Contract Farmer and Poultry Farm Efficiency in Bangladesh: A Data Envelopment Analysis

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Keywords:	poultry contract farming, efficiency, DEA, Tobit analysis, Bangladesh

For Peer Review

I. Introduction

The economic growth and stability of Bangladesh is primarily dependent on agriculture. The poultry sub-sector in comparison to other sectors has a high potential for growth for a wide range of reasons. Poultry meat farming has a considerable potential for providing income opportunities, reducing malnutrition, generating employment and alleviating poverty in Bangladesh (Jensen, 1999). Poultry meat has a great demand as compared to other meat, simply because of its low cost as well as the religious taboos in case of pork and beef in Bangladesh.

In Bangladesh, commercial poultry farming started not earlier than the 1980's. Being a meat deficit country with a fast growing population in an already densely populated country, from the 1990's Bangladesh has pursued a development policy in the poultry sector based on enhancement of the commercial poultry meat production. This resulted in a spectacular increase in the number of poultry farms (ECNEC, 1999). This policy has also led to a substantial increase in poultry meat production from 66,357 thousand metric tons in 1990 to 102,000 thousand metric tons in 2007 (FAOStat, 2008). However, the per capita yearly demand is 7.67 kg/year, whereas per capita production is only 3 kg/year, resulting in a per capita deficit 4.67 kg/year. Thus the current production is not so impressive given a deficiency of 61% meat demand in the country.

Under above circumstances, the poultry sector productivity growth needs to be fostered, either through technological development or an increase in production efficiency or a combination of both, in order to stand the demand pressure and self sufficiency of meat production. Therefore, it appears that commercial poultry farming systems must be further developed and ways must be sought to improve the efficiency of the existing production technology. To this end, measuring farms' efficiency is an important issue that could be a first logical step in a process that leads to substantial resources utilization improvement.

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The present farming system of poultry meat in Bangladesh can be broadly divided into two systems: the traditional rural backyard and the commercial farming. The commercial farming system can be also divided into two types, the independent farming and the contract farming system. In the case of independent farming, farmers run their business by themselves without any contractual agreement with a third party, bear all production expenses by themselves and accept all the risks and benefits resulting from their decisions. On the other hand, the contract farmers have a contractual agreement with the integrator for supply or purchase of inputs and for supply or sale of outputs at pre-determined prices. The integrator also provides technical know-how to the contract farmers through a company supervisor.

Contract farming has been introduced in poultry farming in Bangladesh in 1994 by a big agribusiness company, named ABFL (AFTAB Bahumukhi (multipurpose) Farm Limited). Contract farming could be a possible way to increase farm's efficiency but none of the previous studies have provided an in-depth explanation about the role of vertically integrated poultry contract farming systems on farm efficiency.

In an economy where technologies are lacking, efficiency studies show the possibility of raising productivity by improving efficiency without increasing the resource base or developing new technology (Yusuf and Malomo, 2007). It also helps to determine the under utilization or over utilization of input factors. Therefore, the aim of this paper is to investigate technical, allocative and economic efficiency of poultry farms in Bangladesh. Many researchers have used DEA as a useful tool to investigate efficiency in the agricultural sector (Kelvin Balcombe *et al.*, 2008; Zaibet & Dharmapala, 1999) but a less research studies (Lansink. A. O. and Reinhard. S., 2004) using focus on the efficiency of livestock farm. We used data envelopment analysis (DEA) in order to estimate consistent measures of efficiency. Next, the paper assesses the determinants of

efficiency measures using a Tobit or censored regression model and also to estimate elasticities to provide the information on the magnitude of the variables influence on technical, allocative and economic efficiency. Although there have been several studies that have analyzed the efficiency of agricultural production in Bangladesh (Kamruzzaman *et al.*, 2007; Wadud and White, 2000; Coelli *et al.*, 2002), but most of them have focused on major food crops like rice, wheat, etc. To our knowledge, so far no studies have focused on poultry meat farms in Bangladesh, which makes this paper unique for the Bangladesh context. This study gives valuable information for policy makers, not only because it generates awareness concerning inefficiencies in poultry farms, but also provides insight into possible improvements by exploring the determinants of these inefficiencies.

