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A Study of the Factors Affecting Walnut Production in Iran

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Abstract: The present investigation utilized primary data collected from 383 walnut growers in provinces of Semnan Hamadan and Fars in Iran. The Cob-Douglas production function was used to test the factors effective on walnut (Juglans regia) production. The variables of this study were Zulonfloo poison, labor, machinery, Iron fertilization, water and acreage. The Cob-Douglas production function selected as the most appropriate model to analyze the walnut production function. Econometric analysis results revealed that walnut growers have used the factors of production in the second area of production and human labor, farmyard manure, chemical fertilizers, water for irrigation and transformation contributed significantly to the yield. The result showed that there is increase of returns to scale in walnut orchards of Hamadan, Fars and Semnan Provinces. The findings also showed that the elasticity of factors production such as Zulonfloo poison, labor, machinery, Iron fertilization, water and acreage were 0.810, 0.169, 0.097, 0.212, 0.158 and 0.093, respectively. Finally, the result of Wald test showed that there is an Increase of Returns to Scale (IRS) in walnut orchards of Hamadan, Fars and Semnan Provinces. Returns to scale is 1.226 means Increase of one percent of all production factors simultaneously causes 1.226% increases in product.

Key words: Juglansregia, walnut orchards, Cob-Douglas production functions, returns to scale, elasticity of production

INTRODUCTION

Walnuts are part of the tree nut family. This food family includes hazelnuts (filberts), pistachios, pecans, pine nuts and walnuts (Blomhoff *et al*., 2006). Walnuts are a rich source of heart-healthy monounsaturated fats and an excellent source of those hard to find omega-3 fatty acids, walnut seeds are high density source of nutrients, particularly proteins and essential fatty acids. The 100 g of walnuts contain 15.2 g protein, 65.2 g fat and 6.7 g dietary fiber. The protein in walnuts provides many essential amino acids. Nutrients such as potassium, magnesium, phosphorus, iron, calcium, zinc, copper, vitamins B9, B6, E, A and other substances have been found in walnuts (Koyuncu *et al*., 2004).

Absorbed of this product by domestic market is limited, so access the foreign markets is essential to enhance production. To achieve the global markets while other countries like America, China and Turkey have a long history of exporting the product, without improving quality, reducing cost of production and export infrastructure would not be possible. Walnut exports directly led to an increase in employment in manufacturing and ancillary industries and indirectly led to growth, rural development, poverty reduction and to achieve sustainable development. These days, the government has supported the export of agricultural products. Therefore, economic analysis of the walnut production like cost, technical, economic and allocate efficiency, productivity of factor production and problems of export in third province which has ranks seventh of walnut production in the country is essential.

Iran is ranked fourth in the world after USA, China and Turkey in walnut production (Aquastat, 2008). The production of walnuts was about 450000 tons per year in Iran and the harvested land area was 162,025 ha in 2012. Hamadan, Fars and Semnan Provinces were the first walnut producer per hectare and provided one of the most desirable and high grade walnut of world. Therefore, determination of effective factors on the production of walnuts and estimation of walnut production function in these provinces and the estimate of walnut production could be particularly important in this regard. The objectives of this study are:

- To determine the effective factors of production of walnut
- To consider the different region of walnut production function for different inputs

In micro-economics and macro-economics, a production function is one that specifies the output of a firm, an industry or an entire economy for all combinations of inputs. This function is an assumed technological relationship, based on the current state of engineering knowledge it does not represent the result of economic choices but rather is an externally given entity that influences economic decision-making. Almost all economic theories presuppose a production function, either on the firm level or the aggregate level (Daly, 1997; Cohen and Harcourt, 2003).

A meta-production function compares the practice of the existing entities converting inputs into output to determine the most efficient practice production function of the existing entities, whether the most efficient feasible practice production or the most efficient actual practice production. In either case, the maximum output of a technologically-determined production process is a mathematical function of one or more inputs. Put in another way, given the set of all technically feasible combinations of output and inputs, only the combinations encompassing a maximum output for a specified set of inputs would constitute the production function. Alternatively, a production function can be defined as the specification of the minimum input requirements needed to produce designated quantities of output, given available technology. It is usually presumed that unique production functions can be constructed for every production technology by assuming that the maximum output technologically possible from a given set of inputs is achieved, economists using a production function in analysis are abstracting from the engineering and managerial problems inherently associated with a particular production process. The first aim of the production function is to address appropriation efficiency in the use of factor inputs in production and the resulting distribution of income to those factors. Under certain assumptions, the production function can be used to derive a marginal product for each factor which implies an ideal division of the income generated from output into an income due to each input factor of production.

