ECONOMIES OF POTATO PRODUCTION (BAGHDAD PROVINCE AS A CASE STUDY)

F. H. N. AL-Bahadely* **O. K. AL-Ukeili**
Researcher **Prof.**
Direct. of Agric. In prov. of Baghdad **College of Agric. Univ. of Baghdad**
faiselhassan19@yahoo.com **usamakadhim@yahoo.com**

ABSTRACT

The research aimed at estimating the production function and the total cost function, as well as calculating the efficiency of resource use, technical, economic, price and cost efficiency. The research was based primarily on a simple random sample of 115 farmers in Baghdad governorate for the spring season 2016.The finding of the study reveal that the optimal size of production and the size of production that maximize profit reached about 98.6512, 112.8316 tons respectively. Technical, economic and price efficiencies were estimated at (61.8588, 61.8585, 90.479)% consequently, while cost efficiency was estimated at 0.66720, and the net farm income that achieved over all the sample less about 3726.9726 thousand dinars than that achieved at optimal size. The results of the resources efficiency criteria indicated that potato farmers were efficient in using resources (seeds, human labor) and were inefficient in using the irrigation resource. The research concluded that the quantity of seeds had the greatest impact on potato production and that there was waste in using the available resources, which led to the actual production being less than the optimum size of production. The research recommends that the related institutions should work to provide good quality potato seeds to cover the needs of local farmers, And from good sources in a timely manner and at the right price to increase the production and productivity of this important crop and reduce production costs. As well as the protection of the local producer by adopting price policies that grant best income of farmer.

Key words: potato production, economic efficiency, cost efficiency.
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اقتصاديات انتاج البطاطا (محافظة بغداد – حالة دراسية)

فيصل حسن ناصر البهادلي*
باحث علمي
مديرية الزراعة في محافظة بغداد/الرصافة
faiselhassan19@yahoo.com

اسامة كاظم جبارة العكيلي
استاذ
قسم الاقتصاد الزراعي – كلية الزراعة– جامعة بغداد
usamakadhim@yahoo.com

المستخلص

استهدف البحث تقدير دالة الانتاج ودالة التكاليف الكلية فضلا عن حساب كفاءة استخدام الموارد والكفاءة الفنية والاقتصادية والسعرية وكفاءة الكلفة. اعتمد البحث في المقام الاول على عينة عشوائية بسيطة قوامها (115) مزارعاً في محافظة بغداد للموسم الربيعي (2016). توصل البحث الى أن الحجم الأمثل للإنتاج وحجم الانتاج المعظم للربح بلغا نحو (98.6512، 112.8316) طناً على الترتيب، قُدرت الكفاءة الفنية والاقتصادية والسعرية نحو (61.8588، 61.8585، 90.479)% على الترتيب، بينما بلغت كفاءة الكلفة نحو (0.6652). وان صافي الدخل المزرعي المتحقق على مستوى العينة يقل بمقدار (3726.9726) الف دينار عن نظيره المتحقق عند الحجم الأمثل. وأوضحت نتائج معايير كفاءة استعمال الموارد أن مزارعي البطاطا كانوا كفؤين في استعمال موارد (التقاوي، العمل البشري) وغير كفؤين في استخدام مورد الري. استنتج البحث ان مورد كمية التقاوي كان له الأثر الاكبر في انتاج البطاطا وان هناك هدراً في استخدام الموارد المتاحة ادى الى جعل الانتاج الفعلي اقل من نظيره المتحقق عند الحجم الأمثل للتكاليف، ويوصي البحث بضرورة قيام المؤسسات ذات العلاقة بالعمل على توفير تقاوي البطاطا ذات النوعيات الجيدة لتغطية حاجة المزارعين المحليين، ومن المصادر الجيدة و في الوقت المناسب و بالسعر المناسب لزيادة انتاج و انتاجية هذا المحصول المهم وتخفيض تكاليف الانتاج. علاوةً على حماية المنتج المحلي باتباع سياسات سعرية تضمن دخل مجزي للمزارعين .

