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AGRICULTURE AND CLIMATE CHANGE

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Abstract

Agriculture plays a rather important role in the Romanian economy, with the agricultural sector accounting for 4.3% of GDP at the end of 2017. The agricultural sector is represented by different branches and production systems that have an essential and strategic role in improving the quality of life and quality by supplying various Romanian and / or organic products on the market. The agricultural sector is non-indispensable and indispensable to man. But, what is the link between climate change and agriculture, what does this relationship define? Agriculture is the victim of climate change or is agriculture responsible for climate change? This paper seeks to analyze climatic factors with a major influence on agriculture characterized by: temperature and precipitation, but also the role played by agriculture in climate change through greenhouse gas emissions. The paper deals with a topic of national, European and global interest, because these climate changes are reflected in food production, land and marine ecosystems, affecting the economy and the main culprit, the man.

Key words: *adaptability, agro-environment, climate, pollution*

INTRODUCTION

Climate change is increasing more and more from time to time, and it can be seen from the high-temperature differences that are unusual at certain times of the year. Climate gaining extreme features in the winter, with higher temperatures and lower snowfall, while the spring arrives earlier, recording temperatures above normal. All these changes affect man, as well the activities undertaken by him, such as agriculture. The factors that contributing to these climate change are numerous, and these are the result of how people carry out their activities in everyday life.

Whether we are talking about greenhouse gas emissions, non-biodegradable waste, non-environmentally friendly substances discharged into unsuitable places or others, it is certain that those that most influence climate change are greenhouse gases, the other affecting structures of different ecosystems. Greenhouse gases are a result of energy production centres, factories producing different goods, means of transport used in our travels (cars, planes, etc.) or differed farms producing and processing human daily food.

In order to focus our attention on the topic of this theme, it will highlight the factors that influencing climate change, as well as its effect on agriculture. Also, data on how agriculture is practiced at the national level and factors influencing the climate will be presented, on the basis of these aspects will be set the relationship between agriculture and climate change. The issue of agriculture and climate change has grown since 1970 [13], when it began to talk more and more often about the changes that man causes in the environment, so this topic has been brought to the attention of the institutions and the public through the environmental protection movements, also through alarm signals that are drawn by scientists around the world. The "Man-Made Climatic Changes," published by Helmut E. Landsberg (1970) [13], talks about how human activities have changed the climate in rural and urban areas and can affect the global climate in the future. Since then, greenhouse gases have been discussed and, through the work mentioned above, the author proposes to eliminate or reduce these gases directly from the source.

At a 43-year difference, more precisely in 2013, Hoffmann U. talks about the same

issues that man creates in the environment through his various activities. Through the paper "Agriculture - a key driver and a major victim of global warming," [11] the author talks about the relationship between agriculture and climate change, underlining the fact that they are in a process of interdependence.

This issue of climate change has grown from one year to the next, being widely debated (European and world level) trying to find the causes and solutions that support the environment and humanity.[6]

Thus, in 2018, a series of studies and reports on the impact of CO2 emissions on human nutrition at the global level were launched, and through the work "Impact of anthropogenic CO2 emissions on global human nutrition" Smith, Matthew R. and Myers, Samuel S. mentions that in common food crops a reduction of 3 to 17% in zinc, protein and iron [15] content would be noted. While, Hille Karl mentions through the paper "Rising carbon dioxide levels will help and hurt crops", the impact of this gas on crops is noticeable by increasing the rate of photosynthesis, favouring faster water loss as a result of stomata closure. [10]

Climate change such as global warming is also felt on precipitation, and this is due to the evaporation increases that lead to storms in some areas, but also to the emergence of arid areas creating an imbalanced climate through: floods and droughts. [12]

Porter, JR and al, said in "Food Safety and Food Production Systems" chapter 7 in the report "Climate Change 2014: Impact, Adaptation and Vulnerability" that climate change is already affecting agriculture, with unequal effects distributed around the globe. These changes will increase the risk of food insecurity for vulnerable groups (those with a difficult financial situation). [2]

As mentioned in the summary of this paper, the subject is of interest and requires highlighting and defining the relationship between agriculture and climate change.

