ESTIMATING PROFIT AND COST FUNCTIONS AND ECONOMIC AND TECHNICAL EFFICIENCIES OF WHEAT PRODUCTION NEJAF PROVINCE – AL-ABBASSI TOWNSHIP (A CASE STUDY) FOR SEASON 2016

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ABSTRACT

Wheat is one of the most important cereals, occupying a discrete economic position worldwide as a main source for human nutrition due to its content of essential nutrients. Therefore, wheat has a strategic trait in international economic relationships, and most developing countries, including Iraq, are seeking for achieving self-sufficiency from this crop. This study aimed 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 production of wheat. A random sample of 45 wheat farms in Nejaf province was selected during the agricultural season 2016. From efficiency scales of profit function, it was shown that the average production costs had the greatest impact on the profit compared to other variables (product price and yield). According to the cost function, the optimal cost-minimizing production size was 49.40 tons. Both technical and economic efficiencies were 61.96%, while price and cost efficiencies were 35.1% and 0.53 respectively. From these data, it can be concluded that the actual production uses only 62 % from economic resources and it affords 38% extra cost. The study recommends following a production policy which increases the economic efficiency and achieves the optimal exploit for available resources.

Keywords: Profit Function, Cost Function, Technical Efficiency, Economic Efficiency, Cost Efficiency

تقدير دالة التكاليف والربح والكفاءة الاقتصادية والفنية لانتاج القمح في محافظة النجف – ناحية العباسية (حالة دراسية) للموسم الزراعي 2016

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المستخلص

يعد محصول القمح من أهم محاصيل الحبوب التي تحتل مركزا اقتصاديا متميزا في معظم دول العالم كونه يشكل مصدرا غذائيا مهما للإنسان لاحتوائه على عناصر غذائية أساسية ، لذلك فلا غرابة من أنه يحتل سمة إستراتيجية في العلاقات الاقتصادية الدولية ، وتسعى معظم الدول النامية ومنها العراق إلى تحقيق الاكتفاء الذاتي منه.استهدف البحث تقدير دالة الربح ودالة التكاليف الكلية وتقدير الكفاءة الفنية والاقتصادية والسعرية وكفاءة الكلفة وحساب بعض المؤشرات الاقتصادية عند حجم الإنتاج الفعلي والأمثل والمعظم للربح لمحصول القمح في محافظة النجف. لذلك اخذت عينة عشوائية من مزارعي هذا المحصول في محافظة النجف للموسم الزراعي 2016 بلغت 45 مزرعة . وتبين من خلال حجم معلمات دالة الربح إن لمتوسط التكاليف الانتاجية أهمية كبيرة في الربح مقارنة مع بقية متغيرات سعر الناتج وكمية الانتاج . واعتمادا على دالة الكلفة فقد بلغ حجم الإنتاج الأمثل والمدني للتكاليف 49.40 طن وبلغت كل من الكفاءة الفنية والكفاءة الاقتصادية 61.96 %، اما الكفاءة السعرية فقد بلغت82.06% وبلغت كفاءة الكلفة 0.64 . نستنتج من الدراسة إن الانتاج الفعلي ينتج باستخدام 62 % من الموارد الاقتصادية المستخدمة في العملية الإنتاجية ويتحمل كلفة إضافية مقدارها 38% ، توصي الدراسة بأتباع سياسة إنتاجية تهدف إلى زيادة الكفاءة الاقتصادية وتحقيق الاستخدام الأمثل للموارد المتاحة مما ينعكس على زيادة الكفاءة في استخدام الموارد الإنتاجية.

الكلمات المفتاحية:– دالة الربح, دالة التكاليف, الكفاءة الفنية, الكفاءة الاقتصادية ,كفاءة الكلفة.

