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Evaluation of milk production efficiency in large dairy farms in northwest of Iran

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ABSTRACT: This research investigates the efficiency of milk production in dairy farms with an annual production of more than 30 tons in Mianeh city of East Azarbaijan province, northwest of Iran. The Data was collected by completing the questionnaire and Deap software package was used for analyzing the data. The results of the study showed that the average technical efficiency of 28 units in the constant and variable returns to scale were 0.86 and 0.89, respectively. Among the dairy farms, units 21 and 24 were selected as the reference (six times) more than the rest. According to the results in nine units (32%), there was a possibility to increase production by a total of 217.64 tons per year, which was equivalent to an increase of 10.7% in current production.

***Keywords*:** Technical Efficiency, Economic Efficiency, Optimal Allocation, Production Management

INTRODUCTION

Efforts to reduce the cost of manufacturing units are one of the ways to increase profitability in production units. In order to achieve this goal, two strategies for improving the efficiency and improving the technology are recommended. Improving the technology is long-term and time-consuming, but improving the efficiency of a shorter-term problem. In order to examine this and identify ways to improve efficiency, various approaches, including the data envelopment analysis (DEA) approach, are presented.

Eshraghi and Kazemi (2014) studied the economic and technical efficiencies of dairy farms using parametric and nonparametric approaches in Gorgan city. The results of the Cobb-Douglass model estimation showed that the average technical and economic efficiency were 75% and 72%, respectively. In another study, Torabi and Ghorbani (2015) investigated the efficiency of dairy farms in Mazandaran province using fuzzy data envelopment analysis approach. The results showed that the efficiency of the units in the different groups was not the same and in the group of 6 to 10, the highest value was.

Karbasi et al. (2015) investigated the effect of subsidies on the efficiency and productivity of industrial dairy farms in Isfahan city. In this study, DEA approach was used and the results indicated a decrease in technical efficiency and increase of allocation efficiency during the study period (2009 and 2011). Molaei and Sani (2015) studied technical and environmental performance in dairy farms in Sarab City, using DEA. According to their results, the average technical, scale and environmental efficiencies were 95%, 55% and 88%, respectively. Spearman's correlation coefficient showed that units with higher technical efficiency could produce less pollutant.

The milk production efficiency in Pennsylvania, USA, was evaluated using DEA approach. The results showed that only nine of 44 manufacturers are fully functional (Heinrichs et al., 2013). The results of technical efficiency study using DEA in Irish dairy farms showed that the average technical efficiency in constant return to scale was 0.755 and in variable return to scale was 0.799. The results indicated that only 12% of the operators were in the optimal scale (Kelly et al., 2013).

In the present study, by using field data, the efficiency of dairy cattle units in the city of Mianeh using the DEA approach was investigated. The contents of the article are organized in three parts: materials and methods, results and discussion and conclusion.

MATERIALS AND METHODS

If the methods for evaluating and measuring the efficiency are divided into two groups of frontier and non-frontier, DEA method is placed in Frontier method group. In these methods, unlike non-frontier methods in which absolute efficiency is calculated and performance variations of each unit are measured, the efficiency is compared with a reference level. In other words, the function of the units is obtained from the best available solution. This level, called the efficiency boundary, represents the minimum inputs needed to produce a unit of product. To illustrate the concepts of efficiency, we can use Figure 1 (Farrell, 1957). In this hypothetical diagram, production units operate on an optimal scale; in other words, there is no change in the level of activity affecting the average cost.