MATERIALS AND METHODS

The processed information is statistically provided by the competent institutions (National Institute of Statistics, Eurostat, Faostat) regarding the average outputs for the culture under analysis, as well as data on meteorological factors (temperatures, precipitations) provided by the National Meteorological Administration.

The statistical data will show the influence of climatic factors on crop yield.

Also, to determine the influence that agriculture has on climate change, data on gas emissions will be analysed, data provided by the European Environment Agency.

Thus, by analysing the meteorological and agricultural factors, the aim was to achieve the proposed objective by studying and modelling the selected data, making a correlation between agriculture and climate change, establishing the relationship between them, using the simple linear regression statistic-econometric model, using SPSS program.

The literature as well as the legislation in the field of environmental pollution and greenhouse gas emissions were also analysed.

RESULTS AND DISCUSSIONS

In the last 20 years at national level, average yields for rapeseed crops showed fluctuations from one year to the next, thus the largest decrease in average production was recorded in 1998 as compared to the previous year when it decreased by 35.2% (520 kg / ha). At the opposite end, the highest increase in average production is the year 2004 compared to 2003, when it grows approximately 3 times, meaning an abundance of 1,511 kg / ha. [16]

According to figure 1, the highest average yield of rapeseed at national level is registered in 2016, which is 2,835 kg / ha, 13.4% higher than the previous year and 75% higher than in 1997 The average production at region level also shows oscillations from one year to the next, the highest being registered in 2014 by 2,631 kg / ha. The most significant decrease of the average production in the region is registered in 2000 compared to the previous year when it decreases by 43.8%, while at the

opposite pole, the largest increase is registered in 2001 compared to the year 2000, when the average production equals and grows approximately twice.

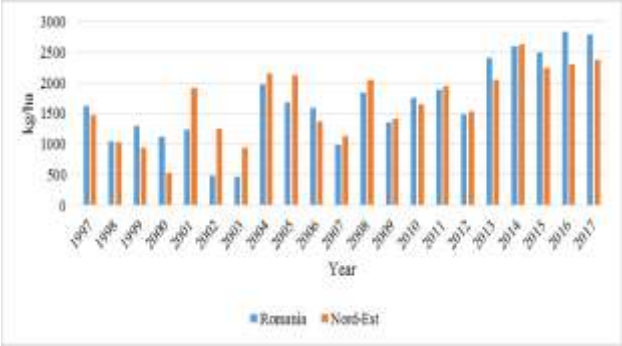

Fig. 1. Mean rapeseed production at national and Northeast level
Source: own design based on statistical data provided by INS, 2019.

The factors that contributed to these yield oscillations for rape crops are varied, but to get closer to the subject of this paper, it is necessary to highlight and analyze climatic factors to determine how they affect the yield of the present crop.

The plant's requirements for climate and soil are the same, but climatic factors (temperature, precipitation) differ from one county to another, so we don't have to generalize, as the results will not be conclusive. Thus, as the average production of the rapeseed in a single region has been analyzed, it is necessary to analyze the climatic factors on the same region (North-East) comprising the counties: Iasi, Suceava, Bacau, Neamt, Botosani, Vaslui.

Using the data provided by the National Meteorological Institute [14] as well as the archives provided by the wunderground.com site [4], the average temperature measured in Celsius degrees and the precipitations measured in millimeters during each calendar month for the entire analyzed period, respectively 1997-2017, we can observe the temperature and precipitation differences for the region studied. These will be correlated with average yields for rapeseed, but in order to be correlated, it will be necessary, to sum up the grades and precipitations for each year, since the number of variables analyzed is not equal, thus to create the simple linear regression model the number of variables must be equal.

For the North East region, the sum of median monthly grades showed an upward trend for the analyzed period (according to the trend line, figure 2), so that the sum of the grades is 7.84% higher in 2007 compared to the sum of the grades registered in 1997, while the sum of grades in 2017 is 36.94% higher than in 2007 and by 47.68% higher than those registered in 1997 (Fig. 2). This can also be seen in Fig. 3 when the average monthly temperature values are taken into account. In the figure above, it can be noticed that the temperatures for the year 2017 have increased considerably compared to those of the years 2007 and 1997.

