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RESEARCH ARTICLE

AN ECONOMETRIC ANALYSIS FORTHE IMPACT OF CLIMATIC CONDITIONS ON THE PRODUCTIVITY OF MANGO CROPS IN EGYPT BY USING PANEL DATA MODELS

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Abstract

Horizontal agricultural expansion is one of the most important pillars of the national economy in Egypt, so the country makes strenuous efforts to make optimal use of agricultural resources, and despite these efforts, the climate prevents it**.**Recently, global warming has increased and climate change is expected to worsen the frequency, intensity, and impacts of some types of extreme weather events that affected mango productivity during the last years, which led to a decrease in productivity by about 37%, with a value of financial losses amounting to 4.8 billion pounds in 2021.Therefore, the research aims to estimate the impact of extreme weather on mango productivity during the last three years (2021-2019) at four studied governorates representing 75% of the total area of mango in Egypt. The Fixed Effect Cross of Panel Data Model was adopted as the appropriate model, to illustrate the impact of the phenomena on the productivity of mangoes. The results show that there is a statistical significance and a negative effect for both the minimum and maximum temperatures, as productivity decreases by about 1.05%, and 1.79% with an increase in each of the minimum and maximum temperatures by 1%, respectively. The negative impact has been shown on the governorates of Buhaira and Ismailia. Also, the individual effect was studied for each month,it was found that there was a statistically significant negative effect of the minimum and maximum temperatures for the months of flowering and fruiting.

Introduction:-

Weather is the main factor that controls crop production. Crop development and season length are dependent on weather (Ouda,2022). The term “climate variability” is often used to denote deviations in climate statistics over a given short time (such as a specific month, season, or year) from the long-term climate statistics relating to the corresponding calendar period (Sami Ul Din et al. 2019).Extreme weather events, such as droughts, heat, cold waves, and flooding have serious effects on food production. It is expected to cause instability of crop yields and forms a high risk to global crop production (Lobell et al. 2013).Crop yields show a strong correlation with

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temperature change and with the duration of heat waves, which differ based on plant maturity stages during extreme weather events (Hoffmann 2013).Schlenker and Roberts (2009) indicated that extremely high daytime temperatures are destructive and could be lethal to crops. Rosenzweig et al. (2001) reported that higher temperatures than threshold temperatures may lead to significant reductions in crop yields. Due to differences in growth patterns among crops, the impact of warming temperatures and weather extremes is crop-dependent. The physiological processes of a crop could be affected by extreme weather events and cause physical damage (van der Velde et al. 2012). Acceleration in the phenological development of crops under warmer conditions is observed, which reduces the growing season, reduces net photosynthesis, and consequently reduces yield (Lobell and Ortiz-Monasterio 2007). Ben-Asher et al. (2008) indicated that photosynthesis rates of sweet corn were decreased by at least 30% when the temperature exceeded 30 °C. Furthermore, higher air temperatures than 36 °C cause pollen to lose viability in maize (Motha 2011). Fruit is one of the most important components of agricultural income, including mango, the queen of tropical fruits, as it is distinguished by its high nutritional value, in addition to its economic importance at the global level, as it is considered the third export crop after citrus and grapes. Egypt is famous for the cultivation of mangoes, as it accounts for about 20% of the fruit area, and thus mangoes are second only to oranges in terms of cultivated area. It contributes about 10.5% of the value of agricultural income from fruits. The country was keen to increase the fruit area in the new lands, as it is one of the main areas of agricultural development, in addition to achieving price stability in the local markets, increasing foreign trade rates, and improving the value of the trade balance. The objective of this study is to estimate the impact of extreme weather on mango productivity during the last three years (2021-2019) at four studied governorates representing 74% of the total area of mango in Egypt.

Materials and Methods:-

Study area

The study was conducted in four locations in Egypt (Ismailia, Sharkia, Nubaria, and Behira) which were distributed into three governorates (Ismailia, Sharkia, and Behira). The studied areas were selected depending on the climatic difference between the locations and highest area and the productivity of mango crop which represents 74% of the total area of mango in Egypt in comparison with other governorates according to the Agricultural Statistics Bulletin (ASB 2020). The four locations under study are located in the North Delta region, which is located within latitudes 30.6 and 31.2 degrees. longitudes 30 and 32 degrees, with a maximum temperature of around 24.9 degrees, and a minimum of 15.4 degrees, the wind speed is also around 2.58 m/s, with relative humidity is 72%. The evaporation rate is 3.7 km/day and the average rainfall is 106.7 km/year.

