AN ECONOMIC ANALYSIS OF COST FUNCTIONS AND TECHNICAL AND MARKETING EFFICIENCIES OF MAIZE FARMS IN IRAQ

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Abstract

This study aimed to measure the production efficiency, cost efficiency, profit-maximizing production level, and net income at actual, cost-minimizing, and profit-maximizing production, as well as to calculate the minimum price accepted by maize producers to supply their products, as well as to estimate the marketing efficiency of maize. A random sample of 50 maize growers from Diyala/ Iraq during the agricultural season 2017 was selected. Due to its harmony with economic and statistical logic, cubic formula was used to estimate the cost function. The results showed that maize production at the lowest point of the ATC (total average production) was 124 tons, which is higher than the actual production of 51.18 tons. The greatest net return was achieved at the optimal production level. However, the actual 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 13122.3, 31070.7 and 70741.29 thousand ID/ ton for actual, optimal and profit-maximizing production respectively. Furthermore, the study revealed a marketing efficiency of 94.4%, which is a good indicator for marketing performance. which means that the marketing costs afforded by farmers was less than the production cost.

Key words : Profit-maximizing output, optimal output, actual output, marketing efficiency.

Introduction

Maize crop is an important cereal crop and ranks third after wheat and rice in terms of importance at the global level. Iraq is one of the countries where it is best to grow this crop. Maize grain is consumed directly or indirectly by humans. It is suitable for bread preparation when mixed with wheat flour 5-15%, and also its seed is used in the production of starch because they contain 70-80% of the carbohydrate and also in the production of oils as it contains 4% oil (Al-Younes,1993). Such oil is characterized by good nutritional and health qualities. Furthermore, maize seeds are used as poultry nutrition. Legs and leaves of maize be used as green or dry feed. The cultivation of maize crop is concentrated in the central areas of Iraq, especially Diyala governorate. The average cultivated area and total production reached 13 thousand dunums and 260 tons, respectively, which accounted for 4.40%, 3.27% of the total cultivated area and the total production of the country in 2017. The impact of increasing producing cost on the cultivated areas in Diyala governorate led to a significant decrease in the number of farmers and consequently in cultivated areas as well

as productivity. Due to the importance of the crop in terms of industrial and food, the high production costs and low productivity of the unit area, it is necessary to conduct a study to determine the optimal size of the product and how close farmers are to this size. The research is based on the hypothesis that the maize farmers in Diyala province are making "economic profits" that enable them to expand their production. The aim of the research is to estimate the total cost function, calculate the size of the production-minimizing costs, the size of the maximal profit and the lowest price accepted by the farmers to display their production as well as to calculate some economic indicators at the level of actual, optimal and profit-maximizing production, and to derive the long-term supply function. Several previous studies have addressed this issue regarding maize [Ali and Ferhan, 2012; Dahla, 2009; Oyewo, 2011; Susan, 2011; Paudel, 2009; Ogundari and Ajibefun, 2015] and other crops in different geographical areas [Mohamed,1988; Helfan *et al.,* 2004; Ghazal *et al.,* 2010; Morsy *et al.,* 2014; Zaidan, 2015; Mohammed, 2015; AL- Ukeili *et al.,* 2015 ; Zaidan, 2016; Jumaili, 2017; AL- Qaysi, 2018; Mahmood, 2018; Mahmood *et al.,* 2018].

Materials and Methods

Cross-sectional data obtained through a random sample involving 50 maize farmers were included in the study who represented 15% of the total farmers (750) in Diyala. Eviews.10 and Excel software were used for data analysis.

Descriptive Analysis of the Cost Components of Maize Production

Variable costs represented 93.42% while only 6.58% 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 1.

Table 1: Relative importance of fixed and variable costs from total costs of maize crop growing season 2017.

% Relative importance	Value (thousand dinars	Total costs items items
93.42	12258.85	Variable cost
6.58	863.4	Fixed cost
100%	13122.3	Total cost

Source: calculated based on the questionnaire form.

(Table 2) shows the contribution of each variable cost items in the total cost. These included all mechanical processes, production requirements, marketing cost, waged-labor, and maintenance and transportation costs. The cost of production requirements has captured the bulk of total variable cost (TVC) with55.53%.

Table 2: Relative importance of items of variable costs maize crop**.**

Value (Dinars) importance	% Relative	Variable cost items
55.53	6807.31	Production requirements
19.93	2443.18	Mechanical costs
5.74	703.66	Marketing costs
11.22	1375.44	Rented labor
4.98	610.49	Fuel
2.55	312.60	Water pump repair
0.05	6.13	Production transfer
100%	12258.8	Total variable costs

Source: calculated based on the questionnaire form.

(Table 3) shows different items of fixed cost included family labor cost, land renting, and the interest over capital. The high cost of family work compared with other costs was shown to be due to the proximity of farms to farmers' housing in the area surveyed. Therefore, a large number of families devote their time to farm management. Land rent costs came second which were relatively high because most of the land was under contract with the state.

