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SUSTAINABLE DEVELOPMENT OF AGRICULTURE BASED ON THE SMART SPECIALISATION APPROACH: CASES OF THE CENTRAL AND EASTERN EUROPEAN COUNTRIES

Purpose. *The purpose of the study is to analyse and systematise the smart priorities of the territories of Central and Eastern Europe with a focus on the sustainable development of the agricultural sector and to identify current trends in the innovative development of agriculture.*

Methodology / approach. *The main research method is benchmarking which includes identification, comparative analysis, generalisation and application of best practices in various fields of activity. The authors' methodology of regional benchmarking has been tried out in the work. The methodology provides implementation of a set of scientific and analytical measures at the following stages: (1) mapping and identification of smart priorities in focal economic activities; (2) analysis of regional priorities according to the European goals of smart specialisation policy including the structure of their selection; (3) studying the content and goals of the regional priorities establishing cross-sectoral links; (4) examination of the exploit of established and emerging clusters in the regional smart specialisation with identification of their localisation and selected priority areas; (5) analysis of interregional cooperation in smart specialisation domains; (6) processing and formalisation of the obtained research results.*

Results. *We identified and analysed 44 priorities involving the agricultural sector, which belongs to 12 Central and Eastern European countries. The dominant policy objectives of smart specialisation of these territories are Sustainable Innovation, Public Health & Security and Key Enabling Technologies, which are mainly focused on achieving sustainable agriculture, establishing bioeconomy and providing food security & safety. These smart specialisation domains at the national and sub-national levels clearly contribute to the attainment of the Sustainable Development Goals. Priorities were grouped according to their internal goals and content, which allowed identifying key trends of innovative development of the territories with the involvement of the agricultural sector. It is concluded that the regions combine knowledge and assets through the intensification of cross-sectoral, interregional cooperation and the use of clusters. We determined that cross-sectoral links within smart priorities are mostly formed within existing value chains, but recently, new cross-sectoral and interregional partnerships emerge and actively develop. They are mainly focused on the diffusion of innovative bio- and digital technologies in agro-food systems. We highlighted the key issues that need to be addressed by regional working groups while selecting the smart priorities of the Ukraine's regions.*

Originality / scientific novelty. *This paper presents the results of the thematic research in a*

new understudied direction – Smart Specialisation Strategies for Sustainability. Based on the authors' methodology of regional benchmarking, the smart priorities in the agricultural sector of Central and Eastern European countries have been analysed.

Practical value / implications. *The results of the study can be used by regional working groups of the Entrepreneurial discovery process to draw up possible ways of agricultural development. The obtained results may also be of interest to researchers from different countries involved in the implementation of smart specialisation approach and the improvement of its methodology.*

Key words: *smart specialisation, sustainable development, agriculture, Central and Eastern European countries.*

Introduction and review of literature. Agriculture is an important and socially significant sector of the world economy, which ensures public welfare and food security affecting people's well-being and quality of life. Agricultural development has boosted economic growth in many industrialised countries, increased jobs, incomes, and created incentives for national economies (Boettiger et al., 2017).

Recent global challenges put forward new tasks to the agro-food sector. On the one hand, population growth on our planet exacerbates the problem of food shortages and, consequently, requires an increase in agricultural productivity. On the other hand, in the process of intensification of human activity, the need for green production in all value chains has been taken into account.

The Sustainable Development Goal to "End hunger, achieve food security and improved nutrition and promote sustainable agriculture" (SDG 2) is aimed at resolving such a contradiction. The Goal states that "much more effort and innovation will be urgently needed in order to sustainably increase agricultural production, improve the global supply chain, decrease food losses and waste, and ensure that all who are suffering from hunger and malnutrition have access to nutritious food" (SDG 2. Knowledge Platform, 2019).

The emphasis on sustainable development increases with each subsequent period of designing strategy at all levels and in each segment of the economy. SDGs set strategic guidelines for planning economic activities and adapting them to growing external requirements and restrictions in the future. The competitiveness of enterprises, regions and countries will increasingly depend on their success in advancing to sustainability. And this trend is also characteristic of the agricultural sector.

The report of Food and Agriculture Organisation of the United Nations (FAO) "The future of food and agriculture – Alternative pathways to 2050" states that global environmental risks are increasing and, therefore, all countries without exception in the next 30 years have to transform their food and agricultural systems and make them sustainable in the long run. Transformations of such systems can occur in different ways under the influence of a number of factors: population growth, dietary choices, technological progress, income distribution, the state and use of natural resources, climatic changes and efforts to prevent and resolve conflicts. FAO specialists emphasise the importance of bridging the knowledge gap over sustainable

development of food and agricultural systems and combining efforts of different countries, international organisations, civil society and academia (FAO, 2018).

The European Union plays an active role in the implementation of sustainable development ideas. In December 2019, the European Commission adopted a new growth strategy Green Deal that continues the policy of sustainable development of the EU countries. The main goal of the policy initiatives of this strategic plan is to achieve carbon neutrality in Europe by 2050 and to create modern competitive economy. One of the selected driving sectors is agriculture, for which the following goals are set: "to ensure food security in the face of climate change and biodiversity loss; reduce the environmental and climate footprint of the EU food system; strengthen the EU food system's resilience; lead a global transition towards competitive sustainability from farm to fork" (European Commission, 2019). Other European strategy documents, including The Common Agricultural Policy, have been agreed with Green Deal.

In order to achieve the set goals, it is necessary to apply new approaches to strategic management. The key pillar of green transformations can be Smart Specialisation (Meyer, 2020). Smart specialisation (S3), which infers identification and targeted support of the unique internal capabilities of regions/countries to transform economies and their innovative development, was the main concept of Cohesion policy of the European Commission for 2014–2020 and part of the Europe 2020 Strategy.

According to Foray et al. (2012), the smart specialisation approach is "smart" for two main reasons. Firstly, it uses the entrepreneurial discovery process (EDP) as a new way of the setting innovation priorities by policy makers in close cooperation with local actors. Secondly, this process is carried out taking into account the situation in the external environment, forcing regions to be both ambitious and realistic linking local assets and capabilities to external sources of knowledge and value chains. "The EDP is the motor of the S3 methodology" and "distinguishes the S3 from older policy approaches". This process is aimed at combining knowledge and "is scattered across stakeholders" (Gianelle et al., 2016).

