Estimation of the Supply Response Function for Sesame Crop in Qena Governorate

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ABSTRACT

Agriculture is one of the most important pillars of the national economic structure, as it is responsible for providing the food needs of society members, in addition to its contribution to economic development by increasing agricultural GDP, reducing imports and increasing exports. The area cultivated with sesame in Egypt reached about 90.39 thousand feddans in 2021 and about 527 feddans in Qena governorate, and it produces about 578 tons/feddan in Egypt and about 603 ton/ feddans in Qena, representing 104.3% of the average of Egypt. The production in Egypt governorate reached about 52.25 thousand ton and about 318 ton in gena, representing 0.61% of the average of Egypt in 2021.

The results showed the farmer's response to the per-feddan productivity of sesame in the previous year. The adjusted coefficient of determination also shows that about 75% of the changes affecting the area of sesame in the current year in Qena governorate are due to per-feddan productivity, while the remaining changes are due to other factors not measured by the function.

The results of the study showed that an increase in the farm price of sesame in the previous year by one pound leads to an increase in the area cultivated with sesame in the previous year by 139 feddans, assuming that the other factors remain constant at a certain level. The elasticity of supply response of sesame crop was also about 0.17, indicating that an increase in the farm price of sesame in the previous year by 1% leads to an increase in the area cultivated with sesame in the current year by 0.17%. The study also found that an increase in the net per-feddan yield of sesame in the previous year by one pound leads to an increase in the area cultivated with sesame in the previous year by 108 feddans, assuming that the other factors remain constant at a certain level.

The study also showed that there is a positive economically and statistically significant relationship between the area cultivated with sesame in the current year in thousand feddans and the farm price of peanuts and peppers in the previous year in thousand pounds. The elasticity of response was about 2.29 and 0.451 for peanuts and peppers, respectively. This indicates that an increase in the farm price of the two crops in the previous year by 1% leads to an increase in the area cultivated with sesame in the current year by 2.29% and 0.451%, respectively. The study also showed that there is a negative relationship between the area cultivated with sesame in the current year and the farm price of tomatoes. The elasticity of response was about (-2.39). This indicates that an increase in the farm price of tomatoes in the previous year by 1% leads to a decrease in the area cultivated with sesame in the current year by 2.39%. This does not agree with economic logic, despite its significance. The value of the coefficient of determination showed that about 94% of the changes affecting the area cultivated with sesame are attributed to the variables in the response model. The overall significance of the model has been established.

The study also showed that there is a positive and statistically significant relationship between the area cultivated with sesame in the current year in thousand feddans and the per-feddan production costs of cucumbers in the previous year. The elasticity of response was about 0.641. This indicates that an increase in the per-feddan production costs of cucumbers in the previous year by 1% leads to an increase in the area cultivated with sesame in the current year by 0.641%. The value of the coefficient of determination showed that about 53% of the changes affecting the area cultivated with sesame are attributed to the variables in the response model. The overall significance of the model has been established.

key words: Sesame crop; Supply Response; Costs; Net revenue.

INTRODUCTION

Agriculture provides some other industries with the basic raw materials needed for these industries, such as food processing for food products, sugar production, and textile products from spinning and weaving (Ghonuim *et al.,* 2017). Oilseeds represent about 50%-60% an important place in the Egyptian agricultural economy, and their importance comes from the fact that the demand for them is derived from the demand for the production of edible vegetable oils, which form a prevailing and essential dietary pattern for the Egyptian consumer. Sesame crop is considered one of the most important oilseeds crops in Egypt in general and Qena governorate in particular, as it is cultivated in light, heavy, and sandy yellow lands that have been recently reclaimed.

The area cultivated with sesame in Egypt reached about 90.39 thousand feddans and about 527 feddans in 2021 in Qena governorate, while the per-feddan yield of sesame in Egypt was estimated at about 0.58 tons/feddan and about 603 tons/feddan in 2021 in Qena

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governorate. It also produces in Egypt about 52.25 thousand tons/feddan in 2021 and about 318 tons/feddan in Qena governorate, representing 0.61% of the average of Egypt (Fangary, 2021). In addition, vegetable oils are important food commodities with a gap due to the local production deficit from meeting the increasing consumption, which in turn leads to fluctuations in their local prices.

Research Problem

The research problem is the difference in the degree of response of sesame farmers to economic variables in recent times according to the prevailing market mechanisms.

Research Objectives

The research aims to study the productive and economic indicators related to the cultivated area, per-feddan yield, total production of sesame crop, and the profitability of the spent pound, in addition to estimating the supply re sponge functions for sesame crop in Qena governorate to identify the most important economic variables affecting the cultivated area of sesame crop during the period 2007-2021.

Research Methodology

The research was based on the methods of descriptive and quantitative statistical analysis, where the simple and multiple linear regression method was used (Gittinger, 1982), as well as the estimation of the general temporal trends of some economic and productive phenomena related to the study crop during the period 2007-2021. The research also relied on secondary published data, which were collected from agricultural statistics, costs, and net return bulletins issued by the Economic Affairs Sector of the Ministry of Agriculture and Land Reclamation.

RESULTS AND DISCUSSIONS

Evolution of Productive Indicators of Sesame Crop in Egypt

Cultivated Area:

The data shown in Table (1) show that the average cultivated area of sesame in the Arab Republic of Egypt during the period 2007-2021 was about 74.53 thousand feddans. This area ranged between a minimum of about 57.58 thousand feddans in 2012 and a maximum of about 102.37 thousand feddans in 2020.