Data and Methodology:-

To achieve the study's objectives, the descriptive and quantitative analysis method to determine the impact of climate on the productivity of mango at the studied locations by using some statistical analysis methods like (averages and percentages, analysis of variance, and panel data models).The climate data for the minimum and maximum temperatures relative humidity and wind speed during the period from 2019 to 2021 were collected from the early warning unit at the climate change information center. The economic data was collected from bulletins issued by the Economic Affairs Sector of the Ministry of Agriculture and Land Reclamation.

Panel data models

Panel data models are an important tool in agricultural economics as well as the related disciplines of regional sciences, geography, urban and real estate economics, economic geography, public economics, and local public finance (Baltagi, Song, and Koh, 2007c).

Schlenker and Roberts (2006) advise using panel data to overcome the problem where a cross-section of yields is followed over time and using fixed-effect analysis to account for regional determinants of yields.The advantage of panel data or the statistical approach for analyzing the impact of climate change on farming depends on its methodological nature. The data requirement is relatively small, it has a spatial resolution, and the goodness of fit is higher. The model can be tested for validity using historical changes and predictions used out of the sample. The big limitation of the model is the focus on the yield response without considering adaptation dynamics. However, the model is an effective approach tothe impact of climatic conditions analysis on agricultural production.The regression of the Panel Data method was used in its three models in the present study:- the Pooled Regression Model (PRM), the Fixed EffectsModel (FEM), and the Random Effects Model (REM) as Schlenker and Roberts (2006) advised.

Results and Discussions:-

The mango crop is considered one of the most promising horticultural crops in Egypt. Governorates of Ismailia, Sharkia, and Behira are some important agricultural provinces in Egypt because it's characterized by growing many fruit crops, especially mango crops.

1) Analysis of the current situation of mango production:

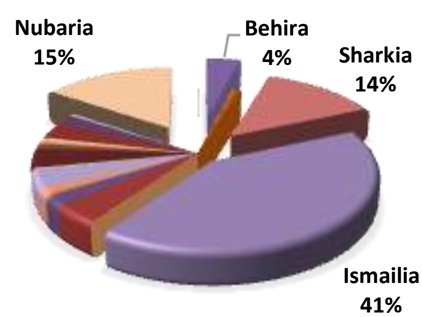
Table (1), show that Egypt’s average production of mangoes was about 1.02 million tons during the period (2019-2021), grown in an area of about 280 thousand feddans (1 feddans = 4200 m^2), and the average productivity per feddan was about 3.68 tons.Also, mango productivity declined by 37% during 2021 compared with 2019.By studying the most critical producing governorates, it was found that the Ismailia governorate comes in first ranking with an average production of 282 thousand tons, and its production constitutes about 28% of Egypt's production despite its acquisition of about 38% of the fruit area of mangoes; This is due to the low productivity per feddan, which amounted to about 2.57 tons, and thus it is lower than the average productivity of Egypt by about 30%. It was found that the rate of decline in productivity amounted to about 34%. The farmers explained that heat waves during the flowering season had a negative impact on productivity. The Nubariaregion comes second in the ranking of production, with an average about 26% of the total production of Egypt, with an area representing about 15% of the total mango area. The advancement in rank is due to the high average productivity compared to most governorates.Despite this, productivity declined in 2021 by about 57% compared to 2019. Sharkia and Behiracome in third and fourth places, respectively, with an average production of about 137,66 thousand tons.Despite this, productivity declined in 2021 by about 57% compared to 2019. Sharkia and Behiracome in third and fourth places, respectively, with an average production of about 137 and 66 thousand tons with rates representing 13% and 6% of Egypt's production. The average productivity was estimated at 4.1 and 5.17 tons/feddan, and the decline rate in Sharkia productivity was about 53%.It is noted that the production of the four governorates constitutes 74% of the total production of Egypt, and it is produced in an area about 73% of the total area of mangoes. Accordingly, any difference or decline in productivity constitutes a waste of productive and economic resources for farmers and the country.

