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Case Study

A comparative study of water productivity in joint stock and agricultural companies in relation to the squireen of neighboring villages to optimize water consumption in the agricultural sector (case study: Torbt-e Jam)

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ABSTRACT:

Increasing productivity in agriculture will increase the level of villagers, reduce their immigration to cities and finally sustainable rural development. In this research, we have focused on the issue of water productivity in the light of recent droughts in Iran and the water shortage crisis in agriculture and the impact of this on rural livelihoods. So we chose joint stock and agricultural companies as an exploitation system with modern cultivation and irrigation at a large and integrated level against the squireen of neighboring villages with traditional cultivation and irrigation in small and scattered parts and then compared them with each others in a partial index of water productivity. The research method is causality and comparative method and the calculations of partial water productivity are computed by comparison of the means and the use of the T test, the Loon test, and generalized average productivity. Required data were collected through a questionnaire and among the joint stock and agricultural companies and the squireen of neighbouring villages in Torbat-e-Jam for two products of melon and barley in the crop year 2016-2017. The results showed that water productivity in the joint stock and agricultural companies are higher than the squireen in both barley and melon products using partial productivity and generalized average productivity.

Keywords:

Water productivity, Joint stock and agricultural companies, System of squireen.

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INTRODUCTION

Increasing production is always achievable by two methods: one by increasing the inputs of the production and the other by increasing the product through better use of the production factors. In this research, we are dealing with the second method and we have proved the superiority of water productivity in the joint stock and agricultural companies compared to the squireen by demonstrating better resource management and employing new methods for optimal use of one of the inputs (water) (Mandare *et al.,* 2008). Increasing water productivity in agriculture increase the livelihoods level of villagers, reduce waste of water resources, increase quantitative agricultural products at the level, durability of villagers and their business sustainability, and finally lead to sustainable rural development (Vazifedoust *et al*., 2008).

The importance of productivity in terms of government is such that laws approved in the agricultural sector in 2010 (on increasing productivity in the agricultural sector and natural resources) mention to the issues including promoting productivity and reforming production patterns in agriculture and natural resources. However, high productivity increases production, exports, the use of new productive capacity and investment, agricultural development and finally reduces the cost of each unit of production (Seckler *et al*., 1998). With the new investment, the construction of a water reservoir, pipe-laying in the waterway to the farm and the implementation of a pressure-irrigation scheme can increase the productivity and efficiency of water use in agricultural lands, which will ultimately lead to the development of the agricultural sector. In other words, productivity can be related to development, and as development is a gradual and forward-looking process that seeks to improve the existing conditions, productivity can also be considered as one of the indicators of development, a gradual process and a step forward (Zwart and Bastiaanssen, 2004).

One of the important problems of agriculture in Iran is land and the system of exploitation (Abbasi and Sohrab, 2011). Smaller units of production and dispersion of agricultural land have caused limitations for using advanced techniques, equipping infrastructure, using machinery, improving irrigation efficiency and agricultural development. In this regard, some methods have been considered for the optimum use of production resources (labour, water, cash capital and machinery) including the effects of the formation of agricultural corporations on the production efficiency. Today, we always see uncontrolled imports of agricultural products, while there is potential for the export of some agricultural products in Iran (Abbasi and Sohrab, 2011). Unfortunately, due to the low productivity of production factors (especially water) and the lack of authorities' attention to the agricultural sector, some problems have been made such as increasing imports of agricultural products, damaged to other conversion and lateral industries and unemployed workers. The low water productivity in the agricultural sector, in addition to the waste of water resources, has endangered the livelihood of villagers and has increased the rural migration to the cities, evacuation of villagers as well as the economic, social and cultural problems caused by the marginalization of the cities.

Our purpose in this study is to find solutions to prevent waste of water and improve water productivity in agriculture. In this regard, we have done a comparative study between Torbat-e Jam joint stock and agricultural companies and the squireen on water productivity, and provided some results and useful strategies for predicting future plans in the agricultural sector (Vazifedoust *et al*., 2008).