Table 1. Evolution of Cultivated Area, Yield, and Total Production of Sesame Crop at the Level of the Republic and Qena Governorate during the Period (2007-2021)

Year	The republic			Qena Governorate		
	Production (thousand tons)	Productivity (ton/feddan)	Area (thousand feddans)	Production (thousand tons)	Productivity (ton/feddan)	Area (thousand feddans)
2007	41.52	0.56	74.87	1.44	٠,٧٠	٢,٠٧
2008	36.46	0.55	66.35	1.840	0.662	2.78
2009	49.99	0.51	98.79	1.96	0.669	2.92
2010	46.16	0.53	87.87	1.38	0.64	2.16
2011	45.22	0.58	78.33	0.846	0.651	1.30
2012	34.81	0.61	57.58	0.643	0.699	0.92
2013	36.12	0.61	59.61	0.59	0.69	0.84
2014	37.47	0.59	63.82	0.88	0.65	1.35
2015	38.51	0.61	62.90	0.742	0.634	1.17
2016	39.60	0.57	69.84	0.587	0.660	0.89
2017	35.47	0.57	61.93	0.356	0.555	0.641
2018	34.66	0.52	66.28	0.484	0.618	0.783
2019	39.99	0.52	77.00	0.354	0.551	0.642
2020	59.56	0.58	102.37	0.252	0.575	0.438
2021	52.25	0.58	90.39	0.318	0.603	0.527
Average	41.85	0.56	74.53	0.84	0.64	1.30
Minimum	34.66	0.51	57.58	0.25	0.55	0.44
Maximum	59.56	0.61	102.37	1.96	0.7	2.92

Source: *Data collected and calculated from: Ministry of Agriculture and Land Reclamation, Central Administration of Agricultural Economics, Agricultural Statistics Bulletin, various issues.

By studying the general temporal trend of the evolution of the cultivated area of sesame crop in the Arab Republic of Egypt during the period 2007-2021, it was found that the data revolves around the arithmetic mean of about 74.53 thousand feddans, due to the insignificance of any of the different mathematical models (Table 2).

The productivity:

The data shown in Table (1) show that the average yield per feddan of sesame in the Arab Republic of Egypt during the period 2007-2021 was about 0.56 tons/feddan. This yield ranged between a minimum of about 0.51 tons/feddan in 2009 and a maximum of about 0.61 tons/feddan in 2013.

By calculating the general temporal trend of the evolution of the yield per feddan of sesame crop in the Arab Republic of Egypt during the period 2007-2021, it was found that the data revolves around the arithmetic mean of about 0.56 tons/feddan. This is due to the insignificance of any of the different mathematical models (Table 2).

Total Production:

The data shown in Table (1) show that the average total production of sesame in the Arab Republic of Egypt during the period 2007-2021 was about 41.85 thousand tons. This production ranged between a minimum of about 34.66 thousand tons in 2018 and a maximum of about 59.56 thousand tons in 2020.

By calculating the general temporal trend of the evolution of the total production of sesame crop in the Arab Republic of Egypt during the period 2007-2021, it was found that the data revolves around the arithmetic mean of about 41.85 thousand tons. This is due to the insignificance of any of the different mathematical models (Table 2).

Evolution of Productive Indicators of Sesame Crop in Qena

Cultivated Area:

The data shown in Table (1) show that the average cultivated area of sesame in Qena during the period 2007-2021 was about 1.3 thousand feddans. This area ranged from a minimum of about 438 feddans in 2020 to a maximum of about 2.92 thousand feddans in 2009.

Table 2. General Temporal Trend Equations for the Evolution of Cultivated Area, Yield, and Total Production of Sesame Crop at the National and Qena Governorate Levels during the Period 2007-2021.

Variable	Dependent Variable	Equation	R^2	F
The republic	Area (thousand feddans)	$\hat{Y}_i = 71.44 + 0.386X$ $(8.88)^{**}$ (0.436)	0.014	0.19
	Productivity(ton/feddan)	$\hat{Y}_i = 0.56 + 0.001X$ $(29.56)^{**}$ (0.377)	0.011	0.14
	Total production(thousand tons)	$\hat{Y}_i = 38.48 + 0.359X$ $(9.61)^{**}$ (0.804)	0.047	0.65
Qena Governorate	Area (thousand feddans)	$\ln \hat{Y}_i = 2.90 - 0.122X$ $(7.37)^{**}$ $(-8.17)^{**}$	0.84	$(66.77)^{**}$
	Productivity(ton/feddan)	$\hat{Y}_i = 0.703 - 0.008X$ $(39.77)^{**}$ $(-4.23)^{**}$	0.58	$(17.87)^{**}$
	Total production(thousand tons)	$\hat{Y}_i = 171 - 0.109X$ $(11.42)^{**}$ $(-6.58)^{**}$	0.77	$(43.35)^{**}$

Where: $\hat{Y}_i$ is the estimated value of the cultivated area, productivity per feddan, and total production of sesame in the Arab Republic of Egypt in year (i).

X is the time variable during the study period.

(i) = 1, 2, 3, 4, ..., 15.

The values between parentheses refer to the calculated (t) values.

(**): Significant at the 1% level. (*): Significant at the 5% level.

Source: Collected and calculated from the data of Table (1).

By calculating the general temporal trend of the cultivated area of sesame in Qena Governorate during the period 2007-2021, it was found that the exponential form is the best form to express this relationship. This is shown in the equation shown in Table (2). The results of the estimation indicate that the average area decreased at a rate of about 0.122% during the study period. The value of the coefficient of determination also showed that about 84% of the change in the area of sesame in Qena Governorate can be explained by the change in the economic, social, and technological factors associated with time.