With the growing public awareness of the importance of combating climate change and preserving the environment, the attention of the EU institutions to environmental issues increases and the pan-European policy on the implementation of the European Green Deal improves. This also has not bypassed the concept of S3, which got a new trajectory, formulated as Smart Specialisation Strategies for Sustainability (S4). The S4 approach is aimed to systematically mobilise innovation for cross-sectoral solutions and change government policies concerning investment in countries/regions in order to regulate development towards the Sustainable Development Goals (Smart Specialisation Platform, 2022a).

The need to combine the concepts of Sustainability and Smart Specialisation is caused by the search for opportunities to quickly and effectively adapt economy and society to the new environmental and social requirements of today. These two concepts have different purpose and meaning. The conceptual provisions of the

theory of sustainable development define the ideal socio-economic model, but do not reveal the vision of ways and mechanisms to ensure the transition to it (McCann & Soete, 2020; Cecchin et al., 2021). Such a transition involves complex and large-scale changes in technologies, markets, culture, politics, and governing institutions (Coenen et al., 2012).

As for political changes, they should, first of all, take place in the innovative policy of countries and regions. In modern conditions, a new policy of innovation is essential, which directs science, technology and innovation to the needs of society and the achievement of the Sustainable Development Goals (Schot & Steinmueller, 2018). An important aspect of the successful implementation of innovation policy should be the construction of a self-sufficient, effective innovation ecosystem that brings science and business together and is able to overcome global challenges (Kuzior et al., 2022; Shevtsova et al., 2020). In addition, the transition to a sustainable development model must be accompanied by certain institutional transformations. In particular, at the regional level, the transition to sustainable growth is related to the process of decentralisation and requires the coordination of various organisational, administrative, and financial measures on the part of the authorities (Halhash et al., 2020).

Smart Specialisation is considered as a regional research and innovation policy tool that should trigger the transition of economies to sustainable development, but needs some improvement (Polido et al., 2019; McCann & Soete, 2020). To this end, the S3 concept has recently undergone certain changes, which are the result of purposeful work to create evidence-based scientific support for the European policy of smart, sustainable and inclusive growth, reflecting the transition from S3 to S4.

The most powerful works in this direction were prepared within the framework of the projects of Joint Research Center (JRC). The formation of the academic and conceptual base of the S4 concept was initiated by P. McCann and L. Soete, who prepared a report based on the results of the work of the Expert Group "Linking smart specialisation and mission-oriented policy for sustainable development" (McCann & Soete, 2020). The main idea of this work is that within the framework of the Green Deal adopted by the EU "a place-based innovation policy for sustainability will require a solid multi-level governance and a policy flexibility to address possible trade-offs early on. Smart specialisation strategies have built the foundations but would now need to marry bottom-up leadership with the new directionality of sustainability and inclusiveness" (McCann & Soete, 2020).

The following Science for Policy report by the JRC highlights the importance of "...to increase policy coherence to harness synergies..." and the need "...to orient existing smart specialisation approaches towards sustainability challenges and the achievement of the SDGs..." (Nakicenovic et al., 2021). The result of another study by a group of experts involved in the JRC was the expansion of the Smart Specialisation guidelines in the context of Sustainability and embedding the SDGs in the components of S3. The principles indicated in the original Guide on Research and Innovation Strategies for Smart Specialisation (Foray et al., 2012) remain relevant,

but three more are added to them. The new principles orient strategies towards achieving the Sustainable Development Goals, namely:

- shared direction towards the SDGs;
- whole-system transformation towards sustainability;
- responsibility and reflexivity (Miedzinski et al., 2021).

With the accumulation of empirical material, there are surveys dedicated to studying the practice of using Smart Specialisation to achieve Sustainability. In particular, new connections between local assets, potential markets and social problems of regional development are revealed on the basis of S3 (Meyer et al., 2022) and Sustainability in regions is analysed through the implementation of the concept of Smart Specialisation (Šipilova et al., 2017). Special attention in these studies is paid to rural and peripheral regions, which are the most problematic from the point of view of both promoting the ideas of Smart Specialisation and meeting the sustainable development challenges.

Our scientific interest in the agricultural sector in the context of Smart Specialisation Strategies for Sustainability arises from its importance for the national economy of Ukraine and the solution to today's global food problems. Agriculture is one of the leading sectors in Ukraine. According to the State Statistics Service of Ukraine, in 2021, farmers created 12.4 % of value added and provided 35.1 % of export revenues. However, today the agricultural sector of Ukraine does not meet current priorities of sustainable development in terms of structure and trends of its changes (Stadnyk et al., 2021).

Having significant agricultural potential, the country can considerably strengthen its position in the world market due to intensive factors. Ukraine owns 28 % of the world's chernozem, which is 40 % of the country's territory. Ukraine is the largest in Europe in terms of arable land. The National Strategy for Economic Development until 2030 states that the Ukrainian agricultural sector should become one of the global centres of food security, a world leader in the supply of high value-added food and technology-intensive services for agribusiness (Platform of the Centre of Economic Recovery, 2021). Structural technological modernisation of the Ukrainian agricultural sector and its development on an innovative basis is required to achieve this goal.

Having signed the Association Agreement with the European Union, Ukraine continues to move towards the European integration course and has joined the collective global processes of sustainable development. The Sustainable Development Goals by 2030, proclaimed in 2015 by the United Nations General Assembly, have been adapted to take into account the specifics of Ukraine's development and adopted as strategic guidelines for the transformation of the national economy (Verkhovna Rada of Ukraine, 2019). Also in March 2021, Ukraine joined the UN pilot programme on SDG to support countries and develop an integral national policy to achieve the Sustainable Development Goals through science, technology and innovation (Government portal, 2021). Solving challenges faced by the country requires working out new models of local democratic governance for

Ukraine (Halhash et al., 2020), introduction of effective administrative methods of state regulation of investment activities (Morhachov et al., 2019) and the formation of regional innovation ecosystems involving key groups (sectors) of actors (business, government, research, finance, infrastructure and society) (Pidorycheva et al., 2020).

