MINISTRY OF AGRICULTURE
OF THE CZECH REPUBLIC

Research, Development and Innovation Strategy of the Ministry of Agriculture for 2023 – 2032

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Final version approved by the Government of the Czech Republic in Resolution No 724, dated from 24th August 2022.

The document was prepared by the Ministry of Agriculture, Department of Precision Agriculture, Research and Education, in cooperation with the Czech Academy of Agricultural Sciences.

Contents

1. The purpose and position of the R&D&I Strategy of MoA 2023+ in the sector

1.1 Outline of the preparation of the R&D&I Strategy of MoA 2023+

The Research, Development and Innovation Strategy of the Ministry of Agriculture for the period 2023-2032 ("the R&D&I Strategy of MoA 2023+") was prepared in cooperation of experts in the relevant fields (from research organisations, manufacturing enterprises and professional chambers) and managers responsible for managing the support of research, development and innovation. The preparation team consisted of the staff of the Ministry of Agriculture's body responsible for research and development (R&D), the technical part was prepared by experts from the Czech Academy of Agricultural Sciences (CAAS) in cooperation with a broad range of experts from fields defined by the research priorities, working in thematic working groups. Supervision and valuable comments during the preparation of the R&D&I Strategy of MoA 2023+ were contributed by the Technology Centre of the Czech Academy of Sciences. The document then underwent a commenting procedure involving representatives of the relevant professional chambers, non-governmental non-profit organisations, research organisations in the agricultural sector and also the Research, Development and Innovation Council of the Government of the Czech Republic (the RDI Council). Their comments were integrated into the R&D&I Strategy of MoA 2023+ and, after an inter-ministerial commenting procedure, the Concept was approved by the Czech Government.

The R&D&I Strategy of MoA 2023+ was prepared in the period 2020-2022, i.e. at a time of discussions over the proposed comprehensive amendment to Act No 130/2002 Coll. on support for research, experimental development and innovation from public funds and amending some related acts (the Act on Support for Research, Experimental Development and Innovation), as amended - the key legal framework for R&D&I support. Other conceptual documents at the national, European and international level include the National Research, Development and Innovation Policy of the Czech Republic 2021+ (National R&D&I Policy 2021+) approved in Government Resolution No 759 of 20.07.2020, or the National Research and Innovation Strategy for Smart Specialisation of the Czech Republic 2021-2027 (National RIS3) approved in Resolution No 66 of 25.01.2021. The R&D&I Strategy of MoA 2023+ follows on from the Research, Development and Innovation Concept of the Ministry of Agriculture for the period 2016 – -2022, approved in Government Resolution No 82 of 03.02.2016. The new R&D&I Strategy of MoA 2023+ also responds to the mid-term evaluation of the Research, Development and Innovation Concept of the Ministry of Agriculture 2016-2022 and the Applied Research Programme of the Ministry of Agriculture 2017-2025 - EARTH, and to the final evaluation of the programme Comprehensive Sustainable Systems in Agriculture 2012-2018 (the CSS Programme)[1].

[1] See URL <https://eagri.cz/public/web/mze/poradenstvi-a-vyzkum/vyzkum-a-vyvoj/narodni-agentura-pro-zemedelsky-vyzkum/hodnoceni-programu-1/hodnoceni-programu-kus-2012-2018.html> and the executive summary of the final report on the mid-term evaluation of the R&D&I Concept of MoA 2016-2022 and the Earth programme in Annex 5.

1.2 Objective and purpose of the R&D&I Strategy of MoA 2023+

The main objectives of the R&D&I Strategy of MoA 2023+ are to define a set of management tools for managing the sector research, to define the areas of research topics needed for the future development of Czech applied agricultural research and to define the benefits for the users of the results. The Concept establishes a fundamental framework for the direction of the sector research in the upcoming period in line with the current societal challenges, global trends and key postulates arising from current core strategic documents that include mainly the European Green Deal and a strategy derived from it, called A 'farm to fork' strategy for a fair, healthy and environmentally-friendly food system. The main guidelines for formulating the key areas (priority objectives) of the R&D&I Strategy of MoA 2023+ and the related research directions and priorities are the green and digital transition of the economy (or the agri-food sector, forestry and water management). This is to be achieved through targeted support of research topics concerning the circular economy, minimisation of the use of chemical pesticides, fertilisers and antibiotics (including the intent to expand organic farming), and support of rational exploitation of opportunities brought about by technological progress and digitisation (using the challenges of precision agriculture and smart agricultural in general).

Other objectives of the R&D&I Strategy of MoA 2023+ are to bring new tools and procedures for ensuring sustainable production of safe and nutritionally complete food and commodities, as well as to search for an effective approach to the protection of biodiversity and to adaptation and mitigation of the impacts of global changes, or to contribute to addressing global challenges on the regional scale.

The Concept establishes a fundamental framework and formulates topics for various systems of management of arable land and permanent grassland - conventional, integrated, organic.

Moreover, the Czech research in the agricultural and food sector (agri-food sector), forestry and water management must be more integrated with international research than it has been to date. The research defined this way should bring (also to public administration) new knowledge for setting the processes and value chains that will lead to sustainable development in this area, as well as for shaping a socially responsible agricultural policy.

The **purpose** of the R&D&I Strategy of MoA 2023+ is to present a **vision of the thematic focus of research** in the agri-food sector, forestry and water management, defining the key areas (Chap. 3.1), that are developed into research directions, research priorities (Chap.3.2) and research areas (Annex 1).

The ambition of the R&D&I Strategy of MoA 2023+ is to contribute to the development and progress in the following key areas:

1. Bioeconomy
2. Smart agriculture
3. Global changes in the biosphere.

In the area of **management**, the purpose of the R&D&I Strategy of MoA 2023+ is to contribute to creating conditions for efficiently managed and financed research that achieves quality results both in terms of domestic needs and in an international comparison. Another goal is to effectively apply the research results in practice and, thanks to cooperation with strategic

partners, to achieve synergies with related fields. Researchers are motivated to carry out scientific work on socially important topics (Chap.3.3).