كلمات مفتاحية: انتاج البطاطا، كفاءة اقتصادية، كفاءة الكلفة.

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INRODUCTION

Potatoes is popularly known as the king of vegetables and its growing in more than 100 countries around the world (5). Potato is an important vegetable crop that has entered to Iraq during 1960s. This crop have been cultivated in Baghdad, Anbar and Nineveh. The demand of potatoes has increased due to population increase, (13).The cultivated area increased from 4467.750 ha in 1980 to 50925 ha in 2005 (6). Potato have been cultivated two times during the year in Iraq (spring, and autumn) (24). the Iraqi National Development Plan 2013-2017 in terms of potato production extend the cultivation seasons of this crop to more two seasons (summer, and winter) (11). Despite of the economic importance of potato ,it is still suffering from a decline in production compared with production levels in regional countries. The objective of this research is to estimate the production function of potato for the spring season 2016 in Iraq – Baghdad province, and determine factors that have a significant effect on potato production. Primarily, this research was based on a cross section data obtained by selecting a random sample of 115 potato farmers in the spring season 2016. A number of studies have been carried out in this field, such as the study of (1, 2, 10, 12, 15, 16, 17, 18, 22).

MATERIALS AND METHODS

In this study, several statistical methods have been used in accordance with the objectives of the study, including:

First: descriptive analysis, which deals with the description of the data and the changes occurring therein and the relative importance of there,

Second: inference analysis: which is specialized in estimating and testing hypotheses.

RESULTS AND DISCUSSION

First: Descriptive Analysis of Costs Production of Potato

1-Total cost: The total cost of potato can be divided into fixed ,and variable costs. Table 1 shows that, the variable costs consisted in total cost by 87.01%, while, fixed costs contributed in total cost by 12.98%.

Table 1. Relative importance of fixed and variable costs of total potato crop costs

Total cost items	Value by (thousand Dinars)	Relative importance%
variable cost	1853193.09	87.011
fixed cost	276646.30	12.989
total cost	2129839.39	100

Source: Collected and calculated from the sample data of the research.

2-fixed cost: Fixed costs divided among basic variables such as family labor, and land rent. Based on opportunity costs method, rent of land was calculated.

Table 2. Relative importance of fixed cost items from total fixed cost.

Fixed cost items	Value by (thousand Dinars)	Relative importance%
family labor	272800.92	98.61
land rent	3845.38	1.39
total fixed cost	276646.30	%100

Source: Collected and calculated from the sample data of the research

3-variable cost: Table 3 shows that, variable costs classifications, include costs for both production requirements, marketing costs, labor costs, total mechanization costs and irrigation costs, as shown in table 3.

Table 3. Relative importance of variable cost items from total variable cost

Variable cost	Value (thousand Dinars)	Relative importance%
Production requirements	1331463.44	71.847
Labor	223309.77	12.050
Mechanization	158077.37	8.530
Marketing	124824.25	6.735
Irrigation	15518.26	0.837
Total variable cost	1853193.09	100

Source: Collected and calculated from the sample data of the research

Second: Estimation and Analysis of Production Function

The production function of potato expresses the technical relationship between the amount of production as a dependent variable, and the seed quantity, no. of irrigations, and labour as independent variables. Table 4 shows the results of variables estimation

Table 4. Estimated parameters of potato production function for spring season 2016in Baghdad governorate (Dual Logarithmic Formula)

explanatory variables	Estimated parameters
Intercept term	0.566
	(1.169)
quantity of seeds(ton) lnx_1	0.746
	(10.140) **
No. of irrigations lnx_2	0.221
	(2.339) *
No. of human working hours lnx_3	0.253
	(3.543)**
$Observations$	115
R^2	0.758
R^{-2}	0.751
D-W	1.862
F	115.885

Source: Collected and calculated from the sample data of the research
Significance at level 0.01. * significance at level of 0.05**