As part of improvement of state and regional management of socio-economic development, in 2018 Ukraine began implementing the European methodology for smart specialisation strategy. In all regions, strategies until 2027 have been approved, and certain strategic goals have been defined on the basis of S3 with varying degrees of elaboration. The analysis of smart goals showed that in most regional strategies competitive and innovative development is associated with unlocking the potential of the agricultural sector.

The Russian invasion of Ukraine is causing substantial economic losses, including in agriculture, as well as causing significant environmental damage. It is clear that from the current position, previously developed national and regional strategies will require a significant revision and adaption. However, in terms of ensuring the sustainable and innovative development of the country's economy, the relevance of the strategic vision has not been lost, but on the contrary, it is becoming even more in demand. It is the further implementation of the concept of smart specialisation with the combination of economic growth based on knowledge and innovation with the goals of social and environmental sustainability that can ensure a reasonable, sustainable recovery and development of the agricultural sector and the entire economy of Ukraine. Therefore, the experience of promoting the ideas of sustainable development through the application of the S3 approach, which is already available in European regions, is of scientific and practical interest.

So, we have set the following research questions: (1) what are the priorities of the regions that rely on the agricultural sector; (2) how do the selected priorities align with the objectives of agricultural transformation in the context of sustainable development; (3) what current trends of innovative sustainable development of the agricultural sector are relevant for Ukraine?

The purpose of the article. The purpose of the study is to analyse and systematise the smart priorities of the territories of Central and Eastern Europe with a focus on the sustainable development of the agricultural sector and to identify current trends in the innovative development of agriculture.

Materials and methods. The choice of strategic focus of innovation and competitive development according to smart specialisation methodology requires mandatory consideration of the regional context (Foray et al., 2012). Each region is unique for the emergence of innovation due to the level of its socio-economic development, structure of the regional economy, efficiency of the institutions, accumulated knowledge and competencies, cultural attitudes of the population (Pidorycheva et al., 2020). The study by German scientists shows that there is a relationship between the quality of the regional innovation environment and its productivity (Ruhrmann et al., 2020). Regions/countries differ in the level of development of innovation systems and, accordingly, the ability to create innovation.

Regional conditions also determine the development of the institutional environment and the effectiveness of local government, which also significantly affects the development and implementation of smart specialisation strategies (Rodríguez-Pose et al., 2014; McCann & Ortega-Argilés, 2015; Capello & Kroll, 2016; Palinchak et al., 2021; Rodríguez-Pose, 2020).

Taking into account the importance of contextual factors, to achieve the goal of the study it is necessary to determine the reference regions for Ukraine. Neighbouring regions are chosen as such regions, namely Central and Eastern European countries (CEECs). According to the Organisation for Economic Co-operation and Development (OECD) definition, this is the group of countries comprising Albania, Bulgaria, Croatia, the Czech Republic, Hungary, Poland, Romania, the Slovak Republic, Slovenia, and the three Baltic States: Estonia, Latvia and Lithuania.

The main information base of the study was Smart Specialisation Platform that is a digital product of the European Commission, designed to support countries/regions in the development and implementation of smart specialisation strategies. The study was conducted with a focus on sector A01 – Crop and animal production, hunting and related service activities according to the Statistical classification of economic activities in the European Community (NACE Rev. 2). The main research method is regional benchmarking.

The European Smart Specialisation S3 Platform contains an interactive tool Regional Benchmarking, which allows quickly identifying structurally similar European regions with analogous conditions and characteristics (social, economic, technological, institutional and geographical) that affect innovative development of the regions (Smart Specialisation Platform, 2022b). This tool was developed in collaboration with the Orkestra – Basque Institute of Competitiveness based on the relevant methodology (Navarro et al., 2014). The latter makes it possible to position each region relative to others according to endogenous structural characteristics. The results of such an analysis can be used at any step in the development of the Strategy for Smart Specialisation (Foray et al., 2012): (1) "Analysis of the regional context and potential for innovation"; (2) "Governance: Ensuring participation and ownership"; (3) "Elaboration of an overall vision for the future of the region"; (4) "Identification of priorities"; (5) "Definition of coherent policy mix, roadmaps and action plan"; (6) "Integration of monitoring and evaluation mechanisms". However, the authors of the mentioned methodology themselves believe that a comparative analysis of the characteristics of regions is necessary to build sound innovation strategies for smart specialisation, but not sufficient. In particular, at the fourth step, the analysis of endogenous structural conditions for innovative development "...should be accompanied by an analysis of the priorities established by other regions, making the most of the Eye@RIS3 online database..." (Navarro et al., 2014). There are no methodological recommendations for conducting such an analysis.

The identification of a limited number of priorities for investment in areas of activity with growth potential based on knowledge and innovation occurs during the

Entrepreneurial Discovery Process, which covers the fourth step mentioned above. It is advisable to study, involve and adapt the best regional practices of smart prioritisation at this key stage of strategising. For this, a different type of regional benchmarking is needed, aimed at determining promising intra-sectoral, cross-sectoral and interregional priorities by regions, taking into account current trends, goals and initiatives of the European Union, as well as the accumulated experience of smart prioritisation of European regions.

In this study, we used our methodology of regional benchmarking, which complements the methodology discussed above and involves the study and generalisation of regional smart prioritisation practices with similar industry focuses using available digital tools. This technique includes a complex of scientific and analytical measures (Shevtsova & Shvets, 2021):

- mapping and identification of smart priorities by focal types of economic activity using the interactive tool and Eye@RIS3 databases;
- analysis of regional priorities according to the European goals of the smart specialisation policy with determination of the structure of their selection, including by groups of innovators according to the Regional Innovation Scoreboard (RIS);
- study the content and goals of regional priorities, which involves the selection of priorities with cross-sectoral interaction and the identification of partner industries and the nature of the existing connections between them;
- examination of involvement in regional smart specialisation of cluster formations with determination of their localisation and selected priority areas of S3 based on European Cluster Collaboration Platform data;
- analysis of interregional cooperation according to a selected thematic area of S3 Platform to obtain a case study of relevant sectoral innovative solutions;
- processing and formalisation of the obtained results for presentation to members of the EDP regional working group.

