Journal of Agricultural Economics and Social Sciences

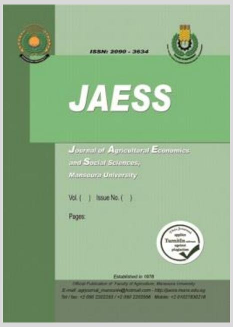
Journal homepage & Available online at: www.jaess.ekb.eg

Impact of Climate Change on Olive Production in Egypt

Mai M. H. Morsi[1*]; Basma H. Saad[2] and Sherin Sherif[1]

[1] Department of Economics and Agribusiness, Faculty of Agriculture, Alexandria University, Egypt.
[2] Department of Rural Development, Faculty of Agriculture, Alexandria University, Egypt.

Cross Mark



ABSTRACT

The research investigated the relationship between climate change and olive production in Egypt. Eight main olive-producing regions across Egypt are surveyed. Results showed that the technical factors, farmers' characteristics, and climatic variables are found to be statistically different among the eight olive-producing areas. Furthermore, not only that the technical variables or the personal characteristics of the olive producers are different among the eight olive-producing areas, but also climatic variables are further not the same amongst the eight olive-producing areas. Consequently, it cannot be generalized that the climate is the same among the eight olive-producing areas. The results also suggested that the irrigation method and soil type are the two technical factors most affecting average olive productivity. The farmer's educational level and the number of years of experience of the farmer are the two factors most affecting olive productivity; however, they came in the ranking of variables after the two technical factors. Frequency of rainfalls and the frequency of experiencing severe drop in temperatures are the two climatic factors most affecting olive productivity. Nevertheless, these climatic variables came in the ranking after both of the technical variables and the personal characteristics variables of the olive producer.

Keywords: Climate Change,, ANOVA, Chi-Square test, Logit Regression, Egyptian Olive Production

INTRODUCTION

For thousands of years, humans have taken an interest in olive due to their admiration of the olive plant because of its longevity, as well as its therapeutic fruit and oil. Olive has been one of the most important sources of income for many civilizations throughout the history in the East Mediterranean. Ancient Egyptians, among other civilizations have all cultivated olives and produced olive oil. The Romans are responsible for spreading olives from the East Mediterranean to Spain. Olives have not been perceived as an asset of economic value only but have become prominent in many cultures as divine gift. The olive culture has played an active role in the lives of all nations living around the Mediterranean (Efe et al., 2011).

Growers prefer olive cultivation because of its resistance to drought and salinity conditions, in addition to low fertilization needs comparing with other fruit trees. Olives are known to contain significant amounts of vitamin E, some essential fatty acids, antioxidants, along with other nutrients. World production of olives was set at 23.05 million tons. The major producing countries are those of Spain, Italy, Turkey, Morocco, Portugal, and Egypt in 2021 (FAOstat, 2023).

In Egypt, olive cultivation has increased considerably during the last two decades. This is due to the great efforts made for expanding olive cultivated areas with new cultivars in reclaimed areas. El-Nubaria, Ismailia, and El-Fayoum are the most important areas of olive production. Egyptian olive production was about 1.01 million tons produced from an acreage of 0.27 million feddans (1 Feddan = 0.42 Hectare), most of which are processed mainly as table olive and the rest is extracted to olive oil. (Ministry of Agriculture and Land reclamation, 2022).

Research Problem

Olives and olive oil played an important role in ancient Mediterranean economies. Today, olives contribute billions of dollars to the global economy which gives a strong motive to develop and facilitate harvest techniques. There are over 800 million olive trees across the globe. Olives and their oil now sustain an industry producing about $10 billion annually. Therefore, it is extremely important for all growers to try maximizing production efficiency and to lower harvesting costs. Therefore, the research problem can be formulated in the following question: Does the climate changes affect the olive production in Egypt? And if so, are these effects direct.

Research Objectives

The research aimed mainly to address the relationship between Climate Change and Olive Production in Egypt through On-field-surveying some major olive-cultivated areas in Egypt (primary data analysis of a representative random sample of producers) to identify olive varieties grown in each region, and all of the variables associated with olive production and climate change impacts (olive producers' profile), Assessing the existence of variations in olive yields and returns amongst the olive-producing areas to identify, if any, the impact of climate change among regions on olive yields and returns through the analysis of the primary data gathered, Identifying the existing marketing channels using the primary data collected from the different olive producing areas.

MATERIALS AND METHODS

The research conducted the analysis of ANOVA, Chi-Square Goodness of fit test, Linear regression, and a binary logistic regression model based on a questionnaire of 294 olive production farm over a three-month period; namely,

[*] Corresponding author.
E-mail address: mai.hassan@alexu.edu.eg
DOI: 10.21608/jaess.2024.284984.1287

May, June, and July of the year 2019, distributed over of 11 governorates as following:

1. New Valley or Wadi El-Gedeed (18 questionnaires);
2. Suez (9 questionnaires);
3. Sharkia (3 questionnaires);
4. South Sinai (36 questionnaires);
5. Beni Suef (9 questionnaires);
6. Ismailia (34 questionnaires);
7. Beheira (34 questionnaires);
8. Fayoum (34 questionnaires);
9. Menia (25 questionnaires);
10. Matrouh (57 questionnaires); and
11. Giza (35 questionnaires).

