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The Economic Effects of Climate Change on the Most Important Agricultural Crops in Egypt

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ABSTRACT

The Egyptian agricultural sector is considered one of the most important sectors affected by climatic changes, due to the sensitivity of agricultural crops to temperature changes, whether by rise or fall. It was concentrated in the Nile Valley, the Delta, and the new areas, which led to an inflation in prices for those crops, and by studying the effect of carbon dioxide emission on the productivity of wheat, maize, and cotton, it was found that there is a decrease in the productivity of wheat by about 0.0009 tons/ feddan, which leads to a decrease in the productivity of maize Shamiya by about 0.029 ardeb/feddan, which leads to an increase in the productivity of cotton by about 0.004 tons/feddan, and by studying the effect of temperature on the productivity of wheat, maize, and cotton, it was found that it leads to a decrease in the productivity of wheat by about 0.028 tons/ feddan, and leads to a decrease in productivity of maize by about 0.78 ardebs/feddan, which leads to an increase in the productivity of cotton by about 0.089 tons/feddan, and the cultivation of high-yielding varieties of wheat can achieve A significant increase in productivity, at least 50%, compared to the low-productive items. The cultivation of these high-productivity varieties at the most suitable time for planting can achieve another increase of up to 3-5% in the case of wheat crop, and the cultivation of these high-productivity varieties at the most suitable time for planting can achieve another increase of up to 5-12% in the case of wheat Maize crop. The cultivation of high-productivity varieties and the selection of the most appropriate date for cotton cultivation for each climatic region will lead to an increase in the productivity of this crop under the conditions of climatic changes 12-27%, and the increase in the amount of added water is accompanied by an increase in production by about 9%, and an increase in plant density is accompanied by an increase of about 2%.

Keywords: wheat, maize, cotton, climate, productivity, varieties, planting date

Introduction

Climate change is an important environmental issue and a long-term global problem, involving complex interactions with political, social, environmental and economic implications. The main reason for the phenomenon of continuous climate changes is attributed to human activity and the misuse of available natural resources, which led to an environmental imbalance. Climate change also constitutes one of the most important threats to sustainable development in developing countries, and the Egyptian agricultural sector is considered one of the most important sectors affected by climate changes due to the sensitivity of agricultural crops to temperature changes, whether by rise or fall. Egypt has suffered from the effects of climate change during the heat wave in the years (2010- 2015) several farms concentrated in the Nile Valley and Delta, the new areas were severely damaged, which led to a sharp increase in prices. Agricultural productivity has also been affected by high temperatures. It is expected that the total cultivated area in Egypt will reach about 11.5 million feddans, and the average per capita share of agricultural land resources in Egypt will decrease by about 3.7% by 2030, compared to its counterpart in 2011, and that there is a possibility of losing Between about 12, 15% of the area of high-quality agricultural land is in production in the delta region as a result of sinking or salinization with a sea level rise of only about half a meter, which will have an impact on Egyptian agriculture as well as Egyptian food security

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Problem

The research problem is limited to measuring the resulting effects of climatic changes on the most important agricultural crops of wheat, corn, and cotton and measuring the effect of temperature change and carbon dioxide emission, whether by rise or fall due to what Egypt suffers from the effects of climate change. Agricultural crops have been severely affected by high heat and low humidity The increase in the amount of carbon dioxide emissions in previous years, which was concentrated in the Nile Valley, the Delta and the new areas, which led to an inflation in the prices of those crops. Agricultural productivity has also been affected by rising temperatures.

Objective

The research aims to measure the resulting effects of climate change on the most important agricultural crops in general by studying the following sub-objectives

1-Understand the most important concepts of climate change
2-Measuring the evolution of temperature and carbon dioxide emission
3-Evolution of the productivity of the most important crops of the study
4-Measuring the impact of climatic changes on the production of the most important agricultural crops.
5-Estimating the effects of climatic changes on the feddan productivity of each of the agricultural crops of wheat, corn, and cotton.
6-Putting forward the means that can overcome or mitigate these effects by adopting climate-smart agriculture to confront the potential effects of climate change.

Methodology and data sources

The study relied on descriptive and quantitative methods in presenting the topics it included, and used the equations of the general time trend. This is in addition to averages, annual growth rates and simple linear regression models. The research also relied mainly on published and unpublished secondary data, from various sources such as the Central Administration for Agricultural Economy - the Ministry of Agriculture - and the Central Agency for Public Mobilization and Statistics - the National Information Center - the annual report on environmental statistics - organization International Food and Agriculture Organization (FAO) in addition to some researches, studies and scientific theses - Central Bank of Egypt - United Nations Organization.