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INTRODUCTION

National food security is among the most important and urgent problems facing the almost all developing countries including Iraq. Wheat is considered the cornerstone for strategic crops involved in food security. The demand for this crop is continuously increasing and exacerbating due to the increased population. Historically, Iraq is well-known an original country for wheat which is now cultivated all over the country. The characteristic features of wheat that bestow this unique importance are the balanced contents of protein and carbohydrate, and the presence of gluten which eases the bread formation. Furthermore, wheat cereals have high nutritional value represented by 63-71% starch and 2-3% glucose, making this crop a favorable source of carbohydrate (28). Apart from nutritional value, wheat effectively increases farmer's income. However, many obstacles are facing farmers when they want to expand the crop cultivation. Increased wheat cultivated area does not only depend on the land availability, but also on efficient use of technologies in all growing stages, such as using improved seeds, chemical fertilizer, modern agricultural machineries, and spray irrigation system, beside, of course, the optimal benefit from economic studies in this regard. This research based on a hypothesis that wheat farmers in Nejaf can achieve profit that enables them to expand their production of this crop. Accordingly, this study aimed to estimate profit and total production functions, calculate the profit-maximizing and cost-minimizing production, and to measure the technical, economic, price and cost efficiency for wheat. Many previous studied have shed light on the cost function and scale economic for wheat. In Sudan, Ali and Imad (5) studied the economic efficiency of wheat and faba bean production for small scale farmers. The study revealed that faba bean was more economically efficient than wheat. Used cost function to estimate the technical and cost efficiency and profit for wheat and barley crops in Diyala province (6). The study indicated the possible expansion in cultivation of these crops exploiting the advantage of mass production. analyzed the cost function and economical size for wheat in Salahuddin province. The average actual cost per unit area was 172.835 thousand dinars per donum. On the other hand, the optimal level of production was 25.64 tons, while the optimal area that could be cultivated to achieve the optimal level of production was about 39.38 donums (19). studied the cost function of wheat in Wasit province,and showed that optimal size of production was 196.529 tones which required a cultivation of about 230.038 donums, while the optimal cultivation area 544 donums which gives about 473.5 tons yield (2). Several other studies have addressed this issue using different agricultural crops in different geographical locations (3,7,13,14,19,22,23, 24,27). Results varied according to variables, analysis method and the studied crop.

MATERIAL AND METHODS

Studying the production cost function is very important for agricultural crops, especially wheat. That is because such study shed a light on some vital indices that determine the appropriate income for producers and appropriate price for consumers. Furthermore, production cost functions could be considered as important economic indicators for production stage which farmers follow, and then to determine the optimal size of production for better using of economic resources. The availability of such data provide essential information for policy makers to determine the consumer price which serves the agricultural policy to achieve its goals. The current research depends on both quantitive and descriptive analysis, and statistical and economice analysis. The first analysis is represented by displaying the cost items and their relative importance, and some data concerning the sample farmers, while the second analysis estimated the total cost function from which the economic derivatives related to the study objectives were calculated. Other indices, such as economic and price efficiencies, optimal and actual average cost, cost efficiency and others were also calculated during data analysis. Data were obtained directly from field sources in Nejaf province in 2016 during field survey conducted by the researchers. A suitable questionnaire was constructed in cooperation with Nejaf Agricultural Directorate. Forty-five farmers were included in the study who represented 5% of the total farmers (900) in Al-Abbassiya township/ Nejaf. Eviews and Excel software were used for data analysis.

RESULTS AND DISCUSSION

Fixed and variable costs for wheat farms were analyzed to elucidate each item in these costs. The variable costs were further subdivided into production requirements costs which included seeds, fertilizers, pesticides, and mechanical processes costs (land digging, smoothing, settlement, and channel opening), marketing cost, harvesting cost (knowing that the harvesting was mechanical), the rented labor cost, and cost for production requirement transportation.

Table 1. Relative importance of items of variable costs wheat crop

Variable cost items	Value (Dinars)	% Relative importance
Production requirements	218000	75.8
Mechanical costs	17000	5.8
Rented labor	16000	5.5
Production transfer	5000	1.8
Water pump repair	11000	3.8
Fuel	24000	8.2
Total variable costs	291000	%100

Source: calculated based on the questionnaire form.

Table 2 shows that fixed cost have distributed among its main items which included family labor cost, land renting, and the interest over capital

Table 2. Relative importance of fixed costs items of wheat crop

Fixed cost items	Value(thousand dinars)	% Relative importance
Family labor cost	6700	36.4
Farm rent	9993	10.22
Interest on invested capital	1900	53.7
Total fixed cost	18059	%100

Source: calculated based on the questionnaire form

The table shows a rise in land renting compared to family labor cost due to high rent in the studied area. The reason behind low family labor cost is the remote location of the farms from farmers' residence. Therefore, only one or two individuals from the family devote their time for farm management. Regarding the cost of interest rate on capital, it was relatively high due to low financial capacity of most farmers who resort to get loans (which involve interests), and the minimum requirement insurance to get loans. Table (3) shows the relative importance of each of fixed cost items, and variable costs to total costs.

Table 3. Relative importance of fixed and variable costs from total costs of wheat crop planting season 2016 sample study

Total costs items	Value (thousand dinars)	% Relative importance
Variable cost	291000	94.2
Fixed cost	18059	5.8
Total cost	309059	%100

Source: calculated based on the questionnaire form

Variable costs represented 94.2% while only 5.8% of the total cost is attributed to fixed costs. Thus, variable costs are far more important that fixed costs, and any attempt to minimize the costs should aim to minimize one or all items of the variable costs as shown in table 3.

