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TECHNOLOGY TRANSFER IN ROMANIA`S AGRO-FOOD SECTOR. AN OVERVIEW

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Abstract

Technology transfer represents a strategic domain for enhancing the competitiveness and economic sustainability of Romania`s agro-food sector. The adoption of modern technologies in production, processing, and distribution can optimize resources, reduce costs, and support sustainable development. This paper analyzes technology transfer in Romania`sagro-food value chain. The research results indicate an underdeveloped infrastructure for processing, such as facilities for sorting, packaging, and freezing, which limits the added value of products. Technological integration, whether through precision agriculture or short supply chains, supports farmers by reducing intermediaries and logistical costs. Public policy documents highlight the need for financial support, collaboration between farmers and academia, and the implementation of successful models. To leverage the potential of technology transfer, integrated policies are necessary to support farmers' associations, modernize infrastructure and promote innovation. These measures can transform Romania`s agro-food value chain into a competitive and sustainable sector, capable of meeting both domestic and international market demands.

Key words: *technology transfer, agrifood chain, challenges, research units*

INTRODUCTION

An applied research that addresses major societal issues is a priority on the agenda of the European Union (EU). The main directions targeted by funding through the multi-annual research and innovation framework programmes are the development of European research, aiming to be more competitive at international level; strengthening industrial innovation, investments in key technologies; easier access to funds and support for SMEs; technological progress aimed at achieving viable products with market commercialization potential; development of mutually beneficial partnerships between the public and private sectors [6].

Research and technological developmentis a priority of EU policy, as reflected in European regulations. Since 1980, a framework programme dedicated to research has been launched. During the period 2014–2020, the main method of financing European research was the Horizon 2020 programme, which aimed primarily at maintaining the EU's international competitiveness. Currently, the financing of these objectives is carried out through Horizon Europe funds, active for the period 2021–2027 [8].

An analysis of the competitiveness of European agro-food chains and of the key factors influencing their activity is carried out within the COMPETE project. Innovation is essential for competitiveness and is based on the interaction of main actors: farmers, industry, research centres, public authorities, universities, and consumers. The report recommends the development of networks and interdisciplinary collaborations to facilitate technology transfer and adapt knowledge to market needs. Open innovation involves cooperation between companies and external actors (research entities, universities, clusters, etc.) for a faster innovation process. The food industry is particularly dependent on this form of innovation, as companies require greater external resources and technological expertise. Although the EU has developed several tools to support innovation (Horizon 2020, EIP-AGRI, structural and cohesion funds), there is no coherence between policies on education, research, agriculture, and rural development.

Experts from Wageningen University recommend integrating these policies into a functional system (Agricultural Knowledge and Innovation System) that can support innovation in all links of the agro-food chain. The report mentions that Romania is classified among European countries with a weak national innovation system, characterized by poor links between stakeholders (farmer–industry–research–government). From the perspective of RDI (research, development, and innovation) expenditures, Romania's system records the lowest public and private investments [11].

The same recommendation regarding a coherent framework of public policies to support innovation in the "from farm to fork" process — essential for supporting the competitiveness of the agro-foodindustry — is also found in the European Commission (2009) report [16]. Technology transfer must be based on public-private partnerships, with simplified access to funding for SMEs and support for RDI initiatives targeting the agro-food chain [7].

For emerging economies, the development and modernization of agriculture requires public agricultural extension services that can mediate the relationship between research and farmers. The lack of public investments and diffusion mechanisms leads to the isolation of innovations within academia, without impact on the business environment. Agricultural research technology transfer is not available to farmers due to institutional separation between universities, research institutes, and R&D units, significantly reducing the practical applicability of innovations. Reforming the system must aim at integrating these actors into a coherent national technology transfer system [5].

The application of transferred technologies in practice is conditioned by economic factors, namely the capacity of the agricultural extension system to support farmers in integrating innovations into production. The absence of a standardized technology transfer system in the agro-food sector may lead to isolated and uncoordinated actions [3].