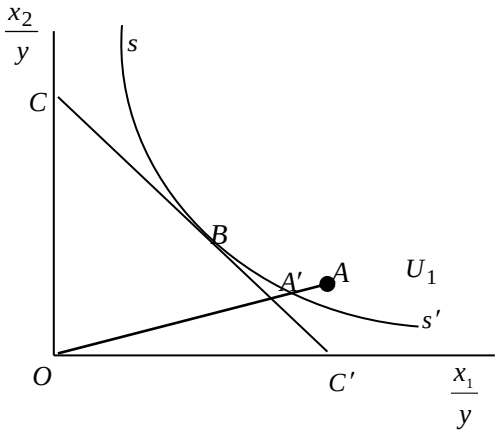

Figure 1. graphical display of technical efficiency index calculation

In figure 1, $s\acute{s}$ is the isoquant curve for best functions which is possible with different ratios of resources specified with x_1 and x_2. From a technical point of view, it is an efficient enterprise when matches on the production curve, so any deviation from it represents inefficiency. Typically, consider the unit U_1. This unit operating at point A and needs to be moved to $\acute{A}$ to achieve its maximum efficiency. The difference between the current situation and the optimal situation is equal to $\acute{A}A$, which indicates the amount of technical inefficiency (TI), and the concept is that it is possible to produce with less inputs or produce more with current inputs. The technical inefficiency is calculated by dividing $\acute{A}A$ to $O\acute{A}$. Since the technical inefficiency is between zero and one, so technical efficiency (TE) is calculated from $(1-TI)$. Equation (1) shows the mathematical model that is used for calculating TE in output-oriented and variable return to the scale conditions:

$$\begin{aligned} &max_{\phi,\lambda}\phi, \\ &st \quad -\phi q_i + Q\lambda \geq 0, \\ &\quad x_i - X\lambda \geq 0, \\ &\quad \acute{I}1\lambda = 1, \\ &\quad \lambda \geq 0. \end{aligned} \qquad (1)$$

Where $\frac{1}{\phi}$ is TE score, q_i and x_i are i-th unit output and input vectors which are defined for each unit separately ($i = 1,..,I$). The vectors of inputs used by different units make X matrix with $N \times I$ dimensions. Q is output matrix

with $M \times I$ diminsions and λ is a $I \times 1$ vector of constants. By removing the expression $I\lambda = 1$ from equation 1, TE is calculated with constant return to scale assumption (Coelli, 1997).

RESULTS AND DISCUSSION

The evaluation of technical efficiency showed that most units have a good performance. Table 1 shows the results of Deap software.

Table 1. Technical and Scale efficiencies of dairies in the city of Mianeh

Dairy	efficiency			Dairy	efficiency		
	CRSTE	VRSTE	SCALE		CRSTE	VRSTE	SCALE
1	0.97	1	decreasing	15	1	1	-
2	0.55	0.63	decreasing	16	0.69	0.70	increasing
3	0.75	0.78	decreasing	17	1	1	-
4	1	1	-	18	1	1	-
5	1	1	-	19	0.47	0.47	decreasing
6	1	1	-	20	1	1	-
7	1	1	-	21	1	1	-
8	0.81	1	increasing	22	0.70	0.71	decreasing
9	0.73	0.82	decreasing	23	1	1	-
10	0.82	1	increasing	24	1	1	-
11	1	1	-	25	0.73	0.74	decreasing
12	0.38	0.52	decreasing	26	0.88	1	increasing
13	1	1	-	27	0.66	0.68	increasing
14	1	1	-	28	1	1	-

The results of Table 1 show that in large dairy farms, average technical efficiency in terms of constant and variable return to scale is 0.86 and 0.89, respectively. In other words, it is possible to increase production by at least 11% of current production with improved performance. In addition, of the 28 studied units, 13 units did not operate on optimal scale, of which eight units are more than optimal on a scale. In Table 2, the increase in production generated by efficiency management has been reported.

Table 2. Expected increase in milk production due to improved efficiency (ton per year)

Dairy	production		
	Original value	Projected value	change
2	66	106.68	39.68
3	99	127.22	28.22
9	66	80.07	14.07
12	33	63.30	30.3
16	49.5	70.47	20.97
19	33	69.86	36.86
22	36.3	51.19	14.89
25	49.5	66.55	17.05
27	32.5	48.09	15.59

As can be seen from the results of Table 2, the highest annual increase was observed in unit 2, which is 39.68 tons. This unit has a technical efficiency of 0.63. The total expected increase in production by improving the efficiency of units was 217.64 tons, which was roughly equivalent to 10.77% increase in current production. In extension activities, identifying and introducing successful units had a significant role in guiding other operators. Based on the research findings, units 21 and 24 were identified as reference units.

CONCLUSION

The results of the study showed that the units under study were in a favorable situation, however, there was still a possibility of increasing production through improving efficiency. Most inefficient units operated on a non-optimal scale. Therefore, managing the scale of production could increase the efficiency of these units. Comparing the benefits of efficiency management with other performance enhancements strategies would allow prioritizing development activities. It was suggested that superior units has been used as benchmark in knowledge transfer plans.

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