Plant Archives Vol. 19, Supplement 2, 2019 pp. 1457-1463 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

ESTIMATION OF PRODUCTION FUNCTION OF RICE IN NAJAF PROVINCE FOR SEASON 2016

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Abstract

The objective of this study was to estimate the production function (Cob-Duglas) of rice using the regression method of the Robust M-Weighted Estimator (R.M.W) to represent the functional relationship between quantity of produced rice, and the independent variables (seed size, cultivated area, the amount of fertilizer, pesticide, number of mechanical working hours and number of human working hours). These variables represents 78% of changes in the level of production. While 22% of those changes are due to other factors not included in the model. The results indicated that the total elasticity was (1.043), which is greater than the correct one. This means that there is a growing scale return, which allows the possibility for increasing the production of the rice more and more by a proportional increasing of resources usage. Thus, rice farmers are producing within the first production stage of the decreasing yield law, and all the independent variables included in the model are used in the second stage (the economic productivity stage). It is clear from the measurement of resource efficiency that it is close to the correct one, i.e. that there is an efficiency in the use of resources except fertilizer and pesticides due to the irrational use of these resources. The study recommends adapting policies and programs to enable farmers to achieve distributional efficiency in the use of resources by spreading awareness about how to use pesticides correctly.

Keywords: Robust M-Weighted, resource efficiency, return scale, rice.

Introduction

The increase in agricultural production of grain crops is the focus of many countries in the world due to the problem of lack of food and the increasing demand for food as a result of the increase in population. Such increase requires raising the level of agricultural production in general and grain crops, in particular, to meet the growing needs. The most important crop in this regard is the rice. It is the second most important crop after wheat in terms of importance. It feeds a half of the world's population, particularly the Middle East, Japan and India, with an estimated 92 percent of world production in Asia. The cultivation of rice requires the availability of certain conditions related to the temperature, where it can be cultivated in environments where the temperature during the growth season is not less than 22 C, as well as the soil moisture content between 75% and 90%. The estimated requirement for one hectare for water is between 2500-4000 liters. Rice crop prefers a medium of heavy clay soil containing 70% clay and silt, pH ranging from 4 to 6.5 and not salty. The nutritional importance of rice is attributed to its digestibility. It contains 7.5% protein, 76.7% carbohydrate, 10% oil, 13.3% water, 9% salts and minerals, as well as about 346 calories (Ministry of Irrigation, 2016).

The economic importance of rice is reflected in the fact that it enters as raw material or assistance in many food industries. Furthermore, rice has a great role in being useful in the reclamation of newly reclaimed salt soils because of its great ability to carry a high proportion of salts and consumption of large quantities of water, which helps to derange salts dissolved in water faster than other crops (Al-Younes, 1993). Despite the economic importance of the crop, the fluctuation of cultivated areas led to a decline in the production of this crop, which may be attributed to technical and economic problems such as farmers underestimation of the concept of optimization of production and resources used. The research is based on the hypothesis that rice farmers in the province of Najaf have not been optimized either in terms of production or resources, which has led to low economic efficiency. The objective of the research was to determine the optimal quantities of resources through the estimation of the production function and economic derivatives of rice. Preliminary data were obtained from their field sources in three regions (Al-Abbassyia, Al-Miskhab and Al-Manathera) which are known as the main producers of rice in Najaf province in the light of a questionnaire prepared for this purpose. Data were collected through the direct interview with randomly selected 240 farmers represented 7.5% of the total rice farmers in Najaf province, several previous studies have addressed this issue using rice (Enwerem, 2013; Mohamed, 2015) and other crops in different geographical areas (Zaidan, 2015, 2016; Jumaili, 2017; Mahmood, 2018; Mahmood *et al*., 2018).

Descriptive analysis of rice production farms within the sample

1. The educational level of the research sample

It is scientifically proven that a worker's productivity increases with his/her educational level. In order to identify the educational level, the sample was divided into four categories (illiterate, primary, intermediate, preparatory, higher) as in Table (1).

