Journal of American Science

Websites:
http://www.jofamericanscience.org
http://www.sciencepub.net

Emails:
editor@sciencepub.net
sciencepub@gmail.com

MARSLAND PRESS
Multidisciplinary Academic Journal Publisher

The Economic Impact of Climate change on maize crop in Egypt

Dr. Doaa Samir Mohamed Morsy, Dr. Amal Abd El Menam Abd El Hamed Mohamed, Dr. Eman Salem El. Batran

Senior Researcher - Agricultural Economics Research Institute - Agricultural Research Center, Egypt
Dr_amal.mohammed@yahoo.com

Abstract: The research aims to study the effect of the most important climatic changes represented in the maximum and minimum temperatures and relative humidity on the yield per feddan of the summer maize crop in Egypt. The results revealed an increase in the cultivated area, yield per feddan, production available for consumption, the quantity of imports, and the value of maize imports in Egypt at a statistically significant annual rate of about (9.60 thousand feddan, 0.02 tons/feddan, 80.85 thousand tons, 327 thousand tons, 289.10 One thousand tons, 82.81 million dollars) for each of them during the period (1990-2021). The results of the Ricardo model show that the minimum temperature, maximum temperature, and relative humidity under study explain about 54% of the changes in the summer net yield of maize in Egypt during the period (2017-2021). As evidenced by the results of the sensitivity analysis, the negative impact of a decrease in the minimum temperature by about (0.5, 1) degrees Celsius on the net return yield per feddan of the maize crop was at a rate of 4.8% and 3.4% from the calculated average net return yield. It also showed the negative effect of an increase in the maximum temperature by about (0.5, 1) degrees Celsius on the net return yield per feddan of the maize crop, at a rate of about 9%, 9.6% of the average net return yield calculated from the model. 10% on the net return yield per feddan of the maize crop, at a rate of about 5.6% and 1.5%, respectively, on the average net return yield calculated from the model. The increase in the maximum temperature comes in the negative effects, which indicates the sensitivity of the crop to that, and therefore the net yield of the maize crop is sensitive to the climatic changes under study, which are the decrease in the minimum temperature, the increase in the maximum temperature, the increase and decrease in relative humidity, which indicates the need to choose The right place to grow the maize crop to face the climate changes, with the development of varieties commensurate with the expected climate changes.

[Doaa Samir Mohamed Morsy, Amal Abd El Monam Abd El Hamed, Eman Salem El. Batran. **The Economic Impact of Climate change on maize crop in Egypt.** *J Am Sci* 2023;19(7):44-59]. ISSN 1545-1003 (print); ISSN 2375-7264 (online). http://www.jofamericanscience.org 05.doi:10.7537/marsjas190723.05.

Keyword: Climate change - Net Yield - yield per feddan - Governorates of Egypt

Introduction:

Climate change is a disturbance in the Earth's climate with a rise in temperature, a significant change in natural phenomena and a continuous deterioration of vegetation cover. The agricultural sector in Egypt is one of the sectors most affected by climatic changes due to the sensitivity of agricultural crops to temperature changes, whether with a decrease or a rise, as some agricultural crops are positively affected by high temperatures, while others are negatively affected by low temperatures, in addition to the increase in water consumption. to preserve soil moisture (4), and climate changes result in many challenges facing Egyptian food security and achieving sustainable development goals. The refore, the agricultural sector must adapt to climatic changes by building the ability to confront it and contribute to mitigating its effects, and this requires conducting more studies and practical research to face all these challenges. Climate changes play a fundamental role in crop production in general, and the maize crop in particular, as it is one of the most important food grain crops in Egypt, as it is grown on an area of 2.2 million acres and contributes to the production of 7.164 million tons during the average period (2019-2021).

The agricultural sector in Egypt faces many challenges, the impact of which increases with the change in temperature and relative humidity on the one hand, and the increasing demand for agricultural products, especially in light of the limited supply of these products as a result of the increasing population growth year after year on the other hand. Studies conducted in this regard indicate that there is a negative impact on the yield of the maize crop in Egypt on the one hand, and an increase in water consumption on the other hand, as it is expected that the yield of maize will decrease by about 19%, and the water consumption will increase by about 8% compared to its water consumption under the conditions. Normal weather, which results in lower production than consumption, which constitutes a burden on the Egyptian balance of payments, especially in light of the economic conditions that the world and Egypt are going through.

Research problem:

Agricultural production is considered one of the most sensitive activities and is affected by climate changes, as it is expected to be affected due to its strong association with climate changes in the different stages of growth of agricultural crops, and the change in weather factors, by increase or decrease, leads to a deterioration in the acre yield of maize, and then the negative impact on the total production of maize in Egypt, and thus the net return per feddan decreases. This research shows the sensitivity of the summer maize crop to climate changes.

Research objective:

The research aims to study the impact of the most important climatic changes represented in the maximum and minimum temperatures and relative humidity on the yield per feddan of the summer maize crop in Egypt, and this goal is achieved through several sub-goals confined to the following:

1- To identify the current situation of production, consumption and imports of maize in Egypt.

1- Identifying the productive merit of the maize-producing governorates in Egypt.

2- Studying the impact of climatic changes in terms of maximum and minimum temperatures and relative humidity on the the net return per feddan of maize using the Ricardo method in order to reach the sensitivity of maize to climate changes.

3- The future situation of maize production, consumption and imports in Egypt.

Research Method

The Ricardo model is based on evaluating the economic impacts of climate change on agricultural crops. It is a cross-sectional regression model for the response of land value or net return to changes in environmental characteristics, as it allows measuring the extent to which these factors contribute to net return or land value in order to reach the sensitivity of the crop to climate changes. This model allows calculating the direct impact of climate change on the yield of different agricultural crops.This is in addition to the indirect substitution between the different inputs and the potential shift to a different climate by measuring the prices of agricultural crops or the return, as any element that affects the yield of the land affects the value of the land or the net return, and therefore the value of the land or the net revenue contains Information on the value of climate as one of the characteristics of land yield, and thus the marginal contributions of all farm income inputs can be determined. Ricardo's model relies on a set of properties (twice differentiation of a continuous function, that the function is semi-strongly concave, and the marginal products are positive). If the production function takes the following form:

Qi=Qi (Kij,E) (1)

Where: - Qi: the quantity of commodity production Kij ,i The vector of production inputs j used to produce E ,Qi is the direction of the external environmental factors such as temperature, rain and soil, assuming the existence of the prices of the elements Wj, Q, E and the low costs of the following costs function:

Ci=Ci(Qi,W,E) (2)

Where: Ci is the cost of producing the commodity i W (w1, w2…………wn), the price vector for the elements using the cost function Ci at market prices, and maximizing profits for farmers as follows:

Mxπ=(PiQi-Ci (Qi,W,E)- PLLi) (3)

PL= Fixed annual costs or rent for the land in the case of perfect competition, as all profits in excess of the return are zero.

PiQi- Ci= (Qi, W,E) – PL Li=0 (4)

If commodity i is produced from maximum use of land E, then the market rent for land is equal to the annual net profit from the production of commodity E. As in the previous equation, the land rent is equal to the net revenue per unit.