The productivity:

The data shown in Table (1) show that the average yield per feddan of sesame in Qena Governorate during the period 2007-2021 was about 0.64 tons/feddan. This yield ranged from a minimum of about 0.55 tons/feddan in 2019 to a maximum of about 0.7 tons/feddan in 2007.By calculating the general temporal trend of the yield per feddan of sesame in Qena Governorate during the period 2007-2021, it was found that the linear form is the best form to express this relationship. This is shown in the equation shown in Table (2). The results of the estimation indicate that the average yield decreased at a rate of about 8 kilograms during the study period with a decreasing growth rate of about 1.26%. The value of the coefficient of determination also showed that about 58% of the change in the yield per feddan of sesame crop in Qena Governorate can be explained by the change in the economic, social, and technological factors associated with time.

Total Production:

The data shown in Table (1) show that the average total production of sesame in Qena Governorate during the period 2007-2021 was about 845 tons. This production ranged from a minimum of about 252 tons in 2020 to a maximum of about 1.96 thousand tons in 2009. By calculating the general temporal trend of the total production of sesame in Qena Governorate during the period 2007-2021, it was found that the linear form is the best form to express this relationship. This is shown in the equation shown in Table (2). The results of the estimation indicate that the average production decreased at a rate of about 109 kilograms during the study period with a decreasing growth rate of about 12.90%. The value of the coefficient of determination also showed that about 77% of the change in the production of sesame crop in Qena Governorate can be explained by the change in the economic, social, and technological factors associated with time.

Evolution of Economic indicators of sesame crop in Egypt

Production Costs:

The data shown in Table (3) show that the average production costs of sesame in the Arab Republic of Egypt during the period 2007-2021 were about 4,080 Egyptian pounds. These costs ranged from a minimum of about 1,860 Egyptian pounds in 2007 to a maximum of about 7,670 Egyptian pounds in 2021.

The average production costs of sesame in Egypt during the period 2007-2021 ranged from a minimum of about 1,860 Egyptian pounds in 2007 to a maximum of about 7,670 Egyptian pounds in 2021. A general temporal trend analysis of the evolution of production costs for sesame in Egypt during the period 2007-2021 showed that an exponential function is the best form to express this relationship. This is shown in the equation in Table (4). The estimation results indicate that the average production costs increased by a rate of about 0.09% during the study period. The value of the coefficient of determination also showed that about 92% of the change in production costs for sesame can be explained by changes in economic, social, and technological factors associated with time.

Total revenue:

The data in Table (3) show that the average total revenue for the sesame crop in Egypt during the period 2007-2021 was about 7.66 thousand Egyptian pounds. The revenue ranged from a minimum of about 3.7 thousand pounds in 2007 to a maximum of about 13.73 thousand pounds in 2021. By calculating the general temporal trend of the total revenue of the sesame crop in Egypt during the period 2007-2021, it was found that the exponential function is the best form to express this relationship. This is shown in the equation in Table (4). The estimation results indicate that the average revenue has increased by a rate of about 0.98% during the study period. The value of the coefficient of determination also showed that about 96% of the change in total revenue for the sesame crop can be explained by changes in economic, social, and technological factors associated with time.

Net revenue:

The data in Table (3) show that the average net revenue for the sesame crop in Egypt during the period 2007-2021 was about 3.58 thousand Egyptian pounds. The net revenue ranged from a minimum of about 1.57 thousand pounds in 2009 to a maximum of about 6.06 thousand pounds in 2021.

Table 3. Evolution of production costs, total revenue, net profit, farm price, profitability of the pound spent, and profitability of the product for the sesame crop during the period 2007-2021.

Year	Total Production costs (thousand pound)	Total Revenue (thousand pound)	Net Return per Feddan (per pound)	Market Price (pound)	The ratio of the net return to the total costs	Profitability of the Pound Spent (pound)	Profitability of the product (pounds per ton)
2007	1.86	3.70	1.84	708	1.99	0.99	473.97
2008	2.44	4.09	1.65	809	1.68	0.68	419.80
2009	2.51	4.08	1.57	908	1.63	0.63	387.41
2010	2.59	4.38	1.79	936	1.69	0.69	434.79
2011	2.96	4.77	1.80	972	1.61	0.61	433.65
2012	3.24	6.69	3.46	1357	2.07	1.07	823.09
2013	3.27	6.87	3.60	1393	2.10	1.10	832.10
2014	3.15	7.12	3.98	1429	2.27	1.26	910.53
2015	3.47	6.93	3.47	1478	2.00	1.00	782.39
2016	3.47	7.24	3.77	1512	2.09	1.09	842.19
2017	4.78	8.81	4.03	1912	1.84	0.84	858.21
2018	5.24	10.82	5.59	2188	2.07	1.07	1181.61
2019	6.85	12.43	5.58	2433	1.82	0.81	1148.76
2020	7.67	13.26	5.59	2617	1.73	0.73	1154.54
2021	7.67	13.73	6.06	2824	1.79	0.79	1180.97
Average	4.08	7.66	3.58	1565.1	1.89	0.89	790.93
Minimum	1.86	3.70	1.57	708	1.61	0.61	387.41
Maximum	7.67	13.73	6.06	2824	2.27	1.26	1181.61

Source: *Collected and calculated from data of: Ministry of Agriculture and Land Reclamation, Central Administration of Agricultural Economics, Cost and Return Bulletin, various issues.

By calculating the general temporal trend of the net revenue of the sesame crop in Egypt during the period 2007-2021, it was found that the linear function is the best form to express this relationship. This is shown in the equation in Table (4). The estimation results indicate that the average revenue has increased by about 341.3 pounds at a rate of about 9.5% during the study period. The value of the coefficient of determination also showed that about 91% of the change in net revenue for the sesame crop can be explained by changes in economic, social, and technological factors associated with time.

