



# Economic Pricing of Water in Pistachio Production of Sirjan

Nasrin Ohadi<sup>1</sup> and Jaleh Kurki Nejad<sup>2</sup>

Received: 23 February 2014,  
Accepted: 19 July 2014

## Abstract

Given the strategic remarkable rank of pistachio in non-oil exports, inputs' management in its production is so important. As the scarcest input in agricultural sector, water is considered to be among the most important inputs of pistachio production. Water inadequate supply and climate conditions increase water demand in pistachio growing areas. It is necessary to determine the real value or price of water for establishing a balance between its demand and supply. Therefore, this study has aimed at estimation of water economic value. The method used in this research is the production function approach. Requested data sets were obtained from the questionnaires was filled out for crop years of 2013-2014. The results show that the average economic value of irrigation water is 50360 RLS but the average price paid by farmers is 1771 RLS per cubic meter of water. Thus, there is a wide gap between water value and the price paid by farmers with which appropriate pricing of water based on its economic value can be eliminated.

### Keywords:

*Economic value of water, Pistachio, Production function approach, Sirjan*

<sup>1</sup> Master of Agricultural Economics, University of Sistan and Baluchestan, Iran.

<sup>2</sup> PhD student of Agricultural economics, Faculty Member, University of Payam- Noor Sirjan, Iran.

\* Corresponding author's email: [Nasrin.ohadi@yahoo.com](mailto:Nasrin.ohadi@yahoo.com)

## INTRODUCTION

The water is considered as a valuable scarce input because of its capability of creating goods and services flows over the time. Water usage is limited by physical, economic and spatial terms and has a very significant impact on yield and farmers' income under controlled conditions. Water as the most precious production inputs, almost assign high percentage of subsidies itself in most countries. Remained water from irrigation projects usually has costs such as operating and capital expenditures which paid by consumers. On one hand, low pricing of water leads to its inefficient use. On the other hand, it causes income transfer from dry farmed lands to irrigated ones and thus, increases inequality of income distribution. In addition, there are no costs or fines for water contaminating through wasting it, fertilizers or chemicals. As a result, any fines won't be considered for environment damages leading to resources abuse. Chosen method for cost based on pricing of water is, requiring water value knowledge and information and varies for plant type, area and water quality. This method seems to be more complicated than the cost pricing and leads to a more equitable distribution of costs and efficient usage of scarce resources such as water (Kashakoglu and Erol Cakmak, 1997). Iran is the world's largest producer and exporter of pistachio; 40 percent of production, 63 percent of the cultivated areas is of Iran (Food and Agricultural Organization, 2009). According to the latest statistics of the ministry of agriculture, pistachio cultivated areas of Iran are about 420 thousands hectares. Kerman province contains 70 percent of Iranian pistachio cultivated areas based on these statistics (Abdollahi Ezatabadi, 2008). Having 60 thousands hectares of pistachio cultivated areas, Sirjan is one of the main pistachio producers of Kerman (Jahad-Keshavarzi of Sirjan region, 2013). Pistachio cultivation is done in desert and arid areas where rainfall is very low and the weather has a borderline state (very cold winters and very hot dry summers). High salinity and inadequate contents of agricultural water resources in many areas have been major constraints of pistachio production in recent years (Sedaghat, 2006). Kerman province experiences hot and dry climate and has the problem of water scarcity. Due to unequal rainfall distribution, neighborhood of the Lout Desert and Kavir plains, high evaporation and exceeded usage of resources; water

scarce issue in desert regions is severely obvious. Declining ground-water is over 50 cm in Kerman the year. Because of illegal utilization, aquifer levels have been declined in some regions especially pistachio growing areas accompanying with dangerous problem of salinity. Thus, it's necessary to consider optimum using of this vital resource (Mehrabi Boshrabadi, 1995). Drop of aquifer level of ground-water in world is yearly between 750 to 800 billion cubic meters and drop of aquifer level in Iran is equivalent to 7 billion cubic meters. That is 1 percent of drop aquifer level of world's ground-water. According to report of Iranian water resource management corporation in water year 2001-2002 (Department of Energy, 2005). The economic valuation of water input, therefore, is essential for its efficient usage. Water-extracted values are categorized in two groups of use values and non-use values:

1- Use values include: this classifications is based on :A- consumptive and non-consumptive values. B- Position type. C - Economic role.