Table 1 : Educational levels of the research sample

Educational level	Number of farmers	The ratio %
Reads and writes	46	19.2
Primary	60	25
Secondary	111	45.2
University	23	9.6
Total	240	100

Source: calculated based on the questionnaire form.

From the table, it is obvious that secondary education is prevailing representing 45.2% followed by primary education (25%) and then read and write (19.2%), and finally university education (Bachelor, Diploma) by 9.6%.

2. Experience in the cultivation of rice (jasmine)

Since the Jasmine crop was recently discovered and is considered a "hybrid" variety, the years of experience in growing it ranged from 4-25 years as shown in table (2). The skill and experience used in the agricultural process aims at maximizing agricultural output and minimizing its costs.

Table 2 : Years of experience in crop cultivation

Categories By Years of Experience (Years)	Number of farmers	The ratio %
1-16	23	9.6
7-12	83	34.6
13 -18	77	32
More than 18	57	23.8
Total	240	100

Source: calculated based on the questionnaire form.

The experience years (Table 2) showed that an experience of 7-12 years accounts for 34.6% of farmers, while 23.8% of farmers had more than 18 years' experience.

3. Patterns of tenure:

In the light of the field survey, there are three types of tenure: individual ownership, rent and contracts. Table (3) shows that the dominant tenure system in Najaf governorate was the pattern of individual ownership representing (49.2%) of sample farmers, followed by the contract system (35.4%) and the rent system (15.4%).

Table 3 : Distribution of tenure patterns of the total number of farmers

The ratio %	Number of farmers	The ratio %	Size of possession (dunums)	Pattern of tenure
49.2	118	64.8	2762	Individual ownership
15.4	37	13.7	583	rent
35.4	85	21.5	918	Contracts
100	240	100	4263	Sum

Source: calculated based on the questionnaire form.

3. The size of the possession

Table (4) shows the different sizes of possessions. The highest percentage of farms lies in the first category (1-10 dunums) representing (53.3%). The total possession within this category was 988 dunums, with an average of 7.71 dunums per farmer. Their total possession was (23.2%). In terms of total possession, the highest percentage was for 30 dunums (36.4%) of the total cultivated area, with an average of tenure 86.2) dunums per farmer, indicating that a high percentage of farmers possess large areas of land enabling them to maximize Agricultural output.

Table 4 : Distribution of tenure size and retention rate of the study sample

Size of possession / (dunum)	Number of farmers	The ratio %	Average size of tenure	Total possession	The ratio %
1-10	128	53.3	7.71	988	23.2
11-20	73	30.4	16	1168	27.4
21-30	21	8.8	26.4	555	13
More than 30	18	7.5	86.2	1552	36.4
Sum	240	100	17.76	4263	100

Source: calculated based on the questionnaire form.

4. Average age of farmers of the research sample

In order to identify the average age of farmers for the research sample, farmers were divided into five age groups, as shown in Table (5).

Table 5 : Age groups of farmers of the research sample

The ratio %	Number of farmers	Average Age (years)	Age groups (years)
8.3	20	28	Smaller or equal to 30
25	60	36	40-31
36.7	88	46	50-41
17.5	42	55	60-51
12.5	30	68	Greater than 60
100	240		Total

Source: calculated based on the questionnaire form.

Table (5) shows that the highest percentage of farmers was in the third age class which was 36.7% with an average age 46 years. The second age class ranked second (25%) with an average age 36 years, while fourth age class came third (17.5%) with an average age of 55 years, and fifth age class ranked fifth (12.5%) with an average age of 68 years. The first age class ranked the last (8.3%) with an average e age of 28 years. The majority of farmers' ages are limited to groups second, third and fourth. They are 35 years and older, as accounting for (79.2%) of the total sample. It can be concluded that young people represent a small percentage of the total number of farmers, which means that young people are reluctant to practice agriculture and move to other professions.

5. Production and productivity:

The total amount of rice production was (5298) tons and the productivity rate was (1242) kg / dunum, while the seed rate was 50.11 kg / dunum as shown in Table 6. The sale rate was 1.48 liters / dunum and the chemical fertilizer used was 147 kg / dunum in average.