However, the analysis of variance (ANOVA) will be conducted considering 8 producing areas only through grouping the 9 surveys of Suez with the 3 of Sharkia with the 34 of Ismailia for a total of 46 questionnaires, as one producing area. Whereas the 9 surveys of Beni Suef will be grouped with the 25 questionnaires of Menia for a total of 34 questionnaires, as one producing area. The reason for this grouping is to allow for having more degrees of freedom for the ANOVA, and consequently, better statistical significance of the analysis conducted. As for the attitude measurement index that will be made to measure the attitude of olive producers towards climate change impacts on agricultural production, the total sample of 294 questionnaires will be made.

RESULTS AND DISCUSSION

1- Descriptive Statistics of the Primary Data of the Whole Sample:

This section of the paper presents a summary result of the descriptive statistics of each of the study variables.

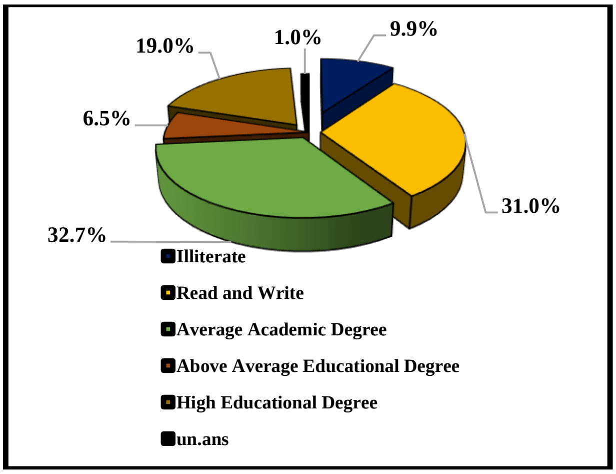
Personal and General Information:

1. The majority of the sample are found to be farmers (256 out of 294), or equivalently 87.1% of the sample. The remaining 25 individuals, or equivalently 8.5% of the sample, are found to belong to the set of experts.
2. The number of years of experience in the sample varied between one year only and 65 years, with an average year of experience of 18 years, a standard deviation of 10 years, and a coefficient of variation of 65.13%.
3. As shown in Graph (1), About 32.7% of the sample represents producers who possess average education degrees. On the other hand, 31% of the sample know only how to read and write. The set of producers who have university degrees are 19% of the total sample.
4. The majority of the sampled producers (94.6%) did not acquire any training in the field of climate change. Only 4.8% of the sampled olive producers received training of some sort in climate change.
5. Same as the previous point, 93.5% of the sampled producers did not attend any environmental awareness programs and the like, vis-à-vis 5.8% of the producers attending.
6. About half of the sample, or 53.4% belonged to the youth who are less than 35 years old. About 22.8% of the sample are of the age group between 35 and 50 years old, whereas another 22.8% belonged to the set of farmers more than 50 years old.
7. The sample also shows that the number of farmers who own farms is about 199 individuals (67.7%), with 6.5% of the sample own companies, and 1% own factories.

Table 1. Descriptive statistics of Personal and General Information:

Question	Item	Frequency	%
First: Personal and General Information			
Indicate what suits you the most:	Farmer (producer)	256	87.1
	Expert	25	8.5
	Processor	0	0.0
	Marketer	0	0.0
	Others	10	3.4
	Un answered	3	1.0
Total		294	100.0
Educational Level:	Illiterate	29	9.9
	Read and Write	91	31.0
	Average Academic Degree	96	32.7
	Above Average Educational Degree	19	6.5
	High Educational Degree	56	19.0
	Un answered	3	1.0
Total		294	100.0
Have you obtained training sessions or workshops in the climate change field?	Yes	14	4.8
	No	278	94.6
	Un answered	2	0.7
Total		294	100.0
Have you attended awareness symposiums or the like in the field of climate change?	Yes	17	5.8
	No	275	93.5
	Un answered	2	0.7
Total		294	100.0
Indicate your age category:	Less than 35	67	22.8
	from 35 to 50	157	53.4
	more than 50	67	22.8
	Un answered	3	1.0
Total		294	100.0
Do you have	a company	19	6.5
	Processing Plant (factory)	3	1.0
	Farm	199	67.7
	Un answered	73	24.8
Total		294	100.0

Source: collected and calculated from questionnaire data.

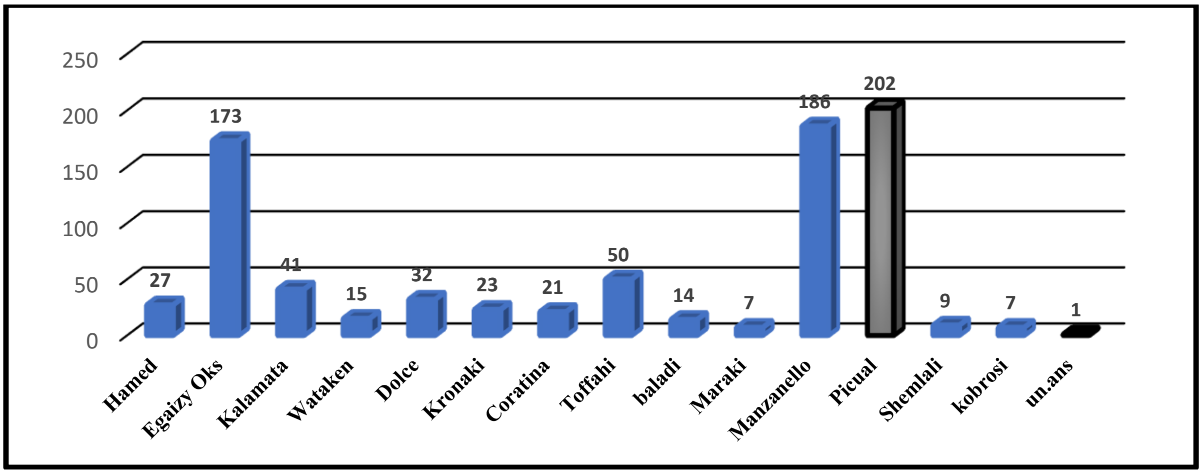


Graph 1. Educational Level:

Source: Calculated from the primary data of the study through Excel.