The proposed methodology for benchmarking smart priorities is universal and can be used by EDP regional working groups to set specific sectoral priorities defined by NACE Rev. 2.

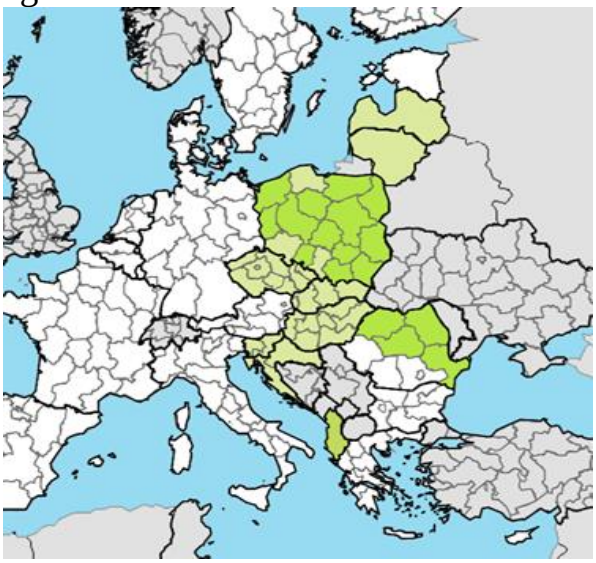
In the benchmarking study of the regions and countries of Central and Eastern Europe, the methods of structural and logical, correlational, contextual and content analysis, and groupings were used.

Results and discussions. The results of the study are presented in the sequence of the stages of the benchmarking study according to the author's methodology.

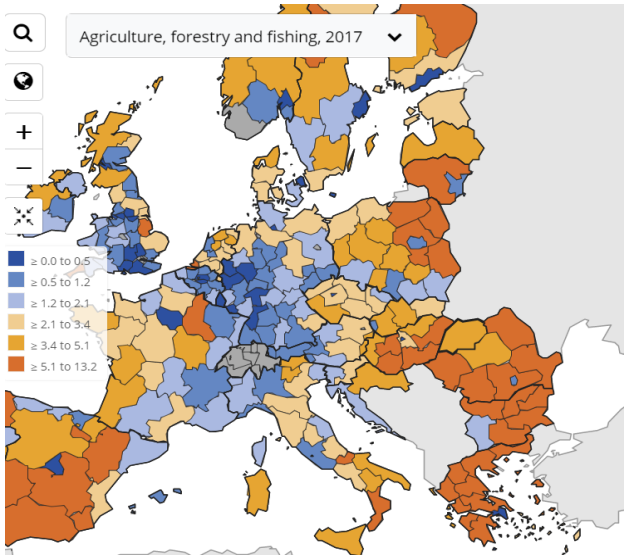
1. Mapping and identification of smart priorities involving the agricultural sector. At the first stage of benchmarking of CEECs regions, the mapping of sector "Crop and animal production, hunting and related service activities" was carried out using the built-in tool Eye@RIS3 Smart Specialisation Platform (Smart Specialisation Platform, 2022c). The platform database issued 34 priorities for the installed filters "Territorial Level" and "Economics domains". The mapping results showed that 10 out of 12 Central and Eastern European countries (except Bulgaria and Estonia) associate smart specialisation prospects with this sector. Using

hierarchical levels of the Nomenclature of Territorial Units for Statistics (NUTS), we identified 9 smart priorities in NUTS-1 regions, 24 smart priorities in NUTS-2 regions and 1 smart priority in NUTS-3 region (Figure 1a). The regions of Poland (20 areas) and Romania (5 areas) have the highest number of priorities.

The second external component that characterises the selected regional strategic areas on the Smart Specialisation Platform is Scientific domains, which are defined according to the Nomenclature for the Analysis and Comparison of Scientific Programs and Budgets – NABS 2007. As a result of adding this filter indicating Agriculture, the total number of priorities was 45. According to this result, the involvement of the agricultural sector was demonstrated by all CEECs. The increase in the number of priorities can be explained by the individuality of the regional context and the subjectivity of the characteristics of the priorities chosen by countries/regions. Thus, in Estonia, in the description of the strategic field "Biotechnology", only one field of activity is specified in the Economics domains – Professional, scientific and technical activity, while the Scientific domains component shows the concentration of scientific programs also in the field of Agriculture.



a) CEECs regions (green colour) that form smart priorities based on the involvement and development of the Crop and animal production, hunting and related service activities sector



b) Distribution of the regions by the share of agriculture in Gross value added at basic prices (the largest share is marked brown)

Figure 1. Mapping results of the EU regions

Source: interactive maps of the S3 Platform (Smart Specialisation Platform, 2022c) and Regions in Europe – statistics visualised, Eurostat.

Such a wide involvement of the agricultural sector in the priorities of smart growth is primarily due to the traditional specialisation of these regional economies. Most of the regions of CEECs according to the Eurostat typology are rural regions (Figure 1b). They are characterised by a high percentage of the agricultural sector's contribution to Gross value added. This indicator mostly exceeds the EU average level (Table 1). Even more revealing is the share of people employed in agriculture,

which in certain regions is many times higher than in the EU27. The given indicators prove the high concentration of CEECs in agriculture. The question of scientific interest is how much the existing specialisation of territories influenced the choice of development priorities specified in Smart Specialisation Strategies.