Table 6 : Production, Productivity and Production Input Rates for the Sample of the Study

The details	Quantity
Production / ton	5298
Production rates kg / dunum	1242
Seed rate kg / dunum	50.11
Average pesticides per liter / dunum	1.48
Rate of fertilizer kg / dunum	147

Source: calculated based on the questionnaire form.

Results and Discussion

Economic and Statistical Analysis

The production function was estimated using the Ordinary least squares (OLS) method to estimate model parameters. This method is one of the most widely used methods in estimating economic model relationships because of its typical characteristics such as unbiased and minimal variance. Several models, including the linear function, the double logarithmic function, and the semi-logarithmic function were designed to represent the relationship between the total output of the rice crop as a dependent variable, and the quantity of seeds, the cultivated area, fertilizers, pesticides, number of total mechanization hours, and number of working hours as explanatory variables. Results showed that the double log function was the most one which is in line with economic logic. For representing the relationship, the model (Debertin, 1986):

$$LY = \beta_0 + \beta_1 Lx_1 + \beta_2 Lx_2 + \beta_3 lx_3 + \beta_4 lx_4 + \beta_5 lx_5 + U_i$$

The dependent variable is the total production of the rice that is actually achieved from farmers' possessions estimated in tons.

Independent Variables (Xs): The following variables were included:

1. Total seed quantity (X1): The actual quantity of seeds used by farmers (Kg).
2. Quantity of Fertilizers (X2): The total quantity of fertilizers during the production season (Kg).
3. Quantity of pesticides (X3): All control materials, pesticides and liquid stimulants used during the production season (L).
4. Mechanical work hours (X4): Total mechanization services used during the season were (hr). These services included (tillage, modification, settlement, milling, planting, fertilization, control, spraying of pesticides and quarries).
5. Number of hours of work (X5): The manual work (family and wage) used during the season is estimated at (hr).

The variable (Ui), stochastic variable, includes all other variables that affect the production of rice crop and not included in the model such as climatic, environmental and technical conditions ... etc.

After conducting statistical analysis using Eviews.10, the production function of the rice crop was estimated according to the following model:

Table 7 : Estimated parameters of rice production function.

Variable	Coefficient	Std. Error	t- Statistic	Prob.
C	-2.222720	0.253004	-8.785326	0.0000
LX_1	0.187363	0.055149	3.397408	0.0008
LX_2	0.141492	0.040264	3.514144	0.0005
LX_3	0.274005	0.057264	4.784929	0.0000
LX_4	0.291847	0.053429	5.462341	0.0000
LX_5	0.149283	0.045275	3.297227	0.0011
R-squared	0.950651	Mean dependent var	2.687633	
Adjusted R-squared	0.949596	S.D. dependent var	0.785561	
Sum of regression	0.176365	Akaike info criterion	-0.607843	
Log likelihood	78.94113	Schwarz criterion	-0.520827	
F-statistic	901.5392	Hannan-Quinn criter.	-0.572782	
Prob(F-statistic)	0.000000	Durbin-Watson stat.	1.919671	

Source: Calculated using Eviews.10

Dependent Variable: LY

Method: Least squares

Date: 09/24/18 Time:15:51

Sample: 1-240

Included observation: 240 after adjustments.

Diagnostic tests indicate that the model has exceeded the problem of self-correlation using the Durbin-Watson test, which showed the absence of the problem of self-correlation because the value of (D) was located in the acceptance area of the null hypothesis that D equals 1.919, 5% and degrees of freedom (200), we find that D lies between 1.820 <1.919 <2.18 ie, du <D <4-du, and from this we conclude that there is no positive or negative self-correlation of the random variable of the first order. While multicollienerity between independent variables was found to be less than 20 using variance inflation factors test. From the last result, it can be concluded that the model is free from multicollienerity (Gujarati, 2004).