2- Non-use values include: A Existence value. B - Option value. C – Bequest value.

Economic valuation is a complex topic of economics. In absence of markets or their sufficient performance, one can utilize non-market methods to determine the value. The methods used for determining the economic value of water can be divided into two categories of inductive and deductive ones. All methods are practically practicable but some of them are more common than others because of limitations. Observation of agricultural land market transactions and wastewater are examples of simple methods. In complex practical methods, one can mention mathematical programming procedure and production function estimation approach (Department of Energy, 2011). The method used in this study is production function estimation. Since the parametric method allows statistical testing of econometric models' estimated parameters, it is used with production function technique in this study. Hence, the water value obtained can be more reliable. There is no need to specify the water restriction threshold and supply type in parametric methods. Among these, production function approach was chosen because of the impossibility of applying the profit and cost functions (Dashti *et al.*, 2010).

Hayati *et al.* (2009) with using translog production function estimated that the actual price

of irrigation water in wheat and barley for North Khorasan, Razavi Khorasan and South Khorasan. The results showed that irrigation water price in North Khorasan, Razavi Khorasan and South Khorasan for wheat were 122.14, 2882.24 and 456.30 RLS per cubic meter and for barley were 703.01, 1343.67 and 112.67 RLS per cubic meter, respectively. That is higher than the prices which was paid by farmers.

Dashti *et al.* (2010) estimated the economic value of water for Damghan. In this study they used method of production function. The results of analysis showed that the economic value of irrigation water for wheat was 403.2 RLS, the estimated amount is higher than current value of water in region for study.

Shamsoldini *et al.* (2010) determined the economic value of water through analysis of the production function among sugar beet farmers of Marvdasht city. Based on the prices of 2006, the price was assessed 211.6 RLS per cubic meter of water in sugar beet production.

Khaje Roshanaei *et al.* (2010) applied production function method in wheat production of Mashhad to determine the economic value of agricultural water. In order to assess production function coefficients, the classic and generalized maximum entropy models were used. According to the results, the classic method and Translog functional form led to the best outcomes. The economic value of water for wheat was calculated 1870 RLS.

Ehsani *et al.* (2011) with using the production function approach and the Dual cost function, determined the water economic value from the viewpoint of wheat suppliers in areas irrigated via Qazvin plain irrigation network in crop year of 2007-2008. They set the economic value of water 586 and 609 RLS per cubic meter.

Dehghanpour and Sheykhezodin (2013) determined the economic value of agricultural water in Ardakan- Yazd plain of Yazd province. In this study the economic value of agricultural water was calculated by using production function. Also, water economic value and water unit price per cubic meter were calculated 997.5 and 530.8 RLS, respectively. The difference between economic value and unit price of water can be one of the reasons of excessive and inefficiency water use in wheat production.

Karthikeyan (2010) determined the economic and social value of irrigation water. The results showed that the comparison of the economic

value of estimated water with using different methods, strongly suggests that the present water use pattern will not lead to sustainable use in the tank command areas.

In a study aimed at determining the optimal cropping pattern and water shadow price calculating under hazardous conditions in Baft region, Zare Mehrjerdi (2011) used a combination of mathematical programming methods of under risk target Motad and the residual value procedure. In this study, water shadow price was determined 944 RLS per cubic meter.

Given the importance of ground-water in the city of Ravar, Sherzei and Amir Teimouri (2012) determined the economic value of water using input productivity value calculation method. The economic value of Ravar ground-water was obtained 19870 RLS per cubic meter in their study.

Garcia and Reynaud (2004) studied water pricing method using econometric patterns and simulation of social variables. They concluded that there is a significant difference between the observed market prices and the marginal production value of water.

In their study "increasing of irrigation through water demand management by implementing different policy methods of pricing", Yousef *et al.* (2008) resulted that various pricing methods leads to encourage the farmers in selecting and cultivating of water scarcity resistant crops but pricing policy is not a reliable tool for improving irrigation efficiency.

Mesa-Jurado *et al.* (2010) estimated marginal value of water for irrigated olive grow with the production function method. Net marginal value of water obtained were € 0.60 m<sup>-3</sup> for the allocation of 100 m<sup>3</sup> ha<sup>-1</sup> and € 0.53 m<sup>-3</sup> for the water right allowance of 1500 m<sup>3</sup> ha<sup>-1</sup>.