It is noted from the previous table that the estimated parameters have a high degree of significance based on test-t, and the model is also highly significant based on the (F) test, which was 115.885. While the value of the modified determination coefficient was about 0.751, indicating that about 75.1% of the total fluctuations occurring in dependent variable are caused by fluctuations in the explanatory variables in the model and that the rest of the of the fluctuations are due to other factors not included in the model and have absorbed the impact of the stochastic factor. In order to test the varianc instability (Heteroscedasticity), the Park test was adopted to detect it by expressing the error term square as a dependent variable, (seed quantity, no. of irrigations, no. of human working hours) as independent variables of the Dual logarithmic formula and individually for each variable (9). That is, we obtained a constant variation of the random error. SPSS program using to estimated parameters from the last model, and then uses these parameters in the original regression extraction model and the variance analysis table and in theR^2, SEE and other estimates. This method is also known as GLS (4). After processing in the least squares method, the production function can be estimated as in Table 5.

Table 5. Estimated parameters of potato production function in Baghdad governorate after processing

explanatory variables	Estimated parameters
Intercept term	0.982
	(1.974)
quantity of seeds(ton) lnx_1	0.786
	(10.013) **
No. of irrigations lnx_2	0.243
	(2.382) *
No. of human working hours lnx_3	0.182
	(2.487)*
$Observations$	115
R^2	0.740
R^{-2}	0.733
D-W	1.902
F	105.221

Source: Collected and calculated from the sample data of the research
Indicates the level of significance 0.01. * Indicates a significance level of 0.05

With regard to the problem of linear correlation between the independent variables (Multicollinearity), the model based on the (Klein) test, which is used to detect this problem(14). Through the partial correlation matrix, it show no problem was found there , as can be seen in the simple correlation matrix between the variables in table 6, the simple

correlation coefficient between the independent variables was smaller than the total correlation coefficient of the estimated model after treatment.

Table 6. Simple correlation matrix between the variables of the estimated potato production function

	lny	lnx_1	lnx_2	lnx_3
lny	1	0.846**	0.044	0.729**
lnx_1		1	-0.092	0.718**
lnx_2			1	-0.011**
lnx_3				1

Source: Collected and calculated from the sample data of the research.
**** level of significance 0.01**

From Table 5 which it shows that the estimated parameters have a high degree of significant based on (t) test, and that the model is also highly significant according to the test (F) which amounting to (105.21). while the coefficient of adjusted determination (R^{-2}) was (0.733), indicating that about 73.3% of the total fluctuations in the dependent variable (potato production) are caused by fluctuations in the explanatory variables in the model. The signal of all parameters is consistent with economic logic, since the parameter value of the variable in the double logarithmic function represents the productive elasticity of this variables, it was found that the production elasticity of the variant of the seed quantity, which reached about 0.786, is positive and higher than the average due to the lack of use of this resource. This means that increasing the use of the quantity of seed by (1%) leads to an increase in output by 78.6%. The total productive elasticities of the production resources shown in the production function were found to be greater than the correct one, reaching about 211, which means that they reflect increasing returns to scale and indicate that the increase in the quantities of productive resources shown in the production function by 1% leads to increased potato production by 1.211%, This means that potato farmers are producing withen the first productive stage of the 1 diminishing productive law.

Efficiency of using resources of potato production

The economic theory assumes that there is efficiency when the value of the marginal product of each resource (VMP) is equal to the marginal factor cost of each resource (MFC). This is because the revenue is equal to the cost. When this ratio is less than the correct one, this means that the cost exceeds the value of revenue, When the ratio is greater than the correct one, this means that the return exceeds the cost (7). Resource efficiency is estimated by deriving the marginal output equation from the previously estimated production function, to calculate the resource use efficiency, the following equation can be used:

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

As: r: the efficiency of the resources used in potato production

VMP: the value of the marginal product which is equal to the output

price multiplied by the resource's marginal output.