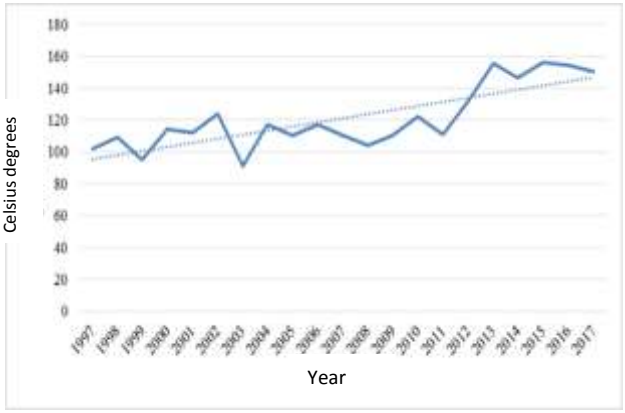

Fig. 2. Sum of monthly average grades in a calendar year-North East Region
Source: own processing of statistical data provided by INMH;(https://www.wunderground.com/history/monthly/en/LRBS/ date / 1997-17).

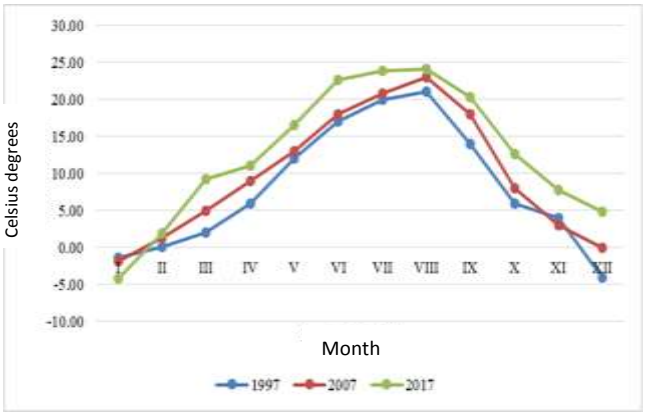

Fig.3. Average temperature per month North East Region
Source: own processing of statistical data provided by INMH;(https://www.wunderground.com/history/monthly/en/LRBS/ date / 1997-17).

The sum of the average monthly rainfall in the North-East region kept a balanced trend, but they did not record significant changes, but according to figure no. 4 the trend is decreasing (according to the trend line). Analyzing the precipitations from 2007 as compared to 1997, it is noted that they decreased by 7.063%, while the rainfall recorded in 2017 decreased by 3.17% compared to 2007 and by 10.01% as compared to 1997. This can also be seen in Figure 5 when average precipitation values are taken according to the month, with year 2017 coming out of normal parameters.

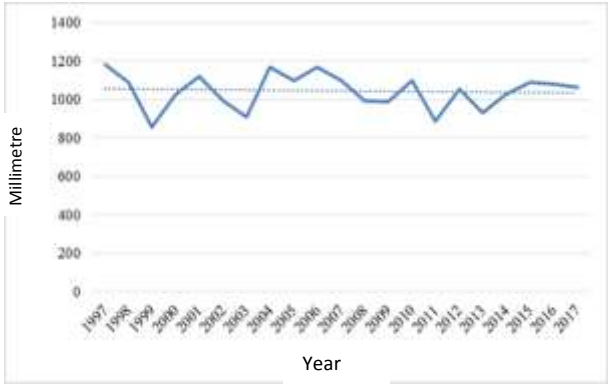

Fig. 4. Sum of monthly average rainfall in a calendar year North East Region
Source: own processing of statistical data provided by INMH.

