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Evaluation of Irrigation Water Price Addition on Productivity of Agriculture Section in Iran (Case: Kashan Region)

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Abstract

The shortage of irrigation water is one of the most important problems which Iran is facing. Irrigation water pricing is one of the economic approaches to manage irrigation water consumption and using it efficiently. This study purpose is to evaluate the effect of irrigation water price induction on productivity of agriculture section in Iran (case: Kashan). This study is an application development in terms of objective and a post-event in terms of the study design, and is descriptive in terms of conclusion. The study results show that during study period (2006-2010), irrigation water price has risen in Kashan region. But this leads not only to increasing average cultivated land per a farmer, but also to increasing crops and garden products' monetary productivity. It means that Iranian government can use irrigation water price induction as a tool for increasing productivity in agriculture section in Iran. In addition, crops and garden products have different productivities. Results also show that dill and apricot have the highest productivity in all crops and garden product in the region respectively.

Keywords

Productivity, Irrigation Water, Price, Crops, Garden Product, Kashan Region

Subject Areas: **Economics**

1. Introduction

The world is currently living a water crisis. For more than one billion people in the world, clean water supplies are not available. Until 2025, more than half of the world's population will live in countries where over 40 percent of their re-usable water resources are abolished. Although water covers three-quarters of the Earth's surface, only 3 percent of the world's resources are freshwater and usable for agriculture. For the purpose of expanding

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agricultural lands, the restrictions of water provision are the following—the deficit of renewal water in the world, the high costs and complexities of projects for water provision, the emergence of new competitors in the field of water consumption and the reduction of water allocation in agriculture due to the increase in drinking and industrial requirements, the demand of greater attention for the biosphere and the reduction of usable water supplies in agriculture, as a result of loss in water quality (dissolved salts in water). Thus, the only way to meet the increasing demand for food is the effective use of water resources acquired for agriculture by using less amounts of water to get larger volumes of products [1]. However, the above mentioned way of water consumption is not the only one; here, the selection of crops is also very important. Along with the world water shortage (as the most important basic matter/factor in the field of agriculture), in various continents the uneven distribution of water is also an additional problem next to this crisis. Asia with 60 percent of world's population is secured only with 30 percent of water resources. Iran's population is more than 1 percent of the world's population. Yet, only 0.36 percent of re-usable freshwater is available to the country and is unevenly distributed [2].

Based on Iran's comprehensive project surveys, the renewal water resources of the whole country are around 130 billion·m^3, of which 89.5 billion·m^3 are used in agriculture, industry, mining and for household consumption, of which around 83 billion·m^3 (or 93 percent) are given to agriculture [3].

On one hand, agriculture, which is the main consumer of recycled fresh and re-usable waters, forms 18 percent of GNP and 25 percent of employment and secures 85 percent of public food; it forms 25 percent of non-oil exports and 9 percent of raw materials used in industry. On the other hand, Iran is located in arid and semiarid climatic conditions in the region, where the average yearly precipitation rate is 261 mm (the calculation of the average annual precipitation is 860 mm). And the average annual volume of re-usable water per capita is 1900 m^3 (when the world's average annual volume of re-usable water per capita is 7500 m^3). From which, more than ever, the necessity to pay attention to water deficit is felt. The issue of water pricing is very important for the effectiveness in agricultural sector.

During evaluation of irrigation water factors and efficiency, the presentation of its economic and social consequences is essential. This is important insofar that irrigation not only brings economic consequences, but also has the social issue. In Islamic Republic of Iran water is equated with life. It plays a major role in the development of communities, enhances prosperity, and decreases migration and reproduction of population. Thus, apart from its economic importance, in water tariffs, it is also essential to see the social image. In the International Conference of Freshwater 2001, which was held in Bonn, the pricing of water was represented as just one tool for water management purposes, and the support and payments of financial and operative expenses of water were on focus. The most important measure of the conference was the fact that water is human right. Based on that right, no one shall be deprived of water. In IRI, the issues of water usage and pricing are the most important in agriculture, because here around 90 percent of the water used is spent for economic needs. Thus, the methods and models of water pricing in agriculture have appointed significance. Meanwhile, water may serve as a way to ease the migration of the poor people from the mountainous regions of the IRI.

