ISSN 1819-1878

Asian Journal of Animal Sciences

Knowledgia SCIENTIFIC
A Place to Publish Outstanding Research

http://knowledgiascientific.com

Asian Journal of Animal Sciences 4 (4): 221-228, 2010
ISSN 1819-1878 / DOI: 10.3923/ajas.2009.25.32

Economic Efficiency of Caspian Cattle Feedlot Farms*

A. Ghorbani, S.A. Mirmahdavi and E. Rahimabadi
Department of Animal Science,
Agricultural and Natural Resources Research Center of Guilan,
Ministry of Jihad-e-Agriculture, Iran

Abstract: The objective of this study was to measure Technical Efficiency (TE), Allocative Efficiency (AE) and Economic Efficiency (EE) in Caspian cattle feedlot farms. In this research, 70 farms were selected and efficiency estimated by Data Envelopment Analysis (DEA) approach. The results showed that for the case of Constant Returns to Scale (CRS), mean technical, allocative and cost efficiencies were 67.66, 80.57 and 53.5%, respectively and for the case of Variable Returns to Scale (VRS), mean technical, allocative and cost efficiencies were 87.23, 74.87 and 65.90%, respectively. crsTE were significantly affected by farm size ($p<0.05$). vrsTE were not significantly affected by farm size ($p>0.05$). crsTE and vrsTE were not significantly affected by farmer's age, farmer's education and farmer's experience ($p>0.05$). On the basis of results of this research, we can improve efficiency of Caspian cattle feedlot farms by correct using of production inputs, such as increasing length of fattening period, decreasing farm size and decreasing metabolizable energy and crude protein intake of calve.

Key words: Data envelopment analysis, technical efficiency, cattle, production

INTRODUCTION

For all agricultural sectors, achieving a high level of technical efficiency is essential for competitiveness and profitability. Cattle raising has been identified as a main products in Iran agriculture beef production and has not been sufficient for domestic consumption. Iran meat consumption per capita is about 12 kg and 65244 tons meat were imported in 2007. In the last two decades, several agricultural policies, particularly in Iran, have attempted to address questions about the economic efficiency of the Iranian native cattle based on the assumption that it is inefficient for production. To design and implement meaningful policies, there needs to be precise measures of efficiency that show what does and does not influence it.

These measures are necessary to understand the magnitude of the public policy challenge. There are causes for worry concerning the future development of cattle production in Iran. First, cattle are normally raised by unskilled person. Second, the Iran government has significantly influenced on agriculture through a variety of policies.

Because of these factors, economists and policy makers have raised the question of the economic efficiency of Caspian cattle feedlot in Iran, especially at farm level. This study has been the first application of Data Envelopment Analysis (DEA) in order to measure and explain economic efficiency and its components of Caspian cattle feedlot farms in Iran. This enables more detailed understanding of the nature of economic efficiency in these farms.

Technical efficiency is a measure of how well the individual transforms inputs into a set of outputs based on a given set of technology and economic factors (Aigner *et al*., 1977; Kumbhakar and Lovell, 2000).

Corresponding Author: Ahmad Ghorbani, Department of Animal Science,
Agricultural and Natural Resources Research Center of Guilan,
Ministry of Jihad-e-Agriculture, Iran

Originally Published in Asian Journal of Animal Sciences, 2009

Two individuals using the same set of inputs and technology may produce considerably different levels of output. While part of the difference may just be random variations found in all aspects of life, other parts may be attributed to individual fundamental attributes and to opportunities that could be influenced through public policies (Ortega, 2002).

Likewise, efficiency has direct implications for the public welfare since resources are used more effectively. DEA is a mathematical programming approach to assessing relative efficiencies within a group of decision making units (DMUs) (Kao, 1994).

A decision unit can be each object, which can be characterized by inputs and output. It is important that with an application of the DEA to a group of decision units, all decision units have the same inputs and outputs. So, that the application of the DEA supplies a meaningful result, only decision units should be considered with an application, which are similar. The DEA makes possible for a user to consider several inputs and several outputs. For the evaluation of the efficiency of the decision units for each decision unit an efficiency value is computed. With the application of the DEA to a group of decision units an optimization problem must be solved for each decision unit. Many studies have been published dealing with applying DEA in real-world situations. All efficiencies are restricted to lie between zero and one (i.e., between 0 and 100%). In calculating the numerical value for the efficiency of a particular DMU weights are chosen so as maximize its efficiency, thereby presenting the DMU in the best possible light (Beasley, 2008).

