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Article

# An Economic Study of the Reality of Sesame Cultivation in Iraq

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**Abstract:** The study aims to examine the trends of industrial sesame area, production, yield, and prices in Iraq from 1990 to 2023. The results showed that the average area of industrial sesame cultivation exceeded 14,000 hectares, the average production exceeded 11,000 tons, the average yield exceeded 6,000 kg/hectare, and the average price exceeded 1,400 Iraqi Dinars. The results showed that the growth rates of area, production, yield, and prices were 6.2%, 5.3%, 2.8%, and 4.2%, respectively. However, the study showed a decline in industrial sesame production due to the increase in the cost of production, the government's weak support, and the ineffectiveness of agricultural policies. The econometric model showed a high level of explanation of the independent variables ($R^2 = 0.89$). The results showed that the cultivated area (0.897) and the price index (0.714) had a statistically significant positive effect on industrial sesame production at the 5% level of significance. However, the results showed a statistically insignificant negative effect of the yield (-0.098). The diagnostic tests showed the validity of the model and the absence of autocorrelation and multicollinearity. The results of the study showed the importance of providing incentives through prices, increasing the area of industrial sesame cultivation, and the need to implement flexible agricultural policies to support investment in sesame production in Iraq.

**Keywords:** Economic Study, Sesame Crop, Cultivated Areas, Production, Yield.

## Introduction

Plant yields are of vital importance in terms of economic growth in agricultural countries. In Iraq, for example, during the mid-1990s, there was a fluctuation in grain yields as people started cultivating other crops. In 1996, a substantial part of the country's requirements was met through a memorandum entered into with the United Nations Oil-for-Food Programme. During this period, restrictions on compulsory farming schemes were lifted, and drought-related problems faced by Iraq during the late 1990s were alleviated [1]. In economic terms, outputs are of great importance as they represent the value addition created through available capital. In economic terms, agriculture has immense importance for any country's economy as it has a direct link to human sustenance and has a great potential for generating economic activities [2]. In Iraq, cereal farming is quite common throughout the country; however, variations exist depending on regional conditions [3]. The development of agricultural projects and removal of obstacles for such development are of great importance, particularly through investment in land development and motivating farmers to continue working [4].

For sesame, the investors are required to overcome a number of challenges, including the availability of fair prices, cheap sources of pesticides and fertilizers, and support from the government, especially in the procurement of fuels for machinery [5]. Sesame is a plant grown for its seeds, which are used for the production of oil and other industrial products. This plant is grown in many countries across the world, including Iraq. Sesame is a highly valued crop in the economy of Iraq, with many uses in the food and pharmaceutical industries. In Iraq, sesame is grown in areas such as Wasit, Salah al-Din, Kirkuk, Anbar, Babylon, and Diwaniyah, which are known for their fertile soils and favorable climates for the crop [6]. Sesame seeds are used in many foods, including roasted seeds for the production of tahini and sesame oil used in salads, margarine, perfume, and medicine. Sesame seeds are also used to garnish bread, cakes, and other baked products. Sesame seeds are rich in nutrients, with a composition of 25.3% protein, 15% carbohydrates, and 47% oil [6]. Apart from its use in the production of edible oils, sesame seeds are used in the production of soaps, machinery oils, and lighting oils, although with the increase in production costs and a subsequent reduction in production levels, the plant is now used for food products only [7]. In Iraq, local varieties that have developed and adapted over time are cultivated: white and red sesame. There exist two varieties of sesame. The first variety is the white sesame. The special feature of this type of sesame is its high percentage of oil content, about 54%, and its resistance to wilt disease. The second type of sesame is the red sesame. The special feature of this type of sesame is its large size and dark color. The difference in color is also reflected in the sesame oil [8].

**Research Problem:** In Iraq, sesame farming has been declining due to increased costs of farming, agricultural policies, lack of support from the government, and economic factors.

**Research Objective**:The research aims at examining the changes in the area of cultivation, output, yield rate, and prices of industrial sesame from 1990 to 2023. The research will be conducted using descriptive and quantitative methods.