2. Literature of Review

Hirshleifer *et al*. (1960) prefer water pricing based on marginal cost, rather than average cost water pricing. They also believe difference between pricing for on-peak and off-peak demand [4].

Riordan (1971) suggests multistage marginal cost pricing technique. She finds that her proposal is able to provide 10% - 20% increase in total net benefits more than the typical average cost pricing techniques [5].

Dandy *et al*. (1984) study a water pricing method with constraint (where there are constraints on the amount of permissible price change in a charge form average cost pricing to an optimal marginal cost pricing rule). They show that such a method, which has less efficient than the optimal water pricing obtained in their study, can still raise society's benefits more than actual average cost pricing practice [6].

Johansson *et al*. (2000) mention that on economically efficient allocation of water causes the highest return for a certain water resource. They also suggest that to achieve this effectiveness, the price of water should be equal to sum of the marginal cost of supplying an additional unit of water and the shortage value of the resource [7].

Garcia and Reynaud (2004) mention that marginal-cost pricing (MCP) as a public utility causes maximizing social welfare. Also, in order to maximize aggregate net surplus, the famous law of equality of price and social marginal cost, and the following equation must be exist:

$$P = \frac{\partial C(Q)}{\partial Q} + \lambda$$

where λ and Q show marginal shadow price of water and volume produced by a water utility respectively [8].

Huang *et al*. (2006) design policies that can lead to water consumption thrift in China. They find a new water policy in which by increasing water prices, direct intensives is created on water consumers to save water.

The results show that increases in water prices at the level of VMP can lead to significant water savings [9].

Cardio, A. and Calatrava, J. (2010) believe that water pricing can increase more than full supply recovery rates and charge physical consumption for water resources, as a means to ensure more efficient use (*i.e*. full cost recovery) in Mexico and 5 European Union countries.

The main purpose of this article is to make an empirical study of irrigation water pricing across five European Union countries where irrigation is important and Mexico, to examine irrigation water price ranges and characteristics, and also the price paid by the irrigators for water recovers operation and maintenance costs, and capital cost (*i.e*. renewal investment and new investment) for water delivery to the farm (*i.e*. full supply costs). In order to increase efficiency of water use, water pricing can rise more than full supply recovery rates and charge physical consumption for water resources (*i.e*. full cost recovery) [10].

Moghaddasi *et al*. (2009) express water pricing policy in Iran, aiming improvement in water allocation efficiency. The results show that water pricing policy has an effective role in reduction of irrigation water use. When the water price level is high, in most cases, it has higher effects than other policy scenarios in order to reduction of irrigation water use [11].

Verdi-nejad *et al*. (2008) calculate the water productivity (WP) for two year (2005-2006) and (2006-2007). Based on water costs and price of productions, average economic productivity of water gross profit and net profit for first period was 1060 and 419 Rials per m^3 and for second period was 2392 and 666 per m^3 respectively [12].

Balali *et al*. (2008) believe that results analysis shows that water pricing by itself can decrease considerably the demand of farmers for ground water in Baha-Hamedan Region [13].

Salami *et al*. (2006) believe there is a big challenge facing most of the nations including Iran in the world and that is water crisis. Exceeds of demand over supply of water has led to this crisis. Theoretically, in order to overcome this problem either an increase in supply, or decrease in demand or both, should be occurred. The results of this study after comparing the economic value of irrigation water with the calculated overage cost in ALAVIYAN dam and network, and the current price paid by the farmers shows that the economic value of water is much greater than its current price and much less than the total average cost of its utilization. This price contemplate economic, environmental, sustainability and efficiency considerations. Therefore an increase in the existing price of irrigating water seems adjustable [14].