Weather changes

Climate change means any effective and long-term change in the weather for a particular region and includes a change in temperature rates, rainfall rates, and wind patterns, and recently there has been certainty of these climate changes, and an increase in greenhouse gas concentrations.

Global warming phenomena.

It means the rise in the average temperature of the atmospheric air in the lower layer of the Earth's surface during the past century or two, and it occurs when the sun's heat is trapped in the Earth's atmosphere after it enters it, which raises the Earth's temperature and makes it warmer, and this is done by During the absorption of atmospheric gases, such as carbon dioxide, the energy of the sun and trapping it near the earth, which contributes to the rise in temperature.

The economic effects of climate change on the productivity of the most important agricultural crops.

1-The economic effects of climate change on wheat productivity

productivity, it is evident from Table (1) and Figure (1), A study of the development of wheat productivity in Egypt during the period (2000-2021), where the minimum limit for total wheat yield was about 2.9 tons during 2010, while the maximum reached about about 2.88 tons in 2020 with an average of about 2.74 tons and a growth rate of 2.7%. It was found from studying the impact of carbon dioxide emission on wheat productivity through equation No. (1) in Table (2) it becomes clear with the increase in carbon dioxide emission by an amount that leads to a decrease in productivity of wheat by about 0.0009 tons / feddan, meaning that the change in wheat productivity during the period (2000-2021) took a general decreasing trend and was statistically significant at a significant level of 0.05. By

studying the effect of temperature on the productivity of wheat, it is evident through equation No. (2) in Table (2) that it becomes clear with the increase in temperature by the amount of the unit, which leads to a decrease in the productivity of wheat by about 0.028 tons / feddan, meaning that the change in wheat productivity during the period (2000-2021) He took a general decreasing and statistically significant trend at a significant level of 0.05.

2-The economic effects of climatic changes on the productivity of maize

By studying the effect of carbon dioxide emission on the productivity of maize, it is clear from Table (1) and Figure (1), a study of the development of maize productivity in Egypt during the period (2000-2021), where the minimum yield of maize was about 20.86 ardeb / feddan during the year 2011, while The maximum amount was about 26.89 ardeb / feddan in 2007, with an average of about 24.2 ardeb / feddan, and the growth rate was 26.3%.

Table 1: Productivity development of the most important crops and climatic changes during the period (2000-2021).

Years	Wheat productivity Ton/acre*	Corn productivity Ardeb/acres*	Cotton production ton/feddan*	CO_2 emissions per thousand kilotons**	Temperature*
2000	2.67	25.7	1.16	141	22.3
2001	2.67	25.9	1.09	125	22.6
2002	2.7	26	1.12	127	23.1
2003	2.73	26.2	1.11	148	22.4
2004	2.76	26.4	1.1	151	22.4
2005	2.73	26.5	1.14	167	23.1
2006	2.7	26.8	1.09	179	23
2007	2.72	26.8	1.03	189	22.9
2008	2.73	26.24	1.01	199	23
2009	2.71	21.86	1.02	207	24.1
2010	2.39	21.59	1.1	203	23.4
2011	2.75	20.86	0.895	217	23.2
2012	2.78	25.5	0.892	220	22.9
2013	2.8	23.27	0.865	214	22.1
2014	2.74	21.6	0.715	228	22.1
2015	2.77	22.2	1.11	225	22.4
2016	2.79	23.16	1.21	239	24.1
2017	2.88	23.18	1.21	244	24.5
2018	2.77	24.02	1.22	255	24.6
2019	2.79	22.05	1.26	267	24.7
2020	2.78	23.09	1.1	271	24.8
2021	2.77	23.14	1.3	282.5	25
Average	2.74	24.2	1.08	204.48	23.3
Minimum	2.39	20.86	0.72	125	126
Maximum	2.88	26.89	1.3	282.5	25
Annual growth rate	2.67	26.37	1.04	136	22.3

Source:1-* Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Central Administration of Agricultural Economy, Agricultural Statistics Bulletin, various issues.
2- **The dataset was produced by the Climatic Research Unit (CRU) of University of East Anglia (UEA).