Estimation of Profit Function

Ordinary least square was used to estimate the parameters of profit function and short-term cost function. The function model was estimated according to economic theory which states that the profit equals to total revenue (TR) minus total cost (TC)(11) . The cost function can be derived as follows (1):

$\pi = TR - (TVC + TFC) \ldots\ldots\ldots\ldots(1)$===$TR = P_Q * Q\ , TC = P_X.X + TFC$

$\pi = \sum P_Q.Q - [\sum P_X.X + TFC] \ldots\ldots(2)$===Where:

π: Profit or net return.
P_Q: Product price.
Q: Product size.
X: quality of variable resources.
P_X : price of variable resources.=
TFC : total fixed costs.
From equation 2, the profit function can be derived as follows: $\pi = (P_Q, C, Q)$
Accordingly, the profit function model can specified as follows: $\pi = b_o + b_1 P_Q - b_2 C + b_3 Q + U_I$
Where:
π: profit .
P_Q: sale price per ton (1000 ID)
C: average production cost (1000 ID/ton)
Q: product size of wheat (ton)
b_O: intercept
b_i: regression coefficients
U_I: error term.

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 logarithmic model (Table 4).

Table 4. Estimation of profit function for wheat in Najaf for the season2016

Dependent Variable: LPROFIT
Method: Least Squares
Date: 10/19/17 Time: 10:29
Sample: 1 45
Included observations: 45

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4.801197	4.102142	1.170412	0.2486
LPY	1.382160	0.702422	1.967707	0.0559
LAC	-1.441051	0.130441	-11.04756	0.0000
LQ	0.994337	0.091075	10.91779	0.0000

R-squared	0.979257	Mean dependent var	7.771480
Adjusted R-squared	0.977740	S.D. dependent var	1.426013
S.E. of regression	0.212759	Akaike info criterion	-0.172621
Sum squared resid	1.855931	Schwarz criterion	-0.012029
Log likelihood	7.883982	Hannan-Quinn criter.	-0.112754
F-statistic	645.2042	Durbin-Watson stat	2.017365
Prob(F-statistic)	0.000000		

Heteroskedasticity Test: Breusch-Pagan-Godfrey	**2.339488(0.0867)**
Heteroskedasticity Test : RCH	**0.516188(0.4725)**
Serial Correlation LM Test	**4.284528 (0.1174)**
Jarque-Bera(Prob)	**1.7900 (0.408590)**
Ramsey Reset	**0.001206(0.4582)**

Source: Calculated using Eviews.10

Diagnostic tests indicated that the model has passed the econometric tests such as the absence of autocorrelation by using LM at 0.1174 probability for two lag periods. Therefore, the null hypothesis could be accepted, that is the model is free from autocorrelation. Also, the normal distribution of residuals has been satisfied by using Jarque-Bera test at 0.40859 probability, which is far greater than 0.05. From this test, we can accept the null hypothesis that the model's residuals have normal distribution. Breusch-Pagan-Godfery and ARCH tests revealed the absence of heteroscadiscity at 0.0867 and 0.4725 probability respectively for two lag periods. The result of Ramsey Reset test suggested a rejection for the presence of error in model determination, while multicollienerity between independent variables was found to be less than 10 using variance inflation factors test. From the last result, it can be concluded that the model is free from multicollienerity (15).

Table 5. Variance Inflation Factors Test of profit function for wheat

Variance Inflation Factors
Date: 11/19/17 Time: 01:07
Sample: 1 45
Included observations: 45

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
C	16.82757	16728.47	NA
LPY	0.493396	18277.14	6.270277
LAC	0.017015	507.1804	1.632912
LQ	0.008295	55.76996	7.217463

Source: Calculated using Eviews.10

From the coeffiecient of determination value R^2, it is obvious that the model explains 98% of the total changes in the profit function of wheat. This implies the major influence of explained factors (LPY, LAC, and LQ) on profit function. On the hand, the exogenous variables (represented by dummy variable) responsible for only 2.1% of explained factors. Studying the overall significance of the model reveals that calculated F value was 645; significant at 1% level, which is a proof that the model has a high statistical significance, and the explained variables within this model have an effect on the profit function. To test the statistical confidence in the estimations of the model coefficients, t test was used to measure the individual significance of the variables in the profit function. Results showed the statistical significance of these variables at 1% probability (except the product price %5,which indicates the reality of parameters of these variables. 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. That means, an increase of 1% in price will result in 1.380 ID increase in profit, and one-ton increase in product will result in 0.990 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 1% ID in production cost will result in 1.440 ID decrease in profit. It obvious from coefficients of scale variables that the production size has a great influence on the profit.

