ESTIMATING PROFIT, COST FUNCTION AND TECHNICAL EFFICIENCIES OF RICE PRODUCTION IN NEJAF FOR SEASON 2016*

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ABSTRACT

The aim of this study was to estimate the profit and cost functions as well as economic, price, cost, and technical efficiencies beside the other economic indices at actual, optimal and profit-maximizing output of rice. A random sample of 240 rice farms in Nejaf province was used during the agricultural season 2016. From efficiency scales of profit function, it was shown that the output quantity had the greatest impact on the profit compared to other variables (average output costs and price). According to the cost function, the optimum output level and the profit-maximizing output level for the short run were 64.84 tons and 117.4 tons respectively. The lowest price that the farmer can accept was 194.83 thousand dinars / ton. At this price, the producer loss all fixed costs in the short run, hoping that the price of rice will improve in the long run. Net profit was estimated on the basis of actual output, cost minimizing output (optimal) and profit-maximizing output, which amounted to 8084.32, 30852.65 and 45547.5 thousand dinars, respectively. The of technical efficiency were 34%, and the cost efficiency was 0.52. We conclude from the study that economic resources have not been exploited optimally, indicating that actual output is far from optimal output. The study recommends a output policy aimed at increasing economic efficiency and optimizing the use of available resources.

Keywords: profit-maximizing output, optimal output, actual output.

*Part of M.Sc. thesis of the 1st author.

Received: 18/8/2018, Accepted: 9/12/2018
INTRODUCTION

Rice is one of the most important crops in the development of the agricultural sector. It is also a staple food for the most tropical and subtropical countries. This crop is a main food for more than half of the world's population, especially in the Far East, Japan, India, China, Vietnam, Pakistan and other countries. It is the third main crop after wheat and barley in Iraq and the first major summer crop, which occupies a prominent position in the agricultural production. It is highly favored and consumed by Iraqis. Rice grains contain 6-8% protein, 65-70% starch and 4-6% oil. Rice is easy to digest, so it is recommended for people suffering from gastric diseases (21). Although rice cultivation is ancient in Iraq, it is relatively very limited compared to the production of other cereal crops such as wheat and barley. This is due to the lack of irrigation water available in the rivers during the growing season, and there are insufficient drains in most of the land to discharge excess water. This crop is grown at different areas of Iraq especially province of Najaf and Dewaniya which are are front of the provinces in runs of area and production followed by the province of Maysan. Statistics of agricultural production indicate that the quantities produced from cereals such as wheat, barley and rice are insufficient to meet the needs of domestic consumption. So, Iraq has to import these crops from abroad to meet the shortage in their production. The average rice cultivated area in Iraq was 331 thousand dunums, while the average cultivated area in Najaf was 142 thousand tons during the period 1980-2016. The contribution rate represented 43% of the average cultivated area in Iraq for, while the average total production was about 230 thousand tons, from which Najaf contributes by 47% (8). The research problem is the fluctuation of cultivated area of rice in Najaf province which led to a decrease in the production of this crop. Such decrease may be attributed to a technical and economic problems facing the cultivation of this crop including a decrease in the water quota and absence of optimization concept from farmers ideology. Therefore, it is necessary to search for modern methods to overcome these problems and the obstacles facing the cultivation of this crop. The study is based on the hypothesis that the rice farmers in Najaf province did not reach optimization both in runs of output or resources exploitation in the production process, which led to a decrease in economic efficiency of rice production. This study aimed to estimate function production costs in the short-run, measurement of technical and economic efficiency and the efficiency of the cost for a sample of farmers in order to show how to expand the production that achieves the optimum level of the output and input. Several other studies have addressed this issue using the rice crop in different geographical locations (1,2,3,5, 6,14,15,16,17,20,22).

MATERIALS AND METHODS

Well organized questionnaires were used to collect cross sectional data from a random sample of 240 rice (Jasmine variety) farmers which represented 7.5% of the total population in Najaf province for three districts: Abbasiya, Al-Manathira and Mashkhah during the agricultural season of 2016. Collected data were analyzed in statistical programs, Excel and Eviews 10.