The remainder of the paper is organized as follows. The next section II presents the methodology of the study. The DEA models used for our efficiency calculations in addition to the sample size and data collection are described in this section. Results concerning various efficiency scores, their determinants and efficiency elasticities are presented and discussed in Section III. Section IV provides conclusions.

II. Methodology

Model specification

Efficiency is a widely used concept in economics. Economic efficiency could be expressed as a combination of technical and allocative efficiencies. Technical efficiency gives an idea about how to minimize input utilization in the production process of a given output vector. Alternatively, it also refers to how to maximize an output vector without changing input quantities used. In this sense, a given farm is technically efficient only if it is impossible to increase the quantity of output without increasing the use of one, or many, inputs or if, for a

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given level of output, it is impossible to decrease the level of inputs used. Allocative efficiency measures the ability of the farmer to use inputs in optimal proportions given input prices. Economic efficiency (EE) finally is the product of allocative and technical efficiency and captures performance in both measures. Different methods were used by several researchers to measure the allocative and technical efficiency in different sectors of economy. Among them there are two widely used efficiency measurement methods of a decision making unit, one is the non-parametric Data Envelopment Analysis (DEA) and the other is the parametric Stochastic Frontier Analysis (SFA). Some studies have compared the two approaches (DEA & SFA) (Lovell (1993); Sharma *et al.* (1997); Hjalmarsson *et al.* (1996); Fecher *et al.* (1993)).The choice between the stochastic frontier approach and DEA approach to measure efficiency will therefore depend mainly on the objective of the research, the type of firms and the data availability.

The framework for the non-parametric DEA method was initiated by Farrell (1957) and reformulated as a mathematical programming problem by Charnes, Cooper and Rhodes (1978). Given a number of producing units, which are called “Decision Making Units” (DMUs), the DEA model constructs an efficiency frontier from the sample of the best performing DMUs. Units that are not on the frontier are considered to be inefficient. The method enables to find out the relative efficiency of a given farm by examining its position in relation to the optimal situation. The strength of DEA is that it does not require any assumptions about the functional form of the production technology.

DEA at constant return to scale (CRS) means that for a DMU producing an output Y by using an input X , it is feasible to produce aY using aX amount of input (a is a scalar). The assumption of constant returns to scale is not true where increased amounts of inputs used do not proportionally increase the amount of output produced (Speelman *et al.*, 2008). For this reason, a variable

returns to scale (VRS) assumption is also considered in the efficiency calculation. In fact, to know whether production is either CRS or VRS, the values of efficiency levels are calculated using the DEA technique under both assumptions and then compared. The comparison of efficiency levels of CRS and VRS assumptions gives also information on the scale efficiency. The scale efficiency is higher if the VRS efficiency estimates converge to the CRS efficiency estimate.

DEA can be input or output-oriented where the difference is that either the objective is to continue using the same amount of inputs while producing more outputs (output-oriented DEA) or the objective is to produce the same amount of output by using fewer inputs (input-oriented DEA) (Speelman *et al.*, 2008). This study uses an input-oriented approach that reflects the objective of a decrease in scarce resources (input) use.

DEA uses data of the individual poultry farmers that are called DMUs in the DEA context. The $k = 1, \dots, K$ DMUs produce $m = 1, \dots, M$ outputs using $k = 1, \dots, N$ inputs. Each farmer (the DMU) can decide individually upon both inputs and outputs. The $K \times N$ input matrix $\mathbf{X}$ and the $M \times N$ output matrix $\mathbf{Y}$ represent the data for all the farms.

The most common approach to assess CRS efficiencies is the use of following programming model as proposed by Charnes *et al.* (1978):

$$\text{Min}_{\theta, \lambda} \theta$$

$$\text{Subject to } -y_i + \mathbf{Y}\lambda \geq 0$$

$$\theta x_i - \mathbf{X}\lambda \geq 0$$

$$\lambda \geq 0. \quad (1)$$

Where θ is a scalar and λ is a vector of constants, x_i and y_i , are column vectors with the input and output data for the i -th farm. The value θ is a score always lying between zero and one, with a value of one indicating that the farm lies on the frontier and is efficient. The implicit assumption of the model described above of constant returns to scale can be relaxed by adding a convexity constraint: $\Pi' \lambda = 1$, with Π a vector of one's (Banker *et al.*, 1984).