Estimation of Cost Function

Multiple models were used to estimate the total cost function using three forms of cost function (linear, square, and cubic). It was found that the cubic model was the most suitable model for the dependent relationship in this research. That is because this model suits the statistical, econometric and economic theory (17). Based on the economic theory, the short-run total cubic cost function using Robust Least Square (8) was used to whites heteroscedasticity standar errers, which occurred due to data aberration as the estimation of this model with traditional methods such as OLS will result in loosing of its good characteristics for estimation of model coefficients table(6).

Table 6.Estimation of cost function of wheat in Nejaf

Dependent Variable: TC
Method: Robust Least Squares
Date: 12/26/17 Time: 07:27
Sample: 1 45
Included observations: 45
Method: MM-estimation
S settings: tuning=1.547645, breakdown=0.5, trials=200, subsmpl=4, refine=2, compare=5
M settings: weight=Bisquare, tuning=4.684
Random number generator: rng=kn, seed=1789570303
Huber Type I Standard Errors & Covariance

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	728.3655	118.0560	6.169659	0.0000
Q	156.4905	10.25950	15.25322	0.0000
Q^2	-0.485775	0.128098	-3.792220	0.0001
Q^3	0.007938	0.000346	22.95210	0.0000

Robust Statistics

R-squared	0.681031	Adjusted R-squared	0.657692
Rw-squared	0.994186	Adjust Rw-squared	0.994186
Akaike info criterion	55.55041	Schwarz criterion	65.21542
Deviance	7171589.	Scale	378.7664
Rn-squared statistic	192351.5	Prob(Rn-squared stat.)	0.000000

Non-robust Statistics

Mean dependent var	4213.356	S.D. dependent var	6429.505
S.E. of regression	22742.68	Sum squared resid	2.12E+10

Source: Calculated using Eviews.10

Results showed that all estimated coefficients for cost function were significant at 1% probability according to Z test. Determination coefficient was 0.68 which means that the total output explains about 67.8% of changes occurring in the production cost of wheat, while other variables (which represented about 32.2%) 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.

Economic Analysis

1- The optimal cost-minimizing production

The optimal production can be obtained by finding the minimum limit of total average cost function and equals it with zero (12).

$$Min\ ATC = \frac{\partial SRATC}{\partial Q} = -728.366Q^{-2} - 0.485775 + 0.015876Q \ldots \ldots . . (3)$$

Multiply equation 3 by - Q^2 results that:

$$728.366 + 0.485781Q^2 - 0.015876Q^3 = 0 \ldots \ldots . . (4)$$

Equation 4 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 (16). Wheat production was then estimated at lowest point of ATC (optimal production average) to be about 49.40 ton. This average is greater than that of actual production (30.61 tons) by 18.79 tons.

2- Profit Maximizing Production Size

This size can be calculated by equivalence the marginal cost with the product price (12) which is 450 thousand ID/ton .

$$156.4906 - 0.971562Q + 0.023814Q^2 = 450 \ldots \ldots \ldots \ldots (5)$$

$$-293.51 - 0.971562Q + 0.023814Q^2 = 0 \ldots \ldots \ldots \ldots (6)$$

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

Economic analysis showed the product size which maximizes the profit was 92.48 tons which is higher than the optimal production size (49.40 tons) by 43.08 tons.

3- The least price accepted by farmers to supply their products of wheat

This was estimated by achieving the first differentiation for average variable cost function and equivalence it with zero (15).

$$SRAVC = 161.025 - 0.257235Q + 0.005906Q^2 \ldots\ldots\ldots\ldots(7)$$

$$\frac{\partial SRAVC}{\partial Q} = -0.485781 + 0.015876Q = 0 \ldots\ldots\ldots\ldots(8)$$

$$Q = 30.61$$

Thus, the production size at the lowest point of average variable costs was estimated to be about 30.61 ton. By substitution of this value in equation 8, the minimum value for average variable cost was obtained which was 369.29 thousand ID that represents the minimum price acceptable by the producers.