**Research Significance**: Sesame is one of the top crops in the world with significant value in the industrial sector. Therefore, it forms a very important part of the agricultural sector. The agricultural sector forms a very important part of the economy. Sesame farming also helps in the independence of the country from other countries. Sesame farming can also be done alongside other crops.

**Research Hypothesis**: The research hypothesis is that with a good agricultural policy, the production level and area of sesame can be maximized.

**Materials and Methods**

The research used data from the Ministry of Planning and Ministry of Agriculture. The data used included sesame cultivation area, production, yield rate, and prices from 1990 to 2023. The data was collected from the Ministry of Planning: Central Statistical Organization-Agricultural Statistics Department and Ministry of Planning-Agricultural Product Prices Department. The research also used data from the Ministry of Agriculture-Agricultural Statistics Department. The research used descriptive and quantitative methods. The research used the integrated approach. The research used descriptive methods by calculating arithmetic means, growing rates and using graphs using statistical software.

In quantitative analysis, Ordinary Least Squares (OLS) is used to identify the relationship between sesame crop production and its major factors [9]. OLS is one of the most frequently used econometric techniques to identify the relationship between one or more independent and one dependent variable. The general form of simple linear regression analysis is [10].

$$Y = a + bX$$

The simple linear regression model has two unknowns. The first is the intercept a, which is the value of Y when X is equal to 0. The second is the slope b, which measures the change in X as it affects Y. We can estimate these parameters using a method called Ordinary Least Squares (OLS). This method involves minimizing the sum of the squared differences between what is actually observed $(Y_i)$ and what is predicted $(\widehat{Y}_i)$. The objective function is given by [11].

$$E = \sum(Y_i - \widehat{Y}_i)^2$$

Since $\widehat{Y}_i = a + bX_i$, the error function becomes:

$$E = \sum[Y_i - (a + bX_i)]^2$$

In this environment, E represents the residual sum of squares, which is to be minimized. The minimization process is based on the principles of calculus. Since the function to be minimized is quadratic in form, its minimum occurs at that set of values for which all of its first partial derivatives with respect to the parameters a and b equal zero. This leads to the following set of equations [12]:

$$\frac{\partial E}{\partial a} = -2\sum[Y_i - (a + bX_i)] = 0$$

$$\frac{\partial E}{\partial b} = -2\sum X_i[Y_i - (a + bX_i)] = 0$$

After rearranging, these expressions can be written as [13].

$$\sum Y_i = Na + b\sum X_i$$

$$\sum X_i Y_i = a\sum X_i + b\sum X_i^2$$

The solution to the normal equations of ordinary least squares estimation provides the best linear unbiased estimates of the intercept parameter ( a ) and the slope parameter (b ), as postulated by the Gauss–Markov assumptions. The normal equations give the least squares estimates of ( a ) and (b), which are usually expressed as the solution for the intercept ( a ) and the slope ( b ) [14].

$$b = \frac{\sum(X_i - \bar{X})(Y_i - \bar{Y})}{\sum(X_i - \bar{X})^2}, a = \bar{Y} - b\bar{X}$$

In this case, $\bar{Y}$ and $\bar{X}$ represent the averages of the dependent and independent variables, respectively. These estimators are chosen to ensure that the errors are minimized to the lowest possible degree by considering the sum of the squared differences between what is observed and what is predicted by the model [15].

To create the regression model, the process begins with defining the problem and identifying the essential factors that influence sesame production. This process combines economic theory with insights gained from previous studies to create a hypothesis on how the parameters will behave.

