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The Impact of Climate Variability on Corn Yield in the North-East Region of Romania

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INTRODUCTION & AIM

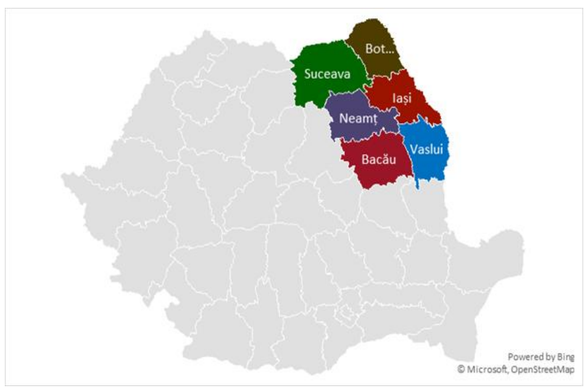
Climate change poses a major challenge to agricultural sustainability, particularly in regions where variations in temperature and precipitation directly affect crop productivity. This study examines the relationship between interannual climate variations and corn production in northeastern Romania, using official data from the National Institute of Statistics and the National Meteorological Administration for the period 2017-2022. Pearson correlation coefficients were applied to assess the direction and strength of associations between yield, temperature, and precipitation in six representative counties.

The aim of this study is to analyze the relationship between climatic factors (espe-cially average temperature and average precipitation) and corn crop yields in the North-East region of Romania during the period 2017–2022. The study seeks to identify the influence of climate on production variations and to highlight the counties where climatic factors have had a significant impact. Thus, by statistically correlating these variables, the research provides a scientific basis for guiding agricultural practices and adopting measures to adapt to climate change at the regional level.

The main objective of this study is to analyze the relationship between average corn production and climate factors, in particular average annual temperature and average precipitation, in the counties of the North-East region of Romania between 2017 and 2022. To this end, the study aims to identify the counties where these climate variables have significantly influenced corn yields, using the Pearson correlation method. It also aims to formulate relevant conclusions and recommendations for adapting agricultural practices in the context of regional climate variability.

METHOD

The North-East Region is a historical part of Romania, made up of six counties: Bacău, Botoșani, Iași, Neamț, Suceava and Vaslui [59], classified according to Eurostat and NUTS, it is part of Macroregion 2 of the country, with an area of 36.850 km², rep-resenting about 15.46% of the total of Romania (figure 1). The region is characterized by economic activities such as agriculture, viticulture, fruit growing and timber ex-ploitation. In 2018, the rural population made up 58.13% of the region's total, with the highest proportions in Neamt, Suceava and Botosani counties.



The methodology for analysing the impact of climate change on maize production yields in the Northeast Region of Romania involves several steps, including description of the study area, collection and analysis of baseline climate and maize area data, and assessment of the correlation between maize production and climatic conditions.

1. Climate data analysis:

To assess climate change in terms of annual mean temperatures in the Northeast Region, the annual mean temperatures recorded in each of the six counties for the period 2017-2022 were calculated, then these averages were compared with the climatological normal and deviations from it were calculated for each year. Similar to the temperature analysis, annual averages of precipitation recorded in each county for the period were calculated and compared with the climatological normal. Deviations from the normal were calculated and monthly rainfall variations were analyzed to identify trends and patterns.

Formulas used:

2. Analysis of maize area data:

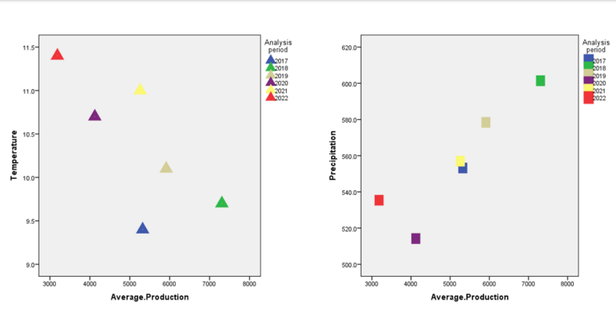
Data on the area under maize in each year for the period 2017-2022 in the six counties of the North-East Region were analysed, so as part of the analysis averages and variations were calculated to identify trends in the evolution of the area under maize in the region. Along with the area data, total and average maize production data for each year were also analysed to assess the maize yield in the region.