1.3 Users of the R&D&I Strategy of MoA 2023+

The R&D&I Strategy of MoA 2023+ is mainly intended for all entities carrying out research in the agri-food sector, forestry and water management, and seeks to provide them with a thematic and institutional framework for designing and implementing their own long-term plans of research development and, partly, stabilise their staff. The entities include research organisations (ROs) governed by the Ministry of Agriculture (MoA) and private ROs long established in the sector, as well as ROs and facilities of other ministries, research institutes of the Czech Academy of Sciences (CAS), universities but also manufacturing enterprises and agricultural entrepreneurs.

Other important users of the R&D&I Strategy of MoA 2023+ are state administration bodies, mainly the Ministry of Agriculture that implements the institutional measures arising from it, including financial (so-called institutional) support of ROs and purpose-tied aid programmes. Moreover, the R&D&I Strategy of MoA 2023+ is an important document for coordinating research, development and innovation (R&D&I) at the national and international level: for the RDI Council that will use it for strategic management and efficient financing of the national system of research, development and innovation (in line with the National R&D&I Policy 2021+); for defining the links and for a long-term coordination of programme support with the Technology Agency of the Czech Republic; for the Ministry of Education, Youth and Sports (MEYS) that is responsible for international collaborations in research and development and for institutional support for the development of higher education institutions as ROs; and for many other ministries that need to generate knowledge in thematically similar areas such as protection of natural resources and the environment (Ministry of the Environment), materials from biomass (Ministry of Industry and Trade), healthy nutrition (Ministry of Health) or safety (Ministry of the Interior). The emphasis on dissemination of research results and innovation transfer is also part of the Strategic Plan of the Common Agricultural Policy 2023-2027 (the CAP Strategic Plan).

2. Starting points for the design of the R&D&I Strategy of MoA 2023+

2.1 Context of the R&D&I Strategy of MoA 2023+

The R&D&I Strategy of MoA 2023+ is based on specific needs of the agri-food sector, forestry and water management in the context of the National R&D&I Policy 2021+ and respects the frameworks/concepts of other key actors of that policy - mainly providers of R&D&I support (the Key Actors are listed in Annex 4 with a general outline of their impact on the R&D&I Strategy of MoA 2023+).

It is apparent from the diagram of links among strategic documents and sources of R&D&I financing, set out in Annex 2 , that the support of research in the agri-food sector, forestry and water management is interlinked with policies and objectives of strategic documents at the national and European level, both horizontal (e.g. Agenda 2030) and sectoral (e.g. the European Green Deal, the 'Farm to fork' strategy for a fair, healthy and environmentally-friendly food system, the Ministerial Strategy of the Ministry of Agriculture of the Czech Republic with an outlook until 2030). Apart from the documents set out in the diagram, the R&D&I Strategy of MoA 2023+ is also based on the following key national sectoral strategies and conceptual documents: The Strategy on Adaptation to Climate Change in the Czech Republic and its National Action Plan for Climate Change Adaptation, the proposal for a Strategic Framework of Circular Economy of the Czech Republic 2040, the Biodiversity Protection Strategy of the Czech Republic 2016-2025, the State Environmental Policy of the Czech Republic 2030 with an outlook till 2050, the Concept of Bioeconomy in the Czech Republic from the point of view of the Ministry of Agriculture 2019-2024, the Action Plan for Organic Farming Development 2021-2027, the State Forestry Policy Concept until 2035 and its Action Plan.

The scope and form of R&D&I support by MoA is also influenced by the Innovation Strategy of the Czech Republic 2019-2030 that defines the main directions of development so that, within twelve years, the Czech Republic (CZ) ranks among innovation leaders in Europe and becomes a country of technological future. The National R&D&I Policy 2021+ represents a strategic framework for the development of all components of research, development and innovation in CZ, and the policy of R&D&I support by MoA derives from it. The R&D&I policy of MoA is also harmonised with the goals set for the development of the European research area, expressed, inter alia, in the objectives of aid under EU framework programmes for research and innovation, namely the Horizon 2020 framework programme for the 2014-2020 period and the Horizon Europe framework programme for the 2021-2027 period.

At the level Member States, co-financing from the European Structural and Investment Funds (ESIF) and national budgets is used to support selected R&D&I measures defined in operational programmes and other strategic documents, subject to conditions of using European funding.

The main coordinating strategic document for effective targeting of R&D&I support from European and state budget resources (in line with Act No 130/2002 Coll.) in the area of oriented and applied research leading to innovation is the National Research and Innovation Strategy for Smart Specialisation of the Czech Republic, currently for the 2021-2027 period (National RIS3) that was approved by the Czech Government in Resolution No 66 of 25.01.2021. The National RIS3 will reflect the dynamic development of the innovation

environment and the newly emerging trends and opportunities by means of its ongoing updates. The latest update was made to Annex 1 “Cards of thematic areas” (version 2) in October 2021. The R&D&I Strategy of MoA 2023+ fully reflects the strategic topics of the specialisation domain Green technologies, bioeconomy and sustainable food resources, backed by the National Innovation Platform VI Sustainable agriculture and the environmental sector. The research priority areas, not covered by the National RIS3, are further developed in the National priorities of oriented research, experimental development and innovation (NPOR) (excluding basic research) and providers of purpose-tied aid are obligated to describe in their purpose-tied aid programmes the relationship of the programme to the relevant priorities defined in that document.

