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Technical Efficiency of broiler farms in Thailand: Data Envelopment Analysis (DEA) approach

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Abstract. The objective of this study was to determine the economic efficiency of resource utilization in broiler production farms. The evaluation of the effect of the farm specific factors on the efficiency focused on the farm size productivity relation. To improve the broiler production in North Region of Thailand, we used the Data Envelopment Analysis (DEA) Approach to compute the technical efficiency of farm because technical efficiency does not require higher poultry intensity and development of new technology. From the results, we found that age, and more experience of farmers is tending to be more Technical Efficient (TE) of broiler farms. Therefore, the socioeconomic or characteristic of broiler farms was the important variable to improving the broiler production.

Keywords: Broiler production, North region, DEA approach, Technical Efficiency, Farmer

1. Introduction

In Thailand, livestock accounts for about 10 percent of the agricultural gross domestic product (GDP). The valued added by the poultry sector contributes 3-4 percent of the agricultural GDP and more than 40 percent of the livestock GDP (Viroj NaRanong, 2004). Although there are a several types of poultry raised and consumed in Thailand, chicken is the most important. There are three main types of chicken in Thailand: broiler, layer, and native chicken. From an economic perspective, broiler is the main sector production in the livestock sector, both for domestic consumption and export. The growth of Thai poultry sector is largely attributed to the successes achieved in the broiler industry. Other sectors that also exhibited high growth performances were the swine and egg production. Poultry activity is concentrated in the Central Region of Thailand on relatively larger-scale farm operations-more than 2000 birds on 2000s. While the North Region of Thailand is the second poultry activity farm operations are relatively small-500 birds. Northeast and South Regions, also still reply on small farms.

To improve broiler production in North Region of Thailand, we used the Data Envelopment Analysis (DEA) approach to compute the technical efficiency of farms. The improvement of technology is the most suitable approach in short period of time because it does not require more are higher poultry intensity and development of new technology (Coelli et al, 1996). Therefore, the estimation of technical efficiency in livestock has remained an important what for the North Region of Thailand where potential to increase the production through expansion in productivity and development/ adoption of new technology is limited. In this study, Chiang Mai province was selected because it is the major output center poultry production in North Region of Thailand (DLD, 2003). Furthermore, there are no known studies to determine the technical efficiency (TE) of broiler farmers in Chiang Mai province. The objective of this study is measure the technical efficiency of farms and to find out which factor have the greatest impact on the efficiency differential among growers using farm-specific variable. To fulfill the objective of this study, at first, DEA is used to measure the efficiency level. Then, the Tobit models are estimated as a function of various attributes of the farms within the sample to figure out which aspects of the farms' investment of human and physical resource might be change to improve efficiency (Chavas et al, 2005)

2. Material and Method

2.1. Data

The data used in this study were collected from a cross-section survey of broiler farmers in Chiang Mai province, Thailand. The cross data were collected from the quota sampling of 52 broiler farms in the Chiang Mai province, Thailand. The file survey conducted on October, 2011 to November, 2011. The questionnaire for the survey was constructed to ask for the detail about the poultry operation on the farms. In particular, questions were included to determine the number of broilers and the use of input, such as labor, feed and capital. Information was also obtained on some basic personal characteristics of the sample farmer such as age, education, status, and etc.

2.2. Method of Analysis

In the first step: we used the DEA approach to investigate the sample poultry farmers under an input orientated and output orientated as suggested by Coelli et al (1996) . We have chose input-orientated CCR formulation with constant return to scale (Charnes et al, 1978) to use resource more efficiently, which is conventional model suggesting how a unit can be efficiency by reducing the inputs. The model was presented for m input and s output for each i-th farmers or decision making unit (DMU). A DEA model is defined by:

$$\begin{aligned} &(\theta,\lambda)\ \text{Min}\theta_i \\ &\text{Subject to}\quad +Y\lambda \geq 0, \\ &\theta x_i - X\lambda \geq 0 \\ &\lambda \geq 0 \end{aligned} \tag{1}$$

where θ is a scalar of efficiency rate, λ is an $n \times 1$ vector of constants. $Y\lambda$ and $X\lambda$ are the efficiency projections on the frontier. The measure technical efficiency can take value ranking from 0 to 1, where a value of $\theta_i = 1$ addressed that the farmer I is full technically efficient. Therefore, $1 - \theta_i$ shows how much of i-th farmer input can be proportionally reduced without any loss in outputs according to Farrell's definition.

Second step, we studied the associated the technical efficiency. We tried to include as much as existing socioeconomic factors what are currently important to the research and play vital role in the broiler system in this region. In this study we have used human variables such as age, education, farm experience, and the number of family size. T role of farm specific factors to technical efficiency, by the Tobit regression model (2), efficiency, is a censored variable with an upper limit of one (Lockheed et al, 1981). This Tobit model is employed using the DEA approach to estimate the factor associated with efficiency with the help of LIMDEP statistical tool. The dependent variable in this model is the initial E_i calculated by DEA.

$$TE_i = \beta_0 + \beta_1 Age + \beta_2 edu + \beta_3\ hh + \beta_4 train + \beta_5 credit + \varepsilon \tag{2}$$

Where, TE_i represent technical efficiency (CRS); Age is the age of the farmer in year; Edu is the education of the farmer (years); hh is the family size (person); train is the dummy variable (if the farmer is trained = 1, and otherwise = 0); credit is the credit to access (it the credit access = 1, and otherwise = 0); and ε is the error term.