However, based on the technical and allocative efficiency the economic efficiency can be determined as $EE^1 = AE * TE$. Allocative efficiency itself is calculated in two steps. First a cost-minimizing vector of input quantities given the input prices is determined using the model from program 2:

$$\begin{aligned} & \text{Min}_{x_i^*, \lambda} w'x_i^* \\ & \text{Subject to } -y_i + Y\lambda \geq 0 \\ & x_i^* - X\lambda \geq 0 \\ & \Pi' \lambda = 1 \\ & \lambda \geq 0. \end{aligned} \tag{2}$$

where, w is a vector of input prices for the i -th farm and x_i (which is calculated by using linear programming) is the cost-minimizing vector of input quantities for the i -th farm, given the input prices w and the output levels y_i . The other symbols are defined the same as in equation 1. The economic efficiency (EE) of i -th farm is calculated as the ratio of the minimum cost to the observed cost (equation 2)

$$EE = w_i x_i^* / w_i x_i$$

Data and field survey

¹ Called also “cost efficiency” (Coelli, 1996)

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3 135 The analysis was based on primary data collected through a comprehensive field survey. A
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6 136 sample of 75 farms was chosen. The data were composed by Excel and finally analyzed by a
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8 137 DEA-Solver, namely Win4DEAP (Coelli, T. J., 1996). We used also the STATA software to
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10 138 resolve the Tobit regression and elasticities.
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13 139 Kaliakoir and Sripur Thanas under the Gazipur district (see Figure 1) were selected as
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16 140 representative study areas for commercial poultry farm because the district has been declared by
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18 141 the government of Bangladesh as poultry region and have a high concentration of poultry farms.
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20 142 The other study area was Kishorganj district where the pioneer integrated company ABFL
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23 143 offering contracts is situated. The two regions were necessary to include in the analysis to
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25 144 compare both contract (Kishorganj) and non-contract farmers (Kaliakoir and Sripur Thanas).
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27 145 Both regions have well road communication and transportation facilities with the country's
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29 146 capital city Dhaka, which is the main poultry output and input market for the both areas.
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32 147 Therefore we assume that there can be no systematic region effect in the analysis.
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35 148 Contract farming data were collected from two Upazilla (an administrative area), Bajitpur and
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37 149 Kuliarchar under Kishorganj district. The summaries of the main features of the contract
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40 150 arrangements of ABFL are highlighted in Table 1. According to the agreement ABFL provides
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42 151 day old chicks, feed, veterinary supplies, which have been given on credit, and implement final
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44 152 marketing of the output. The company also provides technical assistance for the poultry
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46 153 producer. From other side, the farmer provides space, equipment, labor, and daily management.
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48 154 ABFL buys back the matured birds at a pre-determined price and the credit is then adjusted to
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51 155 the price of the farmer's product. One requirement that farmers must meet in order to participate
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54 156 in contract farming is providing land and housing for chicks. However, farmers can decide the
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56 157 number of chicks they wish to raise.
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A field survey was carried out on 75 commercial poultry farms (25 independent and 50 contract poultry farms) randomly. In the case of contract farming, stratified sample has been used to obtain and proportional distribution of farm size. The entire study population of all 560 contract growing farmers, obtained from ABFL officials, was categorized to their farm sizes as follows:

1) small farmers raising 1200 birds, 2) medium farmers raising 1201 up to 2000 birds, 3) large farmers raising more than 2000 birds. This subdivision has lead to 202 small, 280 medium, and 78 large farms. The selected sample of 50 contract farms contains therefore 18 small, 25 medium and 7 large farms.

