AGRICULTURAL RESEARCH AS A RESPONSE TO THE STRUCTURAL CHALLENGES OF THE ROMANIAN AGRI-FOOD SECTOR

FOGHIS GIORGIANA MARIA[1*], IANOSEL PETRICĂ[1], RABA DIANA NICOLETA[1], FEHER ANDREA[1,2]

[1]University of Life Sciences „King Mihai I" from Timisoara/ Faculty of Management and Rural Tourism, Romania

[2]Romanian Academy-Timisoara Branch/Research Centre for Sustainable Rural Development of Romania, Timisoara, Romania

*Corresponding author's e-mail: giorgiana.foghis@usvt.ro

Abstract: *This paper analyzes the interaction between the structural challenges of the Romanian agri-food sector and the capacity of the agricultural research, development, and innovation (RDI) system to provide tailored solutions. Based on a literature review addressing structural polarization of farms, productivity deficits, and economic fragmentation, the study highlights the need for strategic restructuring grounded in technology transfer and digitalization. The assessment of Romania's current agricultural research framework reveals valuable genetic, institutional, and human resources, yet hindered by underfunding, outdated infrastructure, and limited capacity for transfer to the productive environment. The conclusions emphasize that agricultural research can become a key instrument for enhancing the resilience and competitiveness of Romanian farmers, provided that cooperation between RDI institutions, the economic sector, and coherent public policies is strengthened.*

Key words: agricultural policies, agricultural research and development, agri-food sector, rural digitalization, technology transfer

INTRODUCTION

In the current context of the Romanian economy, the agri-food sector is undergoing continuous restructuring, driven by both internal and external pressures. Structural challenges, such as land consolidation, modernization of rural infrastructure, alignment with European and global market demands, and climate change, require a strategic rethinking of the role of agricultural research. It can no longer be viewed as an isolated activity, but rather as an integrated instrument for innovation, sustainability, and competitiveness.

Romania possesses significant agricultural potential, yet it remains underutilized. Agricultural research institutions play a crucial role in generating knowledge and technologies tailored to local conditions. Moreover, integrating research into national and European rural development strategies is vital for attracting funding and strengthening innovation capacity.

The Romanian agricultural research system comprises a network of 60 public research, development, and innovation units (RDIs), managing approximately 30,000 hectares of land. These units also hold a genetic heritage of 100 species of agricultural, horticultural, fruit-growing, viticultural, ornamental, medicinal, and aromatic plants; valuable genetic resources from domestic animal breeds, bees, and silkworms; and a piscicultural gene pool including native and non-native freshwater and brackish species. Additionally, the system includes a plant genetic resource bank and a forest genetic heritage encompassing species specific to the Carpathian–Danubian–Pontic region.

Agricultural research provides solutions for resource optimization, development of environmentally friendly technologies, productivity enhancement, and production diversification. Furthermore, it contributes to the formulation of coherent public policies based on scientific evidence and supports the emergence of smart agriculture capable of responding swiftly to market and environmental challenges.

Climate change is among the most pressing structural challenges facing Romanian agriculture. The increasing frequency of extreme weather events (droughts, floods, hailstorms, heatwaves) impacts crop yields, water resource availability, and the stability of agricultural ecosystems. In this context, agricultural research plays a vital role in developing adaptive and resilient solutions.

Digitalization of Romanian agriculture is a strategic direction essential for modernizing the agri-food sector and capitalizing on research outcomes. In a context marked by climate pressures, labor shortages, and increasingly stringent requirements for traceability and sustainability, digital technologies are becoming indispensable allies for both farmers and researchers.

MATERIALS AND METHODS

The primary objective of this research is to analyze how agricultural research contributes to addressing the structural challenges of the Romanian agri-food sector, with a focus on climate change adaptation, agricultural digitalization, technology transfer, and integration into public policies.

The study is based on the analysis of bibliographic references, including strategic and legislative documents (MARD Strategy 2023–2030, NRDP 2014–2020, National Climate Change Adaptation Plan, European Green Deal), statistical data (Romanian Statistical Yearbook, Eurostat, FAO), research reports from Agricultural Research and Development Station Lovrin, and scientific literature.

The research method consists of a documentary analysis of the aforementioned sources.

RESEARCH RESULTS

A study of the agri-food system requires an integrated approach to its core components: the agricultural sector and the food industry.

A diagnostic analysis of Romania's agri-food sector must address key issues such as the evolution of agricultural production and productivity, the degree of mechanization and digitalization of system institutions, economic performance, and export dynamics.

Regarding the evolution of agricultural production and productivity in Romania, significant transformations have occurred over recent decades, driven by economic, technological, and policy-related factors.

