearity among the input variable causes problems in estimation. However, a little presence of multicollinearity among the factors price does not create a severe problem in cost function analysis.

The translog cost function estimates the approximate true minimum cost using a second order logarithmic Tylor series expansion around variable levels of output, Q, and input prices P_i ($i = 1, \ldots N$). The equation expressed mathematically as a cost function in the logarithms forms:

$\ln C = f(\ln P_i, \ldots, \ln P_n; \ln Q)$

where ln is the natural logarithm, C is the cost of production, and P_i are input prices, and Q is output.

Now, function generates the translog cost function based on second order Tylor series expansion with the equation number (2):

$$\ln C = \alpha_0 + \alpha_Q \ln Q + \frac{1}{2}\beta_{QQ}(\ln Q)(\ln Q) + \sum_i \alpha_i \ln P_i$$
$$+ \frac{1}{2}\sum_i\sum_j \beta_{ij}(lnP_i)(lnP_j) + \sum_i \delta_{qi}(lnQ)(lnP_i) \quad (2)$$

where α, β, and δ are parameters to be estimated.

A three-input translog cost function was assessed using seemingly unrelated regression (SURE) where two share equations were estimated simultaneously. Hence, the simultaneous system of equations to be assessed, imposing symmetry and homogeneity (deflating by the price of labour). The estimated equation is as follows with the equation number 3:

$\ln(C/P_L) = \alpha_0 + \alpha_f \ln(P_f/P_L) + \alpha_{ch}\ln(P_{ch}/P_L) + \alpha_q \ln Q + \frac{1}{2}\beta_{ff}\ln(P_f/P_L)^2 + \frac{1}{2}\beta_{chch}\ln(P_{ch}/P_L)^2 + \frac{1}{2}\beta_{qq}\ln(Q)^2 + \beta_{fch}\ln(P_f/P_L)^* \ln(P_{ch}/P_L) + \beta_{fq}\ln(P_f/P_L)^* \ln Q + \beta_{chq}\ln(P_{ch}/P_L)^*\ln Q \quad (3)$

Where, P_f = price of feed, P_{ch} = price of day-old chick and P_L = price of human labour. The selection of these inputs was based on two considerations: (i) the shares of these inputs into total expenditure are relatively high, and (ii) input price and expenditure data exist for each firm.

In this study, restrictions imposed in assessing translog cost function are given below:

(1) Adding up criteria imply that the sum of the cost-shares must equal unity.

Symbolically, $\sum_i \alpha_i = 1 \sum_i \beta_{ij} = 0$
$\sum_i \delta_{ij} = 0$

(2) Symmetry implying that typical properties of neoclassical production theory are satisfied.

$\beta_{ij} = \beta_{ji}$

(3) Concavity in input price implies that the partial elasticity of own price must be negative.

However, according to Shephard (1953), the share of input cost in total cost can be regarded as share in total production, which is called Shephard's Lemma. Following the Shephard's Lemma, the cost minimization share equation for inputs in the production process can be obtained by differentiating Eq. (3) concerning input prices.

The derived demand equations and the cost-share equations are as follows with the equation number 4 and 5:

$$S_f = \frac{\delta lnC}{\delta lnPf} = \alpha_f + \beta_{ff}\ln(P_f/P_L) + \beta_{fch}\ln(P_{ch}/P_L) + \beta_{fq}\ln Q \quad (4)$$

$$S_{ch} = \frac{\delta lnC}{\delta lnPch} = \alpha_{ch} + \beta_{chch}\ln(P_{ch}/P_L) + \beta_{fch}\ln(P_f/P_L) + \beta_{chq}\ln Q \quad (5)$$

Here, S_f and S_{ch} are the cost shares of feed and day-old chick cost.

In the above equation, several parameters emerged more than once in the cost-share equation and again, all the cost-share equation parameters appeared in the translog cost function. The equality of these parameters is a necessary condition for the system of the equation to be consistent with the cost-minimizing behaviour. All the costs function of broiler

production was normalized by the other cost so that the three cost shares reduced at two cost shares and all the terms with other costs vanished. The cost minimized share function for this study were estimated using iterative seemingly unrelated regression (ISUR) method. This method adjusts the contemporaneous correlation in cross equation. Moreover, this method ensures the invariant estimation to the excluded equation and coverage asymmetrically for maximum likelihood estimation (Berndt and Savin, 1975).

