

1. **Name of the priority area – Agriculture and environment, including modern environment-friendly chemical technologies**

2. **Specific subtopics of the areas of research specialisation:**

**Topic 1 – Sustainable and ecological system for the use, protection and restoration of rural landscapes, effective plant and animal production, production of quality food and non-food raw materials from soil**

**Short description**

Research and innovation to ensure a sustainable use, protection and restoration of the rural landscape in biomass creation and production (plants and animals) and to enhance economically efficient and environment-friendly agricultural productivity. Environmental technologies and processes to avoid the degradation of ecosystems (including agro-ecosystems) and prevent biodiversity loss. Innovative cultivation, breeding and processing practices, technologies and solutions with improved utilisation of the production potential of soil, plants and animals. Genetic improvement of plants and livestock and the creation of new genotypes. Comprehensive ecosystem services as a tool for modelling and optimal management of interactions between the environment, the use of natural resources (especially land and water) and agricultural production. Research to mitigate and adapt the impacts of global changes on agriculture (climate change, biodiversity reduction, hydroclimate extremes). Targeted research of increasing the safety, availability and quality of primary agricultural products and biomass. New processes and technologies to ensure quality agricultural production, food production and processing of biomass, reducing energy demands further to the reduction of unwanted waste and emissions. Comprehensive information systems about the landscape and the agricultural sector, focusing on the use of data about the agricultural landscape, natural resources, plants and animals, biophysical economic and socio-economic modelling of the interactions of landscape protection, production systems and agro-ecosystems.

**Key words:** agricultural research, soil, water, plants, animals, food, protection and management of agro-ecosystems, bioeconomy, biomass production, biodiversity, quality and safety of agricultural production, agro-ecosystem services, climate change, biophysical, economic and socio-economic modelling

**Detailed description of the areas of research and development under RIS3 SK specialisation with regard to the RIS3 areas of economic and/or prospective specialisation**

**Subtitle 1: Research aimed at increasing the added value and quality of agricultural production, increasing the value of the domestic raw materials base in the context of global changes, and implementation of the bioeconomy strategy**

- Research of the biological and genetic diversity of agro-ecosystems, plants and animals for the purposes of agriculture and the environment;
- Creation of new genotypes of plants and animals with regard to durability, health, adaptability to new climate conditions, and active use of their potential in agriculture and food industry, industrial sectors, energy and environment protection;
- Study of changes in regional climate conditions (including extremes) and preservation of the productive potential of soil;

- Comprehensive research and innovation in processing, quality and safety of primary agricultural production with a more extensive use of domestic resources and secondary raw materials;
- Research and development of the optimisation of cultivation technologies and farming practices for sustainable plant and livestock production in multi-functional agriculture;
- Elimination and reduction of negative environmental impacts on the rural landscape and on the production of adequate quantity and quality of agricultural products with long-term sustainable production processes in plant and livestock production;
- Ecosystem services of agricultural ecosystems and agro-ecosystem accounting.

**Subtitle 2: Research on the identification, protection and revitalisation of rural landscapes, their production capacities to maintain a sustainable level of ecosystem services, food production, animal feed, renewable energy sources and bio-technical raw materials**

- Research of the biological and genetic diversity of ecologically and economically important plants and animals, including its protection and recovery in areas used for agricultural purposes;
- Research of the interaction of soil, water and biomass in relation to the sustainable use of rural landscapes in order to enhance overall agricultural productivity;
- Preservation and sustainable management of soil and water resources – optimisation of the functions of soil, water and biomass in relation to ecosystem services of agricultural landscapes;
- Research of the capacity increase of agricultural land, soil and sustainable biomass production in relieving hydroclimate extremes and in the adaptation to global and regional impacts of climate change;
- Research of the impact of agricultural activities on the quality of natural resources;
- Sustainable capacity of the rural landscape with regard to food production, renewable bio-energy generation, waste recycling, carbon economy and the economic development of rural regions in Slovakia;
- Integrated ecological approaches "from farm to country";
- Research of rural landscapes and efficient use of the historical structures of agricultural landscapes in addressing the optimal consolidation of the agricultural landscape;
- Comprehensive research on environmental risks, including biological invasions related to the intensification of biomass production.