Bagherian (2005) shows in his research that no farmers operate in optimal status and do not apply resources in the best way. Function analysis shows that farmers don't reaction to price changing in low prices. Therefore, using price instrument for diminishing water consumption is not sufficient alone and other instruments are required [15].

3. Study Questions

Purpose of the study is to answer the following questions:

3.1. What relation is between increasing irrigation water price and agriculture section productivity?

3.2. What differences are between productivity of several kinds of garden products?

3.3. What differences are between productivity of several kinds of tillage products?

4. Study Method

Study method contains all the tools and stages of collecting systematic information and the way of their rational analysis to reach to a certain purpose, which is generally to discover the facts. This study is an application-development one in terms of objective and descriptive in terms of conclusion and will answer the questions as well. Also the study is a post-event in terms of the study design and has been conducted through librarian documents and literature and also interviews. In this paper irrigation water price addition is an independent variable that is

shown by X and irrigation land expansion which is shown by Y_1 and money productivity which is shown by Y_2 are dependent variables.

$Y_1 = f(X)$ & $Y_2 = f(X)$

4.1. Study Population

The study population is the farmers of Kashan Region (a city in center of Iran) who were acting from 2006 to 2010 in this region including farming or gardening, according to the following properties:

1) Had been working during the mentioned time, continually.
2) Had cultivated more than 1 Hectare land.
3) Their documents had been available in Agriculture Organization of Kashan.

4.2. Data Collection Method

In order to collect data, documents of agriculture organization of Kashan, librarian literature and also interviews with the farmers and experts have been used. Also since according to experts of Agriculture Organization of Kashan there are almost 3500 farmers who have above characteristics, therefore the number of sample is obtained by Cochran's formula as follow:

$$n = \frac{NZ^2pq}{Nd^2 + Z^2pq} \Rightarrow 93 = \frac{3500 \times (1.96)^2 \times 0.5 \times 0.5}{3500 \times 0.1^2 + 1.96^2 \times 0.5 \times 0.5}$$

4.3. Sampling

In order to gathering the required information from the sample, a questionnaire in three parts including questions related to respondent's data, general questions and main questions was prepared. Through interview with 93 member of study population randomly, questionnaire were completed.

4.4. Study Findings

After data collection and analyzing them, the results in tables and figures are obtained.

In **Table 1**, according to average water use per a hectare land, the farmer in the sample are divided to 5 group. Then some data such as the number of each group, total cultivated land, and total production for 5 main product, average revenue per ton of production, total revenue in each product and average revenue per hectare have been calculated. The most average revenue per hectare is 2,395,000 Tomans which is belonged to 5th group that has used more than 14,001 m^3 irrigation water per hectare land, while the average revenue is 1,639,000 in total.

Table 1 divides the study population based on average water use per hectare land. As it is shown, 93 farmers in study population have used different average amount of water in their irrigated lands. The most number of farmers in five groups are the farmers who have used from 10,001 to 12,000 m^3 irrigation water per hectare land, that they are 28 farmers. But the farmers, who have used more than 14,001 m^3 water per hectare land, have gained the highest average revenue per hectare that is 2,395,000 Tomans.

Table 2 shows some data about 10 main crop products which were produced by the farmers in sample during 2006-2010. As it shows the highest and the least gross product per 1 m^3 are belonged to alfalfa with 11.25 and cotton with 0.36 kg respectively. Also dill has the highest gross income per 1 m^3 with 2625 Tomans and wheat has the least with 245 Tomans.

Figure 1 shows that alfalfa has the maximum and cotton has the minimum physical productivity (the ratio of production quantity to quantity of water use) among the crops. Due to the specific shape of root and several harvests in a crop year, alfalfa has very high productivity.

Figure 2 shows that dill has the most and wheat has the lowest money productivity (the ratio of revenue from product sales to cost of water use) among the crops cultivated in the region. It means dill is more profitable than other crops.