In the cost shares equations, the estimated coefficients do not have any clear economic meaning, but these form the basis for deriving the elasticities of substitution and demand. Uzawa (1962) has demonstrated that the Allen price elasticity of substitute (APES) between two inputs i and j, which can be expressed as follows with the equation number 6:

$$\sigma_{ij} = \frac{CiCij}{CiCj} \quad (6)$$

where $C_i = \delta C/\delta Pi$ and $\sigma_{ij} = \delta^2 C/\delta Pi\delta Pj$

Here, σ_{ij} denotes APES between inputs i and j. The above equation is given in general terms and the elasticities of substitution for two inputs are symmetric. Now, for the translog function, the APES and own price elasticity are presented with the equation number 7 and 8,

$$\sigma_{ii} = \frac{\beta ii + Si(Si - 1)}{Si^2} \quad \text{for all i,} \quad (7)$$

$$\sigma_{ij} = \frac{\beta ij + SiSj}{SiSj} \quad \text{for all } i \neq j \quad (8)$$

Where Si and Sj are the shares of the i-th and j-th input, respectively. Here, the positive value of APES between i and j indicates a substitute relationship between i and j and the negative value implies the complementary relationship between these two variables. The APES relationship between two variables assesses the response of one variable for quantity demand for the change in price of other related variables by keeping the output constant but, others quantities of different factors can vary.

Allen (1938) demonstrates the relationship between elasticity of substitution and elasticity of input demand as below with the equation number 9 and 10:

$$E_{ii} = \frac{\delta lnXi}{\delta lnPi} = \frac{\beta ii + Si(Si - 1)}{Si} = S_i\sigma_{ii} \quad (9)$$

$$E_{ij} = \frac{\delta lnXi}{\delta lnPj} = \frac{\beta ij + SiSj}{Sj} = S_j\sigma_{ij} \quad (10)$$

Where Es denotes the elasticities of input demand for broiler inputs. Here, it is assumed that cross price elasticities are not equal; thus, the share of input of ith are not equal to the share of the jth input.

2.5. Ethical standard

The ethical standard of this research has been approved by the Ethical Review Committee (ERC) of Research Management Committee (RMC) of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU). Data gathered for this research were treated confidentially. Participation in this survey was anonymous, voluntary, and consent of all prospective respondents was ensured prior to the interview.

3. Results and discussion

3.1. Socioeconomic characteristics

Studying farmers' socioeconomic characteristics is crucial for describing broiler farming, ownership, and other social perspectives in

Table 1. Socioeconomic characteristics of broiler farmers.

Category	Number	Percentage
Age of farmers (years)		
Young (20–30)	22	10.48
Middle aged (30–50)	152	72.38
Old (>50)	36	17.14
Educational Level (years)		
Below Primary	20	9.52
Secondary	143	68.10
More than Secondary	44	20.95
Experience of broiler farming		
Less than 5 years	54	25.71
5–10 Years	110	52.38
More than 10 years	46	20.95
Scale of Business according to farm size		
Small (<1000 birds)	124	59.05
Medium (1000–2000 birds)	78	37.14
Large (>2000 birds)	8	3.81
Source of credit		
Owner/shareholder capital	119	56.67
Loan from other sources (Bank, money lenders etc.)	91	43.33

