STUDY ON THE INFLUENCE OF CLIMATE CHANGE ON AGRICULTURAL CROPS

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Abstract. *Climate change is having a significant impact on agricultural production around the world, affecting crops, cultivated area and yield. These climate changes include changes in temperature and precipitation, extreme weather events, and changes in regional weather patterns. Climate change brings major challenges for agriculture, with a significant negative impact on farmland, productivity and food security. In this regard, it is necessary to adapt through sustainable agricultural practices, the use of advanced technologies and the implementation of climate risk management strategies, to support and improve agricultural production in a changing climate. Climate change is one of the most pressing global issues of our time. They are manifested by significant and long-lasting changes in weather patterns, global temperatures and the distribution of climatic phenomena. The virtual certainty that climate and CO2 will continue to develop in the future raises many questions about food security, one of which is whether the aggregate productivity of global agriculture will be affected. Climate change is not only affecting crop yields, but also the areas where they are grown. Extreme weather events such as storms, heat waves, and floods can damage crops and make certain areas unsuitable for farming. In addition, changes in rainfall and temperature regimes can lead to changes in the geographical distribution of crops, forcing farmers to adapt to new climatic conditions.*
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JEL*: J43,P25, Q13*
UDC*: 631.95*

Introduction. Climate change is one of the biggest challenges of the 21st century, with a significant impact on agricultural production around the world (Challinor et al., 2014). As agriculture is a sector that is sensitive to weather conditions, it will directly feel the effects of climate change, affecting production, arable land areas, economic efficiency, etc. The effects of climate change are manifested by changes in temperature, precipitation, and the frequency and intensity of extreme weather events, which together can have a major impact on food security (Rust, et al., 2013).

It is estimated that climate change will have negative effects both socially and economically, with high temperatures reducing yields, favoring the appearance of

pests and weeds. Most farmers are already feeling the effects of climate change, especially as it is expected to intensify in the coming decades.

This change may initially seem beneficial to agriculture, as it can extend the growing period of crops. However, the negative effects include periods of frost suddenly interrupted by high temperatures, which can affect crop development and make prematurely developed plants vulnerable to frost following successive cold waves. Autumn climate change is manifested by an increase in the frequency and intensity of extreme weather events, such as torrential rains and storms. These events can negatively affect crops, flooding farmland and destroying crops.

Summer in Romania is getting hotter and hotter, prolonging the drought season. Although Romanian agriculture has always been exposed to this risk, climate change has accentuated the problem. Dry soils and lack of water resources severely affect agricultural crops, reducing production and crop quality. In addition, high temperatures favor the spread of pests and diseases, directly affecting plant health.

Material and methods. In order to achieve the main objective of this study, where analyzed the production and cultivates areas of the main agricultural crops, in the period 2013-2023. The research methods used were the comparative method, quantitative and qualitative analysis of data.

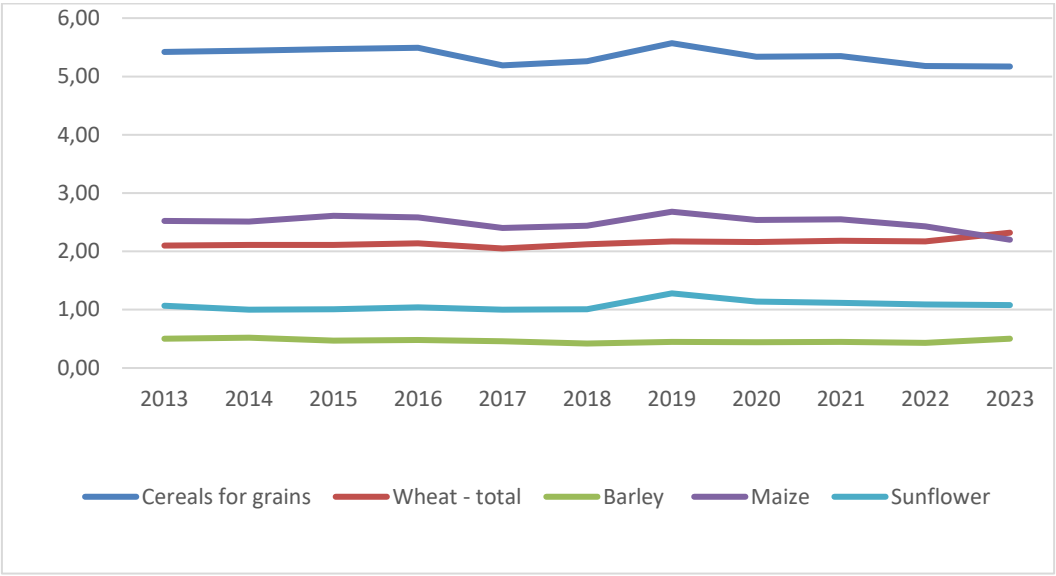
Results and discussions. Following the analysis, were identified the crops, were evaluated the areas and total production for: grain cereals, total wheat, barley, maize and sunflower. The informations are synthesized as follows:

Table 1. **Areas of agricultural crops (million hectares)**

Culture	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
Cereals for grains	5,42	5,44	5,47	5,49	5,19	5,26	5,57	5,34	5,35	5,18	5,17
Wheat - total	2,10	2,11	2,11	2,14	2,05	2,12	2,17	2,16	2,18	2,17	2,32
Barley	0,50	0,52	0,47	0,48	0,46	0,42	0,45	0,44	0,45	0,43	0,50
Maize	2,52	2,51	2,61	2,58	2,40	2,44	2,68	2,54	2,55	2,43	2,20
Sunflower	1,07	1,00	1,01	1,04	1,00	1,01	1,28	1,14	1,12	1,09	1,08

Source: www.insse.ro, own calculations

If in 2013, the area of cereals for grains was 5.42 million hectares, in 2023 it reached 5.17 million hectares, which indicates a decrease of 4.6%. In the same year, 2013, the total wheat area was 2.10 million hectares, reaching 2.32 million hectares in 2023, which represent an 10.5% increase. The area cultivated with barley was 0.50 million hectares in 2023, up with 16% compared to the previous year (Table 1 and graph 1).



Graph 1. **Areas of agricultural crops (million hectares)**
Source: www.insse.ro, own calculations

The area cultivated area with maize in 2013 was 2.52 million hectares, reaching to 2.20 million hectares in 2023, indicating a decrease of 12.7%. For sunflower, the cultivated area has increased with 0.93%, from 1.7 million hectares, to 1.08 million hectares. (Table 1 and graph 1).

Table 2. **Main statistical indicators (million hectares)**

CULTURE	AVERAGE	MINIMUM	MAXIMUM
Cereals for grains	5,35	5,17	5,57
Wheat - total	2,15	2,05	2,32
Barley	0,47	0,42	0,52
Maize	2,50	2,20	2,68
Sunflower	1,08	1,00	1,28

Source: www.insse.ro, own calculations

The analysis of the data in table no. 2, shows that the highest value was recorded for grain crops in 2019 (5.57 million hectares) and the lowest in 2022(5.18 million hectares). The area cultivated with wheat - total, the maximum value was recorded in 2023 - 2.32 million hectares - and the minimum in 2017 - 2.05 million hectares. with 17 million hectares above the average of the period.

For barley crops, the area varied between 0.52 million hectares in 2014 and 0.42 million hectares in the 2018. At maize crop, the maximum area was recorded in 2019 with 2.68 million hectares, and the minimum in 2023 with 2.20 million hectares.

The area cultivated with sunflowers has varited between 1.28 million hectares in 2019, and 1.0 million hectares in 2014 and 2017. (Table 2).