Figure 3 shows that plum has the most and walnut has the least physical productivity among garden products.

Table 3 shows some data about 10 main garden products which were produced by the farmers in the sample during 2006-2010. As it shows the highest and the least gross product per 1 m^3 irrigation water are belonged to

Table 1. Total production & revenue of different groups of farmers in Kashan in 5 main products.

	5	4	3	2	1	Average water use per hectare land (m^3)
Total `	More than 14001	From 12001 to 14000	From 10001 to 12000	From 8001 to 10000	Less than 8000	
93	8	24	28	20	13	Farmers number
2446	119	694	874	457	302	Cultivated land (hectare)
2291.5	12.5	417	610	518	734	grain
102	17	44	33	8	-	cotton
1636	35	514	977	110	-	pomegranate
385	-	64	290	31	-	rose
3562	468	230	1215	1050	499	vegetable
		——— 480,000 ———				grain
		——— 700,000 ———				cotton
		——— 520,000 ———				pomegranate
		——— 1,500,000 ———				rose
		——— 450,000 ———				vegetable
911.24	45.22	158.46	231.8	196.84	278.92	grain
71.4	11.9	30.8	23.1	5.6	-	cotton
845.68	18.2	262.28	508	57.2	-	pomegranate
577.5	-	96	435	46.5	-	rose
1602.9	210.6	148.5	546.75	472.5	224.55	vegetable
4008.68	285.92	696	1744.65	778.64	503.47	Total revenue (million Tomans)
1639	2395	1002	1995	1703	1665	Average revenue per hectare (1000 Tomans)

Total production(ton)

Average revenue per ton of production (Toman)

Total revenue in each production (million Tomans)

Table 2. Irrigation water use productivity in crops.

		Description	Wheat	Barley	Corn	Vegetable	Mint	Leek	Alfalfa	Onion	Cotton	Dill
1		Irrigation water use (m^3)	6840	5060	10,920	7820	17,820	17,850	17,780	12,900	13,900	4000
2	Per hectare	Irrigation water cost (1000 Tomans)	410	304	655	469	1069	1071	1066	774	834	240
3		Total production (kg)	3500	4000	8500	30,000	120,000	150,000	200,000	40,000	5000	35,000
4		Total revenue (1000 Tomans)	1680	1600	5100	13,500	36,000	15,000	40,000	12,000	3500	10,500
5		Revenue per 1000 Tomans irrigation water cost (Tomans)	4097	5263	7786	28,784	33,679	14,005	37,523	15,504	4197	43,750
6		Gross product per 1 m^3 water use (kg)	0.51	0.79	0.78	3.83	6.73	8.4	11.25	3.1	0.36	8.75
7		Gross income per 1 m^3 water use (Toman)	245	316	468	1724	2019	840	2250	930	252	2625

Table 3. Irrigation water use economic productivity in garden product.

h		Description	Sole	Pomegranate	Apricot	Pistachio	Quince	Almond	Walnut	Grape	Rose	Plum
1		Irrigation water use (m^3)	13,000	17,560	13,000	18,060	15,060	14,680	16,340	14,920	10,000	13,000
2	Per hectare	Irrigation water cost (1000 Tomans)	780	1054	780	1084	904	881	980	895	600	780
3		Total production (kg)	22,000	30,000	25,000	3500	14,000	4500	3000	30,000	4000	30,000
4		Total revenue (1000 Tomans)	17,600	15,600	37,500	10,500	9800	5400	7500	18,000	6000	24,000
5		revenue per1000 Tomans water cost (Toman)	22,564	14,800	48,077	9686	10,840	6129	7653	20,111	10,000	30,769
6		Gross product per 1 m^3 water use (kg)	1.69	1.71	1.92	0.19	0.93	0.31	0.18	2.01	0.40	2.3
7		Gross income per 1 m^3 water use (Toman)	1352	889	2880	570	651	372	450	1206	600	1840

