

An Evaluation of Production Factors Productivity in Agricultural Holdings Producing Mazafati Dates: A case study

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Abstract

Always, lack of resources has been considered as the critical limitations in the manufacturing process. Hence, due to progress of science and new technologies in the world today, identification of productive resources and optimal use of them should be considered as the main factors to achieve success in economic development, so that political and economic prosperity of every nation depends on exploitation and use of all facilities, abilities, and material and spiritual talents of the society. Studying the status of agriculture in developing countries shows the fact that lack of sufficient knowledge regarding the production resources and low productivity and efficiency of agricultural production factors leads to fail the agricultural development goals in these countries. Therefore, paying attention to the issue of productivity and efficiency in the agricultural economy of developing countries such as Iran is very important. The main purpose of this paper is to evaluate the productivity of production factors in agricultural holdings producing Mazafati dates which has been conducted as a case study in Bam-Iran. The data has been gathered using questionnaire and personal visit. The sample has been selected using stratified random sampling including 149 orchardists of Bam Township in 2011.

Keywords: productivity, transcendental production function, Mazafati dates, Bam Township

Introduction

Date is of horticultural products adjusted with the climates of Southern and central regions of Iran. Date is a product which is of high importance in social-economic plan of Iran so that it has supplied near 14% of world's date with annual output of 1016610 tons, worth approximately U.S. \$ 519186000, and it is allocated the third place in the world to Iran in terms of dates production (FAO, 2010). Among the dates produced in Iran, Mazafati variety is considered as the most important economic variety of Iran dates after Estamiran and Shahani varieties (Hashempour, 2001). Bam Township is one of the most important poles of producing Mazafati

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date in Iran and it is allocated the first place in Iran to Bam in terms of producing Mazafati dates with annual output of 90313 tons (agricultural statistics, 2009). Since Iran is a major producer and exporter of dates in the world and because of the relative advantages and importance of this product in the city of Bam in terms of production, the area under cultivation, and job creation, it is important to study the economic role of this product in economic prosperity of Iran and Bam. According to the lack and constrains of production resources, studying the productivity of agricultural holdings producing dates is one of the most effective methods to achieve economic prosperity in agriculture. Hence, the increase of productivity in date production helps to propel the production resources towards improving poor economic infrastructures and find a suitable place in major international competitions (Chizari and Sadeghi, 2000). Thus, the present study investigates the productivity of agricultural holdings producing dates in Bam Township. Many domestic and foreign studies have been performed regarding the productivity of agricultural products including the studies conducted by Zaranezhad and Ghanadi (2005), Pourkand and Motamed (2011), Ghaemyasl and Salimifar (2012), Kiresur (1995), Chandrasekan and Seridharan (1993), Kogel (2005), Mirotschi and Taylor (1993), Mcerlean and Wu (2003), Amadi et al. (2004), and Kurousaki (2003).

Productivity

In the literature of development economics, the productivity is defined as output levels of a certain amount of one or more inputs. This criterion indicates the use of production factors and resources at a time and includes triple effects of technological change, changes in the efficiency of use of inputs, and scale change; in other words, it shows moving toward frontier production function from inside. Thus, changes in productivity from one period to the next or the productivity gap among production units within a period of time indicates changes and differences in technical capability and performance of the economic unit or sector in terms of converting inputs into products or services; in other words, it indicates changes in the effectiveness of a set of inputs to produce outputs (Salami, 1997).

Two methods including nonparametric and econometric methods have been provided by economists to calculate the productivity. In the econometric method, the productivity is calculated through evaluation of production and cost functions, but in the second method, the productivity criterion is determined using mathematical programming or the calculation of index number. The econometric method used to measure the productivity is based on the value observations of inputs and outputs. In this method, the parameters of production function are estimated and the residual component is considered as the total productivity. The testable capability of this method is its major advantage compared with nonparametric methods (Emami Meybodi, 2005). Hence, the econometric method has been used to evaluate the production function in this study. As the terms “Average Productivity” and “Marginal productivity” which are of the partial productivity concept are mostly used by economists; firstly, their definitions are provided here. The average productivity is defined as the output resulted from a unit of certain input; the marginal productivity is defined as the value which is added by each unit of production factor to the total output. Therefore, the marginal productivity is the first derivative of the production function with respect to the relevant agent (Seyedan, 2003).

Materials and Methods

In the present study, the data was gathered using library studies, survey research, questionnaires (personal interview). The statistical population included the producers of Bam Mazafati date and the sample was selecting through stratified random sampling. The selection of stratifies was based on the level of Mazafati date cultivation in Bam. The data was gathered using questionnaire and personal visit. The sample has been selected using stratified random sampling including 149 orchardists of Bam Township in 2011.

