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Evaluating Effective Factors on Water Use Efficiency Resources in Wheat

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ABSTRACT: Considering water use efficiency resources and improving productivity level due to the contentious drought is very necessary. It is also notified that considering the effects of these factors and their relations to water inputs and reciprocal influences during consuming production inputs is very important. In this research water use efficiency is studied economically. Moreover, in the first step DEA (Data Envelopment Analysis) is applied to evaluate the technical efficient and use of water resources. In the second step, using Logit Model the led factors to efficient use of water will be recognized. To do so, the information of 103 wheat cultivator is analysed in Shahindej, West-Azerbaijan in 2013-2014 during farming season. The results show that the average of water consuming in this region is low, about 56/3%. Variables like literacy level, the importance of water economizing, the soil and irrigation system types are positive. On the other hand, variables such as the age and area of field have negative effects on the efficient of irrigation water based on the consonant efficient to the scale. According to these findings, it seems that implementing classes in improving the functions of studied units and costing irrigation policy are very effective.

KEYWORDS: Technical Efficient, DEA (Data Envelopment Analysis), Shahindej, Logit Model.

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1. INTRODUCTION

Nowadays, water as an economic good has a vital role in agricultural and industrial productions and meet the health and drinking needs of world. The agricultural sector, among others, is the largest consumer of water. So, paying attention to the optimal management of water consuming in agriculture is very important (Sabouhi et al., 2009). Iran is located at one of the world's arid and semi-arid places and its main source of water supply is precipitation in the form of snow and rain, which is estimated about 429 billion cubic meters. In addition, water is the main constraint in our country agriculturally. In this part more than 90 percent of groundwater is allotted. The estimated efficiency is 35 percent (Karimi, et. al. 2007).according to increasing demands on agricultural products, more effective using of rare resource is inevitable. Through optimizing these resources to provide society's needs as a main purpose, the efficiency of this method can be increased.

Considering water use efficiency resources studies have been done based on economics and started by Farrel's unique work (Farell, 1957). The efficient evaluation in agricultural products is a crucial issue in enforcing agriculture improvement in developing countries. Since this theory in convenient decision making for accurate management, for devoting resources and agricultural policy making gives helpful information to the planners (Khan, 2010). Generally speaking, due to the known facilities and existence limitations in Iran's agriculture economic; it seems the best way to increase production and farmers incomes is to apply production elements suitably or to get maximum produce of the total fixed collection of them (Najafi, 1994).

So any kind of study on in the efficiency of farmers for producing agricultural crops as well as recognizing the ups and downs of them can be fruitful in efficiency improving and production increasing. Investigating the efficiency of agricultural crops producers through various ways; specially in country's main crops may be helpful in this project.

2. LITERATURE REVIEW

Some many researches have been done on this issue as following:

Saboohi et al (2011) have studied the efficient of water consuming in Sistan's greenhouse based on DEA method in 2011. The effective factors on the efficiency of measured water have been surveyed by Tobit Regression. Their results showed the average of water use efficiency considering constant and variable to scale are 49 and 71 percent respectively. In addition, it is indicated that variables such as age, education, experience and water supply resource have a positive effect and field area has a negative effect on water use efficiency.

Alipour et al (2012) studied wheat water use efficiency in Zarghan through using temporal data of farming season (2010-2011) and to evaluate wheat technical efficiency and water consuming efficiency; DEA method is applied. Findings indicated that the mean of water use efficiency in this region is very low, about 32%. They also use T-test to compare water use efficiency between two efficient and inefficient groups and concluded that water use efficiency among the efficient farmers is more that the inefficient one and increasing meaningfully. They added that policies including implementing training classes to use the modern irrigation systems and amend irrigation tariffs in water use efficiency increasing are profitable.

Dhehbi et al (2007) through 144 samples information of gardeners' in Nabeul, Tunisia region and a stochastic frontier functions estimated technical efficiency and irrigation water use efficiency. Besides; in this study the differences causes in water use efficiency have been identified by a two-step regression. The results indicated that variables like; farmer age, education, agricultural training, the distribution of productive trees and access to water increase the technical efficiency and irrigation water use efficiency.