Descriptive analysis of rice costs for the research sample

Total variable costs (TVC): Results in Table 1 shows variable costs (for each donum) including production requirement costs (seeds, fertilizers, pesticides), mechanical processes, labor costs, and fuel and maintenance. According to the table, production requirement costs had the largest contribution among variable cost (35.55%), followed by the cost of mechanical work (29.63%), rented labours (20.11%), and finally fuel and maintenance (14.7%).

| Variable cost items                  | Value (1000 Dinars) | Relative importance% |
|--------------------------------------|---------------------|----------------------|
| Production requirements (Seeds, fertilizers, pesticides) | 461007.2            | 35.55                |
| Mechanical labor costs               | 384346.18           | 29.63                |
| Rented labor                        | 260835.18           | 20.11                |
| Fuels and maintenance                | 190587.00           | 14.70                |
| Total variable cost                 | 1296775.76          | 100%                 |

Source: calculated based on the questionnaire form.
Fixed costs (FC) fixed costs were divided into two items: family labor costs, which constitute 84.1% of the fixed costs, and land rent (15.9%).

Table 2. Relative importance of fixed costs items of rice production.

| Fixed cost items      | Value (thousand dinars) | Relative importance % |
|----------------------|-------------------------|-----------------------|
| Family labor cost    | 190827.75               | 84.1                  |
| Farm rent            | 35962.5                 | 15.9                  |
| Total fixed cost     | 226790.2                | 100                   |

Source: calculated based on the questionnaire form

Total costs (TC)
The total costs of the rice production was divided into fixed costs and variable costs. The variable cost contribution ratio was 85.11%, while the fixed costs share did not exceed 14.89%. This gives a clear picture that the relative importance of variable costs is greater than fixed costs as shown in Table 3.

Table 3. Relative importance of fixed and variable costs from total costs of rice production

| Total costs items | Value (thousand dinars) | Relative importance % |
|-------------------|-------------------------|-----------------------|
| Variable cost     | 1296775.76              | 85.11                 |
| Fixed cost        | 226790.25               | 14.89                 |
| Total cost        | 1532566.01              | 100                   |

Source: calculated based on the questionnaire

Estimation of profit function
Ordinary least square was used to estimate the parameters of profit function. The function model was estimated according to the economic theory which states that the profit equals to total revenue (TR) minus total cost (TC) (7). can be derived as follows:

\[ \pi = TR - (TC + TFC) \]

\[ TR = P_0 \times Q + TC = P_X \times X + TFC \]

\[ \pi = \sum P_0 \times Q - [\sum P_X \times X + TFC ] \]

Where:
- \( \pi \): profit
- \( P_0 \): output price per ton (1000 ID)
- \( C \): average production cost (1000 ID/ton)
- \( Q \): product size of rice (ton)
- \( b_0 \): intercept
- \( b_i \): regression coefficients
- \( U_t \): error run

Accordingly, the profit function model can be specified as follows (10):

\[ \pi = b_0 + b_1 P_0 - b_2 C + b_3 Q + U_t \]

Economic, statistical and econometric analysis of profit function: The econometric relationships among profit function were analyzed by OLS which showed that the best model, according to economic and statistical logic, was the linear model (Table 4).

Table 4. Estimation of profit function for rice production

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|----------|-------------|------------|-------------|-------|
| C        | -18099.16   | 2597.575   | -6.667713   | 0.0000|
| P        | 27.81494    | 3.680398   | 7.57590    | 0.0000|
| Q        | 425.5893    | 4.028052   | 105.6564   | 0.0000|
| AC       | -5.189854   | 1.130801   | -4.859537  | 0.0000|
| R-squared| 0.980848    | Mean dependent var | 8108.046|
| Adjusted R-squared| 0.980605| S.D. dependent var | 14177.82|
| Sum of regression | 2049.783 | Akaike info criterion | 18.10530|
| Log likelihood | 9.89E+08 | Schwarz criterion | 18.16331|
| F-statistic | 4028.870 | Hannan-Quinn criter. | 18.12868|
| Prob(F-statistic) | 0.0081000 | Durbin-Watson stat. | 1.766343|

Source: Calculated using Eviews.10

Diagnostic tests indicated that the model has no autocorrelation by using LM at (0.184) probability for two lag periods. Therefore, the null hypothesis could be accepted, that is the model is free from autocorrelation.