In econometric method, the Cobb-Douglass, transcendental, transcendental logarithmic, and Debertin functions are used to calculate the marginal productivity. In the present paper, to make relation between inputs and outputs, the obtained data were compared for processing and selection of appropriate production function; finally, the Cobb-Douglass and transcendental functions obtained more appropriate fitness in comparison with the other functions. Then, the constrained least squares F-test was used to obtain the best form of the production function. Equation 1 shows the general form of constrained least squares F-test:

$$\text{Eq. 1: } F = \frac{(R_{ur}^2 - R_r^2)/M}{(1 - R_{ur}^2)/(N - K)}$$

In above equation, R_{ur}^2 , R_r^2 , K , N , and M stand for the coefficients for determination of unbound regression, the coefficients for determination of constrained regression, the number of parameters in the unbound regression, number of observations, and the number of linear constraints, respectively. Also, in equation 1, the models of Cobb-Douglass and transcendental production function are constrained and unbound, respectively (Fatahi Ardekani, 1998).

Finally, the transcendental production function was selected using the constrained least squares test. This function is simply converted into a linear form using the logarithm to the base e . The most important features of the transcendental function are the fluctuation of inputs production elasticity and dependence of their value to the consumption amount of the same input (X_i). The other desirable feature of this function is the fluctuation of returns to scale and its dependence to the consumption amount of the inputs. In addition, this function shows three neoclassical production areas (Seyedan, 2003). The general form of the transcendental function is as follows:

$$\text{Eq. 2: } Y = a \prod_{i=1}^n X_i^{\beta} e^{\gamma_i * X_i}$$

In above equation, Y , " α , β , and γ ", and X_i stand for the amount of product, parameters, and inputs values, respectively. Here, the dependent variable is the amount of date production per kg and the independent variables include the annual water consumption per cubic meter, area under cultivation per hectare, consumption of toxin per liter, manpower per person – working day, hours of using agricultural machineries, the amount of consumed pollen per the number of panicles, the number of ropes, the amount of fertilizer per kg, and the amount of animal manure per ton.

In the mentioned model, assuming that the manufacturers provide the production factors referring to competitive markets; the average productivity, marginal productivity, inputs production elasticity, and the value of marginal productivity are obtained from the following equations:

$$\text{Eq. 3: } MP_{ij} = \frac{\partial Y_j}{\partial X_{ij}}$$

$$\text{Eq. 4: } AP_{ij} = \frac{Y_j}{X_{ij}}$$

$$\text{Eq. 5: } E_{X_{ij}} = \frac{MP_{ij}}{AP_{ij}}$$

$$\text{Eq. 6: } VMP_{ij} = MP_{ij} \times P_Y$$

In above equations:

MP_{ij} stands for the j-th exploiter's marginal productivity of the i-th production factor.

AP_{ij} stands for the j-th exploiter's average productivity of the i-th production factor.

$E_{X_{ij}}$ stands for the j-th exploiter's production elasticity of the i-th production factor.

VMP_{ij} stands for the j-th exploiter's marginal productivity value of the i-th production factor.

P_Y stands for the selling price of a kilogram of the product used by the exploiters of the studied region.

Y_j stands for the j-th exploiter's products.

X_{ij} stands for the i-th production factor used by the j-th exploiter.

Finally, the software SPSS 16.0 and Eviews 6 has been used to calculate the results.

Discussion and results

The results obtained from analyzing the data collected from questionnaires have been presented as the proper production function, identification of the factors affecting the production, the calculation of partial productivity, production elasticity, and the value of marginal productivity. After evaluation of various functions, finally, the Cobb-Douglass and transcendental functions were selected based on the features of an appropriate model. The constrained least squares F-test was used to determine the best function, which the results are presented below:

$$\text{Eq. 7: } F = \frac{(0.82-0.804)/8}{(1-0.82)/(149-18)} = 1.459$$

According to equation 7, the transcendental function is more appropriate than the Cobb-Douglass function with the probability of 99% ($F=1.459$). Table 1 shows the results of production function coefficients and their significance levels. The used variables are as follows:

LN: the logarithm to the base e (the natural logarithm)

Y: The amount of date production per kg

X_1 : The area under cultivation per hectare

- X_2 : The annual water consumption per cubic meter
- X_3 : The manpower per person–working day
- X_4 : The hours of using agricultural machineries
- X_5 : The amount of animal manure per ton
- X_6 : The consumption of toxin per liter
- X_7 : The amount of consumed pollen per the number of panicles
- X_8 : The amount of fertilizer per kg
- X_9 : The number of ropes