PL= (Pi Qi- Ci (Qi, W,E)/Li (5)

The present value of current and future return streams is given by the value of the land V

$$V_L = \int_0^{\infty} P_L e^{-rt} dt = \int_0^{\infty} \left[(P_i Q^*_i - C_i(Q^*, W, E) / L_i \right] e^{-rt} dt \tag{6}$$

The basis of the analysis is the effect of external changes of environmental variables on the net economic welfare, as the net welfare Economic is the change in well-being caused by a change of environment from one region to another, and the change in well-being is measured Economic in terms of the change in the capital value of the land or alternatively in the net farm income, and the change in Annual well-being as a result of environmental change from ecological area A to B causing environmental inputs to change from EA to B EB is measured as follows:

$$\Delta W = W(E_B) - W(E_A) = \int_0^{Q_B} [(P_i Q_i - C_i(Q_i, W, E_B) / L_i] e^{-rt} dQ - \int_0^{Q_A} [(P_i Q_i - C_i(Q_i, W, E_A) / L_i] e^{-rt} dQ$$

If the market prices did not change as a result of the change in E, then the previous equation is as follows:

$$\Delta W = W(E_B) - W(E_A) = \left[PQ_B - \sum_{i=1}^{n} C_i(Q_i, W, E_B) \right] - \left[PQ_A - \sum_{i=1}^{n} C_i(Q_i, W, E_A) \right] \tag{7}$$

substituting $P_L L = PiQi^*-Ci(Qi^*,W,E)$ From equation 5

PLL = PiQi* - Ci (Qi*, W, E) by

$$\Delta W = W(E_B) - W(E_A) = \sum_{i=1}^{n} (P_{LB} L_{Bi} - P_{LA} L_{Ai}) \tag{8}$$

Where: PLA, LA at EA, and both PLB, LB at EB the present value of welfare change is as follows:

$$\int_0^{Q_b} \Delta W e^{-rt} dt = \sum_{i=1}^{n} (V_{LB} LB_{Bi} - V_{LA} L_{Ai}) \quad (9)$$

The Ricardo model takes Equation (8) or Equation (9) according to the available data for the annual net return or net capital return (land value VL).

Data Sources:

In achieving its objectives, the research relied on published and unpublished secondary data from the Central Agency for Public Mobilization and Statistics, the General Authority of Meteorology, publications of the Economic Affairs Sector of the Ministry of Agriculture and Land Reclamation, and the Institute of National Planning.

Presentation and discussion of research results:

First: The development of the current situation of maize in Egypt:

Table (1) shows the development of production and consumption indicators, the quantity and value of maize imports in Egypt during the period (1990-2021), and from it the following appears:

- The average cultivated area of maize in Egypt during the study period (1990-2021) amounted to about 2.16 million feddan, and it ranged between a minimum of about 1.94 million feddan in 1998, and a maximum of about 2.64 million feddan in 2009. As shown in Table The cultivated area of maize in Egypt increased at a statistically significant annual rate of about 9.60 thousand feddans, and the annual growth rate was about 0.44%.

- The average feddan yield was about 3.08 tons/feddan during the study period, ranging between a minimum of about 2.20 tons/feddan in 1996, a decrease of about 28.54% from the average, and a maximum of about 3.50 tons/feddan in 2005, with an increase of About 13.70% from the average. By comparing yield at the end of the period with its beginning, it is clear that it did not change to an exact degree. The feddan yield increased at a statistically significant annual rate of about 0.02 tons/feddan, and the annual growth rate was about 0.70%.

- The average total production of maize was about 6.72 million tons during the study period. It decreased to about 4.66 million tons in 1996, an estimated rate of 30.62% over the annual average, while it increased to about 8.09 million tons in 2011, an increase of about 20.46% over the annual average. overall average. Total production also increased at a statistically significant annual rate of about 80.85 thousand tons, with an annual growth rate estimated at 1.20%.

- And by reviewing the development available for consumption, it is clear that it increased at the end of the period compared to its beginning, as it averaged about 11.43 million tons during the study period. It decreased to about 6.22 million tons in 1990, an estimated rate of 45.57% from the annual average, while it increased to about 16.95 million tons in 2021, an increase of Its percentage is about 48.35% from the annual average. The available for consumption increased at a statistically significant annual rate of about 327 thousand tons, and the annual growth rate reached about 2.86%. From the foregoing, it is clear that the rate of growth in consumption is greater than the rate of growth in production, which necessitates the need to work on increasing yield to achieve an increase in the volume of production and then reduce the gap between production and consumption.

Table (1): The evolution of the cultivated area, production, consumption, and imports of maize in Egypt during the period (1990-2021).

Variable	Minimum rate	Maximum rate	average	α	β	Value (t)	R^2	F	* Annual growth rate (%)
Cultivated area (thousand feddans)	1945 Year 1998	2643 Year 2009	2169	2010	9.6	**3.54	0.30	**12.50	0.44
yield (ton/feddans)	2.2 Year1996	3.5 Year2005	3.08	2.72	0.02	**4.27	0.38	**18.22	0.70
total production (thousand tons)	4661 Year1996	8093 Year2011	6718	5384	80.85	**7.60	0.66	**57.75	1.2
available for consumption (thousands of tons)	6219 year1990	16952 Year2021	11426	5867	327	**13.84	0.86	**191.60	2.86
Quantity Imports (thousands of tons)	1330 Year1990	9371 Year2021	4575	912.36	215.81	**9.57	0.75	91.66	4.72
import price (dollars/ton)	29.55 Year 1990	406.44 Year 2012	152.66	20.62	8	**6.90	0.62	**48.83	5.24
Value Imports (million dollars)	39.3 Year 1990	2861.2 Year 2021	992.57	373.77	82.81	**15	0.9	**226.25	8.34

α =The value of the equation constant of the time trend, β =The amount of annual change

tb= The calculated t-value for the variable , R^2 =R Square, * Annual growth rate (%)=value b÷ average ×100

<u>Source</u>: Compiled and calculated from data:

1- Ministry of Agriculture and Land Reclamation, Central Department of Agricultural Economy, Bulletin of Agricultural Economics, separate issues.

2- Central Agency for Public Mobilization and Statistics, Annual Bulletin of the Movement of Production, Trade and Available for Consumption, various issues.

- While the average amount of maize imports amounted to about 5.38 million tons during the study period, it decreased to about 1.33 million tons in 1990, at an estimated rate of 75.31% from the general average for the study period, while it increased to about 10.64 million tons in 2020, with an increase of about 97.56%. than the general average. The quantity of imports has taken a general increasing trend at an annual rate of about 289.10 thousand tons, and this increase is statistically significant at the level of 0.01. The annual growth rate of the quantity was about 5.37%.

- While the average import price of maize was about 152.66$/ton during the study period, it decreased to about 29.55$/ton in 1990, an estimated rate of 80.64% from the general average for the study period, while it increased to about 406.44$/ton in 2012. An increase of about 166% over the general average. The import price took a general increasing trend, reaching about 8$/ton, and this increase was statistically significant at the level of 0.01. The annual growth rate was about 5.24%.

- The average value of maize imports amounted to about 992.57 million$ during the study period. It decreased to about 39.30 million$ in 1990, an estimated rate of 96.04% over the general average for the study period, while it increased to about 2861.2 million$ in 2021, an increase of about 188% over the period. overall average. The value of imports took a general increasing trend, amounting to about 82.81 million$, and this increase is statistically significant at the level of 0.01. The annual growth rate was about 8.34%.

Second: The productive merit of the governorates producing the summer maize crop in Egypt:

Table (2) shows the productive merit of the maize crop in Egypt during the period (2017-2021). From it, it is clear that the governorates outside the Valley ranked first in terms of feddan yield, with a general average of about 3.50 tons/feddan. and the highest yield was in Noubaria Governorate, where it reached about 3.65 tons/feddan, with an increase of about 4.36% over the general average of the governorates of outside the valley, Followed by the New Valley Governorate, with a feddan yield of about 3.10 tons/feddan. While it was less productive in the governorate of North Sinai, where it reached about 0.68 tons/feddan, with a decrease of about 80.46% from the general average of the yield of governorates outside the valley during the study period.