2.1.1 National R&D&I Policy 2021+ and other strategic documents relevant as starting points for formulating the priorities in the management of the R&D&I Strategy of MoA 2023+

The National R&D&I Policy 2021+, approved by the Government on 20.07.2020 in Resolution No 759 is an umbrella strategic document at the national level for R&D&I. The R&D&I Strategy of MoA 2023+ adopted the objectives of the National R&D&I Policy 2021+ as the basic framework for specifying its priorities in the area of management. At the same time, it takes into account systemic changes arising from the gradual implementation of the Methodology 17+ and the upcoming plans for the comprehensive amendment to Act No 130/2002 Coll.

The National R&D&I Policy 2021+ defines 4 key areas that will be developed through measures co-implemented by ministries:

1. **Management and financing of the R&D&I system.** Reducing the administrative burden of providing aid, harmonising the rules among providers, concentrating the support in line with the Innovation Strategy and in response to the results of evaluation of the R&D&I quality and impacts (and using any outputs of technology foresight and technology assessment). Another important topic is the use of tools for legal protection of intellectual property.
2. **Motivating people to pursue research careers and developing people’s potential.** Measures to reconcile family and professional life of carers for dependent family members and developing human resources tools in ROs to create a motivating and transparent working environment and to make a maximum use of the potential of scientists.
3. **Quality and international excellence in science and research.** A higher involvement of ROs in Community programmes (including ERC projects) and, in general, strengthening the openness of the research environment by connecting to the international research community through cooperation and two-way international mobility of staff (including taking into account the specific needs of scientists and researchers with regard to their gender and age). An opportunity is the use of the newly built science and research centres, so-called large research infrastructures. Inter-regional and cross-border cooperation of ROs and companies is also increasingly important. Motivating small and medium-sized enterprises to pursue excellence, including technology transfer support.
4. **Collaboration between the research and the application sector.** Domestic enterprises need to develop far more their research and development activities and build

their competitiveness not on cheap labour force but on applying new knowledge and manufacturing products with higher added value, mainly in the area of promising technologies such as nanotechnologies, information and communications technologies, biotechnologies, space technologies etc. A suitable form of support is CZ participation in national and international project frameworks that will enable companies to develop international partnerships and establish themselves in international supply chains.

Other strategic documents relevant as starting points for formulating the priorities in the managerial governance of the R&D&I Strategy of MoA 2023+

- The National RIS3 is a strategic document ensuring an effective targeting of European, national, regional and private funding intended to support oriented and applied research and innovation in prioritised promising areas that have high potential to create a long-term competitive advantage for CZ, based on the use of knowledge and on innovation. A relevant specialisation domain in the National RIS3 is the domain Green technologies, bioeconomy and sustainable food resources.

The National RIS3 defines 4 horizontal priorities / strategic objectives:

1. Increasing the innovation performance of companies
2. Increasing the quality of public research
3. Increasing the availability of qualified people for R&D&I
4. Increasing the use of new technologies and digitisation.

- Ministerial Strategy of the Ministry of Agriculture of the Czech Republic with an outlook till 2030, defining the strategic objectives and indicative values for increasing the quality and effectiveness of R&D&I and accelerating the application of results in practice.
- The national priorities of oriented research, experimental development and innovation provide the focus mainly for applied research but partly also for basic research on topics and technologies that will help to address the current and foreseeable future economic, social and environmental problems and challenges of CZ.
- Strategy for the Equality of Women and Men 2021-2030, already a second framework government document for applying the policy of equality between men and women, and a prerequisite for fulfilling one of the enabling conditions for using the European Social Fund Plus. The chapter dedicated to the topic of knowledge sets the goals for levelling the inequalities between men and women in education, science and research. The strategic objectives relevant for the R&D&I Strategy of MoA 2023+ are: Ensuring maximum development of the potential of girls and boys, or women and men, Expanding the content of education, science and research with the gender perspective, and Applying the gender perspective in the operation and management of educational and science and research institutions.
- Horizon Europe, the 9th EU framework programme for research and innovation (for the 2021-2027 period), contributes to the EU strategic objectives by providing new knowledge and technologies. Horizon Europe supports European cooperation in research, in topics that are common to Member States and where coordination and collaboration increase the efficiency of producing knowledge while promoting equality

in access to knowledge. The programme also supports the development of both excellence in research and transfer of scientific knowledge to practice and its subsequent commercialisation in the business sector.

- The Advisory System Concept of the Ministry of Agriculture for the period 2017-2025 and the Training Concept of the Ministry of Agriculture until 2026 defining the actors and tools of support for consultancy and training in the agri-food sector, forestry and water management. The Advisory System Concept of MoA is also linked to the goal of the CAP Strategic Plan in the area of modernising the Agricultural Knowledge and Innovation System (AKIS), and to the support for cooperation among advisory services and the CAP Network within the AKIS.

2.1.2 Czech research in the European and global context

Czech research is not and cannot be limited to addressing exclusively national priorities. It is a natural part of the European global system of R&D, both in terms of sharing knowledge (scientific results) and in terms of achieving the objectives that are inevitably global in a globalised world. The development of Czech research is thus conditioned by the intensity of knowledge exchange on the one hand and objectives defined in international strategic documents on sustainable development on the other hand.

These include in particular:

- **Agenda 2030** with 17 Sustainable Development Goals (SDGs). The Concept mainly responds to sub-goals of SDGs: 2.4, 2.5, 2.a, 15.6, 15.b, to ensure systems of sustainable production of food and sustainable agricultural procedures, to maintain or increase genetic diversity, to increase investment in agricultural research and rural infrastructure and protect and promote sustainable use of terrestrial ecosystems.
- **EU Biodiversity Strategy for 2030: Bringing nature back into our lives**, emphasising the need to stop the decline of species (animals, plants) and to enhance the resilience of the landscape through landscape features, tree planting, expansion of areas important for carbon storage, or expansion of highly protected areas.
- The **European Green Deal** and its sectoral transposition to the **'Farm to fork' strategy for a fair, healthy and environmentally-friendly food system**.