Table (1):- Geographical distribution of the average area, production, and productivity of mangoes during the period (2019-2021)

Area: feddan, productivity: tons, production: tons/feddan

Governorate	Total area	Fruitful area	productivity	production	Total area (%)	Fruitful area (%)	relative productivity	rate of change in productivity	Production (%)
Behira	16466	12759	5.17	65900	5%	5%	140%	1.1%	6%
Sharkia	42926	34469	4.10	136741	14%	12%	111%	-53%	13%
Ismailia	117352	110197	2.57	282038	38%	39%	70%	-34%	28%
Nubaria	48240	47064	5.67	265892	15%	17%	154%	-57%	26%
Other	86742	75047	-	269897	28%	27%	-	-	26%
Egypt	311726	279535	3.68	1020469	100%	100%	100%	-37%	100%

Figure 1:- Average fruitful area per feddan in the four locations (2019-2021).



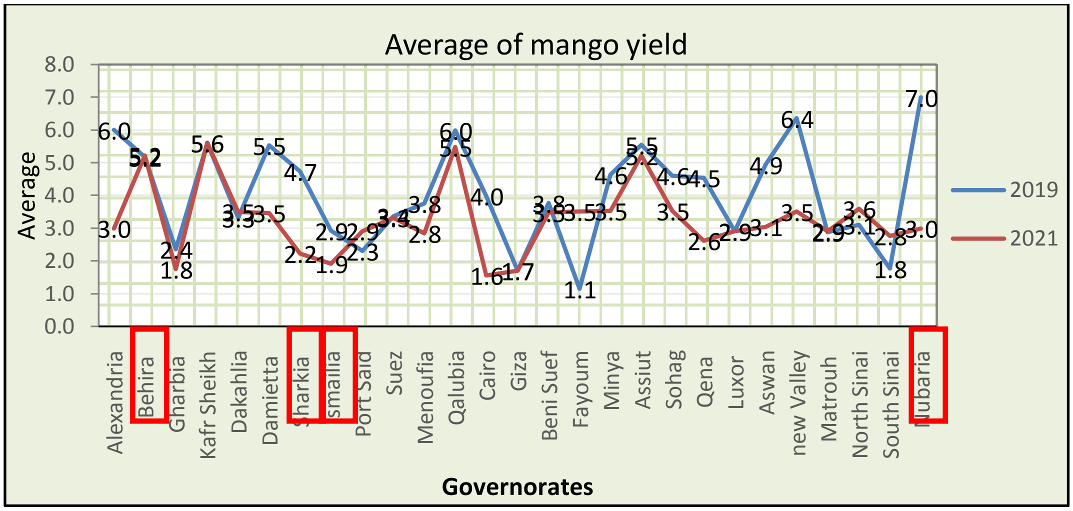


Figure 2:- Average of mango yield during 2019 and 2021.
(Red cells are the study areas)

2) Economic losses due to low mango productivity:
The results of the previous table showed that the productivity of the mango crop decreased by about 37%, which had a decisive impact on the level of income of farmers as well as on the economic resources of the country.

Assuming that all factors are constant and the reason for the decrease in productivity is attributed to the impact of climatic conditions, the financial losses are estimated based on the difference between the average productivity for the year 2021 compared to 2019. Behira Governorate was excluded from the estimate due to a slight increase in productivity.Thus, the data in a table (2) indicates that the total financiallosses due to the decrease in the productivity of mangoes in Egypt were about 4.8 billion pounds during the year 2021, with a losses production estimated at 482 thousand tons.Despite the small cultivated area of mangoes in Nubaria compared to Ismailia, the losses in Nubaria were about 1.95 billion pounds, equivalent to 40.5% of the total losses, due to the high average productivity per feddan.The losses in Ismailia and Sharqia were about 24.3% and 25.5%, respectively. Thus, the losses of the three locations constitute about 90% of the total losses of Egypt, which reflects the magnitude of the suffering of the farmers of these locations, as well as the country's economy.

Table (2):- Estimating the financial losses due to the decrease in mango productivity during the period (2019-2021).