The main purpose of this study is to measure and investigate factors affecting economic inefficiency and production improvement of cattle feedlot farms in Iran.

MATERIALS AND METHODS

The data used in this study is based on a direct interview survey of 70 farms that were selected by randomized sampling method classified with proportionate appointment in Guilan Province which are predominantly cattle producing areas in North of Iran (near Caspian Sea) during one fattening period. Questionnaires were completed and data such as, numbers of calve, farmers age, education and experience in years, monthly live weight, daily feed intake, metabolizable energy and crude protein intake of calve and length of fattening period were obtained. Also, cost of inputs and value of output were obtained.

This study applied the DEA approach to measure economic efficiency using the 2007 farm-level data of Caspian cattle feedlot farms. The farms selected were owner operated and had faced a similar economic and marketing environment for inputs and outputs.

One output and 6 inputs were used in the empirical application of this study. Six inputs were number of calve per farm, number of labour/days/hours, length of fattening period (days), total metabolizable energy intake (Mcal), total crude protein intake (kg) and total cost of hygiene-treatment of calve (Rials). The output were total live weight gain (kg) of calve per farm.

Charnes *et al*. (1978) proposed a model which had an input orientation and assumed constant returns to scale (CRS). Subsequent papers have considered alternative sets of assumptions, such as Banker *et al*. (1984), who proposed a Variable Returns to Scale (VRS) model.

Following Fare *et al*. (1985), Banker *et al*. (1996), Coelli *et al*. (2005) and Sharma *et al*. (1999), the VRS model is discussed below. Let us assume there is data available on K inputs and M outputs in each of the N decision units (i.e., farms). Input and output vectors are represented by the vectors x_i and y_i, respectively for the ith farm. The data for all farms may be denoted by the $K\times N$ input matrix (X) and $M\times N$ output matrix (Y).

The envelopment form of the input-oriented VRS DEA model is specified as:

$$
\begin{aligned}
&\mathrm{Min}_{\theta,\lambda}\ \theta \\
&\text{st } -y_i + Y\lambda \geq 0 \\
&\theta x_i - X\lambda \geq 0 \\
&N1'\lambda = 1 \\
&\lambda \geq 0
\end{aligned}
\tag{1}
$$

where, θ is the input Technical Efficiency (TE) score having a value $0 \leq \theta \leq 1$. If the θ value is one, indicating the farm is on the frontier, the vector λ is an $N\times1$ vector of weights which defines the linear combination of the peers of the ith farm. Thus, the linear programming problem needs to be solved N times and a value of θ is provided for each farm in the sample.

The CRS DEA model is specified as:

$$
\begin{aligned}
&\mathrm{Min}_{\theta,\lambda}\ \theta \\
&\text{st } -y_i + Y\lambda \geq 0 \\
&\theta x_i - X\lambda \geq 0 \\
&\lambda \geq 0
\end{aligned}
\tag{2}
$$

In order to investigate the economic efficiency or cost efficiency, the cost minimisation DEA is specified as:

$$
\begin{aligned}
&\mathrm{Min}_{\lambda, x_i*}\ w_i'\, x_i* \\
&\text{st } -y_i + Y\lambda \geq 0 \\
&x_i* - X\lambda \geq 0 \\
&N1'\lambda = 1 \\
&\lambda \geq 0
\end{aligned}
\tag{3}
$$

where, w_i is a vector of input prices for the I-th farm and x_i* is the cost-minimising vector of input quantities for the I-th farm. The economic efficiency can be calculated as:

$$
EE = \frac{w_i' x_i*}{w_i' x_i}
\tag{4}
$$

Allocative efficiency can be specified and calculated as:

$$
AE = \frac{EE}{TE}
\tag{5}
$$

Note that this procedure will include any slacks into the allocative efficiency measure, reflecting an inappropriate input mix (Ferrier and Lovell 1990). Efficiency scores in this study were estimated using the computer program, DEAP Version 2.1 described by Coelli (1996).