- While the governorates of Lower Egypt ranked second, with an average yield of about 3.42 tons/feddan, and the highest yield was in Dakahlia Governorate, where it reached about 3.87 tons/feddan, with an increase of about 12.93% over the general average of the governorates of Lower Egypt, followed by the governorates of Kafr El-Sheikh and Menoufia, where It amounted to about 3.59 tons/feddan, an increase of about 4.99% over the general average for the governorates of Lower Egypt. Then Behera Governorate, where it reached about 3.51 tons/feddan, then Sharkia Governorate, where it reached about 3.50 tons/feddan, while it was less yield in Cairo Governorate, where it reached about 2.13 tons/feddan, with a decrease of about 37.81% of the general average of the yield of Lower Egypt governorates. during the study period.

Table (2): Geographical distribution of yield per feddan of maize crop in Egypt during the average period (2017-2021)

Governorates	**Yield (Ton/feddan)**	**Relative importance (%)**	**Arrange**
Dakahlia	3.87	119.65	1
Kafr - El Sheikh	3.59	111.24	3
Menoufia	3.59	111.24	3
Behera	3.51	108.52	4
Sharkia	3.5	108.42	5
Damietta	3.44	106.45	6
Qalyoubia	3.42	105.88	7
Gharbia	3.4	105.27	8
Ismailia	3.25	100.48	10
Alexandria	2.91	89.98	13
Suez	2.5	77.31	19
Port Said	2.43	75.15	20
Cairo	2.13	65.89	24
Lower Egypt	**3.42**	**105.95**	**-**
Giza	3.27	101.2	9
Menia	3.01	93.05	12
Beni Suef	2.89	89.44	14
Fayoum	2.85	88.15	15
Middle Egypt	**2.95**	**91.25**	**-**
Suhag	2.8	86.65	16
Assuit	2.67	82.74	17
Luxor	2.36	72.94	21
Aswan	2.25	69.7	22
Qena	2.17	67.11	23
Upper Egypt	**2.64**	**81.81**	**-**
Inside the valley	**3.12**	**96.67**	**-**
Noubaria	3.65	112.96	2
New Valley	3.1	95.77	11
Matruh	2.62	81.03	18
North Sinai	0.68	21.15	25
Outside the valley	**3.5**	**108.24**	**-**
Total	**3.23**	**100**	**-**

Source: Collected and calculated from the data of the Ministry of Agriculture and Land Reclamation, Central Administration of Agricultural Economics, Bulletin of Agricultural Economics, separate issues.

- While the governorates Middle Egypt ranked third in terms of acre yield, as the average yield of maize crop reached about 2.95 tons/feddan. The highest yield was in the governorate of Giza, which amounted to about 3.27 tons/feddan, an increase of about 10.90% over the general average of the governorates of Middle Egypt, followed by the yield of the Menia governorate, with an average of about 3.01 tons/feddan, an increase of about 1.97% over the general average of the governorates of Middle Egypt. While it was less yield in Fayoum governorate, where it reached about 2.85 tons/feddan, with a decrease of about 3.40% from the general average of yield in the governorates of Middle Egypt during the study period.

- The governorates of Upper Egypt ranked last in terms of yield, as the average yield of the maize crop was about 2.64 tons/acre. The average rose in Sohag governorate to the highest yield, reaching about 2.80 tons/feddan, with an increase of about 5.92% from the general average of feddan yield in the governorates of Upper Egypt, followed by Assiut governorate, with a feddan yield of about 2.67 tons/feddan, while it was the lowest in Qena governorate, where it was less yield. It amounted to about 2.17 tons/feddan, with a decrease of about 17.97% from the general average of the yield of Upper Egypt governorates during the study period.

Third: The evolution of the net yield per feddan and climatic changes of the summer maize crop in Egypt:

Table (3) shows the development of the net yield per feddan and climate changes of the maize crop in Egypt during the period (2000-2021), and from it the following appears:

- The average net yield per feddan of maize in Egypt during the study period ranged between a minimum of about 752 pounds/feddan in 2001, and a maximum of about 3220 pounds/feddan in 2012, with an annual average of about 2075 pounds/feddan. As shown in Table (4), the net yield per feddan of maize increased at a statistically significant annual rate of about 3.88%.

- The average Maximum temperature of maize in Egypt during the study period was about 13, 21.67, 18.87 degrees Celsius for each of the cultivation, growth and harvest periods. respectively, while the statistical insignificance of the harvest period was proven, which indicates its relative stability around the arithmetic mean, as shown in Table (4).

- While the average minimum temperature of maize in Egypt during the study period was about 26.79, 34.68, 33.64 degrees Celsius for each of the three periods, respectively while the statistical significance of the harvest period was proven, as the annual growth rate reached about 0.61%. The statistical significance of the cultivation and growth periods was not proven, which indicates their relative stability around the arithmetic mean.

- While the average relative humidity of maize in Egypt during the study period was about 58.52%, 51.06%, and 61.83% for each of the three periods, respectively. The statistical significance of the cultivation and harvesting periods was proven, as the annual growth rate for them reached about 1.44% and 0.19% for each of them, respectively, while the statistical insignificance was proven for the growth period, which means its relative stability around the arithmetic mean, as in Table (4).

Table (3): The evolution of the net yield per feddan and climate changes of the maize crop in Egypt during the period (2000-2021)

years	Net return	Maximum Temperature			Minimum Temperature			Relative Humidity		
		cultivation period	growth period	harvest period	cultivation period	growth period	harvest period	cultivation period	growth period	harvest period
2000	762.9	11.9	20.4	18.3	26.7	34.6	32.4	51.6	50.7	57
2001	752.2	11.8	20.3	18.6	26.7	34.6	32.4	51.7	50.8	57.2
2002	824	11.8	20.4	18.3	26.7	34.6	32.4	49.4	52.2	57.4
2003	856	11.9	23.3	18.6	26.7	34.7	32.3	52	50.6	57.2
2004	1935	11.9	20.3	18.6	26.7	34.7	32.3	51.7	50.8	67
2005	1821	11.9	20.3	18.6	26.7	34.7	32.3	51.7	50.8	67
2006	1881	11.9	20.4	18.7	26.7	34.8	32.3	52	50.9	57.4
2007	3051	11.9	20.4	18.7	26.7	34.8	32.3	52	50.9	57.4
2008	1753	11.9	20.4	18.7	26.7	34.8	32.3	52	50.9	57.4
2009	1611	12.7	22	20.7	27.1	35.3	33.6	53.8	52.6	58.3
2010	2430	14.6	22.7	21.1	27.1	35.8	33.7	53.1	52.2	55.6
2011	2658	14.3	20.3	17.4	26	33.4	33.2	68	50.7	61.7
2012	3220	12.7	21.9	17.5	25.9	33.2	33.2	68	50.3	65.3
2013	3038	14.1	23.9	18	26.3	33.2	32.9	67.7	51.3	64.8
2014	2921	13.9	21.7	18.2	25.6	32.9	33.6	66.7	51.3	66.5
2015	2234	14.1	22.9	19	25.7	33.6	34.3	64.7	51.7	66.9
2016	1629	13.4	21.7	18.4	25.7	34.3	33.7	65.3	50.7	65
2017	2050	13	21.5	20.6	24.7	33.7	35.6	67	51.7	65
2018	1958	13.6	21.1	18.4	29.9	35.6	37.2	63.3	50.7	63.6
2019	2903	13.9	24.3	19	28.1	37.2	36.2	63	50.7	63.4
2020	2385	14.2	22.4	19.4	28	36.2	36.2	61.7	50.7	63.3
2021	2977	14.7	24.2	20.4	29	36.2	35.6	61	50.2	65.9
Average	**2075**	**13**	**21.67**	**18.87**	**26.79**	**34.68**	**33.64**	**58.52**	**51.06**	**61.83**

Source: Calculated from data:

1- Ministry of Agriculture and Land Reclamation, Central Department of Agricultural Economy, Bulletin of Agricultural Economics, separate issues.