Table 3. **Crop yields (million tonnes)**

Culture	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Cereals for grains	20,90	22,07	19,33	21,76	27,14	31,55	30,41	18,15	27,79	18,86	20,78
Wheat - total	7,30	7,58	7,96	8,43	10,03	10,14	10,30	6,39	10,43	8,68	9,62
Barley	1,54	1,71	1,63	1,82	1,91	1,87	1,88	1,14	1,98	1,71	2,00
Maize	11,31	11,99	9,02	10,75	14,33	18,66	17,43	10,10	14,82	8,04	8,74
Sunflower	2,14	2,19	1,79	2,03	2,91	3,06	3,57	2,12	2,84	2,11	2,02

Source: www.insse.ro, own calculations

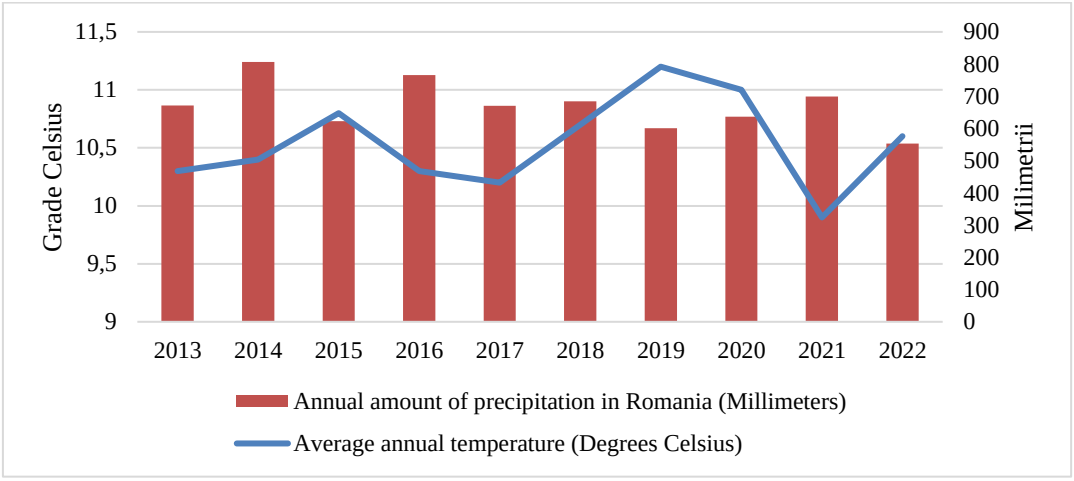
Yields of cereal crops for grains fluctuated significantly. Thus, if in 2018, it reached 31.55 million tons, in 2020 there was a significant decrease, reaching 18.15 million tons, which represents a decrease of 34.1%. As for wheat production, it has steadily increased from 7.30 million tons in 2013 to 9.62 million tons in 2023, the fluctuations are less pronounced compared to the other crops, indicating an increase of 31.78% in the analyzed period. Regarding the production of barley, it registered an upward trend, from 1.54 million tons in 2013 to 2.00 million tons in 2023, with an increase of 29.87%. For maize production, significant variations were highlighted between 18.66 million tons in 2018 and 8.04 million tons in 2022, with a decrease of 53.16% being observed during the period. The sunflower crops, recorded production ranged from 1.79 million tons in 2015 to 3.57 million tons in 2019, indicating an increase of 99.44%. (Table 3).

Table 4. **Average annual temperature and annual precipitation amounts in Romania**

Specification	Years										
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2022/2013
Average annual temperature (Degrees Celsius)	10,3	10,4	10,8	10,3	10,2	10,7	11,2	11	9,9	10,6	1,03
Annual amount of precipitation in Romania (Millimeters)	671,7	806,4	622,9	766,1	670,4	684,9	601	636,7	699,6	553,2	0,82

Source: www.insse.ro, own calculations

Regarding the temperature, in the period 2013-2022, has been recorded an increase trend of the average annual temperature of 0.3 % , from 10.3 °C in 2013 to 10.6 °C in 2022. (Table 4 and graph 2).



Graph 2. **Dynamics of the average annual temperature and precipitation amounts**

Source: www.insse.ro, own calculations

As for the annual amount of precipitation, the trend was negative, with an decrease of 0.82%, from 671.7 mm in 2013 to 553.2 mm in 2022. (Table 4 and graph 2).