Academic institutions with well-developed research centres can act as promoters of technology transfer, through pre-acceleration programs and academic entrepreneurship. Entrepreneurial skills and market-oriented research are necessary. The main barriers to technology transfer in the agrifood sector are research directions misaligned with business needs and limited business competencies among researchers. The development of regional innovation ecosystems can stimulate cross-sector collaboration [3].

Research conducted under the auspices of FAO by Duczmal (2001) shows that technology transfer activities are key components in modernizing and increasing the competitiveness of the agro-food sector, especially in transition economies such as Romania. To ensure successful TT, efficient knowledge transfer systems in agriculture are required to support accessible production practices based on applied research. Otherwise, scientific research results remain in academic centres, with limited economic or social impact. The lack of correlation between research entities, academic institutions, and agricultural production units is the main weakness of TT. These entities often operate independently, without common objectives, leading to duplication of activities and low practical applicability of scientific results. System reform should include the strengthening of connections between stakeholders, development of collaborative platforms, and applied research aligned with the real needs of agricultural production and food processing [5].

At EU level, there are strategic initiatives promoting artificial intelligence along the agro-food chain (e.g., Digital Innovation HubsTesting and Experimentation Facilities and the Data Act), with the main goal of creating a community-wide database in the agricultural domain. Fair access to AI-based technologies, avoiding monopolies in data usage, and support measures for small farms in the digital transition are key actions. AI can have a major impact on European agro-food chains, through massive data collection and automated decision algorithms. AI tools can optimize agricultural resources (water, fertilizers, inputs) and enhance precision agriculture. The main challenges in the sector

concern data privacy, ethical principles, and the lack of digital skills among farmers [4].

Technology transfer in horticulture can bring several benefits to Romanian farmers. EU funds can be used to create specialized TT units (e.g., the Advanced Institute for Horticultural Research in Transylvania), which can offer an integrated framework for all segments of horticulture, promoting collaboration between research units, industrial processing, and administrative departments [19].

A study on TT in the agro-food sector, carried out by multinational companies in agro-food processing, evaluates three main channels: contract farming, internal collaboration for innovation, and spillover effects of foreign direct investments. Although FDIs may have some technological benefits, in many cases the overall impact on the innovation system of the host economy is limited or selective. The author recommends cautious approaches in public policy formulation and proper integration of multinationals into the local economy to enhance technology transfer [15].

The digitalization of the agro-food system is a European-level priority, with the potential to improve its efficiency and sustainability.

The application of computerized data management systems and modern technologies associated with precision agriculture contributes to the efficiency of agricultural production, food processing, as well as marketing and consumption activities. The large-scale integration of IoT and ICT supports the development of food products tailored to individual needs and better synchronization among economic actors along the agri-food value chain [14].

The import of high-performance technology, namely modern agricultural machinery, can represent a model of good practice in technology transfer. The example of Uzbekistan, which has achieved technological progress and improved sesame export capacity due to the import of specialized agricultural equipment from Turkey, can also be applied to other emerging economies. Econometric models used to assess the impact of technology transfer show that exchange rates and domestic demand can have a significant effect on Uzbekistan's sesame exports [1].

Agricultural consultancy activities and the involvement of specialized educational institutions in agricultural education have a positive impact on achieving technology transfer in Russia. Modernizing infrastructure and improving innovative support methods for agro-industrial production, along with strengthening collaboration among science, education, and industry, can support the continuous development of the agricultural sector [21].

The use of digitalization in agro-food production has been boosted by Industry 4.0, and the implementation of these modern solutions was accelerated by COVID-19. The integration of advanced digital technologies — including AI, big data, IoT, blockchain, smart sensors, robotics, digital twins, and immersive tools like virtual or augmented reality — offers viable solutions to counter the disruptive effects of global crises such as pandemics and climate shifts on food systems. Although digital transformation and the adoption of Industry 4.0 approaches in agri-food chains have begun, these efforts remain at an early stage and demand long-term commitment to enable efficient knowledge and technology transfer [10].