2- Central Agency for Public Mobilization and Statistics, Annual Bulletin of the Movement of Production, Trade and Available for Consumption, various issues.

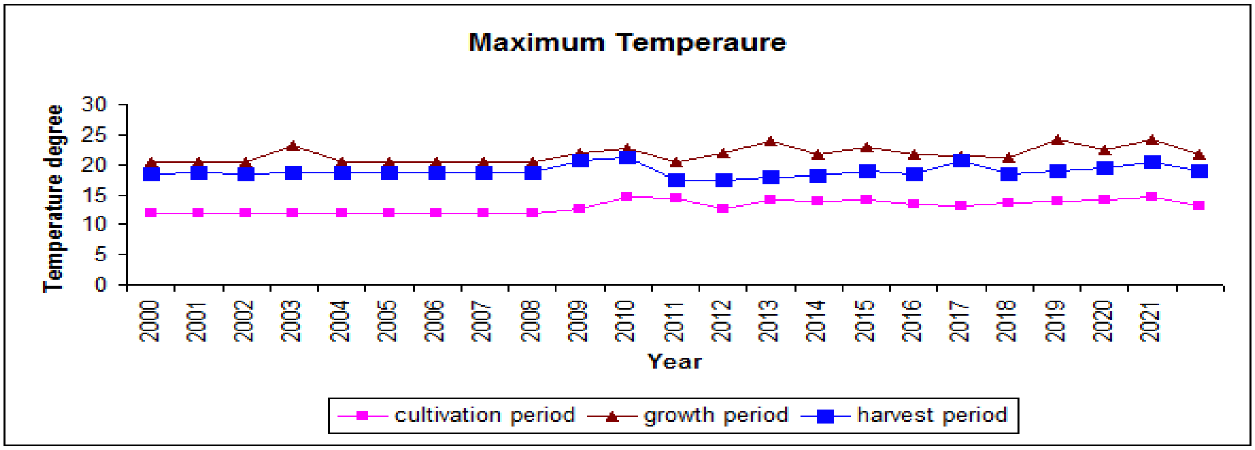

Figure (1): The evolution of climatic changes in the maximum of the maize crop in Egypt during the period (2000-2021).

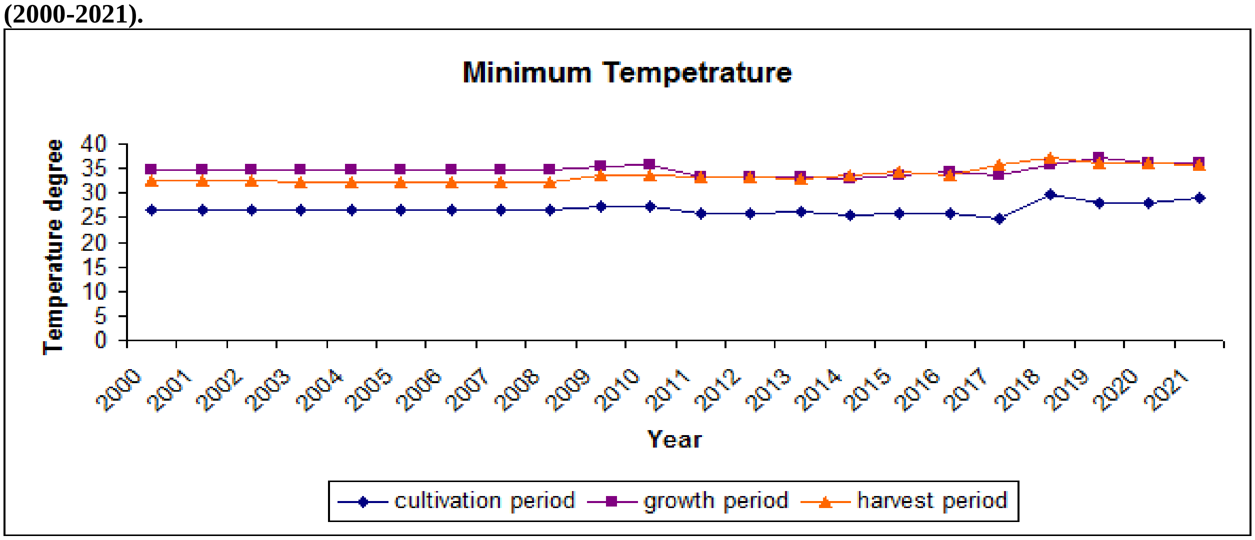

Figure (2): The evolution of climatic changes in the minimum temperatures of the maize crop in Egypt during the period (2000-2021).

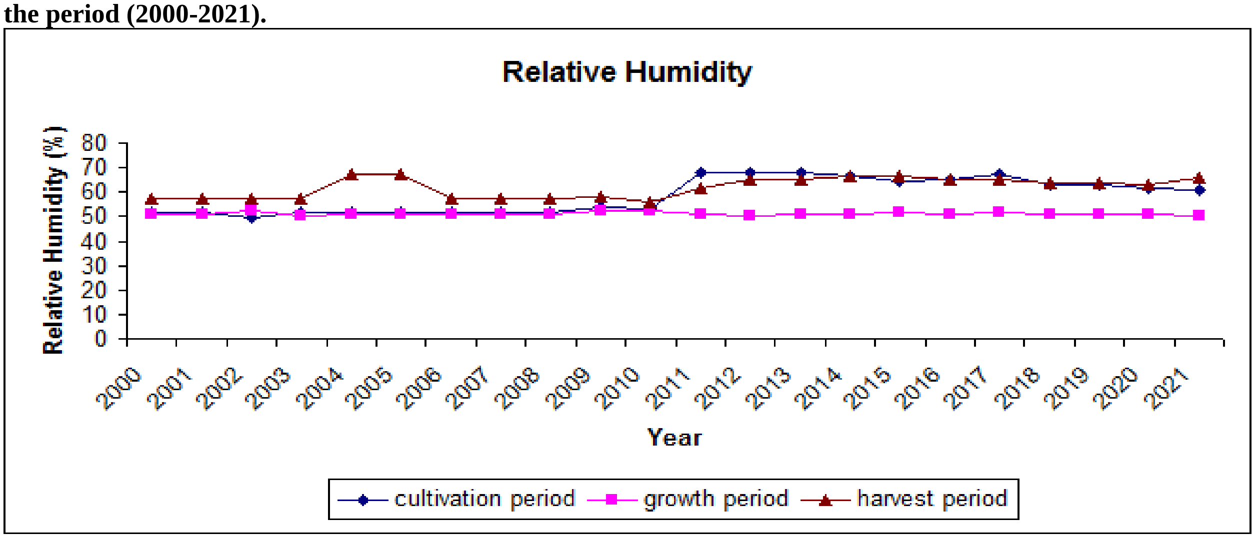

Figure (3): The evolution of climatic changes in the relative humidity of the maize crop in Egypt during the period (2000-2021).

Table (4): Results of the general trend of the development of the net yield per feddan and climate changes of the maize crop in Egypt during the period (1990-2021).

Dependent variable	periods	average	α	β	Value (t)	R^2	F	* Annual growth rate (%)
net return yield per feddan		2075	1149	80.47	**3.92	0.44	**15.43	3.88
Maximum temperature	**cultivation period**	13	11.44	0.136	**6.30	0.66	**39.55	1.05
	growth period	21.67	20.18	0.13	**3.45	0.37	**11.91	0.6
	harvest period	18.87	**It was statistically proven to be non-significant, which indicates its relative stability around the average mean**					
minimum temperature	**cultivation period**	26.79	**It was statistically proven to be non-significant, which indicates its relative stability around the average mean**					
	growth period	34.68	**It was statistically proven to be non-significant, which indicates its relative stability around the average mean**					
	harvest period	33.64	31.27	0.206	**7.65	0.75	**58.59	0.61
Relative humidity	**cultivation period**	58.52	48.84	0.841	**5.52	0.6	**30.43	1.44
	growth period	51.06	**It was statistically proven to be non-significant, which indicates its relative stability around the average mean**					
	harvest period	61.83	57.51	0.116	**3.25	0.35	**10.57	0.19

α = The value of the equation constant of the time trend, β =The amount of annual change
Tb= The calculated t-value for the variable, R^2 =R Square
* Annual growth rate (%)=value b÷ average ×100
Source: Collected and calculated from the data of Table No. (3) in the research.