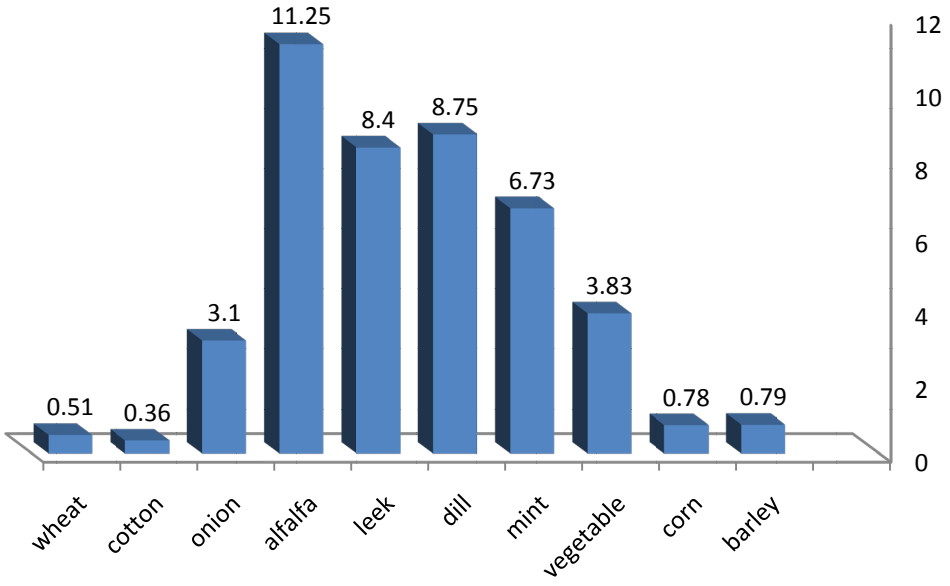

Figure 1. Physical productivity of crops.

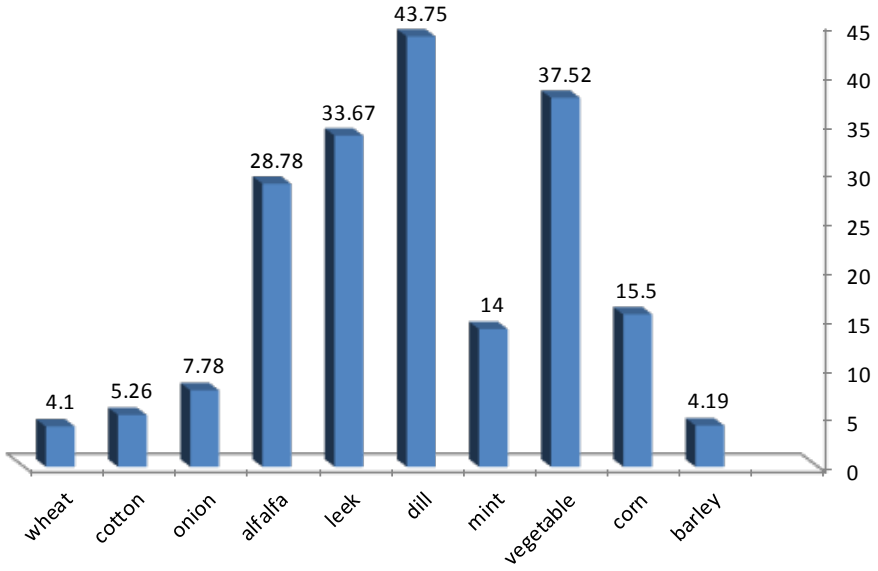

Figure 2. Crop value per 1 Toman of irrigation water (Toman).

