



CLIMATIC DRIVERS OF CEREAL PRODUCTIVITY IN ROMANIA (1997–2024): A MACRO-LEVEL ANALYSIS INTEGRATING ERA5 PRECIPITATION DATA AND NATIONAL CROP STATISTICS

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Abstract
A clear understanding of how climate variability influences cereal productivity is essential for developing resilient agricultural technologies and improving crop management practices. This study examines the impact of seasonal precipitation patterns on Romania's major cereal crops — wheat (*Triticum aestivum* L.), maize (*Zea mays* L.) and barley (*Hordeum vulgare* L.) — over a 28-year period (1997–2024). Monthly ERA5 reanalysis data were aggregated to obtain annual totals and season-specific precipitation windows relevant to crop phenology: April–June for wheat, June–August for maize and March–May for barley. These climatic datasets were integrated with national statistics on sown area, production and yield levels. The results indicate that precipitation remains a primary climatic driver of interannual yield variability, particularly for crops harvested in summer. Wheat shows a moderate and consistent positive association with spring rainfall ($r \approx 0.27\text{--}0.29$), reflecting its sensitivity during stem elongation and grain filling. Maize displays higher climatic vulnerability, with a moderate correlation between production and June–August rainfall ($r \approx 0.36$), confirming the critical importance of water availability during pollination and early grain development. Barley shows weaker correlations ($r \approx 0.13\text{--}0.20$), consistent with its earlier phenology and tolerance to early-season moisture fluctuations. At the national scale, the relationship between total annual precipitation and combined cereal output is weak ($r \approx 0.13$), largely due to compensatory effects among crops and to technological progress in crop management, breeding and input use. Overall, the study provides a macro-level diagnostic framework for understanding the climatic drivers of cereal productivity in Romania. Findings emphasize the need for climate-adapted strategies such as drought-tolerant germplasm, improved sowing schedules and precision water management to enhance resilience under increasing climatic variability.

KEYWORDS
precipitation, cereal productivity, ERA5, climate variability, Romania, wheat, maize, barley

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INTRODUCTION

Cereals are a cornerstone of Romania's agro-food sector, yet their productivity depends heavily on natural rainfall, as most cropland remains unirrigated.



The country's temperate-continental climate, marked by growing seasonal and interannual variability frequently exposes major production regions in the south and south-east to drought and soil moisture deficits.