Fourth: **The economic impact of climate change on the summer maize crop at the governorate level:**

- Table (5) data indicates that the average net return per feddan of the summer maize crop at the level of the most important governorates amounted to about 2127.1 pounds/feddan, and Dakahlia Governorate achieved the highest net return estimated at about 5.43 thousand pounds/feddan, followed by Kafr El-Sheikh Governorate, with a net return of about 3.7 thousand pounds/feddan, then Menoufia governorate with a net return of about 3.55 thousand pounds/feddan, then Gharbia governorate with about 3.44 thousand pounds/feddan, followed by Sharkia governorate with about 3.30 thousand pounds/feddan. While the governorates of Qena and Assiut achieved the lowest net return per feddan, reaching about 356.6 pounds/feddan and 465 pounds/feddan each, respectively, during the average period (2017-2021).

Table (5): Climatic factors and net return per feddan of maize crop in Egypt during the period (2017-2021)

Governorates	Current Net Return (pounds)	Maximum Temperature (degrees Celsius)			Minimum Temperature (degrees Celsius)			Relative Humidity (%)		
		cultivation	growth	harvest	cultivation	growth	harvest	cultivation	growth	harvest
Alexandria	746.4	29.7	34.1	34.1	15.3	20.5	23.6	59.9	63.5	67.6
Behera	2700	29.4	33.4	34.6	18.1	21.2	23.5	60.3	64	68.1
Gharbia	3449.8	30.8	33.9	34.3	16	20.4	22.5	57	59.7	64.2
Kafr - El Sheikh	3749.6	32.5	35.5	36	16.4	20.9	22.8	58.1	60.9	65.5
Dakahlia	5429	31.7	34.5	34.7	15.5	20.4	23	62.8	63.6	51.7
Sharkia	3306.6	32.3	36.6	36.9	17.1	20.6	22.3	52.7	55	60.1
Ismailia	2391.8	31.7	35.7	36.8	16.5	20.7	22.9	50	52.2	57.1
Port Said	775	26.6	30.6	32.3	18.1	22.4	25.7	64.6	65.9	70.8
Menoufia	3557	32	36	36.4	15.1	20.9	23.8	58.9	61.3	59.8
Qalyoubia	2418.8	31.6	35.4	37.4	20.2	24.5	26.3	49.9	51.3	53.9
Giza	1735.6	33	37.2	38.2	16.9	22.1	24.4	46.9	48	50.4
Beni Suef	1739.4	32.3	37.3	38.4	17.8	22.5	23.9	48.5	48.8	53.5
Fayoum	1681.6	33.6	37.9	39	18.7	23.2	24.7	47.7	48.1	52.6
Menia	1097.8	33.3	37.5	38.2	18.3	22.6	24.4	48.4	48.2	53.8
Assuit	2042.6	34.4	38.7	39.5	18.2	23.5	25.8	42.2	41.2	44.2
Suhag	1812.4	35.9	40	40.6	19.7	25.2	26.7	34.7	33.3	32.8
Qena	356.6	33.8	37.7	39	21.6	27.1	29.2	43.5	38.2	41.2
Luxor	960.4	37.1	41	41.7	19.5	25.2	27.2	32.9	31.7	35.4
Aswan	465	37.6	42.1	42.9	22.3	27.5	29.3	22.3	23.9	29.6
Average	**2127.1**	**32.6**	**36.6**	**37.4**	**18**	**22.7**	**24.8**	**49.5**	**50.5**	**53.3**

* The summer maize cultivation period is during May to mid-June, the growth period is during the months of June, July, August, and the harvest period is during August, September.

Source: Calculated from data:

1- Ministry of Agriculture and Land Reclamation, Central Department of Agricultural Economy, Bulletin of Agricultural Economics, separate issues.

2- Central Agency for Public Mobilization and Statistics, Annual Bulletin of the Movement of Production, Trade and Available for Consumption, various issues.

- The average maximum temperature for the cultivation period was about 32.6 degrees Celsius, the highest was in Aswan Governorate at about 37.6 degrees Celsius, while the lowest was in Port Said Governorate at about 26.6 degrees Celsius. While the average maximum temperature for the growth period was about 36.6 degrees Celsius, the highest was in Aswan Governorate at about 42.1 degrees Celsius, while the lowest was in Port Said Governorate at about 30.6 degrees Celsius. While the average maximum temperature for the harvest period was about 37.4 degrees Celsius, the highest was in Aswan governorate at about 42.9 degrees Celsius, while the lowest was in Port Said governorate at about 32.3 degrees Celsius.
- The average minimum temperature for the cultivation period was about 18 degrees Celsius, the highest was in Aswan Governorate at about 22.3 degrees Celsius, while the lowest was in Menoufia Governorate at about 15.1 degrees Celsius. While the average minimum temperature for the growth period was about 22.7 degrees Celsius, the highest was in Aswan Governorate at about 27.5 degrees Celsius, while the lowest was in Dakahlia and Gharbia governorates at about 20.4 degrees Celsius. While the average minimum temperature for the harvest period was about 24.8 degrees Celsius, the highest was in Aswan Governorate at about 29.3 degrees Celsius, while the lowest was in Sharkia Governorate at about 22.3 degrees Celsius.
- The average relative humidity for the cultivation period was about 49.5%, the highest in Port Said Governorate at 64.6%, while the lowest in Aswan Governorate at 22.3%. While the average relative humidity for the growth period was about 50.5%, the highest was in Port Said Governorate at about 65.9%, while the lowest was in Aswan Governorate at about 23.9%. While the average relative humidity for the harvest period was about 53.3%, the highest was in Port Said Governorate at about 70.8%, while the lowest was in Aswan Governorate at about 29.6%.

From the foregoing, it is concluded that the maize crop is one of the crops that are sensitive to maximum and minimum temperatures, as it was shown from the results presented in the previous table that Aswan governorate is one of the governorates with the highest temperatures and the least achieving a net return from the acre, and this is confirmed by the results of the research.

Fifth :The economic impact of climate change on the net yield of maize crop in Egypt:

The results of the Ricardo model in Table (6) show the effect of climate changes on the net yield per feddan of the summer maize crop in Egypt during the period (2017-2021) that the minimum temperature, maximum temperature, and relative humidity variables under study explain about 54% of the changes in net yield per feddan of maize, Most of the variables under study were significant, except for the effect of the average minimum temperature for the cultivation period, the square of the average maximum temperature for the cultivation period, the square of the average relative humidity for the cultivation period, the average minimum temperature × the average relative humidity for the cultivation period.

It was also shown from the table that there is an inverse relationship for the effect of the average minimum temperature for the harvest period and its square for the growth period, the average maximum temperature for the cultivation and harvesting periods, the square of the average maximum temperature for the growth period, the average relative humidity for the cultivation and harvesting periods, the square of the average relative humidity for the growth period, average Minimum temperature × average relative humidity for the growing period, average maximum temperature × average relative humidity for the growing period on net yield of maize crop. While the positive effect of the average minimum temperature for the growing period and its square for the cultivation and harvesting periods, the average maximum temperature for the growing period and its square for the harvesting period, the average relative humidity for the growth period and its square for the harvesting period, the average minimum temperature x average relative humidity for the harvesting period on the net yield of maize .