Kalirajan and Flinn (1983) estimated technical efficiency of production function in Malaysia. Stochastic frontier production function was used while the parameters of this model estimated maximum likelihood. The result showed that the average of technical efficiency was 75%.

Dawson and Linqard (1989) estimated the rice farm specific technical efficiency and production function in central Luzon, Philippines. Using data for 1970, 1974, 1979 and 1982 of the International Rice Research Institute (IRRI) they estimated the stochastic frontier production functions. The results showed that the mean technical efficiency for the 4 years is 64.2, 62.6, 60.4 and 80.8%, respectively. Mirotchie and Taylor (1993) examined the allocation of resources in cereal production in Ethiopia using translog production function. The finding concluded that using of fewer workers, new modern machinery and inputs can be more desirable. The result also has been reported low elasticity of substitution between labor and new inputs.

Hassanpour and Torkamani efficiency of fig producers in Fars Province with using transcendental stochastic frontier production functions estimation through maximum likelihood method. The results showed that the mean technical efficiency of fig producers in Estahban, Kazeroon and Neyriz Cities are 65.7, 80.2 and 63.7%, respectively. The study of the effect of different socioeconomic factors on the technical efficiency also showed that the number of caprification, farm's size and the educational level of producers are directly related to the technical efficiency of fig producers. Jafarzadeh estimated wheat production function using annual time series data during 1980-1994 in Khorasan. The relevant data of this study was collected through questioner. The result showed that the best consumption of fertilizer were 235 kg in watery cultivation and 335 kg in rainy cultivation. The result also showed that rain has positive effects on productivity of wheat production. Karimpour has evaluated Tarom rice production function and have considered the effective factors on it in Babolsar using cross-sectional data. The variables were acreage, seeds, labor, fertilizer, poison, water, education and planting time. Quadratic production function using Weight Linear Square (WLS) were estimated. The results showed that partial elasticity of acreage, labor and seeds were 10, 34 and 4%, respectively. Rostamiyan analyzed economical production of Kolza in Mazandaran. The data was collected through questionnaire. Cob-Douglas and transcendental production functions were estimated while Cob-Douglas was selected as the best model. The results showed that increasing of Kolza production up to increasing of acreage and other variables such as poison and fertilizer have effective significant on production of Kolza. Safavi (2005) estimated kiwi production function in Mazandaran. Data of this study was collected through questionnaire using systematic sampling method. Quadratic production function was selected as the best model to analyze the data. The result showed that the fertilizer, labor and acreage were used less than optimal. Binam *et al.* (2004) determined the effective factors on technical efficiency of farmers in Cameroon forests and agricultural systems including groundnut, maize and groundnut-maize using stochastic frontier Cobb-Douglas production function. The variables were acreage, labor, production costs, seeds and tools of production. The total observations of these systems were 450 farmers. The results showed that the average of technical efficiency of the systems were 77, 73 and 75%, respectively. Also, the result indicated that education, distance to roads, soil quality and join to agricultural communities and cash were had been affected on technical efficiency of farmers. Alvarez and Arias (2003) studied the relationship between technical efficiency and size of farm in the North of Spain during 1993-1998. In this study, production function was used which technical efficiency was used as one of their variables. The finding revealed that the influence of technical efficiency on size of farm depend on fixed inputs, inputs prices and price of variables. The results also indicated that there is positive relationship between farm size and technical efficiency. Noroozi have considered the optimal production function and technical efficiency of rice in Kohgiloyeh V.A. Boyer-Ahmad Province. Data required of this study was cross-sectional which was collected through questionnaire and interview with farmers. Cob-Douglas and transcendental production functions were estimated while Cob-Douglas was selected as the best model. The result showed that the technical efficiency of farmers had been 67.01%.

MATERIALS AND METHODS

The data used in this study are cross-sectional data collected at 2012 (Table 1). In addition to the data obtained by surveys, previous studies of related organizations such as Food and Agricultural Organization (FAO) and Ministry of Jihad-e-Agriculture of Iran (MAJ) were also utilized during this study. The size of sample of stratifications was determined by Neyman technique (Zangeneh *et al*., 2010). The size of 383 orchards was considered as adequate sample size. To achieve the research objectives, the data required for this study were collected through questionnaire by the method of interview. The kind of question in the questioner is open. To ensure the validity of the questionnaire, the experts in this field will be used. To check the validity of the questionnaire, Cornbrash's alpha test was used. In order to analyze the data and to estimate the models EVEIWS Software package was used. After collecting the required data to achieve the research objectives, Cob-Douglas and transcendental production functions were estimated (Cobb and Douglas, 1928). Cob-Douglas and transcendental production functions are as follows, respectively:

$$LNY_i = B_i + B_2LNX_1 + B_3LNX_2 + \ldots + B_7LNX_6 + U_i$$

Table 1: Production costs of walnut in one hectare (before productivity)