Technology transfer and technological adoption remain major challenges in Romania. Technologies transferred from universities or national research entities can be considered in an early stage of development, compared to market-ready technologies, which leads to specific challenges in this field. The research sector in Romania differs relatively from that of other European states. Romanian universities have only recently started to benefit from research funding, with most research historically carried out by public research institutes, under the coordination of the National Research Authority (ANC) or the Romanian Academy. The ANC (formerly the Ministry of Research, Innovation and Digitalization – MCID) coordinates the development of research and innovation policies, while the Ministry of Education and the executive agency UEFISCDI have key roles in project implementation and in the

management of European funding. The public research system is chronically underfunded, characterized by weak institutional capacity, the lack of clear regulations, limited human resources and skills, negative cultural factors, and lack of legislative clarity regarding the commercialization of research results. The system includes 263 public organizations in the RDI field, and a number of private entities (including private incubators, accelerators, and science parks). Public entities include 56 public universities, 46 national research and development institutes, and 65 institutions and research centres under the Romanian Academy. The 34 accredited private universities generally do not benefit from public funds, and some do not carry out any research activities [2].

The research conducted by Stanciu (2018) on innovation and technology transfer in Romania addressed the need to develop these elements to support SMEs and the national economy. The findings highlighted that Romania ranks at the bottom of European innovation indices and that technology transfer is underdeveloped. The study recommended the creation of specialized TT networks and the development of government policies for the sustainable growth of the national economy [17].

In this context, the paper aimed to analyze technology transfer in Romania`s agro-food value chain regarding infrastructure for processing, such as facilities for sorting, packaging and freezing.

MATERIALS AND METHODS

Open-access articles from scientific data bases (Clarivate Analytics, Research Gate, and Google Scholar) were used for bibliographic documentation. Where needed, these sources were complemented by reports from public institutions, research institutes, or professional associations.

The research was based on statistical data provided by Eurostat, the National Institute of Statistics (NIS), and the National Research Authority. The selected information was processed statistically, graphically represented, and interpreted. Artificial intelligence tools (ChatGPT) were used to correct possible language and formatting errors and to ensure the accuracy of English terminology. AI-assisted statistical processing facilitated more efficient identification of patterns and extraction of territorial typologies from complex multi-annual data sets. The results obtained were graphically represented and interpreted. The research conclusions were compared with scientific sources from the literature for validation.

RESULTS AND DISCUSSIONS

In Romania, information related to technology transfer activities is systematized by the National Authority for Scientific Research (ANCS), which has developed a national registry of the entities involved, in the form of the Network of Innovation and Technology Transfer Infrastructures (ReNITT). ReNITT, an initiative of the Ministry of Research and Innovation, aims to increase the visibility of national research and development units, to capitalize on scientific research results, and to enhance the competitiveness of small and medium-sized enterprises through the transfer of technology and knowledge. ReNITT does not have legal personality and lacks the capacity to directly finance technology transfer units. The network has been actively involved in the establishment of the Romanian Association for Technology Transfer and Innovation (ARoTT), which is a legal entity capable of entering international partnerships and participating in international projects [12].

In accordance with legal provisions, the infrastructure is composed of several categories of accredited entities specializing in innovation and technology transfer: Technology Transfer Center (TTC), Technology Information Center (TIC), Technology and Business Incubator Center (TBIC), and ResearchLiaison Office (RLO) [9]. The distribution of technology transfer entities within ReNITT, by category, is presented in Figure 1. The majority of entities fall into the TTC category (36), followed by TIC (6) and TBIC (4). The number of entities specialized in technology transfer is limited. In practice, an analysis of the 46 accredited entities shows that 15 belong to academic

institutions in Romania. Considering that there are 97 accredited universities, only about 15% have an accredited specialized structure. Moreover, these structures are often small in size, generally composed of only 1–2 staff members. By comparison, in Europe, TT entities are usually much larger: 24% of the m employbetween 5 and 10 full-time equivalent (FTE) staff, while 29% employ between 10 and 25 FTEs.