Table 1

Indicators of selection and structure of CEECs and regions

Territo-ries, code NUTS	Share of priorities based on agriculture, %	Share of agriculture in Gross value added at basic prices, %	Share of people employed in agriculture, %	Territories, code NUTS	Share of priorities based on agriculture, %	Share of agriculture in Gross value added at basic prices, %	Share of people employed in agriculture, %
EU27	-	1.80	1.24	PL43	0.333	2.90	6.70
Bulgaria	0.250	5.83	15.90	PL51	0.143	1.40	4.90
Croatia	0.200	3.25	6.50	PL52	0.167	2.80	0.01
Czech Republic	0.167	2.44	3.40	PL61	0.111	3.80	12.80
CZ01	0	0.30	0.50	PL62	0	5.70	1.20
CZ051	0	2.80	4.50	PL63	0.250	2.10	7.50
CZ071	0.125	2.90	3.80	Romania	0	6.44	19.00
Hungary	0.125	5.70	0.60	RO12	0.111	4.40	9.20
Poland	0.400	3.51	9.60	RO21	0.143	7.40	39.50
PL11	0.167	3.10	11.50	RO11	0.167	4.50	16.50
PL12	0.250	9.50	19.60	RO22	0.286	8.40	19.80
PL21	0.286	1.30	8.10	RO31	0.500	7.40	20.20
PL22	0	0.70	2.50	RO41	0.143	7.40	33.90
PL31	0.500	5.60	20.30	RO42	0.250	5.60	6.10
PL32	0.250	1.70	9.70	Slovak Republic	0.200	2.73	3.20
PL33	0.143	4.30	15.40	Slovenia	0.333	2.75	9.00
PL34	0.500	6.80	22.50	Estonia	0.286	2.20	3.80
PL41	0.143	3.60	10.70	Latvia	0.200	4.10	7.90
PL42	0.375	2.70	6.50	Lithuania	0.167	5.00	7.50

Source: developed by the authors according to the data of Eurostat.

The hypothesis of the study was the assumption that the structural indicators of countries/regions have a direct influence on the share of priorities with the agricultural sector, that is, the specialisation of the territory determines the choice of the direction of its development.

The verification of this hypothesis was carried out using correlation analysis according to the data of Table 1. Quantitative assessment of the selection of smart priorities was obtained by calculating the specific weight of priorities based on agriculture in their total number in national and regional Smart Specialisation Strategies. Structural features are determined by the most significant indicators for such an analysis, namely share of agriculture in Gross value added and share of the economically active population employed in agriculture. Albania's indicators were

not included in the set of initial data due to their absence in Eurostat.

We calculated pairwise correlation coefficients:

- between share of priorities based on agriculture and share of agriculture in Gross value added equals 0.23;
- between share of priorities based on agriculture and share of employed in agriculture equals 0.27.

The results of the correlation analysis confirmed the presence of a direct, but weak connection between the structural characteristics of the CEECs economies and their choice of S3 domains involving the agricultural sector. That is, it can be concluded that the indicators of the agricultural sector did not significantly affect the determination of national and regional priorities for the innovative development of the considered territories.

The issue of choosing the trajectories of economic changes by regions and the expediency of preserving traditional regional specialisation in scientific circles remain debatable. In particular, there are different opinions on this issue within the framework of the implementation of the S3 concept. One position is that development efforts should be directed at radical changes in the regions (Grillitsch et al., 2018). Another is that related diversification can improve the efficiency of the regional economy (Balland et al., 2018; Rigby et al., 2022). The latter implies that new industries will emerge from existing ones as a result of endogenous local processes. In this aspect, in our opinion, the agricultural sector plays an important and significant role in ensuring the future growth of local economies.

The agricultural sector is at the beginning of the added value chain, producing primary raw materials for further processing. The raw material importance of this sector for public well-being is not lost, but on the contrary increases in the conditions of growing risk of hunger in the world. And this is the main feature of the agricultural sector, which will remain unchanged. Based on this, the socio-economic growth of the rural area can be ensured by the improvement of agricultural production and the development of related industries, including through related diversification.

2. Analysis of regional priorities according to the European goals of smart specialisation policy. At the next stage of the benchmarking study, we analysed the policy objectives that correspond to selected smart priorities. In accordance with European practice, these objectives determine the external component of the targets for the selection of priority innovation areas. This is a list of current innovation trends identified in the Horizon 2020 Programme and the "Innovation Union Flagship Initiative" Programme: A – Aeronautics & space; B – Blue growth; C – Cultural & creative industries; D – Digital transformation; E – KETs; F – Nature & biodiversity; G – Public health & security; H – Service innovation; I – Social innovation; J – Sustainable innovation; K – Other.

The results of the analysis revealed that the regions that have chosen smart priorities with the involvement of the agricultural sector are mainly focused on three goals: Sustainable innovation, Public health & security and KETs (Figure 2). In most cases, these goals are present in regional strategies simultaneously, complementing

each other.

