Research Journal of Applied Sciences 11 (7): 530-535, 2016
ISSN: 1815-932X

Economic Valuation of Water (Case Study: The Cucumber Greenhouse of Khash)

Javad Shahraki, Neda Aliahmadi, Ali Sardar Shahraki and Mohsen Sarhadi Nasab
Department of Agricultural Economics, University of Sistan and Baluchestan, Iran

Abstract: Economic valuing is one of the complex subjects specially when there are no markets or they don't work efficiently, other non-market methods are used to determine the value. The value of resources is determined based on the goals or certain purposes of the use ofthat resource reflecting the share of them in order to meet these goals. Although, the goals of improving income distributions, the promotion of environmental quality and the desires for non-market goals are significant and important, the goal of economic efficiency has a special importance among the water users (consumers) that is a result of the lack of water resources and an increasing competition. The purpose of this research is the calculation the shadow price of water in Khash. The valuing method has been used based on Residual Imputation. Data for this research have been collected from 151 cucumber greenhouses in 2011-2012.

Key words: Economic valuation, residual imputation, water, Khash City, goal

INTRODUCTION

Water is one of the main natural resources and national investments of each country. The role and the place of water in the economic, social and cultural substructure have been effective, based on the changes of weather conditions and drought phenomenon, the importance of it is very obvious. Also it has a significant importance in production, in agricultural sector, in the limitation of water resources, in the management of consumption of this natural resource and the main input of production (Altaf and Hughesj, 1997). Water should be considered as a natural property and the value of it is contributed to the creation of goods and services.The extracted values are divided to two values, the useable values and unused values. The useable values involving different groups that contain industrial, agricultural, household, transportation, recreation and sewage. The unused values consisting of different groups such as the value of existence, heritage and election. The production of each goods and services will need a combination of resources and inputs such as primary Rials, equipment, management, investment and land. Each of these inputs participates in total value. In order to estimate the advantages of economy value, an input such as water is needed to be separated from total value for production of other share of production inputs that are in production circulation. The theories of production and agency provide a theoretical basis to value the economy welfare for some inputs containing agricultural or industrial water. Economy profit theory is involved in this valuing (Young and Loomisj, 2014). There are 217.2294 ha of greenhouses in Sistan and Baluchestan, the total land under cultivation in Kash was 54.7226 and the amount of production was 52.8 tons in 2010-2011. This town is in the first place in Sistan and Baluchestan. The most important greenhouse products include: cucumber, tomato, strawberry, banana, flowers and plants. Therefore as statistics shown, Khash is one of the most important parts of Sistan and Baluchestan. Considering the dry and semiarid climate, most of the lands are allocated to water cultivation, on the other hand the production of greenhouse and agricultural products must be dependent to underground water in Khash and this problem is accompanied with drought so that it has caused a considerable decrease in the level of underground water in recent years. In present research residual imputation has been used to determine the water price since it shows the reality, the functions of the water users and the minimum restriction.

Pakravan and Mehraby (2010) evaluated the water demand management to produce potato. The results declared that the technical coefficient for water variable in production function and self-price elasticity in producing this product was 1.348, also the shadow price of water to produce potato was 785.7 Rials, since the self-price elasticity is bigger than one and the difference between the real shadow price is 305.53 Rials, therefore the pricing policies are the suitable bar to control the irregular consumption of water and the input demand management.

Shajari *et al.* (2009) evaluated the water input demand management by using pricing policy in Jahroom palm and

Corresponding Author: Javad Shahraki, Department of Agricultural Economics, University of Sistan and Baluchestan, Iran

they surveyed about date. It was concluded that there is a significant and positive relation between the number of date trees in the level of garden, the number of work force and the times of irrigation with the amount of date production. Final utility and water final production value were calculated in 194% and 204.06 kg, respectively the price was 67.23 Rials. For the cost priceelasticity for water in dripirrigation was 3.039 and 5.093, it shows that the demand for water in two methods is elasticity.

Pakravan and Mehraby (2010) evaluated the economic value and water demand function to produce sugar beetin Kerman. The results showed the water is the most effective input in producing this product since the coefficient for this production function is 25% so that it has the most value among effective inputs. Also the self-price elasticity of water derivation demand for this product was 1.71 and if this elasticity is (-1), it declares that the prices policies are the most important factors to control undesirable consumption of these valuable inputs.

Ehsani *et al*. (2010) evaluated the economic value to produce corn in Alborz. They evaluated the economic value of agricultural water considering the applicant's view in farm inputs using strategy of production function in central sector of Alborz in Ghazvin based on collected information. The results declared that the economic value of water input in producing corn was 847 in each square meter; it has a high difference with the payment as watering rate (480 Rials).

