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PERFORMANCE MANAGEMENT AND AGRICULTURAL RESILIENCE UNDER CLIMATE CHANGE CONDITIONS

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Purpose of the article: *In a globally interconnected economy that is increasingly vulnerable to climate change, managerial performance transcends the traditional boundaries of economic efficiency and becomes a strategic tool for organizational resilience. In particular, staple crops directly influence food security, regional economic stability, and international trade flows. This article investigates modern approaches through which management can ensure performance and resilience, with a focus on sustainable agriculture and integration of agricultural commodities into global value chains.*

Methodology: *The research is based on an analysis of recent literature, international reports on climate change and the agricultural economy, as well as comparative studies of best managerial practices in agriculture and related sectors.*

Conclusions: *Managerial performance in the modern economy is linked to the capacity of organizations and the agricultural sector to respond to climatic challenges. The integration of digital tools, advanced analytics and sustainable management strategies strengthens the resilience of regional and global economies, positioning agriculture as a key domain for economic performance and security.*

Originality: *The originality of this study lies in the combination of performance management, climate adaptation, digitalization, and contextual analysis, integrated into a coherent academic framework applicable for public policy.*

Keywords: *managerial performance, agriculture, climate resilience, sustainability.*
JEL Classifications: Q54, Q12, M11

INTRODUCTION

Agriculture in Romania and the Republic of Moldova is currently facing increasingly pronounced effects of climate change, manifested through severe aridification, more frequent droughts, and significant production losses (WWF România., 2023). These phenomena require a reevaluation of the concept of managerial performance, which can no longer be measured solely by economic indicators but must include the capacity to adapt to climate stress, resource sustainability, and the integration of innovative technologies (Ion, G., & Popescu, A., 2022). Within the context of regional and global economies, agricultural crops play a strategic role in ensuring food security, and their resilience directly influences local economies and contributions to agri-food exports. In this regard, modern agricultural management focuses on developing effective strategies that allow farmers and institutions to respond quickly and efficiently to climatic variability and environmental challenges (Ion, G., & Popescu, A., 2022).

Increasingly, precision agriculture, supported by digital technologies and advanced monitoring systems, is becoming a fundamental tool for enhancing the resilience of agricultural enterprises (AgroMedia.md., 2023). Public policies aimed at sustainability and climate adaptation must include financial support mechanisms, incentives for innovation, and insurance schemes against climate risks. Crop diversification and the use of varieties adapted to extreme pedoclimatic conditions represent practical strategies for reducing production vulnerability. Strengthening scientific research and the rapid transfer of results to the agricultural sector are essential prerequisites for maintaining the competitiveness of the industry.

The international agri-food market increasingly values responsible and sustainable practices, offering additional opportunities for producers who adopt eco-friendly standards and green certifications. Thus, managerial performance in agriculture is being redefined by integrating a complex perspective that correlates economic objectives with environmental protection, technological innovation, and climate resilience (Ion, G., & Popescu, A., 2022).

RECENT RELEVANT STUDIES

Over the past two decades, scientific literature has recorded a significant increase in concerns regarding the resilience of agricultural systems in the face of climate change. Unlike other economic sectors, agriculture has a direct and immediate relationship with the environment, making extreme climatic events have immediate effects on productivity, stability, and economic competitiveness. According to the latest assessments by the Intergovernmental Panel on Climate Change (IPCC), periods of drought, heatwaves, changes in rainfall patterns, and increased frequency of extreme weather events have become key determinants of agricultural performance in Central Europe (Smith, J., & Brown, L., 2023).

At the same time, debates in the literature have expanded beyond strictly agronomic aspects to include themes such as managerial performance, digital transformation, resource use efficiency, and agricultural governance. Recent research shows that resilience is not limited to the biological adaptation of crops but involves a complex set of managerial strategies, technological infrastructure, coherent public policies, and intersectoral cooperation models (Ministerul Mediului RM, 2022). For example, studies conducted in European Union member states highlight a direct correlation between the level of farm digitalization and their capacity to absorb climatic shocks while maintaining production and income stability (Smith, J., & Brown, L., 2023).