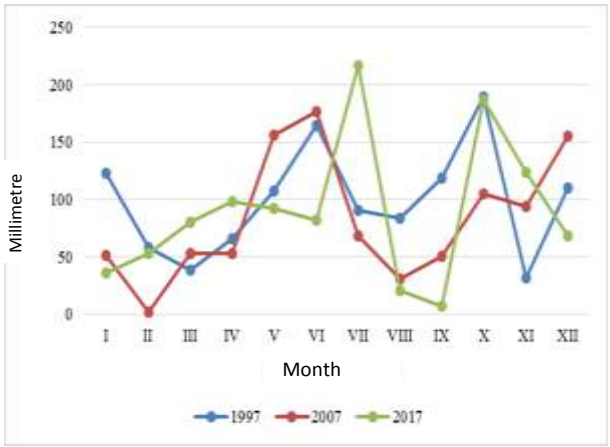

Fig. 5. Monthly average precipitation North East Region
Source: own processing of statistical data provided by INMH.

The lowest amount of precipitations in 2017 was recorded in August and September, excess moisture in July of the same year had negative influences on crops leading to calamity in important areas sown with grain and autumn rape.

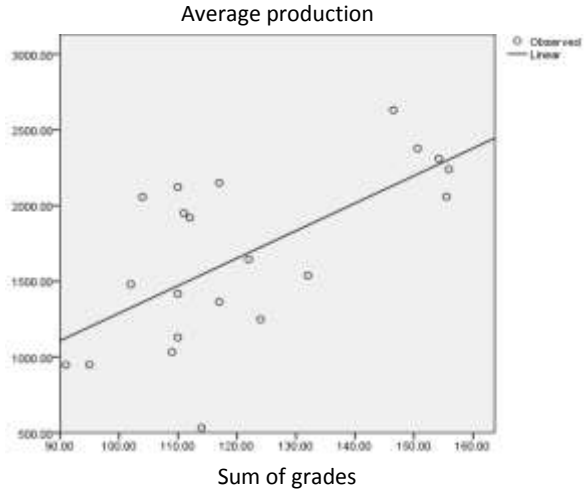

Fig. 6. Evolution of average rapeseed production according to year-to-year variation in the North East region
Source: processing of statistical data in SPSS.

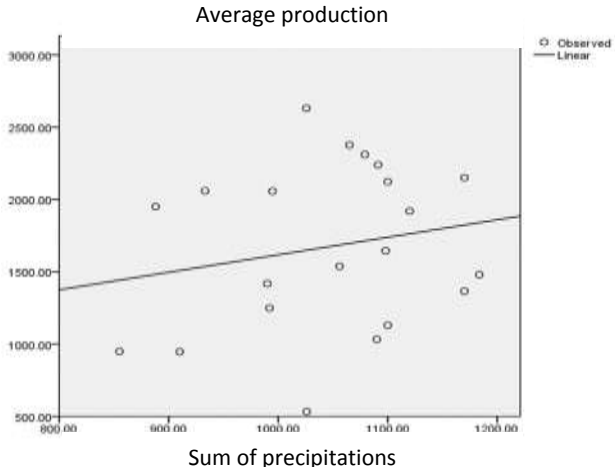

Fig.7. Evolution of average rapeseed production depending on annual rainfall variation in the North East region
Source: processing of statistical data in SPSS.

From the two graphs above, respectively Figures 6-7, we can see two independent variables represented by the sum of the degrees and the sum of the precipitations and a dependent variable represented by the average production for both graphs.
The function is a linear one and is guided by the following equation: $y = ax + b + \varepsilon$, where y represents the dependent variable, and x represents the independent variable. Thus, according to the simple linear regression analysis model, using the SPSS calculation program results a close relationship between the two variables analysed in the first graph

(Figure 6), which shows that the average yield of rape is influenced by the average annual temperatures, the correlation being 0.6459. Regarding the influence of rainfall on the average yield of rapeseed, a correlation of 0.1970 results, which shows that the average production is not closely related to the annual rainfall, so production is not influenced by precipitation.

Of course, this does not apply to all crops, as climate and soil requirements are particular to each plant. For example, according to the paper "Influence of meteorological factors on production per hectare of maize crop in the South-Muntenia region" [5], the production obtained in maize culture is influenced by the annual rainfall, the correlation being of 0.845.