3. Assessing the correlation between maize production and climatic conditions:

To assess the correlation between maize production and mean annual temperatures, and between maize production and annual rainfall, Pearson correlation coefficients were calculated for each pair of variables using the collected data. After calculating the correlation coefficients, their significance was interpreted in the context of the impact of climate change on maize yield in the North-East Region of Romania. The value of the co-efficients and their statistical significance were analysed to draw conclusions on the relationship between maize production and climatic conditions.

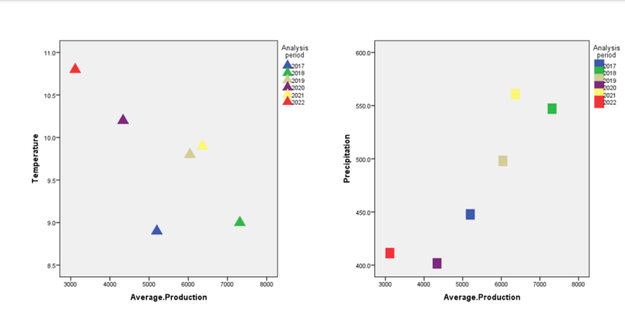
Through these detailed statistical analyses, a deeper understanding of the impact of climate change on the yield of corn production in the North-East Region of Romania was obtained, allowing the identification of trends and complex relationships between climate variables and agricultural production.

RESULTS & DISCUSSION



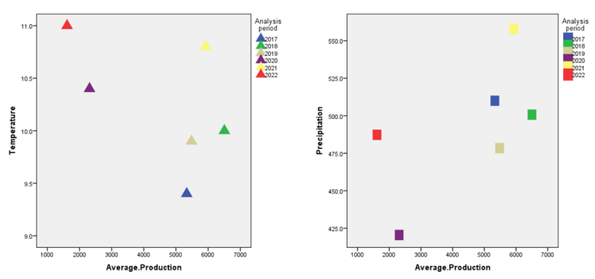
(a) (b)

Figure 2. Correlation between average maize yield per hectare in Bacau and climatic conditions: **(a)** temperature; **(b)** precipitation.



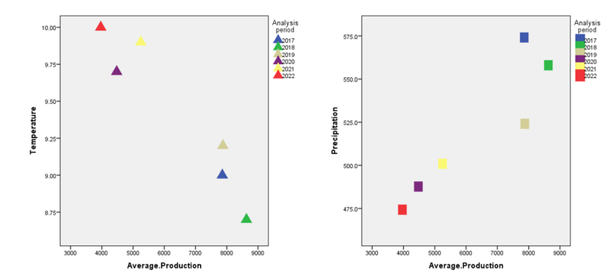
(a) (b)

Figure 3. Correlation between average maize yield per hectare in Botoșani and climatic conditions: **(a)** temperature; **(b)** precipitation.



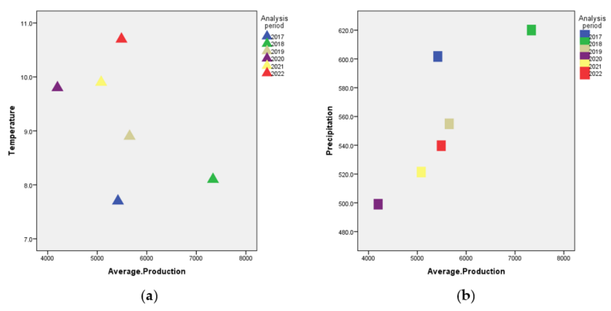
(a) (b)

Figure 4. Correlation between average maize yield per hectare in Iași and climatic conditions: **(a)** temperature; **(b)** precipitation.



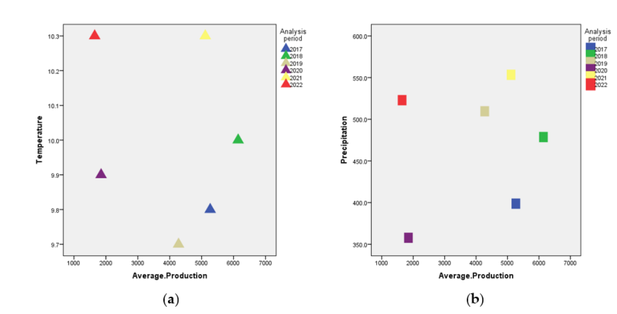
(a) (b)

Figure 5. Correlation between average maize yield per hectare in Neamț and climatic conditions: **(a)** temperature; **(b)** precipitation.



