Investigating the management efficiency of date growers with data envelopment analysis approach in environmental zones

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ARTICLE INFO	ABSTRACT
	Regarding the limitations of date production factors in the rivers, it is necessary to be carried out an optimal management on the production of this product and the use of production inputs. The main purpose of the present study is to identify the factors affecting the management of palm trees by using regression analysis and then to calculate the efficiency of constant returns to scale and variable returns to scale with the approach of minimizing input and maximizing output of management of date growers by separating cities of this region (Including 4 cities) using data envelopment analysis method. According to the limited statistical population, 200 date growers were selected from city, 50 date growers from each city. Data collection tool was a questionnaire which was designed as a Likert scale and its face and content validity was confirmed by relevant professors and experts. The results showed that the management efficiency of date growers in all cities in the region was acceptable. In comparison to cities, Rabi and Shirin Shahr have the most efficient and inefficient management of palm trees, respectively. Average efficiency with constant scale, efficiency with variable scale with input minimization and output maximization for Rabi city has been obtained 100%, 100% and 100% respectively and for Shirin city obtained 97.56%, 98.69% and 98.04%, respectively. The cities of Kut Abdulah and Kanaan have almost equal efficiency.

1. Introduction

Efficiency is one of the most important factors in productivity growth, especially in management of agricultural products in developing countries. The excessive and uneven use of resources to increase agricultural productions has limited the resources available in the agricultural section compared to the past. Therefore, paying attention to the efficiency of agricultural economy in developing countries, including Iran has a great importance (Gittinger and Price, 1997). Date, as the second horticultural crop in the country, is considered much because of many relative advantages compared to other agricultural products. Foreign exchange, job creation in side industries, etc. are among the various advantages caused by date production and exports. Iranian date has been interested by consumers worldwide for taste and it can be one of the major sources of gaining foreign exchange in the agricultural section. Iran, by producing approximately 1076,000 tonnes in 2014, valued approximately $ 564410, has produced 14% of the world date and it has allocated the second rank in the world in terms of production (FAO, 2014).

Karun city has one of the best date palm trees in Khuzestan province. Palm trees of Karun city is one of the most favorable date in Khuzestan province in terms of quality, diversity and proximity to Karun River. Area of palm trees of Karun is 2,800 hectares of which 2600 hectares are fertile palm trees with more than 9 tonnes of date per hectare, which is exported to European countries, the Persian Gulf countries and so on after packaging. Therefore, investigating the factors affecting product management plays an important role in the flourishing of the country's agricultural economy. One of the most effective ways of achieving economic growth and prosperity in agricultural section, especially date production, is to investigate the efficiency of agricultural units producing date according to the scarcity and limitation of production resources. Thus increasing the efficiency in date production will help to resources and manufacturing facilities to be directed to improve weak economic infrastructure and restore competitive position of this product. Numerous studies have been conducted regarding the subject of efficiency; some of them will be discussed below.

Chen and Song (2007) examined the efficiency of cities. They analyzed the data with envelop analysis, and the results showed that the eastern regions have had the most efficiency compared to the other regions. Yuan (2010) investigated water use efficiency in wheat fields of northwest China using data envelopment analysis method. The results showed that the efficiency of farmers is between 20% and 100% and the average is 61.51%. Tajik et al. (2012) investigated the technical efficiency of palm trees in the river region in Hormozgan province using data envelopment analysis. The results showed that about 62% of farmers had efficiency below 20% and only about 15% of them had efficiency above 80%. Behrouz and Meibodi (2014) measured the efficiency of watermelon producers in 12 provinces of Iran using data envelopment analysis method. The results of this study showed that Sistan and Baluchestan and Hamadan provinces are the most efficient and inefficient provinces in producing it. Abdpour et al. (2017) calculates the efficiency of date producers in Bam city with data envelopment analysis and the results showed that all inputs have been used more than the optimal value. Therefore, according to the studies conducted and limitations of date production factors in Karun, it is necessary to carry out optimal management on the production of this product and the use of production inputs. Accordingly, the present study has been conducted to measure the management efficiency of agricultural units producing date in Karun city and determine effective factors on management of mentioned agricultural units.