Recent literature on precision agriculture shows that the use of sensors, satellites, and digital platforms for crop monitoring significantly contributes to optimizing water consumption, reducing losses, and increasing yields under climatic stress conditions (Ministerul Mediului RM, 2022). Best practice models can be identified where investments in smart agricultural infrastructure are accompanied by financial risk-sharing instruments and integrated public policies (AgroMedia.md., 2023).

The situation is markedly different in Eastern European countries such as Romania and the Republic of Moldova, where agricultural resilience faces structural and institutional barriers. The lack of modern irrigation infrastructure, fragmentation of agricultural holdings, limited access to digital technologies, and often inconsistent agricultural policies are inhibiting factors for effective adaptation (AgroMedia.md., 2023). Although initiatives supported by the Food and Agriculture Organization (FAO) and the United Nations Development Programme (UNDP) exist (Organizația Națiunilor Unite pentru Alimentație și Agricultură., 2016), they are still insufficient to generate rapid structural transformation. Nevertheless, analysis of pilot projects in areas with high climate vulnerability – such as the Romanian Plain or southern Moldova – indicates significant potential for the progressive integration of digital technologies, smart irrigation infrastructure, and strategic planning mechanisms (Smith, J., & Brown, L., 2021; AgroMedia.md., 2023; Movileanu, P.(coordonator), Popescu, G., 2010).

Theoretical research increasingly converges on the idea that agricultural performance management under unstable climatic conditions requires a shift from reactive models to anticipatory and adaptive models. This involves using climate forecasts integrated into decision support systems, optimizing seasonal planning, diversifying crops, and reducing dependence on a single water resource. At the same time, the importance of developing human capital – trained farmers, digitally competent farm managers, and institutional structures capable of managing systemic risks – is emphasized (Wang, Xing, Jianying Qi, and Zhengrong Kan., 2024).

Specialized literature and international organization reports highlight the central role of digitalization and precision agriculture in increasing managerial performance and the capacity to adapt to climate change (Ministerul Mediului RM, 2022). In Romania, particularly in the Romanian Plain and Dobrogea, farmers have implemented satellite monitoring, crop rotation, and soil

conservation practices, achieving more efficient resource use and better adaptation to drought conditions (UNDP Moldova, 2022). In the Republic of Moldova, FAO- and UNDP-supported programs have focused on strengthening administrative capacity, developing agricultural infrastructure, and training decision-makers for strategic crops (FAO Moldova., 2022; UNDP Moldova, 2022; Ministerul Mediului RM, 2022).

Cross-border cooperation between Romania and the Republic of Moldova facilitates the exchange of experience and harmonization of adaptation strategies. International models, such as the European Union's Common Agricultural Policy or FAO projects in Central Asia, demonstrate the effectiveness of regional initiatives in resource management and climate risk reduction (Organizația Națiunilor Unite pentru Alimentație și Agricultură, 2016). Rehabilitation of irrigation infrastructure and the development of modern water management systems are priority directions for enhancing agricultural resilience.

Integrating digital technologies – sensors, precision seeders, climate monitoring – combined with efficient water management and the use of drought-tolerant varieties, leads to a significant increase in managerial performance and the resilience of agricultural systems (AgroMedia.md., 2023). Moreover, recent studies emphasize the importance of adaptive leadership and integrated regional strategies for the success of these measures (Ion, G., & Popescu, A., 2022; AgroMedia.md., 2023).

MATERIALS AND METHODS

Most research on modern agricultural management and climate resilience focuses on developed regions or global analyses. This research focuses on Central and Eastern Europe, specifically the Republic of Moldova and Romania – two countries characterized by high drought vulnerability, insufficiently developed agricultural infrastructure, and an intermediate level of sector modernization. This regional focus allows for recommendations tailored to the local context, relevant for policymakers and the scientific community interested in similar agricultural regions (WWF România, 2023; FAO Moldova, 2022; UNDP Moldova, 2022).

The research methodology was interdisciplinary, combining theoretical analysis with an applied evaluation of the latest managerial and technological models. Established scientific sources and empirical data from international reports were integrated to construct an analytical framework capable of capturing the complexity of managerial performance under climate change conditions.