Bangladesh. The categories include the age of farmers, educational background, working experience, business scale, and sources of capital. The data disclosed that with regards to age, the majority of the farmers were middle aged (72.38%), which is supported by the findings of Rahman and Halcyan (2012). Broiler production is generally a capital-intensive business in Bangladesh and this counteracts newcomers from entering the industry. This can be the reason for explaining the fewer number of young farmers (10.48%) in the industry. Moreover, maximum (68%) number of farmers completed secondary education where 20.95% of respondents studied more than secondary and 9.52% have obtained primary school certificates. The results on education level were in line with Islam et al. (2014a) and Rahman and Halcyan (2012). On the experience side, the majority (52.38%) respondents have 5–10 years experience, 20.95% of respondents have more than 10 years experience and 25.71% respondents have 0–5 years experience. Similar results were reported by Abdurofi et al. (2017). To assess their resource productivity, management, and sustainability, farmers were classified into three categories in terms of the number of birds reared in the farm; small scale (less than 1000 birds), medium scale (1,001–2,000 birds), and large scale (above 2,000 birds). The result showed that around 96% of farmers are fall in medium and small scale categories where rest of them in large scale categories. A similar finding is reported elsewhere (Islam et al., 2014a; Sultana et al., 2012) that most farmers are focused on small and medium scale operators in Bangladesh. Credit is considered one of the most important tools in the farming business that enables farmers to purchase input and have the optimal amount of working capital for generating yield. The study revealed that 56.67% of the broiler farmers source their credit independently, while 43.33% of the farmers rely on loans from different sources to raise credit for broiler production (Table 1). This result is consistent with the previous findings of Alam et al. (2014).

3.2. Broiler production and price

The result indicates that the number of broilers rearing per farm among each division differs slightly (Table 2). Dhaka division has the highest number of day-old chick while Mymensingh produced a fewer number of day-old chicks. However, it is crucial to estimate the precious information of FCR which varied area to area for findings of the feed consumptions of each birds (Sahzadi et al., 2006). The Mymensingh division maintains the highest FCR of 1.75 implying that the consumption

of 1.75 kg of corn-based feed will increase the bird's weight by one kilogram. The feed conversion ratios were 1.43, 1.49, and 1.43 for Dhaka, Rajshahi, and Chittagong divisions, respectively, which supported the findings of Rudra et al. (2018), Dutta et al. (2012), and Islam et al. (2014b). The higher FCR value in Mymensingh division might be the result of a smaller farm size and management practices.

3.3. Cost of production

There were two fixed costs, such as housing and broiler equipment cost and the components variable costs were feed, day-old chick, labour, veterinary, utility, veterinary, etc. As expected, feed cost accounts for the highest amount (74.52%) of the total cost, which supported the findings of Chowdhury and Chowdhury (2015). The second highest cost component is the day-old chick constituting about 5.76% of the total cost (Table 3). However, the output level directly relates to the total variable cost particular to a business and varies with scales (Ahmad et al., 2008). These variable costs are mainly present as working capital and apply to the production cycle (Nix, 1979). Overall, the total variable cost among different divisions in Bangladesh differs; Dhaka spends heavily due to the highest annual broiler production compared to other divisions, while Mymensingh represents the minor result of less yearly production. Besides, the study found significant differences among four regions in terms of fixed costs and six variable costs (i.e., labour, day-old chick, utility, veterinary, lamp, and polyethene costs) (Table 3). In a nutshell, the results reflect that the geographical and socioeconomic factors play dominant roles in cost variations among different divisions of broiler production, which is found to be consistent with the findings of Abdurofi et al. (2017).

3.4. Net returns to broiler producers

The net return over the variable cost in Mymensingh was the lowest while that in Dhaka was the highest among the four divisions (Table 4) since farms in Dhaka produce with the lowest production cost, while farms in Mymensingh produce with the highest, which could be due to the differences in farm size, management practices, etc. In terms of cost per kg, the production cost for all the divisions was lower than the farm gate price that means the farms became sustainable in the long-run (Table 5). By contrast, net returns were competitive for all the divisions; market prices are higher than the unit cost. This implies that farms could appropriately manage their cash flows during the production cycles in a year. However, p values indicate no significant difference among the divisions regarding cost (variable) and net return of broiler farming.