Table (6): Estimation of the Ricardo model for the impact of climate change on the net yield per feddan of the summer maize crop during the period (2017-2021)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Average minimum temperature for the cultivation period	-538.39	344.47	-1.563	0.1182
Average minimum temperature for the growth period	9385.15	952.53	9.853	0.0000
Average minimum temperature for the harvest period	-3757.23	856.16	-4.388	0.0000
square of the mean minimum temperature for the cultivation period	20.59	7.15	2.883	0.0040
Square mean minimum temperature for the growth period	-154.81	17.28	-8.962	0.0000
square mean minimum temperature for the harvest period	56.48	14.99	3.765	0.0002
Average maximum temperature for the cultivation period	-2307.16	759.86	-3.036	0.0024
Average maximum temperature for the growing period	4333.92	1114.38	3.889	0.0001
Average maximum temperature for the harvest period	-5081.95	944.35	-5.381	0.0000
square of the mean maximum temperature for the cultivation period	10.46	8.128	1.286	0.1983
square of the mean maximum temperature for the growth period	-35.84	12.063	-2.971	0.0030
Square mean maximum temperature for the harvest period	51.17	10.26	4.986	0.0000
Average relative humidity for the cultivation period	-1063.87	189.80	-5.605	0.0000
Average relative humidity for the growing period	2826.47	257.68	10.969	0.0000
Average relative humidity for the harvest period	-1553.84	228.82	-6.790	0.0000
square of the mean relative humidity for the cultivation period	0.896	0.862	1.038	0.2990
square of the mean relative humidity for the growth period	-4.409	0.929	-4.747	0.0000
Square mean relative humidity for the harvest period	2.339	0.611	3.831	0.0001
Average minimum temperature × average relative humidity for the cultivation period	-3.161	2.887	-1.094	0.2737
Average minimum temperature × average relative humidity for the growth period	-45.174	5.259	-8.590	0.0000
Average minimum temperature × average relative humidity for the harvest period	12.256	4.128	2.968	0.0030
Average maximum temperature × average relative humidity for the cultivation period	31.07	5.005	6.207	0.0000
Average maximum temperature × average relative humidity for the growing period	-33.67	5.783	-5.822	0.0000
Average maximum temperature × average relative humidity for the harvest period	23.68	4.841	4.892	0.0000
the site	-44.028	17.16	-2.565	0.0104
time	408.69	20.24	20.198	0.0000
R-squared	0.547	Mean dependent var		2127.13
Adjusted R-squared	0.543	S.D. dependent var		1731.89
S.E. of regression	1171.074	Akaike info criterion		16.98
Sum squared resid	3.48E+09	Schwarz criterion		17.03861
Log likelihood	-21749.97	Hannan-Quinn criter.		

Source: Calculated from data:

1- Ministry of Agriculture and Land Reclamation, Central Department of Agricultural Economy, Bulletin of Agricultural Economics, separate issues.

2- Central Agency for Public Mobilization and Statistics, Annual Bulletin of the Movement of Production, Trade and Available for Consumption, various issues.

It is clear from Figure (4) that the minimum temperature ranges between two minimum and maximum levels of 14: 30.4 degrees celsius, and it has a negative impact on the net yield per feddan of the summer maize crop in both the lower and higher directions, and this occurs outside the critical range, which is about 15: 26 degrees celsius, and it was found that the maximum temperature ranged between 23.7: 43.4 degrees celsius, It has a negative effect on the net feddan yield of the maize crop with the high temperature, while the relative humidity ranges between 17%: 74.7%, It has a negative effect on the net return yield per feddan of the maize crop, whether the relative humidity tends to decrease or increase.

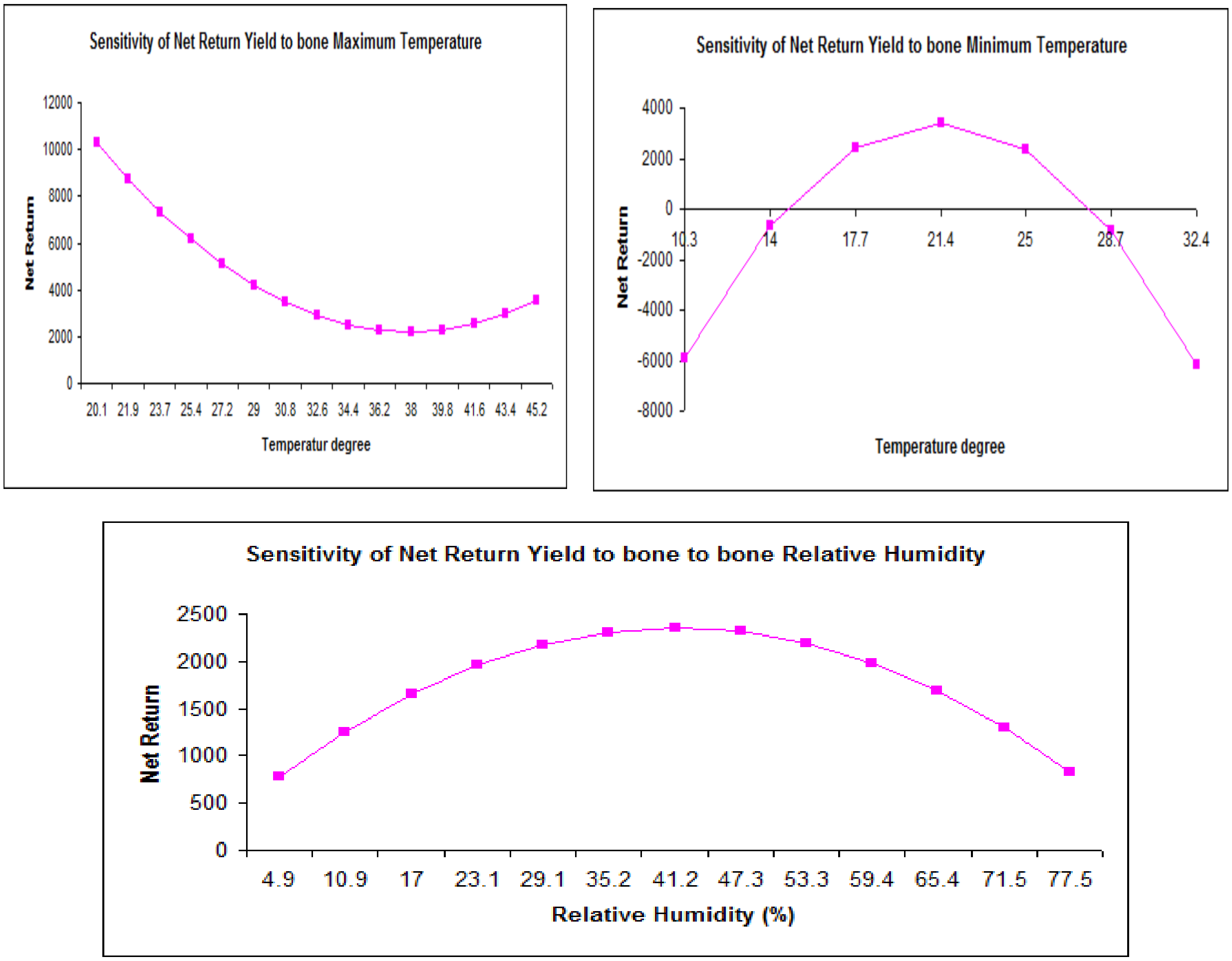

Figure (4) the extent to which climate changes affect the net return yield per feddan of the summer maize crop

Sixth: Simulation of the effect of climate change on maize crop:

To simulate the effect of climate change, the coefficients estimated from the Ricardo model in Table (7) were used to measure the effect of the change in each of the minimum and maximum temperature and relative humidity on the net yield per feddan of the maize crop, taking into account that the level of climate change is associated with the doubling of carbon dioxide carbon, and the expected impact of several scenarios was predicted as follows:

First scenario: the effect of a decrease in the minimum temperature of 0.5 °C on the estimated average net return.