Avian influenza’s outbreak H5N1 affected poultry farming in eight Asian countries (Cambodia, China, Indonesia, Japan, Laos, South Korea, Thailand, and Vietnam) during late 2003 and early 2004. Although at that time there was no bird flu in Bangladesh, but the suspicion of bird flu poultry sector and the resulting consumer reactions has lead to great financial losses. The death of some people at that time by unknown diseases in different places of Bangladesh made the suspicion stronger. People had initially wrongly attributed this to avian influenza. Only a few months later the news came that the suspicious deaths were due to the virus of NIPAH. Nevertheless, since 2003, the Bangladesh poultry industry is every year affected by either bird flu rumours or bird flu itself. Therefore, the analysis relies on data of the year 2002 to compare efficiency of the two systems.

The period of investigation of this study covered the whole year of 2002. Data were collected in January to March, 2003. Figure 1 indicates the map of study area.

<Introduce Figure 1 about here>

<Introduce Table 1 about here>

180 **III. Results and interpretations**

181 **Efficiency measurement**

182 The costs of the sampled poultry farm include labor, day old chicks, feed, vaccine and medicine,
183 transportation, litter, equipment and housing cost. For the measurement of economic efficiency
184 only the following inputs were used because they are the most important and they are available
185 in both physical and monetary terms: (i) human labor (man-days) and wage rate; (ii) day old
186 chicks (cumulative weight) and price of that, and (iii) feed (kilogram) and price of per kilogram
187 feed. The sum of these inputs covers 75 to 80 per cent of the total cost (Begum 2005; Bhuiyan,
188 2003). Table 2 reports the results of test of equal means between independent and contract
189 farming for the variables used in the estimation and also show the maximum and minimum value
190 of sample variables. The same table highlights several clear differences in output and input uses
191 between the two farming system. Day old chick data were recorded by the cumulative weight
192 (cwt.) of one day old birds. Output data were also recorded by the cumulative weight of sold
193 birds. The average input-output prices data which are collected from field survey and used in
194 data envelopment analysis are also presented in Table 2. Table shows that the labor and feed
195 prices are the same in both farming systems while day old chick prices vary between the
196 systems. This variation depends largely on breed quality. Independent farmers purchased
197 different types of strains of day old chicks from the nearby hatchery of the study area, such as
198 Phoenix, Paragon, Kazi. Most of the farmers chose the strain of 'Hubbard', because it's lower
199 mortality and higher disease resistance. Farmers also choose Vancobb, Starbro, Casila, Hi-sex,
200 Ross, because of the good performance on growth and body weight. Contract farmers are bound
201 to choose one out of three strains: I-757, MPK and Arbor-Acres. The average day old chick

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prices of independent and contract farm were 24 and 15 *Taka*² respectively. The price of day old chicks may vary between strains. In the case of contract farms, farmers have to contribute 1.50 *Taka* per chick to the fund at the time of purchase DOCs as insurance premium. ABFL is the only farm in Bangladesh that introduced an internal insurance scheme to cover the risk of loss and safeguard the interest of the contract growing farmers in case of immature death of chicks by diseases and other cogent reasons. According to this scheme, ABFL operates a contributory security fund. Depending on the chick mortality a portion of the initial contribution or risk premium is refunded. For example, if the chick mortality is less than 3 per cent, 4-6 per cent, 7-10 per cent and 11-15 per cent then 80, 40, 20, 10 per cent of the contribution respectively is refunded to the farmer. If the mortality rate is above 15 per cent, the farmer can claim full insurance compensation. In this case, for birds up to 20 days age 20 *Taka* per bird is paid after deducting 15 per cent from the total number of lost birds. For birds beyond 20 days old, 30 *Taka* is paid per bird after calculating the benefits from birds up to 20 days old. This means lower mortality rates leads to higher rates of compensation, but over 15% mortality leads to claim of full insured value compensation. This insurance scheme contains thus incentives to carefully manage the bird but also an insurance against force majeure.