  The European 'Farm to fork' strategy for a fair, healthy and environmentally-friendly food system is targeted at:

  - reducing selected inputs in agriculture and aquaculture, reducing the use of fertilisers and plant protection products, antimicrobials,
  - sustainable practices in farms - expanding the organic farming to cover up to 25% of agricultural land, supporting renewable energy sources (RES) on arable land and in livestock farms, reducing emissions,
  - the food vertical and the market in the globalisation-localisation context,
  - healthy diet and consumption - nutrition, food safety, ethical codes of food producers, food frauds, informed consumers, food myths.

- EC mission **Healthy Soil and Food**, requiring that at least 75% of agricultural land be "healthy" by 2030, i.e. able to ensure basic ecosystem services with significant

environmental, economic and social impacts (as opposed to the present where 60-70% of soil in the EU is “unhealthy”). The mission stresses that this goal is achievable only if effective monitoring is applied in the hierarchy: agricultural parcel, landscape unit, region/state.

- **The strategy A sustainable Bioeconomy for Europe: strengthening the connection between economy, society and the environment.**
- **New EU Forest Strategy for 2030.**
- **Commission Communication "Sustainable Carbon Cycles"**, published on 15.12.2021, containing plans of the Commission for research in carbon storage, monitoring and verification in agricultural and forestry land and for using the Horizon Europe funding.

The R&D&I Strategy of MoA 2023+ was designed at a time of EU discussions on the European Green Deal and the follow-up ‘Farm to fork’ strategy for a fair, healthy and environmentally-friendly food system, the EU Biodiversity Strategy for 2030: Bringing nature back into our lives, and the New EU Forest Strategy for 2030.

The above strategies underline the comprehensive view of the value chains, which must reflect in the design of our national research priorities and research areas of the R&D&I Strategy of MoA 2023+ but also in the new EU framework programme for research and innovation Horizon Europe. Although the achievement of the objectives of the above European strategies is difficult in practice, the research must look for alternatives in all research directions, mainly in the protection and nutrition of plants. All of that, and the new knowledge, absolutely must appear also in the upcoming Common Agricultural Policy.

At the time of developing the R&D&I Strategy of MoA 2023+, the European Commission presented the new climate and energy legislative package called **“Fit for 55”.** That package follows on from the climatic goal of the European Union from 2020. The goal is to reduce by 2030 the total emissions of greenhouse gases in the EU at least by 55% against 1990. So the original target of 40%, approved in 2014, was formally increased. Fit for 55 brings 13 updated or entirely new directives and regulations. All key sectors of the national economy, including agriculture, must adapt to the new EU emission target. The regulation on the shared efforts determines the binding emission targets for each EU Member State. Originally, the Czech Republic had a target to reduce emissions in those sectors in the period 2021-2030 by 14% against 2005. The new proposal increases the Czech target to 26%. The target for energy from renewable sources is also raised from the original 32% to 40%. Those are the two targets with the closest link to agriculture.

In April 2021, the Commission published the final report from the background study “Technical Guidance Handbook – setting up and implementing result-based carbon farming mechanisms in the EU”, dealing with the implementation of carbon farming in practice in the EU. The goal is, through new projects and procedures in agricultural practice, to increase the amount of carbon captured in soil and plants (sequestration) and so reduce the emissions of greenhouse gases e.g. from livestock farming, soil or plants. The Commission recommends that Member States include carbon farming in the future Common Agricultural Policy and in national research programmes. And it is the goal of the Czech Republic and of this R&D&I Strategy of MoA 2023+.

2.2 Analysis of the situation in research in the agri-food sector, forestry and water management

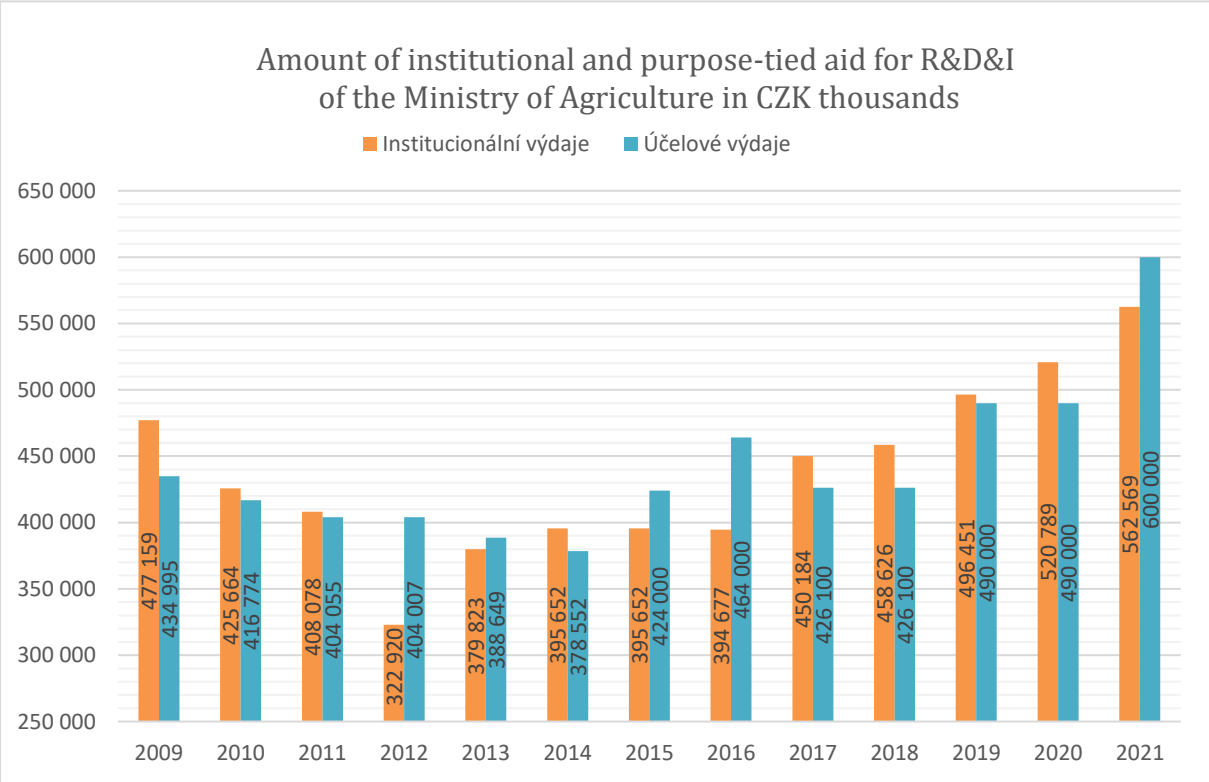
2.2.1 The state of Czech research in the agri-food sector, forestry and water management