Independent variable	coefficients	Standard deviation	t	Sig
	10.67	1.15	9.21	***0.00
	-0.27	0.12	-2.17	**0.03
	0.11	0.059	1.99	**0.048
	1.22	0.33	3.7	***0.0005
	-0.019	0.025	-0.767	0.44
	0.995	0.24	4.09	0.000
	0.23	0.14	1.7	*0.099
	0.06	0.058	0.351	0.72
	-0.997	0.196	-5.07	***0.000
Constant	0.021	0.022	-0.92	0.35
	0.17	0.094	1.82	*0.071
	-3.46	0.02	2.37	***0.019
	-0.21	0.06	-3.3	***0.0019
	0.004	0.004	1.14	0.25
	-0.021	0.158	-6.42	***0.001
	-0.001	4.8×10^{-4}	-2.1	**0.0417
	-0.003	0.007	-0.48	0.62
	0.003	0.001	1.95	**0.053
	0.005	0.002	1.47	0.14
DW=2.24		F=179.8		
N=149		The confidence level (F=0.00)		

Table 1: the coefficients of estimated production function

***, **, and * stand for being significant at the level of 1%, 5%, and 10%, respectively.

According to table 1, the values of function coefficients show that 82% of the changes in dependent variable are explained by the independent variables. The significance of F at a level lower than 1% indicates that there is simultaneously a significant difference between variables

	manpower	under cultivation area	Consumed water	animal manure	toxin	fertilizer
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coefficients and zero. Also, there is no problem regarding multicollinearity, autocorrelation, heteroskedasticity, and explicit bias. Finally, the general form of transcendental production function is as follows:

$$\text{Eq. 8: } \ln Y = 10.67 - 0.27 \ln X_1 + 0.11 \ln X_2 + 1.22 \ln X_3 + 0.995 \ln X_5 + 0.23 \ln X_6 + 0.997 \ln X_8 + 0.17 X_1 - 3.46 X_2 - 0.21 X_3 - 0.021 X_5 - 0.001 X_6 + 0.003 X_8$$

The partial productivity of production factors and their optimal allocation

Continuing the research, the marginal productivity of each input was calculated based on the estimated function. The parameter is obtained through differentiation of the function with respect to each input. The following equations show the marginal productivity of various production factors:

Eq. 9: The marginal productivity of area under cultivation:

$$MP_{X_1} = \left(0.17 + \frac{-0.27}{X_1} \right) Y$$

Eq. 10: The marginal productivity of annual water consumption:

$$MP_{X_2} = \left(-3.46 + \frac{0.11}{X_2} \right) Y$$

Eq. 11: The marginal productivity of manpower:

$$MP_{X_3} = \left(-0.21 + \frac{1.22}{X_3} \right) Y$$

Eq. 12: The marginal productivity of animal manure:

$$MP_{X_5} = \left(-0.021 + \frac{0.995}{X_5} \right) Y$$

Eq. 13: The marginal productivity of toxin consumption:

$$MP_{X_6} = \left(-0.001 + \frac{0.23}{X_6} \right) Y$$

Eq. 14: The marginal productivity of fertilizer:

$$MP_{X_8} = \left(0.003 + \frac{-0.997}{X_8} \right) Y$$

Table 2 shows the results obtained from calculating the marginal productivity, average productivity, production elasticity, and marginal productivity value of date production factors in Bam Township

Marginal productivity		Mean	-1503.7	-1158.9	-25152.3	129.5	280.18	-9.011
		Maximum	-146.8	3961.1	-2563.8	2164.6	2204.9	61.59
		Minimum	-6264.3	-4935.2	-103799.9	-254.16	30.28	-214.75
Average productivity		Mean	18.75	8869.3	0.31	323.6	1255.2	34.78
		Maximum	87.3	22320	2.95	2349.08	9628.8	250
		Minimum	5.6	2066.6	0.034	12.8	138.3	4.9
Marginal productivity value		Mean	-1780781.7	-1190082.08	-29777377.4	130402.12	319027.3	-8634.5
		Maximum	-106145.02	4753320	-1816453.9	2381150.7	1984495.6	98554.4
		Minimum	10022882.2	-9041760	166079973.8	351746.1	15140.17	-236225
Y	> 1	Number	0	15	0	34	123	2
		percentage	0	10.1	0	22.8	82.6	1.3
	= 1	Number	0	5	0	6	12	1
		percentage	0	3.4	0	4	8.1	0.7
	< 1	Number	149	129	149	109	14	146
		percentage	100	86.6	100	73.2	9.4	98
Production elasticity			-81.5	-0.09	-176528.4	0.197	0.19	-0.014
The first area		Number	0	1	0	0	8	18
		percentage	0	0.7	0	0	5.4	12.1
The second area		Number	0	25	0	88	139	20
		percentage	0	16.8	0	59.1	93.3	13.4
The third area		Number	149	123	149	61	2	111
		percentage	100	82.6	100	40.9	1.3	74.5