2. Research method

There are various methods to evaluate the performance and measure the efficiency of decision-making units that are divided into parametric and non-parametric groups (Mohammadi and Sadrolashrafi, 2006). In parametric methods, a specific production function is estimated using different statistical and

econometric methods. Then, efficiency is determined by applying this function. But the special feature of nonparametric methods is that distribution or special form of the mathematical function is not needed (Rahimi Soreh, and Sadeghi, 2004). One of the most important non-parametric methods is data envelopment analysis that is a type of linear programming model that calculates the relative efficiency of a group from decision units. In other words, data envelopment analysis is a quantitative planning technique to measure the relative performance of decision-making units (Yong and Chunweki, 2003). Data envelopment analysis method was used in this study according to the purpose of the research that is the determination of the management efficiency of palm trees and also the important advantage that nonparametric methods have compared to parametric methods in providing model and reference for inefficient units. Indicators were defined and used as entries of model with the views of experts and managers in the field according to the significance of indicators in evaluating the management efficiency of palm trees. Indicators included the level of cooperatives and social participation of palm trees, the level of access to communication channels and agricultural Jihad of date growers, the level of economic welfare of palm trees, the level of using regular irrigation, the level of using principled and regular gardening operations, the level of waste reduction, the level of lands, age and education level of date growers. Also, according to the large number of performance indices in evaluating the performance of palm trees, it has been attempted to be defined and used the most important indicators of performance of palm trees as output indicators of the model using the scientific documentation and expert opinion of the field. The indicators defined and used as outputs of the model are as follows: management level of palm trees, income level and performance level of palm trees.

Paying attention to this point is essential that in this study, two steps are used to calculate the management efficiency of palm trees. In the first step, the factors that influence the management efficiency of the palm trees will be specified and determined using statistical regression analysis and in the second step, the efficiency of the palm trees in each city will be calculated and compared using data envelopment analysis method with the help of effective factors   determined.