3.5. Value of input to output ratio

The input-output ratio is an indicator to evaluate the efficiency of the farm business and estimate the return on investment. The ratio is measured by dividing the output cost as revenue with the input or total cost (Abdurofi et al., 2017). The result found that the ratio of broiler industry in different divisions of Bangladesh was almost similar with slight dissimilarity occurring in Mymensingh and Rajshahi with the result of 1.39 and 1.36, respectively. The distinction in return on investment occurred for the low revenue earning in this study area. Table 6 shows that the highest was observed in Chittagong in terms of ratio for return on investment, while Rajshahi showed the least. It is worthy to note that Dhaka showed the highest value in terms of net return, but regarding returns on investment, the highest ratio was found in Chittagong. This result is not surprising and in some other studies (Ahmad et al., 2008; Khair, 2002), similar trends were observed in broiler farming in which the most profitable farms might not necessarily be the most in return on investment.

Table 2. Production background and average price.

Variable	Dhaka	Rajshahi	Mymensingh	Chittagong	All
Average number of day-old chick in farm	1095	890	771	867	906
Feed conversion ratio	1.43	1.49	1.75	1.43	1.53

Table 3. Cost of broiler production (BDT) in the study areas.

Cost Items	Dhaka	Rajshahi	Mymensingh	Chittagong	All	P-value
A. Fixed Cost						
Housing Cost	62152 (5.80)	55845 (5.30)	37749 (4.79)	18842 (1.91)	43647 (4.48)	0.002***
Broiler equipment cost	43735 (4.08)	49098 (4.66)	27919 (3.55)	14762 (1.50)	33879 (3.48)	0.000***
Total Fixed Cost	105887 (9.88)	104943 (9.96)	65668 (8.35)	33604 (3.41)	77526 (7.96)	0.00***
B. Variable cost						
Feed cost	786056 (73.34)	784385 (74.46)	584481 (74.24)	748684 (76.09)	725902 (74.52)	0.559
Total labor cost	49754 (4.64)	54058 (5.13)	45545 (5.78)	77937 (7.92)	56824 (4.80)	0.000***
DOC cost	66730 (6.22)	45164 (4.29)	36487 (4.63)	35927 (3.65)	46077 (5.76)	0.000***
Utility cost	12593 (1.17)	14147 (1.3)	10273 (1.30)	31412 (3.19)	17106 (1.76)	0.000***
Veterinary	13200 (1.23)	16525 (1.57)	10730 (1.36)	9702 (0.99)	12539 (1.29)	0.000***
Litter cost	8485 (0.79)	8687 (0.82)	8815 (1.12)	9049 (0.92)	8759 (0.90)	0.940
Lamp cost	5276 (0.49)	3144 (0.30)	2929 (0.37)	10159 (1.03)	5377 (0.55)	0.000***
Polythene	4387 (0.41)	3035 (0.29)	2918 (0.37)	5190 (0.53)	3883 (0.40)	0.022**
Transportation cost	17444 (1.63)	15308 (1.45)	15816 (2.01)	19740 (2.01)	17077 (1.75)	0.700
Others	2019 (.19)	4051 (0.38)	3643 (0.50)	2508 (0.25)	3055 (0.31)	-
Total variable cost	965948 (90.12)	948507 (90.04)	721637 (91.65)	950308 (96.58)	896600 (92.04)	0.477
C. Total Cost (A+B)	1071835 (100)	1053450 (100)	787305 (100)	983912 (100)	974126 (100)	0.348

Note: Values in parenthesis indicate the percentage of total cost.
***, ** and * indicate 1%, 5% and 10% significance level.

Table 4. Net return (over the variable cost) in broiler production.

Items	Dhaka	Rajshahi	Mymensingh	Chittagong	All	P-value
Production cost/kg (BDT)	65.31	67.7	68.56	66.76	67.08	-
Price/kg (BDT)	132.27	131.31	128.50	130.23	130.58	-
Total revenue (BDT)	1415984	1291026	1004487	1398858	1277588	0.216
Total cost (variable) (BDT)	965948	948507	721637	950308	896600	0.477
Net return (BDT)	450036	342519	282850	448550	380988	0.703

3.6. Estimation of the cost function

The model suggested for estimating the effect of different cost items in production structure was a logarithmic total cost translog function calculated using SURE. The results of the estimation of the total cost function have been presented in Table 7. The coefficients include the normalized price of the feed, price of day-old chick cost, the square of the feed price, the square of the day-old chick cost price, the multiplication of feed price and day-old chick price, the multiplication of the feed price and quantity, the multiplication of day-old chick cost price and output. The significance of most of the co-efficient and high value of determination of coefficient (equal to 99%) will ensure the suitability of the

Table 5. Variable cost (VC) of broiler per kg.