Rows	Types of cost	Costs in each turn: The amount in each turn	Unit price ($)	Cost of each turn ($)	Interval b/w two turns*	Cost for 1 year ($)	Cost for whole period ($)
1	**Chemical fertilizer**						
	Phosphate (kg)	132	0.028	3.7	1.1	3.3	43.69
	Urea (kg)	68	0.026	1.77	1.1	1.57	13.24
	Nitrate (kg)	33	0.016	0.53	1.1	0.47	6.2
	Other (kg)	65	0.021	1.365	1.1	1.22	16
2	Animal manure (kg)	8397	0.003	25	1.8	13.75	182
3	**Labor plowing and leveling**						
	Plowing and leveling (P/D*)	5	15	75	0	75	75
	Crete category and canalization (P/D)	5	15	75	0	75	75
	Shipping cost of seedling and others (P/D)	8	15	120	0	120	120
	Pruning (P/D)	2.7	15	40.5	1.04	42	556
	Using fertilizer and spraying (P/D)	4.3	15	64.5	1	64.5	838.5
	Using shovel (P/D)	7	15	105	1.2	126	1668
	Weeding (P/D)	2.4	15	36	1	36	468
	Irrigation (P/D)	0.8	15	12	1	12	159
	Others (P/D)	1.4	15	21	1	21	278
4	**Machine**						
	Plowing and leveling (No)	-	-	90	-	90	90
	Crete category and canalization (No)	-	-	8.9	-	8.9	8.9
	Shipping cost of seedling and others	-	-	17.8	-	17.8	17.8
	Using fertilizer and spraying	-	-	1.3	-	1.3	17.25
	Water engine (%)	62		13.45	13	174.85	2315
	Shipping fertilizer and others			33.95	1	33.95	441
	Other costs			16	1	16	209
5	Tools and instruments			17.6	1	17.6	232
6	**Cost of seedling**						
	Initial seedling (tree)	97	0.45	43.65	43.65	43.65	
	Cultivated seedling (tree)	14	0.6	8.4		8.4	8.4
7	Land (Ha)			664	1	664	8792
8	Water (M^3)	122	0.04	504	13	70	929
	Sum of production costs					13716.81	1738.26

*One person in a day; research findings

$$LNY_i = B_i + B_2LNX_1 + B_3LNX_2 + ... + B_7LNX_6 + B_8X_1 + ... + B_{13}X_6 + U_i$$

Where:

- Y_i = Walnut production (per kg)
- X_1 = Zolonfelo (L)
- X_2 = Labor (day)
- X_3 = Machinery (h)
- X_4 = Iron fertilizer (kg)
- X_5 = Water (h)
- X_6 = Acreage (ha)
- B_1-B_{13} = Estimated parameters
- U_i = Error term

General F-test was used to select the best model between the estimated production functions as follow:

$$F = \frac{R^2_{UR} - R^2_R / M}{1 - R^2_{UR} / (N-K)}$$

Where:

- R^2_{UR} = Determination coefficient of the unconstrained model (larger)
- R^2_R = Determination coefficient of the constrained model (smaller)
- M = Number of linear constraints
- N = Observations
- K = Parameters in the larger model

If the calculated F exceeds from the critical value (table F and the degrees of freedom) we reject the null hypothesis, otherwise accept the unconstrained model.

RESULTS AND DISCUSSION

Selection of the suitable model: Different production functions were estimated to analyze the walnut production in Hamadan, Fars and Semnan Provinces which Cob-Douglas and transcendental production functions were selected between them. Other functions have been rejected because was very low, insignificant variables and non-compliance with the methodology. For comparison Cob-Douglas and transcendental production functions and to choice the more appropriate model, F-test was used as follows:

$$F = \frac{\frac{0.7204 - 0.69820}{6}}{\frac{1 - 0.7204}{87}}$$

calculated F (1.536) is less than critical F ($F_{0.05}$ (6.87) = 2.25) at 5% level of significance, therefore Cob-Douglas production function is preferred.

Estimation of Cob-Douglas production function: The cross-sectional data was used to estimate the Cob-Douglas production function. The estimation result of Cob-Douglas production function shows in Table 2.

Estimation of transcendental production function: The estimation result of transcendental production function shows in Table 3.