MATERIALS AND METHODS

In order to obtain water productivity, the easiest way is to use value added on the amount of water consumed, which is the same as the Kendrick-Kramer partial productivity indicator. This approach is criticized by economists. Dummar argued that all of these productivity has been marginal, because at any given time period, the output is compared with just a given data; and this is done without knowing exactly how to change other data. As a result, a certain increase in labour productivity is due to the replacement of capital instead of the workforce (Ebadi, 2000). Mills believes that the output-to-input ratio (which is productivity) is modified by a variety of factors and Proposed Generalized Average Productivity (GAP) (Khalilian and Rahmani, 2006).

Generalized Average Productivity

This method is more precise because of considering the effect of other factors on the productivity of a particular factor in the method of calculating partial productivity and is as follows:

$$GAP_{xi} = \frac{Q}{X_i + \sum X_j \left(\frac{dX_i}{dX_j}\right)} \qquad (1)$$

That Q is total output, Xi ,Xj are factors of production $\frac{dX_i}{dX_j}$ is marginal rate of substitution xj for xi and $\Sigma X_j\left(\frac{dX_i}{dX_j}\right)$ the expression xi is equivalent to other data. According to the above formula, the Generalized Average labor Productivity is:

$$GAP_{xi} = \frac{Q}{W + K\left(\frac{dw}{dk}\right)} \qquad (2)$$

If the Cob Douglas function is in the opposite direction

$Q=AW^{\alpha}K^{\beta}$ (3)

Will have:

$$\frac{\delta Q}{\delta K} = \beta A W^{\alpha}.K^{\beta-1} = \beta\left(A\frac{W^{\alpha}W^{\beta}}{K}\right) = \beta\left(\frac{Q}{K}\right) \qquad (4)$$

$$\frac{\delta Q}{\delta W} = \alpha A W^{\alpha-1}.K^{\beta} = \alpha\left(A\frac{W^{\alpha}W^{\beta}}{L}\right) = \alpha\left(\frac{Q}{L}\right) \qquad (5)$$

as a result:

$$\frac{\delta W}{\delta K} = \frac{\frac{\delta Q}{\delta K}}{\frac{\delta Q}{\delta W}} = \frac{\beta\left(\frac{Q}{K}\right)}{\alpha\left(\frac{Q}{W}\right)} = \frac{\beta W}{\alpha K} \qquad (6)$$

Considering that in agricultural production function, capital variable affects water productivity. Therefore, in order to calculate labor productivity, considering the effect of capital variables on water productivity is essential. As a result, the GAPw formula for the Cobb Douglas production function is as follows:

$$GAP_w = \frac{Q}{W + K\left(\frac{\beta w}{\alpha k}\right)} = \frac{Q}{W + W\left(\frac{\beta}{\alpha}\right)} \qquad (7)$$

RESULTS AND DISCUSSION

At the beginning of the discussion, the statistics on the barley and melon products yield for the joint stock and agricultural companies and the squireen in the Torbat-e-Jam are examined (Table 1). In the crop year of 2016-2017, the average barley yield in the villages have been approximately 2500 kg per hectare and the barley has not been planted in Robat (lands belonging to all three Robat wells) (Singh *et al.*, 2006). Also, given that the barley product is a fall product and there are

Table 1. Barely yield of neighboring villages in Torbat -e-Jam joint stock and agricultural companies in the crop year 2016-2017

S. No	Village	Cultivation of barely (hectare)	Yield (kilogram in hectare)
1	Eslam Abad	20	2500
2	Hosein Abad	5	2500
3	Robat	0	0
4	Robat	0	0
5	Robat	0	0
6	Mansoriye	25	2500
7	Dolat Abad	5	2500

Table 2. Melon yield of neighboring villages in Torbat -e-Jam joint stock and agricultural companies in the crop year 2016-2017

S. No	Village	Cultivation of melon (hectare)	Yield (kilogram in hectare)
1	Eslam Abad	20	15000
2	Hosein Abad	2	15000
3	Robat	20	15000
4	Robat	11	17000
5	Robat	0	0
6	Mansoriye	8.8	4090.9
7	Dolat Abad	12	20000

Table 3. Barley yield of joint stock and agricultural companies in Torbat-e Jam in the crop year 2016-2017