RESULTS

The results showed in Table 1 and 2 that for the case of Constant Returns to Scale (CRS), Mean technical, allocative and cost efficiencies were 67.66, 80.57 and 53.5%, respectively and for the case of Variable Returns to Scale (VRS), mean technical, allocative and cost efficiencies were 87.23, 74.87

Table 1: Inputs observed and recommended in CRS and VRS assumption

Variable	No. of calve	Labour (No./days)	Length of fattening period (days)	Total ME intake (Mcal)	Total CP intake (kg)	Total cost of hygiene-treatment of calve (Rials)
Observed	27.20	145	145	69781	3896	879481
CRS	17.43	128	157	31253	1503	613831
VRS	17.08	146	168	43826	2509	888243

Table 2: Descriptive statistics

Efficiency	Minimum	Mean	SD	SE
vrsTE	0.548	0.87317	0.120229	0.014370
vrsAE	0.250	0.74867	0.187670	0.022431
vrsCE	0.232	0.65904	0.209633	0.025056
crsTE	0.231	0.67659	0.243464	0.029100
crsAE	0.269	0.80573	0.165699	0.019805
crsCE	0.127	0.53496	0.210218	0.025126

n = 70

Table 3: Effect of farm size on crsTE

Herd size	Frequency	Mean	SD	SE
(Group 1) 20-40	55	0.62878a	0.242536	0.032704
(Group 2) 41-60	10	0.81050ab	0.164044	0.051875
(Group 3)>60	5	0.93460b	0.091399	0.040875
Total	70	0.67659	0.243464	0.029100

a, b are statistically different groups

Table 4: Effect of farm size on vrsTE

Herd size	Frequency	Mean	SD	SE
(Group 1) 20-40	55	0.86504	0.122522	0.016521
(Group 2) 41-60	10	0.87310	0.115667	0.036577
(Group 3) >60	5	0.96280	0.075078	0.033576
Total	70	0.87317	0.120229	0.014370

Table 5: Effect of farmer's age on crsTE

Age (years)	Frequency	Mean	SD	SE
(Group 1) <25	2	0.65200	0.492146	0.348000
(Group 2) 25-40	35	0.65891	0.262847	0.044429
(Group 3) 41-55	32	0.68734	0.210860	0.037275
(Group 4) >55	1	1.00000	0.0	0.0
Total	70	0.67659	0.243464	0.029100

Table 6: Effect of farmer's age on vrsTE

Age (years)	Frequency	Mean	SD	SE
(Group 1)<25	2	0.94300	0.080610	0.057000
(Group 2) 25-40	35	0.85669	0.128129	0.021658
(Group 3) 41-55	32	0.88288	0.112789	0.019938
(Group 4)>55	1	1.00000	0.0	0.0
Total	70	0.87317	0.120229	0.014370

respectively. Also, for the case of CRS, minimum technical, allocative and cost efficiencies were 23, 27 and 13%, respectively and for the case of VRS, mean technical, allocative and cost efficiencies were 55, 25 and 23%, respectively. Efficiency summary in CRS and VRS assumption in 70 fattening farms showed in Table 11.

crsTE were significantly affected by farm size ($p<0.05$) (Table 3). vrsTE were not significantly affected by farm size ($p>0.05$) (Table 4). crsTE were not significantly affected by farmer's age ($p>0.05$) (Table 5). vrsTE were not significantly affected by farmer's age ($p>0.05$) (Table 6). crsTE were not significantly affected by farmer's education ($p>0.05$) (Table 7). vrsTE were not significantly affected by farmer's education ($p>0.05$) (Table 8). crsTE were not significantly affected by farmer's experience ($p>0.05$) (Table 9). vrsTE were not significantly affected by farmer's education ($p>0.05$), (Table 10).