Table 8 : Variance Inflation Factors.

variable	coefficient variance	Un centered VIF	Centered
C	0.064008	493.9065	NA
LX_1	0.003041	1028.424	12.23622
LX_2	0.001621	687.7258	7.498660
LX_3	0.003279	187.3446	15.57081
LX_4	0.002854	232.5993	12.31458
LX_5	0.002050	714.3127	8.664380

Source: Calculated using Eviews.10

Because the research depends on cross-sectional data, it is necessary to detect the extent of the heteroscedasticity problem and the Pagan-Godfrey test has been established. The test proved the significance of (F), from which it can be concluded that thee estimated model has a heteroscedasticity problem as illustrated in table (9).

Table 9 : The BPG test shows a heteroskedasticity problem

Heteroscedasticity Test Breusch – pagan –Godfrey			
F-statistic	6.034108	Prob. F(5,234)	0.0000
Obs *R-squared	27.41006	Prob. Chi-Square(5)	0.0000
Scaled explained SS	23.02459	Prob. Chi-Square(5)	0.0003

Source: Calculated using Eviews.10

The variance stability problem in yield function was treated using the Robust M-Weighted Estimator (RMW) regression method. The natural data is often characterized by a natural distribution, but sometimes they may take a different pattern or not a particular pattern of distributions. This is due to the existence of outliers, which have a negative impact on the results of statistical and standard methods in the light of a heteroscedasticity problem (Audibert, 2011). Therefore, this method corrects the standard errors of whites heteroscedasticity - correct stander errors, which occur because of the presence outliers in the data because the estimation of this model by the usual methods such as the method of the ordinary least square (OLS) method leads to loss of good properties to estimate the parameters of the model. This method modifies the extreme values in the matrix Independent variables using the weighting matrix for the method of weighted minimum squares (WLS) and then addressing the extreme values in the response vector by using the error vector (the vector of the weighted minimum squares) using the H-hippocampal method and M finding new capabilities after the recent amendment of these capabilities are called the capabilities of M fortified weighted (Doddy *et al*., 2007).

Table 10 : Estimated coefficients of rice production function using the weighted weight regression method.

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-2.159267	0.264064	-8.177049	0.0000
LX_1	0.181786	0.057560	3.158210	0.0016
LX_2	0.148905	0.042024	3.543361	0.0004
LX_3	0.306588	0.059768	5.129665	0.0000
LX_4	0.271063	0.055765	4.860843	0.0000
LX_5	0.134075	0.047255	2.837297	0.0045
Robust Statistics				
R-squared	0.766708	Adjusted R-squared	0.694931	
Rw-squared	0.959742	Adjust Rw-squared	0.986822	
Akaike info criterion	237.9964	Schwarz criterion	300.9903	
Deviance	6.336647	Scale	1089.784	
Rn-squared statistic	4145.787	Prob. (Rn-squared stat.)	0.000000	
Non-robust Statistics				
Mean dependent var.	2.687633	S.D. dependent var	0.785561	
S.E. of regression	0.176534	Sum squared resid	7.292408	

Source: Calculated using Eviews.10.

It can be noted from the estimated results in Table (10) that the function of rice production after the correction was as follows:

$$\ln Y = -2.159 + 0.182 \ln X_1 + 0.149 \ln X_2 + 0.307 \ln X_3 + 0.271 \ln X_4 + 0.134 \ln X_5$$

The parameters (b_1-b_5) refer to the partial productivity elasticities, as the function was estimated by the double logarithmic formula of the elements mentioned above. These elasticities showed the relative responsiveness in the total production of rice crop for changes in the quantity of the variable productive element by 1% with the other factors are fixed. The total elasticity gives the overall elasticity of the function, which refers to the nature of the return to scale, including the stage of productivity in which production takes place and thus the efficiency of the use of productive resources.