<Introduce Table 2 About Here>

<Introduce Table 3 About Here>

The frequency distribution of the efficiency estimates obtained from the DEA frontier and their summary statistics are presented in Table 3. Given the large variability in the computed measures, efficiency scores are clustered into five groups such as 60 -70%, 71- 80%, 81–90%, 91-99% and 100%. The estimated mean values of technical, allocative and economic efficiency

² 1 US\$=58.50 *Taka*, 2003

are 86, 87 and 74 and 93, 99 and 93 per cent for independent and contract poultry farms in CRS DEA frontier, respectively and those are 91, 89 and 81 and 96, 98 and 94 per cent for VRS DEA frontier. The results of DEA analysis reveal significant differences between the efficiency level of independent and contract poultry farms. Therefore, there is some scope for reducing cost in production and hence obtaining output gains through efficiency improvement. In terms of scale economics, 53 per cent farms are characterized by increasing return to scale, 12 per cent farms have constant return to scale and 35 per cent farms are characterized by decreasing return to scale (Table 4). If all farms are using the same technology, then we would expect returns to scale to be increasing for farms with a relatively low output and decreasing return to scale farms with a relatively high output. Constant return to scale would be expected for farms with an output level equal to mean output (Silberberg, 1990). The mean output of the sub-optimal scale is larger than the super-optimal as well as optimal scale for the sample poultry farms (Table 4). The results indicate that the sub-optimal output levels overlap a great portion of the optimal and super optimal output values.

<Introduce Table 4 About Here>

Identifying factors of efficiency using Tobit analysis

The second step in the analysis is to identify the factors that influence the farm technical, allocative and scale efficiency by using a Tobit model and also to estimate elasticities to provide the information on the magnitude of the variables influence on technical, allocative and economic efficiency.

The factors used in this study consist mainly of farm's human capital variables. The set of variables includes farmer's age, farmer's educational background or schooling (number of

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years), farmer’s occupation indicating whether the poultry farming is considered as main or subsidiary occupation, poultry farm size and participation in contractual system.

To explain efficiency scores variation across farms, many research studies regressed the efficiency scores on the farm-level characteristics, using a Tobit model, since the efficiencies vary from zero to unity (Reig-Martinez and Picazo-Tadeo, 2004; Iraizoz *et al.*, 2003; Lockheed *et al.*, 1981). In this research, Tobit analysis has been used because the dependent variable, initial efficiency (IE_i) calculated by DEA model, is a censored variable with an upper limit of one. This Tobit model is employed using DEA method to estimate the factors associated with efficiency with the help of STATA software. The model could be written as following:

$$IE_i = \alpha_0 + \alpha_1AG + \alpha_2sch + \alpha_3Ocu + \alpha_5Cont + \varepsilon$$

Where,

IE_i is the technical, allocative or economic efficiency of poultry farms,

AG is the age of the farmers in years,

Sch is the schooling /education level of the farmers (years),

Ocu is the main occupation of the farmer dummy variables = 1 if poultry farming, = 0 otherwise,

Cont is the contracting on poultry framing dummy variable = 1 if farmer engaged with contract framing, = 0 otherwise,

ε is the error term.

Both the CRS and VRS specification scores were regressed. The results are presented in table 5. The results show that the contract system is an important explaining dummy variable which is positively and significantly related to farm’s technical, allocative and economic efficiency (Table 5).

The Tobit results also show that the age of the farmer is positively and significantly related to farm's allocative efficiency. This is expected because the higher aged farmers are more likely to be efficient to allocate their scarce resource as compared to their less aged counterparts as a result of their better skills and experience.

<Introduce Table 5 About Here>

The main occupation of the farmer is positively and significantly related to farm's allocative & economic efficiency in CRS. This positive effect for full time poultry farmers can be explained by the fact that specialization increases efficiency.

Formal education, commonly measured in years of schooling, is the farmer attribute that seems to have received more attention in the efficiency literature. In this study farmer's schooling is insignificant to both CRS and VRS efficiencies in the models. Various other studies also have found no statistically significant relationship between these two variables (Bravo-Ureta and Evenson, 1994; Kalirajan, 1991; Phillips and Marble, 1986).