The study area is Karun city in Khuzestan province in southwestern Iran. The city center is Kut Abdullah and consists of 4 cities of Kut Abdullah, Kanaan, Rabi and Shirin. In order to achieve the objectives of the study, this study began in April 2017 and ended in winter 2017. In this study, in order to collect the required data and to achieve the research objectives, library studies, survey research and completing questionnaire were used as face-to-face interview. The statistical population of the study consisted of all date growers with at least one hectare palm tree in Karun city. There were 1,032 date grower in Karun. Therefore, the statistical population of the study consisted of 1032 date growers in 4 cities of Karun city. According to Cochrane's formula, the sample size was 188 people, 47 people from each city. 240 questionnaires were distributed in 4 cities of the statistical population (60 people in each city) to ensure return of the questionnaire to the target number. Finally, 200 questionnaires (50 questionnaires from each city) were returned and analyzed. The questionnaire was developed based on the objectives, questions, and hypotheses of the study and consisted of 9 parts: Part One: Level of management of palm tree (with 14 effective items: the use of pressurized irrigation or other modern irrigation methods; the use of windbreaker; the use of specific male pollen; removal of cluster residues; non-planting of date with other trees; removal of pests and offshoot; pruning of petiole; use of cover for date clusters; lack of various figures of date and uniformity of palm tree; arranging cluster as closing on petiole; considering hygiene tips in palm trees; palm tree nutrition; principal spraying against pests and at the end, thinning of date clusters have been measured), Part Two: The level of social partnerships and co-operatives of date growers (with 5 items affecting it: Local organizations; cooperatives of rural production; rural cooperatives; village council and at the end, mobilization have been measured); Part Three: the level of access to communication channels and agricultural Jihad of date growers (With 9 items affecting it: Neighbors and friends; Agricultural Jihad promotion and service centers; rural production cooperative; Television and radio; sellers of chemical entities; Agricultural Jihad Organization; Research centers; Agricultural Jihad management of the city and at the end, journals and newspapers have been measured) Part Four: The level of economic welfare of date growers (with 9 items affecting it: physical and mental health of household members; the use of health care and proper insurance; willingness to continue living in the village; Feelings of belonging to the village; Satisfaction of access to services and communications; having housing according to family dignity; having facilities for leisure times in the village; Access to drinking water and at the end, satisfaction from government performance at the rural level), Part Five: Fertility of soil (with 7 items affecting it, in order of priority from the point of view of date growers: using elements of nutrition; Soil test; Use of green fertilizer; Use of chemical fertilizers of high-consumed elements; Use of organic fertilizers; having housing according to family dignity; integrated management of nutrition and at the end, planting in palm trees) Part Six: The level of using principled irrigation (with 5 items affecting it, in order of priority from the perspective of date growers: the use of pressurized irrigation; supplemental irrigation to reduce soil salinity; irrigation at pollination and fruiting stages; regular irrigation during year and use of mulch to reduce consumed irrigation water), Part Seven: the level of using principled and regular horticultural operations (with 8 items affecting it, in order of priority from the perspective of date growers: mechanical pollination; pruning; arranging and directing cluster; removing the residuals of cluster at the right time; the use of cover on cluster; cluster thinning; teaseling and considering the ratio of leaf to cluster), Part Eight: the level of waste reduction (with 8 items affecting it, in order of priority from the perspective of date growers: having an initial warehouse in the palm trees; proper harvesting and transfer of dates from the palm to the ground level; multi-stage harvesting; management of irrigation and nutrition of palm trees; non-use of inappropriate date at various stages of production of byproducts; Primary sorting weed control to isolate undesirable dates from harvested crop; Integrated management of pests and diseases and product packing) and at the end, Part Nine including age of date growers; education level of date growers; Palm trees income per hectare; performance level of palm trees in kg and land area per hectare. It is noteworthy that the parts one to eight have a Likert scale with one (very low) to five (very high) coding. The level of education of the date growers is also coded by one (illiterate), two (high school), three (diploma), four (associate degree), and five (undergraduate and above).

As it was stated above, the factors affecting management of palm trees are examined using regression. At this stage, the management of palm trees as dependent variable and the factors of cooperatives and social participation of date growers; access to communication channels and agricultural jihad of date growers; economic prosperity of date growers; soil fertility; the use of principled irrigation; the use of regular and principles horticulture operations; waste reduction; land area; age and education level of date growers are examined as independent variables. The results of this step, which show the factors affecting management of palm trees, are applied in the next step, which is the calculation of management efficiency of palm trees.

In this study, equation 1 was used to calculate the efficiency of palm trees with constant returns to scale (it is worth noting that the assumption of constant returns to scale for a system means that by increasing inputs, output level will increase as well):

$$\min Y_0 = q$$

$$\text{s.t.} \quad \sum_{j=1}^{n} l_j X_{ij} \le q X_{i0} \quad , (i = 1, \ldots, m)$$

$$\sum_{j=1}^{n} l_j Y_{ij} \ge Y_{ro} \quad , (r = 1, \ldots, s) \tag{1}$$

$$l_j \ge 0, \quad j = 1, K, n$$

In the above equation, Y matrix is an N × M matrix of products, and the X matrix is a N × K matrix of production factors as well as a 1 × N vector contains constant numbers and represents the reference weights. The scalar values obtained for q will be for firm performance that provides the condition $q \pounds 1$ (Mehregan, 2009).