The emission of carbon dioxide by the unit amount leads to a decrease in the productivity of maize by about 0.029 ardebs/feddan, meaning that the change in the productivity of maize during the period (2000-2021) took a general decreasing trend and statistically significant at a level of significance of 0.05.And by studying the effect of temperature on the productivity of maize, it is evident through equation No. (4) in Table (2) that it becomes clear with the increase in temperature by the amount of the unit that leads to a decrease in the productivity of maize by about 0.78 ardeb / feddan, meaning that the change in the productivity of maize during the period (2000). -2021) took a general decreasing trend and statistically significant at the level of significance 0.05

3-The economic effects of climatic changes on cotton productivity

Table 2: Estimation of simple linear regression equations to measure the effect of carbon dioxide emission and temperature on the productivity of threshing crops during the period (2000-2021).

Equation number	Trace	a^	B^	The coefficient of determination	Sig (T)	Sig (F)
1	The effect of carbon dioxide emission on wheat yield	2.5	-0.0009	0.59	(-3.24)*	(11.48)**
2	The effect of temperature on wheat yield	2.06	-0.28	0.32	(-2.55)*	(3.73)*
3	The effect of carbon dioxide emission on maize yield	30.1	-0.03	0.42	(-2.60)*	(3.56) *
4	The effect of temperature on the yield of maize	42.6	-0.78	0.39	(-2.64)*	(3.48) *
5	The effect of carbon dioxide emission on cotton yield	0.99	0.0049	0.32	(2.55)*	(2.73)*
6	The effect of temperature on cotton yield	-1.016	0.089	0.38	(3.5)*	(11.53) **

Source: The results of the analysis using the spss program from the data of Table (1)

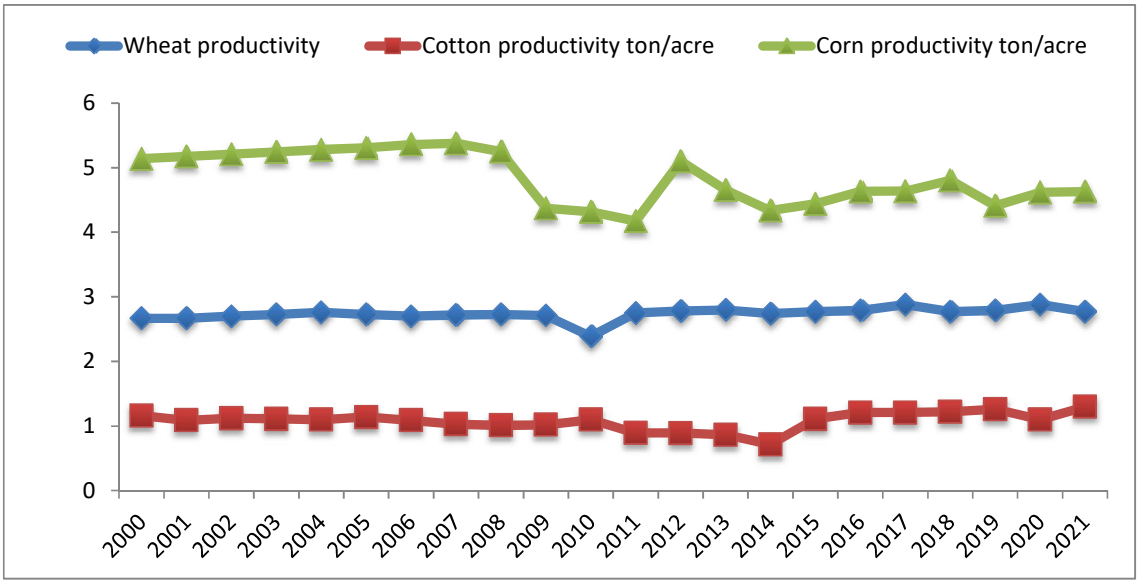

Fig. 1: Development of the productivity of wheat, maize and cotton in Egypt during the period (2000-2021)

Source: Calculated from the data of Table (1).

By studying the effect of carbon dioxide emission on cotton productivity, it is evident from Table (1) and Figure (1), a study of the development of cotton productivity in Egypt during the period (2000-2021), where the minimum level of cotton productivity reached about 0.72 tons/feddan during the year

2014, while the maximum About 1. ton / feddan in 2021, with an average of about 1.08 ton/feddan, and the growth rate was 1.1%. By studying the effect of carbon dioxide emission on cotton productivity, it becomes clear through equation No. (5) in Table (2), it becomes clear with the increase in the emission of carbon dioxide Carbon dioxide per unit leads to an increase in cotton productivity by about 0.0004 tons/feddan, meaning that the change in cotton productivity during the period (2000-2021) took an increasing general trend and statistically significant at a level of significance of 0.05.