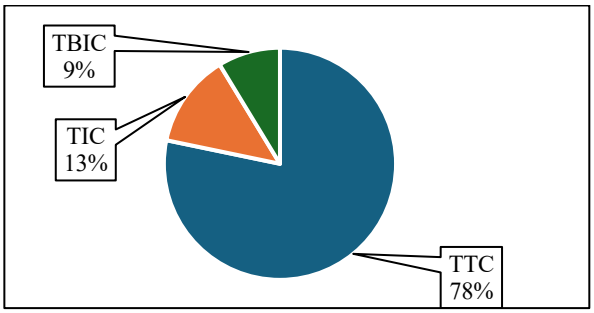

Fig. 1. TT Entities in Romania (by Category)
Source: Author's elaboration based on [12].

The Polytech Technological Transfer and Business Centre, affiliated with the "Gheorghe Asachi" Technical University of Iași, operates with a staff of 20, although a significant number of these employees are also engaged in activities unrelated to technology transfer. Among the 46 identified entities, 23 have specific functions linked to the agro-food sector or associated domains, such as bioeconomy, biotechnology, agriculture, the food industry, or precision farming (Figure 2).

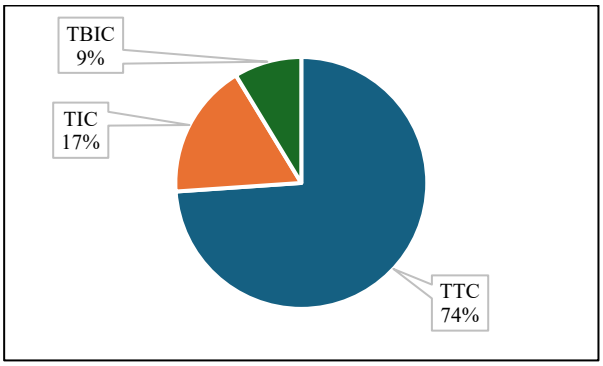

Fig. 2. TT Entities in the Agro-Food Sector (by Category)
Source: Author's elaboration based on [12].

Most of the units withr esponsibilities in this domain are Technology Transfer Centers (TTCs) – 17 in total, followed by Technology Information Centers (TICs) – 4, and Technology and Business Incubator Centers (TBICs) – 2.Of these, 11 are affiliated with universities:
CTT USAMVBT – Banat University of Agricultural Sciences andVeterinary Medicine, Timișoara;
CTT-USAMV AGROBIOLIFE – University of Agronomic Sciences andVeterinary Medicine, Bucharest;
CTT UGAL – "Dunărea de Jos" University of Galați:
CTT UOC – "Ovidius" University of Constanța;
CTT POLITEHNICA 2020 – Politehnica University of Timișoara;
CTT UCB – "Constantin Brâncuși" University of Târgu Jiu;
CTT CENTI – ICIA (Research Institute for Analytical Instrumentation), affiliated with INOE 2000, with university collaboration in Cluj;
CTT INCDTIM – National Institute for Research and Development of Isotopic and Molecular Technologies, Cluj-Napoca – collaborates with local universities, e.g., Technical University of Cluj-Napoca;
CTTC Cluj – Technical University of Cluj-Napoca;
CTT-UBB-TechTransfer – "Babeș-Bolyai" University of Cluj-Napoca;
CTT UMC – Maritime University of Constanța.
Examples of involved entities include those affiliated with research institutes, chambers of commerce, or private commercial companies. Among them are:IT IND-AGRO-POL – IND-AGRO-POL Association (an independent legal entity); INMA-ITA – National Institute for Research and Development of Machinery and Installations for Agriculture and the Food Industry, based in Bucharest; CTT-ICCF – National Institute for Research and Development in the Chemical and Pharmaceutical Industry, Bucharest; CTT IBA – National Institute for Research and Development of Food Bioresources, Bucharest; CTT BINNOTEH – National Institute for Research and Development in Biological Sciences, Bucharest; CTT ICECHIM – National Institute for Research and Development in Chemistry and

Petrochemistry, Bucharest; CIT ALBATECH – Alba Chamber of Commerce and Industry; IPA CIFATT – ITA Craiova – IPA SA (Research and Design Institute for Automation), Entrepreneurship and Technology Transfer Center, Craiova Branch;
The county-level distribution of these entities is presented in Figure 3.

