BULGARIA'S AGRIBUSINESS SYSTEM IN TURBULENT TIMES

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Abstract

The approach implemented with the different EIP-AGRI instruments, including Horizon 2020 (at the transnational level) and CAP (at the national and regional level), gradually builds a comprehensive knowledge base capable of responding to the practical challenges faced by agriculture and food/non-food sectors. Therefore, the focus is now on improving information and innovation flows within AKIS. Innovation is essential to building and sharing knowledge and creating a space for participants to meet and develop ideas. The development and spread of innovative practices in agricultural holdings in Bulgaria depend to a considerable extent on the development of agricultural science and the potential impact of scientific results. In this regard, the state-of-the-art and recent trends for developing the agribusiness system in Bulgaria will be analysed from the perspective of global and regional challenges.

Keywords: *agribusiness, innovation eco-system, innovation potential*

1. INTRODUCTION

Agribusiness (agriculture and related value chain activities) is key to developing a national economy. As one of the traditional sectors for Bulgaria, agriculture has a share of 5% in the generated Gross Added Value at current prices in 2022, providing just over 6% of employment and 17% of total exports for the country. The sector participates in the formation of a significant share of the resource provision of a number of related industries and activities. Nearly 50% of the country's territory is used for agriculture. Although it has a weaker economic role compared to services and industry, agriculture has been declared a priority sector for attracting foreign direct investment by the Bulgarian Investment Agency. **Bulgaria's agricultural sector plays a decisive role in the country's transition to sustainability and carbon neutrality and in the implementation of the "Green Transition" because it is one of the sectors identified as the "culprit" for increasing the level of carbon emissions** [1]. That is why a large part of the funds from the Strategic Plan of Bulgaria in the field of agriculture (about 30%) are directed to the development of "green measures", through the implementation of different types of innovations. Reducing emissions from agricultural activity through the use of "green measures" is becoming a challenge that requires innovative solutions.

Food security, national security and competitiveness, as well as the impact on the environment are just some of the factors that **require agribusiness to be part of the state's strategic priorities and to be seen as a source of competitive advantages in international markets**. It is no coincidence that within the framework of the European Union (EU), the oldest, large-scale in terms of financing and harmonised in terms of application and management is precisely the Common Agricultural and Economic Policy (CAP). The COVID-19 crisis and Russia's war against Ukraine have caused major upheavals in a number of global agricultural markets, fuelled inflationary trends and raised fears of social tensions and a humanitarian-food catastrophe in the world's poorest countries. This focuses attention on the key importance of global trade in agricultural commodities and the importance of the sector to the global social balance [2]. Some of the most significant challenges facing humanity have a direct impact on the development of the agricultural sector [3]: climate change and decline in agricultural productivity, scarcity of natural resources, population growth in the Global South and population decline in the Global North and growth in food needs, food waste and environmental pollution [4]. As a result, **farmers face**

the dual challenge of producing food in a cost-effective way while preserving nature and biodiversity and adapting to increasingly diverse diets and preferences [5].

2. MATERIALS AND METHODS

The main approaches to achieve the objectives of the present report include 1) Systems approach – The understanding that the different stages of the innovation process, transfer and diffusion of technological knowledge are based on extensive interaction between different groups of stakeholders, depending on a number of internal and external factors, and in this sense represent a kind of innovation systems, is crucial. In this sense, the focus of the research will be aimed at identifying the system boundaries of the sectoral innovation system of agribusiness, the elements that build it, and the system-forming connections between them. 2) Strategic approach - This is achieved through the main directions and dynamics of development of the various aspects of the innovation potential of the sector, its vision, priorities, competitive advantages, programmatic and strategic framework for the development of national and European levels. The implemented desk research focused on scientific literature on innovation, evaluation of innovation potential, and sectoral innovation systems, including agribusiness.

3. RESULTS

3.1. Reconstructing the sector of agribusiness based on technological innovation

Innovation is one of the most recognisable factors for economic growth and competitiveness [6]. However, until the early 1960s, scientific interest in innovation was rather limited. The Austrian economist and political scientist Joseph Alois Schumpeter is one of the few exceptions [7]. The main reason lies in the dominant static and mathematical model approach in economics during this period, which fails to capture the creative beginning of innovations and the high level of uncertainty inherent in them. Innovation is seen as a "black box" [8] whose parameters, processes and behaviour cannot be measured. The renaissance of Schumpeter's ideas responds to this challenge by combining insights from economics, sociology, and history in a highly original approach to the study of long-term economic and social change, the crucial role of innovation, and the factors that determine it.