In this section we also estimate efficiency elasticities to provide information on the magnitude of the variables which are used in the Tobit model. For doing so, we used STATA software and the derivation strategy was followed from Rahman and Rahman (2008) although the estimation process of efficiency elasticities originally adopts the framework of Frame and Coelli (2001). However, to calculate elasticity we first need to estimate the marginal effects of efficiency (technical, allocative and economic efficiency scores regressed in the Tobit models) of the i_{th} farm with respect to j_{th} Z vector. To calculate elasticity of the i_{th} farm with respect to j_{th} Z vector we apply the following equation

$$\eta_{E_{ij}} = \frac{dE_{ij}}{dZ_{ij}} \cdot \frac{Z_{ij}}{E_i}$$

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Where dE_{ij}/dZ_{ij} is the marginal effect of the variable Z_{ij} on the efficiency E_{ij} derived from tobit regression.

Our elasticity estimate reveals that efficiency will increase if the farmer's main occupation is poultry farming (Table 6). In fact, a 1% increases in the number of contract farms increases technical, allocative and economic efficiency by 0.05%, 0.09% and 0.14%, respectively in CRS specification and 0.03%, 0.07% and 0.09%, respectively in VRS specification (Table 6). This is expected because under contractual agreement, in order to obtain sufficient supplies of the right quality of poultry meat and at the right time, the company provides technical know-how assistance through company's recruited supervisor, production inputs & services, and production credit along with intensive supervision (Figure 2), which in turn improves farm efficiency. By receiving technical knowledge from company's supervisor contract farmers have gained more knowledge on their resource and practices, which enables them to use resources more efficiently. For instance, commercial poultry farming requires highly technical knowledge to produce chicken efficiently which is not always easy to adopt for illiterate or little educated farmers. The highly technical knowledge refers to knowledge of keeping temperatures for rearing poultry birds appropriately, the appropriate timing of feeding, lighting and vaccination. A broiler needs different temperatures in different stages of its growth. For example, it needs 35⁰C, 32.2⁰C, 29.4⁰C, 26.6⁰C and 23.7⁰C in the 1st, 2nd, 3rd, 4th and 5th week, respectively. Furthermore appropriate lighting according to the age of the day-old chicks is also important for its growth. Also, the feed amount of day-old chicks varies according to growing stage. A day-old chick requires everyday 10 g, 20 g, 30g, and 40 g of feed, in the 1st, 2nd, 3rd and 4th week, respectively. Finally, a broiler requires 100 g of feed everyday in 10th week. Timely vaccination of birds is also important for the growth of chicks. Thus the information transfer may involve knowledge

about feed mixtures or feed timing, lighting and heating knowledge that result in higher efficiency. Besides, it is possible that the inputs and services provided by the integrator/company, such as feed, veterinary care, and especially the breed quality of day old chick, may be superior to that available to an independent farmer, resulting in efficiency gain. Consequently, part of the estimated gains in efficiency may be the result of our inability to account for quality differences in the inputs. Some of the efficiency gains from contracting might be explained by differences in access to capital—if contract farmers are able to obtain more financing support because they face less risk then they could more easily adopt newer and more productive capital equipment (such as brooder, generator), than independent farmers. For the same financial resources as independent farmers, contract growers could obtain technology (as contract farmers do not have to purchase DOCs, feed, and medicine provided by integrators) that is more productive and thus achieve more efficient scale of production.

<Introduce Table 6 About Here>

<Introduce Figure 2 About Here>

IV. Conclusion

In this study technical, allocative and economic inefficiency in the poultry farms of Bangladesh has been estimated by using the DEA approach and the variation in economic inefficiency is explained using various farm-specific human capital variables. The results have shown that under constant return to scale (CRS) and variable returns to scale (VRS) specification, technical, allocative and economic efficiencies are on average 91%, 94%, 85% and 94%, 95%, 89% respectively. But under CRS and VRS specification, technical, allocative and economic efficiencies of the independent farms are 86%, 87%, 74% ; 91%, 89%, and 81%, respectively which are below than the contract farm (93%, 99%, 93% ; 96%, 98%, and 94%, respectively).