(a) (b)

Figure 6. Correlation between average maize yield per hectare in Suceava and climatic conditions: **(a)** temperature; **(b)** precipitation.



(a) (b)

Figure 7. Correlation between average maize yield per hectare in Vaslui and climatic conditions: **(a)** temperature; **(b)** precipitation.

The results obtained from the Pearson correlation analysis highlight a series of trends that can guide the interpretation of climatic phenomena in relation to corn yield in this geographical area. In general, the data indicate a negative relationship between average annual temperature and corn production, while precipitation shows a positive, often statistically significant, relationship with yield.

Higher average temperatures can negatively affect corn production. In the counties of Bacău, Botoșani, Neamț, and Iași, a negative correlation was found between average annual temperature and corn production, with Pearson coefficients ranging from -0.406 to -0.808. In Neamț County, this correlation is one of the strongest in the region (-0.808), being close to the statistical significance limit (p = 0.052). These data indicate that as the average temperature increases, corn productivity tends to decrease. In Suceava and Vaslui counties, the negative correlation between temperature and production is much weaker (-0.250 and -0.112, respectively), and the statistical significance is insignificant. This can be explained by microclimatic variations or by the greater adaptability of the varieties used in these areas.

Precipitation has a positive influence on corn yield, with the most relevant correlations recorded in the counties of Botoșani (r = 0.957, p = 0.003) and Neamț (r = 0.799, p = 0.057), suggesting that an increase in annual precipitation is associated with an increase in production. In the counties of Bacău and Iași, the positive correlation between precipitation and production is statistically significant (r = 0.890, p = 0.017 for Bacău and r = 0.693, p = 0.127 for Iași), but with variations in the intensity of the relationship. In Suceava and Vaslui, although the correlations are positive (r = 0.716 and 0.295, respectively), they are not statistically significant.

In all six counties, no significant correlation was found between corn production and cultivated area, indicating that yield fluctuations are more related to climatic conditions than to crop extension. This result is important from an agricultural policy perspective, as it indicates that expanding cultivated areas is not sufficient in itself to ensure increased production without measures to adapt to climate conditions.

The correlation analysis suggests that climate change is already significantly influencing maize cultivation in the north-eastern region of Romania, particularly by increasing water and heat stress. thus highlighting the need for adaptive measures at the local level, such as detailed phenological monitoring, the use of drought- and heat-resistant hybrids, optimization of plant density, and conservative soil water management. Furthermore, the expansion of irrigation systems and the rehabilitation of existing ones could significantly contribute to mitigating the negative effects of drought.

CONCLUSION

An important limitation of the study is the small sample size (six years), which may influence the statistical significance of the identified relationships. Furthermore, the analysis focused exclusively on temperature and precipitation, without including other relevant factors such as soil moisture, solar radiation intensity, soil quality, fertilizer use, or specific agricultural technologies. For the future, it is recommended to extend the analysis period to at least 10-15 years and to integrate other agronomic and climatic variables. It is also essential to develop predictive models that include regional climate scenarios, using tools such as the WEAP-MABIA model.

Overall, the study confirms that climatic factors, especially precipitation, have a significant impact on maize production in several counties in the Northeast region. High temperatures negatively affect production, while precipitation can play an essential role in ensuring satisfactory yields. These results can help guide regional agricultural policies and the formulation of sustainable strategies to ensure the resilience of the agricultural sector in the face of increasingly severe climate change.

FUTURE WORK / REFERENCES

A future direction of research may consist in developing an integrated model for analyzing and predicting climate risks to corn crop productivity in the Northeast Region, using advanced machine learning techniques (such as random forest regression, neural networks, or XGBoost), capable of integrating historical data on temperatures, precipitation, crop phenology, soil characteristics, and agricultural practices, with the aim of identifying complex relationships between variables, estimating the vulnerability of each county to climate variability, and generating robust predictive scenarios for optimizing agricultural decisions in the context of climate change.