International Journal of Agricultural Management and Development (IJAMAD)
Available online on: www.ijamad.iaurasht.ac.ir
ISSN: 2159-5852 (Print)
ISSN:2159-5860 (Online)

Measurement of Technical Efficiency and Production Risk in Zabol Dairy Farms, Iran

Javad Shahraki [1], Mosayeb Pahlavani [2] and Nasrin Ohadi [3*]

Received: 24 August 2014,
Accepted: 16 November 2015

Abstract

Given entrepreneurs' special role in the economic growth and development, many developed and developing countries are attempting to motivate more number of people who have entrepreneurial characteristics towards entrepreneurship and entrepreneurial activities. The purpose of this research was to study the effectiveness of entrepreneurship training courses in Ilam Province, Iran. In this research a descriptive survey method was used. The statistical population consisted of 830 people that based on Cochran's formula and by using proportionate stratified random sampling method 130 people were selected as the sample. The research tool was a questionnaire which its validity was confirmed by a panel of experts' and its reliability was estimated using Cronbach's alpha as to be 0.83 proving its high reliability. Data were analyzed by SPSS Software Package. It was found that participants' inclination towards self-employment and entrepreneurship was increased after attending the courses. Also, significant differences were observed in participants' readiness to start a business, their familiarity with entrepreneurship concepts and their ability to make a business plan before and after attending the courses.

Keywords:
dairy farms, risk production, technical efficiency, Zabol

[1,2] *Associate Professor, Department of Economics, University of Sistan and Baluchestan, Zahedan, Iran*
[3] *Ph.D. Candidate of Agricultural Economics, Department of Economics, University of Sistan and Baluchestan, Zahedan, Iran*
* *Corresponding author's email: nasrin.ohadi@yahoo.com*

INTRODUCTION

Since ancient times, animal husbandry has been an important field of agricultural and economic activity. Sub-sector of animal husbandry and growing of poultry in Iran's agricultural sector was the second most important sub-sector after crop production. In this sub-sector, value-added agriculture has grown such that its share in agricultural sector ranged from 30 to 35 percent (Ministry of Agriculture, 2006).

Cattle breeding to produce milk and dairy products is one of the most important activities of agricultural sector in Iran. The number of dairy units (both active and inactive) was 24,659 for the year 2011 with total capacity of 2.7 million heads of cattle and their number and capacity have increased by 31 and 22.3 percentages as compared to 2008, respectively. Milk production in the dairy industry is reported to be more than 3.20 million tons in 2010, constituting about 48 percent of the country's total milk production. Milk production in the dairy industry has increased by about 33.2 percent in 2010 as compared to the statistics reported in 2007 (Statistical Center of Iran, 2011).

Population growth, particularly in developing countries and food poverty in other parts of the world, has led to the fact that adequate access to food for responsiveness to population's basic needs still remains high on the agenda of social-economic policy maker. Hence, it is essential to increase production of animal husbandry products with the same amounts of available inputs. Additionally, it is important to examine how much inputs are used to enhance production (Erilouzadeh and Saleh, 2010).

Mohammadi et al (2015) studied the efficiency of industrial dairy farms of Saqqez and Divandarreh counties by the super-efficiency approach. The super efficiency estimation showed that the mean of farms super-efficiency based on the assumption of variable return to scale for input-oriented approach is 1.01. About 58 percent of the studied dairy cattle farms were inefficient and the super-efficiency of about 42 percent of total farms got scores below the average. The amount of λ*k for all farms except for farms three and five was zero. Furthermore, these two farms in primitive super efficiency model became infeasible; therefore, they were considered as reference farms. The results of super-efficiency method and efficiency conventional Data Envelopment Analysis (DEA) method were compared together, and inefficient farms got the similar efficiency and super-efficiency scores. Efficient farms whose super-efficiency score was equal or greater than 1 stood over frontier production function in the conventional model.

Dourandish et al (2013) estimated multi-output technical efficiency for the dairy farms of the Northern Khorasan Province (applying stochastic production and stochastic distance frontiers). The Stochastic Production Frontiers (SPF), with and without the inclusion of inefficiency effects, estimated the average technical efficiency to be 0.96 and 0.93, respectively. In addition, the experience, targeting subsidies and main job of dairy farmers had significantly positive impact on technical efficiency. The results showed that the numbers of cattle, land size, and investment in equipments, labor, and feed costs have significantly positive impact on the income of milk production. The Stochastic Distance Frontiers (SDF), with and without the inclusion of inefficiency effects, estimated the average technical efficiency to be 0.91 and 0.94, respectively. The experience, targeting subsidies, and main job of dairy farmers had significantly positive impact on technical efficiency. The numbers of cattle, land size, and investment in equipment, labor, feed, and veterinary costs had significantly positive impact on the income of the milk production.