Governorate	Productivity difference Ton/Feddan	Average of area	Losses in production by thousand tons	Farm lossesby million pound
Sharkia	-2.5	49.2	-123	-1226
Ismailia	-1.0	117.9	-118	-1176
Nubaria	-4.0	49.0	-196	-1953
Total of Egypt	-1.5	321.0	-482	-4823

• The average of farm price was about 9965 thousand pounds/ton.
Source: Collected and calculated from the Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Bulletin of Agricultural Statistics.

By estimating the losses in economic resources represented in (land and water resources, human and mechanical work - and assuming that capital losses were estimated in financial losses), the losses of land resources are estimated at about 186 thousand feddan, which is the wasted area according to the low productivity per feddan and according to the results of the table (3).And by estimating the losses of water resources according to the water requirements for mango trees in the study governorates, estimated about 6500 m3 / feddan, the total loss of water resources is about 1.2 billion m3 - with constant evaporation rates and the average water requirements according to the current temperatures.And by estimating the average number of workers in the farm, it was found that the losses are estimated at about 2.78 million workers, and the waste in machine working hours is estimated at about 4.27 million working hours.Based on the opinions and complaints of mango farmers, the decline in productivity is mainly due to climate impacts. It was necessary to study the effect of these phenomena on feddan productivity.

3) Climatic impacts onmango yield:
Egypt is divided into nine agro-climatic regions according to Central Laboratory for the agricultural climate. The four locations under study (Behira, Ismailia, Sharkia, and Nubariya) are located in the North Delta region, which is located within Latitudes 30.6 and 31.2 degrees. Longitudes 30 and 32 degrees, with a maximum temperature of around 24.9 degrees, and a minimum of 15.4 degrees, the wind speed is also around 2.58 m/s, with relative humidity is 72%.

Table (3):- Estimating the losses in economic resources due to the decline in mango productivity during the period (2019-2021).

Governorate	Productivity difference Ton/Feddan	Wasted land area by thousand feddan	Wasted water resources by million m^3	**Wasted workers**		Wasted machine work	
				Average number of workers per feddan	Total number of workers per feddan	Average number of machine working hours	Total number of machine working hours
Sharkia	-2.5	-55	-359	15	-829	23	-1272
Ismailia	-1.0	-61	-399	22	-1350	30	-1842
Nubaria	-4.0	-65	-424	16	-1045	30	-1959
Total of Egypt	-1.5	-186	-1206	20	-3712	27	-5012

- Source: Collected and calculated from the Ministry of Agriculture and Land Reclamation, Economic Affairs Sector, Bulletin of Agricultural Production Requirements.
- Central Agency for Public Mobilization and Statistics, Water Resources and Irrigation Bulletin, 2020.

By analyzing variance to determine the extent of the difference in climatic factors during the period (2019-2021), we found the following:

Minimum temperature:
The data in a table (4), indicated that the minimum temperature in Ismailia, Sharkia, and Nubaria was below 10 degrees during February, March, and April, which led to a decline in productivity during the three years, as shown in Table (1). The data of the studied regions indicate that the rate of increase in the minimum temperature during the growing season ranged between 4.3% - 7.1% during 2021 compared to 2019, and Ismailia recorded the highest rate of increase in temperature. Also,It was found that there was a significant variation during February and May, and this is due to the temperature fluctuation during most days of the month, while the significant variation did not appear during March and April, because the duration of heat waves did not exceed one or two days during the month. This means that the effect may not be clear during the analysis, which is one of the problems facing estimating the impact of climatic phenomena during the production season.

Table (4):- Variation analysis of the daily minimum temperature during the months of flowering and fruiting for the period (2019-2021).

Items	Behira				Ismailia			
	February	March	April	May	February	March	April	May
lowest value	11.8	11.9	13	17.5	6.1	6.9	9.4	14.3
highest value	13.7	14.5	17.3	20.8	10.5	12.2	15.6	19.4
monthly average	12.8	13.5	15.2	19.2	8.3	10	11.1	13.1
rate of change	%4.9				%7.1			
variation	*13.63	0.99	0.788	*7.94	2.3	1.6	0.03	**3.3

Items	Sharkia				Nubaria			
	February	March	April	May	February	March	April	May
lowest value	7.2	7.7	9.6	15.6	6.8	7.5	9.3	13.5
highest value	10.2	11.5	15.2	19.8	9.8	11.5	13.9	18.9
monthly average	8.4	9.8	12.3	17.2	8.1	9.5	11.6	16.3
rate of change	%4.3				%4.6			
variation	*6.8	1.2	0.26	*8.5	*12.6	1.4	0.94	****4.7**