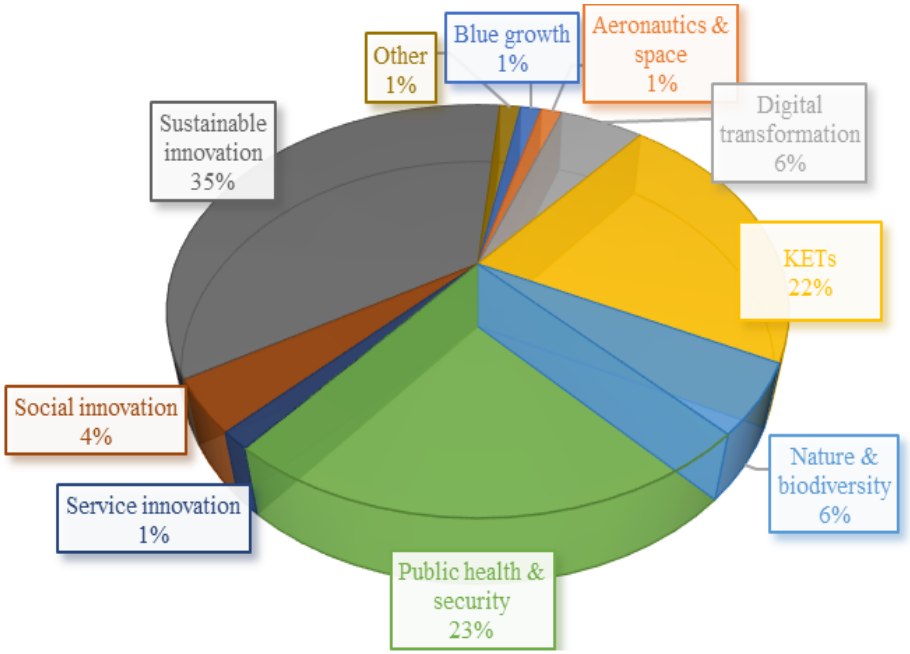


Figure 2. Policy objectives chosen by CEECs regions

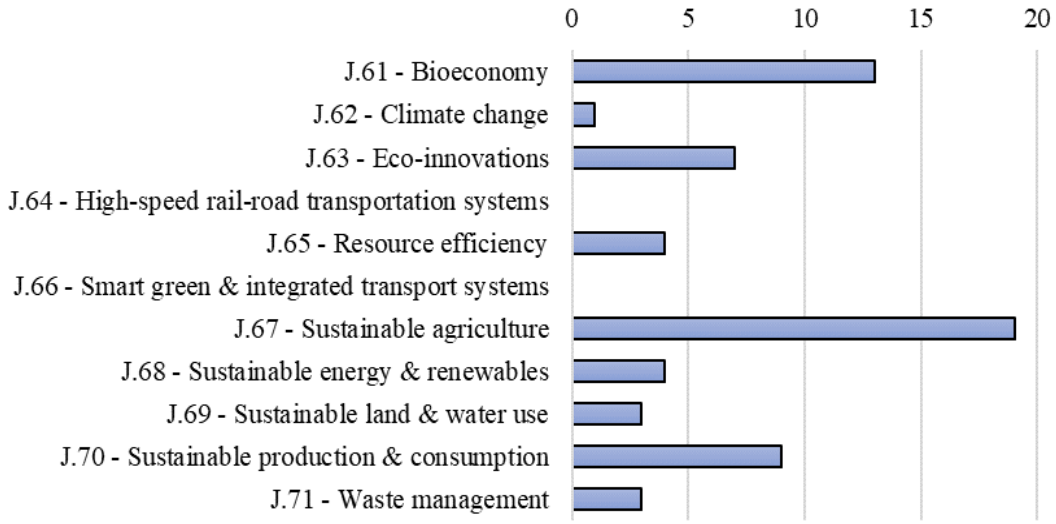
Source: formed by the authors based on the information of S3 Platform (Smart Specialisation Platform, 2022c).

Each of these goals includes several components that reveal the subject area of innovation. Policy objective J – Sustainable innovation is clearly aimed at achieving the Sustainable Development Goals and covers various current R&D areas, including sustainable agriculture. At the same time, the other two goals also contribute to the SDGs, addressing the challenges of resource management, environmental care, quality improvement and sustaining life. The results of the in-depth study of subject areas of R&D as part of the selected three policy objectives are presented in Figure 3.

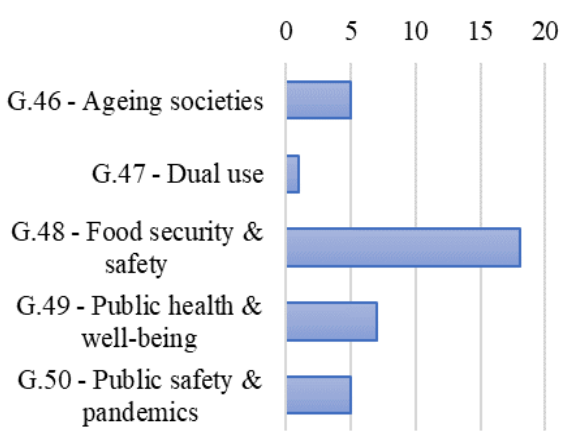
Having chosen the external component of the Sustainable innovation targets with the involvement of the agricultural sector, the regions mainly focused on its transformation to achieve sustainability. Also, the trend in the formation of bio-economy, in which agriculture plays a significant role as a supplier of renewable resources for the use of biotechnology has become common. One of the mainstream research and innovation in this area is the development of bio-energy based on the use of biomass. Experts claim that this innovative direction has a high potential in the context of sustainable development, particularly, "… biomass energy offers a triple opportunity at advancing (i) rural access to energy, (ii) environmental protection, and (iii) rural development" (Zhang et al., 2020). However, the creation of such innovations must comply with the principle of balance while meeting the need for food, materials, biochemicals, and natural forests (Miceikienė & Bužinskienė, 2020).

Regions also gear up towards bioeconomy through policy objective E – KETs, focusing on industrial biotechnology developed and implemented in various production segments. EU institutions back in 2012 highlighted the importance of Key Enabling Technologies for the innovation of the European economy (European Council, 2012; European Commission, 2012; European Economic and Social

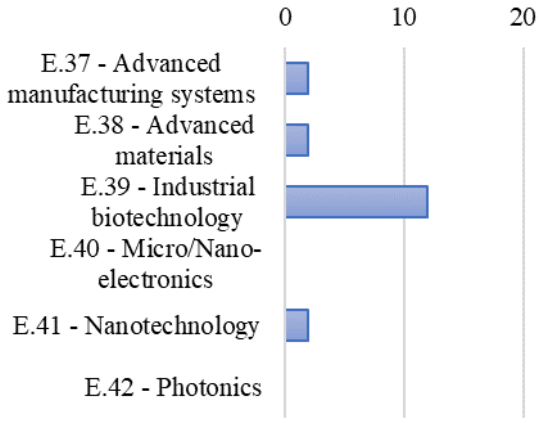
Committee, 2012).



J – Sustainable innovation



G – Public health & security



E – KETs

Figure 3. Choice by CEECs regions of the main subject innovative areas

Source: formed by the authors based on the information of S3 Platform (Smart Specialisation Platform, 2022c).

The dominant subject area within the objective G – Public health & security is G.48 – Food security & safety, which implements the idea of creating sustainable food and agricultural systems and achieving SDG2 "End hunger". Involvement of the agricultural sector is unconditional here. Nevertheless, it has to solve sometimes contradictory tasks: to promote production of safe food, on the one hand, and to ensure food security, on the other hand.

3. Analysis of the content and goals of regional priorities. The goals of the smart specialisation policy considered above lay down general external vectors of innovative development of the regions, which correspond to the current overall trends of research and innovation, and strategically important determinants of growth. Within the set external benchmarks and taking into account the existing in the region's competence and resource possibilities for the creation and implementation of

innovation, internal goals are identified on site, which are disclosed in the regional smart specialisation strategies. Therefore, at the third stage of benchmarking, a comparative and substantial analysis of selected smart priorities was performed. Baseline information for analysis is presented in the online database Eye@RIS3 on S3 Platform (Smart Specialisation Platform, 2022c). Based on the results of the contextual analysis, the grouping of priorities by content was carried out in order to determine key trends of regional innovation development with the involvement of the agricultural sector. Table 2 presents four selected groups and examples of smart priorities.