Farm Information:

1. The farm area ranged between half a feddan, as a minimum, and 1000 feddans, as a maximum, with an average area of 76 feddans, a standard deviation of 20 feddans, and a coefficient of variation of 198.26%.
2. *Picual*, the Spanish olive variety, is found to be the most common olive species grown. It is cultivated in 202 farms. It is followed by the cultivar *Manzanello* which is grown in 186 farms, and *Egaizy* which is grown in 173 farms. For the olive varieties *Kobrosi* and *Maraki*, they are found to be the least grown in the sampled olive producers, as shown in and Graph (2).



Graph 2. Olive Varieties Cultivated

Source: Calculated from the primary data of the study through Excel.

3.As shown in table (2), The most common cultivation distances are 6x6 m; whereas cultivation distances of 3x2 m, 6x9 m, and 8x7 m are the least cultivation distances adopted.

Table 2. Olive Cultivation Distances

Question	Item	Frequency	
Cultivation Distances	3*2	1	0.3
	3*4	6	0.3
	3*5	2	2.0
	4*2	1	0.7
	4*4	2	0.7
	4*5	11	3.7
	5*5	25	8.5
	6*3	7	2.4
	6*4	27	8.8
	6*5	49	16.7
	6*6	64	21.8
	6*7	41	13.9
	6*8	2	0.7
	6*9	1	0.3
	7*5	1	0.3
	7*7	26	9.2
	8*7	1	0.3
	8*8	3	1.0
	8*9	1	0.3
	8*10	2	0.7
	10*10	16	5.4
	Un answered	5	1.7
Total		294	100.0

Source: collected and calculated from questionnaire data

4. The age of olive trees in the sample varied between one year minimum and 50 years maximum, with an average of 14 years, a standard deviation of 8 years, and coefficient of variation of 58.51%

As shown in table (3):

5. About 66.7 of the sampled producers use the dripping irrigation system, vis-à-vis 25.2% using the flooding system, and 8.2% relying on rainfalls.
6. About 66.7% of the sampled producers use chemical fertilizers with irrigation (fertigation), against 32.7% of them using fertilization through application to soil by scattering or strewing (top dressing or broadcasting).
7. About 92.9% of the sampled producers serve the soil, with 6.8% of the producers who do not do any special servicing to the soil.
8. Productivity per feddan varied between 0.2 tons as a minimum and 16 tons a s a maximum, with an average, standard deviation, and coefficient of variation of 5.77 tons, 2.29 tons, and 39.72%, respectively.
9. Calcareous soils represented 49.3% of the sampled farms against 31.6% and 16.3% standing for sandy soils and clay soils, respectively.
10. Wells are found to be the major source of irrigation water in the sampled olive-producing farms (75.2%) set against 15.3% and 6.8% standing for canal irrigation and rainfall irrigation, respectively.
11. Irrigation water quality is found to be of the average type in the studied farms with 52.6% share, set against 26.5% and 18.4% representing good quality waters and bad quality waters, respectively.

Table 3. Descriptive statistics of Farm Information:

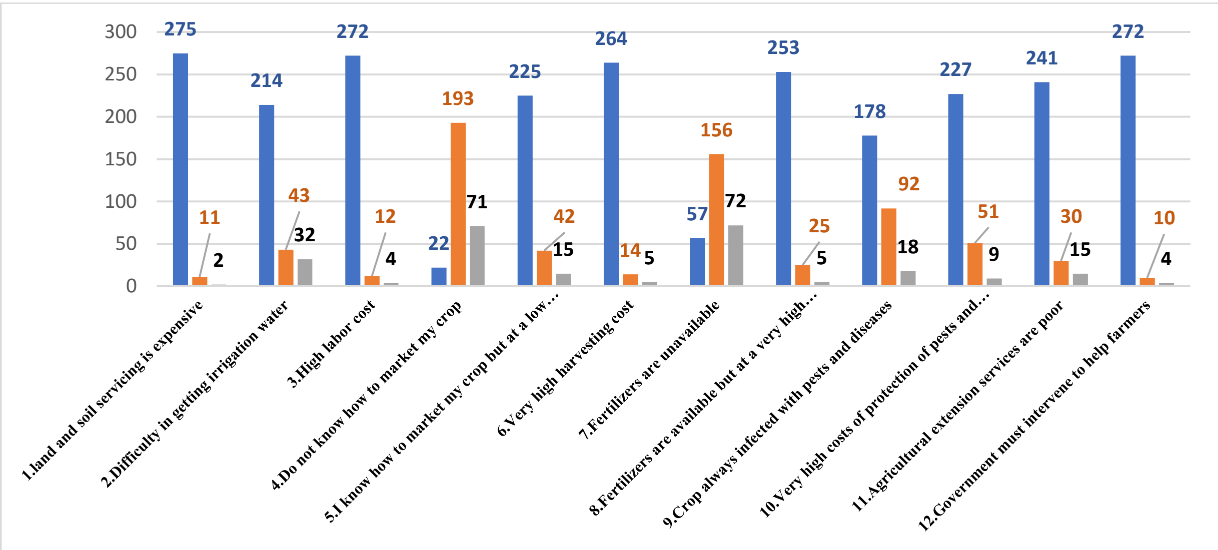
Question	Item	Frequency	
Irrigation System Used	flooding	74	25.2
	drip	196	66.7
	Rain fall	24	8.2
	Un answered	0	0.0
Total		294	100.0
Fertilization Methods Adopted:	soil surface	96	32.7
	Chemical with irrigation water	196	66.7
	Un answered	2	0.7
Total		294	100.0
Soil Servicing	Yes	273	92.9
	No	20	6.8
	Un answered	1	0.3
Total		294	100.0
Type of Soil in Your Farm	Sandy	93	31.6
	calcareous	145	49.3
	clay	48	16.3
	Un answered	8	2.7
Total		294	100.0
Source of Irrigation water	Well	221	75.2
	Cannel	45	15.3
	Rain fall	20	6.8
	Un answered	8	2.7
Total		294	100.0
Quality of Irrigation Water	Good	78	26.5
	Average	155	52.7
	Bad	54	18.4
	Un answered	7	2.4
Total		294	100.0