Regression analysis is a statistical technique for exploring causal relationships between variables and predicting the outcome based on these causal relationships. By using the regression analysis technique, a mathematical framework is developed to measure how the independent variables affect the dependent variable[16].

$$Y = b_0 + b_1X_1 + b_2X_2 + \cdots + b_nX_n + e_i$$

Here, Y is the dependent variable, X represents the independent variables, b represents the parameters, and e is the stochastic error term. For the current study, the focus is on the relationship between sesame production and its main determinants as given by the following mathematical expression:

$$Y = f(X_1, X_2, X_3)$$

This general functional form is then translated into different regression specifications for estimation:

- **Linear model:**

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + e_i$$

**Semi-logarithmic model:**

$$\log Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + e_i$$

- **Inverse-logarithmic model:**

$$Y = b_0 + b_1\log X_1 + b_2\log X_2 + b_3\log X_3 + e_i$$

- **Double-logarithmic model:**

$$\log Y = b_0 + b_1\log X_1 + b_2\log X_2 + b_3\log X_3 + e_i$$

The choice of the most appropriate functional form is guided by statistical fit, economic theory, and diagnostic tests, ensuring that the final model captures the true relationship between production, cultivated area, productivity, and price.

**Dependent Variable ($Y$)**

- **Production of Sesame (tons):**

  This represents the annual domestic production of industrial sesame in Iraq, measured in tons. Domestic production indicates the ability of the country to meet internal demand, although many countries may rely on international markets to compensate for shortfalls caused by farmers' production decisions or climate variability.

**Independent Variables ($X$):**

Several key economic factors were included as explanatory variables:

- **$X_1$ – Cultivated Area (hectares):**

  The total area planted with sesame is a fundamental determinant of production. This variable captures the effect of land expansion on total output and is expected to have a positive influence on production.

- **$X_2$ – Productivity (kg/ha):**

  Productivity measures the yield per hectare and serves as a critical efficiency indicator. This variable assesses how variations in yield affect total production and provides insight into technological performance and resource use at the farm level.

- **$X_3$ – Crop Price Index (Iraqi dinars):**

  The domestic price of sesame is a key economic incentive for producers. A higher price encourages farmers to increase production by expanding cultivated areas and improving crop management. The standard price index is calculated as:

$$\text{Price Index} = \frac{P_t}{P_0} \times 100$$

where $P_t$ is the price in the comparison year and $P_0$ is the price in the base year.

**Additional Notes:**

- b1, b2, b3 are the estimated coefficients, which represent the extent to which each independent variable affects production.

- e_i is the stochastic error term, representing the influence of variables not included in the model.

**Results and Discussion**

**Illustrative analysis of the reality of the Industrial Sesame Crop Agriculture in Iraq.**

Sesame is a crop with both industrial and nutritional significance. If we take a look at the data from 1990 to 2023, it is apparent that there are fluctuations in the land area, production, yield, and price of the crop. This indicates a need for further investigation into the problems affecting the crop. On average, the land area allocated for the crop is just over 14,000 hectares, with a maximum of 35,000 hectares in 2005 and a minimum of 522 hectares in 2023. On average, production is above 11,000 tons, with a maximum of 24,000 tons in 2005 and a minimum of 782 tons in 2023. Moreover, the average yield per hectare is high, above 6,000 kg/ha, with a maximum of 9,933 kg/ha in 2020 and a minimum of 1,498 kg/ha in 2023. These fluctuations indicate a number of underlying problems affecting the crop, including the high production costs, lack of support from the government, and absence of a sustainable agriculture policy in the country. These problems are related to land, human resources, technology, politics, and the economy. It is also interesting to note the fluctuations in price, with an average price of 1,400 IQD, a maximum price of 2,250 IQD in 2015, and a minimum price of 2 IQD in 1990. It is apparent that price plays a vital role in the life cycle of the crop. Figures and tables are included in the study to show the fluctuations from 1990 to 2023.