Table 2

Grouping and examples of smart priorities by content similarity of CEECs regions

Territories, code NUTS	Smart priority	Brief description of smart priority
Group "Agro-food systems development"		
Examples		
Hungary (HU)	Agricultural innovation	The aim of the priority is to advance and establish the innovations facilitating sectoral renewal from the agricultural knowledge centres through producer undertakings to individuals, with the aim of enhancing the innovation potential of the sector. Such complex agribusiness developments should be implemented that represent an opportunity to use innovative R&D solutions in crop production and protection technologies, in addition to animal production and veterinary medicine
Lódzkie (PL11)	Innovative agriculture and agri-food industry	Various aspects of agri-food value chain ensuring sustainability which include precision breeding of plants and fungi with fertilizers or biologically active substances for plants respecting soil protection, water or energy consumption rationalisation, functional food and low-naturally processed food, food supplements, medicines and cosmetics production, biofuels and other energy products, food quality assessment systems during food storage and processing, innovative systems to ensure the achievement of hygiene standards and to secure equipment in agriculture
Group "Formation of bioeconomy"		
Examples		
Latvia (LV)	Knowledge intensive bio-economy	Innovative, risk-reducing plant and animal breeding technologies; Development of innovative high value-added niche products from traditional and unconventional agricultural plant and animal raw materials; Technological solutions for the use of plant and animal breeding and processing by-products; Food safety

Continuation of Table 2

Lubelskie (PL31)	Bioeconomy	The use of agricultural and industrial biotechnology, nanotechnology, biophysics in the value chains of sustainable primary production, bio-resources and food production in the sectors of pharmaceutical, energy, eco-business, agro-food, chemical, paper, wood and furniture, information services
Group "Industrial development"		
Examples		
Malopolskie (PL21)	Chemical industry	Programmes to implement new compounds, materials and chemical technologies, including chemical engineering solutions, in areas (9 domains) related to health care, agriculture, food, wood, pulp and paper industries, biological and environmental chemistry, energy, raw materials, waste management, materials for construction and transport, advanced materials and nanotechnologies, sensors
Zachodniopomorskie (PL42)	Chemical and materials engineering products	Production of standardised materials, products and semi-finished chemical products (including organic and mineral fertilisers) and chemical processing and specialty chemicals, waste management and biomass production, in particular in the context of the use of renewable energy sources
Group "Health and quality of life"		
Examples		
Mazowieckie (PL12)	Safe food	Measures to increase the availability and to enable the development of high quality, sustainable food products that are safe for both the final consumer and the environment throughout the production and distribution chain.
Podkarpackie (PL32)	Quality of life	Mobility (sustainable transport); climate and energy (renewable energy sources and related technologies); sustainable tourism (excluding mass tourism); Health, food, nutrition, innovative technologies, processes and products of the agri-food sector, highest biological and health quality

Source: formed by the authors based on the information of S3 Platform (Smart Specialisation Platform, 2022c).

The "Formation of bioeconomy" group has nine priorities, mostly of the technological type, based on the development of biotechnologies in different types of economic activities. In such priorities, agriculture mainly plays the role of a supplier of bioresources for the production of environmentally friendly products.

The three priorities form the "Industrial Development" group and belong to the Polish regions. They include development of new materials from alternative raw materials, development of renewable energy sources, as well as the provision of agriculture with next-generation agrochemicals. In such priorities, the agricultural sector acts not only as a supplier of raw materials, but also as a consumer of industrial products.

The rest of smart priorities have a common goal to create a healthy society and improve the quality of life. They are characterised by the involvement of a wide range of sectors and a combination of very different strategic objectives. A distinctive feature of such priorities is also mixing of different value chains, which include development of new products and technologies.

The analysis of cross-sectoral interaction at the next stage of the study revealed a certain pattern in the identified groups of priorities. The priorities of the group "Agro-food systems development" mostly encompass traditional links between agriculture and food industry, which according to NACE Rev. 2, include divisions C10 – Manufacture of food products and C11 – Manufacture of beverages. At the same time, there are isolated cases of the emergence of new cross-sectoral cooperation between the agriculture and the IT sector, particularly represented by such divisions as J62 – Computer programming, consultancy and related activities and J63 – Information service activities. The most diverse interactions between sectors with a large number of new connections are observed in the groups "Formation of bioeconomy" and "Health and quality of life". For example, the priority of the Polish region Mazowieckie "Safe food" is based on interaction with the IT sector, as well as the development of cross-sectoral trends in divisions E38 – Waste collection, treatment and disposal activities; materials recovery, Q86 – Human health activities (with the involvement of actors from the division M72 – Scientific research and development). Also, dissemenation of the bioeconomy concept, development of biotechnologies and their application in various sectors of the economy have determined the circular interaction between chemical manufacturing and agriculture. In other words, the chemical industry still supplies fertilisers and agrochemicals to the agricultural sector and receives biomass from it for processing.

It should be highlighted that the identified set of cross-sectoral links of the agricultural sector does not reflect its relationship with the education sector. This, on the one hand, may indicate a sufficient supply of regions with the necessary specialists and compliance of educational programmes with modern requirements, and on the other hand, it omits the importance to modernise education to develop new knowledge and meet future labour market needs for professionals with new competencies.

4. Analysis of involvement of cluster formations in regional smart specialisation. In the methodology of smart specialisation, clusters are considered as a source of existing production advantages, assets in the region and the basis for setting strategic priorities and making sound political decisions (Foray et al., 2012). Their involvement in regional smart specialisation is a powerful factor in the boosting of innovation and investment processes and socio-economic development of the territory.