**Subtitle 3: Research and promotion of intelligent technologies in the management of agricultural landscapes**

- Development and creation of information systems (including forecasting and signalling) for integrated landscape management, for the support of decision-making regarding the sustainable use of agricultural landscapes and biomass production in agro-ecosystems;
- Research and innovation focusing on green technologies, nature-friendly methods of protection against degradation phenomena and climate extremes, use of renewable natural resources, and research of renewable energy of soil products;
- Research and innovation of the creation of information tools and services, including socio-economic services in the agricultural sector, and creation of user comfort;
- Development of tools to optimise decision-making on landscapes in environment creation and protection.

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**Topic 2 – Research, innovation and enhancement of the competitiveness of forestry and wood processing sectors**

**Short description:** Research on the production and use of forest biomass as a strategic domestic renewable raw material in the context of the adaptation of production sectors and wood processing to climate change. Innovations in the intensification of timber production in the most common tree stands and fast-growing and precious tree species, increasing the added value of products in wood processing,

and increasing the processing efficiency and energy use of wood biomass. Research addressing issues of multi-functional forestry, adaptive forest management, ensuring ecological stability of forests in the context of climate change, and research on the provision of ecosystem services.

**Key words** – biomass, timber production, innovation, technologies, wood processing, renewable resources, sustainable forest management, climate change, ecosystem services, other than production functions of forest.

**Closer description of the areas of research and development under RIS3 SK specialisation with regard to the RIS3 areas of economic and/or prospective specialisation**

**Subtitle 1: Increasing the domestic added value of products, in particular through an effective transfer of technologies and R&D results into the production process**

- Research of appraisal methods and support for the marketing of selected ecosystem services of forestry;
- Research of the adaptive systems of forest management and development of systems for supporting decision-making with a focus on production safety and optimisation of forest revenues:
  - Innovative approaches to the modelling of forest dynamics and the creation of prognoses on the basis of growth simulators;
  - Development of a multi-criteria optimisation module for optimising timber production with regard to other ecosystem services of forests and preferences of stakeholders in the use of forests;
  - Research of the methods of timeless treatment of forests of different ages (close to nature);
- R&I in technologies for the collection, processing, integration, sharing and provision of data and information of forestry sectors, wood processing and environment, including application of remote Earth surveying methods;
- R&I in integrated forest protection as a tool to ensure safe timber production and the reduction of environmental risks in timber production:
  - environment-friendly methods of control and fight, preferring prevention to direct suppression;
  - research and development of methods for the monitoring of the health condition of forest ecosystems and fight against invasive pest species, related environmental demands and risks in the context of Central Europe;
- Research aimed to increase the level of completion and creation of added value in the manufacturing of products from wood biomass;
- Research of the optimal recovery of wood-based products after expiry of the period of their use.

**Subtitle 2: Increasing the effectiveness of production and logistic processes**

- Research of the gene pool and adaptability of forest tree species and the use and conservation of genetic resources to increase production and resistance of forests;
- Research on the use of biotechnologies for obtaining new varieties resistant to adverse environmental factors and hybrid plants produced by applying methods of genetic and cellular engineering;
- Research on the production of pure and mixed stands of economically important tree species;
- Research on the production of forest trees on non-forest lands, in industrial forest plantations and agro-forestry systems and their management models;
- Research of risks related to the intensification of biomass production in terms of their possible impacts on non-productive forest functions and on nature and landscape protection;
- Innovative methods of extraction, collection, transport and handling of biomass under different production conditions;

- R&I targeting the harmonisation of the size, structure and technological background of domestic processing capacities with the production possibilities of forests.

**Subtitle 3: Energy effectiveness and renewable energy resources – research and innovation in the energy utilisation and processing of forest biomass**

- Research for improving the energy properties of forest biomass, the processes of its storage, modifications of its physical properties in order to improve transport possibilities and efficiency of energy generation, research of the fractionation of the basic components of wood biomass;
- Technologies for energy generation from biomass and innovative techniques for waste utilisation in energy generation;
- Research of the methods of optimisation of the economic and energy parameters in energy generation, supply and production processes and other uses of biomass;
- Research on the impacts of production and subsequent use of forest biomass for energy purposes on the balance of soil nutrients, carbon sequestration, greenhouse gas balance and air quality;
- Research on the optimisation of forest biomass flows in terms of enhancing economic activities and employment, especially in rural areas.

**Topic 3 – Innovation and modern methods of production and control of quality and safe food from domestic sources**

**Short description** – Strategic research focused on a substantial increase of productivity and competitiveness of Slovak food and raw materials through an effective use of research and development and of the production potential of primary agricultural production and free human potential in all regions of Slovakia. Innovation to ensure the production of own, safe and high-quality food promoting health. Creating the conditions for enhancing the recovery of secondary raw materials from agricultural production and primary food production.