Table 5. **The main statistical indicators of the average temperatures and the amount of precipitation of Romania**

Specification	**Average**	**Standard deviation**	***Coefficient of variation (%)**	**Annual growth rate (%)**
Average annual temperature	10,54	0,39	3,74	0,32
Annual amount of precipitation in Romania (millimeter)	671,29	75,02	11,1	-2,13

Source: www.insse.ro, own calculations

Between 2013 and 2022, the average annual temperature ranged from 9.9°C in 2021 to 11.2°C in 2019, recording an average of 10.54°C, with a standard deviation of 0.39°C. The value of the coefficient of variation is 3.74%, which indicates a small variation, and the positive value of the annual growth rate of 0.32%, indicates a trend of increase in the average annual temperature. As for the annual amount of precipitation, it ranged from 806.4 mm in 2014 to 553.2 mm in 2022. The average of the period being 671.29 mm, with a standard deviation of 75.02 mm, the value of the coefficient of variation of 11.1%, and the annual growth rate being negative of -2.13%, indicate the downward trend at the level of the analyzed period.

Conclusions. In the cereal crop for grains, production had a decreasing trend, which may be a consequence of climate change. Thus, in 2023, it had a downward trend, with a minimum value of 5.17 million, these values may be a consequence of the fact that climate change has had a negative impact on the yield of this crop, also affecting the growing and harvesting periods.

In the wheat crop, yields have seen a significant increase, which indicates a better adaptability of this crop to climate change. This suggests that, despite climate variability and the challenges associated with them, wheat is managing to adapt and produce higher yields. This increase in yields can be attributed to several factors, such as improved agricultural technologies, the use of more resilient wheat varieties, advanced agronomic practices and better management of natural resources.

For barley, production has remained relatively constant, although there have been fluctuations from year to year, suggesting moderate adaptability to climate change. The recorded yield was 0.50 million tons per hectare in 2013 and remained at the same level until 2023.

The yields of the maize crop have been in a continuous decrease, this may be an indication of the sensitivity of this crop to climate change. Prolonged periods of drought and extreme temperatures can have a significant impact on crop yields.

In 2013, sunflower production was 1.07 million tons and increased with 1% in 2023 (1.08 million tons). Although the fluctuations were moderate, with a minimum of 1.00 million tons in 2014 and a maximum of 1.28 million tons in 2019, sunflower maintained a relatively constant production, with a slight increase, this may indicate a moderate resistance to climatic variations.

In the cereal crop for grains, here the decrease in production is observed in 2023 and can be correlated with the variability of rainfall and the increase in temperatures, which negatively affect their yields.

For wheat – total, here the increase in production may reflect a better adaptability of the wheat crop to the new climatic conditions and the use of advanced agricultural techniques.

For barley and barley, production stability suggests moderate resilience to climate change, although annual fluctuations in rainfall can directly affect productivity.

For grain corn, the significant decrease in yield is a sign that this crop is very sensitive to frequent droughts and high temperatures.

In the sunflower crop, the relative stability and slight increase in production suggest a moderate resistance to climate change, but changes in rainfall could also affect this crop.

Climate change has been rapidly degrading crop production conditions in recent decades. Salinization and drought phenomena are constantly increasing in all areas of the world, as well as in Romania. On the other hand, there is a continuous demographic growth worldwide, which means that new species and genotypes tolerant to these factors are identified and used for modern-future agriculture. Drought and salinity tolerant species exist, they have an ecological plasticity and a

high biodiversity value, due to the different climatic conditions in their area of origin, but, at the moment, they are unused and neglected. Climate change is not only affecting crop yields, but also the areas where they are grown. Extreme weather events such as storms, heat waves, and floods can damage crops and make certain areas unsuitable for farming.Climate change and its effects on existence on earth are becoming increasingly relevant as physical evidence of climate change begins to mount. Animal production and our dependence on it for survival is a reality. It is also a reality that this global source of food and income will be prone to the effects of climate change.

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