Source: collected and calculated from questionnaire data

Problems and Obstacles Faced When Cultivating Olives:

Nearly 12 problems and obstacles have been identified to represent issues facing olive cultivation in Egypt for the examined farms. The main problem reported is the high cost of land and soil servicing. The least problem reported is the one pertaining to fertilizers availability. A summary of the findings is presented below as shown in graph (3):

1. About 93.5% of the olive producers consider the high cost of land and soil servicing, whereas only 0.7% not.
2. About 72.8% of the sampled producers claim that it is difficult to obtain irrigation water, set against 10.9% not.
3. Nearly 92.5% of the sampled producers complain about high labor cost. Only 1.4% of the sample denied so.
4. Surprisingly, only 7.5% of the sampled olive producers claim that they do not know how to market their olives. About 24.1% opposed to that.
5. Nearly 67.5% of the producers complain about marketing their production at low prices, with 5.1% objecting to that.
6. High harvesting cost is confirmed by 89.8% of the sampled olive producers, with only 1.7% denying so.
7. Nearly 19.4% of the producers complain about the unavailability of fertilizers, with 24.5% resenting that.
8. The majority of producers, or equivalently 86.1% of the producers complain about the high costs of fertilizers, set against 1.7% disagreeing to that.
9. About 60.5% of the producers emphasized that infections with pests and diseases is a big problem, with 6.1% of them denying so.
10. The high cost of disease prevention and crop protection is said to be a major problem to 77.2% of the sampled producers, with 3.1% objecting to that.
11. Nearly 82% of the producers complain about the lack of good agricultural extension services, with 5.1% denying that.
12. Nearly 92.5% of the sampled olive producers whine from the non-intervention of the government to solving their problems, with only 1.4% objecting to that.



Graph T.S.3. Problems and Obstacles Faced When Cultivating Olives.
Source: Calculated from the primary data of the study through Excel.

4. Olives Marketing Information:

Table (4) shows that the majority of the olive producers in the sample market their olives fresh to the *kelala* trader (a trader who visits the land of the farmer and approximates the monetary value of his harvest by the eye of the expert). Their percentage is in the neighborhood of 58.8% about 15% of the producers take their products directly to the processing factories. Nearly 18% of the producers take their production to the retailer trader. The rest of the olive producers are found to sell their olives directly in the form of pickled olives or sell their processed olives to either the traders or the consumers directly.

Table 4. Olives Marketing Information

The marketing channel	Frequency	%
I sell olives fresh to the *kelala* trader.	173	58.8
I take my olives directly to the processing factories.	44	15.0
I sell my olives to the retailer directly.	53	18.0
I sell my olives by myself directly in a pickled bag (*sorra*)	4	1.4
I sell my processed olives to the trader directly.	5	1.7
I sell my processed olives to the consumer directly	3	1.0
Un answered	12	4.1
Total	294	100.0

Source: collected and calculated from questionnaire data

5. Production Indicators of Olives Under Appropriate Climatic Conditions:

1. A question is asked about the productivity of olives in the farmer in the past three years. Answers are as follows: productivity ranged between 0.1 tons and 12 tons, with an average, standard deviation, and coefficient of variation of 2.03 tons, 2.06 tons, and 101.78%, respectively, in the first year. In the second year the minimum, maximum, average, standard deviation, and coefficient of variation are set at 0.1 tons, 16 tons, 3.27 tons, 2.2 tons, and 67.3%, respectively. For the third year, the corresponding figures are as follows: 0.1 tons, 11 tons, 3.05 tons, 2.15 tons, and 70.42%, representing the minimum, maximum, average, standard deviation, and coefficient of variation, respectively.
2. Production costs per feddan varied between a minimum of 500 Pounds a maximum of 42,500 Pounds, an average of 8,413.2 Pounds, a standard deviation of 48,664.43 Pounds, and a coefficient of variation of 57.82%.
3. Total revenues per season varied between a minimum of 2000 Pounds, a maximum of 42,000 Pounds, an average of 18,247.55 Pounds, a standard deviation of 11,252.44 Pounds, and a coefficient of variation of 61.67%.
4. Net revenues per feddan ranged between a minimum of 1000 Pounds, a maximum of 30,000 Pounds, an average of

9,626.34 Pounds, a standard deviation of 7,125.02 Pounds, and a coefficient of variation of 74.02%.

