Journal of Scientific Research and Development 2 (6): 8-12, 2015
Available online at www.jsrad.org
ISSN 1115-7569

Estimating efficiency of water input for the production of different products in Ahwaz city

Hossein Ostadi, Hadi Izadi *

Department of Economic, Dehaghan Branch, Islamic Azad University, Isfahan, Iran

Abstract: One of the major factors affecting the economic growth and development in most countries is the development of agriculture sector. Agricultural products directly affect the production cycle and it can be considered as producing employment, production and economic growth, particularly in the processing industry. The importance of this sector in the economic life of people of the society and its impact on the country's growth and development has led the performance of the agricultural sector to be considered more carefully. In this study, the cost function of agricultural products in Ahwaz in the period of 2008-2012 has been estimated using panel data and Frontier software and performance of different products have been measured. Then, to measure the amount of water efficiency in agriculture, the CPD index or index of Crop per Drop has been used. Based on the results of the study, the index of performance per cubic meter of water for wheat, barley and maize in 2012 was 0/901, 0/878 and 0/850, which had the highest value compared to other products and for each cubic meter of water, they have produced the highest products. Therefore, these three products use water more correctly and logically than the other products. Canola and rice (paddy) products with the 0/479 and 0/463 ratio in 2012 had the lowest index.

Key words: Efficiency of water input, Ahwaz city, Stochastic Frontier analysis, CPD index

1. Introduction

Water is one of the most important resources and one of the most vital natural elements for the preservation of organic beings and it will have a high value in countries located in arid and semiarid parts of the world. It is predicted that in the not too distant future, one of the major global challenges will be water scarcity. Located in the dry zone of the Northern Hemisphere, the Iranian plateau has very poor water supplies, low precipitation and severe annual evaporation and about 80 percent of the 164 million hectares land areas of the country has arid and semi-arid conditions. The mean annual rainfall in these areas is low and is estimated to be between 50 and 250 mm.

On the other hand, today factors such as increasing growth of population, increase of urbanization rates, changing consumption patterns, rising health level, development of other water uses (industrial, services, tourism, recreation, etc.) have increased water intake. In addition, the scarcity of water resources and the inability of humans to produce water in contrast to other products require more attention to the economics of water resources. These factors create difficulties, requirements and new needs in the field of the economics of water resources for a dry and arid country like Iran, where two-thirds of its area is deprived of appropriate atmospheric fallout. Since in the management of water resources paying attention to cost and social benefits related to resources allocation and the use of economic tools to improve performance in the water sector is essential, the view of water as an economic good for the country will be of vital importance. Solving the problem of water resources shortage and proper utilization of existing water resources needs paying attention to water resources management.

Water shortage in Iran is considered as one of the main factors limiting the development of agricultural activities in the present and the future; because, the average rainfall in Iran is 252 mm per year, which is equivalent to a third of the average rainfall in the world. Thus, while one percent of the world's population lives in Iran, Iran's share of renewable water resources is only 0/36 percent. Thus, food production and implementation of sustainable agriculture in the country is subject to correct and rational use of limited water resources. One of the most effective ways of dealing with the water crisis and qualitative and quantitative increase of agricultural production is paying attention to water efficiency and improving it by applying proper methods and policies.

Water is one of the country's basic infrastructures that can act as an engine of growth in the economy and cause the growth of other sectors, especially agriculture and related activities, so that each investment unit in the water sector causes /029 person to be employed directly and indirectly. Calculation of previous and subsequent bonds shows that the water in terms of subsequent bonds is in the eleventh grade and in terms of the previous bonds is

* Corresponding Author.

in the sixth grade, which indicates the fact that water is one of the key sectors of the economy. The role of water in agriculture: one of the main factors limiting the development of agriculture in Iran is water input. Experts believe that if there was no water restrictions, 30 to 50 million hectares of land in the country were arable. Based on the initial analysis, the water needs of the agricultural sector alone will reach about150 billion cubic meters up to the horizon of 1400. Hence, in the next two decades Iran will face challenges in the water sector. The current rate of extraction of water in the country is 113 billion cubic meters and the annual rainfalls in the country is about 400 billion cubic meters and given the climatic situation in Iran, particular consideration of operation management, especially in the field of surface and underground water resources is essential and limestone (karst) eater resources should be allocated for drinking and national plans.