(*) indicates significance at the 0.01 statistical probability level,(**) indicates significance at the 0.05 statistical probability level

Source of data: Climate Change Information Center and Renewable Energy, Early Warning Unit**.**

Maximum temperature:

Table (5), shows that the temperature range of the study areas ranged between 18-36.3 degrees.Which is not compatible with the temperature range of mango trees.The data of the studied locations indicate that the rate of increase in the maximum temperature during the growing season ranged between 2.1% - 4.8% during 2021 compared to 2019, and Ismailia also recorded the highest rate of increase in temperature. It was found that there was a significant variation in the maximum temperature in most of the locations during April and May.

Table (5):- Variation analysis of the daily maximum temperature during the months of flowering and fruiting for the period (2019-2021).

Items	Behira				Ismailia			
	February	March	April	May	February	March	April	May
lowest value	15	17.4	18	23.3	16.9	20	22	29.4
highest value	20.4	20.9	26.3	29.3	24	24.8	31.6	38
monthly average	18	19.1	21.9	26.9	20.4	23.1	25	27.8
rate of change	%2.3				%4.8			
variation	1.66	0.83	**1.2	**4.4	1.3	1.5	**4.7	*6.9
Items	Sharkia				Nubaria			
	February	March	April	May	February	March	April	May
lowest value	19.8	21.8	22.7	32.9	17.4	19.7	20.8	27.3
highest value	26.1	28.2	35	40.6	23.5	26.7	33.8	38.1
monthly average	21.7	24.4	29	36.3	20.6	22.5	26.7	33.4
rate of change	%3.6				%2.1			
variation	1.35	0.78	**3.7	*12.8	2.2	1.0	1.6	*5.2

(*) indicates significance at the 0.01 statistical probability level,(**) indicates significance at the 0.05 statistical probability level

Source of data: Climate Change Information Center and Renewable Energy, Early Warning Unit**.**

Wind speed

The data of the studied areas indicated that the rate of increase in wind speed during the growing season ranged between 2.5%-7.5% during 2021 compared to 2019, and Behira governorate recorded a decrease in wind speed by about 3%.

Table (6):- Variation analysis of the daily wind speed during the months of flowering and fruiting for the period (2019-2021).

Items	Behira				Ismailia			
	February	March	April	May	February	March	April	May
lowest value	3.29	3.79	3.42	3.67	2.6	3.2	3	3.3
highest value	7.36	7.78	7.26	6.91	5.2	6.3	6	5
monthly average	5.1	5.6	5.1	4.8	3.7	4.3	4.3	4.2
rate of change	-%3				%2.5			
variation	0.21	0.9	0.36	2.3	0.64	0.44	0.65	*6.02
Items	Sharkia				Nubaria			
	February	March	April	May	February	March	April	May
lowest value	2.5	3.3	2.8	3.5	2.9	2.8	3.1	3.1
highest value	4.9	5.9	5.3	5.6	5.7	7	5.3	5.9
monthly average	3.6	4.2	4.1	4.2	3.9	4.5	4.2	4.2
rate of change	%7.5				%6.8			
variation	0.76	0.92	1.77	2.7	0.5	0.54	1.5	**1.6**

(*) indicates significance at the 0.01 statistical probability level,(**) indicates significance at the 0.05 statistical probability level

Source of data: Climate Change Information Center and Renewable Energy, Early Warning Unit**.**

4) The effect of climatic conditions on productivity

The research assumes an inverse relationship between the average feddan productivity as a dependent variable and the explanatory factors represented in the minimum and maximum temperatures during the months of flowering and fruiting. As well as a direct relationship between productivity and wind speed, as confirmed by studies and farmers' opinions. The model was used in the logarithmic form to estimate the parameters of sectional time series modeling as it was one of the best mathematical models used, and the function was represented in the following formula:

$$\mathbf{Liny_{it} = c - LinTmin_{it} - \beta LinTmax_{it} + \beta LinTws_{it} + \mu_i + \gamma_t + U_{it}}$$