Between 2018 and 2022, cereal production exhibited notable regional variations. The areas with the highest yields and output were those that adopted modern technologies and benefited from greater land consolidation agricole [6,7]. Romania remained among the top agricultural producers in the European Union, with an agricultural output valued at approximately €21 billion in 2022 [4].

However, labor productivity in agriculture experienced dramatic fluctuations. In 2020, for instance, a decline of 47.2% was recorded compared to the previous year, one of the steepest drops in the EU. This decrease was influenced by unfavorable weather conditions, the impact of the COVID-19 pandemic, and the lack of effective adaptive solutions [12].

Agricultural research, the possibility of accessing European funds through research and development projects and the urgent need to streamline agricultural processes have determined the acceleration of the process of mechanization and digitization of agriculture.

Mechanization began to develop in the 1960s, with the introduction of the first modern seeders and advanced crop technologies. Currently, large farms are generally well equipped

with high-performance tractors, combines and specialized machinery, but small and medium-sized farms still face a lack of access to modern equipment.

Digitalization involves the use of: sensors and drones for crop monitoring, GPS systems and autonomous tractors, artificial intelligence and big data for decision-making and a digital platform for farm management and production traceability.

Romania has made important steps in this direction, but the degree of digitalization is still low compared to other European countries, and the challenges relate to digital infrastructure, farmer training and land fragmentation.

The economic performance of the Romanian agri-food sector is a mix of success and structural challenges.

On the one hand, Romania became the largest exporter of cereals in the European Union in 2024, with 5.1 million tons exported in just six months – almost a third of total EU exports [1,2,3]. The value of agricultural production reached 22.2 billion euros, ten times more than in 2007, which places Romania in the top 7 European agriculture [1,2,3].

On the other hand, the agri-food trade deficit increased significantly, reaching 6.3 billion euros in 2023, three times higher than a decade ago. This imbalance is mainly caused by massive imports of meat, fruit and dairy products, while exports are focused on raw materials such as cereals, seeds and live animals [9,12].

This polarization shows that Romania excels in primary production, but has difficulties in processing and exporting value-added products. The lack of storage infrastructure, land fragmentation and external competition (e.g. Turkey, Moldova, Ukraine) contribute to this situation.

Romanian agriculture faces deep structural problems, which limit the competitiveness and sustainability of the sector: one of the most fragmented agricultural structures in the EU, with over 2.8 million farms in 2020, but an average area of only 3.6 hectares per farm; over 60% of farmers are over 55 years old, and young people are increasingly less interested in agriculture; most farms are subsistence or semi-subsistence, with an economic value of less than 2,000 euros/year [16,11,12].

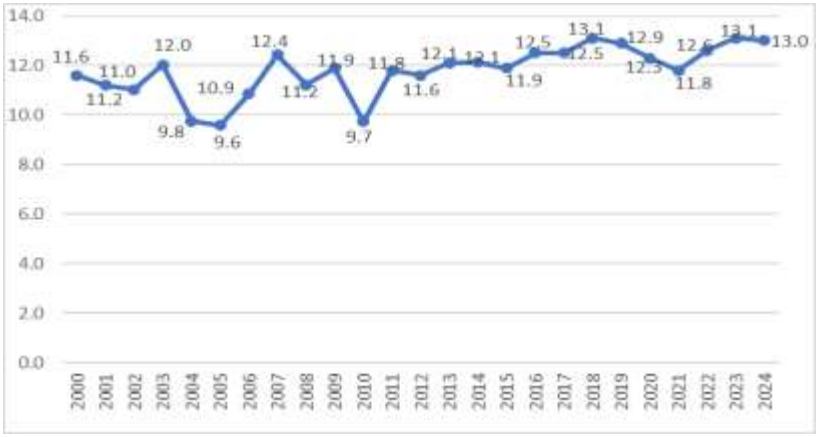

Figure 1. Evolution of average temperature in Romania during 2010-2024 (degrees Celsius)

Source: Archive of the Lovrin Agricultural Research and Development Station [17]

In addition, the agricultural sector is facing the increasingly visible effects of climate change: increasing average temperatures, the frequency and intensity of droughts, instability

of precipitation and the occurrence of extreme phenomena [11]. In this context, agricultural research plays an essential role in identifying adaptation and mitigation solutions, contributing to food security and the sustainability of agro-ecosystem systems [14].