Wang (2010), using the DEA method studied wheat production technical efficiency in the northwest of China. In that research, the average of technical efficiency applied of inputs is 61 percent. And the irrigation water use efficiency is estimated about 30 percent. Moreover, Tobit

Regression findings showed that variables as farmer age, education and the area of farm have the positive effects on water use efficiency, as well as the state of conduits and various ways of irrigation has a meaningful effect on water use efficiency.
Ximing et al (2011), assessed water productivity in dry farming and irrigation crops of the coaster of Yellow River in Basin in China including wheat, corn, soya and rice. The findings reveal that there is a significant difference for soybeans in dry and irrigation farming lands. However, water productivity in rain-fed areas for two crops is a little higher than irrigated one.
Iglesias (2010) examined the performance of a group of farmers in Spain for the period 2001-2004 using data envelopment analysis and stochastic frontier analysis. Galanaplvs et al. (2006), as well as used non-parametric method of data envelopment analysis to evaluate the degree of technical efficiency and scale commercial farms breeding pigs in Greece. Average technical efficiency of the units surveyed, 83 findings show the potential capacity to increase the efficiency of use of inputs in domestic pig farms.
Udok (2009), using data envelopment analysis combined with Malmquist index to present a brief statistical inference to determine the efficiency of grain production in the period 1987 to 1997 in Norway. The results show that the degree of inefficiency in the abundance of grain production in the period existed.
Zhu, Dmitry and Lansink (2012) in an article entitled technical efficiency and dairy farms productivity differences in three countries of the Europe union and the common role of agricultural policy subsidies using function of the product, it concluded that by increasing the amount of subsidies compilation in support of agriculture, the effectiveness is reduced and the circumstances motivating the farmers to do the job efficiently is less than when their incomes depend largely on subsidies. Finally, they concluded that the amendment to the common agricultural policy (PAC), which was adopted in 1992, may be the global competitiveness of farmers by reducing their technical performance.
Nastis, Papa Nagatv and Zamandys (2012) in hay production farms efficiency study using the DEA investigated and concluded that one percent increase in the ratio of subsidies to the product range reduce as same as of pure technical efficiency

3. THEORETICAL FRAMEWORK

Overall performance has very broad sense and was discussed more in the field of engineering, economic management. Therefore; different definitions of the performance of the various sources of functionality are presented below to provide some of them.
Manouchehr Farhang in his Economic Glossary gives a definition on efficiency, he puts: "Efficiency is the ratio of product amount to the amount of factors which are perfomred[4]" it should be mentioned that he believes that economic and technical efficiency are identical categories. In "Webster" Glossary efficiency is defined as an effectiveness and optimum production capacity with minimum consumption of energy, time, money or materials.[4]Farrell also is a researcher in the field of efficiency with a variety of activities and has proposed a way to evaluate it. In his article entitled "Measuring the efficiency of production in 1957", he believes the efficiency of a firm is "to produce a given amount of output to input more than one." Farrell also uses this definition to express the efficiency of technical efficiency, specialized efficiency and economic efficiency (economic efficiency of the product model Farrell technical efficiency, specialized efficiency) (Eid Mohammadzadeh et al., 2006).

4. METHODOLOGY

4.1. Data Collection

Shahindej in West-Azerbaijan is one of agricultural pole. It is the research area and its farmers are the population of this study. Survey method and Proportional stratified sampling used in Shahindej research and103 farmer has been interviewed directly. A questionnaire is used for

collecting information and its content validity is amended and verified through using the experts view in irrigation, agriculture and farming.
In this study at first, technical efficiency and irrigation water use efficiency of wheat farmers estimated based on DEA method in constant efficiency to the scale. At the second level, the differences led factors in water use efficiency are recognized by Logit Model.

4.2. DEA (Data Envelopment Analysis) Data Patterns

It is a consonant model to the scale input-oriented, Charles et al (1987) has identified it. We can identify it as following (Pakravan[4] et al, 2009).

$$\mathbf{Min}_{\theta,\lambda}\ \theta, \qquad (1)$$

s.t.

$$-y_i+Y\lambda\geq 0$$

$$\theta x_i-X\lambda\geq 0,$$

$$\lambda\geq 0$$

In (1) θ is one scalar, λ is the vector of N*1; consonant values, and x_i is the inputs vertical vector for the i^{th} farmer, where x is k*n inputs, Y outputs, K the number of consumed inputs in wheat and straw production, M the number of studied crop, N the number of farmers. The amount of θ shows technical efficiency of the i^{th} producer is less than or equal to 1. This number (1) indicates technical efficiency. In this study of 6 input fertilizer (k=6), seed, poison ration, machineries, work force and water is used to investigate 103 wheat farmers (N=103). The amount of straw and wheat, and outputs (M=2) are in West-Azerbaijan. For illustrating the matrix for 1 relation we can say x matrix ٧*١٠٣ is for consumed inputs in wheat and straw producing and y matrix for wheat and straw. In the first relation the initial limitation shows that whether the real amount of wheat and straw, produced straw by the i^{th} producer of introduced inputs can be more than this or not? The second limitation in 1 proves that the producing elements by the i^{th} producer of wheat and straw, at least should be as much as the applied elements by the main producer (farmers the condition and inputs of the farm are evaluated based on him).