where

$\mathbf{Liny_{it}}$	= logarithm of the dependent variable (yield).
$\mathbf{LinTmin_{it}}$	= logarithm of the independent variable (minimum temperature)
$\mathbf{LinTmax_{it}}$	= logarithm of the independent variable (great temperature)
$\mathbf{LinTws_{it}}$	= logarithm of the independent variable (wind speed)
$\mathbf{c}$	= constant
$\boldsymbol{\mu_i}$	= Sectional effects that vary from one governorate to another, but are constant over time.
$\boldsymbol{\gamma_t}$	= common temporal effects between governorates that change over time.
$\mathbf{U_{it}}$	= random variable

The data of Table (7) Refer to the results of the estimates of Panel Data by three models during the period(2019-2021),It is evident from the significance of the three models. To determine the most appropriate models,The test was conducted onthe Redundant Fixed effect-likelihood ratio to compare between Pooled and Fixed.The hypotheses for this test are:

H0: The combining linear regression model is the appropriate modal.

H1: The fixed effects model is the appropriate model.

The data in Table No. (8) indicates that the probability value of the Chi-square statistic test is less than 0.05, thus we reject the null hypothesis and accept the alternative hypothesis, which states that the appropriate model is the fixed effects model.

In order to differentiate between the fixed and random effects models, the Hausman test was performed. The hypotheses of this test are:

H0: The random effects model is the appropriate model.

H1: Fixed effects model is the appropriate model.

The data of the same table indicates that the probability value according to this test is less than the value for the statistical probability level 0.05, and thus we reject the null hypothesis and accept the alternative hypothesis, which states that the appropriate model is the fixed effects model.

Table (7):- Shows the results of estimating the parameters of the panel data models.

Variables	PRM	FEM	REM
C	0.537 (0.43)	8.1 (**2.4)	0.537 (0.45)
Ln(Tmin)	0.040 (0.16)	-1.056 (**-2.2)	0.040 (0.14)
Ln(Tmax)	-0.276 (-0.69)	-1.794 (**-2.54)	-0.276 (-0.73)
Ln(Ws)	1.11 (**2.5)	1.137 (**2.58)	1.11 (**2.68)
C Behira		-0.605	
C Ismailia		-0.405	
C Sharkia		0.137	
C Nubaria		0.873	
R^2	0.22	0.346	0.223
R^{-2}	0.17	0.249	0.167
F-statistic	4.14	3.608	4.144
F_{sig}	0.011	0.0057	0.0113
D.W	1.99	1.911	1.991

F_{sig}=0.05 **

Source: Results of data using Eviews 12.

The results of Table (7) indicate that the statistical significance of the model was estimated at the statistical probability level of 0.05. The F-statistic value was about 3.086. There is no autocorrelation problem between the errors, as the D.W value was about 1.9. The value of the modified coefficient of determination $\overline{R^2}$ was about 0.249, which means that the minimum and maximum temperature and wind speed explain about 25% of the changes in mango productivity during the period 2019-202, while the rest of the changes are attributed to other factors.

There is a statistical significance and a negative effect of the minimum temperature, as the function indicates that an increase in the minimum temperature by about 1% leads to a decrease in productivity by about 1.05%, which is consistent with economic logic. Also,there is a statistical indication and a negative effect of the maximum temperature, as the function indicates that an increase in the maximum temperature by about 1% leads to a decrease in productivity by about 1.79%, which is consistent with economic logic.Statistical significance and positive effect for wind speed, which means that an increase in wind speed by 1% increases the productivity of mangoes by about 1.137%.Due to the illogicality of the event, although there was no difference in wind rates during the studied period, the effect of wind speed was not predicted.The function indicates that there is a negative impact on the governorates of Behiraand Ismailia, according to the fixed effect cross.

Table (8):- Test results of Hausman and likelihood ratio.

Test Summary	Statistic	d.f	Prob.
likelihood ratio			
Cross-section Chi-square	8.406	3	0.038
Hausman Test			
Cross section random	7.847	3	0.043

Source: Results of data using Eviews 12.