Equation 2 was used to calculate the efficiency of the palm trees with variable returns to scale. For this purpose, in formulating the dual problem in linear programming, assuming constant return to scale, by adding constraint $N/\cancel{c} = 1$ (Convexity), calculations are performed by assuming variable return to scale (Ghasiri et al, 2008).

$$\min Y_0 = q$$

$$\text{s.t.} \ \overset{n}{\underset{j=1}{a}} \ l_j Y_{rj} {}^3 \ Y_{ro} \quad , (r = 1, ..., s)$$

$$qX_{i0} - \overset{n}{\underset{j=1}{a}} \ l_j X_{ij} {}^3 \ 0 \ , (i = 1, ..., m) \qquad (2)$$

$$\overset{n}{\underset{j=1}{a}} \ l_j = 1 \qquad , (j = 1, K, n)$$

$$l \ {}^3 \ 0$$

In this study, the variable return to scale is calculated using the output maximization approach and the input minimization approach. In the output maximization approach, the goal is to maximize production according to the specified amount of inputs, but in the input minimization approach, the goal is to use the minimum inputs to achieve a certain amount of product. In this study, constant return to scale and variable return to scale are calculated using output maximization approach and input minimization approach for palm trees of four towns of Karun city and the results are compared.

It should be noted that SPSS and MATLAB software were used for data analysis. In order to determine the reliability of the questionnaire, 30 versions of the questionnaire were randomly completed in a region other than the study region, and then the reliability of the questionnaire was investigated using Cronbach's alpha coefficient. According to the results, the reliability of the questionnaire was 0.87 which is acceptable.

3. Findings

As it was mentioned previously, the factors affecting management of palm trees are initially determined.
1- Determining the factors affecting management of palm trees
Linear regression model was used to investigate the factors affecting management of palm trees. In this study, management of palm trees as a dependent variable and variables of participation and social cooperatives; access to communication channels and agricultural jihad of date growers; economic prosperity of date growers; soil fertility; the use of principled irrigation; the use of regular and principles horticulture operations; waste reduction; land area; age and education level of date growers are examined as independent variables. In linear regression, the effect of each of the independent variables on the dependent variable has been investigated. Therefore, a linear regression test between dependent variable and independent variables has been performed. The results of this test are presented in Table 1. As it can be seen, according to the level of significance level (sig.)which less than 0.05 is significant, only the co-operative and social participation have no significant effect on management palm trees, so it is not included in the next step that is calculating management efficiency of palm trees.

Other independent variables with significance level less than 0.50 are considered significant and are included in the model in calculating management efficiency of palm trees. Also, to interpret any of the regression coefficients presented in Table 1, it can be stated that, for example, if access to the communication channels and the agricultural jihad of date growers to be increased one unit, management of palm trees would be improved 0.57 units. The interpretation of the rest of the regression coefficients of the other variables will also be as follows.

Table 1. Investigating the effect of each variable on management of palm trees using regression test

sig.	T test	Values of regression coefficients	Variable
20/0	30/1	01/0	Cooperatives and social participation
00/0	[**]50/6	57/0	Access to communication channels and agricultural
00/0	[**]46/3	11/0	jihad
00/0	[**]57/4	44/0	Economic prosperity
02/0	[**]38/2	11/0	Soil fertility
00/0	[**]22/5	31/0	The use of principled irrigation
03/0	[**]09/1	20/0	The use of regular and principles horticulture
00/0	[**]5/2	12/0	operations
02/0	[**]37/2	41/0	Waste reduction
00/0	[**]28/3	32/0	Land area (per hectare)
			Age of date growers
			Education level of date growers

** Significant at 0.05 level   Sig: 0.00   F:419/79

It should be noted that the value of F statistic equal to 79/419 with 0.99 confidence and significance level (sig.) less than 0.01 stated below Table 1 indicates the significance of linear regression test.
2. Statistical description of product and inputs
The following results can be deduced from the total description of the product and the inputs in 4 Karun cities in Table 2:
- It seems that the level of access to communication channels and agricultural jihad and the economic prosperity of date growers in Shirin city is more than other cities on average.
- The fertility of the soil of palm trees of the two cities of Rabi and Shirin is almost the same and more than the other two cities.
- The use of principled irrigation is low on average for all cities, which requires training of date growers and greater emphasis in this field.