Mehrjou et al (2012) studied technical efficiency of dairy cattle cooperative companies. The results showed that the applied bran and salt were located in the first area of production function. Average technical efficiency of dairy farm units was approximately 94 percent that could be increased by 6 percent via improving management practices. Sing et al (2000) measured technical efficiency, allocative efficiency, and economic efficiency of cooperative dairy plants in Haryana and Punjab states of India by through the DEA method. The average technical efficiency, allocative efficiency, and economic efficiency were estimated to be 91.2, 73.1, and 66.7 percent, respectively. Alvarez and Arias (2004) investigated the relationship between technical efficiency and scale of milk production in North of Spain. The study lasted for 6 years (1993-1998). The results showed that farm size depended on technical efficiency, constant inputs, outputs price, as well as variable input and that there was a positive relationship between farm size and technical efficiency. USDA (2006) explored the influence of managerial factors on productivity of dairy cattle in America. The results showed that the number of animals in the farm, the genre of animals, the animals' age, the dairy farmers' age, the number of labor, the amount of capital, and size of farm had positive effects on milk production for non-commercial and commercial cattle. Mohammadi and Torkamani (2011) estimated technical efficiency and food rations of fattening calves by using production function. The results of this study showed that non-optimal use of food was the most important factor in non-profitability of the studied units in Fars. Zibaie and Soltani (1995) examined the technical efficiency of milk production units by linear programming methods, modified least squares, and maximum likelihood method. The results showed that the technical efficiency determined by maximum likelihood was higher than that determined by the other two methods.

In this study, the researchers evaluate all active dairy farms in Zabol County and measure technical efficiency for the studied units. Next, they examined the effect of various factors on the efficiency of dairy farms units. The results of this study can, then, be used to develop appropriate policies aiming to increase technical efficiency of units and to activate the inactive units.

MATERIALS AND METHODS

So far, several methods of identifying and measuring technical efficiency are introduced by economists. Two main methods have been developed for measuring efficiency and productivity: the parametric (econometric) and non-parametric (mathematical programming) approach. These approaches have different strengths and weaknesses. The essential differences largely reflect the different maintained assumptions used in estimating the frontier. The main strength of the parametric approach stems from the fact that frontier is stochastic, and this allows the effects of noise to be separated from the effects of inefficiency. The non-parametric approach is free from the misspecification of functional form and other restrictions, but it does not account for statistical noise and is, therefore, vulnerable to outliers (Ferrier & Lovell, 1990; Fulginiti & Perrin, 1998; Kwon & Lee, 2004; Sharma et al., 1997).

Stochastic frontier analysis (SFA)

Battese and Coelli (1995) considered the method of Stochastic Frontier Analysis (SFA) more suitable than Data Envelopment Analysis (DEA) for using in agriculture, particularly in developing countries. The main objective of these methods is to estimate frontier function and calculate the amount of this function for each firm's inputs as well as to measure the amount of each firm's outputs. The differences between actual production and frontier production for each firm lie in inefficiency. In the stochastic frontier model, the reason for the difference between actual production and frontier production is technical inefficiency and random factors. Hence, if the performance of a firm is less than frontier production, a part of inefficiency is created by technical and the other part is created by random factors. Yet, if firms can act higher than frontier production function, it is because of random factors. The weakness of stochastic frontier production function approach for calculation of technical efficiency scores is that computational technical efficiency is assumed to be uncorrelated with explanatory variables of stochastic frontier function. If the possibility of computational technical efficiency not correlating with production function parameters is not considered, the calculated values will be skewed and inconsistent (Battese & Coelli., 1995).