By studying the effect of temperature on cotton productivity, it is evident through equation No. (6) in Table (2) that it becomes clear with the increase in temperature by the unit amount, which leads to an increase in cotton productivity by about 0.089 tons / feddan, meaning that the change in cotton productivity during the period (2000-2021) It took a general increasing trend and statistically significant at the level of significance 0.05.

Different scenarios for the productivity of study crops under different planting dates, varieties and high temperature.

1-Wheat

It is clear from Table No. (3) that when planting high-yield varieties of wheat (Sakha 69 - Giza 163 - Giza 164) at the most appropriate time for planting, it can achieve an increase in productivity of up to 3-5%, and by measuring the impact of climatic changes on those varieties and their planting dates from During the rise in temperature leads to a decrease in the productivity of Sakha 69 variety by about (18%-20%), while in the Giza 163 variety by about (16%-20%), while in the Giza 163 variety by about (16%-20%). From the above it is clear that the high temperature leads to a decrease in the productivity of wheat.

Table 3: Different scenarios of wheat yield under different planting dates and varieties.

Class	Planting dates	Wheat productivity		% Change
		Current yield (tons/acre)	Yield under climate change conditions(tons/acre)	
Sakha 69	11- November	2.18	1.79	-18
	26- November	2.18	1.79	-18
	11-December	2.17	1.77	-18
	26-December	2.16	1.73	-20
Giza163	11- November	3.42	2.74	-20
	26- November	3.38	2.84	-16
	11-December	3.31	2.78	-16
	26-December	3.21	2.68	-17
Giza164	11- November	3.42	2.74	-20
	26- November	3.38	2.84	-16
	11-December	3.31	2.78	-16
	26-December	3.19	2.68	-17
Average		2.94	2.43	-18

Source: compiled and calculated using SPSS program compiled and calculated using SPSS program

2-Maize

It is clear from Table (4) that when planting high-yield varieties of maize (Giza 2-triple hybrid 310-Biober) at the most appropriate time for planting, it can achieve an increase in productivity, and by measuring the impact of climatic changes on those varieties and their planting dates The increase in temperature leads to a decrease in the productivity of the Giza 2 variety by about (15%-21%), while in the triple hybrid variety 310 it is about (14%-24%), while the Biobir variety is about (10%-21%). The temperature leads to a decrease in the productivity of maize.

3**-Cotton**

It is clear from Table (5) that when planting high-productivity varieties of cotton (Giza 75-Giza 95 triple-Dandara) at the most appropriate time for planting, it can achieve an increase in productivity, and by measuring the impact of climatic changes on those varieties and their planting dates from During an increase in temperature by about 4 degrees Celsius, it leads to an increase in productivity in both the Giza 75 variety by about (8%-35%) and in the Giza 95 variety by about (25%-36%), while

the Dandara variety by about (32%-46%) and the above It turns out that the increase in temperature leads to a rise in the productivity of Egyptian cotton.

Table 4: Different scenarios for the productivity of maize crop under different planting dates and varieties

Class	Planting dates	Maize productivity		% Change
		Current yield (tons/acre)	Under climate change conditions (ton / acre)	
Giza 2	18-May	3.31	2.62	-21
	03-June	3.39	2.75	-19
	June 18	3.32	2.83	-15
	03-July	3.52	2.82	-20
Triple Hybrid 310	18-May	3.69	2.79	-24
	03-June	3.81	3.08	-19
	June 18	3.75	3.21	-14
	03-July	3.88	3.15	-19
Biober	18-May	3.44	2.73	-21
	03-June	3.43	2.87	-16
	June 18	3.29	2.96	-10
	03-July	3.65	2.97	-19
Average		3.54	2.9	-18

Source: Compiled and calculated using SPSS program compiled and calculated using SPSS program

Table 5: Different scenarios of cotton yield under different planting dates and varieties.