A number of scientific concepts in the field of innovation theory are launched for the first time and validated on the basis of data and analysis of the development of the agricultural sector. Examples in this regard are the long economic cycles in the economy, based on the accumulation and exploitation of new technological knowledge [9] and the theory of diffusion of innovations [10]. Today, in the conditions of exceptional growth opportunities arising from the dynamic development of new technologies and digital transformation processes, on the one hand, and a number of global challenges on the other hand, agribusiness is the intersection of significant changes in both political and regulatory mechanisms. impact, as well as business models and sources of entrepreneurial and innovation activity.

In the dynamic development of Industry 4.0 and Industry 5.0 technologies, agribusiness is becoming an application field for leading scientific achievements and modern technological solutions that change the sector's overall appearance and business model (the so-called AgriTech or Agriculture 4.0) [11]. Technological innovations play a decisive role in the development of the agricultural sector. The application of high-tech products and services contributes significantly to increasing the sector's productivity and to the more efficient use of resources such as land, water, fuels, fertilisers and pesticides [12]. According to GlobalData, **investments in the technological renewal of the agricultural sector are primarily aimed at the application of artificial intelligence, robotics, new materials, cloud services, big data, and** the Internet of Things. It is noteworthy that in implementing these processes, **the specificity of the agricultural sector as a low-tech type of activity does not conflict with the high-tech nature of the products and solutions that the sector implements**. On the contrary, we are witnessing the so-called creative destruction of innovations as such and their transformation into a service (Innovation-as-a-service) [13] offered outside the companies within whose limits it is applied [14]. In this sense, the interaction within the sectoral innovation ecosystem is of key importance [15]. At the same time, new technologies, although crucial for economic and environmental development,

often come into conflict with social indicators, leading to a reduction in the number of jobs [16] and a lack of skilled labour.

3.2. Agribusiness innovation eco-system – current state of the research

Several studies from the end of the last century prove **the necessity of applying the system approach in the analysis of the sources and factors of innovation activity** [17]. The further development of the theory of innovation systems leads to the identification of a number of features at the sector level that predetermine technological dynamics and are the basis for distinguishing high-tech from low-tech industries, sectors and activities [18]. Although the European Union as a whole invests significant funds in the development of innovations, a number of authors talk about the so-called "European paradox" [19]. Europe leads the world in terms of high scientific achievements, as measured by the number of academic publications, but is less able than other regions to transform these results into innovation results, such as patents, technologies or other market innovations. Agriculture is no exception to this trend [20]. Therefore, not only systemic but also joint innovations are needed. The main policy approach adopted by the EU to overcome this shortcoming is to provide political, legislative and financial support to strengthen the links between research and practice and to transform the way actors work together in the innovation process. For example, the European Agricultural Productivity and Sustainability Innovation Partnership (EIP-AGRI) aim to "accelerate" innovation by requiring projects to be implemented by "multistakeholder" partnerships that bring together the complementary knowledge and other resources of different types of actors (farmers, foresters, enterprises, researchers, NGOs, etc.), and apply the "joint innovation" model. Partners are expected to "co-create" new, "demand-driven" knowledge "throughout the project" (EIP-AGRI, 2013). The co-innovation approach is also strongly supported by international agencies such as FAO (FAO, 2014.) and the World Bank (World Bank, 2012).

Innovations are sector-specific – such as content, development and implementation process, determinants, and visible and invisible effects. The engines for the success of innovation projects are different, as are the policies that influence, initiate, predetermine, and direct them. This is the reason why the assessment of the innovation potential at the national level logically goes down one level - to its sectoral characteristics. Sectoral differentiation reveals the way in which participants in technological chains and sectoral innovation systems interact in the process of creation, integration and implementation of technological, organisational and marketing innovations. Analyses of sectoral innovation systems in the field of agriculture [21] provide evidence of the essence and importance of the innovation activity of the companies included in them and thus support the creation of sector-based innovation-oriented policies and measures with a real effect on the economy. The creation of impact mechanisms, not imposed from outside but resulting from and prompted by the natural transformation processes in the relevant sectors, has the potential to provide a healthier environment for the functioning of the innovation ecosystem as a whole.