Table 5. Test (LM) to detect the problem of autocorrelation

| Breusch-Godfrey Serial Correlation LM Test |
|------------------------------------------|
| F-statistic  | 1.703599 | Prob. F(2.234) | 0.1843|
| Obs*R-squared | 3.444231 | Prob. Chi-Square(2) | 0.1787|

Source: Calculated using Eviews.10

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The result of Ramsey Reset test suggested a rejection of the presence of error in model determination at probability (<0.001) for two lag periods.

| Table 6. Ramsey Reset to detect an error in the model |
|----------------|----------------|----------------|
|                | Value          | df            | Probability |
| t-statistic    | 5.142434       | 235           | 0.0000      |
| F-statistic    | 26.44463       | (1,235)       | 0.0000      |
| Likelihood ratio | 25.59288     | 235           | 0.0000      |
| F-test summary: | Sum of Sq.     | df            | Mean        |
| Test SSR       | 1.00E+08       | 1             | 1.00E+00    |
| Restricted SSR | 9.92E+08       | 236           | 420128      |
| Unrestricted SSR | 8.91E+08     | 235           | 379240      |

Source: Calculated using Eviews.10

On the other hand, multicollinearity between independent variables was found to be less than 10 using variance inflation factors test.

| Table 7. Variance Inflation Factors Test of profit function for rice production |
|----------------|----------------|----------------|
| Variable       | Coefficient Variance | Uncenter VIF | Centered VIF |
|                |                   |               |              |
| C              | 6747396.          | 3854477       | NA           |
| P              | 1354533           | 3665343       | 1.000731     |
| Q              | 1622520           | 1507475       | 1.057339     |
| AC             | 1278711           | 1527005       | 1.057016     |

Source: Calculated using Eviews.10

From the last result, it can be concluded that the model is free from multicollinearity (12).

| Table 8. Heteroskedasticity Test By (BPG). |
|----------------|----------------|----------------|
| F-statistic    | 15.99005       | Prob. F(3,236) | 0.0000      |
| Obs*R-squared  | 40.54241       | Prob. Chi-Square(3) | 0.0000      |
| Scaled explained SS | 543.1386 | Prob. Chi-Square(3) | 0.0000      |

Source: Calculated using Eviews.10

This problem was treated using the Robust M-Weighted Estimator (R.M.W) regression method. Data is often characterized by natural distribution, but sometimes it may take a different pattern. This is due to the presence of abnormal values, which have a negative impact on the results of statistical and standard methods through a problem Heteroscedasticity (12). RMW method corrects the standard errors of White Heteroscedasticity that occurs as a result of the presence of outliers in the data. Estimation of this model using traditional methods such as OLS leads to the loss of its good properties. The RMW method modifies the extreme values in the matrix of the independent variables using the weighting matrix for the Least Squares Method (WLS). Then, the extreme values are addressed in response vector using the error vector (weighted least squares error vector). Finally, the new estimates are found by RMW (9).
The sign of all variables was in accordance with economic theory. Coefficients of product price and quantity took the positive sign with profit, which implies a reverse relationship between profit and the average cost of production. An increase of thousand dinars in production cost will result in 5.41 thousands ID decrease in profit. It is obvious from coefficients of scale variables that the product price has the greatest influence on the profit.