4.3. Water use efficiency evaluation

In the current paper, for evaluating water use efficiency; DEA method is used due to its simplicity and allows assessing as Farrel et al (1957). Water use efficiency in DEA method is based on this concept that; a farmer with less water and equal harvest is more efficient to the other. So, water use efficiency evaluation in this study and its difference with engineering approaches is a division of harvest to the consumed water per surface unit. Therefore water use efficiency will be assessed through DEA. This is a series of planning linear problem in which the surface of other inputs and consonant crop is considered, Spliman et al (2007) presented it as follow.

$WE_i = \min_{\theta,\lambda} \theta_i^w$

S.t

$-y_i+Y\lambda\geq 0$ (2)

$\theta_i^w x_i^w - X^w \lambda\geq 0$

$x_i^{k-w} - X^{k-w} \lambda\geq 0$

$x_i - X\lambda=0$

$N1'\lambda\neq 0$

$\lambda>0$

Where K stands for the number of inputs, N is the number of farmers. K×N the input matrix, X is the matrix of crops; Y is for inputs for all of the N farmers in this sample. Besides; vertical vectors; X_i & Y_i are inputs and outputs for the i^{th} respectively if $1\leq i\leq N$. θ_i^w is a scalar which shows the rate of water use efficiency for the i^{th} farmer and is about [0,1]. 1 means that the farmer is on the water use efficiency and it is optimal. N1 is a one unit vector of N×1. λ is a consonant value of N×1 . In the second limitations X_i^w and X^w has only water input. In the third limitation, the statement x_i^{k-w} and X^{k-w} is the K input it does not have the water input. It should be mentioned that number 1 relation is in the consonant state to the scale and prevent the bulge limitation. As Frazr and Kvrdyna (1999) have pointed out it is assumed that farmers act according to their optimum. For assessing the effective factors on Farmers irrigation water use efficiency the Logit Regression used after evaluating technical efficiency values of inputs and determining efficiency and inefficiency, the depended variable is between 0 and 1.

Since the dependent variable is the amount of water efficiency among farmers; related Regression model to these issues has a dependent variable which essentially represents two states. In fact, the dependent variable is a Dichotomous or Binary Variable takes 0 and 1. On the other hand the effective structures on water use efficiency among farmers may be quantitative or qualitative. In such cases, qualitative dependent variable regression model is used to investigate the factors affecting water use efficiency. Some of these models can be Linear Probability Model, logit model, the probit model and Tobit model. Since the linear probability models may has some problems such as non-normality of Ui distribution, Ui variance difference, placing Y out of the range of 0 and 1 and low R^2 in their estimating. Therefore this study is based on Logit model due to its long background.

In this paper; dependent variable is the rate of water use efficiency among farmers. The 1 code for efficient farmers and 0 for inefficient farmers used water improperly.

If the rate of water use efficiency among farmers is Z_i and X_i is a vector shows the i^{th} farmer's economic, individual and geographic specifications then the effective factors on water use efficiency is as following.

$Z_i^* = \theta\alpha+\beta x_i +u_i$ (3)

In this relation A and B are pattern parameters, U_i its error. Relation 3 indicates that a number of factors can be effective on water use efficiency among the wheat farmers. Then in Logit Model, the probability of the i^{th} to use efficiently of the water is defined as below.

$$P_i = f(z_i) = f(\alpha+\beta x_i+\Upsilon D_j) \quad (4)$$

$$= 1/(1+e^{-z}{}_i)=1/1+e^{-(\alpha+\beta xi+\Upsilon Dj)}$$

Here e is the base of natural logarithm (Nipper number). Since the sum of whole probability is 1, the probability of the i^{th} to be inefficient in water using can be calculated as below:

$$1/1+e^{-(\alpha+\beta xi+\Upsilon Dj)}.\ 1/(1+e^{-z}{}_i)= 1-p_i \quad (5)$$

The followings are obtained through dividing water use efficiency probability of the i^{th} to the water use inefficiency probability and logarithm them.

$$p_i /1-p_i=1+e^{z}{}_i /1+e^{-z}{}_i = e^{z}{}_i \quad (6)$$

$$L_i = \ln(p_i /1-p_i) = \alpha+\beta x_i+\Upsilon D_j \quad (7)$$

L is the logarith of the proportion of efficiency to inefficiency and it is obtained in terms of Xi and Di which are linears. Here L is refered to Logit and models like 7 are Logit model, a, B and γ are pattern parameters.