**Key words** – safe and quality food, traditional food, innovation in food industry, waste recovery

**Closer description of the areas of research and development under RIS3 SK specialisation with regard to the RIS3 areas of economic and/or prospective specialisation:**

**Subtitle 1 – Research of advanced food technologies and development of methods to increase the safety, quality and creation of the added value of products**

- Research and innovation to improve food quality, availability and security, diversification of agricultural and food production, use of new processes and technologies for the production and processing of agricultural products;
- Research and innovation in the field of nutritional and hygienic quality of products with regard to the risk of chemical and biological contamination throughout the food chain;
- Development and improvement of efficient analytical and diagnostic processes to verify authenticity and check the allergen content and health safety of food;
- Development of new highly sensitive qualitative and quantitative chemical, physical-chemical and molecular-biological methods to check the content of contaminants, toxic substances and pathogenic microorganisms in raw materials and products and in food production and storage;
- The development and improvement of efficient analytical and diagnostic procedures for the verification of authenticity, allergen content and health food safety;
- Research and innovation of traditional Slovak food products from domestic raw materials using modern microbiological, chemical, physico-chemical and molecular-biological knowledge;
- Research and development in the monitoring of regional origin of food using objective physico-chemical characteristics, as well as detection and elimination of selected contaminants in

- foodstuffs;
- Research in the field of food quality, health and hygienic safety in terms of production and control;
  - Research and innovation with regard to the preparation and use of domestic natural and additive substances in the food industry;
  - Research and innovation of new construction nodes and technology, optimisation of technology cycles for the recovery of organic waste. Development of the database of analytical features for the food data bank (nutritional quality of food) and for the identification and authentication of food.
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#### **Topic 4 - Modern chemical technologies for environment-friendly agriculture**

**Short description** – Research and development of advanced and effective technological processes and methods to reduce the negative impacts of agricultural activities on the environmental spheres and damage to the ecological stability of the landscape with an emphasis on nature and landscape protection, the development of technologies for the manufacturing of products enhancing soil quality, effectiveness of agricultural production and products used in nutrition.

**Key words** – no-waste and low-waste technologies, best available technologies (BAT), remediation, recovery, waste, biomass, fertiliser, contaminants, greenhouse gas emissions, erosion, plant protection, plant nutrition, climate change.

**Closer description of the areas of research and development under RIS3 SK specialisation with regard to the RIS3 areas of economic and/or prospective specialisation:**

**Subtitle 1 – Development of production processes in chemical industry with a focus on effective use of available resources in agriculture**

- Research and development of technologies for the processing and recovery of organic waste and municipal waste into usable products;
  - Development of new technologies and practices enabling biomass decomposition for the production of chemical substances;
  - Development of best available technologies (BAT) and / or combinations of remediation methods for an effective decontamination of soils polluted by contaminants;
  - Development of technologies and products with a high added value on the basis of domestic agricultural production;
  - Development of low-waste technology for the production of organic products for plant nutrition and protection;
  - Development of products for the adaptation of agriculture to climate change and products minimising greenhouse gas emissions from agricultural production;
  - Substitution of hazardous chemicals in accordance with the REACH legislation (Registration, Evaluation, Authorisation and Restriction of Chemicals) – new green chemistry products;
  - Development of technologies and processes for the production of bioplastics and biodegradable packaging based on substrates of domestic production;
  - Research and development of technologies for the production of 2<sup>nd</sup> generation biofuels;
  - Development of environmental technologies to reduce the environmental impacts of chemical production.
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3. **Links/relationships between the long-term strategic research programme and the addressing of some/several development trends on the basis of available R&I capacities** (short description of the links, if such exist with respect to the specific area):

- Soil, water and natural resources represent a vital and, in terms of human life, a non-renewable resource. Optimal management of these resources requires the application of the latest knowledge from research areas listed in this strategic programme. The proposed strategic research programme will enable the development of innovative solutions for **rational agriculture and forestry management, reducing environmental burdens, such as advanced fertilising systems and chemical substances used in these sectors in ensuring the protection, rehabilitation and sustainable land use.**
- The proposed strategic programme will enable an optimal definition and **implementation of the Bioeconomy Strategy** in Slovakia. The Bioeconomy Strategy is currently the principal EU strategy.
- **The dealing with the research topics will contribute to the design of nature-friendly and technical measures** and procedures required for the tackling of problems related to the **adaptation of the country and its productive sectors to climate change and strengthening internal security** (protection against the impacts of hydroclimate extremes, preventing the devastation of the land).
- The application of the results of research in the agricultural sector (in primary production and the production of food, feed and biomass products) **will contribute to the strengthening of Slovakia's internal security (food sovereignty), allow production with a higher added value** (primary products of agriculture, wood processing industry, food production and chemistry).
- Research will ensure the maintaining of the level of ecosystem services of the rural landscape for its socio-economic development and the **development of technologies for obtaining electricity and heat from renewable sources.**