Farm price:

The data in Table (3) show that the average farm price for the sesame crop in Egypt during the period 2007-2021 was about 1,560 Egyptian pounds. The price ranged from a minimum of 708 pounds in 2007 to a maximum of 2,820 pounds in 2021. By calculating the general temporal trend of the farm price of the sesame crop in Egypt during the period 2007-2021, it was found that the exponential function is the best form to express this relationship. This is shown in the equation in Table (4). The estimation results indicate that the average price has increased by a rate of about 0.09% during the study period. The value of the coefficient of determination also showed that about 98% of the change in the farm price of the sesame crop can be explained by changes in economic, social, and technological factors associated with time.

Yield to costs ratio:

The data in Table (3) show that the average return on costs ratio for the sesame crop in Egypt during the period 2007-2021 was about 1.89. The ratio ranged from a minimum of 1.61 in 2011 to a maximum of 2.27 in 2014. By calculating the general temporal trend of the return on costs ratio for the sesame crop in Egypt, it was found that the data fluctuated around the mean of 1.89 due to its non-significance.

Profitability of the pound spent:

The data in Table (3) show that the average profitability of the pound spent for the sesame crop in Egypt during the period 2007-2021 was about 0.89 Egyptian pounds. The profitability ranged from a minimum of 0.61 pounds in 2011 to a maximum of 1.26 pounds in 2014. By studying the general temporal trend of the profitability of the pound spent for the sesame

crop in Egypt, it was found that the data fluctuated around the mean of 0.89 pounds due to its non-significance.

Profitability of the product:

The data in Table (3) show that the average profitability of the product for the sesame crop in Egypt during the period 2007-2021 was about 790.9 Egyptian pounds/ton. The profitability ranged from a minimum of 387.4 pounds/ton in 2009 to a maximum of 1,180 pounds/ton in 2018.

Analysis of the general temporal trend of the profitability of the product for the sesame crop in Egypt during the period 2007-2021 showed that the linear function is the best form to express this relationship. This is shown in the equation in Table (4). The estimation results indicate that the average profitability of the product has increased by about 62.2 Egyptian pounds at a rate of about 7.86% during the study period. The value of the coefficient of determination also showed that about 87% of the change in the profitability of the product for the sesame crop can be explained by changes in economic, social, and technological factors associated with time.

Statistical estimation of supply response functions for sesame crop in Qena:

To estimate the supply response for the crop under study, the dynamic **Mark Newlove** model was used, which is considered one of the best models for supply response. Through it, the relationship between the area cultivated with sesame in the year (t) as a dependent factor with the most important explanatory variables in the previous year (t-1) was studied, which is attributed to its effect on the dependent factor.

The model used depends on the impact of price changes as well as the impact of other variables that the research assumed to affect the area cultivated with sesame. Some other independent variables that are assumed to affect the dependent variable are excluded. **The** stepwise multiple regression model is also used to mitigate the negative effects of linear redundancy on the accuracy of the model's statistical estimates (Allen, 1991).

Table 4. Equations of the general temporal trend of the Evolution of production costs, total revenue, net profit, farm price, profitability of the pound spent, and profitability of the product for the sesame crop during the period 2007-2021.

Variable	Equation	R^2	F
Production costs	$\hat{LnY}_i = 1.75 + 0.09X$ $(14.55)^{**}$ $(12.40)^{**}$	0.92	$(153.7)^{**}$
Total revenue	$\ln \hat{Y}_i = 3.19 + 0.98X$ $(20.48)^{**}$ $(18.24)^{**}$	0.96	$(332.8)^{**}$
Net revenue	$\hat{Y}_i = 0.854 + 0.341X$ $(3.18)^{**}$ $(11.56)^{**}$	0.91	$(133.7)^{**}$
Farm price	$\hat{LnY}_i = 654.6 + 0.098X$ $(26.19)^{**}$ $(23.27)^{**}$	0.98	(541.5)**
Yield to costs ratio	$\hat{Y}_i = 1.83 + 0.007X$ $(16.14)^{**}$ $(0.55)^{n.s}$	0.02	0.31
Profitability of the pound spent	$\hat{Y}_i = 0.835 + 0.007X$ $(7.35)^{**}$ $(0.557)^{n.s}$	0.02	0.31
Profitability of the product	$\hat{Y}_i = 293.4 + 62.19X$ $(4.8)^{**}$ $(9.33)^{**}$	0.87	$(87)^{**}$

Where: $\hat{Y}_i$ refers to the estimated value of production costs, total revenue, net profit, farm price, profitability of the pound spent, and profitability of the product in Egypt in year (i).

X is the time variable during the study period.

(i) = 1, 2, 3, 4, ..., 15.

The values between parentheses refer to the calculated (t) values.

(**): Significant at the 1% level. (*): Significant at the 5% level.

Source: Collected and calculated from the data of Table (3).

1- Statistical estimation of supply response functions for variables related to the crop

By estimating the supply response functions using the modified Mark Nerlove model, which depends on measuring the relationship between the future and past behavior of producers, considering that the area cultivated with sesame in the current year (Yt) is a function of the area cultivated with the same crop in the previous year with a delay of one-year Y(t-1) with each of (Henderson and Quandt, 1958):

- Yield per feddan of sesame in tons in the previous year (X_1(t-1))
- Farm price of sesame in thousands of pounds in the previous year (X_2 (t-1)).
- Production costs of sesame in thousands of pounds in the previous year (X_3 (t-1)).
- Net return per feddan of sesame in thousands of pounds in the previous year (X_4 (t-1)).

The results shown in Table (5) indicate the supply response functions for sesame crop in Qena Governorate using the modified dynamic Mark Nerlove model, where the response of the farmer to the yield per feddan of sesame in the previous year is evident. The adjusted coefficient of determination shows that about 75% of the changes that affect the area of sesame in the current year in Qena Governorate are due to the yield per feddan, while the remaining changes are due to other factors that are not measured by the function.