Table 1. explenatory variables affecting water efficiency

Varialbes	Definition
X_1	Farmer Age
X_2	Farm Area
X_3	The number of advocacy class attending related to water saving systems

Table 2. Vague variables affecting water efficiency

Variable	Definition	Value	
		0	1
D_1	Education level	lower than Diploma	Higher than Diploma
D_2	Irrigation Ssystem Type	Traditional	Pressurized Irrigation
D_3	The importance of Saving Water	Low	High
D_4	Water resource	Well	Non-Well
D_5	Soil Sort	Sandy	Clay
D_6	Irrigation Time	Warm Hours	Cool Hours

5. Results and Discussion

5.1. Evaluating water use efficiency and technical efficiency

Based on the results of the linear planning problem; the details of technical efficiency with consonant efficient to the scale is shown in the table3.

Table 3. The detail of straw and wheat production technical efficiency in Shahindej, West-Azerbaijan

Efficiency Range	0-25%	25%-50%	50%-75%	75%-100%
Farmers Number	**0**	0	5	98
Percentage	**0**	0	4.9%	95.1%

Technical Efficiency Average	89.5%
The number of inefficiency units	81
The number of efficiency units	22

Table.3, technical efficiency in wheat production in Shahindej, West-Azarbaijan based on input pattern with the average of 89.5 percent is shown. It is also indicated that relied on the Software's inputs 82 wheat producer units are less than 100 percent and is so called inefficient. So, of 103 studied farmers, only 21 are on the technical efficiency. After evaluating wheat and straw production and indicating the efficient and inefficient units in inputs consuming, water use efficiency in wheat production in this district; considering the consonant efficient to the scale in input-oriented has been assessed. It is shown in the Table.4 as following:

Table 4. The detail of Water consuming among straw and wheat farmers

Efficiency Range	**0-25%**	**25%-50%**	**50%-75%**	**75%-100%**
Farmers Number	٠	51	25	27
Percentage	٠	49.5	24.2	26.2
The average of water use efficiency		56.3%		

According to Table4, the average of water efficiency consuming for this district's straw and wheat farmers is low, about %56.3. It is inferred that the probability of water decreasing in this region for farmers without considering production level and consonant is about 44%. It is also shown that the majority of farmers are in low water use efficiency intervals which imply their ignorance to applying suitable water inputs.

5.2. Experimental Results of Logit Model

To evaluate Logit Model, Binary Logistic Regression method and Eview8 Software are applied. Before assessing Logit Model and after initial evaluations, co-linearity of variables is considered and there is no problem in the final model.

Table.5. Logit Model Estimation

Effective Factors	**Variable**	**Coefficient**	**Meaningful**
Consonant Coefficient	C	-2.24	0.43
Farmer Age	X_1	-0.41	0.00
Farm Area	X_2	-3.13	0.00
Education Level	D_1	8.94	0.00
Irrigation System Type	D_2	12.42	0.00
The importance of water Saving	D_3	11.62	0.00
Soil Type	D_5	6.26	0.00

The pre-condition of efficiency increasing understands the socio-economic effective factors in water use efficiency. So the effective factors among the wheat farmers are studied and the results are shown in Table 5. These findings show that education level, the importance of water saving, irrigation system and soil types in the state of consonant efficient have the positive effect and in 5 percent are meaningful. The coefficients such as farm area, farmer age have the negative effect and in 5 percent are meaningful.

6. CONCLUSIONS

The results obtained in this study with the results of Wang's research (2010), Deihami et al. (2007) and Sabouhi et al (2009) are in line and common variables have similar relations to efficiency increase.
These results show that the farmer's age has a negative effect on inefficient probability of farmer's water using. The effect of this variable is negative and optimum. As the farmer gets older the probability of using the modern method in irrigation will decrease. This issue is more related to their more personal characteristics and vulnerability than the young farmers. Soil type has a significant effect on water use efficiency. Due to the sandy soil texture and low water retention capacity likely the reason of irrigation efficiency declining is because of deep percolation losses. Education level has a positive effect i.e. the first condition of technical efficiency increasing is education. Type of irrigation system has also positive effect on increasing water use efficiency, so that the farmers used the modern system have more efficient that the traditional based ones. The other element that has a positive effect on water use efficiency increasing is the importance of water saving. Working on the urban water using showed the positive results. We can get these aim through implementing advocacy classes for farmers in optimum water saving.

According to the interview results with farmers and observations of the existence irrigation system in this district, researchers suggest that traditional irrigation method should be replaced by modern one. It is also important to train some experts to transfer agricultural knowledge to the framers. It needs research and education organization cooperation.

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ETHICAL CONSIDERATION

Authenticity of the texts, honesty and fidelity has been observed.

AUTHOR CONTRIBUTIONS

Planning and writing of the manuscript was done by the authors.

CONFLICT OF INTEREST

Author/s confirmed no conflict of interest.

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