All of the above studies emphasized on determining economic value of water in their studied region and results show that the price paid by farmers is lower than estimated economic value of irrigation water.

The aim of present study is estimation of economic value of water in Sirjanian pistachio producers.

## MATERIALS AND METHODS

Determination of the water economic value has several procedures dividing into two overall categories of parametric and nonparametric methods. Given water usage in agriculture sector as an input, production function and mathe-

mathematical programming methods are the most famous ones in estimating its economic value. Since the parametric method allows statistical testing of econometric models' estimated parameters, it is used with production function technique in this study. Hence, the water value obtained can be more reliable. There is no need to specify the water restriction threshold and supply type in parametric methods. Among these, production function approach was chosen because of the impossibility of applying the profit and cost functions (Dashti *et al.*, 2010).

**Production function method**

Production function is a completely physical concept showing simply the relationship between production outputs and inputs. The most general form of the production function is (Chambers, 1988):

$$Q=f(x,z) \tag{1}$$

Where Q is the production rate; f denotes the functional relationship, x shows variable inputs vector and z represents the vector of fixed or quasi- fixed inputs.

i-th input is calculated through differentiating of expression (1) with respect to the desired input of production function:

$$MP_{xi} = \frac{\partial f(x)}{\partial x_i} \tag{2}$$

Average production rate representing production per input consumption unit is:

$$APP_i = \frac{Y}{x_i} \tag{3}$$

The economic value of water, therefore, is obtained from the following equation (Mousa Nejad and Najarzadeh, 1997):

$$VMP_w = MPP_w \times P_y = P_w \tag{4}$$

Where  $MPP_w$  is marginal production of water input,  $P_y$  denotes the product price,  $VMP_w$  represents the value of marginal water input production and  $P_w$  is the economic value of water. The marginal production rate can be calculated using the following equation (Ehsani *et al.*, 2010):

$$MP_W = E_W \times AP_W = \frac{\delta \ln(y)}{\delta \ln(w)} \times AP_W \tag{5}$$

Given dependence of water economic value to the production function, Cobb-Douglas, Transcendental and Translog production functions were tested to select the best form for estimating the water economic value in this study. Three

forms of these functions are shown in expressions (6), (7), and (8) respectively:

$$\ln(y) = \alpha_0 + \alpha_i \sum_{i=1}^9 \ln(x_i) \tag{6}$$

$$\ln(y) = \alpha_0 + \alpha_i \ln(x_i) + \beta_i \sum_{i=1}^9 x_i \tag{7}$$

$$\ln(y) = \alpha_0 + \sum_{i=1}^9 \alpha_i \ln(x)_i + 1/2 \sum_{i=1}^9 \beta_i (\ln(x_i))^2 + \sum_{i=1}^9 \sum_{j=1}^9 \gamma_{ij} \ln(x_i) \ln(x_j) \tag{8}$$

Where Y is the production (kg),  $X_1$  is N fertilizer consumption (kg),  $X_2$  represents  $PO_4$  fertilizer consumption (kg),  $X_3$  denotes K fertilizer consumption (kg),  $X_4$  is animal manure consumption (ton),  $X_5$  is pesticide consumption (lit),  $X_6$  indicates rented labor (Individual – day),  $X_7$  is family labor (Individual – day),  $X_8$  represents machines using (hours) and  $X_9$  is the water consumption ( $m^3$ ).

Population of the study is Sirjan city pistachio Growers. In this study, the use of simple random sampling 67 pistachio growers were chosen and necessary information obtained from a questionnaire.

**RESULTS AND DISCUSSION**

In order to choose the best form of production function, Cobb-Douglas, Transcendental and Translog functions were estimated in this study. Since among non-flexible production functions such as Cobb-Douglas and Transcendental have no limitation on production function and depict more suitable real behavior of economic factors (Salami and Mohammadi Nejad, 2002). In this study translog production function has been used. Since among flexible production functions translog form although has less limitation production function in compare to other forms of functions, this shape of function is proper for presenting technology of production (Kumbhakar, 2004).