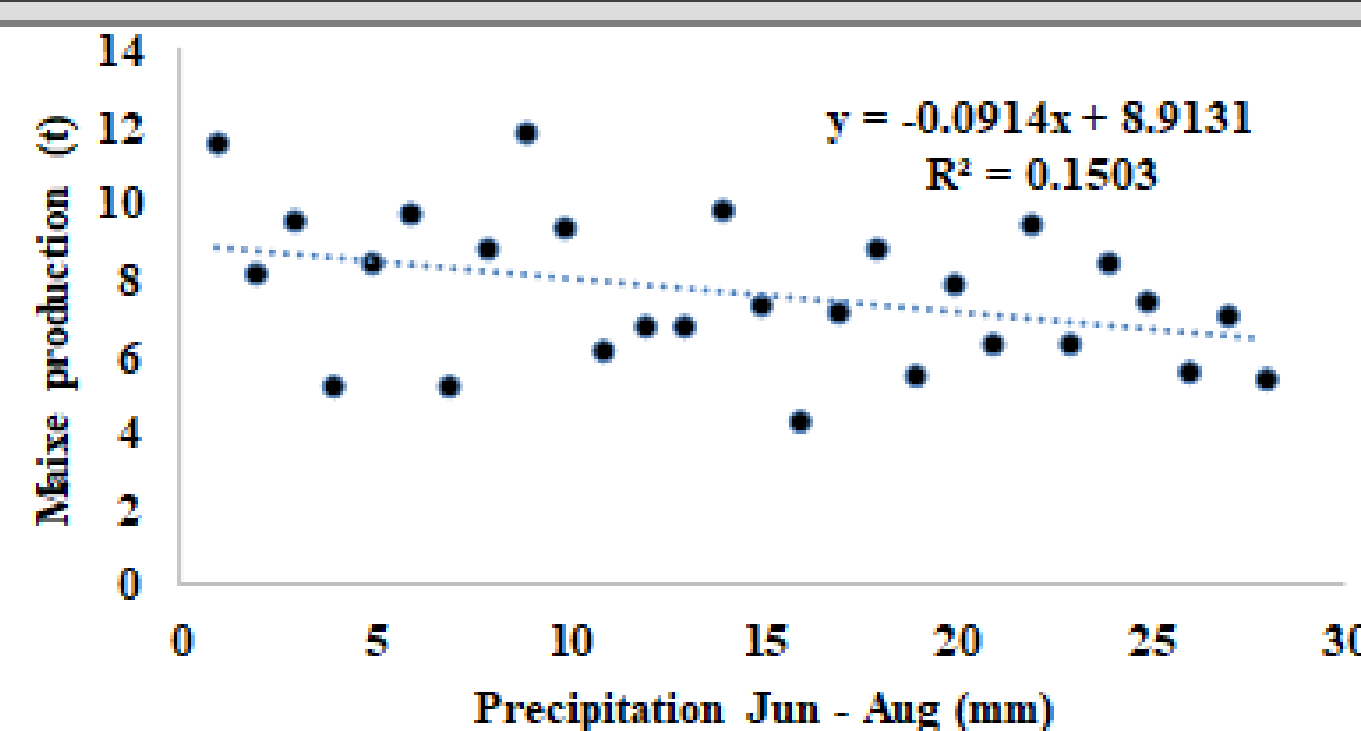
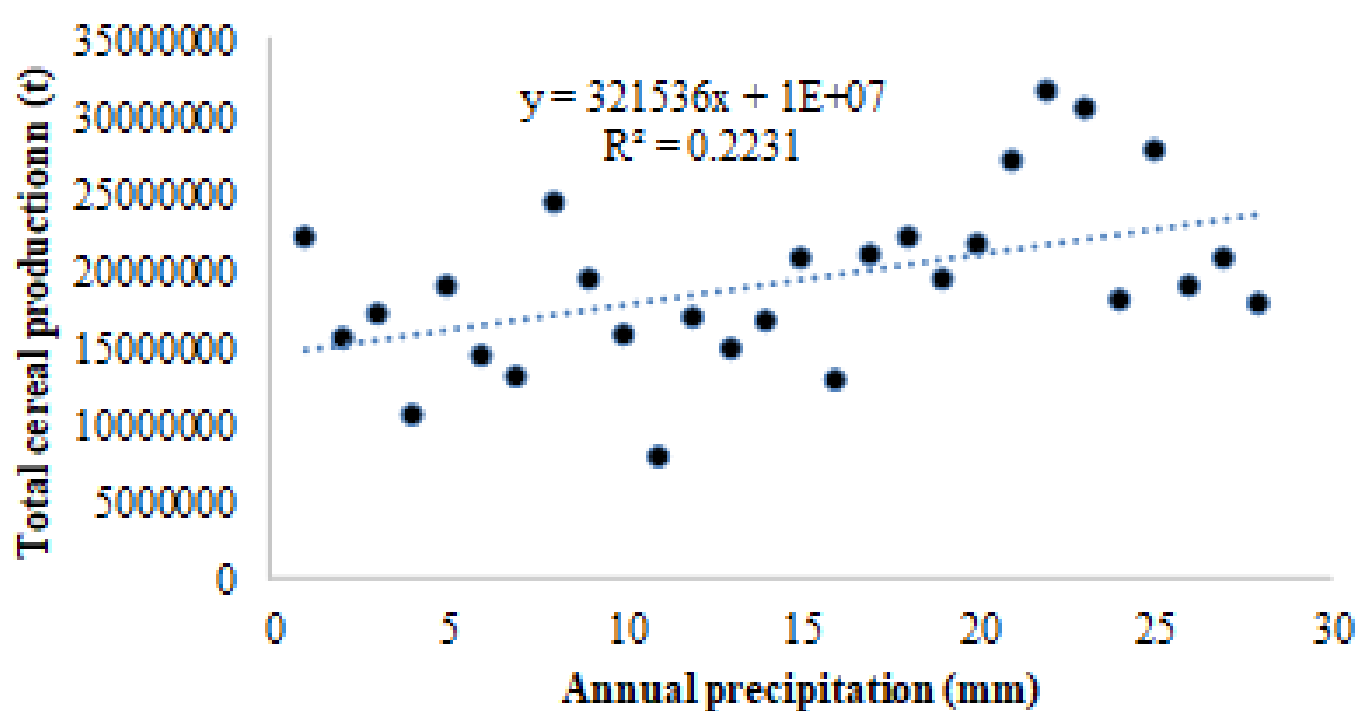