The results also show that an increase in the yield per feddan of sesame in the previous year by one ton leads to an increase in the area cultivated with sesame in the previous year by 1.53 thousand feddans, assuming that the other factors remain at a certain level. The elasticity of the supply response of sesame crop was also about 1.53%, indicating that an increase in the yield per feddan of sesame in the previous year by 1% leads to an increase in the area cultivated with sesame in the current year by 1.53%. The response coefficient was about 0.24, while the period required to achieve full response by the farmer was about 4.17 years starting from the year following planting.

The results in the same table also indicate the farmer's response to the current farm price of sesame in the previous year. The adjusted coefficient of determination shows that about 64% of the changes in the sesame area in the current year in Qena Governorate are due to the farm price. The remaining changes are due to other factors that are not measured by the function.

The results also show that an increase in the farm price of sesame in the previous year by one Egyptian pound leads to an increase in the area cultivated with sesame in the current year by 139 feddans, assuming that the other factors remain constant at a certain level.

Table 5. Estimation of the supply response of the sesame crop in Qena according to the productivity per feddan, farm price, production costs per feddan, and net return per feddan during the period (2007-2021).

Variable	Equation	R^{-2}	F
The productivity per feddan	$\ln \hat{Y}_i = 0.626 + 0.761 \ln Y_{t-1} + 1.53 \ln X_{1t-1}$ (1.04) (4.33)** (1.185) n.s	0.75	(20.9)**
Farm price	$\hat{Y}_i = 0.13 + 0.891 Y_{t-1} + 0.139 X_{2t-1}$ (0.164) (3.42)** (0.448)	0.64	(13.3)**
Production costs	$\ln \hat{Y}_i = 1.044 + 0.387 \ln Y_{t-1} - 0.900 \ln X_{3t-1}$ (2.406)** (1.73) (-2.63)**	0.83	(32.7)**
Net return per feddan	$\ln \hat{Y}_i = 0.246 + 0.947 \ln Y_{t-1} + 0.108 \ln X_{4t-1}$ (0.305)** (2.92)** (0.205)	0.72	(18.04)**

Where: $\hat{Y}_i$ refers to the estimated value of the sesame crop area in Qena Governorate in year (i).

X: refers to the independent variables during the study period.

(t) = 1, 2, 3, 4.....15

The values between the parentheses refer to the calculated (t) values.

(**): Significant at the 1% level. (*): Significant at the 5% level.

Source: Collected and calculated from the appendix Table (1-3)

The elasticity of supply response of sesame crop was about 0.17, which means that an increase in the current farm price of sesame in the previous year by 1% leads to an increase in the area cultivated with sesame in the current year by 0.17%. The response coefficient was about 0.109, while the time required for the farmer to achieve full response was about 9.17 years starting from the year after planting.

The results in the same table also indicate the farmer's response to the cost of production per feddan of sesame in the previous year. The adjusted coefficient of determination shows that about 83% of the changes in the sesame area in the current year in Qena Governorate are due to the cost of production per feddan. The remaining changes are due to other factors that are not measured by the function

The results also show that an increase in the cost of production per feddan of sesame in the previous year by one Egyptian pound leads to a decrease in the area cultivated with sesame in the current year by 900 feddans, assuming that the other factors remain constant at a certain level. The elasticity of supply response of sesame crop was about 0.20%, which means that an increase in the current farm price of sesame in the previous year by 1% leads to an increase in the area cultivated with sesame in the current year by 0.17%. The response coefficient was about 0.613, while the time required for the farmer to achieve full response was about 1.63 years starting from the year after planting.

Finally, the results in the same table indicate the farmer's response to the net farm return per feddan of sesame in the previous year. The adjusted coefficient of determination shows that about 72% of the changes in the sesame area in the current year in Qena Governorate are due to the net return per feddan. The remaining changes are due to other factors that are not measured by the function.

The results also show that an increase in the net return per feddan of sesame in the previous year by one Egyptian pound leads to an increase in the area cultivated with sesame in the current year by 108 feddans, assuming that the other factors remain constant at a certain level. The elasticity of supply response of sesame crop was about 0.11%, which means that an increase in the net return per feddan of sesame in the previous year by 1% leads to an increase in the area cultivated with sesame in the current year by 0.11%. The response coefficient was about 0.053, while the time required for the farmer to achieve full response was about 18.87 years starting from the year after planting.

2-Statistical estimation of supply response functions of variables associated with the most competitive crops.

This is done through three scenarios to reach the strongest variables affecting the farmer's response to planting sesame (Adam & Mahmoud, 2016 and Ahmed *et al.,* 2022).

First scenario: Estimation of the supply response of sesame crop to the variables of the farm price of the most competitive crops with a delay period of one year.

The area cultivated with sesame crop in thousands of feddans in the current year representing the dependent variable and the following independent variables:

- Farm price of corn crop per ton in the previous year (X_1 (t-1)).
- Farm price of peanut crop per ton in the previous year (X_2 (t-1)).
- Farm price of tomato crop per ton in the previous year (X_3 (t-1))
- Farm price of pepper crop per ton in the previous year (X_4 (t-1)).
- Farm price of eggplant crop per ton in the previous year (X_5 (t-1))
- Farm price of cucumber crop per ton in the previous year (X_6 (t-1)).