The state budget expenditure on research and development in agriculture, according to data of the Czech Statistical Office (CZSO) (broken down to the main socio-economic directions of NABS 2007) formed 4-5% of the total budget expenditure on research and development in the period 2009-2019. Specifically, in the period 2009-2010, it was 5%, and in the period 2011-2019 it was 4% of the expenditure.

The level of expenditure from the MoA budget chapter for R&D&I ranges just below 3% (in the period 2012-2020) of all national public expenditure on R&D&I, although the R&D&I expenditure in CZ has been significantly growing. For illustration, in 2020, the CZ state budget allocated CZK 36.247 billion to R&D&I, of that the MoA budget for R&D&I received CZK 1.01 billion (i.e. 2.73% of R&D&I expenditure of the CZ state budget). Only in 2021, the support for agricultural research provided to the MoA budget from the total CZ state budget expenditure on R&D&I exceeded 3% (3.06%) for the first time since 2012.

The trend of expenditure from the MoA budget for R&D&I, broken down to institutional and purpose-tied aid, is shown in Chart 1 below.

Chart No 1: Trend of institutional and purpose-tied aid provided by MoA to R&D&I in the period 2009-2021



Institutional aid expenditure Purpose-tied aid expenditure

Research in the agri-food sector, forestry and water management is financed through national programmes of purpose-tied aid also by other aid providers apart from MoA, these are mainly the Grant Agency of the Czech Republic and the Technology Agency of the Czech Republic.

The support from operational programmes co-financed from the CZ state budget and ESIF has been minimal from the point of view of agricultural sciences. According to the Sectoral Analysis of the Technology Centre of CAS, enterprises and ROs carrying out research in agricultural sciences received 1.7% (i.e. CZK 271 259 thousand) of the total volume of support provided for research and development by the Operational Programme Research, Development and Education and the Operational Programme Enterprise and Innovation for Competitiveness in the period 2015-2018. Out of that amount, the vast majority of the funding went to higher education R&D&I if we do not consider support for veterinary sciences separately. Enterprises received only minimum support (0.3% for agriculture, forestry and fisheries, and 1.2% for veterinary sciences). The involvement of ROs in the EU framework programme for research and innovation Horizon 2020 was also low in an international comparison, although CZ had an above-average participant success rate in the societal challenge FOOD, exceeding the overall success rate of EU-15 and EU-12 states.

The development of total expenditure on research and development (R&D) by sector in agriculture and veterinary sciences varies over time, the total R&D expenditure in agriculture and veterinary sciences in the national currency oscillated between CZK 1.728 bil. and CZK 2.409 bil. in the period 2010-2017 according to OECD data. Of that, business sources formed around 30% of the R&D&I expenditure, the government sector funding ranged between 21% and 40%, the R&D&I expenditure in the higher education sector averaged around 35% of the financial expenditure on the said area of research.

In an international comparison of GERD, CZ ranks among countries with the lowest level of total R&D&I expenditure in agriculture and veterinary sciences. In the monitored period (2014-2017), the share of expenditure on research in agriculture and veterinary sciences in the total research expenditure does not grow over time, but is slightly decreasing. The background analyses are provided in Annexes 7 and 8.

According to CZSO data for 2019, there are 177 research centres in CZ with prevailing R&D activities in agriculture (which is 5.5% of all research entities in the CZSO statistics in 2019), of that 137 belong to the business sector (made up of 125 private domestic enterprises and 7 private foreign enterprises), 24 to the government sector and 8 to the higher education sector. The highest share (46%) of those entities spend annually less than CZK 1 mil. on R&D, 33% of the entities spend CZK 1-9.9 mil. on R&D, 15% of them spend CZK 10-49.9 mil. and 6% (10 entities in absolute terms) spend CZK 50 mil. and more. It is worth pointing out that the enterprises involved in R&D in agriculture are predominantly private domestic enterprises.

According to data from the Register of Research Results (RRR), forming a part of the information system of research, experimental development and innovation (R&D&I IS), research results were registered in the period 2005-2020 in the scientific field of agriculture and veterinary sciences (according to OECD classification) by 128 entities, of that 34 were from the business sector, 37 from the government sector, 54 from the higher education sector (i.e. faculties of HEIs, if we look at HEIs as such, results were registered by 20 different HEIs) and 3 from non-profit sector organisations.

In terms of the number of researchers in the field of agricultural sciences in the CZSO data for 2019, the fields employ 3.7% of all researchers, in absolute terms this is 2 332 persons, which

equals to 1 510 full-time equivalents (FTEs). Out of the number of researchers, 17% of them work in the business sector, 31% in the government sector, 52% in the higher education sector, and less than one percent in the non-governmental non-profit sector. The representation of men and women among researchers in agricultural sciences is balanced. Women make up 46.75% of researchers in the business sector, 50.69% in the government sector, 48.10% in the higher education sector, and 50% in the non-governmental non-profit sector.