6. Impact of Climate Change on Productivity and Net Revenue per Feddan:

As shown in table (5):

5.Given the producer's experience and past history, the number of times where they got heavy rains or floods in the past periods is 6 times. Rarity of rainfalls is repeated 10 times, experiencing very high temperatures happened 12 times, and having severe cold weather is reported to be happening 6 times maximum.

6.The majority of the sampled producers could not answer the question on the impact of ordinary rainfalls on productivity per feddan (85.7%), with 1% only agreeing that ordinary rainfalls increases productivity, with 3.7% of the producers denying so.

7.The same case is found when olive producers are asked about the impact of ordinary rainfall on net returns per feddan, with 85.7% not answering, and 5.8% objecting to that.

Table 5. The most important climate changes on productivity and net revenues per feddan

Climatic Condition	Changes on	Increase		No relation		decrease		Un-answered		Total
		Frequency	%	Frequency	%	Frequency	%	Frequency	%	
Normal rainfalls	Productivity per Feddan	3	1.0	28	9.5	11	3.7	252	85.7	294
	Net Revenue per Feddan	0	0.0	25	8.5	17	5.8	252	85.7	294
Heavy rainfalls	Productivity per Feddan	11	3.7	20	6.8	18	6.1	245	83.3	294
	Net Revenue per Feddan	8	2.7	20	6.8	21	7.1	245	83.3	294
Drought	Productivity per Feddan	2	0.7	30	10.2	43	14.6	219	74.5	294
	Net Revenue per Feddan	0	0.0	30	10.2	45	15.3	219	74.5	294
Extremely High temperatures	Productivity per Feddan	5	1.7	18	6.1	27	9.2	244	83.0	294
	Net Revenue per Feddan	4	1.4	13	4.4	33	11.2	244	83.0	294
High temperatures	Productivity per Feddan	4	1.4	14	4.8	61	20.7	215	73.1	294
	Net Revenue per Feddan	3	1.0	11	3.7	64	21.8	216	73.5	294
Low temperatures	Productivity per Feddan	62	21.1	21	7.1	8	2.7	203	69.0	294
	Net Revenue per Feddan	63	21.4	15	5.1	13	4.4	203	69.0	294

Source: collected and calculated from questionnaire data

8.Same again is found when farmers are asked about the impact of heavy rainfall on per feddan productivity (83.3%), with 3.7% of the producers claiming that heavy rainfalls increase productivity and 6.1% objecting to that. Some producers claimed from the lack of yield due to heavy rains. The reason is that climate changes lead to sharp fluctuation in both temperature and rain from year to other Also, distribution of rain during autumn, winter and, spring differed due to climate changes. So, if heavy rains are fallen during flowering and fruit set, it will affect olive yield. Also, heavy, rains during fruit ripening in autumn will affect fruit quality.

9.Similar answers are obtained when olive producers are asked about the impact of heavy rainfalls on net returns per feddan with 83.3% not answering, 2.7% agreeing, and 7.1% declining this phrase.

10. Again, similar answers are obtained when the olive producers are asked about the impact of drought on per feddan productivity, with 74.5% not answering, 0.7% saying drought increases productivity, and 14.6% asserting that drought decreases productivity.
11. Also, drought effects on net returns per feddan are unanswered by 74.5% of the olive producers, and 15.3% saying drought reduces net returns per feddans.
12. Same case is found when farmers are asked about the impact of very high temperatures on per feddan productivity with 83% not answering, 1.7% saying it increases productivity, and 9.2% disagreeing.
13. Same answer for the impact of having extremely high temperatures on the per feddan net returns with 83% not answering, 1.4% agreeing this having a positive impact on returns, and 11.2% disagreeing.
14. About 73.1% did not answer the question on the impact of high temperatures on productivity, with 1.4% saying it is good for productivity, and 20.7% disagreeing.
15. Same for the impact of high temperatures on net returns per feddan, with 73.5% not answering, 1% claiming it increases returns, and 21.8% disagreeing.
16. About 69 % did not answer the question on the impact of low temperatures on productivity, with 21.1% claiming low temperatures increase productivity, and 2.7% disagreeing.
17. Also 69% of the olive producers did not answer the question on the impact of low temperatures on net revenues per feddan with 21.4% saying yes it does increase net returns and 4.4% disagreeing.

7. Miscellaneous Questions:

As shown in table (6):

1. About 58.5% of the sampled olive producers agree on the role the woman plays in olive cultivation. They say that this is particularly true when it comes to harvesting, sorting, packing, and processing. About 14.3% of the

sampled olive producers disagree to the role of women being positive or significant.

2. About 73.13% of the sampled olive producers agree about the importance of youth in olive cultivation, starting from production, all the way to marketing.
3. About 38.78% of the sampled olive producers believe that the activities of pests and insects have increased lately as a result of climate change. However, 34.35% of the sample producers disagree to that as they see no change in the activities of insects that could be significantly realized lately as a result of climate change.
4. The majority of the sampled olive producers emphasized the significant positive role of the private sector in the olive industry and say its contribution outweighs 85%.

By conducting a chi-square test for goodness of fit, the results show that the test is statistically significant at the level of 1% and 5%, which means rejecting the null hypothesis for the questions under study in Table No. I and accepting the alternative hypothesis that indicates to the woman and youth aged below 30 years old have a role in the cultivation, production, processing, and marketing of olives, there is an increase in the activity of pest and insets and more spreading of diseases as a result of rising temperature in the past five years.