Obviously, the role of professionals with experience in water with different orientations and participation in this area is important. Given the state of the country’s water and that water is the cause of development and construction, the current structure of water in the Ministry of Energy cannot meet the challenges of water and environment of the country in the horizon of 1400; because in most countries of the world the water structure or natural resources and in some countries environment is focused in an organization or ministry and in some countries the water sector has an independent organization. In order to speed up the affairs and that some of the duties of the water are in other departments or centers, the Ministry of Water and Environmental Affairs with strong and capable leadership in executive affairs for a country like Iran, where water is the basis for development, seems necessary. Water is the most important and basic factor in the agricultural sector. The increasing population and limited water do not meet the needs of our farmers, and we should think of an essential way in this field; thus, considering ways of better utilization of water with the aim of achieving sustainable agriculture is possible when water and soil resources of the country are preserved. In this way, using new irrigation methods in addition to affecting better crop improvement of agricultural products in particular, the possibility of more and better use of existing water, it will also prevent soil erosion.

Undoubtedly achieving self-sufficiency and development in the field of agriculture is not possible without preventing the loss of water and utilization of new technologies. In this regard, the use of drip irrigation control system is the harbinger of good promise for future generations that require further consideration to prevent the loss of the national capital. The phenomenon of rain, fertility of clouds, how to create and produce and distribute water and other items are among the topics that are related to water, which indicate that water is renewable in the agricultural sector and renewable water resources in Iran is about 25% of the global average. Since the issue of water is critical, specific consideration should be given to this important matter.

Given the importance of agriculture sector in the economy of Ahwaz and extreme dependence of this product to water input, the present study was conducted aimed to investigate the factors affecting water efficiency in selected crops cultivated in Ahwaz in 2008 to 2012.

According to the concept of virtual water, Brown et al. (2009) evaluated the breakeven of the allocation of water resources in the two catchments of Canada called Lower Fraser Valley basin (LFV) (a catchment in a temperate climatic zone) and Okanagan (a catchment in dry climatic zone). The results of this study showed that in the catchment of the temperate climatic zone, the main demand of water for agricultural activities was related to livestock sector and feed production. In the LFV catchment, berry orchards need 32 million cubic meters of virtual water per year and have a potential value of $ 95 million. The main orchard products in Okanagan catchment require 63 million cubic meters of virtual water per year and have a potential value of $ 68 million. In the two catchments, blue berry orchards and vineyards have a relatively high average of virtual water content. Results also indicated that in the temperate climatic zone, virtual water of the livestock products is nearly 4.5 times more than orchards and agricultural products, but in the catchment in the dry climatic zone, virtual water was nearly similar for all agricultural products.

Hanasaki et al. (2010) evaluated and estimated the state of import and export of virtual water of main agricultural and livestock products in a global scale using hydrological model of H08. This model is capable of estimating green water and blue water at the same time in different parts. The results showed that export of the virtual water of five crops (barley, maize, rice, soybeans and wheat) and three livestock products (beef, pork and chicken) are 545 cubic kilometer annually.

El-Sadek (2010) has proposed virtual water exchange as a way to cope with water shortage in Egypt. In this study, the concept of virtual water has been used to check the status of water resources in Egypt. In this investigation, it was found that the main share of virtual water in this country is allocated to the production of agricultural products and the substantial amount of virtual water comes to this country through import of wheat and maize. It was also noted that the application of the concept of virtual water alone is not important, but the relevance of this concept to food security has made it important. Finally, using the concept of virtual water has been proposed as a tool for decision making in water resources management.

2. Research model

The general form of generalized quadratic function, the way of calculating the elasticity of production factors and final efficiency is as follows, taken from Chambers.