Aigner and Chu (1968) estimated parametric frontier production function by using Cobb – Douglas production function. The model is defined as follows:

$$Ln(y_i)=x_i\beta-u_i \qquad i=1,2,.....N \qquad (1)$$

$$Ln(yi)=xi\beta+vi-ui \qquad i=1,2,.....N \qquad (2)$$

where, Y_i is scalar output of the ith farm, X_i is a vector of input quantities and β is a vector of parameters to be estimated, V_i is the disturbance term assumed to be independent and

symmetrically distributed $N(0,\sigma_V^2)$ and it captures the effects of random shocks outside the farmers control (e.g. weather, disease outbreaks, measurements errors, etc.), Ui is a non-negative random variable associated with technical inefficiency in production.

Stochastic frontier production function model with risk of production inputs

The nature of the stochastic frontier production function model with risk of production inputs was reviewed here (Khan et al., 2010; Tan et al., 2010).

$$Y_{it}=f(X_{it},\alpha)exp(\varepsilon_{it}) \qquad (3)$$

where, Y_{it} is scalar output of the ith farm, X_{it} is a $K\times 1$ vector of inputs quantities and explanatory variables, α is a $K\times 1$ vector of parameters to be estimated, i is the number of observations, t is the number of periods studied and ε_{it} is compound error term that defined as follows (Khan et al., 2010; Tan et al., 2010).

$$\varepsilon_i=g(X_i;\beta)V_i-h(X_i;\delta)U_i \qquad (4)$$

where g $(Xi;\beta)Vi$ is risk of function and $h(Xi;\delta)Ui$ is inefficiency of function. β and δ are vectors of parameters. The above model when the function $f(Xit,\alpha)$ was determined (eg, Cobb-Douglas, Transcendental or Translog) and with regard to the distribution assumptions for Uit (half normal) can be maximized by maximum likelihood. V_{it} is the disturbance term assumed to be independent and symmetrically distributed $N(0,\sigma V_2)$ and it captures the effects of random shocks outside the farmers control. Uit is a non-negative random variable associated with technical inefficiency in production. Finally, technical efficiency is obtained from the following equation (Aigner et al., 1977):

$$EF_{it}=exp(-U_{it}) \qquad (5)$$

This index for farm which acts exactly on frontier production function and is absolutely efficient is equal to one. Otherwise, a computational number is obtained between one and zero. Frontier models can test various hypotheses (Khan et al., 2010; Villano et al., 2005).

Villano et al. (2005), according to the model proposed by Kumbhakar (2002), allowed positive or negative effects of inputs on production risk in comparison with the Just and Pope model. They determined error component by the following equation:

$$\varepsilon_i=g(X_i;\beta)[V_i-U_i] \qquad (6)$$

Assuming the equality g (Xi; β) Vi= h (Xi; δ) Ui can be written as:

$$Y_i=f(X_i;\alpha)+g(X_i;\beta)[V_i-U_i] \qquad (7)$$

The above equation is stochastic frontier production with flexible risk characteristics that was used by Batties and Coelli (1997). This state is reviewed to determine average and variance of product for the ith farmer, provided that there are quantities of inputs and technical inefficiency effects (U_i):

$$E(Y_i\,|X_i,U_i) = f(X_i;\alpha) - g(X_i;\beta)U_i \qquad (8)$$

Variance of risk function is defined here as:

$$Var(Y_i|X_i,U_i) = g^2(X_i;\beta) \qquad (9)$$

Final product risk for the j_{th} input is defined via the partial derivative of production variance by taking X_j as positive or negative:

$$\partial Var(Y_i|\ X_i\,,U_i)\ /\partial X_{ij} \quad >0 \text{ or } <0 \qquad (10)$$

Accordingly, technical efficiency for the i_{th} farmer (TE_i) is defined as follows:

$$TE_i=E(Y_i|X_i,U_i)/E(Y_i|X_i,U_i=0)=1\text{-}TI_i \qquad (11)$$

Where, TI_i is technical inefficiency and is defined as potential missed product:

$$TI_i=(U_i.g(X_i,\beta)/(E_i|X_i,U_i=0)=(U_i.g(X_i,\beta)/(f(X_i;\alpha) \quad (12)$$

If the parameters of stochastic frontier production function are known and given, then the best criterion to predict Ui is conditional expectation TE_i that is determined for actual quantities of random variable $W_i = V_i - U_i$ (Villano et al., 2005).