S. No	Joint stock and agricultural companies	Cultivation of Barely (Hectare)	Yield (Kilogram in Hectare)
1	3 Bojgan	6	2684
2	3 Nilshahr	20.5	3737
3	15	19.26	4534
4	21	18.5	4418
5	22	21.34	4092

Table 4. Melon yield of joint stock and agricultural companies in Torbat-e Jam in the crop year 2016-2017

S. No	Joint stock and agricultural companies	Cultivation of melon (Hectare)	Yield (Kilogram in Hectare)
1	3 Bojgan	12	19984.5
2	3 Nilshahr	6	33590
3	15	7	2311
4	21	20	28126.5
5	22	20	17917

rain and snow in the fall and winter seasons, the management of water (optimal use or water loss) is not predicted through our research (Kiziloglu *et al*., 2006).

In the crop year of 2016-2017, Melon has not been cultivated in the well No. 3 of Rabat. Furthermore Mansouriyeh has been faced with the lack of water due to waste of water well at the time of flowering melons and then the engine of well was shut off by the power company, which led to lower yield. Also, Dolat Abad has a better melon yield than other villages because of good management and construction of a water reservoir, pipe-laying and pumping water to the farms (Moldem *et al*., 2001). The yield of joint stock and agricultural companies for barley and melon products in Torbat-e-Jam are shown in Table 3- 4 and Figure 1-4.

Table 5. Comparison of the partial water productivity of barley

S. No	Product	Squireen	Joint stock and agricultural companies
1	Barley	0.503	0.547
2	Melon	1.401	1.577

Table 6. Levin test for variance equality between two groups of melon joint stock and agricultural companies and squireen

	F-test	Significance level
Variance equality	0.146	0.711

After collecting information through field operations and library research, it is time to calculate water productivity through both the Krediccher-Kramer partial productivity and the generalized average productivity. In the first section, the partial water productivity index is obtained for barley and melon products in two groups of the jointstock and agricultural companies and the squireen in Torbat-e Jam using Kendrick-Kramer index and SPSS software.

Table 5 shows that the partial water productivity of melon product is higher than the partial water productivity of barley product in both of the jointstock and agricultural companies and the squireen. Also, the partial water productivity of the jointstock and agricultural companies are higher than partial water productivity of the squireen for both barley and melon products.

After comparing the partial water productivity of barley and melon products for two jointstock and agricultural companies with squireen, T test and Levin tests the results of comparison of average in two groups of jointstock and agricultural companies and squireen in Torbat-e Jam for melon product are in tables 6 and 7. In the first step, the variance equality between two groups (agricultural and small stock companies) are investigated by using Levine test.

As the results of Table 2 show, the assumption of variance equality is confirmed between the two groups. The t-test results showed that there is no significant difference between the two groups of jointstock and agricultural companies and squireen (Table 6).

The results also showed the equivalence of variance between the two groups of agricultural and jointstock and agricultural companies, as well as the lack of significant difference between the partial

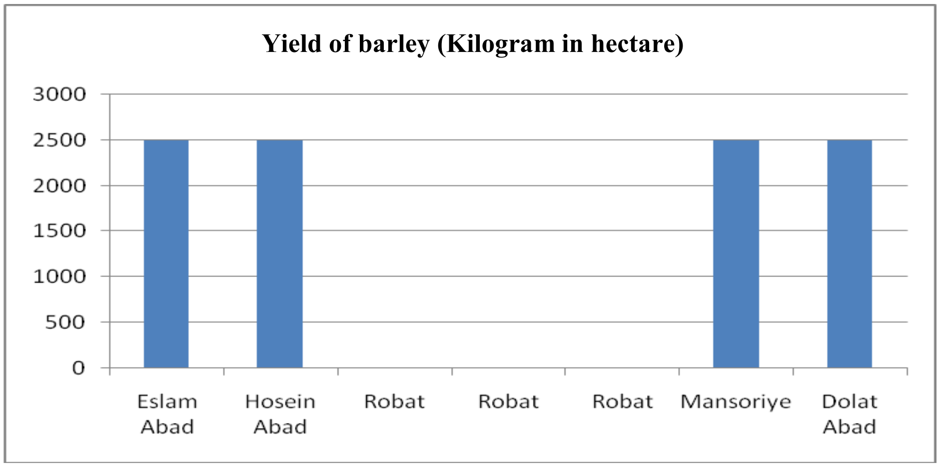

Figure 1. Barely yield of neighbouring villages in Torbat-e-Jam joint stock and agricultural companies in the crop year 2016-2017