Variable cost per unit	Dhaka	Rajshahi	Mymensingh	Chittagong	All
Feed cost	53.0	56.0	54.91	52.82	54.18
Total labor cost	3.40	3.86	3.92	3.81	3.74
DOC cost	4.57	3.22	4.47	3.91	4.04
Utility cost	0.86	1.01	0.98	2.23	1.27
Veterinary	0.9	1.18	1.02	0.69	0.94
Litter cost	0.58	0.62	0.84	0.64	0.67
Lamp cost	0.37	0.22	0.28	0.72	0.39
Polythene	0.31	0.21	0.28	0.37	0.29
Transportation cost	1.19	1.09	1.51	1.40	1.29
Others	0.13	0.29	0.35	0.17	0.23
Total VC per unit	65.31	67.7	68.56	66.76	67.08

Table 6. Value of input to output (returns) in producing broiler.

Items	Dhaka	Rajshahi	Mymensingh	Chittagong
Input (BDT)	965948	948507	721637	950308
Output (BDT)	1415984	1291026	1004487	1398858
Ratio	1.46	1.36	1.39	1.47

Table 7. Estimated coefficients of the translog cost function for broiler using SURE.

Co-efficient	Estimate	Standard Error
α_f	0.380***	0.00056
α_{ch}	0.372***	0.00052
α_q	0.015	0.00022
β_{ff}	0.216**	0.00042
β_{chch}	0.168***	0.00053
β_{qq}	-0.007	0.00012
β_{fch}	-0.148***	0.00044
β_{fq}	0.007*	0.00014
β_{chq}	-0.003*	0.00021
α_0	1.05	0.00041

***, ** and * indicate 1%, 5% and 10% significance level.

estimation. Results showed that the normalized price of feed and the price of day-old chick cost had a positive and significant impact on the cost of production. This result explains that if feed and day-old chick cost increases, the production cost will also increase. Table 7 also revealed that the square price of day-old chick and feed price also had a positive and significant impact on production cost. In contrast, the interaction between the price of feed and the price of day-old chick, price of feed and quantity of production had a negative and significant impact where the price of day-old chick and quantity of production had a positive and significant effect on the cost of production.

To conduct the factor demand analysis, adding up and homotheticity conditions were effectively imposed with cross equation symmetry and homogeneity conditions. The negative value of Allen price elasticity of substitute satisfied the negativity condition. Furthermore, to estimate the Allen price elasticity of substitute, the share function was assessed using the iterative system. Allen's own price elasticity and elasticity of substitution were calculated using the co-efficient value of share function (Table 8). Also, the elasticity of input demand was estimated and presented in Table 9.

A description of the relationship between inputs can be found by Allen-Uzawa elasticities of substitution and the elasticities of factor demand. These elasticities are shown in Table 8, with own-price elasticities of demand on the diagonal and elasticities of substitution on the off-diagonal. The own price elasticities and cross price elasticities were calculated by the mean value of the individual broiler elasticities. The study revealed that own price elasticity for feed, day-old chick price, and labour price were negative, which were -0.00249, -0.05718, and -0.13101, respectively, and indicates that the input demand for broiler production did not respond much to a change in the price of the inputs. The value of feed and labour was justifiable as broiler farms usually use a fixed amount of feed and labour to maintain the farm. The possible explanation for the day-old chick may be that farmers rear a specific

Table 8. Allen partial elasticities of substitution.

Variable	Feed	Day-old chick	Labor
Feed	-0.00249		
Day-old chick	-0.00151	-0.05718	
Labor	-0.00502	0.100979	-0.13101

Table 9. Cross-price elasticities of input demand.