Table 7: Effect of farmer's education in years on crsTE

Age (years)	Frequency	Mean	SD	SE
(Group 1) 0	13	0.61677	0.226663	0.062865
(Group 2) 9	19	0.70179	0.258225	0.059241
(Group 3) 12	28	0.66375	0.223149	0.042171
(Group 4)>12	10	0.74240	0.302254	0.095581
Total	70	0.67659	0.243464	0.029100

Table 8: Effect of farmer's education in years on vrsTE

Age (years)	Frequency	Mean	SD	SE
(Group 1) 0	13	0.85362	0.127021	0.035229
(Group 2) 9	19	0.85968	0.133352	0.030593
(Group 3) 12	28	0.87264	0.115447	0.021817
(Group 4)>12	10	0.92570	0.098776	0.031236
Total	70	0.87317	0.120229	0.014370

Table 9: Effect of farmer's experience in years on crsTE

Experience (years)	Frequency	Mean	SD	SE
(Group 1) 1-5	29	0.71021	0.257321	0.047783
(Group 2) 6-10	22	0.62159	0.245152	0.052267
(Group 3) 11-15	10	0.69780	0.199145	0.062975
(Group 4)>15	9	0.67911	0.253249	0.084416
Total	70	0.67659	0.243464	0.029100

Table 10: Effect of farmer's experience in years on vrsTE

Experience (years)	Frequency	Mean	SD	SE
(Group 1) 1-5	29	0.88793	0.119726	0.022233
(Group 2) 6-10	22	0.85900	0.116472	0.024832
(Group 3) 11-15	10	0.86540	0.103417	0.032703
(Group 4)>15	9	0.86889	0.159448	0.053149
Total	70	0.87317	0.120229	0.014370

Table 11: Efficiency summary in CRS and VRS assumption

Farm No.	*	Sscale efficiency (crste/vrste)	VRS CE (EE)	VRS AE	VRS TE	CRS CE (EE)	CRS AE	CRS TE
1	-	1.00	0.781	0.781	1.00	1.00	1.00	1.00
2	-	1.00	0.983	0.983	1.00	0.99	0.99	1.00
3	-	1.00	0.937	0.937	1.00	1.00	1.00	1.00
4	-	1.00	0.625	0.625	1.00	0.625	0.625	1.00
5	irs	0.993	0.904	0.966	0.936	0.917	0.972	0.943
6	-	1.00	0.343	0.343	1.00	0.614	0.614	1.00
7	irs	0.855	0.545	0.709	0.769	0.553	0.615	0.899
8	irs	0.443	0.185	0.54	0.343	0.232	0.30	0.773
9	irs	0.586	0.541	0.923	0.586	0.81	0.81	1.00
10	irs	0.916	0.525	0.747	0.703	0.538	0.701	0.768
11	irs	0.946	0.492	0.628	0.784	0.51	0.615	0.829
12	irs	0.84	0.461	0.549	0.84	0.557	0.557	1.00
13	irs	0.248	0.127	0.548	0.231	0.281	0.302	0.933
14	irs	0.891	0.687	0.857	0.802	0.698	0.777	0.899
15	drs	0.901	0.49	0.573	0.855	0.61	0.642	0.95
16	irs	0.979	0.628	0.868	0.724	0.647	0.875	0.74
17	irs	0.973	0.651	0.803	0.81	0.677	0.813	0.833
18	-	1.00	0.579	0.579	1.00	0.718	0.718	1.00
19	irs	0.826	0.566	0.905	0.625	0.57	0.753	0.757
20	irs	0.884	0.543	0.842	0.645	0.558	0.765	0.729
21	-	1.00	0.914	0.914	1.00	0.985	0.985	1.00
22	drs	0.968	0.746	0.875	0.852	0.747	0.849	0.88
23	irs	0.733	0.492	0.78	0.631	0.642	0.746	0.86
24	drs	0.995	0.738	0.869	0.849	0.752	0.882	0.854
25	-	1.00	1.00	1.00	1.00	1.00	1.00	1.00
26	irs	0.60	0.361	0.808	0.447	0.426	0.572	0.745