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The farm households appear to be dominantly operating at increasing returns to scale. The sample farmers, on average, could increase their poultry production if they could operate at full technical, allocative and economic efficiency levels, given the existing technology. The results of Tobit regression show that contract farms are more efficient than independent farms. Evaluating factors associated with inefficiency suggests that engagement in contract farming is the most statistically significant factor associated with technical, allocative and economic inefficiency. The elasticity estimate reveals that a 1% increase in the number of contract farm increases technical, allocative and economic efficiency by 0.05%,0.09% and 0.14% , respectively in CRS specification and 0.03%, 0.07% and 0.09%, respectively in the VRS specification. This increased efficiency of contract farming may be due to a transfer of technical “know how” from integrators to farmers. Inefficient farms have used an excess amount of inputs on poultry farms in a rural area of Bangladesh. Thus the results of the study give information to policy makers and extension services on how to better aim efforts to improve poultry farm efficiency. Contract farming could be a good way to promote efficiency at farm level. It is, however, not immediately possible to set up a nationwide integrated contract farm in the short run because the establishment of such integrated contract farm requires huge support from the banking system for credit and from various players for ensuring quality inputs such as feeds, day-old chicks and vaccines. On the other hand the government has to monitor whether or not integrated farms is dominating the market and mis-using market power. It can be suggested that to increase poultry production and develop the poultry industry, the government as well as other private integrators can take initiatives to spread an effective and well organized vertically integrated contract farming system in Bangladesh.

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Table 1. Summary of salient features of contract arrangements of ABFL in the poultry in Bangladesh

Particulars	
1. Name of the company	AFTAB Bahumukhi Farms Ltd. (ABFL)
2. Type of the company	Private Limited Company
3. Form of contract arrangement handled	Formal input-output
4. Backward linkage for contracted product	Company provides day old chicks, feed and veterinary and medical services on credit to contract farmers
5. Size of the contract farmers (in 2003)	560 contract farmers
6. Geographical locations covered	Only KISHORGANJ district
7. Volume of input/product delivered per month	100 MT feed per month for broiler
8. Value of input/service delivered per month	\$854701 per month for broiler
9. Forward linkage for contracted product/services	Own sales center for dressed broiler, dealer for feed and day old chicks (DOC)
10. Criteria for selecting contract farmers	Anyone in the local area can enter
11. location of supply outlet	Dressed broiler: mainly Dhaka and Chittagong DOC and feed: whole Bangladesh
12. Volume of products supplied per day	Dressed broiler: 7 metric ton./day
13. Approximate market share of the company	10% for chicks
14. Provision for enforcement of contract	Mostly informal and social
15. System of ensuring product quality	Inspection, supervision, lab. test

Source: Field survey (2003).

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Table 2. Basic statistics for the survey variables used in the DEA model

Variables	Sample Mean		t-statistics	Prob.> t	Maximum		Minimum	
	Contract system	Independent system			Contract system	Independent system	Contract system	Independent system
Day old chick (cwt. Kg)	367.16	170.08	5.03	0.0000	764	732	86	45
Day old chick (<i>Taka</i>)	139034.6	96754.56	2.29	0.0272	298650	371800	31200	27820
Feed (cwt. Kg)	20004.3	14364	2.044	0.0484	43250	56400	4582	4000
Feed cost (<i>Taka</i>)	272058.9	195350	2.04	0.0484	529660	767040	62310	54400
Labor (man-day)	504.82	318.32	2.33	0.0236	1397	1450	70	59
Labor (<i>Taka</i>)	17134	14063.5	1.15	0.1275	34000	54700	3800	4130
Output (Kg)	11783.54	6763.68	3.67	0.0003	25792	26654	2568	1965
Output (<i>Taka</i>)	629507.8	404201	2.87	0.0066	1228197	1562252	140786	115316
Age	41.46	32.56	1.66	0.0000	65	45	20	24
Education	6.7	7.96	-1.28	0.1025	14	16	1	1
<i>Average input price</i>								
Day-old-chicks	15.00	24.00	-	-				
Labor (man-day)	70.00	70.00	-	-				
Feed (kg)	13.60	13.60	-	-				
<i>Average output price</i>								
Matured bird (price/kg)	54.00	61.00	-	-				