Agricultural knowledge and innovation systems encompass all people and organisations (farmers, farmer organisations and cooperatives, advisors, researchers, businesses, NGOs) that generate, share and use knowledge and innovation for agriculture and interconnected areas such as rural areas, environment, climate, biodiversity, society, consumers and others [22]. In the conditions of a dynamically changing business environment, knowledge and innovation systems in agriculture can take different forms, including, but not limited to, sectoral innovation systems [23], (global) value-added chains [24], innovation clusters [25], and other forms [26]. Concepts such as "outcubation" (which replaces or complements the process of "incubation") and "innovation dating" are being launched in the scientific literature for the symbiosis between micro/small enterprises and large corporations in the field of agriculture.

4. DISCUSSION

4.1. Measuring the innovation potential of agribusiness

The success of the implementation of new technologies and the use of their full capacity depends on many factors, the main one of which is the innovation potential of economic entities operating within agribusiness (farmers, cooperatives, small and medium-sized enterprises, family businesses, and large enterprises). **Innovation potential is determined by the understanding of the importance of innovation, the readiness to implement innovation, the available innovation capacity, and the innovation development practices applied by economic entities (natural and legal entities)**, which can be distinguished on the basis of geographical, sectoral or another sign. Innovation potential also depends on the regulatory and economic environment and on how economic entities position themselves in relation to it.

In this respect, the research hypotheses, which have to be verified through an in-depth analysis and a comprehensive methodology, include:

- Innovations in the agricultural sector are initiated by factors external to the sector - primarily as a result of the development of science and technological progress in economic sectors, which form the inflows in the organisation of agricultural activities;
- The agricultural sector is part of the low-tech industries. The expectation is that, in comparative terms, the innovation potential of the agricultural sector will be lower compared to other sectors, also included in the group of low-tech industries;
- Innovative activity in the agricultural sector is expressed in the application of technological solutions new to the sector but existing in other sectors (intersectoral diffusion), a new combination of or a new application of existing technologies;
- The innovation potential of economic entities involved in agribusiness is influenced by their sub-sector affiliation, varying significantly depending on their size and specific subject of activity in the context of the agri-sector;
- Digitization processes take place with different intensity in different sub-sectors and types of businesses in the agricultural sector and depend mostly on access to skilled labour and not so much on access to financial resources
- The innovation potential of the units in the railway business is intensified when developing joint innovations in the sense of EPI-AGRI, including the exchange of knowledge and experience from different actors.

Despite the existence of a number of developments in the field of innovation potential in general, and in particular, aimed at analysing and evaluating specific areas of its manifestation (limited in time, geographically or in relation to the specific set of indicators that was used, for example the European Innovation Scoreboard, Global Innovation Index and others), in practice **there is no tool/methodology that would allow a systematic survey and recognition of the specifics and peculiarities of agribusiness**, as well as the attitudes and innovation capacity of entrepreneurs in this area as a basis for the implementation of sectoral policies based on data, and for the implementation of measures oriented towards the needs and challenges of those employed in the agricultural sector. In addition, never before has agribusiness been so pressed by the need to innovate to address the challenges listed above. Bearing in mind what has been said so far, it is high time **to develop and test a methodology and create a Sectoral Innovation Scoreboard for research and evaluation of the innovation potential of agribusiness**.

The concept of the innovation system in the agricultural sector makes it possible to cover all participants in the processes of creation, transfer, dissemination and application of new knowledge and technologies both in the field of agriculture and in all related spheres, the existing and potential interactions between them, the impacts on the part of European and national politics, the influence of factors such as funding and quality of human resources. In such a way, the following challenges have to

be addressed: 1) **emphasis on factors promoting innovation activity originating outside the system**, which can find a new application or stimulate the effective use of other internal factors; 2) **the generation of a critical mass in terms of used resources and exchange of ideas is encouraged at the expense of the isolated performance** of individual functions in service of the innovation process; 3) **equal importance is given to innovations dictated by novelties in science and technological development**, and to those originating from changes in the market and the behaviour of end users; 4) the **critical importance of the interaction within the sector** on the individual units of the technological chain on the basis of coordination of activities, generation of knowledge, multiplication of results stands out; 5) an **opportunity to build the innovation capacity of individual participants in the system and of the system** as a whole through systematic and coordinated efforts dictated by the capabilities of research units, the educational system and business; 6) **development of an innovation culture** and an environment supporting innovation through approaches and measures that are adapted to the needs of the system and the goals for its development.