A series of tests can be conducted to test the specification of the models. They are tested through imposing restrictions on the model and using the generalized likelihood ratio statistic to determine the significance of the restriction. The generalized likelihood ratio statistic (LR test) is given by Green (1997) as follows:

$$LR= -2(Loglikelihood\ H_0 - Loglikelihood\ H_1) \quad (13)$$

where, $L(H_o)$ and $L(H_1)$ are the values of the log-likelihood function under the null (H_o) and alternative (H_1) hypotheses, respectively. If the given null hypothesis is true, LR has approximately χ^2 – distribution or mixed χ^2 – distribution when the null hypothesis involves $\gamma=0$

Data envelopment analysis

Data envelopment analysis compares a set of homogeneous Decision Making Units (DMUs) relatively and assigns an efficiency score to each DMU by finding the distance of each unit with that of its peers on the best practice (frontier). Those units that lie on the frontier are recognized as efficient and those that do not as inefficient. Two basic DEA models are CCR (constant returns to scale) which was introduced by Charnes et al. (1978) and BCC (variable return to scale) which was introduced by Banker et al. (1993). The CCR model uses constant return to scale (CRS) concept to assess relative productive efficiencies of decision making units (DMUs) with multiple inputs and outputs. With the CCR model and assuming m inputs, s outputs and n DMUs respectively, the linear programming problem for DMUk is represented as:

$$\text{Max} \qquad \mathrm{h_x} = \frac{\sum_{r=1}^{s} U_r Y_{rk}}{\sum_{i=1}^{m} V_i X_{ik}} \qquad (14)$$

s.t.

$$\mathrm{h_x} = \frac{\sum_{r=1}^{s} U_r X_{rk}}{\sum_{i=1}^{m} V_i X_{ik}} \leq 1$$

$Ur,\ Vi>0,\ r= 1,2,.....,s,\ \ i=1,2,...,m$

where, hX is relative efficiency of the kth DMU, Yrk is the rth outputs of the kth DMU, Xik is the ith inputs of the kth DMU, Ur is the weight of the rth output and Vi is the weight of the ith output.

According to above formulation, the maximum of a ratio of weighted outputs to weighted inputs are the relative efficiency scores of CCR model (Charnes et al., 1978).

The dual problem of CCR model can be written as:

$$\text{Min} \qquad \mathrm{h_x} = \theta - \varepsilon[\textstyle\sum_{r=1}^{s} S_x^+ + \sum_{i=1}^{m} S_i^-] \qquad (15)$$

s.t.

$$\sum \lambda_j Y_{rj} - S_r^+ \geq Y_{rj}$$

$$\lambda_j \geq 0, S_r^+, S_r^- \geq \varepsilon \geq 0 \qquad \forall\ i,r,j$$

r=1,2,……,s, i=1,2,……,m, j=1,2,….,n

where, ε is a small positive number, λ_j is a weight of the jth DMU, S_r^+ is a slack variable of the rth output and S_i^- is a slack variable of the ith input. Considering the convexity restriction ($\sum_i^n$ =1n λ j=1), Banker, Charnes and Cooper introduced BCC model and evaluated technical efficiency and scale efficiency of DMUs. The linear programming dual BCC model is represented by:

$$\text{Min} \qquad \mathrm{h_x} = \theta - \varepsilon[\textstyle\sum_{r=1}^{s} S_x^+ + \sum_{i=1}^{m} S_i^-] \quad (16)$$

s.t.

$$\sum_{i=1}^{n} \lambda_j X_{ij} + S_i^- \leq \theta X_{ij}$$

$$\sum_{i=1}^{n} \lambda_j Y_{rj} - S_r^+ \geq Y_{ij}$$

$$\sum_{j=1}^{n} \lambda_j = 1$$

$\lambda_j \geq 0, S_r^+, S_i^- \geq \varepsilon \geq 0, \forall\ i,r,j$ i=1,2,..s, =1,2,….,m, j=1,2,….,n

Data and Variables

Statistical population included all active dairy farms of Zabol County; therefore, all active dairy farms of Zabol County were investigated by census method (30 dairy farms). The required data were obtained by interview and a questionnaire for the time span of 2012- 2013.

Variables of the study included production of milk in liters (Y), Forage consumption in kg (X_1), concentrate consumption in kg (X_2), bran consumption in kg (X_3), salt consumption in kg (X_4), the use of labor in day-person (X_5), and the number of cattle in person (X_6). Likewise, the explanatory variables of stochastic frontier analysis include: participation in educational classes (Z_1), membership in cooperative (Z_2), dairy farmers (Z_3), dairy farmer's educational level (Z_4), and duration of animal husbandry activity (Z_5).