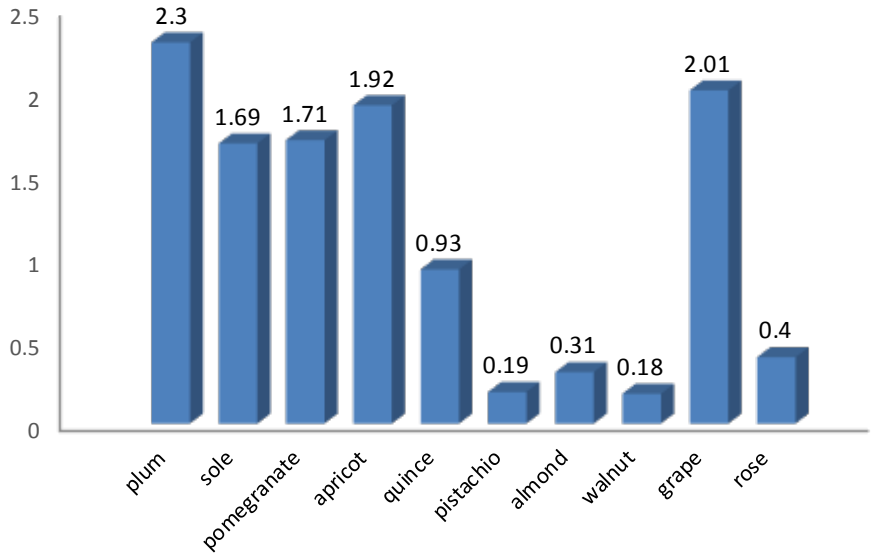

Figure 3. Garden product quantity per 1 m^3 irrigation water (kg).

plum with 2.3 and walnut with 0.18 kg respectively. Also apricot has the highest gross income per 1 m^3 irrigation water with 2880 Tomans and almond has the least with 372 Tomans.

Figure 4 shows that apricot has the highest and almond has the lowest monetary productivity.

Figure 5 shows the trend of irrigation water price during study period (2006-2010).

Figure 6 shows that during study period as irrigation water price rises, the crop value of crop per 1 m^3 of irrigation water (means monetary productivity) also has increased. This indicates that crop monetary productivity has grew from 15.1 to 20.36, it means 35% monetary productivity indication during the study period (2006-2010).

Figure 7 shows at first monetary productivity of garden products has decreased and then increased during the study period. One of the basic reasons of this decrease is extreme cold and frost in the region which destroys many fruit trees in January of 2007. After 2 years downward trend, it increased in 2009 and 2010.

Figure 8 shows the direct relationship between irrigation water price and area under cultivation in the region during the study period. It means irrigation water price addition not only caused the farmers leave their job, but

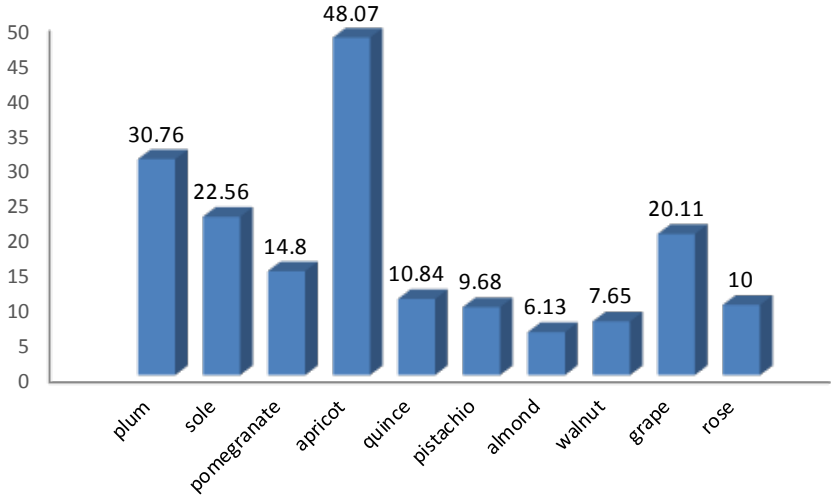

Figure 4. Garden product value per 1 Toman of irrigation water (Toman).