The development of a methodology for evaluating the innovation potential of the agricultural sector also draws ideas from the concepts of Agricultural Knowledge System (AKS) [27], Agricultural Knowledge and Information System (AKIS) [28], Agricultural Innovation Systems (AIS) [29], Agricultural Science Technology and Innovation (ASTI) Systems [30], Learning and Innovation Networks for Sustainable Agriculture (LINSA) [31].

The development and testing of a methodology for the creation of a Sectoral Innovation scoreboard of agribusiness has to be based on:

- the Frascati Manual, the Oslo Manual and the accompanying standards of the Organization for Economic Co-operation and Development (OECD) for measurements in the field of science and technology, which represent a comprehensive methodological toolkit for carrying out quantitative research on science and technology policy and innovation. An important step towards international standardisation in this area is the fact that the Oslo Handbook is a joint product of Eurostat, the statistical office of the European Commission, and the OECD. Despite the importance and benefits of measuring innovation in enterprises, the project will take into account that the standard methods for measuring innovation proposed by the OECD largely exclude the agricultural sector.
- European and international studies of innovation potential, incl. European Innovation Scoreboard, Regional Innovation Scoreboard, Global Innovation Index, OECD Science, Technology and Innovation Scoreboard, Global Entrepreneurship Monitor, etc.
- the international standard for innovation management;
- the publications of international organisations (such as the OECD, the World Bank, the International Intellectual Property Organization and others) that lay the foundations and develop the methodology for measuring research and development activity and innovation in general, and in particular at the sectoral level;
- the analysis of international consulting companies with significant experience and institutional knowledge in the field of the agricultural sector and agro-food chains, for example, McKinsey & Company, Boston Consulting Group and others;
- a significant body of scientific research on various aspects and challenges in measuring, evaluating and reporting innovation and innovation potential;
- the guidelines for digitisation and green transformation of agribusiness, as well as the contribution of agribusiness to achieving the global goals for sustainable development according to the vision of the Food and Agriculture Organization;
- the results of implementing national, European and international projects in the field, including those financed by the Scientific Research Fund, the framework programs of the EC and others.

4.2. Agribusiness innovation eco-system in Bulgaria – the main players

The main centres for making management decisions within the sectoral innovation ecosystem of agribusiness in Bulgaria are distributed among the following participants:

1) Policy (strategic and regulatory framework) in the field of science, technology, education, innovation, knowledge transfer;

2) Creation of new knowledge and technological solutions: Various studies [32] and documents of the European Commission describe the AKIS system in Bulgaria as fragmentary and not functioning well. The inherited fragmentation between institutions and units engaged in fundamental and applied research and training is in the process of transformation in the direction of reconciliation, sharing, multiplication of functions and activities in order to reflect the multidisciplinary nature of innovation processes, the need to search for complex solutions, shorten time and optimise efforts in the process of creating and applying new technologies.

3) Dissemination of information and knowledge, provision of consultancy services: Despite the great attention/provided funds focused on the provision of intermediary services, consultations and brokerage are mainly carried out by the units of the Ministry of Agriculture and Food. Greater independence in the performance of these functions was achieved through the launch of the LEADER-initiative, although in this case the funding was public. Among the main reasons for this are a). the large number of small farms with very limited financial resources, resp. opportunities to use similar services on a market basis; and b). the government's desire to maintain its influence on the development of the sector by implementing specific policy measures. The representatives of the private sector with relevant functions are exhausted with rather sporadic appearances of large companies that provide services in addition to new and improved products; small independent consulting firms and consultants oriented towards the provision of specialised assistance; non-governmental organisations whose portfolio depends on donor organisations at a certain point and in this sense cannot claim sustainability.

4) Application of new technologies: The final users of innovative technologies in agriculture form the following groups: family farms that produce products primarily to satisfy their own needs, making up about 80-90% of all structures in the sector; family farms, whose production is mainly market-oriented while also satisfying their own needs, about 15-20%; large farms (no more than 3-5%) with significant resources (cultivable area, machinery, finance, technology), specialised in the production of certain final products and fully integrated with national/international markets [33].

The research organisations in Bulgaria with a profile of agrarian sciences and related biology, ecology, forestry, aquaculture and others include the Academy of Agriculture, some of the institutes of the BAS, Trakia University-Stara Zagora, Sofia University, Forestry University, medical and some of the technical universities. In addition, the Agricultural University, the University of Food Technology, the University of Plovdiv, the Higher School of Agribusiness and Regional Development, the Medical University, the Center for Plant System Biology and Biotechnology are concentrated in the Plovdiv region. This is also the reason why a major part of the research infrastructure in this area is located in the South Central Planning Region.