- The use of principled and regular horticulture operations of the date growers of the two cities of Rabi and Shirin Shahr is almost the same and more than the other two cities.
- Almost the average waste reduction in all cities is the same and average.
- Almost on average, the level of lands of palm trees in the two cities of Kut Abdolah and Shirin Shahr is the same, and more than the other two cities (the land level of the two cities of Kanaan and Rabi are almost similar).
- The average age of date growers in all cities is almost the same.
- The level of education of date growers in the cities of Kut Abdullah, Kanaan and Shirin Shahr is almost the same (high school), but the level of education of date growers of Rabi city (diploma) is higher than in other cities.
- In terms of date growers, the management and performance of the palm trees of the three cities of Kut Abdulah, Rabi and Kanaan are almost the same, but higher than Shirin Shahr.
- The average income of the palm trees of the two cities of Rabi and Kanaan per hectare is the same and it is higher than the other two cities (the average income of the palm trees of the two cities of Kut Abdulah and Shirin Shahr is almost the same).

Table 2. Statistical description of product and inputs by separating 4 cities

Shirin Shahr			Rabi			Kanaan			Kut Abdulah			Variable
Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	Maximum	Minimum	Average	
1/4	2	3	8/2	7/1	2/2	2/3	9/1	9/1	2/3	3/1	7/1	access to communication channels
4	9/2	6/3	1/3	3/2	8/2	7/3	3/2	5/2	7/3	8/1	9/2	economic prosperity
6/2	1/1	8/1	1/2	1	6/1	1/2	1	2/1	9/1	1	1/1	soil fertility
4/2	2/1	2	6/2	6/1	2/2	6/2	4/1	2	6/2	6/1	2	he use of principled irrigation
6/3	6/2	1/3	3/3	5/1	5/2	8/3	5/1	9/1	3	3/1	9/1	the use of horticulture operations
1/3	9/1	7/2	3	2/2	8/2	3	9/1	4/2	7/2	9/1	5/2	waste reduction
19	1	93/3	9	1	6/2	10	1	7/2	25	1	1/4	land area (per hectare)
83	22	52	74	38	54	78	39	58	78	32	8/53	age date growers
5	1	2/2	5	1	7/2	4	1	3/2	4	1	3/2	Education level of date growers
1/3	2	9/1	9/2	1/2	6/2	9/2	6/2	2/2	3	1/2	5/2	Management level of palm trees
900	6200	1000	8000	1200	4650	7000	4557	3950	6200	1200	4400	Performance of palm trees (in kg)
38000	23400	31858	46000	24000	34390	46000	24000	34300	39000	23400	31938	Income of palm trees (in thousand rials)

4. Calculating the management efficiency of date growers

Results of calculating efficiencies with constant scale, variable scale with input minimization approach and output maximization approach for management of date growers in each city, which indicating the status of date growers in a state that as inputs increase, outputs increase in the same ratio, minimizing inputs and maximizing outputs are presented in Tables 3, 4, 5 and 6. According to the results:
- About the value of constant efficiency to scale, Rabi city, the most efficient and Shirin Shahr, the most inefficient management of palm trees have allocated the averages of 100% and 97.56%, the difference between their efficiency is 2.44%, indicating a low difference between date growers and the optimal use of inputs and obtaining the optimal output value in the same ratio. On the other hand, in Shirin Shahr, the lowest and highest efficiency of constant scale are 80% and 100% respectively that their little difference indicates that there is still great potential for increasing the management efficiency of date growers. The average efficiency of the cities of Kut Abdullah and Kanaan are almost equal with 98.81% and 98.35%, respectively.
- About the value of efficiency of variable scale with input minimization approach, Rabi city, the most efficient and Shirin Shahr, the most inefficient management of palm trees have allocated the averages of 100% and 98.69%. The difference between their efficiency is 1.31%, indicating a low difference between date growers and their effort in reducing inputs with the same output value. However, Shirin Shahr date growers to achieve full efficiency can reduce 1.31% of their input without need to reduce output. On the other hand, in Shirin Shahr, the lowest and highest efficiency of variable scale with input minimization approach are 89% and 100% respectively, that their little difference indicates that there is still great potential for increasing the management efficiency of date growers of this city and reducing input without need to reduce output. The average efficiency of variable scale with input minimization approach of the cities of Kut Abdullah and Kanaan are almost equal with 99.71% and 99.96%, respectively that the little difference with full efficiency indicates that date growers of these two cities have attempted a lot to reduce inputs without the need to reduce output to achieve optimal efficiency.
- About the value of efficiency of variable scale with output maximization approach, Rabi city, the most efficient and Shirin Shahr, the most inefficient management of palm trees have allocated the averages of 100% and 98.04%. The difference between their efficiency is 1.96%, indicating a low difference between date growers and their effort in increasing output without need to increase input. In other words, date growers of this city to achieve full efficiency can increase 1.96% of their output without need to increase input. On the other hand, in Shirin Shahr, the lowest and highest efficiency of variable scale with output maximization approach are 83% and 100% respectively, that their difference indicates that there is still great potential for increasing the management efficiency of date growers of this city and increasing output without need to increase input. The average efficiency of variable