The production function showed that the total elasticity value was 1.043, which is greater than the correct one, and implies an increased scale return, which means that it is possible to increase rice production more and more by addition of equal proportions of resources. In other words, the increase in the use of resources leads to increasing production at increasing rates, which means that rice farmers produce rice under the first production phase of the decreasing yield law. The production function of the rice crop indicates that all the variables (seed fertilizers, pesticides, hours of mechanical work and human working hours) are used at the second stage (the economic production stage) as long as the marginal production is less than the average production which is also decreasing .Almost similar results have been obtained by many researchers (Obaid, 2011; Al-Hassan, 2012 ; Adinku, 2013)

The results of the rice production function indicates that the signal of all the parameters is consistent with the economic logic. It was found that the production elasticity of the seed quantity reached (0.182) which is a positive value and less than half due to the frequent use of this resource. As 1% increase in seed usage increases rice production by (0.182%). The production elasticity of fertilizers showed a low positive value (0.149) due to intensive use of this resource. The increase in fertilizers by 1% results in 0.149% increase in rice production. For pesticide, the production elasticity was (0.307), i.e the increase in the quantity of pesticides by (1%) leads to an increase in production by (0.307%). Likewise, the production elasticity of the mechanized working hours was (0.271) which is also positive and low due to the intensive use of this resource. This means that an increase in the number of mechanical working hours by 1% leads to increased rice production by 0.271%. As for the number of human working hours, the production elasticity of this variable was about (0.134), i.e. the increase in the number of human working hours by (1%) leads to an increase in rice production by (0.134%)

The productive elasticities of resources represented by the number of human working hours, the quantity of utilized fertilizers and the quantity of seeds were the lowest compared to the productive elasticities of number of mechanical working hours and the quantity of pesticides. The productive elasticity of pesticides was greater than that of mechanical hours and seeds. Thus, increasing the amount of pesticides will cause an increase in the rice production in higher rate than the increase in the number of mechanical working hours and the quantity of seeds.

In order to determine the share of each factor of production, the estimated elasticity of each factor divided by overall elasticity of the function. The results showed that the quantity of pesticides came first (29.4%) followed by mechanical working hours, quantity of seeds, fertilizer and finally the number of working hours which were 26.0% 17.4%, 14.3% and 12.8% respectively.

Economic derivatives of the production function

The production function includes some derivatives, the most important of which are those which are obligatory involved in decision-making for adding or reducing a resource, and have a very important role in determining the efficient resources used in the production process. These functions include: average production, marginal production and elasticity of production (Doll *et al*., 1984).

To find economic derivatives, the production function must be converted from its logarithmic formula to the exponential formula:

$$\ln Y = -2.16 + 0.181 \ln X_1 + 0.149 \ln X_2 + 0.306 \ln X_3 + 0.271 \ln X_4 + 0.134 \ln X_5 \quad (1)$$

$$Y = 0.115 X_1^{0.181} X_2^{0.149} X_3^{0.306} X_4^{0.271} X_5^{0.134} \quad (2)$$

The arithmetic mean of the resources included in the production function of the rice crop was as follows:

Mean quantity of seeds used per farm in ton $(\overline{X}_2) = 1.008$

Average quantity of fertilizer per farm in Kg $(\overline{X}_2) = 2620$ $(\overline{X}_2) = 2620$

Average quantity of pesticides used per farm in liter $(\overline{X}_3)$ = 20.08

Mean number of mechanical working hours per farm in hour $(\overline{X}_4)$ = 33.36

Average human work per farm in hour $(\overline{X}_5) = 1117.60$

The sample size was (n = 240).

The total, marginal and average output of each of the production factors in the production function can be calculated after fixation of other factors at their average as follows:

$$Y = 0.115 X_1^0.181 (2620)^0.149 (20.08)^0.306 (33.36)^0.271 (1117.6)^0.134$$

$$Y = 6.165 X_1^0.181 \quad (3)$$

The first differential of the function (3) which gives the marginal product function of the seed as follows:

$$\frac{\partial Y}{\partial X1} = MPP_{x1} = 1.116 x_1^{-0.819}$$

$$\frac{Y}{X_1} = APP_{X1} = 6.165 X_1^{-0.819}$$

Table 11 : The overall productivity, marginality and medium of the seed resource used in rice cultivation

Quantity of seeds / kg X_1	Average production APP_{X1}	Marginal production / ton MPP_{X1}	Total production / ton Y
125	0.118	0.021	14.770
250	0.067	0.012	16.748
500	0.038	0.007	18.987
750	0.027	0.005	20.432
1000	0.022	0.004	21.525
1250	0.018	0.003	22.412
1500	0.015	0.003	23.164
1750	0.014	0.002	23.819
2000	0.012	0.002	24.402
Source: Calculated using equations of total, marginal and average product of the seed source.			