Second scenario: the effect of a decrease in the minimum temperature of 1 °C on the estimated average net return.

Third scenario: The effect of a 0.5°C maximum temperature increase on the estimated average net return.

Fourth scenario: The effect of a 1°C maximum temperature increase on the estimated average net return.

Fifth scenario: the effect of a 10% relative humidity decrease on the estimated average net yield.

Sixth scenario: the effect of a 10% increase in relative humidity on the estimated average net yield.

Forecasting the impact of climate changes on the production of maize crop in Egypt: By studying the forecast scenarios of the extent of the effect of climate changes decrease and increase on the net yield per feddan of the summer maize crop in Egypt during the period (2017-2021).Where it was clear from the sensitivity analysis in Table (7) the negative effect of a decrease in the minimum temperature by about (0.5, 1) degrees Celsius on the net yield of the maize crop per feddan at a rate of 4.8% and 3.4% from the average net yield calculated from the model. It also showed the negative impact of an increase in the maximum temperature by about (0.5, 1) degrees Celsius on the net yield per feddan of the maize crop, at a rate of about 9%, 9.6% of the average net yield calculated from the model, and It was also clear that the negative impact of the two cases of decrease and increase in relative humidity by about 10% on the net yield per feddan of the maize crop, at a rate of about 5.6% and 1.5%, respectively, on the average net yield calculated from the model. It is clear from the foregoing that:

- The effect was negative in the two cases of a decrease in the minimum temperature by about 0.5 and 1 degrees Celsius, and in two cases of a rise in the maximum temperature by about 0.5 and 1 degrees Celsius, and in two cases of deficiency and increase in relative humidity by about 10%.
- The increase in the maximum temperature comes in the negative effects, which indicates the sensitivity of the crop to that, and therefore the net yield of the maize crop is sensitive to the climatic changes under study, which are the decrease in the minimum temperature, the increase in the maximum temperature, the increase and decrease in relative humidity, which indicates the need to choose The right place to grow the maize crop to face the climate changes, with the development of varieties commensurate with the expected climate changes.

Table (7): Results of sensitivity analysis of the effect of change in climatic factors on the net yield of the summer maize crop in Egypt during the period (2017-2021).

Governorates Years	current net return	Calculated net return	First Scenario	Second Scenario	Third Scenario	Fourth Scenario	Fifth Scenario	Sixth Scenario
Alexandria	746.4	2484.3	2565.6	2608.1	2459.4	2447.3	2676.7	2447.1
Behera	2700	2769.2	2912.4	3016.7	2796.2	2836.1	3051.7	3147.2
Gharbia	3449.8	2926.2	2966.7	2968.4	2905.5	2897.7	2862.6	3003.9
Kafr - El Sheikh	3749.6	2969	3082.6	3157.2	3010.3	3064.6	2788.9	3539.6
Dakahlia	5429	5433.6	5635.6	5798.8	5304.3	5187.9	5382.7	4695
Sharkia	3306.6	2671.1	2644.1	2578.2	2670.1	2682	2517.1	2948
Ismailia	2391.8	2290.8	2213.4	2097.1	2274.6	2271.3	2067.2	2522.7
Port Said	775	740.5	969.3	1159.2	789.3	851	1527.4	1168.8
Menoufia	3557	2805	2933.6	3023.5	2780.6	2769.1	2770.1	2825.3
Qalyoubia	2418.8	1712.4	1954.3	2157.4	1713.9	1728.4	2101	2096.5
Giza	1735.6	2152.3	2138.2	2085.1	2115	2090.6	2025	2271.8
Beni Suef	1739.4	2243.4	2292.4	2302.5	2252.9	2275.3	2302	2709.7
Fayoum	1681.6	2043.2	2127.9	2173.7	2067.5	2104.7	2033.2	2635.7
Menia	1097.8	1890.9	1913.9	1898.1	1909.8	1941.6	1848.9	2399.4
Assuit	2042.6	1537.1	1512.6	1449.3	1495.5	1466.8	1461.4	1675.7
Suhag	1812.4	1786.3	1811.6	1798.1	1651.3	1529.1	1798.3	1260.5
Qena	356.6	647.3	870.9	1055.7	645.8	657.3	1017.7	1066.5
Luxor	960.4	756.9	711.8	627.8	684.8	625.5	619.1	747
Aswan	465	554.8	521.3	449	408	274.1	605.6	89.8
Average	**2127.1**	**2127.1**	**2198.9**	**2231.8**	**2101.8**	**2089.5**	**2181.9**	**2276.3**
2017	1239.3	1242	1271.8	1262.8	1206.4	1183.6	1271	1301.8
2018	1580.9	1814.9	1904.2	1954.7	1771.5	1741	1950	1780.4
2019	2581.9	2310.2	2341.9	2334.7	2261.4	2225.4	2374.8	2352.6
2020	2751.3	2580.5	2670.3	2721.2	2567	2566.3	2688.6	2845.1
2021	2482.2	2687.7	2806.1	2885.6	2703	2731.1	2625.2	3101.9
Average	**2127.1**	**2127.1**	**2198.9**	**2231.8**	**2101.8**	**2089.5**	**2181.9**	**2276.3**
calculated rate of change	-	-	**-4.8**	**-3.4**	**-9**	**-9.6**	**-5.6**	**-1.5**

Source: Calculated from the data of Table (6) in the search.

Seventh: Forecasting of the impact of climate change on maize production in Egypt:

The research Forecasting the behavior of the variables under study until the year 2030, and the scientific Forecasting is nothing but a quantitative estimate of the expected values of the dependent variables in the near future based on what we have of data about the past and the present, and the scientific Forecasting assumes that the behavior of economic phenomena in the near future is nothing but an extension behavior of these phenomena in the recent past. This part deals with the impact of forecasting climate changes on the maize crop, by measuring the impact of forecasting the study variables represented in the cultivated area, yield per feddan, and total production, as well as forecasting the imports that will be imported to cover the production deficit to meet potential needs as a result of lower production in the future.

Table (8) shows the expected scenarios for yield per feddan, production, consumption and imports of maize during the period (2021-2030) as follows:-

- It is clear from the first scenario (the situation remains as it is) and the continuation of the climatic conditions as they are without any change that the cultivated area is expected to increase from about 2.33 million per feddan in 2022 to about 2.40 million feddan in 2030, with an increase of about 3.29%, and an increase yield per feddan from about 3.44 tons/feddan in 2022 to about 3.61 tons/feddan in 2030, with an increase of about 5.05%. It is also expected that the total production of maize will increase from about 8.05 million tons in 2022 to about 8.69 million tons in 2030, with a rate An increase of about 8.03%.

-While it is clear from the second scenario related to an increase in temperature by half a degree Celsius, the yield per feddan is expected to decrease from about 3.44 tons/feddan to about 3.34 tons/feddan in 2022, and it will also decrease from about 3.61 tons/feddan to about 3.51 tons/feddan. In 2030. In light of this, it is expected that the total production will decrease from about 8.05 million tons to about 7.78 million tons in 2022, with an estimated difference of 272.23 thousand tons. The total production of maize will decrease from about 8.69 million tons to about 8.44 million tons, with an estimated difference of 256.96 thousand tons in 2030, and this deficiency will be filled by importing from abroad or reclaiming new lands, assuming that this shortfall will be compensated by importing from abroad. (Assuming that the normal conditions of the import price remain constant), we need about 77.50 million$ in 2022, and it will rise to about 89.61 million$ in 2030, in addition to what is imported to cover the current production gap. In the case of land reclamation to cultivate the output difference as a result of low productivity, we need a compensating area that covers this shortfall in production, estimated at 81.43 thousand feddans, with a value of about 20.35 billion pounds in 2022, and about 73.17 thousand feddans, with a value of about 18.29 billion pounds in 2030.