Table 3: Relative importance of fixed costs items of maize crop.

Value (Dinars) importance	% Relative	Variable cost items
85.32	736.70	Family labor cost
5.24	45.24	Farm rent
5.16	44.55	Interest on invested capital
4.28	36.69	Extinction
100%	863.45	Total fixed cost

Source: calculated based on the questionnaire form.

Results and Discussion

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 (Henderson and Quandt,1980). Based on the economic theory, the short-run total cubic cost function using Robust Least Square (Audibert and Catoni, 2011) was used to whites heteroscedasticity standard errors, 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 4.

Results showed that all estimated coefficients for cost function were significant at 1% probability according to Z test. Determination coefficient was 0.95 which means that the total output explains about 95% of changes occurring in the production cost of Maize, while other variables (which represented about 15%) 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.

The short-term cost function was as follows:

$$SRTC = 4.325 + 267.35Q - 0.272Q^2 + 0.0011Q^3 \quad ..(1)$$

From the estimated production cost function equation (1), both marginal and intermediate cost functions were derived and can be expressed in the following equations:

$$MC = 267.35 - 0.544Q + 0.0033Q^2 \quad ... (2)$$

$$SRATC = \frac{SRTC}{Q} = \frac{4.325}{Q} + 267.35 - 0.272Q + 0.0011Q^2 \quad ... (3)$$