Zaremehrjerdi evaluated the desirable cultivation pattern and water pricing using the combination of math programming methods under risk and residual value in Orzooyeh Baft in Kerman. The results demonstrated that the desirable cultivation pattern, the first period (wheat, potato, cotton, watermelon and sunflower) and the fourth period (barely watermelon, corn, cotton and sunflower) are simultaneous and the shadow price of water was 940 Rials in each square meter that shows the increase of net income resulting from the increase of water input unit in this area. Dehghanpoor and Shykhzinodin (2013) determined the economic value of agricultural water in Yazd. The results of the estimation of demand function showed that absolute value of demand price equals determining the elasticity of input demand in ratio to price changes of water, therefore the usage of pricing policies are suitable economic tools in reducing the water consumption. Also economic value of water and cost price were 997.5 and 530.8 in each square meter, respectively. The difference between economic value and the cost price of water is one of the reasons of irregular consumption ofwater in producing wheat.

Garcia and Randal (1994) evaluated the translog cost function of the production function structure in America, England and France by using dual theory. The purposes of this study were the measurement of the reaction of supplying the chemical fertilizer, determining the price policies and the amount chemical fertilizer.

Renwick (2001) calculated the water value in cultivation rice using the analysis of Residual Imputation for Krindioya in the eastern south in Sri Lanka. In this research the economic values of water based on distributed water to the farms (supplier) and consumption water of the rice (demander) were calculated so that the value of distributed water to the farmers was 93% RS in each square meter (RS is the unit of money of Sri Lanka), the value of each square meter and the consumption water of rice was calculated, it was 20.15 RS. Napasintuwong and Emerson (2002) used the translog cost function to evaluate the technical changes in agriculture in America and the relation of it with the politics of emigration of America during 1948-1994. The technology bias, the elasticity ofal substitution, self-elasticity and price cross elasticity were calculatedand then they concluded based on calculated elasticity's.

Unver and Gupta (2003) evaluated the pricing water in Turkey. An image was offered by them so that the management and management improvements in water sector consist of the management in economic and non-economic indexes, the transfer of water management fromthe government monopoly to water consumer, encouragement the participation of private sector, development water markets and valuing water to stable water demand management. Theyemphasized on final purpose of improvements in water sector, encouragement of saving water, the efficiency of using water, minimizes the loss of water, improvement the accessibility to water resources, the long stability of irrigation systems and providing drinking water for urban and rural areas.

Rogres *et al*. (2002) believed that valuing policies related to water resources can support their stability. They stated that if the price of water resources shows the real value and the amount of cost, the consumption will be desirable. Martinez-Espineira (2007) calculated the elasticity of water by using summing technique. Based on the results, the short elasticity was 1% and the long elasticity was 5%. Singh (2007) did a research in GAJRAT of India-the purpose of his research was to improve the efficiency use of water. He believed that there is a big space between price and economic value of irrigable water. It means that the increase majority in water price, the demand and supply should be balanced that lead to the decrease of farmer's welfare. Molle *et al*. (2008) did a research that its purpose was the increase of the irrigation output through the water demand management. They noticed that different methods of pricing policies of the farmers will encourage choosing and cultivating suitable products that are adaptable to the lack of water but pricing policies isn't a valid tool to improve the irrigation output.

Mesa-Juradao *et al*. (2008) used the Residual Imputation so that the cost of using consumption inputs except water must be subtracted from the gross output, the output is attributed to the water and the valuing of water was evaluated in the south of Spain. Medellin-Azuara *et al*. (2010) believed that the economic value of agricultural water is an important instrument for the water management. They investigated Positive Mathematical programming (PMD) in Rio-Bravo-Rio basin in the south of Mexico.

MATERIALS AND METHODS

This is a common method that uses the shadow price of production input. This method is applicable, especially in agriculture; the total value of product is distributed between each input. If the price of inputs except one input can be determined in the market, the remainder of total value of the products is contributed to that input (the input that its price can't be determined) (Young and Gray, 1985). By using the residual imputation, the consumption water in production process can be determined. This is a form and a shape of analyzing the budget searching the maximum regression related to the use of water. It can be found by calculating the total production output and reducing the costs related to the water, the residual value is considered equal to water output and shows the amount of maximum production so the desire to pay for water and input costs should be covered in this case. If we put aside the costs of changeable inputs, the short-term value related to water is obtained, if the other input costs except water to be subtracted (such as the natural rate of invest regression) then the long-term value isobtained. This method is suitable when our input is water and it has the main and important share in the total value of product. This separation is based on two principles: firstly, the cost of all the inputsin production equals to final production. This principle is one of the best conditions for competitive balance. It takes place when there is a complete competitive market for the agricultural inputs. The producers use the input so that the final production value equals to the last employed inputs (it means the input price), if there is no other input that it hasn't been priced, the residual imputation will give us an approximate estimation of water values (Saliba and Bush, 1987).