RESULTS ANS DISCUSSION

Table 1 shows summary of descriptive statistics of the variables used for Zabol County dairy farms. According to this table, average milk production is 1525 liters.

Table 2 shows summary of descriptive statistics of explanatory variable. According to this table, mean age for dairy farmer is 46 years and duration of animal husbandry activity is 19 years.

Table 3 reports the estimated results of production function and the choice of the best functional form. Based on the reported findings, Cobb-Douglas production function was selected and employed as the best production function form the conduct of the present study.

The results of stochastic frontier production function coefficients and factors affecting technical inefficiency were reported in Tables 4 and 5, respectively.

Table 1

Descriptive Statistics of the Variables Used in the Model

Variable	Max	Min	Mean	SD
Milk production (liters)	3840	500	1525	864
Forage consumption (kg)	2000	200	1080	6691
Concentrate consumption(kg)	4000	700	1073	1063
Bran consumption (kg)	2000	120	715	544
Salt consumption (kg)	80	12	38	23
The use of labor (day-person)	7	1	4	1
The number of cattle (person)	16	2	6	3.24

Table 2

Descriptive Statistics of the Explanatory Variables Used in the Model

Variable	Max	Min	Mean	SD
Participation in educational classes	1	0	0.86	0.34
Membership in cooperative	1	0	0.83	0.38
Age of dairy farmers	61	32	46	8.58
Educational level of dairy farmers	2	0	0.53	0.62
Duration of animal husbandry activity	45	6	19	10.36

Table 3

Estimation of Production Functions Results and Choice of the Best Functional Form

The estimated model	SS	Significant level and degrees of freedom	F	Critical value	Result
Cobb-Douglas	1.7	α =5%,(6,18)	1.35	2.66	accepted
Transcendental	1.5				
Cobb-Douglas	1.7	α =5%,(15,3)	6.5	8.7	accepted
Translog	0.93				

Table 4

Coefficients of Stochastic Frontier Production Function Model

Independent Variables	Parameter	Coefficient	SD	t-value
C	β_0	1.44	0.74	1.94^{**}
LnX_1	β_1	0.13	0.13	1.01
LnX_2	β_2	0.08	0.1	0.81
LnX_3	β_3	0.21	0.17	1.22^{*}
LnX_4	β_4	0.09	0.16	0.57
LnX_5	β_5	0.1	0.29	0.34
LnX_6	β_6	0.67	0.22	2.92^{***}

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table 5

Factors Affecting on Technical Inefficiency

Independent Variables	Parameter	Coefficient	SD	t-value
C	δ_0	0.17	0.39	0.45
Z_1	δ_1	-0.18	0.3	-0.6
Z_2	δ_2	1.08	0.13	7.83^{***}
Z_3	δ_3	-0.017	0.012	-1.38^{*}
Z_4	δ_4	-0.095	0.092	-1.03
Z_5	δ_5	0.088	0.008	0.91
Sigma-squared	σ_s^2	0.053	0.01	4.99^{*}
Gamma	γ	0.99	0.002	414.09^{*}
Log likelihood	-	12.11	-	-
LR test	-	12.31	-	-

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

According to Table 4, there is a direct relationship between bran and amount of output. Therefore, the amount of output can be increased considerably by increasing the consumption of this input. Additionally, there is a direct and significant relationship between the number of cattle and the amount of output such that more milk is produced by increasing the number of cattle.

Table 5 reported factors affecting technical inefficiency. Based on these results, there is a direct relationship between membership in cooperative and technical inefficiency, or there is an inverse relationship between technical efficiency and membership in the cooperative. Efficiency of members in cooperative dairy farms has declined because of the annoying laws and regulations in cooperatives. Furthermore, the results show a direct relationship between dairy farmers' age and technical inefficiency. Because young dairy farmers have more education and knowledge and more information as compared to old dairy farmers who use more traditional methods, they are more efficient.

Table 6 presents technical efficiency scores obtained via both SFA and DEA methods. Mean technical efficiency in SFA method was equal to 0.74.