MFC: The marginal factor cost used in the production of the potato crop (20), ie the price of the resource MFC = Pxi

$VMPxi = Py * MPPxiPy$: The output price of potato (thousand dinars /ton)

$Px1$: Average price of seeds (thousand dinars /ton)

$Px2$: Average cost of no. of irrigations (thousand dinars / one watering).

$Px3$:Average price of human labor (thousand dinars /hour)

Table 7. Efficiency of resources used in potato production for the spring season

Resources	Spring Season 2016		
	VMP	MFC	r
Seed Quantity	3189.2755	1917.2737	1.663
No. of irrigation	494.2625	14.453	34.198
Labor	2.0411	2.791	0.731

Source: Calculated using the potato yield function for the spring season 2016

The farmers of spring season crop production 2016 in the study area were efficient in using seed and human labor as the resource efficiency ratio were close to the correct one, while they were inefficient in using irrigation water. Therefore, farmers and responsible government agencies should increase investment in modern irrigation methods. It is also possible to note that the efficiency of the human resource provider was less than one. This indicates a significant increase in using of human labor, indicating that farmers are using the traditional methods of agriculture, which may lead to reduce productivity of the hectare as well as increase production costs.

Third: cost function of potato (short run) for spring season /2016 in Baghdad governorate

The cost function of potato was estimated using three forms of cost functions (linear, quadratic and cubic). The cubic form, is the most suitable to represent the relationship between the dependent variable (total cost by thousand dinars)and the independent variable (production Q by ton) based on the statistical tests (t, F, R^2) and econometrical tests (Klein, Durbin - Watson, Park), and the economic equation represented by reference and the size of its parameters with economic logic (economic theory) as mentioned in table 8.

Table 8. Estimated parameters of the potato cost function

Explanatory variables	Estimated parameters
C	262.264
	(0.152)
Q	430.662
	(4.875) **
Q^2	-3.333
	(-2.701)*
Q^3	0.015
	(3.444)**
$Observations$	115
R^2	0.872
R^{-2}	0.869
$D.W$	1.868
F	253.116

Source: Collected and calculated from the sample data of the research.
*** *level of significance 0.01. * significance level of 0.05**

Based on the t-test, the estimated parameters were found to be significant at the significance level 1% and 5% and the F test showed the significance of the function as a whole, adjusted R^{-2}coefficient showed that 86.9% of changes in total costs were caused by changes in total potato output and that 13.1% of those changes were due to other factors not included in the model and their impact was absorbed by the stochastic factor. Based on D-W test the results showed that there is no autocorrelation problem, it should be noted here that the Q^2 (square output) and Q^3 (cube output) are functionally linked to the Qi variable (output) but by the nonlinear relationship (9), Thus, such a model satisfies the assumption of that there is no linear relationship between independent variables. In order to adopt a cross-sectional data, it is necessary to detect the problem of heteroscedasticity. The Park test, which includes the estimation of the regression equation of the error square as a dependent variable and the product of potatoas an independent variable(9). The logarithmic function is calculated as follows:

$$lnei^2 = 10.891 + 1.161lnQ$$

t (5.020) F = 25.202

Since the estimated function is significant below the 1% level according to the F test, and the calculated t value of the slope of the error regression equation is greater than that of its schedule counterpart, which indicates the existence of the problem of instability of variance and that the relationship as we see a positive relationship, incremental of the variable with the independent variable (production). We using the Weighted Least Squares Method (4).The total cost function of the potato crop was corrected for the spring season 2016. After treatment, the total short-run cost function was estimated as in table 9.