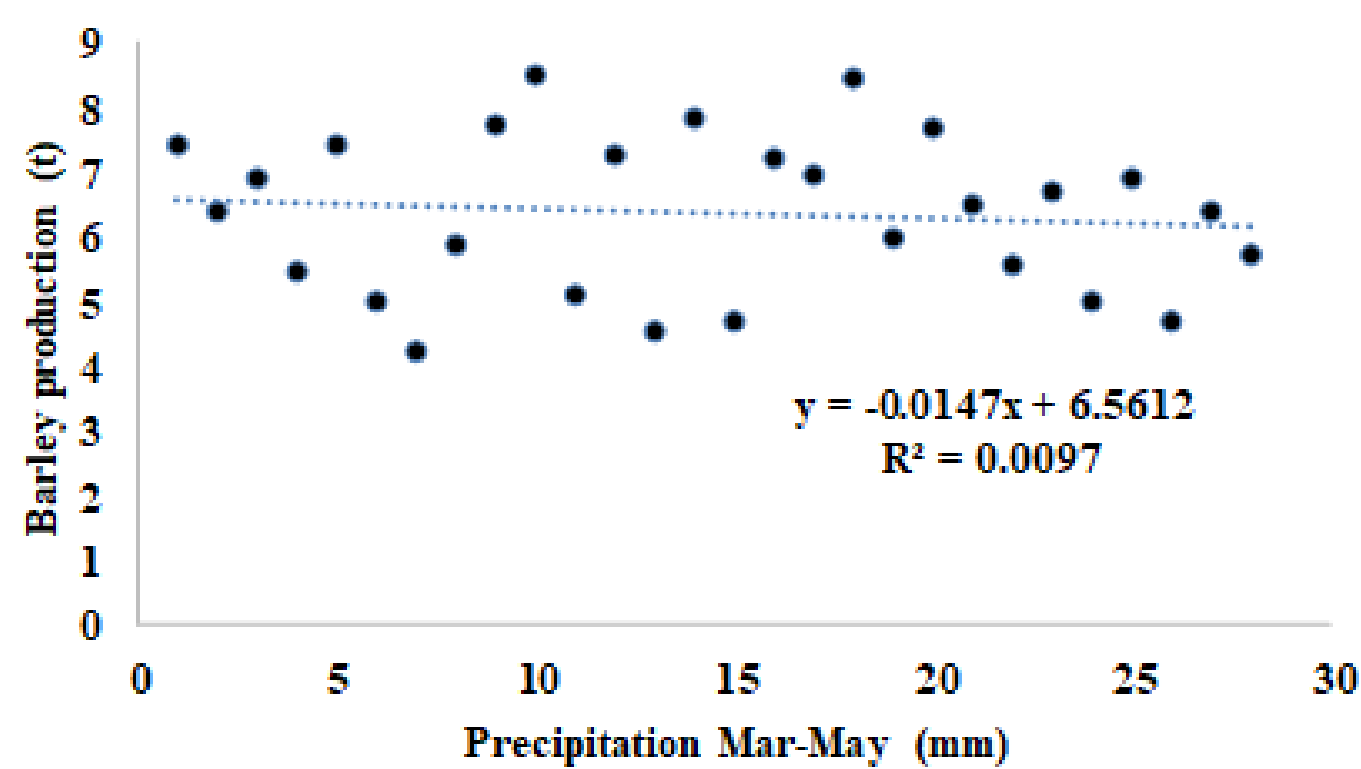
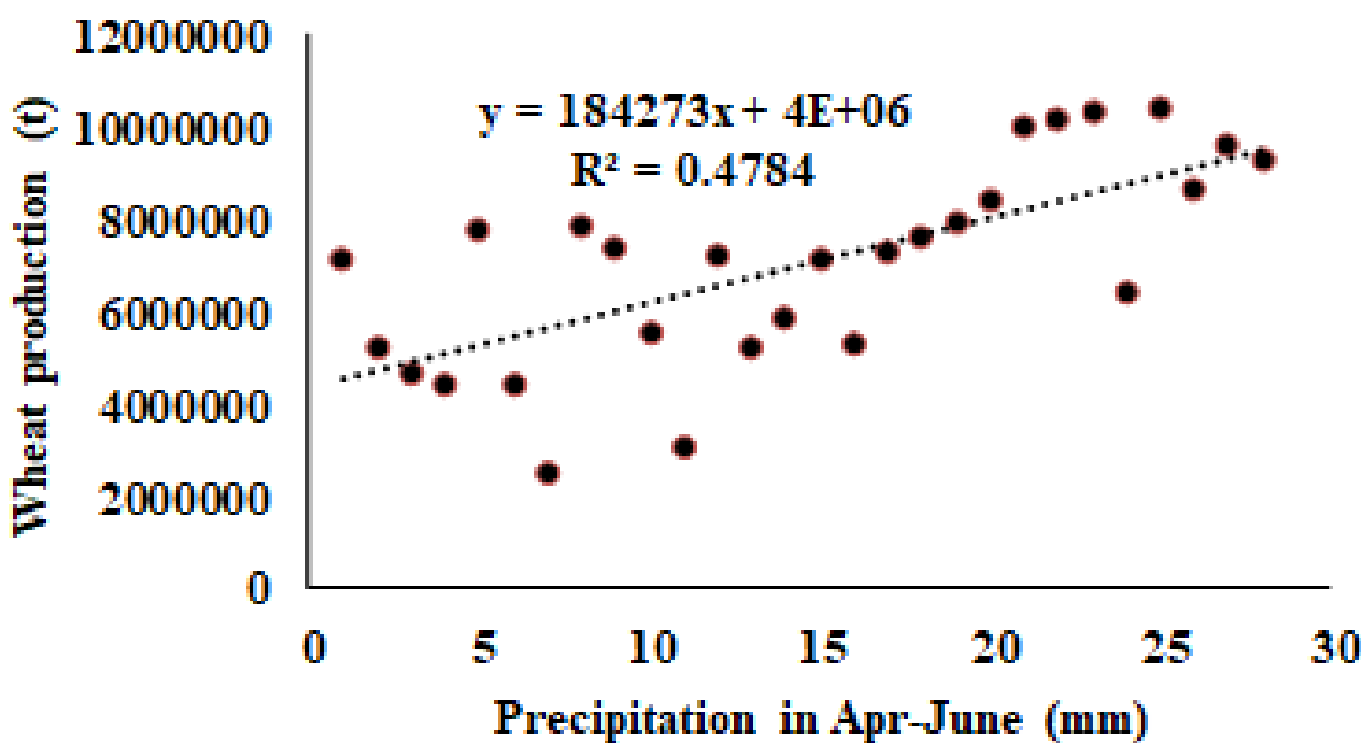
PRECIPITATION