The investigations under CRS assumptions shows that mean technical efficiency is 0.55 and mean efficiency score under VRS assumption is 0.63. Comparison of score efficiency calculated by both SFA and DEA methods shows that mean technical efficiency in SFA method is more than that in the DEA method. Moreover, the mean ef-

Table 6

SFA and DEA Technical Efficiency Scores

	SFA	DEA(CCR)	DEA(BCC)
Max	0.99	1	1
Min	0.43	0.21	0.49
Mean	0.74	0.55	0.63

Table 7
The Estimation Results of Inputs Risk Function

Input	C	t-value
Participation in educational classes	-0.89*	-2.67
membership in cooperative	0.53*	1.87
Age of dairy farmers	-0.54	-0.78
Educational level of dairy farmers	-0.12*	-2.25
Duration of animal husbandry activity	-0.13	-0.45
The coefficient of determination	R^2=0.18	

ficiency score under VRS assumption is higher than that under CRS assumptions. It shows that dairy farms are able to convert their inputs into output efficiently, but their lower technical efficiency is due to their disadvantageous size.

The estimation results of inputs risk function are summarized in Table 7.

In order to investigate the influence of the applied inputs on production risk, production risk function was estimated in a linear form. In fact, in order to estimate inputs marginal production risk, remaining logarithm of production function definitive component upon inputs logarithm in the model was regressed by using ordinary least squares method. In Table 7, estimated coefficients show the type of effect inputs have on production risk and R^2 represents what percentage of production risk is related to inputs.

Based on the results shown in Table 7, R^2 has low value, showing that a low percentage of production risk is related to inputs. Saha (2001) and Villano and Fleming (2006) ported similar results.

CONCLUSION AND RECOMMENDATIONS

Based on the results of the study, the mean technical efficiency of dairy farms is 0.74 percent as reported by the SFA method, and is 0.55 and 0.63 as reported by the DEA model under CRS and VRS assumptions, respectively. The factors affecting technical efficiency are dairy farmers' age and membership in the cooperative dairy farms. There is a direct relationship between bran, number of dairy farmers, and amount of output. Based on these results, the following suggestions are provided for improving dairy farms in Zabol County:

Given the difference between efficient units and inefficient units, it is recommended that training related to optimal use of inputs should be provided and proper management be performed in an attempt to increase the efficiency of dairy farms.

Based on results, there is a direct relationship between the used bran, number of cattle, and the amount of output and these inputs use in the first area of production function; therefore, it is recommended to use more amount of bran and number of cattle can increase the production.

Since there is an inverse relationship between membership in cooperative and technical efficiency, proper actions need to be performed so as to eliminate dairy farms' problems and government as an affecting factor must increase its protection from cooperatives.

The results showed that young dairy farmers are more efficient than older dairy farmers due to their higher educational level and knowledge of animal husbandry. Consequently, they need to cooperate someway so that dairy farmers could be able to transfer their information and experiences to the older ones.

ACKNOWLEDGEMENTS

Authors would like to thank Zabol dairy farmers for their cooperation in this study and their taking time completing the questionnaires.

REFERENCES

Aigner, D.J., & Chu, SF. (1968). On estimating the industry production function, *American Economic Review*, *58*, 826-839.

Aigner, D., Lovell, C., & Schmidt, P. (1977). Formulation estimation of stochastic frontier production function models. *Journal of Econometrics, 6,* 21-37

Alvarez, A., & Arias, Co. (2004). Technical efficiency farm size a conditional analysis. *Agricultural Economics, 30,* 241-250.

Banker, R., & Gadh, V., & Gorr, W. (1993). A Monte Carlo comparison of two production frontier estimation methods, Corrected ordinary least squares and data envelopment analysis, *European Journal of Operational Research, 67,* 332-343

Battese, G. E., & Coelli, T.G. (1995). A model for technical inefficiency effect in a stochastic frontier production function for panel data. *Journal of Empirical Economics, 20*, 325-332.

Battese, G.E., & Coelli, T.J. (1997). Guest editor's introduction to the special issue on papers presented at the New England conference on efficiency and productivity. *Journal of Productivity Analysis, 8*, 323-324.

Charnes, A., & Cooper, W. W., & Rhodes, E. (1978). Measuring the efficiency of decision making units. *European Journal of Operational Research, 2,* 429-444.

Dourandish, A., Nikoukar, A., Hosseinzadeh, M., & Lavshabi, A. (2013). Estimating multi-output technical efficiency for the dairy farms of the Northern Khorasan Province (Applying stochastic production and stochastic distance frontiers). *Agricultural Economics and Development, 27*(2), 114-122.