Table 9. Estimated parameters of the cost function of the potato crop after treatment

Explanatory variables	Estimated parameters
C	1147.945
	(1.676)
Q	372.255
	(6.749) **
Q^2	-2.447
	(-2.413)*
Q^3	0.013
	(2.788)*
$Observations$	115
R^2	0.868
R^{-2}	0.864
$D.W$	1.977
F	242.545

Source: Collected and calculated from the sample data of the research.
**** level of significance 0.01. * significance at level of 0.05**

It was found that the estimated parameters have high morale based on t-test and that the whole function is also highly significant according to the F test. And (86%) of the total fluctuations in the dependent variable (total costs) are explained by the change in the independent variables represented by production (Q) It can be observed from the estimated results in Table 9 that the total cost function of spring after the treatment was as follows:

$$SRTC = 1147.945 + 372.255Q - 2.447\,Q^2 + 0.013\,Q^3 \ldots\ldots (1$$

From the estimated cost function, both marginal and average costs were derived and could be expressed in the following equations :

$$MC = 372.255 - 4.894Q + 0.039Q^2 \ldots\ldots (2)$$

$$SRATC = \frac{SRTC}{Q} = \frac{1147.945}{Q} + 372.255 - 2.447Q + 0.013Q^2 \ldots\ldots (3)$$

the average production of farms is 61.0245 tons, both marginal and average production costs were 7218.836 and 290.1511 thousand dinars respectively, and cost elasticity was 0.754. Production in these farms was increase return to scale (IRS).

Estimating the optimum production cost

Under the previous assumptions, the optimal size of cost was obtained by equating the marginal cost function with the average cost function, or by finding the lower end of the overall average costs function (3), the lower end of the average total cost function was based on the first differential of function no. 3 in relation to the production size (Q) and then in the following equation:

$$\frac{dSRATC}{dQ} = -1147.945Q^{-2} - 2.447 + 0.026Q = 0 \ldots\ldots (4)$$

by multiplying the two ends of equation no. 4 with $(-Q^2)$ resulted:

$$1147.945 + 2.447Q^2 - 0.026Q^3 = 0 \ldots\ldots (5)$$

Equation no. 5 can be solved by the method of trial and error or Newton's method of repetition to solve nonlinear equations Newton's method for Nonlinear Equation(9). We obtain the optimal size at the lowest point of the average total cost of potato , i.e. the optimum production which reached 98.6512 tons. The actual size of the potato production at the sample level is 37.6267 tons less than the optimal production. This means that the farmers are far from the economic efficiency of using there resources. And that the product is still in the first stage and that the average costs exceed the marginal costs, this means there are economies of scale and long-term capacity savings.

The minimum price accepted by farmers for the production of the potato crop of the spring crop 2016

To determine the lowest price that potato farmers accepted for the Spring season to display their output (equal to the lowest point of average variable costs), the following steps can be taken:

From the total cost function 1 we derive the total variable cost function as follows:

$$TVC = 372.255Q - 2.447Q^2 + 0.013Q^3 \ldots (6)$$

To derive the average variable cost function, equation 6 is divided over the output Q :

$AVC =$
$372.255 - 2.447Q + 0.013Q^2 \dots\dots\dots (7)$
It was possible to calculate the production size at the lowest point of average variable costs by taking the first differential of equation 7 for production and equivalent to zero, as follows :
$\frac{\partial AVC}{\partial Q} = -2.447 + 0.026Q = 0 \dots\dots\dots (8)$
From equation8 the size of production which reduces the average variable costs is estimated at 94.115 tons, to compensate for the variable average cost in equation 7, the lowest price accepted by the potato farmers for the spring season which amounted to about 257.105 thousand dinars, is the lowest price to sell the product or continue to produce potatoes according to economic theory.

Level of profit that maximize output

The maximum level of profit can be achieved through the equalization of marginal cost function in equation 2 with the average price that farmers sold their products in wholesale markets, In the study area, which was 316.565 thousand dinars ,as follows:
$MC = 372.255 - 4.894Q + 0.039Q^2 =$
$316.565 \dots\dots (9)$
$316.565 - 372.255 + 4.894Q - 0.039Q^2 =$
0
$55690 + 4.894Q - 0.039Q^2 = 0 \dots\dots\dots (10)$
And using the Code of Mathematical Constitution to solve Equation no. 10 as follows :
$Q = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$
$Q = \frac{-4.894 \pm \sqrt{(4.894)^2 - 4(-0.039)(-55.69)}}{2(-0.039)}$
$Q = \frac{-4.894 \pm 3.9068}{-0.078}$
Thus, the maximum level of production which maximize profit reached about 112.8316 tons.