The approach focused on correlating three essential dimensions: economic management, climate resilience, and digitalization – a combination less explored in the literature dedicated to the region (Ion, G., & Popescu, A., 2022; Smith, J., & Brown, L., 2021; AgroMedia.md., 2023). The research highlights how managerial performance influences farm efficiency, food security, and economic competitiveness at regional and global levels (WWF România, 2023; Ion, G., & Popescu, A., 2022). Comparative analysis between Romania and the Republic of Moldova allowed for identifying similarities and differences regarding climate adaptation strategies, the use of precision technologies, and infrastructure development (FAO Moldova, 2022; UNDP Moldova, 2022; AgroMedia.md, 2023).

Methodology includes:

- Systematic literature analysis using databases such as Scopus, Web of Science, and SpringerLink. Relevant works on performance management, organizational resilience, digital transformation, and the impact of climate change on agriculture were selected.
- Examination of reports from international organizations (FAO, IPCC, World Bank) providing comparative data on climate impacts on crops and adaptation strategies.
- Analysis of international case studies, including precision agriculture in the EU, farm digitalization in the USA, and drought management strategies in Sub-Saharan Africa and South Asia.
- Integration of ESG (Environmental, Social, Governance) principles into the analysis of agricultural managerial models and related sectors.

- Correlation with recent macroeconomic trends using comparative analysis and critical synthesis methods.

For Romania and the Republic of Moldova, national policies, drought adaptation programs, and digitalization initiatives were analyzed. Case studies from the Romanian Plain, Dobrogea, and FAO/UNDP projects focused on anti-drought infrastructure, digital monitoring, and water resource management.

The research included identifying local challenges and innovative practices. These qualitative data were integrated into a comparative framework, allowing the assessment of regional differences and the key determinants of managerial success. The analysis considered the role of public policies, irrigation infrastructure, and agricultural consulting services. Results were complemented with descriptive statistical analyses, charts, and tables, with data triangulated to ensure robustness of conclusions.

The study relied on an integrated methodology (quantitative and qualitative) to analyze the relationship between managerial performance and agricultural resilience under climate change. Systematic literature analysis was combined with evaluation of public policies, international case studies, and field qualitative investigations. The primary aim was to identify and analyze determinants of agricultural managerial performance concerning adaptation capacity in Romania and the Republic of Moldova.

Literature and strategic document analysis

Initially, a systematic literature review was conducted using major scientific databases – Scopus, Web of Science, and SpringerLink – covering 2010–2024. Selection criteria included thematic relevance (agricultural resilience, performance management, precision agriculture, climate impact), publication impact factor, and geographic representation. In parallel, international reports and strategies by FAO, IPCC, World Bank, and the European Commission were analyzed to identify conceptual frameworks and policy instruments applied on a large scale.

Documentary analysis and public policies

Reports and strategic documents published by FAO, IPCC, World Bank, and UNDP were examined, providing comparative data on climate impacts on crops, available infrastructure, and promoted adaptation strategies. For Romania and the Republic of Moldova, national drought adaptation strategies and digital agriculture policies were analyzed.

Data processing

Qualitative data were thematically coded, and results triangulated with literature and international reports. Descriptive and correlational methods were used for quantitative data analysis, especially regarding drought impact on crop productivity and adaptation efficiency. Results were critically interpreted in relation to existing theories on agricultural resilience and managerial performance.

Data analysis methods included:

- Comparative analysis to identify differences between studied regions;
- Critical synthesis to integrate theoretical and practical conclusions;
- Data triangulation (literature – policies – local practices) to ensure consistency and validity of results.

RESULTS AND DISCUSSION

The results highlight that modern managerial performance in agriculture is based on integrating digital technologies, adopting sustainable practices, climate adaptation, and strategic leadership. In the Republic of Moldova, the use of precision seeders, sensors, and crop monitoring systems optimizes resources and reduces drought-related losses, thereby increasing productivity. In Romania, soil conservation practices, satellite monitoring, and the use of drought-tolerant varieties support farm economic competitiveness.