**Table 1.** Cultivated areas and production and yield and price of the industrial sesame crop in Iraq for the period (1990-2023).

| Years | Total Production (ton) | Yield (kg ha$^{-1}$) | Cultivated Areas (ha) | Price (dinar) |
|---|---|---|---|---|
| **1990** | 14022.00 | 6021.00 | 23287.00 | 2.00 |
| **1995** | 13716.00 | 8051.00 | 17037.00 | 1500.00 |
| **2000** | 16698.00 | 8519.00 | 19601.00 | 1247.00 |
| **2005** | 24217.00 | 6827.00 | 35474.00 | 1300.00 |
| **2010** | 13349.00 | 1017.00 | 13123.00 | 1646.00 |
| **2015** | 2000.00 | 9524.00 | 336.00 | 2250.00 |
| **2020** | 5665.00 | 9933.00 | 5703.00 | 1713.00 |
| **2023** | 782.00 | 1498.00 | 522.00 | 1787.00 |
| **Average** | 11306.00 | 6424.00 | 14385.00 | 1431.00 |

Source: The Iraqi Ministry of Planning - Agricultural Statistics Department [17].

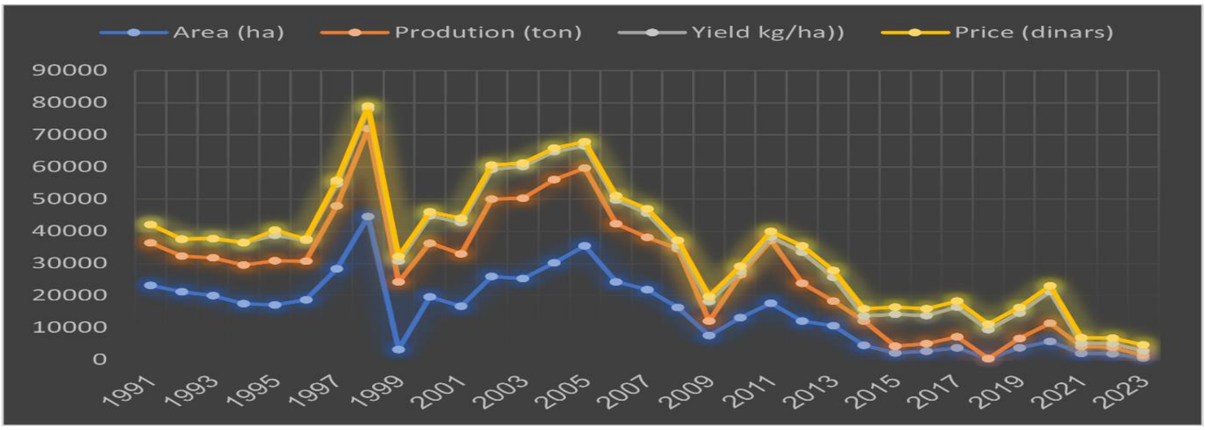


**Figure 1.** Shows the development of the cultivated areas, production, productivity and price of the industrial sesame crop in Iraq for the period (1990-2023).

**calculation of the growing rate, the standard number of price, yield , area and production of the industrial sesame crop in Iraqi for the period (1990-2023)**

Using simple linear regression on the natural logarithms of production, cultivated area, yield, and price over time, the growth rates and standard deviations for each variable were estimated as follows:

$$\log A = b_0 + bT, \log Pro = b_0 + bT, \log Y = b_0 + bT, \log P = b_0 + bT$$

where $(A)$ is the cultivated area, $Pro$is production, $(Y)$ is yield, $P$is price, and $T$represents time. Calculating growth rates is an effective indicator of the performance of agricultural economic policies, particularly in production, as it allows for understanding trends and assessing policy effectiveness.

The data shows positive trends in the development of sesame farming, including the increase in area at 6.2%, production at 5.3%, yield at 2.8%, and price rising by 4.2%. In other words, all the main indicators show positive trends. The data's fluctuation is also shown through its standard deviations at 12.4% for area, 14.7% for production, 17.1% for yield, and 20.3% for price. It is clear that price and yield were more stable than production and area. As can be seen from Table 2, the research has shown a positive impact of agricultural economics measures and policies from 1990 to 2023, although the impact was not strong enough to stabilize production and stop its expansion.