Development trends in the areas of economic specialisation	I Sustainable and ecological systems of use, protection and restoration of the agricultural landscape, effective plant and animal production, production of quality food and non-food raw materials from soil	II Research, innovation and enhancement of the competitiveness of forestry and wood processing sectors	III Innovation and modern processes for the production and control of quality and safe food from domestic sources	IV Modern environment-friendly chemical technologies for agriculture
Increasing domestic value-added products, particularly through the effective transfer of technology and R&D results into the production process	y	y	y	y
Development of production processes in industry focusing on better use of available resources, greater use of recycling materials and environment-friendly materials through scientific and technological development and innovation		y	p	y
The use, placement and replacement of previously used materials for advanced materials with a new and more complex performance, including technological processing (machining, forming, binding)				y
Development of technological investment units, particularly in the field of metallurgy, engineering, energy and integrated industrial equipment, with respect to the application and use of light metals and advanced materials in the manufacture of transport and construction facility to reduce overall weight and contribute to the green economy, development and application usage of composite materials		p	p	p
Development of technological investment units, particularly in the energy and industrial facilities, with respect to internationalisation activities and the development of "emerging countries"		p	p	p
Increasing the effectiveness of production and	y	y	p	p

logistics processes				
Use of ICT and robotics in production processes				
Involvement in supply chains and internationalisation - "the purchase of cooperation is a purchase, too"				
Know-how transfer from large to small subjects and vice versa in the framework of cooperation	y	y	y	y
Energy efficiency and renewable energy				
<b>Areas of economic specialisation</b>				
Automotive and mechanical engineering industries				
Consumer electronics and electrical equipment				
ICT products and services	y	y		
Production and processing of iron and steel				
<b>Prospective areas of specialisation</b>				
Automation, robotics and digital technology	p	p	p	p
Processing and increasing the value of light metals and their alloys				
Production and processing of polymers and advanced chemical substances				y
Creative industry				
Increasing the value of domestic raw material base	y	y	y	y
Supporting smart technologies in the processing of raw materials and waste in the region of their occurrence	y	y	y	y

#### 4. **Expected outputs and the potential of their application and use in economic and social practice** (examples of outputs in indents)

The implementation of the Strategic Programme is expected to bring the following groups of outputs: development of new processes, technologies, products and services, innovation of existing technologies and products resulting in higher economic efficiency, higher quality, an added value, reduction of the environmental impacts of production, safer production and use of products, adaptation to climate change and hydroclimate extremes, increased raw material and product self-sufficiency. Long-term strategic research and development in the abovementioned areas has the potential to bring the following specific practical outputs for the RIS3 areas of economic/prospective economic specialisation:

- Products of the agricultural sector, food industry and related industries with a higher added value and competitiveness with a view to be launched on the domestic and foreign markets, while respecting energy efficiency and the use of renewable natural energy sources;
- Quantification and preservation of the country's ecosystem services in increasing the domestic added value of the agricultural sector, food industry and related industries through an effective transfer of technology and R&D results into primary production and the manufacturing process;
- The practical application of the results will contribute to the creation of more productive, more cost-effective and more durable agriculture and forestry systems, robustness of water resources to ensure sufficient food, feed, biomass and other raw materials and produce broader ecosystem services;
- Development of environment-friendly production processes for better use of available natural resources and more recycling and recovery of materials and waste;
- Reduction of greenhouse gas emissions and degradation of soil and water, reduction of the dependence on international import of vegetable proteins to Europe, and increasing the extent of biodiversity in primary production systems;
- Increasing the resistance of the country and its productive sectors to global changes and the impacts of hydroclimate extremes;

- Know-how transfer from big ones to small ones and vice versa within collaborative relations;
- Development of innovative solutions enabling rational management in agriculture, forestry, water management, reducing environmental burdens (including modern fertilisation systems and chemical substances) and increasing the safeguarding of the country's ecosystem services for society);
- Development of solutions in the context of adaptation to the climate change and strengthening of internal security (food sovereignty, nature-friendly solutions to reduce the impacts of hydroclimate extremes, innovated adaptable genotypes of plants and animals, cultivation and farming practices, land management practices during global changes).