The master's program "Innovations and digital transformation of agribusiness" at the Faculty of Economics and Business Administration of Sofia University provides an opportunity for representatives of business, state and local administration, the non-governmental sector and individual experts employed in the field of the agribusiness sector and related activities to acquire specialized knowledge and skills, integration into sector networks and interactions, and access to specific know-how through meetings with leading professionals from the country and abroad.

The master's program offers a unique range of disciplines in the field of European and national sector policies, agri-food systems and supply chains, entrepreneurship and innovation, the application of

digital technologies, the protection of intellectual assets, the financing of innovation projects, organic agriculture and sustainable development.

The main partners of the program are Institute for Agricultural Strategies and Innovations , AgriHub.BG , Agricultural Academy , Center for Promotion of Cooperation in the Field of Agriculture between China and the Countries of Central and Eastern Europe , Organic Farming Foundation BIOSELENA, TechnoLogica.

Box 1. Education with a focus on agribusiness

Source: FEBA, Sofia University, 2024.

The implementation and spread of innovative practices in agricultural holdings in Bulgaria depend to a very large extent on the development of agricultural science and the potential impact of scientific results—scientific articles, new varieties of plants and breeds of animals, but also citability, recognition on the international scene, and interaction with business.

In this respect, it is significant to note that the Agricultural Academy and the Agrarian University profiles do not appear in the institutional ranking of SCOPUS. The inclusion criterion is for the institutions to have published at least 100 works included in the SCOPUS database in the last year of the selected time period.

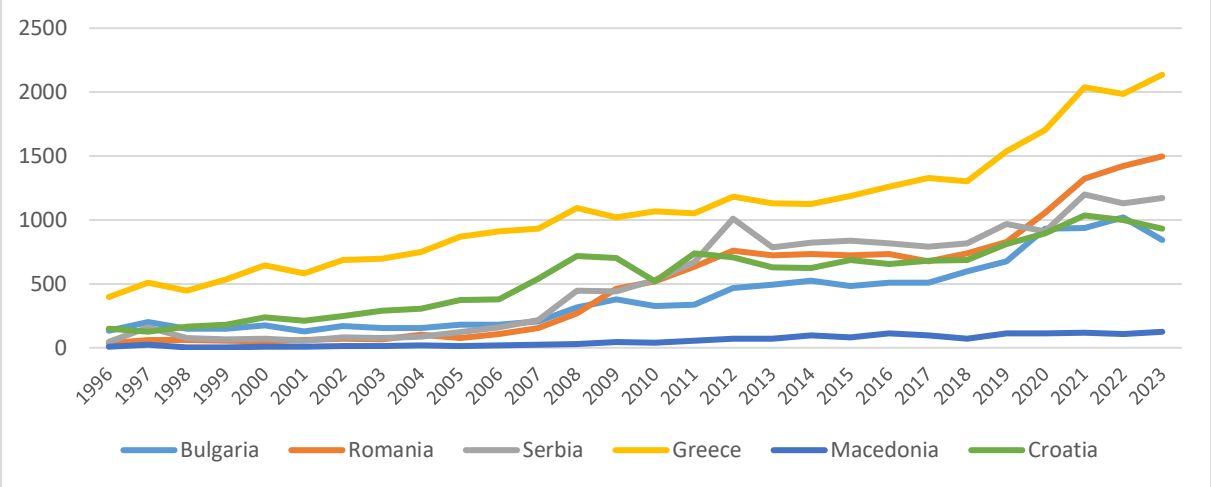

Figure 1. Publication activity, Agricultural and biological sciences, 1996-2021, number of documents

Source: SCImago (2007). SJR — SCImago Journal & Country Rank. Retrieved September 16, 2024, from http://www.scimagojr.com

Regarding publication activity (Figure 1.) in the field of agricultural and biological sciences during the period 1996-2021, within the framework of the total of 235 countries included in the SCOPUS database, Bulgaria ranks 58th with a total of 9305 documents and an H-index of 117. **The country is in 10th place (out of a total of 23 countries) in the group of Eastern European countries, and in 21st place (out of a total of 28 countries) within the European Union**.

In the period 2001-2021, PORB has issued a total of 152 patents in the field of the agri-food chain (agri-sector and food industry). Only 7% of them were created by the scientific units working in this field. The predominant part is the result of research and development activities of the business (Figure 2.).