2 - The total, marginal and average product of the fertilizers were calculated after the other resources in the production function are fixed at their mean arithmetic as follows:

$$Y = 0.115(1.008)^0.181 (X_2)^0.149 (20.08)^0.306 (33.36)^0.271 (1117.60)^0.134$$

$$Y = 1.911 X_2^0.149 \quad (4)$$

By taking the first differential of the function (4) we obtain the marginal output function of the fertilizer can be obtained as follows:

$$\frac{\partial Y}{\partial X_2} = MPPX_2 = 0.284 X_2^{-0.851}$$

$$\frac{Y}{X_2} = APP_{X2} = 1.911 X_2^{-0.851}$$

Table 12 : The overall productivity, marginality and medium of the fertilizers resource used in rice cultivation

Quantity of fertilizers / kg X_2	Average production APP_{X1}	Marginal production / ton MPP_{X1}	Total production / ton Y
1500	0.0038	0.00060	5.682
1750	0.0033	0.00050	5.814
2000	0.0030	0.00040	5.931
2250	0.0027	0.00040	6.036
2500	0.0025	0.00040	6.131
2620	0.0023	0.00035	6.174
3000	0.0021	0.00031	6.300
3250	0.0019	0.00029	6.376
3500	0.0018	0.00027	6.447
Source: Calculated using equations of total, marginal and average product of fertilizers.			

3 - The total, marginal and average product of the pesticide were calculated after the other resources in the production function were fixed at their mean arithmetic mean as follows:

$$Y = 0.115(1.008)^0.181 (2620)^0.149 (X_3)^0.306 (33.36)^0.271 (1117.60)^0.134$$

$$Y = 2.464\ X_3^0.306 \quad (5)$$

Taking the first differentiation of function (5) gives the marginal product function of the pesticide as follows:

$$\frac{\partial Y}{\partial X_3} = MPP_{X3} = 0.754 X_3^{-0.694}$$

$$\frac{Y}{X_3} = APPX_3 = 2.464 X_3^{-0.694}$$

Table 13 : The overall productivity, marginality and medium of the pesticides resource used in rice cultivation

Quantity of pesticides / literX_3	Average production APP_{X1}	Marginal production / ton MPP_{X1}	Total production / ton Y
2.5	1.3046	0.3992	3.261
5	0.8064	0.2467	4.032
10	0.4985	0.1525	4.985
20	0.3081	0.0943	6.162
30	0.2326	0.0712	6.977
40	0.1905	0.0583	7.619
50	0.1631	0.0499	8.157
60	0.1437	0.0440	8.625
70	0.1292	0.0395	9.042
Source: Calculated using equations of total, marginal and average product of the pesticides source.			

4. The total, marginal and average output of mechanical working hours were calculated after the other resources in the production function were fixed at their mean arithmetic mean as follows:

$$Y = 0.115(1.008)^{0}.181(2620)^{0}.149(20.08)^{0}.306(X_4)^{0}.271(1117.60)^{0}.134$$

$$Y = 2.386\,X_4^{0}.271 \quad (6)$$

Taking the first differential of function (6) gives the marginal product function of mechanical work hours as follows :

$$\frac{\partial Y}{\partial X4} = MPP_{X4} = 0.647\,X_4^{-0.729}$$

$$\frac{Y}{X_4} = APPX_4 = 2.386\,X_4^{-0.729}$$

Table 14 : The overall productivity, marginality and medium of the mechanical working hours resource used in rice cultivation

Mechanical working hours X_4	Average production APP_{X1}	Marginal production / ton MPP_{X1}	Total production / ton Y
5	0.7381	0.2001	3.690
10	0.4453	0.1208	4.453
20	0.2687	0.0729	5.373
30	0.1999	0.0542	5.998
33.36	0.1850	0.0502	6.172
40	0.1621	0.0440	6.484
50	0.1378	0.0374	6.888
60	0.1206	0.0327	7.237
70	0.1078	0.0292	7.546
Source: Calculated using equations of total, marginal and average product of the mechanical working hours source.			