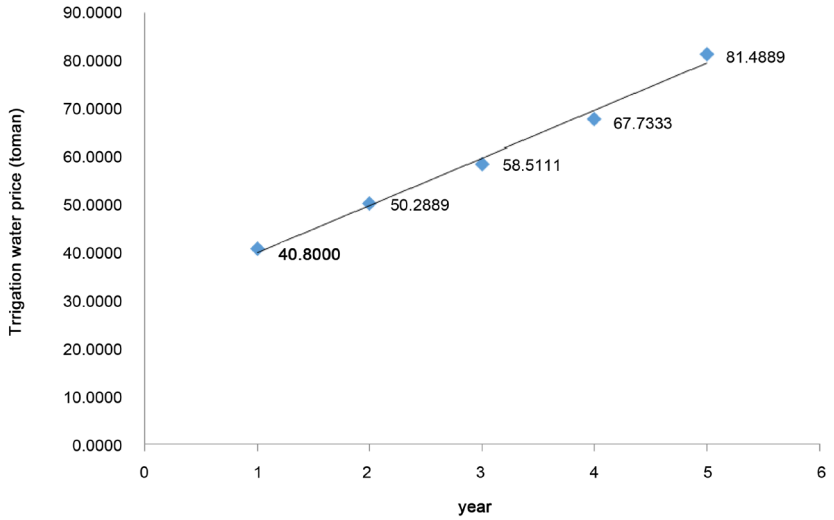

Figure 5. Irrigation water price trend during study period.

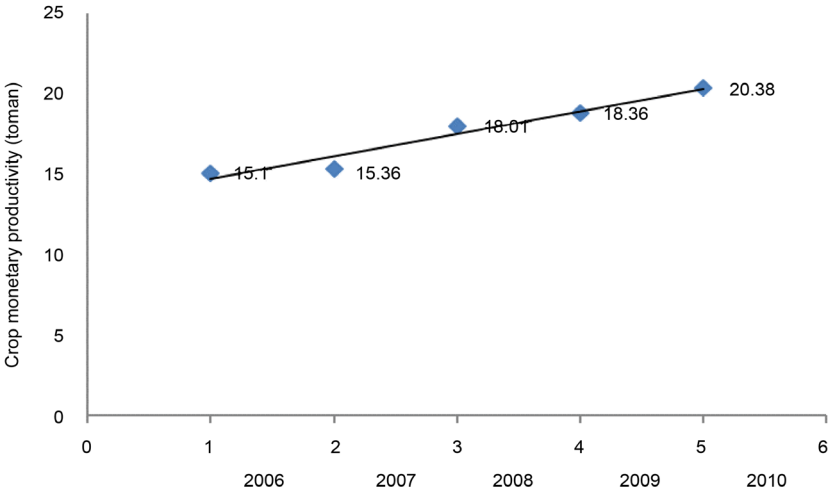

Figure 6. Crops monetary productivity trend during (2006-2010).