Table 11: Continued

Farm No.	*	Sscale efficiency (crste/vrste)	VRS CE (EE)	VRS AE	VRS TE	CRS CE (EE)	CRS AE	CRS TE
27	irs	0.635	0.399	0.866	0.461	0.447	0.616	0.725
28	irs	0.545	0.26	0.87	0.298	0.289	0.528	0.548
29	irs	0.806	0.584	0.905	0.645	0.68	0.848	0.801
30	irs	0.966	0.849	0.979	0.866	0.853	0.952	0.897
31	-	1.00	0.84	0.84	1.00	0.891	0.891	1.00
32	-	1.00	0.717	0.717	1.00	0.985	0.985	1.00
33	-	1.00	0.864	0.864	1.00	0.878	0.878	1.00
34	irs	0.712	0.564	0.864	0.653	0.582	0.635	0.916
35	irs	0.799	0.565	0.939	0.602	0.636	0.845	0.753
36	irs	0.57	0.434	0.872	0.498	0.571	0.655	0.873
37	irs	0.869	0.679	0.861	0.788	0.761	0.84	0.906
38	irs	0.936	0.708	0.927	0.763	0.734	0.90	0.815
39	irs	0.808	0.613	0.772	0.795	0.641	0.652	0.984
40	irs	0.68	0.45	0.962	0.467	0.553	0.805	0.687
41	irs	0.237	0.232	0.978	0.237	0.998	0.998	1.00
42	irs	0.899	0.499	0.762	0.654	0.501	0.687	0.728
43	irs	0.827	0.491	0.852	0.577	0.497	0.712	0.697
44	-	1.00	0.924	0.924	1.00	0.951	0.951	1.00
45	irs	0.423	0.358	0.911	0.393	0.879	0.948	0.927
46	irs	0.54	0.381	0.909	0.418	0.405	0.523	0.775
47	irs	0.343	0.212	0.70	0.304	0.516	0.583	0.886
48	irs	0.652	0.308	0.72	0.428	0.327	0.497	0.657
49	irs	0.513	0.376	0.938	0.401	0.675	0.864	0.782
50	irs	0.686	0.434	0.913	0.476	0.555	0.801	0.694
51	irs	0.808	0.673	0.833	0.808	0.753	0.753	1.00
52	irs	0.315	0.268	0.958	0.279	0.821	0.925	0.887
53	irs	0.363	0.248	0.926	0.268	0.425	0.575	0.739
54	-	1.00	0.438	0.438	1.00	1.00	1.00	1.00
55	irs	0.996	0.55	0.552	0.996	0.55	0.55	1.00
56	irs	0.615	0.475	0.948	0.501	0.628	0.771	0.814
57	irs	0.991	0.45	0.461	0.976	0.554	0.563	0.985
58	irs	0.519	0.314	0.696	0.451	0.465	0.535	0.869
59	irs	0.583	0.539	0.925	0.583	0.944	0.944	1.00
60	irs	0.398	0.332	0.835	0.398	0.809	0.809	1.00
61	irs	0.913	0.245	0.269	0.913	0.25	0.25	1.00
62	irs	0.468	0.38	0.812	0.468	0.547	0.547	1.00
63	irs	0.741	0.679	0.916	0.741	1.00	1.00	1.00
64	irs	0.934	0.587	0.911	0.645	0.591	0.857	0.69
65	irs	0.444	0.335	0.981	0.341	0.609	0.793	0.768
66	irs	0.559	0.358	0.971	0.368	0.382	0.579	0.66
67	irs	0.542	0.432	0.905	0.477	0.727	0.826	0.88
68	irs	0.899	0.491	0.812	0.605	0.53	0.788	0.673
69	irs	0.98	0.783	0.937	0.836	0.787	0.923	0.853
70	irs	0.639	0.285	0.518	0.551	0.299	0.347	0.861

crsTE: Technical efficiency from CRS DEA; VrsTE: Technical efficiency from VRS DEA; Scale: Scale efficiency: crsTE/vrste; *irs: Increasing return to scale, drs: Decreasing return to scale; -: Constant return to scale

DISCUSSION

The empirical results indicate that there are significant possibilities to increase efficiency levels in farms.

Rakipova and Gillespie (2000) examined technical efficiency of beef cattle producers from across Louisiana and were surveyed sixty-two producers in fall 1998. In current research were used 70 producers.

Several farm-specific factors are analysed to assess their influence on technical efficiency. The farmer's age is defined in terms of years, while the farmer's experience and education of farmer's are also defined in terms of years and years of schooling, respectively. In addition, the number of cattle per farm is intended to examine the impact of farm size on the technical efficiency of the feedlot Caspian cattle farms in Iran

In this research, farm size have influenced the crsTE of cattle farms ($p<0.05$). The differences in producers' age, education and experience had not different impacts on crsTE and vrsTE of Caspian feedlot cattle farms ($p>0.05$) and were same as resulted by Krasachat (2007) in Thailand.