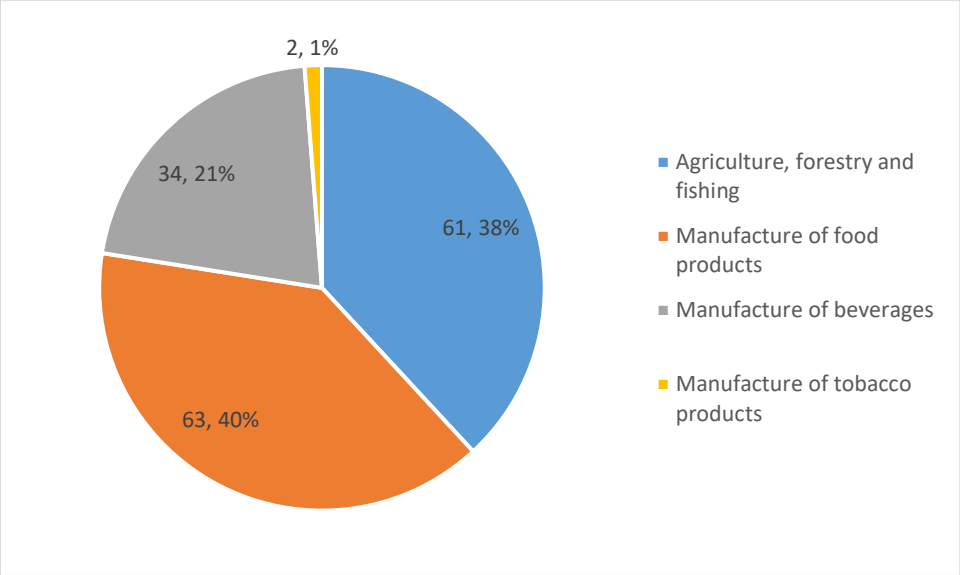

Figure 2. Patent activity in the field of the agricultural sector and the agri-food chain, 2001-2022, %

Source: Own calculations based on data from PORB, 2024. https://bpo.bg

Research organization	Number of patents
Institute of Soil Science "N. Pushkarov", Sofia	3
Agricultural Institute, Shumen	2
Institute of Animal Science, Kostinbrod	3
Wheat and Sunflower Institute "Dobrudja", General Toshevo	1
National Center for Agrarian Sciences, Sofia	1
Institute of Cryobiology and Food Technologies, Sofia	1
Agricultural University Plovdiv	1

Table 1. Patent activity of research organizations in Bulgaria in the field of the agricultural sector and the agri-food chain, 2001-2022, number

Source: Own calculations based on data from PORB, 2024. https://bpo.bg

Scientists at the institutes of the Agricultural Academy are involved in four national scientific programmes: Healthy foods for a strong bioeconomy and quality of life (Foods), Environmental protection and reduction of the risk of adverse events and natural disasters (Environment), Reproductive biotechnologies in animal husbandry (Reprobiotech), and Young scientists and post-doctoral researchers.

	Applications	Titles	Expired titles	Titles in force
2016	35	21	13	391
2017	48	24	n/a	n/a
2018	18	47	52	419
2019	25	30	65	384
2020	26	13	103	294

Table 2. Number of applications for new plant varieties, Bulgaria, 2016-2020

Source: International Union for the Protection of New Varieties of Plants, 2022.

The main direction of research activity of scientific units in agrarian and related sciences is the creation and protection of new varieties of plants (Figure 3.). **In this area, for the period 2016-2020, Bulgaria is in eighth place within the European Union, with 152 applications for new varieties of plants submitted.** The obtained certificates are 135 (nearly 90% success rate), and the total number of valid certificates for the five-year period is 1488. The leader in Europe is the Netherlands, with 3,234 requests for the same period, followed by France (486) and Poland (396).