Continuous farmer training and the use of digital solutions – including integrated Farm Management Systems – enable data-driven decision-making and anticipation of climate risks. National adaptation programs and climate strategies implemented in both countries have proven effective in reducing vulnerability through irrigation infrastructure modernization, managerial training, and digital solution integration.

Sustainable practices, such as crop rotation, reduced soil disturbance, and efficient water management, significantly contribute to soil health conservation and production stability. Regional cooperation and adaptive leadership further strengthen proactive adaptation strategies, develop managerial competencies, and support building a more resilient economic framework.

These findings confirm the need to extend managerial performance indicators beyond economic dimensions, including sustainability, digitalization, and climate resilience as strategic pillars of modern agricultural development.

Data analysis indicated that agricultural resilience is closely correlated with farmers' managerial capacity and the degree of integration of modern technologies. In regions with developed agricultural infrastructure and coherent public policies, farmers have a wider range of adaptation tools and can significantly reduce losses caused by droughts or other extreme phenomena (Banca Mondială, 2022).

The analysis shows that managerial performance plays a crucial role in determining the level of agricultural resilience, especially in areas affected by recurrent droughts. Management models including anticipatory planning, infrastructure investments, and digital technology integration can significantly reduce climate-related losses and stabilize agricultural production.

Successful models in Europe and the USA

Countries with advanced agricultural infrastructure (France, Germany, USA) demonstrate that effective climate adaptation is inseparably linked to strategic management and innovation. Farms with intelligent hydrological monitoring systems and data-driven decisions reduce drought losses by 25–40% compared to traditional farms (WWF România, 2023). Financial support schemes and climate insurance mechanisms further contribute to farm economic stability.

In France and Spain, farms using integrated climate monitoring and smart irrigation systems record a 30–40% average reduction in production losses during severe droughts (Grupul Interguvernamental privind Schimbările Climatice., 2023). In the USA, predictive analytics based on Big Data and integrated agricultural insurance systems contribute to better economic stability of farms, even under extreme climate conditions (Organizația Națiunilor Unite pentru Alimentație și Agricultură, 2016). These farms demonstrate high managerial performance, defined by rigorous strategic planning, crop diversification, and investment capacity in adaptation technologies.

Structural vulnerabilities in the Republic of Moldova and Romania

In Moldova and Romania, results show a significant discrepancy between formulated policies and actual implementation. Despite high agricultural potential, irrigation infrastructure remains outdated and undersized. The lack of modern irrigation infrastructure, climate monitoring systems, and investment capital limits farmers' ability to adopt effective adaptation strategies (Howden, S. Mark, et al., 2017). Studies indicate difficulties in accessing digital technologies and clear risk planning mechanisms. Land fragmentation and lack of functional cooperatives also limit the efficiency of adaptation measures. However, pilot projects – such as those supported by FAO and UNDP in southern Moldova – showed significant increases in production stability during drought years (Movileanu, P.(coordonator), Popescu, G., 2007).

Determinants of resilience

Research results identify four key determinants of agricultural resilience in an unstable climate context:

1. Modern irrigation infrastructure;
2. Access to climate information and early warning systems;
3. Managerial capacity of agricultural enterprises;

4. Integration of digital technologies and ESG principles into decision-making processes.
   Farms with these elements successfully reduced production volatility and diversified economic strategies in the face of climate uncertainty (Wang, Xing, Jianying Qi, and Zhengrong Kan., 2024).

Critical discussions

These findings confirm contemporary theories regarding the transition from passive to proactive adaptation in agriculture. They suggest that resilience cannot be reduced to a technical dimension but must be understood as a complex combination of managerial competencies, infrastructure, financial instruments, and coherent policies. Romania and Moldova are at a strategic crossroads: without accelerated investments in infrastructure and human capital, the structural vulnerability of the agricultural sector risks increasing in the coming decades (AgroMedia.md., 2023).

1. The main barriers include difficult access to financing, lack of specialized consultancy, and weak predictability of public policies (European Commission. Farm to Fork Strategy. Brussels: EC, 2020).