Source: Field survey, 2003

Note: cwt. means cumulative weighted

Table 3. Frequency distribution of efficiency estimates from the DEA model

Efficiency index (%)	DEA Frontier								
	Number of Farms								
	Independent system			Contract system			t-statistics		
	TE	AE	EE	TE	AE	EE	TE	AE	EE
CRS									
61-70	0	0	3 (12)	0	0	0	-	-	-
71-80	4 (16)	2 (8)	22 (88)	0	0	0	-	-	-
81-90	18 (72)	18 (72)	0	16 (32)	1 (2)	18 (36)	-	-	-
91-99	1 (4)	5 (20)	0	30 (60)	48 (96)	31 (62)	-	-	-
100	2 (8)	0	0	4 (8)	1 (2)	1 (2)	-	-	-
Mean	0.86	0.87	0.74	0.93	0.99	0.93	6.40 (0.000)	13.10 (0.000)	21.58 (0.000)
Standard deviation	0.06	0.04	0.03	0.03	0.02	0.03			
Maximum	1	1	1	1	1	1			
Minimum	0.72	0.76	0.66	0.88	0.87	0.87			
VRS									
61-70	0	0	1 (4)	0	0	0			
71-80	2 (8)	4 (16)	13 (52)	0	0	0			
81-90	10 (40)	10 (40)	8 (32)	5 (10)	1 (2)	12 (24)			
91-99	8 (32)	9 (36)	1 (4)	37 (74)	45 (90)	34 (68)			
100	5 (20)	2 (8)	2 (8)	8 (16)	4 (8)	4 (8)			
Mean	0.91	0.89	0.81	0.96	0.98	0.94	2.85 (0.007)	7.29 (0.000)	7.83 (0.000)
Standard deviation	0.07	0.06	0.08	0.03	0.02	0.04			
Maximum	1	1	1	1	1	1			
Minimum	0.75	0.77	0.70	0.90	0.87	0.87			

Note: 1) Figures in the parentheses indicate percentage of farms

2) In the case of t-statistics figures in the parentheses indicate probability statistics

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Table 4. Optimal, sub-optimal and super-optimal outputs for the poultry farm (in cwt)

Scale	Number of farms (%)	Mean output	Output range
Optimal	09(12)	10621.33	6991-14251
Sub-optimal	40(53)	6107.7	1965-12003
Super-optimal	26(35)	16091.12	9532-26654

Note: Figures in the parentheses indicate percentage of farms

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Table 5. Tobit regression analysis of factors associated with inefficiency

Factors	DEA frontiers					
	Constant return to scale (CRS)			Variable return to scale (VRS)		
	TE	AE	EE	TE	AE	EE
Constant	0.829***	0.8479***	0.6982***	0.9064***	0.8549***	0.7681***
Age	0.0005	-0.00001	0.0004	0.0001	0.0008*	0.0009
Schooling	0.0082	-0.0026	0.0046	-0.0017	-0.0106	-0.0106
Occupation	0.0172	0.0155**	0.0296***	0.0108	0.0093	0.0185
Contracting	0.0689***	0.1249***	0.1759***	0.0418***	0.0945***	0.1274***
δ	0.0501	0.0312	0.0346	0.058	0.0361	0.0596
Log-Likelihood	97.40	146.45	138.87	71.66	115.73	81.50
LR (χ^2)	31.45	115.31	148.62	9.34	76.42	58.57
$P > \chi^2$	0.000	0.000	0.000	0.053	0.000	0.000
No. of observation	75	75	75	75	75	75

Note: ***, ** & * indicates 1%, 5% & 10% level of significance

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Table 6. Efficiency elasticities

Factors	Constant return to scale (CRS)			Variable return to scale (VRS)		
	TE	AE	EE	TE	AE	EE
Age	0.0225	-0.0019	0.0199	0.006	0.0346*	0.0417
Schooling	0.0032	-0.001	0.0019	-0.0006	-0.004	-0.0104
Occupation	0.0126	0.011**	0.0231***	0.0076	0.0065	0.0138
Contracting	0.0505***	0.0887***	0.1373***	0.0296***	0.0662***	0.0948***

Note: ***, ** & * indicates 1%, 5% & 10% level of significance

Figure 1. Map of the study area

Figure 2. Vertical stages of poultry contract farming system in Bangladesh