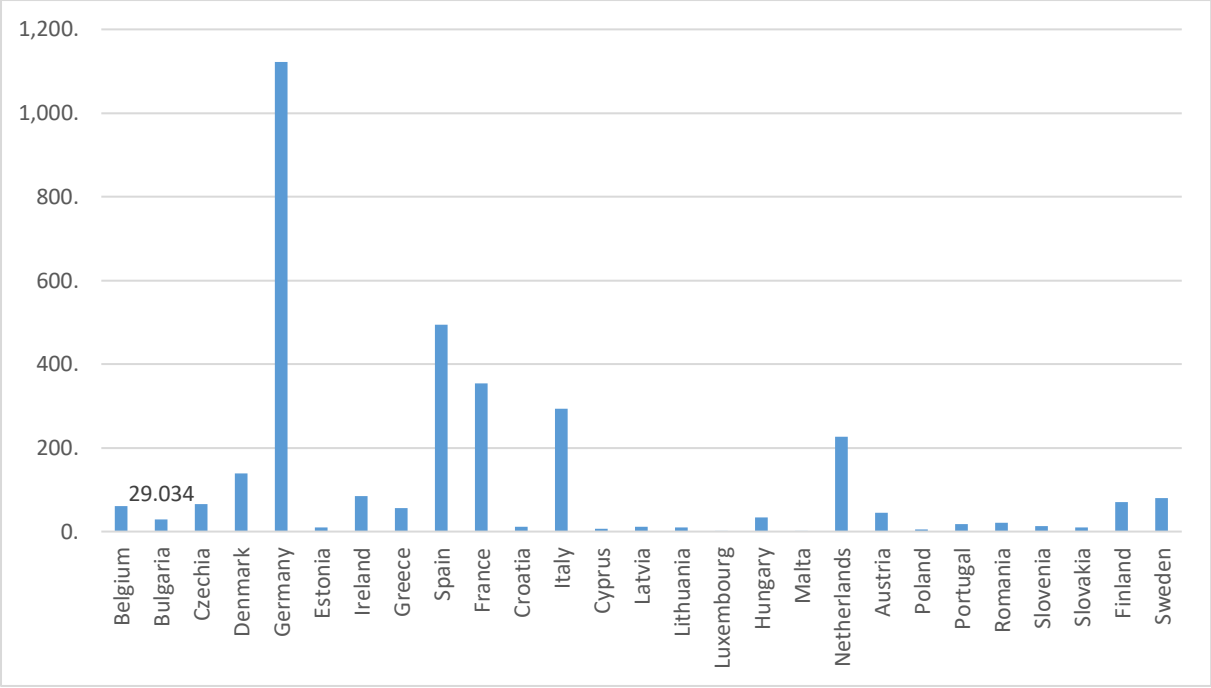

Figure 3. Budgetary expenditures for R&D for socio-economic purposes, agricultural sciences, 2021, million euro

Source: Eurostat, 2024

In the field of the agricultural sector, due to the specificity of the activities carried out and the profile of agricultural producers, the role of consultants and the non-governmental sector in the successful implementation of innovative developments is extremely important. For this reason, the importance of the created intermediary research and innovation infrastructures is even greater.

On November 1, 2022, as part of the implementation of the EU's "Digital Europe" program, four European digital innovation centres (hubs) started operating in Bulgaria:

- **AgroHub.BG**: AgroDigiRise project, number 101083473. The project consortium of 14 partners concluded the Grant Agreement with the European Commission and as of November 1 this year, the implementation of the project began.
- **REGA**, Stara Zagora: Synergy project for regional green digital transformation of South-East region of Bulgaria,: SynGReDiT! It includes 29 partners from the South-East Region: local authorities, business, academia, NGOs.
- **EDIH in the construction sector**, coordinated by the Bulgarian Construction Chamber, partners with the Chamber of Architects in Bulgaria, Higher Construction School "Lyuben Karavelov", Institute of Mechanics - BAS, "Cleantech Bulgaria" Ltd, Bulgarian Association of Construction Project Management, other leading companies in the construction sector and ICT companies - "Planex" Ltd., "Geostroy" AD, "Baumit Bulgaria" Ltd. and "ESRI Bulgaria" Ltd.
- **Digital innovation hub** "Trakia" focuses its expertise on the artificial intelligence field, high-performance computing, cyber security and key base technologies, with leading expertise in the field of cyber security. EDIH "Trakia" will develop activities on the territory of the South-Central Region with a coordination center in the city Plovdiv.

The only center with a direct focus on the agri-sector and agri-food chains is AgroDigiRise. Its activity will be aimed at revealing the innovative potential of the agrarian sector in the South Central region of Bulgaria and supporting business in its digital and green transformation.

The main goal of the hubs is to stimulate the wide application of advanced digital solutions (including high-performance computing, artificial intelligence, cybersecurity and others) in industry, public organizations and academia.