Estimation of cost function

The total cost function was estimated using OLS and different functional formulas to determine the appropriate relationship for variables included in the mathematical form. The linear formula which was subject to tests (economic, statistical and standard) was depended. Based on economic theory, the short-run total cost (10) function takes the following formula:

$$tc = a_0 + b_1Q + b_2Q^2 + b_3Q^3 + ui$$

Table 9. Estimation of profit function for rice production by Robust Least Squares

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|----------|-------------|------------|-------------|-------|
| C        | -11090.14   | 1458.017   | -7.606317   | 0.0000|
| P        | 1870736     | 2065804    | 9.055728    | 0.0000|
| Q        | 390.0880    | 2260942    | 1725334     | 0.0000|
| AC       | -5.41933    | 0.634718   | -8.526519   | 0.0000|

Robust Statistics

| R-squared | 0.698760 | Adjusted R-squared | 0.694931 |
|-----------|----------|---------------------|----------|
| Rw-squared| 0.986822 | Adjust Rw-squared   | 0.986822 |
| Akaike info criterion | 205.2258 | Schwarz criterion | 300.9903 |
| Deviance  | 3.31E+08 | Scale               | 1089.784 |
| R-squared statistic | 32288.41 | Prob(R-squared stat.) | 0.000000 |

Table 10. Estimation of cost function of rice production

| Variable | Coefficient | t-Statistic | Std. Error | Prob. |
|----------|-------------|-------------|------------|-------|
| Q        | 1056.817    | 4.117009    | 256.6954   | 0.0001|
| Q        | 275.1197    | 16.17088    | 17.01328   | 0.0000|
| Q2       | -4.427606   | -4.033907   | 0.109760   | 0.0000|
| Q3       | 0.032921    | 0.284162    | 0.000256   | 0.0000|
| R-squared| 0.957355    | Mean dependent var | 7013.079 |
| Adjusted R-squared | 0.956813 | S.D. dependent var | 8996.835 |
| S.E. of regression | 1869.667 | Akaike info criterion | 17.92143 |
| Sum squared resi | 8.25E+08 | Schwarz criterion | 17.97945 |
| Log likelihood | -2146.572 | Hannan-Quinn alter. | 17.94481 |
| F-statistic | 1766.040 | Durbin-Watson stat | 1.949639 |
| Prob(F-statistic) | 0.000000 |                     |          |

Source: Calculated using Eviews.10

From the coefficient of determination value $R^2$, it is obvious that the model explains 69% of the total changes in the profit function of Rice. This indicates the major influence of explained factors (PY, AC, and Q) on profit function, while only 31% of these changes are attributed to other factors were not included in the model. Results showed that all estimated coefficients for profit function were significant at 1% probability according to Z test. The profit function of the rice crop would take the following form:

$$\Pi = -11090 + 18.707PQ + 390.088Q - 5.412AC$$

The sign of all variables was in accordance with economic theory. Coefficients of product price and quantity took the positive sign with profit which implies a positive association between the profit and each of product price and quantity. Thus, an increase of price by thousand dinars (with other factors are fixed) will result in 18.707 thousands ID increase in profit, and one-ton increase in product will result in 390 thousands ID in profit (with other factors are fixed). On the other hand, production cost coefficients took the negative sign with profit, which implies a reverse relationship between profit and the average cost of production. An increase of thousand dinars in production cost will result in 5.41 thousands ID decrease in profit. It is obvious from coefficients of scale variables that the product price has the greatest influence on the profit.
The model shows that there is no autocorrelation problem because the calculated DW value is equal to (1.949), which is between (du < d < 4-du) i.e. (1.704 < 1.949 < 2.296) and is located in the acceptance area of the null hypothesis which states that there is no problem of autocorrelation between residues. It is important to note that $Q^2$ and $Q^3$ are functionally related to the variable $Q$, but the relationship is nonlinear. Thus, this model satisfies the assumption that there is no linear relationship between the independent variables (11) because the model is nonlinear. Because of the adoption of cross-sectional data, it is necessary to detect the problem of Heteroscedasticity. Breusch-Pagan-Godfrey (12) has been tested using Eviews.10, which includes the estimation of error square regression equation as a dependent variable ($Q$), $Q2$ and $Q3$ as independent variables (13). The test proved significant (F) from which it is possible to conclude that the estimated model suffers from the problem of heteroscedasticity as shown in Table (11).

| Table 11. Heteroskedasticity Test By (BPG). |
|---------------------------------------------|
| F-statistic | 34.46889 | Prob. F(3,236) | 0.0000 |
| Obs*R-squared | 73.12054 | Prob. Chi-Square(3) | 0.0000 |
| Scaled explained SS | 424.0729 | Prob. Chi-Square(3) | 0.0000 |

Source: Calculated using Eviews.10
In order to overcome this problem, the Robust M-Weighted Estimator (RM.W) was used (9).