3. Results and Discussion

The summary statistics of the variables gathered from 52 observed are report in Table 1. The average output of broiler production was 15820.5 kg per one broiler production time with the high weight was 35316.0 kg per one production time. The mean farm size or stock of bird was 9086.54 birds. This shows that broiler production was in the medium scale category in the study area. This agreed with the classification of FAO (2003), which classification of scale poultry farm as having up to 1000 birds, large scale farm has above 5000 birds. The study revealed that poultry farmers were in the categories of medium and large-scale ventures. Feed consumption constituted the major components of poultry production in the study area. The feed to produce the output showed mean at 2796.152 kg. The average labor was 60.48 man-days (2 labors for 30 days). While minimum labor was 20 man-days. This shows that the production technology existing among the broiler farms is a technology incentive.

Furthermore, the commercial poultry farmers were relatively old with mean age of about 54 years. The education level was approximately 6 which mean that they had completed primary school; the family size of farm showed a mean of 4 persons per farm; and the means of famers' experience to produce output was

24.67 years. The dummy variable of other what borrowed from other lenders to invest in broiler farming were 59 percent.

The frequency distribution of the technical efficiency estimation of broiler farmers is obtained from the DEA model as shown in Table 2. That model is input-oriented which analyses how to improve the input characteristic of the unit concerned to active full efficiency. An efficiency score of 1 indicates the farmer i-th is fully technical efficient and a score less than 1 indicates the farmer to be technical inefficient. The technical efficiency rank between 0.44 and 1.00, it found that technical efficiency of the individual farms varied widely. However, the mean technical efficiency score of farmers is 0.62. This means, in principle, that sample farmers can potentially reduce their inputs of broiler production on average by 62 percent and still achieve the same level of output from the existing technology.

The mostly ranging of technical efficiency among the farmers also shows that 46.15 percent of farmers have a technical efficiency ranging between 0.60 and 0.69, while 42.31 percent of farmers have a technical efficiency between 0.50 and 0.59, whereas 3.85 percent of farmers enjoy efficiency ranging between 0.70 and 0.79, and 0.80 and 0.89 efficiency score. However, 1.92 percent of farmers found to be the technical inefficiency ranging less than 0.50 efficiency score and ranging between 0.90 and 0.99.

3.1. Factors of Technical Efficiency

The Tobit regression model was used to estimated factors associated with technical efficiency as illustrated in Equation (2). The maximum likelihood estimation of determinants of technical efficiency of broiler farms is shown in Table 3. From the result family size, experience of farmer, and access to credit appeared to have exerted a positive efficiency; conversely, age and education of farmers appeared to be negative. These results show that increasing positive factors can lead to enhance to technical efficiency of broiler farms.

According to these results, the age of farmers appears to be negatively and significantly at 10 percent significant level which indicates that younger farmers are more likely to be inefficiency than their older counterparts. The experience of farmers is significant and positive at 10 percent level. A possible explanation is that experienced farmers have more knowledge about resource and farming practices, which enables them to utilization resources more efficiency. A possible explanation is the experienced farmers have more knowledge on their resource and practices, which enable them to resource utilization more efficiency (Ismat el al, 2009).

4. Conclusion

In this study technical efficiency of poultry farms in Chiang Mai province of Thailand was estimated by using the Data Envelopment Analysis (DEA) approach and the variation in the technical efficiency was explained using various farm-specific human or characteristic of farmers' variables.

Assessment of technical efficiency of farmers implies considerable amount of technical efficiency among the sample farms under the constant return to scale (CRS) specification. The results showed that 46.15 percent of farmers have a technical efficiency ranging between 0.60 and 0.69 score while only 1.92 percent appear to be the inefficiency in this research. This means that the amount of input used by farmers was lower than what would be needed to maintained the same output level. The farm households appeared to be dominantly increasing return to scale. The sampled farmers, on average, could increase their broiler production if they could operate at full technical efficiency levels, given the existing technology. Evaluating factors associated with the inefficiency suggests that farmers' experience and age are most statistically significant factors associated with technical efficiency.

We believe that benefit of this study is benchmarking, using efficient farms, which would be helpful for setting targets and finding the weakness of current practices. Furthermore, it can produce a target mean value of output by using target meant value of inputs which suggests that it can lead to full efficiency from the individual inefficiency farmers. Moreover, this can provide information to policy makers and extension services on how to better focus efforts to improve broiler farm efficiency.

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Table 1: Summary of input output and socioeconomic variable for the sample farm

Variable	Mean	Minimum	Maximum
Output (kg)	15820	900	35316
Stock (Number of chick)	9086.54	600	20000
Feed (kg)	2796.15	150	6350
Labor (man-days)	60.48	20	180
Age (year)	53.62	40	72
Year of schooling (year)	6.25	4	12
Family size (person)	4.14	2	7
Experience of farmers	24.67	11	47
Access to credit (Dummy	0.59	0	1

Source: Field survey, 2010
Note: Sample size = 52

Table 2: Technical efficiency estimation

Efficiency range	Farmers	Percentage
< 0.50	1	1.92
0.50 – 0.59	22	42.31
0.60 – 0.69	24	46.15
0.70 – 0.79	2	3.85
0.80 – 0.89	2	3.85
0.90 – 1.00	1	1.92
Mean	0.62	
Minimum	0.44	
Maximum	1.00	
Total household	52	

Source: Author calculated

Table 3: Factors explaining of technical efficiency

	Parameter	Co-efficiency	Std. Error
Constant	β_0	0.73***	0.12
Age	β_1	-0.004*	0.002
Education	β_2	-0.002	0.004
Family size	β_3	0.004	0.011
Experience of Farmers	β_4	0.003*	0.001
Access to Credit	β_5	0.024	0.023
Standard error of the estimate (σ)		0.077***	
Log of likelihood function		59.527	

Source: Author calculated