After applying the stepwise multivariate regression analysis method from Table (6), it is clear that the logarithmic model is the best model for estimating the supply response function of the sesame crop, according to the value of the adjusted coefficient of determination and the overall significance of the model. There is a logical economic and statistical relationship between the area cultivated with the sesame crop in thousands of feddans in the current year and the farm price of the peanut crop and the pepper crop in thousands of Egyptian pounds in the previous year. The elasticity of response was about 2.29% and 0.451% for each of the peanut and pepper crops, respectively. This indicates that an increase in the farm price of the two crops in the previous year by 1% leads to an increase in the area cultivated with the sesame crop in the current year by 2.29% and 0.451%, respectively. There is also an inverse relationship between the area cultivated with the sesame crop in the current year and the farm price of the tomato crop. The elasticity of response was about -2.39%. This indicates that an increase in the farm price of the tomato crop in the previous year by 1% leads to a decrease in the area cultivated with the sesame crop in the current year by 2.39%. This does not agree with economic logic, despite its significance.

Table 6. Estimation of the supply response of sesame crop in Qena Governorate according to the farm price, production costs per feddan, and net farm return of the most competitive crops during the period (2007-2021).

Variable	Equation	R^2	F
The farm price	$\ln \hat{Y}_i = 1.02 + 2.29 \ln X_{2t-1} - 2.39 \ln X_{3t-1} + 0.45 \ln X_{4t-1}$ $(8.68)^{**}$ $(-10.4)^{**}$ $(3.08)^{****}$ (17.3)	0.94	$(71)^{**}$
Production costs	$\ln \hat{Y}_i = 1.416 + 0.641 \ln X_{6t-1}$ $(4.34)^{**}$ $(3.65)^{**}$	0.54	$(13.6)^{**}$
Net return per feddan	$\ln \hat{Y}_i = 1.112 - 0.501 \ln X_{6t-1}$ $(5.69)^{**}$ $(-4.65)^{**}$	0.61	$(21.7)^{**}$

Where: $\hat{Y}_i$ is the estimated value of the area cultivated with sesame crop in Qena Governorate in year (i).

'X' is the independent variables during the study period.
't' = 1, 2, 3, 4.....15
The values between parentheses are the calculated 't' values.
(**): Significant at the 1% level. (*): Significant at the 5% level.
Source: Collected and calculated from the appendix Table (1-3)

The value of the coefficient of determination indicated that about 94% of the changes in the area cultivated with the sesame crop are attributed to the variables in the response model. The overall significance of the model has been proven.

Second scenario: Estimation of the supply response of sesame crop to the variables related to the production costs of the most competitive crops with a delay period of one year.

The area cultivated with sesame crop per thousands of feddans in the current year representing the dependent variable and the following independent variables:

- The production costs of corn crop per ton in the previous year (X_1 (t-1))
-The production costs of peanut crop per ton in the previous year (X_2 (t-1)).
- The production costs of tomato crop per ton in the previous year (X_3 (t-1))
- The production costs of pepper crop per ton in the previous year (X_4 (t-1))
-The production costs of eggplant crop per ton in the previous year (X_5 (t-1))
-The production costs of cucumber crop per ton in the previous year (X_6 (t-1))

It is clear from Table (6) that the logarithmic model is the best model for estimating the supply response function of the sesame crop, according to the value of the adjusted coefficient of determination and the overall significance of the model. There is a logical and statistically positive relationship between the area cultivated with sesame crop in thousands of feddans in the current year and the production costs per feddan of cucumber in the previous year. The elasticity of response was about 0.641, which indicates that an increase in the production costs per feddan of cucumber in the previous year by 1% leads to an increase in the area cultivated with sesame crop in the current year by 0.641%. The value of the coefficient of determination indicates that about 53% of the changes in the area cultivated with sesame crop are attributed to the variables in the response model. The overall significance of the model has been proven.

Third scenario: Estimation of the supply response of sesame crop to the variables related to the net return per feddan of the most competitive crops with a delay period of one year.

The area cultivated with sesame crop per thousands of feddans in the current year representing the dependent variable and the following independent variables:

- Net return per feddan of corn crop per ton in the previous year (X_1(t-1)).
- Net return per feddan of peanut crop per ton in the previous year (X_2(t-1)).
- Net return per feddan of tomato crop per ton in the previous year (X_3(t-1)).
- Net return per feddan of pepper crop per ton in the previous year (X_4(t-1)).
- Net return per feddan of eggplant crop per ton in the previous year (X_5(t-1)).

- Net return per feddan of cucumber crop per ton in the previous year (X_6(t-1)).

Finally, it is clear from Table (6) that the logarithmic model is the best model for estimating the supply response function of the sesame crop, according to the value of the adjusted coefficient of determination and the overall significance of the model. It is clear from the equation that there is an inverse and economically and statistically logical relationship between the area cultivated with sesame crop in thousands of feddans in the current year and the net return per feddan of cucumber crop in the previous year. The elasticity of response was about (-0.501), which indicates that an increase in the net farm return per feddan of cucumber crop in the previous year by 1% leads to a decrease in the area cultivated with sesame crop in the current year by 0.501%. The value of the coefficient of determination indicates that about 61% of the changes in the area cultivated with sesame crop are attributed to the variables in the response model. The overall significance of the model has been proven.

REFERENCES

Adam, H.H.A. and M.M. Mahmoud. 2016. An analytical study of the response of supply for winter tomato crop display in Egypt. Arab Univ. J. Agric. Sci. 24: 23-35.

Ahmed, F.A.Q., Y.A.A. Diab, H.H.A. Adam and A.M.M. Ali. 2022. Estimation of the supply response of winter tomato crop in Egypt. J. Afr. Res. Stud. Nile Basin Countries 4: 1-23.

Allen, D.H. 1991. Economic evaluation of projects. 3th Edition, Institution of Chemical Engineer, England, 52-70.

Arab Republic of Egypt, Ministry of Agriculture and Land Reclamation, Central Administration for Agricultural Economics, Agricultural Statistics Bulletin, Various Issues.