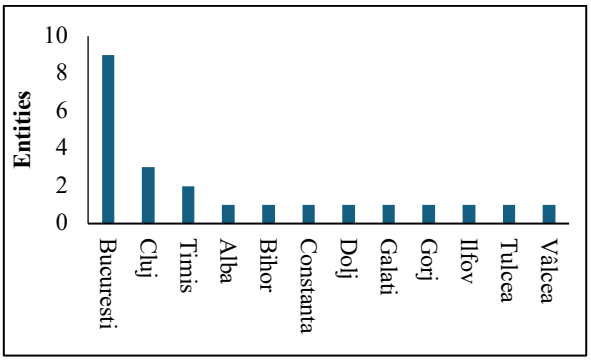

Fig. 3. TT Agrofood Entities (by Counties)
Source: Author's elaboration based on [12].

Romania's capital city, which hosts the largest number of universities and research institutes, holds the top position in this distribution. With 39% of all technology transfer entities specialized in agrofood, Bucharest ranks first among Romanian counties. Cluj (3) and Timiș (2) occupy the next positions, while the remaining counties host only one such entity each.
There is nonational-level data available on the number of spin-offs generated by research institutes or universities. No statistics are collected by the State Office for Inventions and Trademarks (OSIM), ReNITT, the Romanian Association for Technology Transfer and Innovation (ARoTT), or by the relevant ministries. Data from third-party commercial providers (such as Pitchbook) is also limited.
Although the commercial database Dealroom does not report any spin-outs directly from Romanian universities, it does record:
238 start-ups founded by alumni of the Bucharest University of Economic Studies (e.g., Napers, Adevinta, Adversity, Tandem, FintechOS);
120 start-ups founded by alumni of Babeș-Bolyai University of Cluj-Napoca (e.g., Modern Meadow, Pangea, Typing DNA, LiveRail, Frisbo);
107 start-ups founded by alumni of the University of Bucharest (e.g., UiPath, CapsidaBiotherapeutics, BotsAndUs, SkinVision), and several hundred others founded by alumni of other universities across the country.
In Romania, there are approximately 20 business accelerators, along with 6 incubators and 33 coworking spaces. As in other countries, the distinctions between these organizational types are often blurred, which makes strict classification difficult. From the perspective of technology transfer, there is no evidence that these are actively involved in TT activities [2].
To improve technology transfer in Romania, the former Ministry of Research, Innovation and Digitalization (now the National Research Authority – ANC) launched the project call "Transfer Projectstothe Economic Operator (PTE)", which proposed funding of 53,000,000 lei (approximately €10.6 million) to increase the competitiveness of the national economy by capitalizing on the results of research units and transferring them to the market.
The deadline for submitting project proposals was February 16, 2024, at 4:00 p.m. The duration of the projects was to be a minimum of 12 months and a maximum of 24 months, with funding of 1,500,000 lei per project, according to the approved state aid scheme.
Participating enterprises were required to contribute at least 50% of the total publicly funded project value from the irown budget. Each proposal had to be submitted by a research and development enterprise, coordinating the project, in partnership with at least one public or private research organization. Other enterprises could also be part of the partnership structure [13].
In March 2024, the ministry announced the funding of 35 projects, each with a 1.5 million lei grant (approx. €300,000). According to information available on the UEFISCDI website, the evaluation process was ongoing throughout 2024.
Their county-level distribution within Romania is presented in Figure 4.

The vast majority of funding applications were submitted in Bucharest, Ilfov, and Cluj, which together account for over 70% of all submitted projects.Out of the 42 counties in Romania (including Bucharest), no application was submitted by entities from Botoșani, Brăila, Caraș-Severin, or Covasna. As of October 21, 2024, it was announced that the individual evaluation stage had been completed for part of the projects, and intermediate consensus reports were made available to project directors. The final list of the 35 projects accepted for funding is available on the UEFISCDI website [18].