Table 1: The results of production functions

Function	Cobb-Douglas	Transcendental	Translog
Coefficients' numbers	9	18	53
Significant Coefficients number	2	5	31
R <sup>2</sup>	0.20	0.44	0.95
F	1.6*	2.12**	4.88***
D.W	1.9	2.6	2.6
J-B	16.4 (0.00)	0.03 (0.98)	2.9 (0.22)
W	13.6 (0.000)	9.00 (0.000)	1.7 (0.14)

\*\*\*p<0.01 \*\* p<0.05, \*p<0.1

Table 2: The results of Translog production function.

Parameter	Coefficients	Standard Deviation	t-statistics
Ln(x <sub>1</sub> )	11.01	2.59	4.24***
Ln(x <sub>2</sub> )	-15.48	3.84	-4.02***
Ln(x <sub>3</sub> )	9.16	3.74	2.44**
Ln(x <sub>4</sub> )	-7.14	3.08	-2.31**
Ln(x <sub>9</sub> )	3.07	1.16	2.64***
(Ln(x <sub>1</sub> )) <sup>2</sup>	-1.49	0.32	-4.56***
(Ln(x <sub>6</sub> )) <sup>2</sup>	1.34	0.67	1.97**
(Ln(x <sub>8</sub> )) <sup>2</sup>	-1.84	0.92	-1.98**
Ln(x <sub>1</sub> ) Ln(x <sub>2</sub> )	1.07	0.32	4.62***
Ln(x <sub>1</sub> ) Ln(x <sub>3</sub> )	0.62	0.32	1.93**
Ln(x <sub>1</sub> ) Ln(x <sub>5</sub> )	2.94	0.82	3.57***
Ln(x <sub>1</sub> ) Ln(x <sub>6</sub> )	-2.86	0.71	-4.02***
Ln(x <sub>1</sub> ) Ln(x <sub>7</sub> )	-1.31	0.41	-3.14***
Ln(x <sub>1</sub> ) Ln(x <sub>9</sub> )	-1.71	0.49	-3.44***
Ln(x <sub>2</sub> ) Ln(x <sub>4</sub> )	-1.02	0.46	-2.21**
Ln(x <sub>2</sub> ) Ln(x <sub>5</sub> )	-2.27	0.84	-2.67***
Ln(x <sub>2</sub> ) Ln(x <sub>6</sub> )	3.76	0.72	5.17***
Ln(x <sub>2</sub> ) Ln(x <sub>7</sub> )	1.09	0.5	2.17**
Ln(x <sub>2</sub> ) Ln(x <sub>9</sub> )	2.15	0.69	3.09***
Ln(x <sub>3</sub> ) Ln(x <sub>5</sub> )	1.12	0.58	1.92**
Ln(x <sub>3</sub> ) Ln(x <sub>8</sub> )	-1.15	0.54	-2.11**
Ln(x <sub>3</sub> ) Ln(x <sub>9</sub> )	-2.55	0.89	-2.86***
Ln(x <sub>4</sub> ) Ln(x <sub>5</sub> )	-1.92	0.74	-2.59***
Ln(x <sub>4</sub> ) Ln(x <sub>7</sub> )	3.20	0.79	4.03***
Ln(x <sub>4</sub> ) Ln(x <sub>8</sub> )	-3.09	1.01	-3.05***
Ln(x <sub>4</sub> ) Ln(x <sub>9</sub> )	3.7	1.04	3.55***
Ln(x <sub>5</sub> ) Ln(x <sub>6</sub> )	-1.14	0.62	-1.83**
Ln(x <sub>5</sub> ) Ln(x <sub>7</sub> )	-1.44	0.57	-2.52***
Ln(x <sub>5</sub> ) Ln(x <sub>8</sub> )	4.2	1.19	3.53***
Ln(x <sub>6</sub> ) Ln(x <sub>9</sub> )	-1.57	0.87	-2.006**

\*\*\*p<0.01 \*\* p<0.05, \*p<0.1

The results are shown in table 1.

Translog flexible function was chosen as the best function. High value of R<sup>2</sup> statistic indicates appropriate fitness of the model. It shows that 95% of production changes are explained by considered variables and their interactions. According to F statistics, whole of the model is significant in probability level of 99%. This model includes the most significant coefficients shown in table 2.