Producers' experience had not impact on TE , because farmers with more experience, had more age and in 83.1% of farms, daily work of farm were done by themselves.

Efficiency analysis of feedlot cattle farms for the case of CRS is used for long time aims and results for the case of VRS can be used for short time aims (Coelli, 1996).

Beasley (2003), showed that DEA can be viewed as maximizing the average efficiency of the Decision-Making Units (DMUs) in an organization. The producers who have used less ME and CP achieved higher levels of allocative and economic efficiencies and a smaller farm is likely to be economically more efficient compared to a larger one.

As we resulted, Caspian cattle were intaked ME and CP more than their requirements. So, daily ME and CP intake of feedlot cattle must be decrease. It is required to study more about Caspian cattle requirement and factors affecting on farmers that do this study. Farmers (95%) had not mill, mixer and were used to ready concentrate. Certainly, if farmers were made concentrate themselves, had more economic efficiency.

Also, farmers (90%) were not weigh cattle during fattening period. So, they couldn't estimate ME and CP requirements with precision measurement.

All of these factors were made intaking of ME and CP inefficiently in Caspian feedlot farms. In addition, the producers who have used more labour (number $days^{-1}$), achieved lower levels of allocative and economic efficiencies.

Therefore, results of this research should be used to increase the efficiencies of inefficient Caspian feedlot farms in Iran.

CONCLUSION

We can improve efficiency of Caspian cattle feedlot farms by correct using of production sources (inputs), such as increasing length of fattening period, decreasing number of calve per farm and decreasing total metabolizable energy and crude protein intake of calve as recommended in Table1. Also, these results show that must be working on energy and protein requirements of Caspian feedlot cattle.

REFERENCES

Aigner, D.J., C.A.K. Lovell and P. Schmidt, 1977. Formulation and estimation of stochastic frontier production models. J. Econ., 6: 21-37.

Banker, R.D., A. Charnes and W.W. Cooper, 1984. Some models for estimating technical and scale inefficiency in data envelopment analysis. Manage. Sci., 30: 1078-1092.

Banker, R.D., I. Bardhan and W.W. Cooper, 1996. A note on returns to scale in DEA. Eur. J. Operat. Res., 88: 583-585.

Beasley, J.E., 2003. Allocating fixed costs and resources via data envelopment analysis. Eur. J. Operat. Res., 147: 98-216.

Beasley, J.E., 2008. Data Envelopment Analysis. Operational Research Society, England.

Charnes, A., W.W. Cooper and E. Rhodes, 1978. Measuring the efficiency of decision making units. Eur. J. Operat. Res., 2: 429-444.

Coelli, T.J., 1996. A Guide to DEAP, A Data Envelopment Analysis (Computer) Program. Ver. 2.1, Department of Econometrics, University of New England, Armidale.

Coelli, T.J., D.S.P. Rao, C.J. O'Donnell and G.E. Battese, 2005. An Introduction to Efficiency and Productivity Analysis. 2nd Edn., Springer, New York.

Fare, R., S. Grosskopf and C.A.K. Lovell, 1985. The Measurement of Efficiency of Production. Kluwer-Nijhoff, Boston.

Ferrier, G.D. and C.A.K. Lovell, 1990. Measuring cost efficiency in banking: Econometric and linear programming evidence. J. Econ., 46: 229-245.

Kao, C., 1994. Efficiency improvement in data envelopment analysis. Eur. J. Operat. Res., 73: 487-494.

Krasachat, W., 2007. Economic efficiency of feedlot cattle farms in Thailand. Proceedings of the Conference on International Agricultural Research for Development, Oct. 9-11, University of Gottingen, pp: 1-1.

Kumbhakar, S. and C.A.K. Lovell, 2000. Stochastic Frontier Analysis. 1st Edn., Cambridge University Press, New York.

Ortega, L., 2002. Technical efficiency of the dual purpose cattle system in venzuela. Ph.D Thesis, University of Florida.

Rakipova, A. and J. Gillespie, 2000. Technical efficiency of beef cattle producers in Louisiana. Louisiana Rural Economist., 62: 1-2.

Sharma, K.R., P. Leung and H.M. Zaleski, 1999. Technical, allocative and economic efficiencies in swine production in Hawaii: A comparison of paremetric and nonparametric approaches. Agric. Econ., 20: 23-35.