5. The gross, marginal and average output of human working hours were calculated after the other resources in the production function were fixed at their mean as follows:

$$Y = 0.115(1.008)^{0}.181\,(2620)^{0}.149(20.08)^{0}.306(33.36)^{0}.271(x_5)^{0}.134$$

$$Y = 2.410\,X_5^{0}.134 \quad (7)$$

Taking the first differentiation of function (7) gives the marginal product function of the resource number of human working hours as follows:

$$\frac{\partial Y}{\partial X5} = MPP_{X5} = 0.322X_5^{-0.866}$$

$$\frac{Y}{X_5} = APP_{X5} = 2.410X_5^{-0.866}$$

Table 15 : The overall productivity, marginality and medium of the mechanical working hours resource used in rice cultivation

Human working hours X_5	Average production APP_{X1}	Marginal production / ton MPP_{X1}	Total production / ton Y
250	0.0202	0.0026	5.0506
500	0.0112	0.0015	5.542
1000	0.0061	0.00081	6.082
1500	0.0043	0.00057	6.421
2000	0.0033	0.00045	6.674
2500	0.0028	0.00037	6.876
3000	0.0023	0.00031	7.046
3500	0.0021	0.00027	7.193
Source: Calculated using equations of total, marginal and average product of the human working hours source			

The efficiency of resources used in the production of rice Farmers are more efficient in resources using when the marginal product value of each resource to its marginal cost closer to the correct one because the added value is equal to the added cost. When this ratio is less than the correct one, this means that the added cost exceeds the added return. If this ratio is greater than the correct one, it means that the added yield exceeds the added cost (AL-Shafi'I,2005). The marginal product value of each resource is estimated by multiplying the average price of actual product received by farmers by the marginal product derived from the previously estimated function. The marginal product for each resource was calculated as follows:

$$MPP_{X1} = 1.116X_1^{-0.819}$$

Table 16 : Efficiency of resources used in rice production

r	MFC (Thousand dinars / ton)	VMPPX	MPPX	Resources
1.061	716	759.5	1.1088	Seeds
0.538	0.446	0.240	0.00035	Fertilizers
4.928	13.067	64.39	0.094	Pesticides
0.300	1.683	34.387	0.0502	Mechanical work
0.573	59.99	0.506	0.00038	human work

Source: calculated based on estimated production functions

$$r = \frac{VMPx_i}{MFCx_i}$$

Where:

r: The efficiency of resources used in the production of rice.

$VMPx_i$: The marginal output value for each resource.

$MFCx_i$: The marginal cost of each resource represented by price ($MFCx_1i = P_1xi$).

Py: The output price of the rice.

PX_1: Average price of seeds (thousand dinars / ton).

PX_2: Average price of fertilizer (thousand dinars / kg).

PX_3: Average price of pesticides (1,000 dinars / liter).

PX_4: Average price of mechanical work (thousand dinars / hour).

PX_5: Average price of human labor (thousand dinars / hour).

Jasmine rice farmers in the study area were efficient in the use of seeds, the ratio of resource efficiency was close to the correct one, while they were not efficient in the use of the remainder sources. The reasons behind that is the bushes that compete with the crop, with losses ranging from 10 to 50% of the product amount. They require certain types pesticides in specific quantities.

In order to achieve better use of resources, policies and programs must be established to enable farmers to achieve distributional efficiency in the use of resources by expanding awareness on how to use pesticides correctly.

Based on the obtained results, it can be concluded that rice farmers are produced within the first production phase of the production stages, i.e., there are increased return scale that allow increased production of rice crop by increasing the resources used in equal proportions. It implies that increase in the used resources causes increasing in the production rates as the total flexibility of the function is greater than one, and that the efficiency of the resources used in production is close to the correct one. Therefore, there is an efficiency in resources use except for fertilizer and pesticides because of the irrational use of these resources due to the emergence of exotic bushes which adversely affected the efficiency of the resource.

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