Table 6. Descriptive statistics of Miscellaneous Questions

Question	Item	Frequency	%	Chi-Square	Sig.
Does the woman have a role in the cultivation, production, processing, and marketing of olives	Yes	172	58.5	91.81	0.00
	No	42	14.3		
	Un answered	80	27.2		
Total		294	100.0		
Do youth aged below 30 years old have a role in the cultivation, production, processing, and marketing of olives?	Yes	215	73.13	62.91	0.00
	No	0	0.00		
	Un answered	79	26.87		
Total		294	100.0		
Have you realized an increase in the activity of pest and insets and more spreading of diseases as a result of rising temperature in the past five years?	Yes	114	38.78	6.39	0.04
	No	101	34.35		
	Un answered	79	26.87		
Total		294	100.0		
In your opinion, what is the level of participation of the private sector in the activities pertaining to olive cultivation, production, processing, and marketing?	Max	100			
	Min	50			
	Average	85.63			
	Un answered	86			

Source: collected and calculated from questionnaire data

2- Climate-Change Impact Differences Among the Eight-Olive Producing Areas:

The analysis of variance (ANOVA) will be conducted considering 8 producing areas only through grouping the 9 surveys of Suez with the 3 of Sharkia with the 34 of Ismailia for a total of 46 questionnaires, as one producing area. Whereas the 9 surveys of Beni Suef will be grouped with the 25 questionnaires of Menia for a total of 34 questionnaires, as one producing area. The reason for this grouping is to allow for having more degrees of freedom for the ANOVA, and consequently, better statistical significance of the analysis conducted. change impacts on agriculture. Analysis of Variance (ANOVA) test has been performed to identify if these differences, if at all, are statistically significant, or that they are marginal in nature. Recall the eight olive-producing areas of the study are those of: Matrouh, New Valley, Giza, Beheira, Fayoum, South Sinai, Ismailia, and Minia. The examined variables of the study (please refer to the field survey questions) are grouped into three types of variables. They are:

1. **First Group** includes the variables associated with either the practices made to produce olives, or the resources used, or production levels achieved. These variables include soil type, soil servicing, fertilization methods, irrigation methods, irrigation-water source, quality of irrigation water, age of grown trees, farm area, production level in the last year, and production in the last three years;
2. **Second Group** includes the variables associated with the farmer's personal characteristics and efficiency, such as his years of experience, his educational level, whether he acquired training sessions or workshop or attended symposiums related to climate changes, and his methods of marketing his crop; and
3. **Third Group** includes the climatic variables such as the frequency of incurring severe droughts or heavy rainfalls, and frequency of experiencing extremely high temperatures or extremely low temperatures.

The results of the ANOVA test are shown in Table (7) for the 20 study variables associated with olive production and representing all of the above three groups. The codes of the three groups of variables are as follows:

- ***"Soiltype"*** standing for soil type.
- *"Fert"* standing for fertilization used.
- *"Irrigation"* standing for irrigation method utilized.
- *"Irrigationsource"* standing for the source of irrigation water.
- *"Irrigationquality"* standing for the quality of irrigation water used.
- *"Production"* standing for the olive production per feddan obtained in the last year in tons.
- *"Treesage"* standing for the age of the olive trees in the farms.
- *"Soilserving"* standing for the practices made to serve the soil.
- *"Rainfalls"* standing for the frequency of rainfalls.
- *"Drought"* standing for the frequency of droughts experienced by the farmer.
- *"Hightemperature"* standing for the frequency of experiencing extreme high temperatures by the olive producer.
- *"Lowtemperature"* standing for the frequency of experiencing extreme low temperatures.
- *"Marketing"* standing for the type of marketing method adopted by the olive producer.
- *"Experience"* standing for the years of experience of the olive producer.

- *"Occupation"* standing for the type of the occupation of the olive producer (whether he is a farmer or expert or processor, or marketer, etc.
- *"ClimateTraining"* standing for whether the olive producer received training sessions in climate-related training or not.
- *"ClimateAwareness"* standing for attendance of climate-related symposiums.
- *"Area"* standing for the farm size in feddans.
- *"Binary"* standing for the olive productivity in the last three years. This variable takes value "1" if the productivity in the last year is constant or increasing and a zero value if productivity in the last three years is declining.
- *"Education"* standing for the educational level of the interviewed olive producer.

Table 7. the ANOVA test results.