1) Cobb-Douglas function:

$$Y = \alpha \prod_{i=1}^{n} x_i^{\beta_i}$$

$$Y = \alpha \prod_{i=1}^{n} x_i^{\beta_i} e^{\gamma_i x_i}$$

3) Trans log production function:

2) Transcendental production function:

$$\ln y = \alpha + \sum_{i=1}^{n} B_i \ln x_i + \frac{1}{2}\gamma_{ii}(\ln x_i)^2 + \sum_{i=1}^{n}\sum_{j=2}^{n} \gamma_{ij}(\ln x_i)(\ln x_j)$$

4) Generalized quadratic production function:

$$Y = \alpha + \sum_{i=1}^{n} \beta_i X_i + \frac{1}{2}\sum_{i=1}^{n} \lambda_{ii}(X_i)^2 + \sum_{i=1}^{n}\sum_{j=2}^{n} \lambda_{ij}(X_i)(X_j)$$

The relationship of production inputs' elasticity:

$$E_i = \left(\beta_i + \lambda_{ii}(X_i) + \sum_{j=2}^{n} \lambda_{ij}(X_j)\right)\left(\frac{X_i}{Y}\right)$$

The relationship of final (production) efficiency:

$$MP_i = \left(\beta_i + \lambda_{ii}(X_i) + \sum_{j=2}^{n}(X_j)\right)$$

In the above equation, Y is the amount of production, Xi is amount of inputs used in the production process, Ei is the elasticity of production in relation to the i-th input, MPi id the final (production) efficiency of the i-th input. To select a preferred form of the production function from among the estimated functions, econometric tests such as the statistics of coefficient of determination, the number of significant coefficients, F statistics and log maximum likelihood ratio test were used.

In this research, first the amount of cultivation and production rate of each farm were calculated and then all the production factors were adjusted based on hectare. To achieve the objective of the study and determine the final efficiency of water input, functions of producing different products were estimated in different forms, Cobb - Douglas and Translog. Inputs in this study are: Y performance (in tons per hectare), T harvest date of the current year (on a daily basis), S the cultivate level (in hectares), Tlag harvest date of last year (on a daily basis), Age plant's age (in years), Hirr irrigation volume (thousand cubic meters per hectare), P power of the machine (in 10 horsepower per hectare), Nfert frequency of fertilization (number of times) and Hfert volume of fertilization (in tons per hectares).

3. Model estimation

In the stochastic frontier functions, estimation of performance, in addition to be dependent on the distribution form of inefficiency component of U, depends on the explicit form of the frontier cost function (production). The stochastic frontier cost function has been estimated in both Cobb - Douglas and Trans log forms in this study. To estimate the model, panel data and Frontier have been used.

Table 1: Estimating the model of Cobb-Douglas cost function

Coefficient	Value	T Statistic	Prob.	Coefficient	Value	T Statistic	Prob.
β_0	2.09	4.88	0.0001	δ_0	0.71	1.75	0.0576
β_1	0.5	15.36	0.0001	δ_1	0.2	3.38	0.0161
β_2	0.21	4.22	0.0141	δ_2	0.022	0.038	0.3560
β_3	0.22	13.99	0.0001	δ_3	0.092	2.5	0.0054
σ_s^2	0.0536	7.75	0.0001	γ^{**}	0.0386	0.23	0.6530
			Max L = 5.35				

Table 2: Estimating the model of Trans log cost function

Coefficient	Value	T Statistic	Prob.	Coefficient	Value	T Statistic	Prob.
β_0	-100	-3.66	0.0001	β_9	0.18	5.75	0.0001
β_1	2.08	5.05	0.0001	δ_0	0.03	0.1	0.3245
β_2	3.1	5.21	0.0001	δ_1	0.1	2	0.0523
β_3	0.83	3.82	0.0061	δ_2	0.06	2.14	0.0152
β_4	0.01	0.60	0.5240	δ_3	0.006	0.14	0.5142
β_5	0.19	5.05	0.0001	σ_s^2	0.0355	7.75	0.0001
β_6	0.04	4.17	0.0001	γ^{**}	0.0001	0.011	0.1423
β_7	0.24	5.15	0.0001	Max L = 29.86			
β_8	-0.02	-1.34	0.1463				

4. Measuring water efficiency

In order to measure the amount of water efficiency in agriculture, CPD index has been used in this study. This index shows the ratio of amount produced product to the volume of water consumed. So, the higher the ratio, the more accurately reflects the proper consumption of water:

$$CPD = \frac{C}{W}$$

In this equation, C is the amount of produced product in kilograms and W is the volume of consumed water in cubic meter.