AgroDigiRise services will also be aimed at:

- Development of a dynamic and sustainable innovation ecosystem and acceleration of cross-sectoral cooperation, awareness raising and networking at regional, national and European level.
- Providing access to innovative facilities and services for pre-investment testing – creation and expansion of a network of demo points with a focus on precision farming, access to technical expertise and data.
- Increasing the competencies and capabilities of SMEs and the food sector through training for the acquisition of digital skills – development of the digital skills of farmers, SMEs and public administration through custom-made training programs.
- Support of digital and business transformation with consulting and financial services – development of digital maturity in the agricultural sector through technology audits, assessments, consultancy, digitisation and business plans, market analysis, etc.

Thanks to research organizations and universities, as well as the local government of the area, the hub will analyse, test, adapt and support the implementation of digital solutions according to the specific parameters of individual businesses and territories, and the specific needs of producers at regional and national levels.

By connecting fragmented digital solution providers and end-users with academia and the public sector, the project will support the achievement of the objectives of the competitiveness, digital and green transition of the economy.

Box 2. European Digital Innovation Hub in Agriculture

Source: AgroHub.BG, 2024.

On the eve of the 140th anniversary of the establishment of the first research units of the Agricultural Academy and the start of agricultural science in Bulgaria, the Academy reports a number of achievements: 16 titles for new plant varieties, 22 applications for titles for new plant varieties; one patent and one patent application; 597 publications in journals indexed in Scopus and Web of Science; 1,327 citations in Scopus and Web of Science. The Academy had 482 researchers. Although this is a modest 1% increase annually, it could mark the end of the downward trend in the number of scientists (it is less than half the 2020 number of 1,108).

5. CONCLUSIONS

The agricultural sector is very sensitive in terms of political decision-making and inhomogeneous in terms of activities, applied technologies and final products. The approach to its research from the positions of sectoral innovation systems attempts to examine it in its entirety, subject to the high level of interdependence between the individual stages of the technological chain.

The analysis of the state, the potential for development and the intra-system interaction between the units of the sectoral innovation ecosystem of the agricultural sector contrasts the following potential opportunities and challenges:

1) A high level of interaction, including institutional (AA is a secondary budget authority within the Ministry of Agriculture and Food); functional (AA offers training to doctoral students, training and consulting services in relation to business; universities carry out basic research). However, the interaction achieved on a formal basis does not lead to acceleration and facilitation of the process of implementation of new technological solutions along the chain of production of final products of agribusiness.

2) A high degree of geographical decentralisation of the research and university units located in the areas of application of the relevant knowledge/services The decentralisation of the research activity of the AA in 25 regional units allows scientific coverage of the territory of the entire country. Strongly practically oriented research activity. The applied orientation of the research projects carried out within the SSA and the service activities bring the results of scientific activity as close as possible to the problems of agricultural holdings, which are solved on their basis. However, the business is far from ready in terms of financial capabilities, scale, and competence to implement the results of scientific developments.

3) A clearly expressed imbalance of the qualification structure of the staff at the research institute level at the AA - the extremes are from 10.0 (Institute of Agrarian Economics, Sofia) to 0.1 (Institute of Fisheries Resources, Varna) for the ratio between qualified and non-qualified staff. Over 54% of AA staff are over 50 years old, and 1/3 of them are over 60 years old. Tendencies of decreasing the number of scientists and the unfavourable age structure of scientific personnel and academic staff in this field.

4) Effective mechanisms for rapid application of scientific achievements in practice - highly productive varieties and new breeds of animals, complex technologies for soil treatment and production of agricultural products - have not been created. Medium and small farms are not informed about the possibilities for joint activity with the institutes of the AA. Low levels of engagement/cooperation/interaction between farmers and public intermediary structures, a standard approach to the provision of services, inconsistent with the specific needs of the persons/farms to which they are directed.

5) A large number of industry associations. Absent or weakly developed cluster structure.

6) Limited investment in new technology, innovation and research. Scarcity and low quality of raw materials.

The development of the agricultural sector and the food industry and the creation of their basis of national competitive advantages depends on the innovation activity of the units of the sectoral innovation system. Innovation is the most important factor in increasing productivity and overcoming the sources of social inequality. The development of innovation potential should be based on the implementation of policies/addressing of measures that are relevant to the potential of the units of the innovation ecosystem

and the priorities for their development; the orientation of innovation processes to the needs of the practice and the possibilities of application, at the same time under conditions of high return and conversely positive impact on the innovation ecosystem as a whole; the creation of intermediate units to act as a natural bridge between the participants in the innovation process, to orientate/translate the newly created knowledge into the language of those who will apply it.

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