Now the econometric problems of regression like autocorrelation, multicollinearity and heteroscedasticity and specification error of the model are considered. Auxiliary regression test was used for detection of multicollinearity in the model which it indicated that calculated F for all variables were significant at 1% level and it was less than critical F (so, there is no multicollinearity in the model. Heteroscedasticity is a problem in cross-sectional data. Arch and White test were used to detect heteroscedasticity which they confirmed that there is no heteroscedasticity in the model. For detection the existence of autocorrelation in the model, Durbin-Watson and LM test were used. DW, du and dl are 2.521, 1.784 and 1.34, respectively, 2<2.521<2.61 so, there is no auto-correlation in the model at 5% level of significance. RESET Ramzi test was used for specification the mode. The calculated F = 1.458 that rejected existence of error specification in the model. The result of histogram normality showed that JB is 1.54 which accepted normality of error term. Determination coefficient of the model is 0.87 which shows 87% of changes in the dependent

Table 2: Cob-Douglas production function

Variables	Coefficient	t-statistics	Probe.
C	5.465	14.255	0.0000
LNX_1	0.526	16.675	0.0000
LNX_2	0.108	2.589	0.0452
LNX_3	0.134	2.124	0.0604
LNX_4	0.175	2.487	0.0103
LNX_5	0.189	0.304	0.0114
LNX_6	0.076	2.681	0.0279

R^2 = 0.91; AKIC = -0.050; F = 47.305; SC = 0.163; D-W = 2.103; SEE = 0.337; N = 300

Table 3: Transcendental production function

Variables	Coefficient	t-statistics	Probe.
C	5.461	2.425	0.042
LNX_1	0.432	1.356	0.216
LNX_2	0.362	2.634	0.014
LNX_3	0.012	1.724	0.214
LNX_4	0.021	0.103	0.768
LNX_5	0.354	1.104	0.024
LNX_6	0.213	1.542	0.134
X_1	0.134	1.864	0.164
X_2	-0.134	-2.324	0.721
X_3	-0.321	-0.804	0.621
X_4	0.124	0.542	0.891
X_5	0.013	0.346	0.901
X_6	0.214	-0.846	0.624

R^2 = 0.815; AKIC = 0.0345; F = 29.98; SC = 0.423; D-W = 2.521; SEE = 0.421; N = 300; research findings

Table 4: Inputs elasticity of walnut production

Input	Coefficient
Zulonfloo position (X_1)	0.628
labor (X_2)	0.234
machinery (X_3)	0.046
Iron fertilization (X_4)	0.173
Water (X_5)	0.145
Acreage (X_6)	0.034

Research findings

variable has been explained by explanatory variables. The F of overall the regression is significant at 1% level of significance that indicated overall goodness of fit.

Elasticity of production: After selection Cob-Douglas production function as the suitable function is calculated elasticity of production as follows:

$$E_p = \frac{dLNY}{dLNX}$$

The variables of this function were used as logarithm form, thus the coefficient of each variables are elasticity of its variable. The equation of this function is as follow:

$$LNY = 5.345 + 0.628LNX_1 + 0.234LNX_2 + 0.046LNX_3 + 0.173LNX_4 + 0.145LNX_5 + 0.034LNX_6 + U_i$$

According to the above equation, elasticity's of production shows in Table 4. According to Table 4, all coefficients are between 0 and 1 means walnut growers have used the factors of production in the second area of production. The elasticity of factors production such as Zulonfloo poison, labor, machinery, Iron fertilization, water and acreage were 0.628, 0.234, 0.046, 0.173, 0.145 and 0.034, respectively. Returns to scale. Returns to scale are calculated from the whole elasticity in Cobb-Douglas production function:

$$E = 0.628 + 0.234 + 0.046 + 0.173 + 0.173 + 0.145 = 1.226$$

The result of Wald test showed that there is increase of returns to scale in walnut orchards of Hamadan, Fars and Semnan Provinces. Therefore, returns to scale is 1.226 means increase of 1% of all production factors simultaneously causes 1.226% increases in product. The Cob-Douglas and transcendental production functions were estimated. But Cob-Douglas production function selected as the most appropriate model to analyze the walnut production function. The result of this study showed that walnut growers have used the factors of production in the second area of production.

CONCLUSION

The findings also showed that the elasticity of factors production such as Zulonfloo poison, labor, machinery, Iron fertilization, water and acreage were 0.810, 0.169, 0.097, 0.212, 0.158 and 0.093, respectively. Finally, the result of Wald test showed that there is an Increase of Returns to Scale (IRS) in walnut orchards of Hamadan, Fars and Semnan Provinces.

Population growth, change of consumption habits, increase of daily consumption and its diversity has impact on increase of agricultural production. Therefore, quantitative analysis of production through amount of optimum factors production in agriculture is major agricultural policies which it can increase production by ideal consumption of accessible sources.

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