Class	Planting Dates	Cotton Productivity		%Change
		Current yield (tons/acre)	+4°C	
Giza 75	08-March	1.02	1.1	8
	23-March	1.09	1.18	8
	06-April	1.0	1.23	23
	21-April	0.77	1.04	35
Giza 95	February 20	1.37	1.72	25
	06-March	1.42	1.78	25
	21-March	1.39	1.76	27
	05-April	1.27	1.73	36
Dandara	February 20	1.52	2.08	37
	06-March	1.6	2.34	46
	21-March	1.82	2.4	32
	05-April	1.62	2.3	42
Average		1.32	1.72	28.7

Source: compiled and calculated using SPSS program

Sensitivity analysis results

The basis of these results are field experiments conducted in the field to collect data for the different models in order to conduct a calibration and validation process for the models before using them to ensure that they can be accurately predicted under our Egyptian conditions. Simulation studies have been conducted on different agricultural climatic areas in Egypt for a period of 25-40 years. The results of these studies showed the following:

1-Wheat: The productivity of the wheat crop will decrease by about 9% if the temperature rises by 2°C, and the rate of decrease will reach 18% if the temperature rises by 4°C. The water consumption of

this crop will increase by about 2.5% compared to its water consumption under the current weather conditions

2-Maize: The productivity of the maize crop will decrease by about 19% by the middle of this century (at a temperature rise of about 3.5 ° C), compared to the productivity under the current weather conditions, and its water consumption will increase by about 8%.

3-Cotton Climate changes will positively affect the productivity of the cotton crop, and its productivity will increase by about 17% if the air temperature rises by 2°C, and the rate of increase in this crop will reach about 31% under conditions of an increase in temperature of 4°C. Others, its water consumption will increase by about 10% compared to its water consumption under current weather conditions.

Reducing carbon dioxide emissions in agriculture through

1- The use of adaptation mechanisms that resist climate change in Egyptian agriculture, through specific activities such as the use of types of seeds that are resistant to drought or salinity, the use of water resources more efficiently, and improvement in pest management. Changes in agricultural patterns may include reducing the use of fertilizers and developing management rice production.

2-Agriculture can contribute positively to mitigating carbon dioxide emissions by absorbing it, as it is estimated that the contribution of cropland to carbon sequestration by applying better land management methods such as improving soil fertilization and water management, erosion control, and converting croplands in industrialized countries to Permanent forests, pastures or ecosystems, biomass crops, tillage to maintain soils, etc. Agriculture can play a major role in sequestering carbon and as a compensating mechanism for agriculture's contribution to greenhouse gases.

3-Agriculture can also play a role in reducing fossil fuel combustion, and it is possible to replace about 20% of fossil fuel consumption in the short term by using biomass fuel.

How to deal with the phenomenon of climate change

1-Mitigating carbon dioxide emissions from various sectors through the use of clean technology, replacing fuels, and using renewable energies such as wind, sun, waterfalls, and vitality.

2-The threat of exposing a particular place or ecosystem to the risks of climate change outcomes, such as the threat resulting from a lack of water resources.

3-Adaptation by responding to the effects of climate changes and coexisting with the conditions resulting from those conditions, such as the development of new strains of crops that tolerate salinity and high temperatures, the optimal use of water resources through the application of water rationing policies and rationalization of consumption.

The recommendations

1-The possibility of overcoming the severe shortage in the productivity of wheat and maize as a result of being negatively affected by this phenomenon, by changing the date of planting wheat under the conditions of climatic changes from November 1-15 to the period from November 25 to December 10, which could lead to an increase in the productivity of the wheat crop by about 4 In addition, the increase in the nitrogen fertilization rate from about 50 kg of nitrogen per acre to about 70 kg of nitrogen per acre led to an increase in the yield by about 5%. This feddan production is about 4% when changing the planting date from the beginning of May to mid-June, and the shortage can be reduced by another 5% by increasing the amount of irrigation water 100 milliliters for the season to the basic amount of water for this crop.

2-Devising new varieties that can withstand high temperatures, salinity and drought, which are the conditions that will prevail under the conditions of climatic changes, and devising new varieties whose growing season is short to reduce the water requirements needed for them, in addition to changing the planting dates to suit the new weather conditions, as well as planting appropriate varieties in the regions The appropriate climatic conditions to increase the crop yield from a unit of water for each crop.

3-Reducing the area of water-intensive crops such as corn and cotton

4-Irrigation at the appropriate times and with the appropriate amount of water in each irrigation in order to preserve every drop of water, which we will be in dire need of under the conditions of climatic changes.

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