After treatment, the short-run total cost function was estimated as in Table 12.

| Table 12. Estimation of cost function of rice production By Robust Least Squares |
|---------------------------------------------|
| Variable | Coefficient | SW. Error | z-Statistic | Prob. |
| C | 900.2594 | 220.3158 | 4.086223 | 0.0000 |
| $q$ | 307.4431 | 14.60211 | 21.05470 | 0.0000 |
| $q^2$ | -3.676260 | 0.139893 | -26.27899 | 0.0000 |
| $q^3$ | 0.030295 | 0.000327 | 92.71770 | 0.0000 |

Robust Statistics

| R-squared | 0.520592 | Adjusted R-squared | 0.514497 |
| Scale | 1213.733 | Deviance | 1473148. |
| Rn-squared statistic | 245920.9 | Prob(Rn-squared slat.) | 0.000000 |

Non-robust Statistics

| Mean dependent var | 7013.079 S.D. dependent var | 8996.835 |
| S.E. of regression | 45279.07 Sum squared resid | 4.84E+11 |

Source: Calculated using Eviews.10
Results showed that all estimated coefficients for cost function were significant at 1% probability according to Z test. Derurination coefficient was 0.52 which means that the total output explains about 52% of changes occurring in the production cost of rice, while other variables change (which represented about 48%) are attributed to other factors not included in the model, such as education, experience, age, and family size. The function passed all econometric tests, and thus it could depend on to derive the long-run cost functions.

$$SRTC = 900.259 + 307.443Q - 3.676Q^2 + 0.030Q^3 ....(1)$$

Both marginal and inmediate costs were derived from the estimated production cost function (1) and could be expressed in the following equations:

$$MC = 307.443 - 7.352Q + 0.09Q^2 ....(2)$$
$$SRATC = \frac{SRTC}{Q} = \frac{900.259}{Q} + 307.443 - 3.676Q + 0.030Q^2 ....(3)$$

According to average current production of farms which is (22.038) tons, both marginal and Average production costs are estimated at (189.134, 281.856 thousand dinars respectively). The estimated cost elasticity at this production level is about 0.67. Therefore, these farms are subjected to the increase in yields, and when the costs increase by a
certain amount, the production will further increase.

**Optimal behavior of the product in the short run**

In order to find the optimal behavior of rice producers in the short-run, and to identify the optimum level of production, the short-run objective of the product is either to maximize profit and gaining economic profits or to minimize costs (assuming that the market is the perfect market for competition and objective). Therefore, the optimal level of the cost minimizing output can be obtained by finding the minimum end of the average total cost function by performing the first differential of function (3) for the production volume (Q) and then equalizing it with zero as follows:

\[
\frac{d\text{SRATC}}{dQ} = -900.259Q^{-2} - 3.676 + 0.06Q = 0 \quad \ldots \quad (4)
\]

Multiply equation 4 by ( - \(Q^{2}\)) results that:

\[
900.259 + 3.676Q^{2} - 0.06Q^{3} = 0 \quad \ldots \quad (5)
\]

Equation 5 can be solved by trial and error or by Newton approach for solving non-linear equations (3). The last approach requires the assumption of an initial value to find out the current value. This calculation was repeated until the two values (initial and current) are equal or too closed to achieved the required accuracy i.e. the past value is almost equal to its current counterpart (4). Rice production was then estimated at lowest point of ATC (optimal production average) to be about 64.84 ton. This average is greater than that of actual production (22.038 tons) by 42.8 tons.

**The minimum price accepted by farmers to supply their products**

This was estimated by achieving the first differentiation for average variable cost function and equalizing it with zero (1).

\[
\text{SRAVC} = 307.443 - 3.676Q + 0.030Q^{2} \quad \ldots \quad (6)
\]

\[
\frac{\partial\text{AVC}}{\partial Q} = -3.676 + 0.06Q = 0 \quad \ldots \quad (7)
\]

\[
Q = 61.27
\]

Thus, the production size at the lowest point of average variable costs was estimated to be about 61.27 ton. By substituting of this value in equation 6, the minimum value for average variable cost was obtained which was 194.83 thousand ID that represents the minimum price acceptable by the producers.