scale with output maximization approach of the cities of Kut Abdullah and Kanaan are almost equal with 99.13% and 98.44%, respectively that the little difference with full efficiency indicates that date growers of these two cities have attempted a lot to increase output without the need to increase input to achieve optimal efficiency.

Table 3. Number and percentages of different types of management efficiency of date growers in Kut Abdollah

Variable return to scale with output maximization approach		Variable return to scale with input minimization approach		Constance return to scale		Percentage of efficiency
Percentage	Number	Percentage	Number	Percentage	Number	
-	-	-	-	-	-	85-80
-	-	-	-	-	-	90-85
10	5	-	-	12	6	95-90
90	45	100	50	88	44	100-95
13/99		71/99		81/98		Average
32/2		96/0		65/2		SD
90		95		90		Minimum
100		100		100		Maximum

Table 4. Number and percentages of management efficiency of date growers in Kanaan

Variable return to scale with output maximization approach		Variable return to scale with input minimization approach		Constance return to scale		Percentage of efficiency
Percentage	Number	Percentage	Number	Percentage	Number	
-	-	-	-	-	-	85-80
-	-	-	-	-	-	90-85
10	5	-	-	10	5	95-90
90	45	100	50	90	45	100-95
44/98		96/99		35/98		Average
11/2		26/0		12/2		SD
93		98		93		Minimum
100		100		100		Maximum

Table 5. Number and percentages of management efficiency of date growers in Rabi city

Variable return to scale with output maximization approach		Variable return to scale with input minimization approach		Constance return to scale		Percentage of efficiency
Percentage	Number	Percentage	Number	Percentage	Number	
-	-	-	-	-	-	85-80
-	-	-	-	-	-	90-85
-	-	-	-	-	-	95-90
100	50	100	50	100	50	100-95
100		100		100		Average
0		0		0		SD
100		100		100		Minimum
100		100		100		Maximum

Table 6. Number and percentages of management efficiency of date growers in Shirin Shahr

Variable return to scale with output maximization approach		Variable return to scale with input minimization approach		Constance return to scale		Percentage of efficiency
Percentage	Number	Percentage	Number	Percentage	Number	
6	3	-	-	8	4	85-80
2	1	2	1	4	2	90-85
4	2	8	4	2	1	95-90
88	44	90	45	86	43	100-95
04/98		69/98		56/97		Average
31/4		64/2		07/5		SD
83		89		80		Minimum
100		100		100		Maximum