Partial elasticity of water was calculated using model derived coefficients as 3.04 % indicating pistachio growers' presence in the first and non-economic production area. Due to insufficient production of the water input and adequate land as the agricultural constant input in the first area, this is an acceptable result for our agricultural sector. Thus increasing of changing input leads to production increment (Abounouri, 2002). Providing water input increment of 10 %, production rate will increase by 30%. Increment of water input doesn't mean necessarily its consumption per

area unit. Instead, this indicates efficient water to increase available water for pistachio trees because traditional irrigation methods cause water loss in the studied region. Using modern irrigation methods, therefore, water loss can be prevented and water availability for trees will be increased. Once water partial elasticity was calculated and placed in equation (5), marginal production value of water was obtained. Accordingly, minimum, average and maximum economic value of water is 22500, 50360 and 68000 RLS respectively but the average price paid by farmers is 1771 RLS per cubic meter of water. Due to inappropriate pricing of water in agriculture sector, there is a wide gap between water actual price and the price paid by pistachio growers. Since rising price of the product leads to mounting of water marginal production value based on the equation (4), significant increment of pistachio product price in cropping year of 2012-2013 can be considered as another reason of this broad gap.

### CONCLUSION

Economic value per cubic meter of water to pistachio production is higher than its average exchange value in the region leading to non-optimal using of water. Since the studied area is arid and because of recent droughts and aquifers levels' declining, inputs' insufficient using causes serious complications for the pistachio as the most important agricultural export product of Iran. Therefore, the following suggestions are represented based on research results:

1-Appropriate water pricing based on its economic value, to eliminate the gap between the actual price and the paid one. Implementation of this policy should be done in long run.

2-Using of tax implementation policies based on different income categories in order to reduce the water consumption by the government.

3-Increasing of water prices may encourage farmers to use modern irrigation methods but due to low income, some farmers are not able to use these methods. The government can provide long-term low-interest loans and grants to assist them in applying these methods. Thus, water consumption is directed to optimal amount leading to cost saving for farmers.

4-Organizing training courses and informing the farmers about modern ways of irrigation.

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# قیمت گذاری اقتصادی آب در تولید محصول پسته شهرستان سیرجان

نسرين اوحدی\* و زاله کورکی نژاد<sup>۲</sup>

تاریخ دریافت: ۴ اسفند ۱۳۹۲

تاریخ تایید: ۲۸ تیر ۱۳۹۳

با توجه به اهمیت استراتژیک و جایگاه خاص پسته در صادرات غیر نفتی مدیریت نهاده‌ها در تولید این محصول از اهمیت والایی برخوردار است. یکی از مهم‌ترین نهاده‌ها در تولید این محصول نهاده آب است که در واقع کمیاب‌ترین نهاده در بخش کشاورزی محسوب می‌گردد و با توجه به شرایط آب و هوایی در مناطق پسته کاری عرضه آب ناکافی و تقاضای آن بسیار زیاد می‌باشد. جهت برقراری تعادل بین عرضه و تقاضای آب بایستی قیمت و یا ارزش واقعی آب تعیین گردد. لذا این تحقیق با هدف برآورد ارزش اقتصادی آب انجام شده است. روش مورد استفاده در این تحقیق، رهیافت تابع تولید است و اطلاعات لازم جهت سال زراعی ۹۲-۹۱ از طریق تکمیل پرسشنامه حاصل گردید. نتایج نشان می‌دهد که متوسط ارزش اقتصادی آب ۵۰۳۶۰ ریال می‌باشد. ولی متوسط قیمت پرداختی کشاورزان ۷۷۱۰ ریال برای هر متر مکعب آب می‌باشد. بنابراین شکاف بین قیمت واقعی آب و قیمت پرداختی توسط پسته کاران بسیار زیاد می‌باشد که با قیمت گذاری صحیح و مناسب برای آب بر اساس ارزش اقتصادی آن می‌توان شکاف بین قیمت واقعی و پرداختی آب را از بین برد



واژگان کلیدی:

ارزش اقتصادی آب، پسته، رهیافت تابع تولید، سیرجان

<sup>۱</sup> دانش آموخته کارشناسی ارشد اقتصاد کشاورزی، دانشگاه سیستان و بلوچستان

<sup>۲</sup> دانشجوی دکترای اقتصاد کشاورزی و عضو هیئت علمی دانشگاه پیام نور سیرجان

\* ایمیل نویسنده مسئول: [Nasrin.ohadi@yahoo.com](mailto:Nasrin.ohadi@yahoo.com)