Economic Indices for Actual, Optimal and Profit- Maximizing Levels for wheat

The study involved the calculation of some economic indices such as for three production levels (actual, optimal and profit maximizing output depending on profit equation. These levels were respectively found to be 30.61, 49.40 and 92.48, keeping in mind that 450 thousand ID/ton is the price of wheat.

$$\pi = TR - TC$$

$$\pi = 450 * Q - (728.3660 + 156.4906Q - 0.485781Q^2 + 0.007938Q^3 \ldots\ldots(9)$$

Substitution of these levels in equation 9 gives the estimated to these levels where 8483.45, 13999.87 and 24291.21 thousand ID respectively (table 7). The greatest net return was achieved at the profit-maximizing production level. However, the optimal production level which minimizes the cost has an advantage that it produces one ton with minimum costs compared with the other levels. These costs were 166.608, 187.33 and 172.85 thousand ID/ ton for optimal, profit-maximizing and actual production respectively.(10,16,18,21,26) From table 7, it can be noted that the greatest index (283.39 thousand ID/ton) was for average net return which was achieved at the optimal production level; while the least index was for profit-maximizing production level (262.67) thousand ID/ton). The highest level of profit efficiency (1.70) was achieved at optimal production level. Regarding Dinar return index, it was found that every expended 1000 Dinars on optimal production achieved 2.70 relative increases. The index of achieved profit from total income was in its greatest value at optimal production level followed by profit-maximizing product level and finally the actual production level. That means the total income which is obtained from optimal production level achieved 0.629 profit compared to actual and profit-maximizing production levels (0.615 and 0.583) respectively (20). From this analysis it can be concluded that optimal production is the best one according to the economic indices as illustrated in table 7.

Table 7. Economic indicators of wheat crop

Index	Actual product (ton)	Optimal Production size (ton)	Profit max. product (thousand dinars)
Product size (tons)	30.61	49.40	92.48
Total revenue (thousand dinars)	13774.5	22230.56	41615.1
Total costs (thousand dinars)	5291.05	8230.685	17323.89
Net earnings (thousand dinars)	8483.45	13999.87	24291.21
The average net yield (thousand dinars / ton)	277.15	283.39	262.67
Average total costs (thousand dinars / ton)	172.85	166.608	187.33
Return dinar	2.60	2.70	2.40
Profitability efficiency	1.60	1.70	1.40
Profitability of the total revenue	0.615	0.629	0..583

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

Economic and Price Efficiency of wheat

Economic efficiency (EE) refers to the achievement of maximum income with certain costs, or achievement of the same income with minimum cost (9). EE is divided into two components: technical and price efficiency, and can be estimated as follows:

$$economic\ efficiency = \frac{optimal\ average\ cost}{actual\ average\ cost} * 100$$

$$optimal\ cost = \frac{actual\ cost}{optimized\ output}$$

$$actual\ average\ cost = \frac{actual\ cost}{actual\ output}$$

$$optimal\ cost = optimal\ average\ cost * optimized\ output$$

Price efficiency (PE) is the selection of lower cost resources and can be defined as the production of goods and services through the optimal usage of resources regarding their costs (4). PE can be estimated as follows:

$$price\ efficiency = \frac{economic\ price}{actual\ price}$$

Economic price (EP) is a price which equals the total average costs at their lower limit and the product at which achieves the ordinary profit. EP can be estimated from total average costs (1). From table 8, it is clear that EF of wheat is higher than its EE.

Cost Efficiency of Wheat

Cost efficiency can be obtained by dividing TC at actual production level by TC at optimal production level, and calculated according to the following formula (9):

$$CE = (Ci^{bi} \div Ci^{min})$$

=Where:

CE: cost efficiency

Ci^{bi}: TC at optimal production level

Ci^{min}: TC at actual production level

Cost efficiency may take more or less than the correct one. It is achieved when it takes the correct one value (25). Cost efficiency for wheat less than the correct one (table 8) which implies that resources were not optimally exploited.

Table 8. The economic efficiency and price of wheat crop

Paragraphs	
Actual output (tons)	30.610
Optimum output (tons)	49.40
Technical efficiency %	61.96
The actual costs (thousand dinars)	5291.05
Optimal average costs (thousand dinars)	107.10
The actual average costs (thousand dinars)	172.85
Optimal costs (thousand dinars)	5290.87
Economic efficiency%	61.96
Economic Price (thousand dinars)	369.29
The actual price (thousand dinars)	450
Price efficiency%	82.06
Total costs when the actual production volume	5291.05
The total cost of production at the optimal size	8230.69
Cost efficiency	0.64

Source:-calculated based on the estimated cost function

From the aforementioned results, it can be concluded that production size has the greatest impact on profit function of wheat compared with other price variables and production cost average. According to TE and CE, the economic resources used for production were not optimally exploited; a case which led to a decrease in production efficiency and an increase in the production cost of wheat. Calculation of prices which achieved the optimal production (369.288 thousand ID /ton) and comparing them with the priced determined by the state to purchase wheat (450 thousand ID/ton) revealed the determined price satisfied the farmers. Through this price, they can achieve profits that encourage them to continue and expand their 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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