Secondly, the total value of the products is divided to different shares, so that each production input is based on final product value, in this way the total value is divided among the inputs completely. This principle is real while there is a linearly homogeneous production function Euler laws hows that if a production functions has a fixed outcome (output) in ratio to the scale, the total input products will equal to total production (Henderson and Quandt, 1980). This is classified as a farm production budget in applicable agricultural programs. One of the main problems of residual imputation is that the costs of inputs haven't been calculated totally by analysts. This is sensitive to the small changes related to the nature of production function or the price. As a result, this is a suitable method while our input (water in this research) has a significant share in total value of production. The calculation of residual value needs a great deal of information. The basic assumption of Residual Imputation is a part of neoclassic economic theory to maximize net income and production value. It is defined based on final utility as follows:

$$Y = F(X_k, X_l, X_r, X_w) \tag{1}$$

Where:

Y = The yield
X_k = The invest
X_l = The land
X_r = Other natural resources
X_w = The water

If we suppose the market of yields and inputs is a complete competitive market and the price and technology are fixed, so the total value of the production is:

$$YP_y = (VMP_k X_k) + (VMP_l X_l) + (VMP_r X_r) + (VMP_w X_w) \tag{2}$$

In above equation YP_y shows the production value and VMP is the value of final production of each factor. According to the first principle VMP_i or if we substitute then:

$$YP_y = (P_k K_k) + (P_l X_l) + (P_r X_r) + (P_w X_w) \tag{3}$$

While the consumption amount of all the inputs and price (except water) is clear, the water value ($P_w X_w$) is the only unknown variable in Eq. 3 that is calculated from Eq. 4 in this way the water value will be calculated:

$$P_w = \left[YP_y - \left(\left(P_k X_k\right) + \left(P_l X_l\right) + \left(P_r X_r\right)\right)\right]/X_w \quad (4)$$

Now, if we have (n) of inputs and (m) of yields, the calculation of the input price is:

$$X_n P_{xn} = \sum_{j=1}^{m} (Y_j P_{yj}) - \sum_{i=1}^{n-1} (X_i P_{xi}) \quad (5)$$

Where:

X_i = The amount of (i) input
(Y_j) = The amount of yield
P_{xi} and P_{yj} = The price of inputs and yield, respectively
(X_n) = The water input amount

It is concluded that if the total value of annual production yield of the farmers except water to be subtracted, the residual of water is the maximum amount that the farms can pay and all the costs will be covered. All the utility of water is through underground water resources; the rivers are seasonal generally. The water is provided with 918 wells, 393 aqueducts, 369 springs, the water amount is 294 million cubic meters and Gazo, Sangan, Karvander and Irandegan with 20/4 million cubic meters provide Khash with water. Khash has a dry and hot climate. The average of annual rainfall is 174/9 millimeters and the average temperature is 7-37°C changeable. The necessary data were obtained from 151 cucumber greenhouses of Khash in 2011-2012 by using the random sampling method through Cochran formula.

RESULTS AND DISCUSSION

The cost is water harvesting or bringing water to the farm. In this research in Khash underground water resources (deep or semi-deep well). Although, there hasn't been any researches in this area in order to calculate the water harvesting cost the following method has been used for each hectare since there has been no organized researches in this case and because of the different depths of wells, the calculation of water harvesting cost in each hectare is difficult. To solve this problem, a deep and a semi-deep well have been selected. According to the views of experts in protection and utility of Sistan and Baluchestan water company, the depth of a semi-deepwell of 4 inches was 40 m and the depth of a deep well of 4 inches was 70 m. Based on various prices of equipment and digging these two wells and asking from different sellers of well equipment the annual water harvesting cost was calculated as follows:

$$A = \frac{P}{F} \quad (6)$$

$$F = \left[\frac{(1+i)^n - 1}{(1+i)^n i}\right] \quad (7)$$

Table 1: Calculation the annual amortization of semi-deep well

Equipment of well	Annual amortization	Useful life	Primary investment
Digging the well	28,800	20	180,000
Buying and setting up the tube	63,200	20	395,000
Shaft and sheath	107,200	20	670,000
Turbine and elector-motor	238,000	10	1,190,000
Electricity board	600,000	10	3,000,000
Sums of annual amortization	6,437,200	-	-
The cost of annual fuel and storage	800,000	-	-
Sums annual of water harvesting	1,837,200	-	-