- As for the third scenario related to an increase in temperature by one degree Celsius, it is expected that yield per feddan will decrease from about 3.44 tons/feddan in (normal conditions constant) to about 3.25 tons/feddan in 2022, and decrease from about 3.61 tons/feddan to about 3.41 tons/feddan in 2030. In light of this, it is expected that the total production will decrease from about 8.05 million tons to about 7.56 million tons in 2022, with an estimated difference of about 489.27 thousand tons, and the total production of maize will decrease from about 8.69 million tons to about 8.21 million tons An estimated difference of 492.47 thousand tons in 2030. And in the event that this shortfall will be compensated by imports from abroad, then we need about 139.29 million dollars in 2022, and it will rise to about 171.74 million dollars in 2030, in addition to what is imported to cover the production gap. In the case of land reclamation to cultivate the output difference as a result of low yield, we need about 150.56 thousand feddans, with a value of about 37.64 billion pounds in 2022, and about 144.26 thousand feddans, with a value of about 36.10 billion pounds in 2030.

Table (8): Expected scenarios for yield per feddan, production, consumption and imports during the period (2022-2030)

Years	area (thousand feddan)	yield (ton/ feddan)	production (thousands of tons)	import quantity (thousand tons)	mport price (ton/$)	In the case of a temperature increase of half a degree Celsius						In the case of a temperature increase of one a degree Celsius					
						yield (ton/ feddan) (1)	production (thousands of tons) (2)	production teams (3)	Import value (million $) (4)	Required area (thousand feddan)	Reclamation cost (million pounds) (6)	yield (ton/ feddan) (7)	production (thousands of tons)	production teams	Import value (million $)	Required area (thousand feddan)	Reclamation cost (million pounds
2022	2327	3.44	8052	8034	284.70	3.34	7780.11	272.23	77.50	81.43	20357.83	3.25	7563.06	489.27	139.29	150.56	37638.88
2023	2337	3.46	8133	8250	292.70	3.36	7861.45	271.73	79.54	80.77	20193.63	3.27	7642.14	491.05	143.73	150.16	37538.77
2024	2346	3.48	8214	8466	300.70	3.39	7943.20	270.84	81.44	80.01	20001.59	3.29	7721.61	492.43	148.08	149.64	37410.04
2025	2356	3.50	8295	8682	308.71	3.41	8025.36	269.54	83.21	79.13	19782.24	3.31	7801.48	493.42	152.32	149.01	37253.21
2026	2366	3.52	8376	8897	316.71	3.43	8107.92	267.83	84.82	78.14	19536.09	3.33	7881.73	494.02	156.46	148.28	37068.80
2027	2375	3.54	8457	9113	324.71	3.45	8190.89	265.72	86.28	77.05	19263.61	3.35	7962.38	494.22	160.48	147.43	36857.31
2028	2385	3.57	8537	9329	332.71	3.47	8274.26	263.20	87.57	75.86	18965.30	3.37	8043.43	494.03	164.37	146.48	36619.25
2029	2394	3.59	8618	9545	340.72	3.49	8358.03	260.29	88.68	74.57	18641.62	3.39	8124.87	493.45	168.13	145.42	36355.09
2030	2404	3.61	8699	9761	348.72	3.51	8442.21	256.96	89.61	73.17	18293.02	3.41	8206.70	492.47	171.74	144.26	36065.31

(1)= Rated Yield – (Rated Yield x The temperature rise value is half a degree Celsius (2.714) ÷ 100)
(2)= Estimated area x Yield in the case of a temperature rise of half a degree Celsius
(3) = estimated total productivity - total production at a half-degree Celsius rise in temperature
(4) = production difference in the case of a rise in temperature of half a degree Celsius x import price ÷ 1000
(5) = Productivity difference in the case of a temperature increase of half a degree Celsius ÷ Yield in a case of a temperature increase of half a degree Celsius
(6) = the area to be cultivated x the cost of cultivating an feddans (250 thousand pounds).
(7) = Rated Yield – (Rated Yield x The temperature rise value is one degree Celsius (5.428) ÷ 100)

Source: Calculated from data:

1- Ministry of Agriculture and Land Reclamation, Central Department of Agricultural Economy, Bulletin of Agricultural Economics, separate issues.

2- Central Agency for Public Mobilization and Statistics, Annual Bulletin of the Movement of Production, Trade and Available for Consumption, various issues.

In the light of the research results, the research recommends:

1- The need to pay attention to developing new varieties commensurate with the expected climatic changes in terms of high temperatures, salinity and drought.

2- Expanding the reclamation of desert lands to increase the agricultural area to compensate for lost production as a result of high temperatures and climate change.

3- The need to choose the appropriate place to grow the maize crop to face climate changes due to its sensitivity to the changes under study.

4- Responsible authorities joined together to establish an automatic early weather warning system and Forecasting risks to agricultural crops.

5- The need for all parties in the country to unite to address all causes of climate change, how to confront them and limit their impact with modern scientific methods, with the need to raise awareness among citizens of the importance of avoiding everything that increases the impact of climate change on agricultural production.

Reference:-

[1]. Ayman Farid Abu Hadid, Future climate changes and their impact on the agricultural sector in Egypt and how to confront them, report of the Ministry of Agriculture, Land Reclamation and Conservation, October, 2009.

[2]. The Central Agency for Public Mobilization and Statistics, Statistical Yearbook, Department of Geography and Climate, Meteorological Authority, separate issues.

[3]. The Central Agency for Public Mobilization and Statistics, the annual bulletin of the movement of production, trade and available for consumption, separate issues.

[4]. The Central Agency for Public Mobilization and Statistics, study of the impact of climate change on strategic crops in Egypt, during the period (2014/2015 - 2024/2025). January, 2017.

[5]. Basma Kamal Abdel-Zaher Junaidi, The Impact of Climate Change on Egyptian Agricultural Production and Food Security, PhD dissertation, Department of Agricultural Economics, Faculty of Agriculture, Ain Shams University, 2020.

[6]. Gamal Mohamed Siam, Sherif Mohamed Samir Fayyad (Doctors), The Impact of Climate Change on Agricultural and Food Conditions in Egypt, Conference on Climate Change and its Effects on Egypt, Desert Research Center, Cairo, 2-3 November 2009.

[7]. Fawzi Abdel-Aziz El-Shazly, Ibrahim Abdel-Muttalib Ghanem (Doctors), and others, The Impact of Climate Change on Agricultural Productivity in Egypt, Agricultural Research Center, Agricultural Economics Research Institute, October 2010.

[8]. Ministry of Agriculture and Land Reclamation, Central Department of Agricultural Economy, Bulletin of Agricultural Economics, separate issues.

[9]. Mendelson R., Dinar A. & Dalfelt A., Climate Change Impacts on African Agriculture. http://www.worldbank.org/wbi/sdclimate/pdf, 2000

[10]. Mishra, D., & Sahu, N. C. Economic impact of climaate change on agriculture sector of Coastal Odisha. APCBEE procedia, 10, 241-245. (2014).

[11]. Wassim Wajih Rizkallah, Ph.D., The Impact of Climate Change on the Productivity of Agricultural Crops in Egypt, Journal of the Faculty of Politics and Economics, Fifth Issue, January, 2020.

[12]. Zaied, Y. B. Long Run Versus Short Run Analysis of Climate Change Impacts on Agriculture. In Economic Research Forum Working Papers (No. 808) . (2013, December)

7/18/2023