5. **Quality objectives to which the support of long-term strategic programme** is expected to contribute under the RIS3 SK objectives, including the addressing of issues of nationwide concern identified in the RIS3 SK – short description of the objectives and of the ways of achieving them:

The programme builds on thematic area no. 6 – **technological priorities – Agriculture and Environment, addressing the axis: soil, water, climate, plants, animals, foods, and is consistent with the priority "Environment, Agriculture and Food Security"**. It assumes the application of innovative technologies in the various fields of agriculture, forestry and water management, and creates the conditions for the production of safe domestic food, including **adaptation to global changes** and hydroclimate extremes. From the perspective of development trends in the areas of economic specialisation of the economy, the programme aims to increase the domestic added value of products, in particular through an effective transfer of technology and R&D results into the production process and by securing the country's protective functions and ecosystem services and high protection of water resources, thus ensuring the **reduction of emissions, protection and better use of natural resources (especially water, soil and forests) and adaptation to climate changes using nature-friendly methods**. From the point of view of prospective areas of specialisation, the programme refers to an effective recovery of the domestic raw materials base and natural resources. The implementation of the Strategic Programme through the protection, restoration and use of rural landscapes will create **opportunities for young people in changing circumstances**, improve the **quality of life of the ageing population** through a sustainable development of the country's ecosystem functions, and will also increase the **opportunities for marginalised groups and their social inclusion**. The way of achieving these objectives:

- Development of the research base oriented on the actual needs of agriculture, food industry, forestry and water management, and chemical industry in Slovakia, related to the use of the country's potential and the environment, so that the higher extent of novelty based on own research ensures more innovation and added value in production and, hence, greater economic effect and sustainability of ecosystem functions for the society;
- Systematic development of human resources responding to the technological demands of production in the countryside in the near future;
- Systematic development of methodologies, skills, technical bases needed for research, experimental development and manufacture of advanced and innovative products, their structures, technologies, and diagnostic and analytical methods;
- Enhancing regional economic growth and the creation of new and the maintaining of existing jobs and relationships;
- Preservation of landscape functions and attractiveness of rural areas by applying ecosystem measures in rural production sectors;
- Better integration into regional and international industrial research and development projects and prevention of the drain of talented and highly educated people from underdeveloped regions abroad;
- Enhancement of regional economic growth and creation of new and preservation of existing jobs and relationships.



6. **Links to research trends within the EU** (primarily links to specific topics under Horizon 2020, i.e. Horizon 2020 areas in which Slovakia has the chance to be involved more actively in the framework of the implementation of R&D projects financed as long-term ones)

The Strategic Programme topics in this field are linked to **strategic research defined in H2020** in the following particular areas:

- Food Security, Sustainable Agriculture and Forestry, Marine and Inland Water Research and Bioeconomy;
- Climate Action, Environment, Resource Efficiency and Raw Materials.

In addition, involvement in the following thematic areas is expected:

- Secure, Clean and Efficient Energy;
- Nanotechnologies, Advanced Materials, Advanced Manufacturing and Processing and Biotechnology.

The strategic programme topics reflect the **Bioeconomy Strategy, (EC, 2012)**. **The proposed strategic programme relates to the following strategic documents and programmes of macro- and micro-regional international co-operation at the EU level:**

- Sustainable Agriculture, Forestry and Fisheries in the Bioeconomy – A Challenge for Europe – 4th Foresight Exercise (EC, October 2015) – newest prognosis of the Commission’s Permanent Committee for Agricultural Research (SCAR);
- Policy document on NWRM (Natural Water Retention Measures ) (EC, 2014);
- The blueprint to Safeguard Europe's Water resources (Communication from the Commission (COM(2012)673);
- European Union Strategy for Danube Region (COM(2010)715), The Danube Transnational Programme (DTP);
- LIFE programme – aimed to support environmental and climate activities (EU's financial instrument supporting environmental, nature conservation and climate actions);
- Interreg CENTRAL EUROPE – programme for the support of international co-operation between Central European countries (Austria, Croatia, the Czech Republic, Germany, Hungary, Italy, Poland, Slovakia and Slovenia).