5. Discussion and conclusion

In this research, after identifying the factors affecting the management of palm trees by using regression, the efficiency of constant return to scale and variable return to scale with the approach of input minimization and output maximization approach of management of date growers Karun city was calculated be separating 4 cities of this city. The results showed that Rabi and Shirin Shahr have the most efficient and inefficient management of palm trees, respectively. The average all efficiencies with constant return to scale and variable return to scale with the approach of input minimization and output maximization approach for Rabi city was obtained 100% and for Shirin Shahr obtained 97.56%, 98.69% and 98.04%, respectively. According to

the desirable situation of inputs of Shirin Shahr which mentioned before this, it seems that the city's date growers do not use their inputs maximally and still they can increase output without the need for change input. The cities of Kut Abdulah and Kanaan have almost equal efficiency. It can be said that the management efficiency of the four cities' date growers is at an acceptable level. The date growers of Shirin Shahr (the most inefficient city), Kot Abdulah and Kanaan are not far from full efficiency and, they can achieve desirable efficiency with little effort.

Since efficiency difference indicate weaknesses of date growers in knowledge and production skills, increasing the knowledge and skills of date growers is important in this regard. Therefore, training the date growers can help this issue by holding training classes. The points that should be considered are the use of learner-centered participatory training approaches. The good intention of these approaches is that the dates growers learn something better and apply that participate in it. It should also be noted that the educational content should be to empower the date growers to improve their production methods and optimal use of inputs to maximize profits. Also, the results of the consumption of inputs among the date growers testify that the use of water inputs is inefficient. According to the scarcity of water and the critical status of groundwater aquifers in the country, it is suggested that the regional water management of the city should take measures to reduce water consumption and its proper distribution among date growers to help the more efficiency of production in addition to act based on the principles of sustainability of the aquifers.

REFERENCES

Abdpour, A., Asad Abadi, E., & Shaban Ali Femi, H. 2017. Analysis of the Role of Factors Affecting Date Production Efficiency in Bam with Data Envelopment Analysis, Iranian Journal of Agricultural Economics and Development Research, 2(3): 518-507.

Behrouz, A., & Emami Meibodi, A. 2014. Measuring the Efficiency of Iranian Agriculture Sub-sector Using Data Envelopment Analysis (Emphasizing on Blue Watermelon), Journal of Agricultural Economics Research, 6(3): 66-43.

Chen, Z., & Song, S.H. 2007. Efficiency and technical gap in China's agriculture: A regionalmeta-frontier analysis. China economic Review, 12: 1-12.

Food and Agriculture Organization. 2014. Production: Countries by commodity in FAO. Retrieved September 18 (2013) from (http://faostat.fao.org/site/339/default.aspx)

Ghasiri, K., Mehrno, H., & Jafarian Moghadam, A. 2008. Introduction to fuzzy data envelopment analysis. Qazvin: Qazvin Islamic Azad University. Iran

Gittinger, P., & Price, J. 1997. Economic Analysis of Agricultural Projects. Tehran: Tehran University. Iran.

Mehregan, M. 2009. Quantitative models in evaluating the organizations performance (data envelopment analysis). Tehran: Tehran University. Iran

Mohammadi, H., & Sadrolashrafi, S.M. 2006. A study of economic efficiency of production cooperatives in Qomrood Plain. Using stochastic frontier and data envelopment analysis. Journal of Agriculture Sciences, 11: 15 – 29.

Rahimi Soreh, S., & Sadeghi, H. 2004. Factors affecting efficiency and economies of scale in Parametric and non-parametric approaches (Case Study: range management plans in Iran). Journal of economics research, 67: 259 – 291.

Tajik, O., Rostami, K., & Sabuhi Saboni, M. 2012. Estimate the technical efficiency dates growers in Hormozgan Roodkhane br region in 2011. Proceedings of Scientific Conference and Festival of Iranian Dates. 2-3 September (2012). Shahid Bahonar University. Kerman. Iran: 358-363

Yong, T., & Chunweki, K. 2003. A hierarchical AHP/DEA methodology for the facilities layout design problem. European Journal of Operational Research, 147: 128-136.

Yuan, W.X. 2010. Irrigation Water Use Efficiency of Farmers and Its Determinants: Evidence from a Survey in North – Western China. Agricultural Sciences in China, 9: 1326 – 1337.