**The level of output that maximizes profit**

This size can be calculated by equalizing the marginal cost with the product price (9) which is 685 thousand ID/ton, as follows:

\[
307.443 - 7.352Q + 0.09Q^{2} = 685 \quad \ldots \quad (8)
\]

\[
0.09Q^{2} - 7.352Q - 377.557 = 0 \quad \ldots \quad (9)
\]

Constitution approach was used to solve this quadratic equation according to the following formula:

\[
Q = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}
\]

For \(a=0.09\), \(b=-7.352\), \(c=-377.557\):

\[
Q = \frac{7.352 \pm \sqrt{(7.352)^2 - 4(0.09)(-377.557)}}{2(0.09)}
\]

\[
Q = \frac{7.352 \pm 13.785}{0.18}
\]

Economic analysis showed the output which maximizes the profit (117.42 tons) which is higher than the optimal production size (64.83 tons) by 52.59 tons.

**Cost elasticity**

The cost elasticity can be found by dividing the marginal costs on the average costs in the short-run for each of production levels represented by the actual production level of (22.04) ton, optimum production level of (64.84) tons, and the profit-maximizing level of (117.40) ton. The actual, optimal and profit-maximizing level were substituted in both MC and ATC. The elasticity at the actual output level (0.772) was less than the correct one. This indicates that production is subjected to increasing yields i.e there is a relative increase in production at a lower relative cost. Cost elasticity at optimal output was (1). This means that at optimal production level of (64.84) tons, the relative increase in output is equal to relative increase in the cost. Therefore, the production in these farms will be subject to the stage of yield stability. At profit-maximizing level of 117.4 tons, the elasticity was 2.31, which means that the relative increase in output is achieved with a relatively higher cost. Thus, the production of these farms is subject to the period of decreasing yields. (table 13).
Table 13. Marginal costs, elasticity Cost average variable costs and average total costs of rice crop in Najaf Governorate

| Quantity | Average total costs | Average variable costs | Marginal costs | Elasticity Cost |
|----------|---------------------|------------------------|----------------|----------------|
| 10       | 363.709             | 273.683                | 242.923        | 0.667          |
| 22.037   | 244.739             | 241.004                | 189.134        | 0.772          |
| 30       | 254.172             | 224.163                | 167.883        | 0.66           |
| 40       | 230.909             | 208.403                | 157.363        | 0.681          |
| 50       | 216.648             | 198.643                | 164.843        | 0.76           |
| 60       | 209.887             | 194.883                | 190.323        | 0.906          |
| 64.835   | 209.102             | 195.216                | 209.102        | 1              |
| 70       | 209.984             | 197.123                | 233.803        | 1.113          |
| 80       | 216.616             | 205.363                | 295.283        | 1.363          |
| 90       | 229.606             | 219.603                | 374.763        | 1.632          |
| 100      | 248.846             | 239.843                | 472.243        | 1.897          |
| 110      | 274.267             | 266.083                | 587.723        | 2.142          |
| 117.433  | 297.141             | 289.475                | 685.221        | 2.306          |
| 120      | 305.825             | 298.323                | 721.203        | 2.358          |

Source: calculated based on the questionnaire

Measuring the Technical Efficiency of Rice Production

Technical efficiency, in general, means the production of as much as possible net output using a certain amount of resources, or achieve the same amount of output with the minimum possible resources. Technical efficiency can be measured as follows (18).

\[ \text{Technical Efficiency} = \left( \frac{\text{Actual Output}}{\text{Optimum Output}} \right) \times 100 \]

(22.04 / 64.83) \times 100 = 0.33.9%

It is evident from the technical efficiency measures that about 66% of the economic resources have not been fully utilized and this value is high, indicating that actual production is far from optimal production.