Erilouzadeh, R., & Saleh, A. (2010). The economic evaluation of dairies, dairy farm case study. *Journal of Agricultural Development Economics, 17*, 1 - 41.

Ferrier, G. D., & Lovell, C. A. K. (1990). Measuring cost efficiency in banking: econometric and linear programming evidence, *Journal of Econometric, 46*, 229-245.

Fulginiti, L. E., & Perrin, R. K. (1998). Agricultural productivity in developing countries. *Agricultural Economics, 19*, 45-51.

Green, W. (1997). Frontier Production Function, *in Handbook of Applied Econometrics (Volum 2: Microeconomics), Hashem Pesaran, M., Schmidt, P., Blackwell Pub. Ltd., USA.*

Khan, A., Huda, A.Z., & Alma, A. (2010). Farm household technical efficiency, as study on rice producers in selected Area of Jamalpur district in Bangladesh. *Europen Journal of Social Sciences, 14,* 262-271.

Kwon, O. S., & Lee, H. (2004). Productivity improvement in Korean rice farming: parametric and nonparametric analysis, *The Australian Journal of Agricultural and Resource Economics, 48*(2), 323-346.

Kumbhakar, S. C. (2002). Specification and estimation of production risk, risk preferences and technical efficiency. *American Journal of Agricultural Economics, 84*, 386-390.

Mehrjou, A., Moghadasi, R., Mirsalehpoor, M., & Mehjou, N. (2012). Examine the technical efficiency of the dairy cooperative Kohgiluyeh Boyer Ahmad. *Cooperative, 6,* 21-40.

Ministry of Agriculture Jihad. (2006). Statistical annuals. Retrieved from http://maj.ir.

Mohammadi, S.J., Hosseini Yekani, S.A., & Ghaderzadeh, H. (2015). Studying the efficiency of industrial dairy farms of Saqqez and Divandarreh Cities: Using super-efficiency approach. *Agricultural Economics and Development, 29*(2), 159-168.

Mohammadi, H., & Torkamani, J. (2011). *Economic analysis determination of broiler diets on calf fattening units In Fars Province.* Proceedings of the third Conference of Agricultural Economics, February, 17-19, Mashhad: Iran Agricultural Economic Society.

Saha, A. (2001). Risk in Hive traditional rice cultivation: A- enquiry in west Bengal agricultural, Indian. *Journal of Agricultural Economic, 56,* 57-70.

Sharma, K. R., & Leung, P., & Zaleski, H. M. (1997). Productive efficiency of the swine industry in Hawaii: stochastic frontier vs. data envelopment analysis. *Journal of Productivity Analysis, 8,* 447-459.

Sing, So., Fleming, E., & Coelli, T. (2000). Efficiency productivity analysis of cooperative dairy plants In Haryana Punjab States of India. Working Papers Series in Agricultural Resource Economics Issn 1442 1909, University of New Engl. Armidale. Australia.

Tan, S., Herein, N., Kuyvenhoven, A., & Quick, F. (2010). Impact of Land fragmentation on rice producers' technical efficiency in South-East China, *Wageningen Journal of Life Sciences, 57*, 117–123.

Statistical Center of Iran. (2011). Statistical Yearbook. Retrieved from http://amar.org.ir

United States Departments of Agriculture. (2006).

Independence of managerial practices expected financial efficiency. USDA Economic Research Service. Retrieved from http://usda.gov/wps /portal/usdahome

Villano, R., Donnel, C., & Battese, G. (2005). *An investigation of production risk, risk preferences technical fficiency: Evidence from rain fed lowland rice farms in the Philippines*. Working paper Series in Agricultural Resource Economics, University of New England.1,12-30.

Villano, R., & Fleming, E. (2006). Technical inefficiency and production risk in rice farming: evidence from Central Luzon Philippines. *Asian Economic Journal, 20,* 29-46.

Zibaei, M., Soltani, GH. (1995). Different methods for estimating the frontier production function and technical efficiency of milk production units. *Journal of Planning Development, 2*(11), 73-94.

How to cite this article:

Shahraki, J., Pahlavani, M., & Ohadi, N. (2016). Measurement of technical efficiency and production riskin Zabol dairy farms, Iran. *International Journal of Agricultural Management and Development, 6(4), 349-448.*

URL: http://ijamad.iaurasht.ac.ir/article_526336_1ef38833eb856663120a45a40475eb68.pdf