Fangary, A.M. 2021. An economic study of sesame crop in Egypt. Scientific J. Agric. Sci. 3: 245-258.

Ghonuim, Sh. A.M., A.A. Ali and M.A. Mobarack. 2017. An economic study to estimate the supply response of sugar beet in Egypt. Egypt. J. Agric. Econ. 27: 1653-1670.

Gittinger, J.P. 1982. Economic analysis of agricultural projects. 2nd Edition, The johns Hopkins University press, Baltimore and London.

Henderson, J.M. and R.E. Quandt. 1958. Microeconomic theory: A Mathematical approach. McGraw-Hill Book Company, Inc., New York.

Appendix

Appendix 1. Evolution of the area of the sesame crop in Qena and the farm prices of competing crops during the period (2007- 2021).

Years	Dependent variable	The farm price per thousand pounds					
	The area of sesame per thousand feddans	Cucumber	Eggplant	Pepper	Tomato	Peanuts	Corn
2007	2.07	0.53	0.51	0.58	0.6	0.33	0.16
2008	2.78	0.64	0.61	0.69	0.9	0.35	0.24
2009	2.92	0.64	0.62	0.94	1	0.46	0.2
2010	2.16	0.75	0.76	1.05	1.1	0.5	0.19
2011	1.3	0.88	0.79	1.15	1.46	0.53	0.27
2012	0.92	1.29	0.87	1.17	1.48	0.59	0.31
2013	0.84	1.29	0.87	1.18	1.49	0.61	0.32
2014	1.35	1.28	0.89	1.19	1.49	0.65	0.32
2015	1.17	1.3	0.9	1.22	1.5	0.68	0.33
2016	0.89	1.32	1.24	1.6	1.73	0.71	0.35
2017	0.64	1.61	1.56	1.92	1.74	0.84	0.41
2018	0.78	1.9	1.88	2.24	1.76	0.96	0.47
2019	0.64	1.92	1.89	2.27	1.77	0.98	0.48
2020	0.44	1.97	2.68	2.47	1.84	1	0.49
2021	0.53	4.07	4.67	4.75	3.59	1.78	0.57
Average	1.29	1.426	1.38	1.63	1.56	0.73	0.34
Minimum	0.44	0.53	0.51	0.58	0.6	0.33	0.16
Maximum	2.92	4.07	4.67	4.75	3.59	1.78	0.57

Sources: Arab Republic of Egypt, Ministry of Agriculture and Land Reclamation, Central Administration for Agricultural Economics, Agricultural Statistics Bulletin, Various Issues.

Appendix 2. Evolution of the area of the sesame crop in Qena and the costs of competing crops during the period (2007- 2021).

Years	Dependent variable	Production costs per thousand pounds					
	The area of sesame per thousand feddans	Cucumber	Eggplant	Pepper	Tomato	Peanuts	Corn
2007	2.07	2.6	2.9	2.7	3.2	2.2	1.5
2008	2.78	3.5	3.7	3.3	3.6	3.2	1.8
2009	2.92	3.4	3.9	3.6	3.8	3.2	2.9
2010	2.16	4.0	4.2	4.0	4.0	3.5	3.3
2011	1.30	4.3	4.5	16.4	16.6	3.8	3.5
2012	0.92	4.6	4.8	3.9	4.4	3.7	2.8
2013	0.84	5.4	4.2	4.0	4.6	3.9	4.0
2014	1.35	5.0	4.0	4.2	4.9	3.6	3.9
2015	1.17	5.7	4.1	4.5	5.3	4.7	4.2
2016	0.89	6.4	6.0	6.2	7.0	5.8	4.7
2017	0.64	7.7	7.0	8.0	8.5	8.5	6.0
2018	0.78	9.1	8.0	9.7	10.0	11.1	7.4
2019	0.64	9.9	9.1	10.7	10.3	12.7	8.8
2020	0.44	10.7	9.4	12.0	11.4	13.9	9.6
2021	0.53	14.6	14.0	18.4	25.2	15.2	12.7
Average	1.30	6.46	5.99	7.44	8.19	6.60	5.14
Minimum	0.44	2.60	2.90	2.70	3.20	2.20	1.50
Maximum	2.92	14.60	14.00	18.40	25.20	15.20	12.70

Sources: Arab Republic of Egypt, Ministry of Agriculture and Land Reclamation, Central Administration for Agricultural Economics, Agricultural Statistics Bulletin, Various Issues.

Appendix 3. Evolution of the area of the sesame crop in Qena and the net return of competing crops during the period (2007- 2021).

Years	Dependent variable	Net return per thousand pounds					
	The area of sesame per thousand feddans	Cucumber	Eggplant	Pepper	Tomato	Peanuts	Corn
2007	2.07	2.4	2.7	2.7	8.1	4.0	1.7
2008	2.78	2.2	3.5	3.5	13.0	3.5	3.1
2009	2.92	2.2	3.2	3.2	14.0	4.8	1.1
2010	2.16	2.8	4.4	4.4	15.0	5.2	0.6
2011	1.30	3.2	3.8	3.8	4.0	6.0	0.0
2012	0.92	8.6	4.3	4.3	20.7	4.9	2.4
2013	0.84	8.8	3.8	3.8	20.5	7.8	1.3
2014	1.35	5.1	5.8	5.8	20.3	8.7	1.5
2015	1.17	4.8	5.9	5.9	20.0	8.1	0.1
2016	0.89	4.4	5.4	5.4	22.3	7.6	0.3
2017	0.64	6.7	7.2	7.2	20.9	8.3	0.0
2018	0.78	9.0	9.0	9.0	19.5	9.0	-0.4
2019	0.64	7.5	11.9	11.9	19.1	7.8	1.5
2020	0.44	7.1	17.2	17.2	27.6	3.8	0.3
2021	0.53	21.9	37.2	37.2	50.3	18.2	0.3
Average	1.30	6.45	8.35	8.35	19.69	7.18	0.92
Minimum	0.44	2.20	2.70	2.70	4.00	3.50	-0.40
Maximum	2.92	21.90	37.20	37.20	50.30	18.20	3.10

Sources: Arab Republic of Egypt, Ministry of Agriculture and Land Reclamation, Central Administration for Agricultural Economics, Agricultural Statistics Bulletin, Various Issues.