Table 4: Estimation of cost function of maize in Diyala.

```
Dependent Variable: TC
Method: Robust Least Squares
Date: 02/25/19   Time: 13:19
Sample: 1 50
Included observations: 50
Method: S-estimation
S settings: tuning=1.547645, breakdown=0.5, trials=200, subsmpl=4,
    refine=2, compare=5
Random number generator: rng=kn, seed=1894301064
Huber Type I Standard Errors & Covariance
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Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	4.326212	54.12408	0.079931	0.0363
Q	267.3495	2.679896	99.76115	0.0000
Q2	-0.272696	0.020309	-13.42738	0.0000
Q3	0.001169	3.62E-05	32.31333	0.0000

Robust Statistics				
R-squared	0.951396	Adjusted R-squared		0.948226
Scale	242.5492	Deviance		58830.09
Rn-squared statistic	722850.4	Prob(Rn-squared stat.)		0.000000

Non-robust Statistics				
Mean dependent var	13855.83	S.D. dependent var		24858.87
S.E. of regression	5917.692	Sum squared resid		1.61E+09

Source: Calculated using Eviews.10.

When the actual average production of the research sample was compensated by 51.18 tons, the average costs and marginal costs were about 256.394, 248.152 thousand dinars, respectively. The cost elasticity was about 0.968, meaning that the production of these farms is subject to the increase in yields, The increase in costs by a certain percentage leads to increased production by a larger proportion.

Optimal Product Behavior in the Short Term:

1. Determination of the optimum and minimum production cost

The optimal production cost can be obtained by finding the minimum limit of total average cost function and equals it with zero (Doll and Orazem. 1984).

$$\text{Min ATC} = \frac{(SRATC}{(Q} = -4.325Q^{-2} - 0.272 + 0.0022Q$$
... (3)

Multiply equation 3 by - Q^2 results that:

$$4.325 + 0.272Q^2 - 0.0022Q^3 = 0 \quad ... (4)$$

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 (Hassani, 2016). Maize production was then estimated at lowest point of ATC (optimal production average) to be about 124 ton. This average is greater than that of actual production (51.18 tons) by 72.82 tons.

2. Profit Maximizing Production Size

This size can be calculated by equivalence the marginal cost with the product price (AL-Shafi'i, 2005) which is 350 thousand ID/ton.

$$267.35 - 0.544Q + 0.0033Q^2 = 350 \quad ... (5)$$

$$-82.65 - 0.544Q + 0.0033Q^2 = 0 \quad ... (6)$$

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

$$Q = \frac{0.544 \pm \sqrt{(0.54_4)^2 - 4(0.003_3)(-82.6_5)}}{2(0.003_3)}$$

$$Q = \frac{0.544 \pm 1.17_7}{0.006_6}$$

$Q = 260.8$ or $q = 95.9$, the negative value of the

quantities is neglected and the maximum amount of profit is 260.8 tons.

3. The lowest price accepted by farmers to supply their products of maize

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

$$SRAVC = 267.35 - 0.272Q + 0.0011Q^2 \qquad ... (7)$$

$$(SRAVC/(Q = -0.272 + 0.0022Q = 0 \qquad ... (8)$$

$$Q = 233.74$$

Thus, the production size at the lowest point of average variable costs was estimated to be about 123.63 ton. By substitution of this value in equation 8, the minimum value for average variable cost was obtained which was 233.74 thousand ID that represents the minimum price acceptable by the producers.

Economic and Price Efficiency of Maize

Economic efficiency (EE) refers to the achievement of maximum income with certain costs, or achievement of the same income with minimum cost (Chiona,. 2011). EE is divided into two components: technical and price efficiency, and can be estimated as follows:

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

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

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

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 (Al-Dabbagh, 2008). 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 (Adinya, 2009). From table 5, it is clear that EF of maize is higher than its EE.

Table 5: The economic efficiency and price of maize crop.

	Paragraphs
51.18	Actual output (tons)
124260.8	Optimum output (tons)Profit max. product (thousand dinars)
41.3%	Technical efficiency %
13122.3	The actual costs (thousand dinars)
105.83	Optimal average costs (thousand dinars)
256.4	The actual average costs (thousand dinars)
41.3%	Economic efficiency%
233.7	Economic Price (thousand dinars)
350	The actual price (thousand dinars)
66.8	Price efficiency%
13122.3	Total costs when the actual production volume

Source:-calculated based on the estimated cost function.

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

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 51.18, 124 and 260.0, keeping in mind that 350 thousand ID/ton is the price of Maize.

$$(= TR - TC$$

$$(= 350 * Q - (4.325 + 267.35Q - 0.272Q^2 + 0.0011Q^3 \qquad ... (9)$$

Substitution of these levels in equation 9 gives the estimated values to these levels where 93.61, 99.43 and 78.75 thousand ID respectively costs compared with the other levels. These costs were 13122.3, 31070.7 and 70741.29 thousand ID/ ton for actual, optimal,profit-maximizing production respectively.

From table 6, it can be noted that the greatest index (99.43 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 (78.75 thousand ID/ton). The highest level of profit efficiency (0.397) was achieved at optimal production level. Regarding Dinar return index, it was found that every expended 1000 Dinars on optimal production achieved 1.397 relative increases. The index of achieved profit from total income was in its greatest value at optimal production level followed by actual production level and finally the profit-maximizing product level. That means the total income which is obtained from optimal production level achieved 0.284 profit compared to actual and profit-maximizing production levels (0.267 and 0.225) respectively (Mbah, 2012). From this analysis it can be

Table 6: Economic indicators of Maize crop.

Profit max. product (thousand dinars)	Optimal Production size (ton)	Actual product (ton)	Index
260.8	124	51.18	Product size (tons)
91280	43400	17914	Total revenue (thousand dinars)
70741.295	31070.7	13122.3	Total costs (thousand dinars)
20538.7	12329.3	4790.7	Net earnings (thousand dinars)
78.75	99.43	93.61	The average net yield(thousand dinars / ton)
271.25	250.57	256.4	Average total costs (thousand dinars / ton)
1.290	1.397	1.365	Return dinar
0.290	0.397	0.365	Profitability efficiency
0.225	0.284	0.267	Profitability of the total revenue

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

concluded that optimal production is the best one according to the economic.

Measuring Marketing Efficiency

Marketing efficiency is one of the most important economic criteria used to measure the performance of the market. Improving marketing efficiency is a common goal for all producers, consumers and marketing firms for agricultural food commodities and the society in general. It can be estimated according to the following formula (Bdeawe, and Thamer. 2017):

$$ME = 100 - \left(\frac{MC}{MC + PC} \right) * 100$$

ME: Marketing efficiency

MC: Marketing costs:

PC: Total production costs.

Thus, there is a concept that connects the productive and marketing activities through the costs.

When marketing costs equal production costs, the marketing efficiency is 50% and it less than that if the marketing costs are greater than the production costs. If the marketing efficiency is more than 50%, this means that the marketing costs are less than the production costs (Shalaby, H. *et al.*, 2010).

It should be noted that the production and marketing costs of the research sample were 13122.3 and 703.66 thousand dinars, respectively. Then, the marketing efficiency of maize can be calculated as follows:

$$ME = 100 - \left(\frac{703.66}{703.66 + 13122.3} \right) * 100 = \%94.4$$

As the marketing efficiency of maize crop may reach 94.4% This can be considered a good indicator of the

marketing performance of this crop, which means that the marketing costs afforded by farmers less than the production cost. The reason is that the state has developed more than a marketing center to receive products from farmers, so most of the marketing costs are borne by the state. From the aforementioned results, it can be concluded that the economic resources used in the production process have not been effectively exploited.

When estimating the short-term cost function we conclude that the production is subject to the stage of increase in yield, ie, increasing production by a certain percentage leads to increased costs by a larger percentage. By calculating the price of the crop, which achieves the optimum production volume of 233.74 thousand dinars / ton and comparing it with the price determined by the state to purchase the output of rice of 350 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 the need to support production inputs from pesticides, fertilizers and payment of farmers' entitlements so that they can continue the production process and provide extension and marketing services to stimulate farmers to increase productivity.

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