Table 3: Efficiency of water input in 2012

Beans	Peas and broad beans	Mung	Maize	Barley	Wheat
0.801	0.803	0.813	0.850	0.878	0.901
Onion	Garlic	Cabbage	Celery	Lettuce	Vegetable
0.698	0.782	0.785	0.789	0.798	0.795
Zucchini	Eggplant	Melon	Watermelon	Cucumber	Potato
0.627	0.632	0.645	0.668	0.670	0.687
Forage corn	Clover	Alfalfa	Carrot	Turnip	Tomato
0.533	0.548	0.562	0.568	0.573	0.597
Rice (paddy)	Canola	Soybean	Olive	Sesame	Sudangrass
0.463	0.479	0.486	0.493	0.518	0.527

5. Conclusion

Final results of estimating Cobb - Douglas cost function and Trans log cost functions are presented in Tables (1) and (2), respectively. The results indicate the ineffectiveness of β_4 coefficient, i.e. the second order of the plant age and coefficient β_8, i.e. the multiplication of harvest date of last year and plant age. The effect of cultivate input on dependent variable of performance in tons per hectare is positive and significant and suggests that the increase in cultivate level, increases performance in tons per hectare. In other words, this factor can be called scale factor and increasing scale factor can increase the specialization o affairs and thus will increase performance. The power of these two variables also has had a positive effect on performance. The effect of the irrigation volume input on performance in tons per hectare is positive and significant and suggests that the increase in irrigation volume, increases performance in tons per hectare. In other words, the factor of irrigation volume can be called key factor of production and increasing this key factor can increase efficiency and thus will increase performance. The power of these two variables also has had a positive effect on performance. The effect of the fertilization frequency in tons per hectare on dependent variable of performance in tons per hectare is positive and significant. This factor can be called another factor of efficiency and increasing the key factor of fertilization frequency can increase efficiency and thus will increase performance. It should be noted that too frequent fertilizing can lead to poisoning and other problems. The power of these two variables is negative and shows that increase in this independent variable can somehow increase performance and should be carefully increased. The effect of fertilization volume in tons per hectare also has a positive and significant effect on the dependent variable of performance in tons per hectare and suggests that the increase in fertilization volume in tons per hectare, increases performance in tons per hectare. In other words, this factor can be called proficiency factor and increasing the scale factor can increase efficiency and thus will increase performance. The second order of this variable is negative and suggests that increasing this independent factor somehow increases performance and should be increased carefully. The effect of machine factor on performance is positive and significant and the second order of this variable also has a positive effect on performance.

Based on the results of the study, the index of performance per cubic meter of water for wheat, barley and maize in 2012 was 0/901, 0/878 and 0/850, which had the highest value compared to other products and for each cubic meter of water, they have produced the highest products. Since the greater this ratio, it indicates the more correct water use; therefore, these three products use water more correctly and logically than the other products. Canola and rice (paddy) products with the 0/479 and 0/463 ratio in 2012 had the lowest index.

References

Abrishami H and Saidi M, (1997). Estimation of water demand for Mashhad, MA Dissertation, Mashhad University.

Albertson ML, Bouwer H. (1992). Future of irrigation in balanced third world development, Agricultural Water management, No. 21: 31-38.

Easter, W.K., Hearne, R., (1995). Water markets and decentralized water resources management: international problems and opportunities. Water Resources Bull. 31, 9–20.

Hadian M, (2000). Estimation of water demand for regional water corporation in Iran, Minstry of Power.

Hamdy A, Abo-zeid M, Lacirignola C. (1995). "Water crisis in the Mediterranean: Agricultural water demand management". Water International, 20(4), 175-184.

Hoseinzad, G., Salame, H. (1999). Estimate of economic value of water, land, labor inputs in Sugar beet production, Third Conference of Iranian agriculture, planning and research institute of agricultural economics, Iran. PP .53-84.

Johanston, j. (1997). Econometrics Methods Fourth Edition McGraw Hill co.p:150.

Khoshakhlagh R and Hadizadeh H. (2001). Water crisis and its requirements for rural water management: case Iran, minstry of power.

Mohammadi-nejad, A., (2001). Economic value of agricultural water (Case study: Central Plain of Saveh), M. Sc. Thesis, Tehran university, Iran.

Saunders, R.J. (1960). Forecasting water demand: An inter and intra-community Study, West Virginia University, Business and Economic Studies, 11(2).