According to the previous results, the fixed effects model is the appropriate model. It is formulated according to the following equation:

LnY = 8.1 – 1.056 LnMin – 1.794 LnMax + 1.137 LnWs

5) The effect of monthly climatic conditions on mango productivity

The previous analysis relied on studying the impact of climatic phenomena during the season on productivity, and due to the crop being affected by the variation in these phenomena during flowering and fruiting stages, the individual effect was studied for each month, according to the fixed effect model and from the results in a table (9) we found that The high impact of climatic phenomena for March on the productivity of mangoes, as the statistical significance of the F-statistic model, was estimated at 21.35. The value of the modified coefficient of determination $\overline{R^2}$was about 0.72, which means that the minimum and maximum temperature and wind speed for March explain about 72% of the changes in mango productivity during the period 2019-2021. There is a statistical indication and a negative effect of the minimum temperature. The function indicates that an increase in the minimum and maximum temperatures by about 1% leads to a decrease in productivity by about 3.56%. It also shows the statistical significance and direct effect of bone temperature and wind speed.The months of February and May come in the second rank in terms of the impact on productivity, as the statistical significance of the F-statistic model was estimated at 8.84 and 8.89, respectively, and the value of the modified coefficient of determination $\overline{R^2}$ was about 0.50. It was found that there is a statistical significance and a negative effect for each of the minimum temperatures and the bone temperature. And the presence of statistical significance and direct effect of wind speed. The month of April is the month with the least impact on productivity, as the statistical significance of the F-statistic model was estimated at 5.62, and the value of the modified coefficient of determination $\overline{R^2}$was about 0.37. It was found that there is a statistical significance and a negative effect for each of the minimum temperatures, the maximum temperature, and the wind speed, which is consistent with the economic reasoning.

Table (9):- Shows the results of estimating monthly climatic phenomena parameters on mango productivity using the FEM model.

Variables	**February**	**March**	**April**	**May**
C	11.5 (3.14)*	-8.9 (-2.8)*	23.10 (4.57)**	10.7 (3.72)**
Ln(Tmin)	-0.82 (-2.86)*	3.56- (-7.4)*	-1.89 (-1.74)	-3.13 (-4.9)**
Ln(Tmax)	3.13- (-3.09)*	2.34 (3.2)*	- 4.46 (-5.1)**	-1.28 (-2.9)*
Ln(Ws)	0.78 (3.36)*	7.5 (10.5)*	1.6- (-1.9)	2.8 4.4)**(
R^2	0.56	0.75	0.45	0.56
R^{-2}	0.50	0.72	0.37	0.50
F-statistic	8.84	21.35	5.62	8.89
F_{sig}	0.000003	0.00000	0.0003	0.00003

*F_{sig}=0.01, **F_{sig}=0.05

Source: Results of data using Eviews 12.

Discussion:-

The term "climate variability" is often used to denote deviations in climate statistics over a given short time (such as a specific month, season, or year) from the long-term climate statistics relating to the corresponding calendar period (Sami Ul Din et al. 2019). The effect of climate change is expected to have a significant effect on mango production. Weather is the main factor that controls mango production. Mongo trees' development and season length is dependent on weather (Oudaand Zohry, 2022). The optimal temperature for mango growth is between 24–27°C, and the required humidity is between 70–85%. (Zhang et at., 2019).Bhagwanet at., 2013 reported that the shift of low night temperature of less than 15°C from November-December to January-February and the subsequent sudden rise in temperature of above 35°C during February has progressively delayed the flowering and subsequently exposed the emerging flower panicle to high day temperatures might have resulted in less no of perfect flowers, poor fruit set and decrease the productivity of mango.Adamgbe and Ujoh (2013) mentioned that extreme weather events negatively influence crop yields under both irrigated and rain-fed agriculture. Also,Adhi Dharma and Pamungkas (2021) found that any decrease in air humidity will lead to a decrease in the mango crops.

Conclusions:-

Extreme events are expected to cause instability of mango crops and form a high risk to crop production. Variability in weather and climate leads to falls in crop productivity. Egypt has experienced extreme weather events for the past few years. Several measures have been taken to limit the vulnerability of the agricultural system to climate variability. Based on the result of this study, it can be concluded that the expansion of mango cultivation in the governorates and regions is less affected by climate variability. Reducing exposure to climate variability can be done by implementing resilient farming systems like early warning systems. Dopting climate studies as one of the items of feasibility studies for agricultural expansion and investment.

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