Variable		Sum of Squares	df	Mean Square	F	Sig.
Soiltype	Between Groups	63.708	7	9.101	36.036	.000
	Within Groups	70.212	278	.253		
	Total	133.920	285			
Fert	Between Groups	47.241	7	6.749	111.448	.000
	Within Groups	17.197	284	.061		
	Total	64.438	291			
Irrigation	Between Groups	27.822	7	3.975	18.431	.000
	Within Groups	61.675	286	.216		
	Total	89.497	293			
Irrigationsource	Between Groups	45.087	7	6.441	32.764	.000
	Within Groups	54.651	278	.197		
	Total	99.738	285			
Irrigationquality	Between Groups	54.372	7	7.767	28.658	.000
	Within Groups	75.621	279	.271		
	Total	129.993	286			
Production	Between Groups	301.245	7	43.035	10.055	.000
	Within Groups	1159.886	271	4.280		
	Total	1461.131	278			
Treesage	Between Groups	3494.191	7	499.170	8.709	.000
	Within Groups	16336.137	285	57.320		
	Total	19830.328	292			
Soilserving	Between Groups	1.697	7	.242	4.080	.000
	Within Groups	16.938	285	.059		
	Total	18.635	292			
Rainfalls	Between Groups	95.696	7	13.671	15.584	.000
	Within Groups	228.080	260	.877		
	Total	323.776	267			
Drought	Between Groups	630.394	7	90.056	15.981	.000
	Within Groups	1498.964	266	5.635		
	Total	2129.358	273			
High temperature	Between Groups	338.972	7	48.425	13.671	.000
	Within Groups	920.950	260	3.542		
	Total	1259.922	267			
Low temperature	Between Groups	46.879	7	6.697	10.713	.000
	Within Groups	161.915	259	.625		
	Total	208.794	266			
Marketing	Between Groups	53.605	7	7.658	8.204	.000
	Within Groups	255.774	274	.933		
	Total	309.379	281			
Experience	Between Groups	2325.673	7	332.239	3.519	.001
	Within Groups	23699.300	251	94.420		
	Total	26024.973	258			
Occupation	Between Groups	15.472	7	2.210	4.035	.000
	Within Groups	155.009	283	.548		
	Total	170.481	290			
ClimateTraining	Between Groups	.660	7	.094	2.114	.042
	Within Groups	12.669	284	.045		
	Total	13.329	291			
ClimateAwareness	Between Groups	1.129	7	.161	3.079	.004
	Within Groups	14.881	284	.052		
	Total	16.010	291			
Area	Between Groups	792633.828	7	113233.404	5.637	.000
	Within Groups	5484358.303	273	20089.225		
	Total	6276992.130	280			
Binary	Between Groups	7.342	7	1.049	7.078	.000
	Within Groups	39.567	267	.148		
	Total	46.909	274			
Education	Between Groups	57.001	7	8.143	5.880	.000
	Within Groups	391.886	283	1.385		
	Total	448.887	290			

Source: Calculated from the primary data of the study through SPSS software, ANOVA Analysis.

The null hypothesis of this ANOVA test is that the average values of the study variables among the eight olive-producing regions are the same; i.e., no differences among the eight regions.

Table (7) of the ANOVA test shows that there are statistically significant differences at the level of significance of less than 1% among the eight producing regions for 19 of the 20 variables examined, except for the one variable pertaining to receiving training sessions in climate-related issues; namely, *"ClimateTraining"*. The significance level of that variable is at less than the 5% level. In the science of statistics, there are three known levels of significance; namely, the 1% level, the 5% level, and the 10% level. This implies that strong statistically significant differences exist for all of the 20 variables. This statistical significance is expressed in this table by either having a high value of the F-ratio or the low P-value. A low P-value means that the probability of having no significant differences among regions for the said variable is, at least, below the 1% level for the 19 variables and below the 5% level for one variable only. Both implies strong existence of differences among the eight olive-producing areas. Conclusion is to reject the null hypothesis.

In sum, the ANOVA test results conclude that the three groups of variables are statistically different among the eight olive-producing areas. This applies to the First Group of variables, or the Second Group of variables or the Third Group of variables where the climate variables are located. In other words, not only that the technical variables or the personal characteristics of the olive producers are different among the eight olive-producing areas, but also climatic variables are further NOT the same among the eight olive-producing areas. Consequently, it CANNOT be generalized that climate is the same among the eight producing areas.

Finally, a binary logistic regression model is performed, shown in Table (8), to investigate more the impact of climatic factors on olive productivity. This is as it may be important to know how a change in one climatic variable is likely to add to or take from olive productivity. In this probabilistic model, the dependent variable is used as a binary variable taking either the value of one (when average olive productivity in the last three years either goes up or stays steady) or the value of zero (when average olive productivity declines in the past three years). The model shows that the frequency of rainfall is the only factor significantly affecting average productivity for the whole sample. This frequency of rainfall variable, denoted by *"Rainfalls"*, is responsible for 1.6% to 2.5% of the variations in average olive productivity in the last three years (a little share or little contributive impact on olive productivity, that is). The model shows that as the frequency of rainfall increases by one more time, it is more likely that a reduction in average olive productivity will decline by 0.288 tons. This result is found to be statistically significant at less than the 5% level; namely, strong statistical significance.

Table 8. Logit Regression results.

Model	Wald.	Sig.	Omnibus x^2	Sig.	R^2		Overall R^2
					Cox & Snell	Negelkerke	
Constant Rinfalls	1.491 -0.288	0.000 0.048	3.75	0.053	0.16	0.25	78.4

Source: Calculated from the primary data of the study through SPSS software, Binary Logistic Regression Analysis.

This result may require further investigation since it is known that having good rainfalls add to olive productivity. The only possible explanation of that is rainfalls are good for subsequent years of olive production but not necessarily good in the year in which heavy rainfall occurred. This result contradicts with some of the literature made on olive production. However, it should be noted that this result, like the other result of having no significant impact of temperature on the likelihood of impacting olive productivity, is based on the answers obtained from the sample respondents and cannot be affirmed as a scientific fact. Here, we may also be faced with different types of statistical errors that led to this conclusion. This is in addition to the fact that this binary logistic regression model is a probabilistic model, meaning it talks about how likely a change in a climatic variable affects olive productivity. As a result, the conclusion reached here about the impacts of temperature or rainfall on olive productivity cannot be confirmed and this issue needs further scientific investigation and further analysis, probably using other types of models to ascertain or negate the results obtained via this probabilistic model.