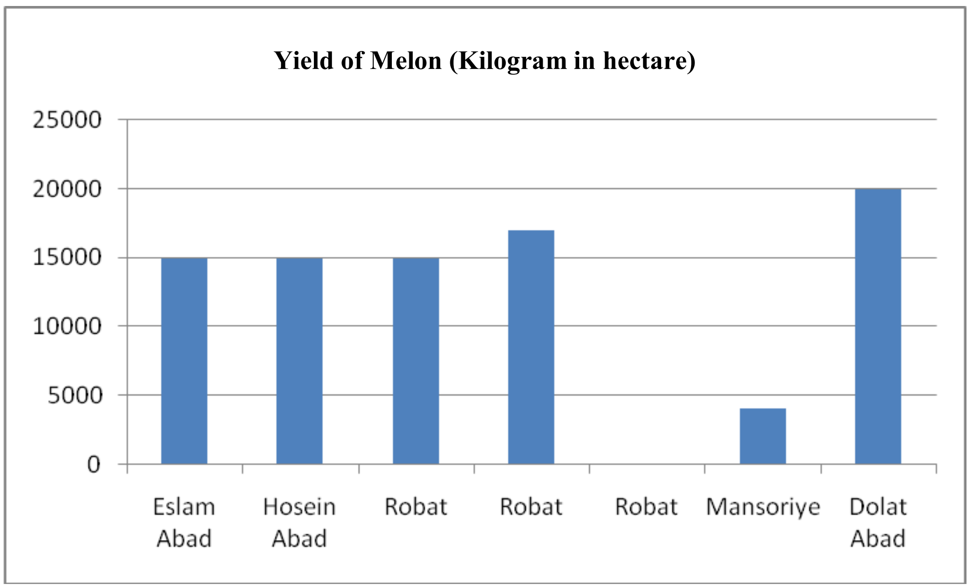

Figure 2. Melon yield of neighbouring villages in Torbat-e-Jam joint stock and agricultural companies in the crop year 2016-2017

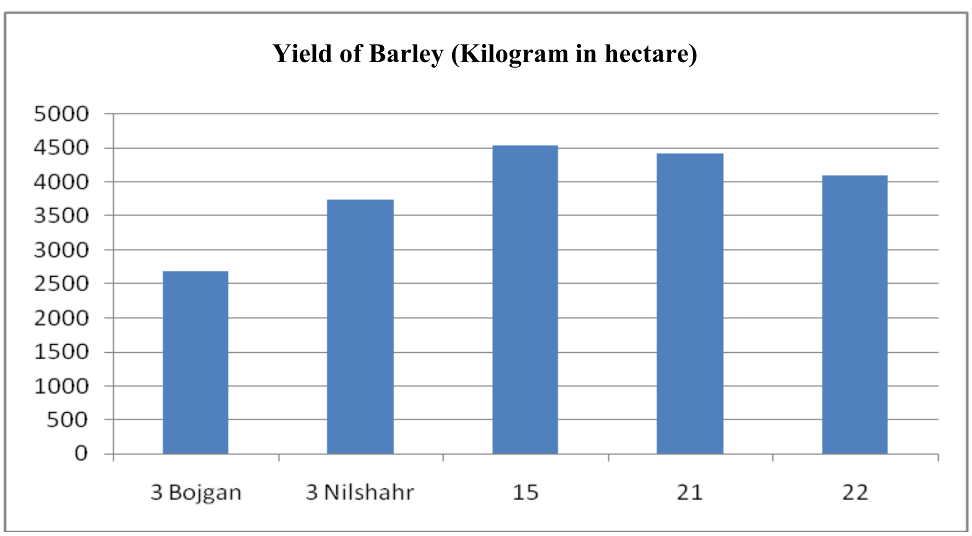

Figure 3. Barley yield of joint stock and agricultural companies in Torbat-e Jam in the crop year 2016-2017