Table 2: the productivity and production elasticity of inputs

According to table 2, the mean values of marginal productivity of manpower, under cultivation area, the consumed water, animal manure, toxin, and fertilizer are reported equal to -1503.7, -1158.9, -25152.3, 129.5, 280.18, and -9.011, respectively. Also, the mean values of average productivity of manpower, under cultivation area, the consumed water, animal manure, toxin, and fertilizer are reported equal to 18.75, 8869.3, 0.31, 323.6, 1255.2, and 34.78, respectively. In addition, the production elasticity of manpower, under cultivation area, the consumed water, animal manure, toxin, and fertilizer are reported equal to -81.5, -0.09, -176528.4, 0.197, 0.19, and -0.014, respectively. The total production elasticity of inputs is reported equal to -176609.6 indicating the diminishing returns to scale among exploiters.

To determine the rate of using production inputs, three areas of production were identified. According to table 2, the percentage of under cultivation area exploiters is reported equal to 82.6% in the third area indicating that the marginal productivity of this input is negative; in other words, it has been used over the optimum.

According to table 2, agricultural holdings were practically unsuccessful to optimally apply and allocate the inputs of water and manpower. Also, all exploiters (100%) of water and manpower are located in the third areas; in other words, these inputs have been used over the optimum.

According to table 2, the percentage of animal manure exploiters in the third and second areas are respectively reported equal to 40.9% and 59.1%.

Regarding the toxin, the use of this input has been relatively better than the others so that 93.3% of its exploiters are located in the second area indicating that the productivity of this input is near the optimum in this area, but the percentage of toxin exploiters in the third and first areas are 1.3% and 5.4%, respectively.

Regarding the fertilizer, 12.1%, 13.4%, and 74.5% of exploiters are respectively located in the first, second, and third areas.

The criterion of $\frac{VMP_{X_i}}{P_{X_i}}$ (in which P_{X_i} and VMP_{X_i} stand for average price of input in the studied region and the marginal productivity value of the i-th input, respectively) was applied to determine the efficient use of production factors. If the value of this criterion is higher than 1, the production factor should be used more in the combination of inputs; if the values is lower than 1, the input should be used less; but when the value is equal to 1, it indicates that the input has been used optimally.

According to table 2 and the mentioned criterion, the percentage of exploiters who have used the lands over the optimum is 86.6%; also, 10.1% and 3.4% of exploiters have used the lands less than and equal to the optimum, respectively.

Regarding the input of water, 100% of exploiters have used it over the optimum that should be considered seriously according to the lack of water and droughts in the studied region in recent years.

Regarding the manpower input, 100% of exploiters have used it over the optimum; also, according to the statistics, it should be paid attention to the hidden unemployment in the region so that the surplus manpower can be used optimally.

Regarding the animal manure, 73.2% and 22.8% of the farmers have used this input over and less than the optimum, respectively.

Regarding the toxin, 82.6% of exploiters have used this input less than the optimum that the reason is the expensive price of toxin and imposition of heavy costs to agricultural holdings which leads to reduction of its consumption.

Regarding the fertilizer, 98% and 1.3% of farmers have used this input over and less than the optimum, respectively. Finally, it is concluded that the farmers have used the inputs of land, water, manpower, animal manure, and fertilizer over the optimum, but the input of toxin has been used less than the optimum.

Conclusion

According to the results obtained from the production function, to improve farmers' productivity it is important to consider the following issues:

- 86% of date exploiters are located in the third area while the farmers of this area do not include sufficient technical knowledge; therefore, in order to increase the productivity of date, it is needed to increase farmers' technical knowledge.
- In terms of the water input, the farmers use it over the optimum; on the other hand, 100% of the farmers are located in the third area. According to the lack of water in the studied region, it is recommended that the authorities of this region think of measures to reduce water consumption and properly distribute it among the farmers. In addition, it is needed to equip the physical infrastructures (such as irrigation channels and precise measuring instruments or encouraging investors to invest in water resources) to increase the economic value of the region and optimal use of water.
- In Bam, the most of manpower are engaged in the palmetums. This has caused the employment in other agricultural and non-agricultural activities to be limited. It is

recommended to improve and develop palm-based industries to reduce the congestion of labor force and improve the productivity of date production.

- Assessment of the production function shows that the farmers do not optimally use the inputs of animal manure and fertilizer so that the use of these inputs is only limited to the third area; therefore, it is needed to increase the optimal use of them through increasing farmers' knowledge and extension services.
- Regarding the input of toxin, it is needed to increase the farmers' knowledge about combat pests and palm diseases through free distribution of extension Journals as well as showing films and using other audiovisual devices.

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