is the dominant climatic driver of wheat, maize and barley yields



This study uses ERA5 reanalysis and long-term agricultural data (1997–2024) to assess how rainfall variability shapes cereal performance and to support climate-resilient agricultural strategies.

RESULTS



MATERIALS AND METHODS



Literature Review

Open-access journals, reports, and institutional databases



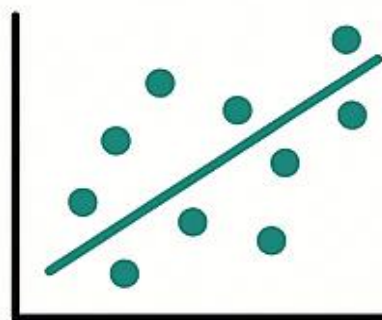
Climatic Data

ERA5 reanalysis, national meteorological reports



Agricultural Data

National statistics and crop reports (INS, MADR)



Analytical Procedure

Correlation analysis of precipitation and crop yields

Data source: ERA5 / INS / MADR

Crop/Indicator	Precipitation window	Pearson r	Interpretation
Wheat production	April–June precipitation	+0.69	Moderate–strong positive correlation; higher spring rainfall is associated with increased wheat output.
Maize production	June–August precipitation	–0.39	Weak negative correlation; summer rainfall alone does not explain yield variation due to high heat-stress sensitivity.
Barley production	March–May precipitation	+0.10	Very weak positive correlation; early-spring rainfall has limited influence on national barley output.
Total cereal production	Annual precipitation	+0.47	Moderate positive correlation; wetter years tend to show higher combined cereal output.

PRECIPITATION VS. CEREAL PRODUCTION



Wheat

April–June
 $R^2 = 0.69$

POSITIVE CORRELATION



Maize

June–August
 $R^2 = -0.39$

NEGATIVE CORRELATION



Barley

March–May
 $R^2 = 0.10$

NEGLIGIBLE CORRELATION



TOTAL CEREAL PRODUCTION

Non-irrigated Romanian agriculture
 $R^2 = 0.47$

MODERATE CORRELATION

REFERENCES