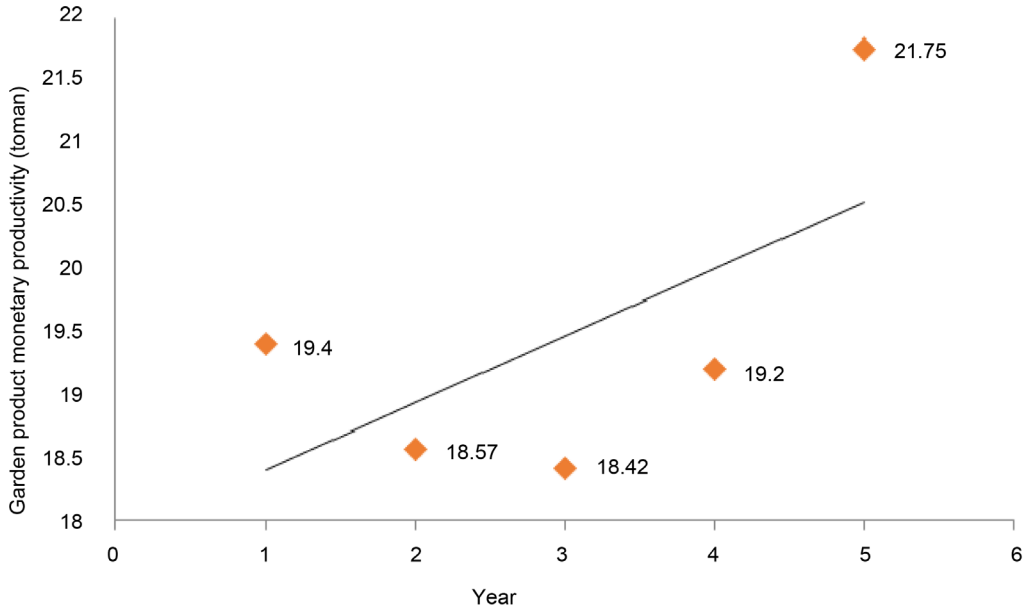

Figure 7. Garden products monetary productivity during (2006-2010).

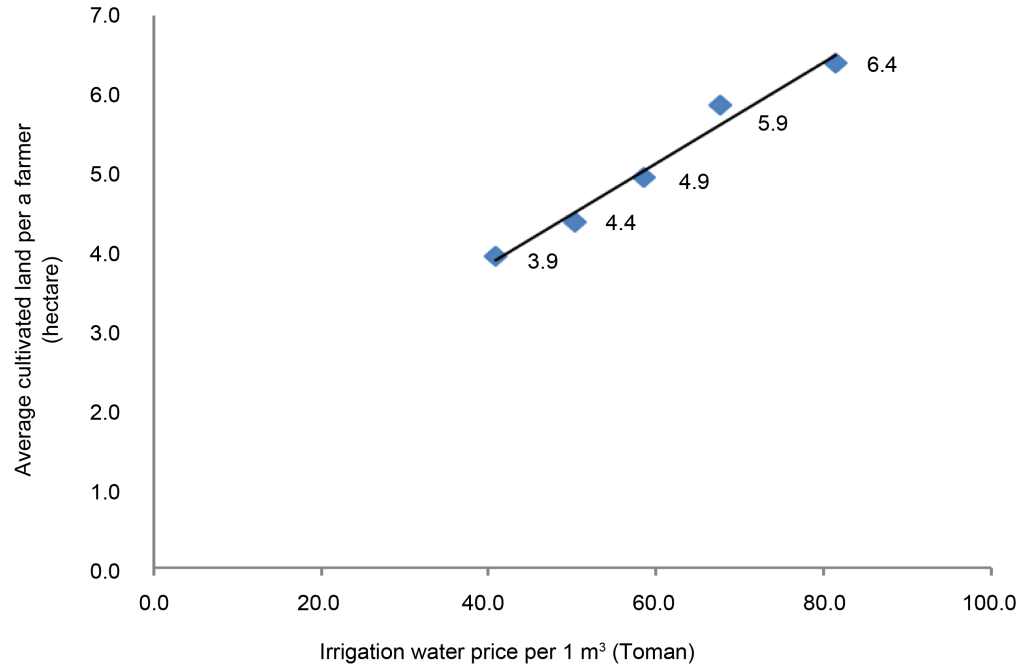

Figure 8. Average cultivated land per a farmer during the study period.

also they developed their activities.

5. Conclusion

As the tables and the figures show during study period, irrigation water price has raised in Kashan region. But this leads not only to increasing average cultivated land per a farmer, but also to increasing crops and garden products' monetary productivity. It means that Iranian government can use irrigation water price induction as a tool for increasing productivity in agriculture section in Iran. In addition, crops and garden products have different productivities. Results also show that dill and apricot have the highest productivity in all crops and garden

product in the region respectively.

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