Thus, after determining the degree of correlation between the variables presented, it can be stated that the average yield of rapeseed was lower in the years when the temperatures were higher, taking as an example years 2015-2017 we can see that the average yield of rapeseed has decreased compared to the previous years (Fig. 1) and this because of the constantly growing temptations (Fig. 2).

Climate changes that are observed by temperatures above or below normal, or through rich or poor quantitative rainfall, have a direct impact on agriculture, influencing both the quantity and quality of the resulting plant products. [3]

The underlying causes of these climate change are mainly caused by greenhouse gases that have increased due to the activities that people undertake. These gases capture the heat and radiate it back to the terrestrial surface, this phenomenon being known as the "greenhouse effect". [9]

These greenhouse gases come from most economic sectors, but according to statistics in 2016 at European level, agriculture was 9.58%, broken down as follows: 4.32% represents enteric fermentation (CH4-methane), 1.48 % manure management, 0.06% rice cultivation; 3.67% nitrification and denitrification of agricultural soils; 0.06% on-farm burning of agricultural residues and others.[8]

According to Eurostat statistics, the evolution of greenhouse gas emissions in Romanian agriculture for the period 1990-2016 registered a significant decrease with a reduction of 18.5 million tons of CO2 equivalent. [7]

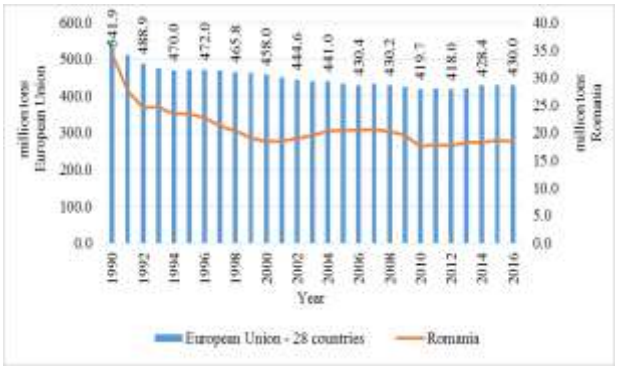

Fig. 8. Agricultural greenhouse gases in agriculture at European and national level (CO2, N2O, CH4, HFC, PFC, SF6, NF3).
Source: own design based on statistical data provided by Eurostat; European Environment Agency (EEA).

According to Figure 8, the greenhouse gas emissions from agriculture have gradually decreased at the European level, so that in 2016 compared to 1990 they decreased by 20.65%, while compared to 2006 they declined by only 0.1 %. The share of Romania in total greenhouse gas emissions at European level is on average for the analysed period of 4.609% and the most significant weight being in the year 1990 of 6.32%. [8] As with European gas emissions, greenhouse gas emissions at national level have declined gradually, so in 2016 they decreased by 46.49% compared to 1990 and by 10.73% compared to 1990 of the year 2006.

To create a correlation between the two variables, namely agricultural gas emissions and climate effects, it is necessary to approximate how much greenhouse gas emissions is attributed to the analysed region, namely North East.

As greenhouse gas emissions from agriculture are presented in European statistics across the country, it has been broken down by region according to the share of each region in the formation of agriculture at national level. Thus, the North-East region has a share of the value of production in agriculture in 2016 of 16.06%, so for 2016 the greenhouse gas

emissions were determined for the region concerned according to the percentage that this region has in the weight agriculture.

Fig. 9. Agricultural greenhouse gases in agriculture at national and regional level (CO2, N2O, CH4, HFC, PFC, SF6, NF3)
Source: own design based on statistical data provided by Eurostat; European Environment Agency (EEA).

In order to determine the influence that greenhouse gas emissions have on climatic factors, it is necessary to relate them to the SPSS program. Thus, from the two graphs presented below, namely Figures 10-11, one can observe two dependent variables represented by the sum of the degrees and the sum of the precipitations and an independent variable represented by the greenhouse gas emissions for both graphs.