Moreover, this conclusion is obtained for the whole sample and not for each individual region separately. ANOVA test showed that the eight-olive producing regions are different from each other on technical grounds, farmers characteristics, and climatic characteristics. Probably if the binary logistic regression model was performed on each olive-producing region separately, the obtained results may be different from one region to the other. Unfortunately, applying this probabilistic model to each olive-producing region separately could not be made due to having low degrees of freedom for each separate region which will lead to the inability of obtaining reliable statistical results. A number of observations of around 100 olive-producer is needed for each region for this type of analysis to be carried out and to have a statistical meaning and explanation.

ACKNOWLEDGMENT

The authors would like to acknowledge the financial contribution made by Regional Office for the Near East Office & North Africa (RNE), 11, Al Eslah El Zerai St., P.O. Box 2223, Dokki, Egypt, www.fao.org, FAO Near East website: http://neareast.fao.org. Without the donation made by FAORNE this research would not have been made accessible. Furthermore, the authors would like to thank the administration of the Faculty of Agriculture, Alexandria University, for providing the logistical aid needed for conducting the field survey.

REFERENCES

Efe, R., Soykan, A., Cürebal, I., Sönmez, S. (2011) Dünya'da Türkiye'de Edremit Körfezi'nde Zeytin ve Zeytinyağı, Meta Basım, ISBN: 978 605 62253 0 7, İzmir

IPCC WG II (2014) Climate Change Impacts, Adaptation, and Vulnerability. Chapter 22 (Africa)

Ministry of Agriculture and Land Reclamation (2022) Agricultural Economics Bulletin. Economic Affairs Sector, Cairo, Egypt.

Muhammad Afzal, Gulzar Ahmed, and Muhammad Nadeem Javaid (2017) Empirical Assessment of Climate Change on Agricultural Crops: Panel Data Analysis in Pakistan. International Journal of Food and Agricultural Economics ISSN 2147-8988, E-ISSN: 2149-3766, Vol. 5, No. 2.

Muhammad, S., M.S. Gheblawi, and Sherin A. Sherif. (2010) Consumers' Attitudes and Perceptions to Food Safety in the United Arab Emirates Journal of Food Distribution Research (JFDR), Mississippi, USA, Vol. 41, No. 2.

Ozdemir, Yasin (2016) Effects of Climate Change on Olive Cultivation and Table Olive and Olive Oil Quality. Scientific Papers. Series B, Horticulture. Vol. LX, 2016, Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653.

Riahi, K. Gruebler, A. and Nakicenovic N. (2007) Scenarios of long-term socio-economic and environmental development under climate stabilization. Technological Forecasting and Social Change, Vol.74, No.7.

Riccarda Moser, Roberta Raffaelli, and Sandra Notaro (2010) The Role of Production Methods in Fruit Purchasing Behavior: Hypothetical vs. Actual Consumers' Preferences and Stated Minimum Requirements. Selected Paper prepared for presentation at the 1st Joint EAAE/AAEA Seminar. "The Economics of Food, Food Choice and Health" Freising, Germany.

Shailesh Shrestha, Pavel Ciaian, Mihaly Himics, and Benjamin Van Doorslaer (2013) Impacts of Climate Change on EU Agriculture. Review of Agricultural and Applied Economics. The Successor of the Acta Oeconomica et Informatica. ISSN 1336-9261, XVI, No. 2.

Simone Pieralli. 2015. The impacts of climate change on French agricultural productivity. Paper prepared for presentation at the 2015 Agricultural & Applied Economics Association.

Sun Ling Wang, Eldon Ball, Richard Nehring, Ryan Williams, and Truong Chau. (2014) Impacts of Climate Change and Extreme Weather on U.S. Agricultural Productivity Growth. Invited paper prepared for presentation at the Agricultural & Applied Economics Association's 2014 Annual Meeting, Minneapolis, MN,

Zewdie, A. (2014) Impacts of Climate Change on Food Security: A Literature Review in Sub Saharan Africa. J Earth Sci Clim Change 2014, Vol 5 No.8, Article by DOI: 10.4172/2157-7617.1000225.

Zikmund, W. G. (2003) Exploring Marketing Research, 8th edition. Thompson, South-Western.

أثر التغيرات المناخية على إنتاج الزيتون في مصر

مي مصطفى حسن[1]، بسمة حسن سعد[2] و شيرين شريف[1]

[1] قسم الاقتصاد وإدارة الأعمال الزراعية - كلية الزراعة - جامعة الاسكندرية
[2] قسم التنمية الريفية – كلية الزراعة- جامعة الاسكندرية

الملخص

اهتم البحث بدراسة العلاقة بين التغيرات المناخية وإنتاج الزيتون في مصر، باستخدام بيانات أولية تم تجميعها من ثماني مناطق رئيسية لإنتاج الزيتون في جميع أنحاء مصر. أظهرت النتائج أن العوامل الفنية وخصائص المزارعين والمتغيرات المرتبطة بالمناخ تختلف إحصائياً بين تلك المناطق. كما أشارت النتائج إلى أن طريقة الري ونوع التربة هما العاملان الفنيان الأكثر تأثيرا على متوسط إنتاجية الزيتون، في حين كان كل من المستوى التعليمي للمزارع وعدد سنوات خبرة المزارع هما العاملان الأكثر تأثيراً على إنتاجية الزيتون، كما أن تكرار هطول الأمطار التعرض للانخفاض الشديد في درجات الحرارة هما العاملان المناخيان الأكثر تأثيراً على إنتاجية الزيتون.

الكلمات الدالة: التغيرات المناخية، اختبار مربع كاي، تحليل التباين، الانحدار اللوجيستي، الزيتون.