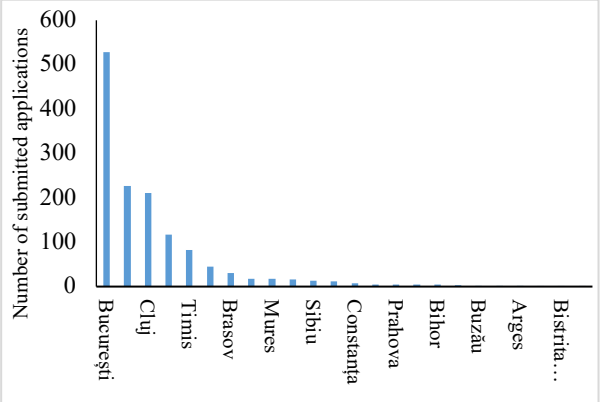

Fig. 4. TT Applications submitted, bycounty of the coordinating institution
Source: Author's elaboration based on [13].

An analysis of these projects shows that 6 of them (approximately 17%) are related to the agro-food, food, or agriculture sectors.
The list of these projects, with the following elements:Project title; Coordinating institution; Academic / R&D partner, is presented below:
1.Optimized Processing Model for a Traditional Product with the Certification of Uniqueness Markers at European Level (PDO Label); Coordinating institution: SICILIANA SRL; Academic / R&D partner: USAMV Cluj-Napoca; INCDTIM Cluj-Napoca
2.Intelligent IoTSystem for GreenhouseAutomation; Coordinating institution: Beia Consult International S.R.L.Academic/R&D partner: INMA; Politehnica University of Bucharest;
3.Exploring Climate Opportunities and Assessing Romania's Territorial Suitability for Optimized and High-Performance Agriculture; Coordinating institution: Indeco Soft SRL; Academic / R&D partner: USAMV Cluj-Napoca; Babeș-Bolyai University; CCDCPN
4.Advanced Technology-Based System for Implementing Agriculture 4.0 in Beef Cattle Farms; Coordinating institution: Beam Innovation SRL; Academic / R&D partner: USAMV Bucharest
5.High-Performance Equipment for Ecological Water Disinfection; Coordinating institution: I.C.P.E. Bistrița S.A.; Academic / R&D partner: Politehnica University of Bucharest
6. Innovative Solutions for Obtaining a Range of Products with Applications in Regenerative Cosmetics; Coordinating institution: Pure Life S.R.L.; Academic / R&D partner: National Institute of Chemical and Pharmaceutical Research – ICCF Bucharest.
Among the research topics, 4 projects targeted agricultural production or food processing (traditional foods, greenhouse digitalization, precision and climate-smart agriculture, Agriculture 4.0), while 2 projects addressed fields connected to the food industry (ecological water disinfection – relevant to the food industry, and regenerative cosmetics based on biological inputs, partially linked to food bioresources).

CONCLUSIONS

Technology transfer represents a strategic direction for the modernization and increased competitiveness of Romania'sagro-food sector.
Romania is taking its first steps in thefield of technology transfer, with progress currently reflected by the low number of TTOs per university and limited investments in RDI. To improve these aspects, it is essential to strengthen the technology transfer infrastructure, increase research and development funding, and encourage collaboration between academia and industry.
Although there is a formal technology transfer infrastructure—represented by 46 accredited entities nation wide—only 23 have direct or related responsibilities in the agro-food sector, and just 15 are affiliated with universities. These figures highlight the low level of

academic involvement in leveraging research results for the productive sector.

Romanian TT entities are generally understaffed and underfunded, which limits their operational capacity. The lack of national databases on spin-offs and the lack of coordination between universities, research institutes, and the business environment are major obstacles in analyzing a functional innovation ecosystem.

Technology transfer activity in Romania is not yet based on a significant mechanism for commercializing academic knowledge. To fully harness the existing potential, systemic reform is needed, ensuring the coherent integration of research, education, industry, and government sectors.

Supporting TT in the agro-food sector requires: investment in processing infrastructure, the development of functional regional TT centers, stimulation of applied research; development of entrepreneurial competencies, and facilitating SME access to innovation.

International examples—such as the German model or European initiatives on agricultural digitalization—canprovide concrete directions for action.

In the context of new global challenges—including health crises, climate change, and pressure on supply chains—the digital transformation of Romania'sagro-food system, supported by effective technology transfer, becomes a strategic priority.

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