As part of the objectives of this study, we examined data from the European Cluster Collaboration Platform. Only one regional cluster specialising in sector A01 – Crop and animal production, hunting and related service activities is located in CEECs. This is ITC – Innovation Technology Cluster Murska Sobota in East

Slovenia. The scope of its activity covers bioeconomy, smart agriculture, innovative food production and food distribution systems and similar smart specialisation areas. The cluster consists of 65 members, including mainly SMEs, such as farmers, food processors, farmers' associations, digital transformation solution providers, as well as research organisations, regional authorities, sectoral agencies, interest groups and non-governmental organisations. The activity of the ITC cluster is aimed at internationalisation. For this purpose, it became the main administration office of the European Digital Innovation Hub – DIH AGRIFOOD, bringing together Slovenian and European research and development expertise in the field of Agriculture Food production & processing and food supply. The focus of this cluster complemented Slovenia's national smart specialisation strategy, and the initially selected policy objective J – Sustainable innovation was supplemented by goals D – Digital transformation and G – Public health & security.

5. *Analysis of interregional cooperation.* The final stage of benchmarking is oriented to identifying interregional partnerships linked to agriculture. The interaction of regions within the framework of smart specialisation strategies gives them access, among other things, to wide business and knowledge networks, opens new markets, strengthens regional research potential, expands entrepreneurial opportunities, improves own strengths and contributes to the increase of investments in regional economies.

S3 Platform provides an opportunity to find out the cooperation of regions in thematic areas. The main goal of Agri-food is to increase competitiveness and establish a sustainable food system in the EU. Within the framework of the regional partnership the following innovative areas are developed: Consumer Involvement in Agri-Food, High-tech Farming, Nutritional Ingredients, Smart Sensors for Agri-Food Traceability and Big Data. Each of the established S3 Agri-food partnerships makes a definite contribution to SDGs and, above all, to SDG2 "Zero hunger". Three of them are aimed at digital transformations in the agricultural sector and envisage the creation of local innovation ecosystems for the development of these areas. Among the CEECs regions identified in the first phase of our study, participants in S3 Agri-food partnerships are national and subnational entities from Hungary, Romania and Slovenia. They are mostly focused on the development of digital technologies for the agricultural sector, in which the latter acts as their consumer.

Conclusions. Identifying high-potential vectors for agricultural development, we focused on the current challenges and necessary transformations of this sector in the context of sustainable development. These transformations are carried out, among others, using the smart specialisation approach. The chosen field of the research is new and understudied. At the beginning of the research, several questions were asked, which were answered based on the results.

(1) What are the priorities selected by regions focusing on the agricultural sector?

Using the authors' methodology of regional benchmarking, the smart specialisation strategies of Central and Eastern European countries, which are

reference regions for Ukraine, are analysed. Mapping has shown that 12 countries in this geographical segment have priorities related to agricultural development, which corresponds to their type of area according to the Eurostat typology and is a reflection of the traditional agri-food specialisation of these regions. Poland has the highest number of such priorities – 2 at NUTS-1 level and 18 at NUTS-2 level.

The results of the correlation analysis showed that the agriculture based specialisation of territories under review did not significantly affect their identification of national and regional priorities for innovative development. Having chosen the objectives of smart specialisation policy, which formed the external component of the targets for prioritising regional development, the CEECs regions mostly focused on the three areas: Sustainable innovation, Public health & security and KETs.

(2) How are the selected priorities consistent with the tasks of transformation of agriculture in the context of sustainable development?

Further research of subject innovation areas within each dominant goal revealed the concentration of regional smart specialisation strategies mainly on achieving sustainable agriculture, establishing bioeconomy and providing food security & safety. All these goals include solving various problems of sustainable development. Thus, it can be argued that national and subnational S3 priority areas related to agriculture provide for the active implementation of the EU's aspirations for sustainability, which only intensify over time.

As a result of comparative analysis of the regional smart specialisation strategies, the priorities were collected into four groups: "Agro-food systems development", "Formation of bioeconomy", "Industrial development", "Health and quality of life", which reflected the main trends of regional innovation development involving agriculture and various roles of the agricultural sector as an economic agent. The analysis of cross-sectoral interactions within the priority areas revealed that the group "Agro-food systems development" is dominated by traditional links between the agricultural sector and the food industry. At the same time, the priorities of the groups "Formation of bioeconomy" and "Health and quality of life" envisage the greatest diversity of cross-sectoral relations and the development of their new types.

We have established that through clustering and interregional cooperation the regions create new and strengthen existing local innovation ecosystems for the development, transfer and application of digital technologies in the agricultural sector and the formation of bioeconomy. The use of clusters and interregional partnerships in Central and Eastern European countries has not yet become widespread. However, in recent years there has been a tendency for CEECs regions to use the potential of interregional cooperation in the field of digital transformations of Agri-food systems in order to increase their efficiency and green activities in all value chains.

(3) What modern trends of innovative sustainable development of the agricultural sector are relevant for Ukraine?

Even in the war conditions and the resulting economic crisis, the Ukrainian

agricultural sector proves its importance for the national and world economy. Its post-war recovery should take place on an innovative basis and include a transition to a high-tech model built on the principles of sustainable development.

Based on the experience of Central and Eastern European countries, the Ukrainian regions need to take into account, first, the growing global demands to accelerate the transition to a green and climate-neutral economy, which requires major transformations, especially in agriculture using the latest technologies. Second, regions can accumulate the research and entrepreneurial potential needed for smart specialisation through clusters and participation in S3 interregional thematic partnerships.

The Ukrainian agrarian sector has great potential for the rise of the national economy and its effective integration into the global economic space through the development of cross-sectoral links, which will provide a powerful multiplier effect and endogenous growth of the country's population income. In this context, we consider the following modern trends to be relevant for the agricultural sector of Ukraine: (1) deepening the processing of raw materials of the agricultural sector and the creation of complex innovative production with high added value; (2) the transfer of biotechnology with the involvement of agribusiness and the expansion of related industries; (3) development of traditional and new cross-sectoral cooperation based on digitalisation of agricultural production.

The results of the study are particularly relevant against the background of Ukraine's socio-economic losses as a result of Russian armed aggression. The obtained conclusions make it possible to clarify the current trends of innovative sustainable development of the agricultural sector, to improve approaches to the development of smart specialisation strategies for the recovery and sustainable development of Ukrainian territories in the post-war period, and to identify potential areas of partnership with European regions/countries in the identified smart priorities.

Further research by the authors will be devoted to the development of practical recommendations for ensuring a favorable institutional environment in Ukraine for the development of cross-sectoral, interregional partnerships within the framework of smart strategising.

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