Technical efficiency of the potato crop of spring season 2016

Technical efficiency means producing as much output as possible with a certain amount of resources, or achieving the same amount of output with as little resources as possible, technical efficiency can be estimated as follows (21):

Technical efficiency= (actual product / optimal product)*100

Economic efficiency means maximizing income (profits) with a certain amount of costs or achieve the same amount of income with minimum cost (23). Economic efficiency can be decompose into two parts: technical efficiency, and price efficiency, which can be estimated as follows:

$\text{Economic efficiency} = \frac{\text{optimal average costs}}{\text{actual average costs}} * 100$
$\text{optimal average costs} = \frac{\text{actual costs}}{\text{optimal product}} * 100$
$\text{actual average costs} = \frac{\text{actual costs}}{\text{actual produt}} * 100$
$\text{price efficiency} = \frac{\text{economic price}}{\text{actual price}} * 100$
$\text{optimal costs} = \text{optimal average costs} * \text{optimal product}$

Economic Price: is equal to the total average costs at its lower end when the firm achieves the normal profit. It is estimated from the total average cost function by the optimal output, it equals the optimum average costs (8).

Cost efficiency: The cost efficiency of any individual farm can be defined as the ratio of the total cost of the actual production size to the total cost of the optimum production size, and can be calculated as follows (19):

Cost Efficiency $C_{EE} = \frac{C^b}{C^{min}}$

and that: C_{EE} represents cost efficiency
C^b :Observed cost represents actual production costs
C^{min}: Minimum costs represent the level of minimum production costs

Through using that , results were reached and can be summarized in Table 10, the technical efficiency revealed that there is a deviation in production estimated about 38.10% from the level of production optimization, this requires a reallocation of resources efficiently through the expansion of production to reach an optimal production volume of about 98.6512 tons. Cost efficiency was less than the correct one and this means that the resources used were not optimally utilized.

Table 10. The economic and price efficiency of the potato crop of the spring season 2016

Items	unit	value
Actual product	ton	61.0245
Optimal product	ton	98.65125
The size of output that maximizes profit	ton	112.8316
Technical efficiency	%	61.8588
Actual costs	Thousand dinars	18520.342
Optimal average costs	Thousand dinars	187.735
actual average costs	Thousand dinars	303.491
Optimal costs	Thousand dinars	18520.292
Economic efficiency	%	61.8585
Economic price	%	286.427
Actual price	Thousand dinars	316.5652
Price efficiency	%	90.479
Total costs when actual production size	Thousand dinars	17706.328
Total costs when optimal production size	Thousand dinars	26538.043
cost efficiency	%	0.6672

Source: Calculated based on actual data, cost function data, and efficiency laws mentioned above

The research concluded that the variable cost was 87.1011% of the total costs, while the fixed cost was about 12.989%. As well as seed variable had the greatest impact on potato production. In addition to the resource were used inefficient led to make the actual production less than optimal production. Also the analysis shows that the lowest price acceptable by farmers in the spring season (2016) was about 257.105 thousand dinars / ton, which at this price has lost all the fixed costs in the short-run in the hope that the potato prices will improve in the long-run. Based on conclusion, the study recommend that the variable quantity of seed has had the greatest significant impact in the production of potatoes and this requires the institutions to provide the seeds of potatoes of good quality to cover the need of local farmers, and good sources at the right time and at the relevant price to increase the production and productivity of this Important crop and reduce production costs. As well as reviewing the use of the available resources in the production of the potato within the quantities recommended by the competent authorities to achieve optimum use of resources. Adopting an agricultural price policy that will increase production and protect the local producers by imposing a minimum price and reducing quantities imported, especially during loacl production season.

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