Cost Efficiency of Rice

Cost efficiency can be obtained by dividing TC at actual production level on TC at optimal production level, according to the following formula (19):

\[ CE = \left( \frac{Ci^{max}}{Ci^{min}} \right) \]

Where:

- \( CE \): cost efficiency
- \( Ci^{bi} \): TC at actual production level
- \( Ci^{min} \): TC at optimal production level

\[ CE = \frac{7013.08}{13556.10} = 51.7 \]

Cost efficiency may take more or less than unit. It is achieved when it takes the correct one value (7). Cost efficiency for rice less than the unit implies that resources were not optimally exploited.

Estimation of net income

The study involved the calculation of some economic indices such as net income for three production levels (actual, optimal and profit maximizing) depending on profit equation (2). These levels were respectively found to be 22.04, 64.83 and 117.42 keeping in mind that 685 thousand dinars is the price of rice ton (9) (equation 10).

\[ \pi = TR - TC \]

\[ \pi = 685 * Q - (900.259 + 307.443Q - 3.676Q^2 + 0.030Q^3) \quad \ldots \ldots \quad (10) \]

Substitution the values of actual, optimal and profit-maximizing production in equation (10), we obtain the net return at those levels which amounted to (8084.32, 30852.45, 45547.5 thousand dinars, respectively), as shown in table (11). The highest net return was achieved in case of profit maximizing production. However, the optimum level of production is characterized by producing one ton of rice at the minimum cost compared to other levels. The average cost of the optimum production volume reached (209.10) thousand dinars / ton, while the average cost at the profit maximizing production was about (297.09) thousand dinar/ton, and at the actual production level about (318.32) thousand dinars / ton. The highest level of average net return index was achieved at the optimum production volume, which was (475.90) thousand dinars / ton and the lowest level in the actual production amounted to about (366.80) thousand dinars / ton. The highest level of profitability
efficiency was achieved at the profit maximizing production which was 2.30. For one dinar return index, it was found that one thousand dinars, spent on the optimal production size achieved a relative increase of 3.28. The profitability index from the total revenues showed that it reached the highest level at the optimal production followed by the profit maximizing production and then actual production. This means that the total revenues obtained from the optimal production will achieve a profit of (0.69) compared with the other levels of production which achieved a profitable profit estimated at 0.56 and 0.54 respectively. It can be concluded from the previous analysis that the level at the optimal production is the best according to economic indicators as shown in table (14).

### Table 14. Economic indicators of rice crop production

| Index                      | Actual production (ton) | Optimal Production size (ton) | Profit max. production (thousand dinars) |
|----------------------------|-------------------------|-------------------------------|------------------------------------------|
| Product size (tons)        | 22.037                  | 64.835                        | 117.42                                   |
| Total revenue (thousand dinars) | 15097.4                | 44408.6                       | 80432.7                                  |
| Total costs (thousand dinars) | 7013.08                | 13556.10                      | 34885.2                                  |
| Net return (thousand dinars) | 8084.32                | 30852.5                       | 45547.5                                  |
| Average net return (thousand dinars / ton) | 366.80            | 475.90                        | 387.9                                    |
| Average total costs (thousand dinars / ton) | 318.20             | 209.16                        | 297.09                                   |
| Return dinar               | 2.15                    | 3.28                          | 2.30                                     |
| Profitability efficiency   | 1.15                    | 2.28                          | 2.30                                     |
| Profitability of the total revenue | 0.542          | 0.695                         | 0.565                                    |

Source: calculated based on the estimated costs and the profit function

Based on the results of this study, it can be concluded that the production quantity had the greatest impact on the profit compared to other variables (average production costs and price). According to technical efficiency and cost efficiency, the economic resources used in the production process have not been optimally explained, resulting in low technical efficiency. By calculating the price of the crop, which achieves the optimum production volume of 194.83 thousand dinars / ton and comparing it with the price determined by the state to purchase the output of rice of 685 thousand dinars / ton, we find that the price specified for the producers achieves economic profits that encourage producers to continue and expand in production. The study recommends to follow a production policy to increase economic efficiency and to achieve the optimal usage of available resources.

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