In terms of the performance of agricultural research, the R&D&I IS registered 4 909 research results in the field of agriculture and veterinary sciences in 2019, which is 5.7% of all registered results in the data collection year 2019. Comparing the level of financial support for the field of science and the number of researchers, this is an above-average number.

The results registered in the R&D&I IS for the field of agriculture and veterinary sciences, compared to the other fields of science, are dominated by applied results of the F type (results with legal protection), N type (methodologies, medical procedures and specialised maps), and Z type (semi-operation, verified technology, plant variety, animal breed). Compared to the other fields of science, the representation of P type results (patent) and J type (peer-reviewed article) is average. So the agricultural sciences are dominated by applied research results.

The evaluation (H17-H19) at the national level of module 1, i.e. evaluation of results registered in 2018-2020 according to their contribution to knowledge and according to societal relevance, evaluated two thirds of the registered results between grades 2 and 3, i.e. high-quality results. Grade 1 evaluation was assigned to only 2.15% of results, which, however, is not surprising given the focus of the agricultural research.

2.2.2 Institutional structure

MoA is responsible for R&D&I in the agri-food sector, forestry and water management. It provides purpose-tied and institutional support. It provides conceptual and methodological guidance to MoA research organisations[2]. It is responsible for implementing the National R&D&I Policy 2021+ and the National RIS3 in its field, and projects them into its own R&D&I Concept of MoA. At ministerial level, it supports international cooperation in research in the agri-food sector, forestry and water management.

2.2.2.1 The management (organisational) structure

The current management structure is illustrated in Diagram 1 below. The key body in the management of the MoA R&D&I is the MoA body responsible for R&D.

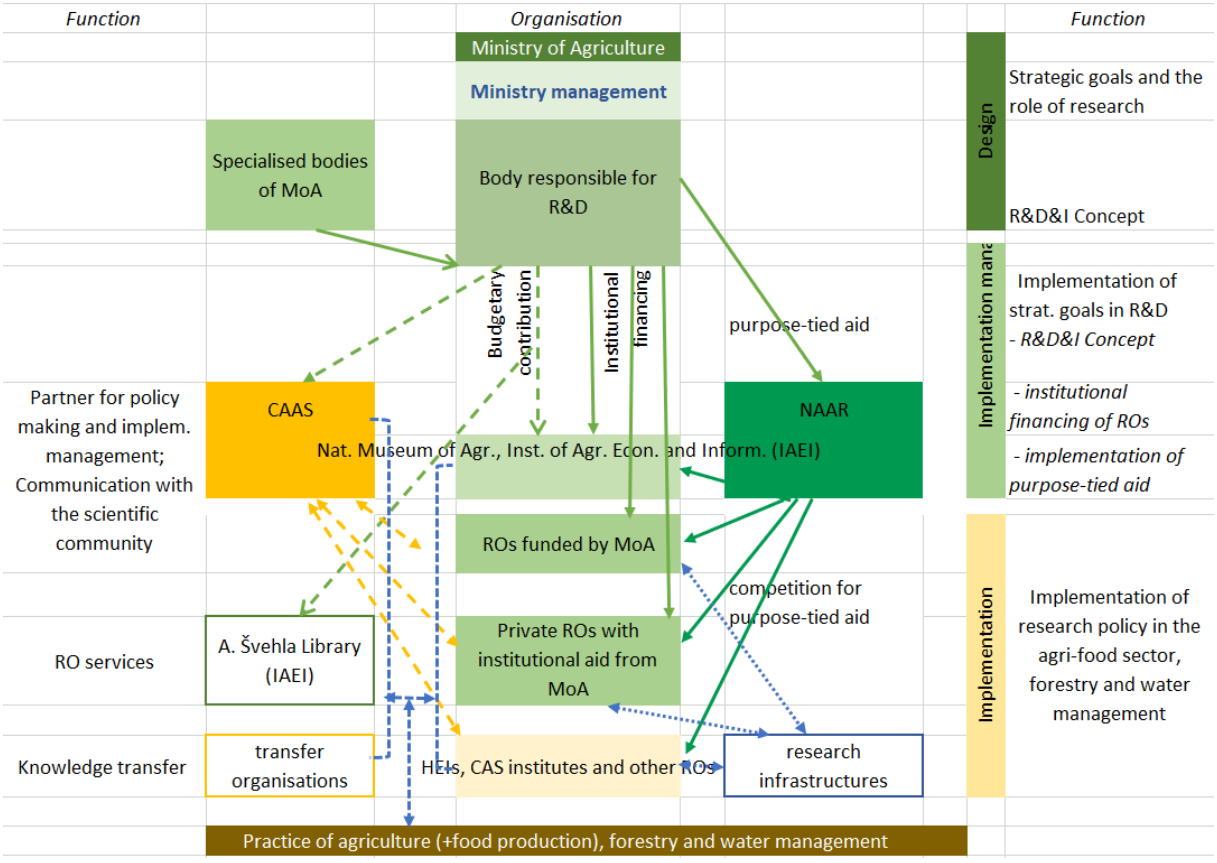
The MoA management activity is supported by the CAAS that represents partnership between MoA (which finances CAAS) and the scientific community (which implements the CAAS activity). CAAS acts as an advisory body, creating a bridge between the management function of MoA for implementation of MoA strategic objectives on the one hand, and the needs and potential of ROs who implement the research strategy on the other hand. Apart from other

[2] ROs implementing the R&D&I policy of MoA and receiving institutional form of support, namely: public research institutions: the Research Institute (RI) of Forestry and Hunting, the RI for Soil and Water Conservation, the Food Research Institute Prague, the Crop RI, the Veterinary RI, the RI of Agricultural Engineering, the Institute of Animal Science; state contributory organisations: the Institute of Agricultural Economics and Information, the National Museum of Agriculture; private companies: Agritec plant research, s.r.o., Agrotest fyto, s.r.o., Agrovýzkum Rapotín, s.r.o., Hop RI, Dairy RI, Oseva Research and Development, Selton Research Centre, Fruit Research and Breeding Institute Holovousy, Potatoe RI Havlíčkův Brod, the RI of Brewing and Malting, the Agricultural Research.

activities, CAAS issues 11 peer-reviewed scientific OPEN ACCESS journals. All 11 journals are presented in the SCOPUS (Elsevier) database and 10 journals are registered in the Web of Science (Core Collection, Clarivate Analytics) database, of which 9 have been assigned the Impact Factor[3].