Variable	Feed	Day-old chick	Labor
Feed	-	-0.00102	-0.00421
Day-old chick	-0.00033	-	0.023406
Labor	0.0000752	0.01111	-

number of day-old chick on the farm irrespective of the price. This may be linked to maintaining the number of broilers or farm capacity rearing the number of broilers. The elasticity of substitution between feed and day-old chick was found negative (-0.00151), indicating a complementary relationship. Besides, the relationship between feed and labour was also complementary (-0.00502), while the day-old chick and labour were found to be substitutes (0.100979). The relationship between these inputs was found inelastic, which implies that change in the price of inputs does not significantly impact the demand of other inputs. The high irresponsive situation for the demand for any input to the price of other input in broiler farming can be the reason for the farmers' static use of inputs in the broiler production. Besides, the poultry farmers in Bangladesh generally operate on a contract basis where they agreed with the input supplier for purchasing the required quantity of input in the starting time of the season. Typically, the backward and forward linkage of poultry farms is operated by other stockholders rather than poultry farmers. Moreover, farmers in Bangladesh use more or less a fixed amount of input in their production process.

Cross-price elasticities of input demand contain the same information in most cases as the elasticities of substitution and own-price elasticities. Between the pairs of inputs, cross price elasticities are not symmetric, as, in the case of elasticities of substitution, they depend on the input share weights. Results for feed and day-old chick price (-0.00102) and day-old chick price and feed (-0.00033) were found to have the same sign with different magnitudes (Table 9). This relationship indicates that if the feed price increases by 1%, the demand for day-old chick will reduce 0.00102%. Similarly, if the price of day-old chick rises by 1%, the demand for feed will reduce by 0.00033%. This result was expected as if the farm owner reduced their chick number in production; they would need less feed to rear the day-old chick. The study showed that the feed and labour was a substitute and inelastic (0.0000752), which indicates that change in feed price had little impact on labour demand. But in the case of labour and feed, the relationship was found complementary (-0.00421); if the cost of labour increases by 1%, then labour demand will decrease by 0.00421%. The relationship between day-old chick price and labour (0.023406) and labour and day-old chick price (0.0111) showed the same sign but different magnitudes. Both relationships were found substitutes. These two values are low and inelastic, which means that day-old chick price has little impact on the demand for labour and vice versa. These findings can be compared with the study of Grisley and Gitu (1985), which was conducted on turkey producers. Cross-price elasticities are of direct use in case of policy formulation. A relative increase in the price of one input can result in changes in the quantity demanded of other inputs. As the results reported, changes in the prices of inputs did not result in large changes in the quantity demanded of other inputs.

4. Conclusion

The principal aim of this study was to assess the financial condition and responsiveness of broiler farmers to input price changes at the farm level. Results revealed that broiler farming was profitable in all divisions, but the net return of Dhaka was the highest, but in terms of returns on investment, Chittagong showed the highest ratio. It was also found that Mymensingh confronted with poor performance from a high unit cost of production and low unit price selling. However, there were no significant differences in cost (variable) and net return of broiler farming among the study areas. The results of the translog cost function revealed that the own price elasticities of demand for feed, labour, and day-old chick were

inelastic where the former two results were expected, while the value of the other one was a little bit lower than expected. A possible explanation is that the farmers tend to maintain a constant amount of day-old chick on the farm. The study also revealed that the relationship between feed and day-old chick and feed and labour was complementary while day-old chick and labour were in a substitute relationship. Also, the cross price elasticities were, in general, found to be highly inelastic. The elasticity of input substitution, cross price elasticities and own price elasticities provide information about input demand and producer's input mix decisions, and producer's response to the price change of inputs employed in the production process. This information about elasticity will provide policymakers, local authorities the crucial information about producers' production behaviour in broiler farming. Moreover, producers will know the relationship among the different inputs in the production process. Although formidable, effective policy measures will boost broiler production, which will increase farmers' welfare through higher profits, those are goals worth pursuing.

Declarations

Author contribution statement

M. Kamruzzaman: Conceived and designed the experiments; Performed the experiments; Contributed reagents, materials, analysis tools or data.

Shamima Islam: Analyzed and interpreted the data; Wrote the paper.

Md. Jaber Rana: Analyzed and interpreted the data.

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Data availability statement

Data will be made available on request.

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The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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