ESG and digitalization as resilience factors

2. Farms adopting ESG principles and digital solutions (e.g., water resource management platforms, moisture sensors, climate forecast models) exhibited significantly increased capacity to adapt to extreme climate conditions (European Commission. Farm to Fork Strategy. Brussels: EC, 2020). This confirms the hypothesis that resilience depends not only on physical infrastructure but also on the quality of managerial decisions.

Key resilience factors identified

- Quality of irrigation infrastructure;
- Real-time access to climate information;
- Managerial capacity (strategic planning, risk analysis);
- Access to financial resources and insurance instruments;
- Support from public policies.

Implications for agricultural policies

Results suggest that improving agricultural resilience in Eastern Europe requires an integrated approach combining infrastructure investments with managerial training programs and incentives for digitalization (Movileanu, P.(coordonator), Popescu, G., 2007). Agricultural policies should shift from reactive measures to anticipatory planning based on climate data and systemic risk assessment.

CONCLUSIONS

The study highlights that agricultural resilience results from the interaction between infrastructure, technologies, public policies, and effective management. Farms with well-developed adaptive strategies are better able to withstand climatic shocks and maintain economic stability.

For Moldova and Romania, strategic priorities should include modernizing irrigation infrastructure, creating accessible digital climate monitoring platforms for farmers, strengthening agricultural consulting, and developing financial support instruments adapted to current climate realities.

These conclusions are relevant not only regionally but also globally, emphasizing that effective management is a central pillar of agricultural resilience in an era of accelerated climate change.

Managerial performance in the agricultural sector of Moldova and Romania emerges as an integrated model combining digitalization, sustainable practices, and climate adaptation strategies. Precision agriculture, climate-adaptive infrastructure, and managerial training contribute to competitiveness, regional food security, and local economic sustainability. This holistic approach highlights that effective management can no longer be conceived without integrating climatic and agro-technical dimensions, adapted to regional specificities and global requirements.

The results confirm that modern managerial performance can no longer be reduced to profit maximization or immediate operational efficiency. In the current global economy, it must be viewed through the lens of an organization’s capacity to adapt and remain competitive in an environment characterized by volatility, uncertainty, and major climate risks.

A first notable finding is the central role that digitalization and data-driven analysis play in achieving managerial performance. In agriculture, the use of soil and crop monitoring sensors, drones for land surveillance, and AI algorithms for crop forecasting has demonstrated significant yield increases and loss reduction. These tools contribute not only to process efficiency but also to strengthening crop resilience against climate variability, proving digital technology integration as an indispensable element of modern managerial performance.

A second finding concerns the importance of sustainable approaches and ESG principles. Case studies show that farms and agricultural companies adopting sustainable practices – such as crop rotation, renewable energy use, and carbon emission reduction – attract more investments, access premium markets, and build trust with local communities. Integrating the social dimension (worker protection, community involvement) and responsible governance has strengthened reputation and organizational stability. Thus, managerial performance is increasingly defined by balancing economic efficiency with environmental and societal responsibility.

Another highlighted aspect is the need for adaptive leadership. In regions where climate change frequently generates extreme events – droughts, floods, storms – managers who demonstrate flexibility, innovation capacity, and the ability to mobilize community resources achieve significantly better results. Leadership is therefore no longer perceived merely as a coordination skill but as an essential factor of resilience and performance.

The research also shows that modern managerial performance involves integrating agriculture into a regional and global perspective. As agricultural crops determine the stability of food markets and influence international trade, effective management becomes a condition for global economic security. Efficient agricultural management practices have chain effects: ensuring constant supply of raw materials, stabilizing prices, preventing food crises, and contributing to reducing economic inequalities between regions.

Discussions on these results lead to the conclusion that modern managerial performance must be understood as a multidimensional construct, where technology, sustainability, and adaptive leadership combine to build resilient and competitive organizations. Agriculture is a reference sector in this regard, being simultaneously one of the most vulnerable to climate change and one of the most influential in the global economy. Therefore, effective management in agriculture represents not only a sectoral necessity but also a condition for global economic stability. A coherent strategic vision centered on modernized infrastructure, digital agriculture, and institutional development is essential.

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