Apart from research organisations that implement the MoA R&D&I policy and provide scientific knowledge and other qualified information for application in practice and for the scientific community in general, the performance of these functions is also shared by the agricultural Library of Antonín Švehla (organisationally part of the Institute of Agricultural Economics and Information) and organisations transferring knowledge and technologies into practice (for a general definition of those actors see Diagram 2 below).

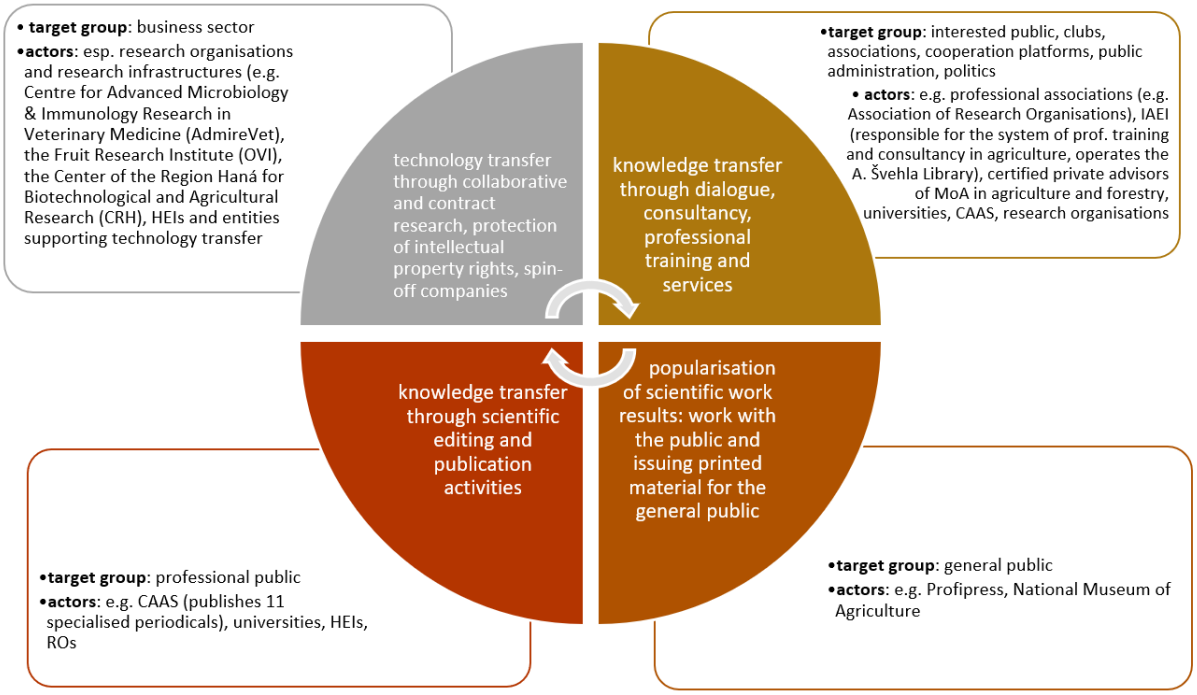
Diagram 1: Diagram of the management structure, institutional links and roles in MoA R&D&I



The MoA support for knowledge and technology transfer has a broader scope and impacts also outside MoA, it involves more actors as is shown in the diagram below.

[3] For an overview of the journals including the impact factor and the databases where the periodicals are listed see URL: <https://www.agriculturejournals.cz/web/>.

Diagram 2: Diagram of knowledge and technology transfer, incl. the transfer target groups and actors



2.2.2.2 MoA tools of financial support for R&D&I in the agri-food sector, forestry and water management

1. **To implement its R&D&I policy, MoA has two instruments of financial support from the state budget:**
   - Institutional aid for long-term conceptual development of a RO
   - Purpose-tied aid - MoA programmes of purpose-tied aid.

Institutional aid

The institutional expenditure for MoA R&D&I represents expenditure on the long-term conceptual development of the aided ROs (the RO development).

In five-year cycles, the ROs submit Applications for Institutional Aid, including a Long-term Concept of the RO Development in which they define their research plans for the five-year period and determine their commitments in the form of indicative values to be achieved in each year for the evaluated aspects (e.g. research results, international collaboration, mobility of researchers etc.). Every year, the ROs submit Periodic Reports on fulfilling their Long-term Concepts of Development. Both the Long-term Concepts and Period Reports are evaluated by an expert advisory body, so-called Steering Committee.

Through institutional aid, MoA provides financial support for research and development for 9 ROs funded by MoA (7 public research institutions and 2 state contributory organisations) and for 11 private ROs (see their list in footnote 2 above).

Programmes of purpose-tied aid

The preparation and publication of MoA research programmes, announcement and conduct of competitive biddings and subsequent administration of the financed projects of research in the agri-food sector, forestry and water management is carried out by the National Agency for Agricultural Research (NAAR). At present, support is provided to R&D projects under the applied research programme of MoA in the period 2017-2025, called EARTH.