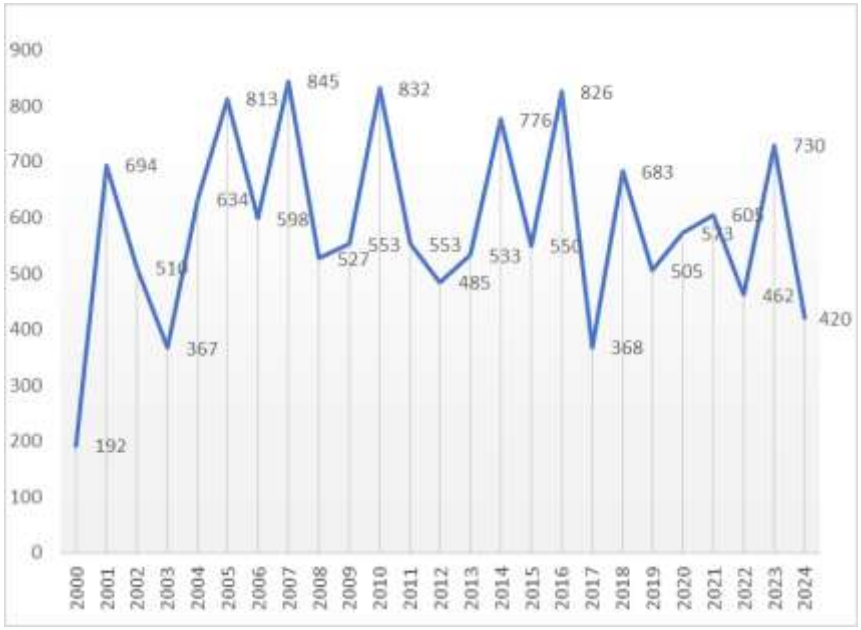

Figure 2. Evolution of precipitation in Romania during 2000-2024

Source: Archive of the Lovrin Agricultural Research and Development Station [17]

These problems are real, topical and require analysis and the development of a medium and long-term strategy, and agricultural research addresses these topics of interest.

The climate change adaptation strategy consists of formulating applicable objectives, but also developing action plans that address climate change adaptation and impact reduction. This process involves determining the carbon footprint, assessing climate risks and developing plans to manage and minimize these risks [5,10,13].

RDI institutions in Romania carry out research programs and projects on the following topics: crop adaptation to heat and water stress (varieties resistant to drought and high temperatures are tested, including through genetic selection and biotechnology), soil and carbon management (research focuses on moisture conservation practices, crop rotation and soil carbon sequestration), climate modeling and agroclimatic scenarios (research institutes collaborate with the National Agricultural Ministry to anticipate the impact until 2050–2070, with a focus on drought, heat stress and declining yields), adaptive agriculture (flexible production systems, agroecology and digitalization are promoted for better climate risk management).

Research institutions create varieties/hybrids of wheat, corn, sunflower, legumes, vegetables, fruit trees with increased tolerance to water and heat stress. Classical breeding methods are used, as well as modern biotechnologies, including molecular markers and assisted selection.

The number of varieties and hybrids created in Romanian research units has registered a constant increase from 45 creations/year in 2005, to 98 creations in 2024 [15] (Table 1).

Table 1.

Evolution of varieties and hybrids created in Romania (2005–2024)

Nr.crt.	Culture	Trend	Number/2024
1	Wheat	Steady growth	29
2	Mais	Steady growth	27
3	Vegetables	Moderate growth	16
4	Fruit trees	Stable, then growth	11
5	Ornamental plants	Slight growth	7
6	Grapevine	Stable	5

Source: ISTIS 2025 Catalogue [15]

In the field of soil management and carbon sequestration, research is aimed at preserving soil fertility through crop rotation, incorporating plant residues and using cover crops [8]. Agronomic schemes are being tested to increase organic matter content and reduce greenhouse gas emissions.

Research projects currently underway on this topic are listed in Table 2.

Table 2.

Research projects underway in Romania on soil management

Nr. crt.	Project name	Running period	Targeted resource type
1	Agricultural technologies for enhancing carbon sequestration (4‰ initiative)	2023-2026	Agricultural soils
2	Soil carbon sequestration through regenerative agriculture	2023-2026	Agricultural soils
3	Conservative farming systems for soil protection and organic carbon	2023-2026	Agricultural soils
4	Soil quality improvement practices and carbon sequestration	2016-2020	Degraded soils
5	Assessment of carbon sequestration capacity in Romanian soils	2018-2021	Agricultural soils
6	Ecological carbon sequestration systems in sandy soils	2022-2025	Sandy soils

Source: ARDS Lovrin archive [17]

Soil management is not just an agricultural practice, but a strategic investment in the future of ecosystems and the agri-food economy. Implementing integrated management strategies is vital to protecting soil resources and ensuring food security [8].

CONCLUSIONS

In conclusion, agricultural research is not just a technical response to structural challenges, but a vital component of a vision of sustainable, competitive and resilient rural development. Romania has the human, natural and institutional resources necessary to transform agricultural research into an engine of progress, provided there is a strong political will, adequate funding and genuine collaboration between the actors involved. By strengthening collaborations, digitizing processes and integrating results into agronomic practices, Romania can effectively respond to climate challenges and actively contribute to the European ecological transition.

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