الملخص العربي

تقدير دالة استجابة العرض لمحصول السمسم في محافظة قنا

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يعتبر القطاع الزراعي من أهم قطاعات البنيان الاقتصادي القومي، حيث يقع على عاتقه توفير الاحتياجات الغذائية لأفراد المجتمع، بالإضافة إلي مساهمته فى التنمية الاقتصادية عن طريق زيادة الناتج المحلي الزراعي، وتقليل الواردات وزيادة الصادرات، حيث بلغت المساحة المنزرعة بمحصول السمسم فى مصر نحو ٩٠,٣٩ ألف فدان فى عام ٢٠٢١ ونحو ٥٢٧ فدان فى عام ٢٠٢١ بمحافظة قنا، وتنتج بنحو ٥٢,٢٥ ألف طن/ فدان فى مصر فى عام ٢٠٢١ ونحو ٣١٨ طن فدان فى محافظة قنا تمثل ٠,٦١ % من متوسط الإنتاج فى مصر.

وأوضحت النتائج استجابة المزارع للإنتاجية الفدانية لمحصول السمسم في العام السابق، كما يوضح معامل التحديد المعدل أن نحو ٧٥% من التغيرات التي تعتري مساحة السمسم في العام الحالي بمحافظة قنا ترجع إلي الإنتاجية الفدانية أما باقي التغيرات فترجع إلي عوامل أخري لا تتضمنها الدالة المقدرة.

كما أوضحت النتائج أن زيادة السعر المزرعي لمحصول السمسم في العام السابق بمقدار جنيه واحد يؤدي إلي زيادة المساحة المزروعة بمحصول السمسم في العام السابق بمقدار ١٣٩ فدان مع افتراض ثبات العوامل الأخري عند مستوي معين، كما بلغت مرونة استجابة عرض محصول السمسم نحو ٠,١٧، الأمر الذي يشير إلي أن زيادة السعر المزرعي الجاري لمحصول السمسم في العام السابق بنسبة ١% يؤدي إلي زيادة المساحة المزروعة بمحصول السمسم في العام الحالي بنسبة ٠,١٧%. كما توصلت الدراسة إلي زيادة صافي العائد الفداني لمحصول السمسم في العام السابق بمقدار جنيه واحد الأمر الذي يؤدي إلي زيادة المساحة المزروعة بمحصول السمسم في العام السابق بمقدار ١٠٨ فدان مع افتراض ثبات العوامل الأخري عند مستوي معين.

وتبين من الدراسة وجود علاقة طردية منطقية اقتصادياً وإحصائياً بين كل من المساحة المزروعة بمحصول السمسم بالألف فدان في العام الحالي والسعر المزرعي لمحصول الفول السوداني ومحصول الفلفل بالألف جنيه في العام السابق، حيث بلغت مرونة الاستجابة نحو ٢,٢٩، ٠,٤٥١ لكل محصولي الفول السوداني والفلفل علي التوالي، الأمر الذي يشير إلي أن زيادة السعر المزرعي للمحصولين في العام السابق بنسبة ١% يؤدي إلي زيادة المساحة المزروعة بمحصول السمسم في العام الحالي بنسبة ٢,٢٩%، ٠,٤٥١% علي الترتيب، كما وضح من وجود علاقة عكسية بين كل من المساحة المزروعة بمحصول السمسم في العام الحالي والسعر المزرعي لمحصول الطماطم، حيث بلغت مرونة الاستجابة نحو (-٢,٣٩)، الأمر الذي يشير إلي أن زيادة السعر المزرعي لمحصول الطماطم في العام السابق بنسبة ١% يؤدي إلي انخفاض المساحة المزروعة بمحصول السمسم في العام الحالي بنسبة ٢,٣٩%، وهذا لايتفق مع المنطق الاقتصادي علي الرغم من معنويتها. كما أوضحت قيمة معامل التحديد أن حوالي ٩٤% من التغيرات التي تعتري المساحة المزروعة بمحصول السمسم، الأمر الذي يعزي الي المتغيرات الموجودة بنموذج الاستجابة، وقد ثبت معنوية النموذج ككل.

كما يتضح من وجود علاقة طردية منطقية اقتصادياً وإحصائياً بين كل من المساحة المزروعة بمحصول السمسم بالألف فدان في العام الحالي والتكاليف الإنتاجية الفدانية الخيار في العام السابق، حيث بلغت مرونة الاستجابة نحو

٠,٦٤١، الأمر الذي يشير إلي أن زيادة التكاليف الإنتاجية الفدانية لمحصول الخيار في العام السابق بنسبة ١% يؤدي إلي زيادة المساحة المزروعة بمحصول السمسم في العام الحالي بنسبة٠,٦٤١%، كما أوضحت قيمة معامل التحديد أن حوالي ٥٣% من التغيرات التي تعتري المساحة المزروعة بمحصول السمسم، الأمر الذي يعزي إلي المتغيرات الموجودة بنموذج الاستجابة، وقد ثبت معنوية النموذج ككل.

الكلمات الافتتاحية: محصول السمسم، استجابة العرض، التكاليف، صافي العائد.