**Table 2.** growing rate and the standard number of industrial sesame crops in Iraq for the period (1990-2023).

| Variables | Standard number of contrasts | Growth rate |
|---|---|---|
| **Yield** | 17.10 | 2.80 |
| **Production** | 14.70 | 5.30 |
| **Sesame price** | 20.30 | 4.20 |
| **Cultivated areas** | 12.40 | 6.20 |

The estimates were developed by the researcher based on data from Table No. (1). Here, time is represented by the annual growth rate, and the standard deviation of the estimates is represented by the standard error of the estimated regression equation.

**Economic and Econometric Analysis**

The study used Ordinary Least Squares (OLS) to develop a multiple linear regression model, which is one of the most frequently used techniques for investigating the relationship between one dependent variable and multiple independent variables. A number of different functions were tested, namely linear, semi-log, inverse-log, and double-log. After checking for standard statistical tests and economic theory, the double-log model was found to be the most appropriate:

$$\log Y = 1.201 + 0.897 \log X_1 - 0.098 \log X_2 + 0.714 \log X_3$$

with t-values in parentheses:

$(1.85, 15.25, -1.10, 1.83)$, and model statistics: $R^2 = 0.89, F = 83.54, D.W. = 2.05$.

The model accounts for 89% of the variability of Iraq's sesame crop production based on its own right-hand side factors, while 11% is explained by factors not included in the model, which pull the dependent variable towards them, measured by the random error term. The results from the t-test show that at a 5% level of significance, all the parameters are significant, except for productivity ($X_2$). This means that both cultivated areas and price have strong explanatory power for crop production.

The results from the diagnostic tests, such as the Durbin-Watson and Klein tests, show that there is no autocorrelation and no multicollinearity, while the results from the F-test show that the model is significant.

From the results, it is clear that an increase in cultivated areas ($X_1$) has a positive and significant impact on crop production, measured at 0.897, which means that for every 10% increase in cultivated areas, crop production increases by 8.9%. However, an increase in productivity ($X_2$) has a negative and insignificant impact on crop production, measured at -0.098, which means that for every 10% increase in crop production due to an increase in productivity, crop production actually falls by 0.098, most likely due to inadequate government support and failure to adopt high-yielding varieties. On the other hand, an increase in the standard price index ($X_3$) has a positive and significant impact on crop production, measured at 0.714, which means that for every 10% increase in the domestic price of sesame, crop production increases by 7.1%.

The study highlights how crop production reacts to changes in factors such as cultivated areas, productivity, and price, and this information is crucial for developing policies to improve strategic crop production.

## Conclusion

The study proves that sesame production in Iraq is on an increasing trend, and this is based on an increase in the cultivated area, production, productivity, and prices, all of which show that there is progress in industrial sesame production. However, this increase is not adequate to meet the growing demand for this strategic crop. The fluctuating annual variations in cultivated areas and production levels have made the agriculture sector unstable, and this poses challenges to farmers and investors.

The econometric study proves that changes in the cultivated areas ($X_1$) contribute to an increase in production, and this relationship is significant at the 5% level, with a coefficient of 0.897. This shows that an increase in the areas under cultivation directly increases production. On the other hand, changes in productivity ($X_2$) show a negative relationship, which is not significant, with a coefficient of -0.098. This shows that low levels of production per unit of land contribute to low levels of production. This may be attributed to inadequate government support and failure to adopt high-yielding seeds. On the other hand, the crop price index ($X_3$) shows a positive relationship, which is significant, with a coefficient of 0.714. This shows that an increase in sesame prices by 10% increases domestic production by about 7.1%.

**Recommendations**

- Encourage the cultivation of industrial crops like sesame through increased funding of agricultural projects because of the high returns realized.
- Provide farmers with essential production inputs like seeds, fertilizers, and machines at discounted rates to reduce costs of production.
- Develop appropriate agricultural and industrial policies to increase production and promote industrial development.
- Develop production policies to resolve the problem of declining sesame and other industrial crop production in Iraq.
- Publicize the purchase price of sesame before the planting season to encourage farmers to cultivate the crop.
- Improve extension services to disseminate information to farmers on how to cultivate sesame.

In summary, a good and flexible agricultural policy that addresses issues like growth rates is important to promote strategic crop production and resolve issues like the decline of sesame production locally.

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