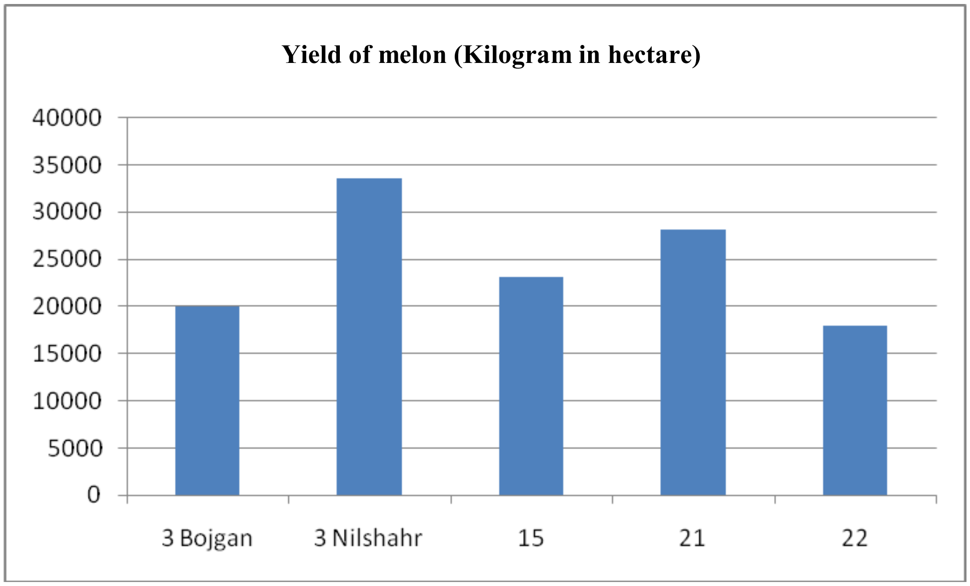

Figure 4. Melon yield of joint stock and agricultural companies in Torbat-e Jam in the crop year 2016-2017

Table 7. Single-group t-test of water productivity (melon)

Variable	Average squireen group	Average joint stock and agricultural companies	T-calculated	Significance level
Water productivity	1.4020	1.5771	0.410	0.691

Table 9. Single-group t-test of water productivity (barley)

Variable	Average squireen group	Average joint stock and agricultural companies	T-calculated	Significance level
Water productivity	0.5036	0.5479	0.396	0.704

Table 10. Single-group t-test of water productivity (squireen)

Variable	Average barley product	Average barley product	T-calculated	Significance level
Water productivity	0.5036	1.4020	-3.966	0.029

Table 11. Single-group t-test of water productivity (joint stock and agricultural companies)

Variable	Average barley product	Average barley product	T-calculated	Significance level
Water productivity	0.5479	1.5771	-2.892	0.029

Table 8. Levin test for variance equality between two groups of joint stock and agricultural companies and squireen

	F-test	Significance level
Variance equality	0.265	0.623

Table 12. Generalized average water productivity for barley and melon products for joint stock and agricultural companies and squireen

Products	Jointstock and agricultural companies	Squireen
Barley	0.31	0.29
Melon	0.76	0.69

productivity of water in these two groups (Tables 8 and 9). After comparing the average of water productivity for barley and melon products for jointstock and agricultural companies and squireen, the average of water productivity of jointstock and agricultural companies and squireen for barley and melon products were compared (Qiu *et al*., 2008). As the results of Tables 10 and 11 show, the melon product has a better performance in water productivity than barley product in both jointstock and agricultural companies and squireen.

The second part deals with the calculation of water productivity using the generalized average productivity method. As Table 12 shows, water productivity in joint stock and agricultural companies is higher than that of the squireen for both barley and melon products, which is similar to those obtained from the Kendrick-Kramer index.

CONCLUSION

From the obtained results for barley and melon products, it was confirmed that joint stock and agricultural companies had higher water productivity than the squireen, due to the use of modern and advanced irrigation systems such as the Rolin, Babler and rain irrigation systems in joint stock and agricultural companies.

Therefore, it is suggested to consider and follow up the problems such as the formation and foundation of an joint stock and agricultural companies or rural-cooperatives to support, train, modify the cultivating patterns and apply new irrigation systems and equipment, and Modern machines in order to have water productivity in the agricultural sector of Torbat-e Jam.

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