Table 2: Calculation the annual amortization the deep well

Equipment of well	Annual amortization	Useful life	Primary investment
Digging a well	32,000	50	200,000
Buying and setting up the tube	60,800	20	380,000
Shaft and sheath	260,000	20	1,625,000
Turbine and electro-motor	374,000	10	1,870,000
Electricity board	700,000	10	3,500,000
Sums of annual amortization	1,426,800	-	-
The cost of annual fuel and storage	1,200,000	-	-
Sums annual cost of water harvesting	2,626,800	-	-

Research finding

Where:

A = The value of annual liabilities
P = The primary investment
n = The useful life and
I = The interest rate

Following other findings, interest rate was 15% (Marvdashti and Farjod, 1996). As you observe in Table 1 and 2, the data about the sample wells have been offered. In order to calculate the amount of water harvesting from the well, the cost of one cubic meter is:

The cost of each cubic meter of water = annual cost of water harvesting\the amount of annual water harvesting (8)

The amount of annual water harvesting is 157680 m^3. In this research, the cost of water harvesting is 16/6 for 1 m^3 and it is 11/6 for every semi-deep well. To calculate the cost of water harvesting for the greenhouse, the cost of every cubic meter multiplies by the distributed water to the greenhouse has been calculated.

Calculation: In the area that we are studying, the irrigation method is newthe amount of the distributed water for special plants is calculated easily. The distributed water is the water that enters the specific area in this research the field area is 1 ha to calculate the volume of the distributed water, first the total output is defined as follows:

Application output x distribution output x transfer output = total output (9)

Table 3: Economic value (net yield) of water for cucumber in Kash (unit: Rials)

Input types	Cost based on market price
Work force	3,373,230
Manure	2,601,990
Seed	8,842,590
Poison	906,040
Chemical fertilizer	2,307,680
Water harvesting	1,325,570
Invest profit	4,933,350
Total cost of one hectare	26,290,450
Management cost (5% of total cost)	1,214,530
Total cost plus management cost	23,075,920
Total gross value	29,019,680
Economic value of water in 1 ha	5,943,760
Economic value of water for each cubic meter	66/780

Research finding

Based on above Eq. 9, the water loss is in three stages: transfer, distribution and application in the greenhouse. The total output is related to the underground water, since the water resources are near, the transfer output isn't necessary, also the distribution is not changeable so the distribution output is 100%. The application output and the consumption of it in the greenhouse is 95%. To calculate the distributed water, the water should be divided by total output to calculate the distributed water for each hectare of underground water (the water which is necessary for cucumber product in each hectare equals to 8900 m^3 during the period).

In Table 3, the economic value of water for each hectare and one cubic meter based on prices for cucumber product has been offered. This determines the share of water input in value of cucumber production. In this research, the value of water for irrigation and the value of water in this area have been considered. If the consumption amounts of inputs and their prices (except one input) are available, the input method will be estimated. All the costs of the input are based on the market priceonly the price of water isn't available. By using residual imputation, the shadow price for each unit was calculated. As the results shown, the real value for each cubic meter of water was 66/780 Rials.

CONCLUSION

The results of this research demonstrated that the shadow price of water is 670 Rials that shows the increase amount of net income which has been caused by the increase in a unit of water input in an area. Therefore, the possibility of the policy of water valuing is based on watering rate but this policy should be done gradually and during a period of time; otherwise the greenhouse with a low efficiency will be removed from production.

SUGGESTIONS

- As it was mentioned, the maximum criteria to pay the watering rate by the owners of greenhouses is economic value or the net yield so that this input has value in production.According to the results and the high economic value of each cubic meter for cucumber product, the producers can pay more watering rate, therefore we can run the pricing policies based on the watering rate but it should be during a period of time, otherwise the farmers will be deleted from production circle. Also water pricing isn't enough the polices for collecting watering rate and using them to improve the water resources should be considered
- Since the water price is unreal, the government can decrease the gap between real price and the payments from the owners of greenhouses by politics
- Creationthe unions to control the water resources and improving these resources
- Considering the necessity of increasing output of water in farms and greenhousesand introducing the new and modern systems for irrigation to farmers and capitalists
- Setting up intelligent counter on the agricultural well and the control of the volume of output controlling the irrigation time and using micro irrigation in greenhouse cultivations

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