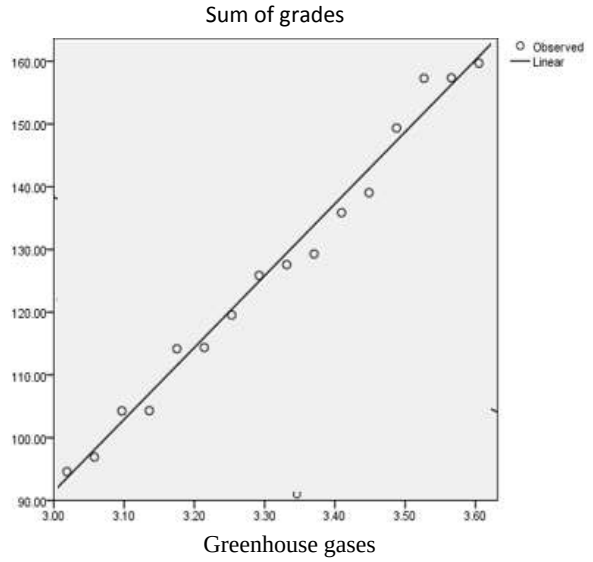

Fig.10. Evolution of annual average temperatures to greenhouse gas emissions variation in North East
Source: processing of statistical data in SPSS.

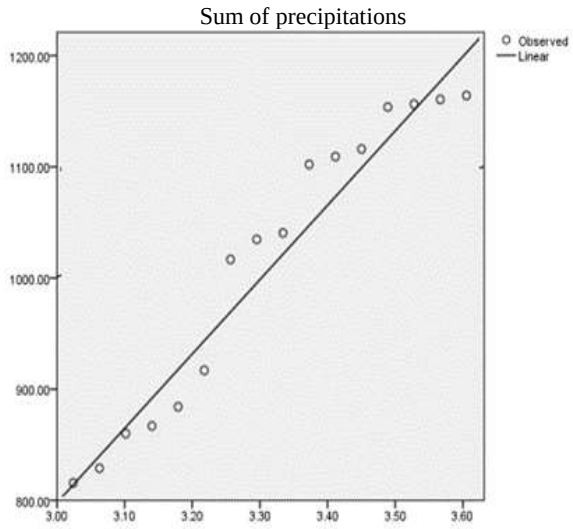

Fig. 11. Evolution of annual average rainfall according to the variation of greenhouse gas emissions in the North East Region
Source: processing of statistical data in SPSS.

According to the simple linear regression analysis model using the SPSS calculation program results a close relationship between the two variables analysed in Fig. 10, demonstrating that annual average temperatures are influenced by greenhouse gas emissions from agriculture, with a correlation of 0.523.
As for the relationship between precipitation and greenhouse gases, a correlation of 0.346 results, which shows that the precipitation falling in the North East region is largely influenced by the quantity of these gases, so climate factors are influenced directly by greenhouse gases produced by the agricultural sector.

CONCLUSIONS

On the basis of the analysed, we can observe the changes in the temperature and the rainfall in the North-East region, they can be perceived as climatic changes, mainly due to the activities that man performs.
Their effect is seen in the yield of rapeseed production, which demonstrates that the agricultural sector is one of the most exposed economic sectors of a country that can be negatively affected by these changes, and

agriculture is directly dependent on climatic factors.

Climate change is directly or indirectly attributable to human activity, as mentioned earlier, the root cause of climate change being the increase in greenhouse gas emissions from various economic sectors of a state.

The agricultural sector is one of the condominiums producing greenhouse gases, so millions of tons of carbon dioxide (CO2), nitrous oxide (N2O), methane (CH4), Pirhoyd HFC , PFC, sulfur oxide (SF6), nitrogen fluoride (NF3), accounting for about 9.6% of the total greenhouse gas emissions produced by all economic sectors. As a result, there is a mutual relationship between agriculture and climate change and they influence each other, it can be said that agriculture plays a double role, being both a responsible part of climate change and the victim of climate change. Climate change is a challenge for agriculture, which has to adapt [1] by creating drought-resistant varieties, building irrigation facilities, growing plants with resistance to diseases and pests favoured by increased humidity or high temperatures, building of garbage storage platforms segregated manure, storage of rubbish in cool and shady places, and covering of liquid waste basins.

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