In 2022, a follow-up programme of applied research will be prepared for the period 2024-2032. Its implementation will be started by announcing the first competitive bidding in 2023. The aid will start to be provided from 2024.

NAAR is responsible for managing the programme, announcing competitive biddings and for other processes related to the role of purpose-tied aid provider. For the implemented projects, NAAR organises the evaluation of their interim and final reports. The projects are administered using the information system of the Technology Agency of the Czech Republic.

2. **Other tools of financial support for MoA R&D&I, co-financed from European Union sources, are:**

    - MoA will take part in the implementation of the CAP Strategic Plan by supporting cooperation in innovation projects with an emphasis on the transfer of research/innovation results into practice. It will continue to support operational groups in the European Innovation Partnership.
    - Financial support from OP Fisheries 2021-2027, activity 2.1.1. Innovation, will be provided to projects developing technical, scientific or organisational knowledge and innovation focused on exploring the technical or economic feasibility of innovative products or processes, including technologies, products or methods in aquaculture. OP Fisheries is co-financed from the European Maritime, Fisheries and Aquaculture Fund in the 2021-2027 programming period.

2.2.2.3 MoA support for international cooperation in R&D&I in the agri-food sector, forestry and water management

The MoA support for international cooperation is determined by conditions set out in the legal framework, stating that the responsible body and coordinator of international cooperation in R&D&I, including negotiations with EU bodies in R&D is MEYS, in line with Section 33 par. 2 letter a) of Act No 130/2002 Coll. MoA support for international cooperation can be implemented after it is endorsed by and coordinated with that responsible body. Non-financial, mainly information support for ROs in their participation in the EU framework programmes for research and innovation is provided by the authorised National Contact Point, which is the Technology Centre of the Czech Academy of Sciences.

In terms of framework support for international cooperation, MoA is currently actively involved in:

- the **Standing Committee on Agricultural Research (SCAR)**, which is a committee of the European Commission (EC) taking part in coordination of agricultural research activities. The aim of that Committee is, with EC support, to build an integrated European Research Area (ERA). SCAR is an organisational component of the Directorate General for Research and Innovation (DG RTD). DG RTD in cooperation with Directorate General for Agriculture and Rural Development (DG AGRI) place a great emphasis on interconnecting research with innovation and

on removing obstacles hindering innovation. SCAR is currently made up of representatives of 37 countries (EU states, associated and candidate countries, Israel).

- the **joint BIOEAST initiative** supporting bioeconomy in Central and Eastern European states, and seeking greater involvement in the Horizon Europe programme. The initiative was originally politically backed by the V4 countries; currently it associates 11 states of Central Europe and the Baltic.

2.2.2.4 Other tools and actors of R&D&I support in the agri-food sector, forestry and water management

Annually, MoA grants **Minister Awards** in two categories (maximum 3 financial awards in each category):

- Minister of Agriculture Award for young scientists (up to 35 years of age),
- Minister of Agriculture Award for the best result of research and experimental development.

Apart from R&D programmes of MoA, there are other programmes of other ministries and institutions contributing to the implementation of the R&D&I Strategy of MoA 2023+ and to R&D support in general. In this group of aid providers, the largest provider is MEYS both in terms of the number of projects and the volume of funding spent on research, i.e. basic and applied research, experimental development and ESIF-supported infrastructure and investment projects developing the R&D infrastructure. The second largest volume of aid is provided by the Technology Agency of CZ (applied research), followed at some distance by the Ministry of Industry and Trade, the Grant Agency of CZ and the Ministry of the Interior. In international cooperation, an important role is played by support of the EU framework programme Horizon Europe and other support programmes.

2.3 Summary of the starting points for the agri-food sector, forestry and water management

The starting points for designing the R&D&I Strategy of MoA 2023+ in the thematic part are the societal and technological trends and the currently estimated predictions and postulates. The fundamental one is the predicted growth of the world population. In 2050, the Earth's population can reach 9 billion. It can also be assumed that migration will continue and the population of Europe will increase significantly. The world demand for food will certainly go up and the structure of the demand will change. At least in Europe, consumers will consider the food quality, safety and production methods more than to date. At the same time, it will be necessary to reduce food wastage, starting with the place of food production up to the food use. An important factor that will enter the value chain of food production will be changes in eating habits.

It can be reasonably expected that societal demand for ecosystem services will grow along with the emphasis on more responsible use of soil and other basic natural resources, also in connection with biodiversity. A strong phenomenon to which the R&D&I Strategy of MoA 2023+ responds is the development of bioeconomy. That does not apply only to the agricultural sector. It is an inter-disciplinary issue, although its link to production concerns that sector the

most. The focus will be on optimising the use of biomass but also on technologies processing waste as raw material for new products.

The R&D&I Strategy of MoA 2023+ must also respond to climate change predictions. Both EU and CZ will continue to implement their commitments to reduce greenhouse gas emissions and use renewable energy sources. With regard to the CZ commitment to drastically reduce greenhouse gas emissions and increase the share of energy from RES in the final consumption by 2030, the energy alternative must be clear, including the innovated technologies for sustainable cultivation and use of agricultural biomass or other innovative ways of energy production on agricultural land (e.g. agrivoltaics). The principles of circular economy and bioeconomy must be applied more than to date. Renewable biomass is also a product of forestry. As a result of the current spruce bark beetle calamity and the continuing impacts of climate change, the volume of produced wood will be temporarily reduced both for energy and mainly industrial processing. Until 2030, the demand for biomass for non-food purposes will grow along with the demand for sustainable ways of long-term carbon storage in agricultural and forest land. The European Commission is developing a concept of carbon farming that should significantly contribute to biological carbon sequestration from 2023. The R&D&I Strategy of MoA 2023+ and the related research must bring new procedures and alternatives for forestry, which will ensure that forests fulfil their economic, environmental and social functions.

Research must respond in advance to trends that are apparent, i.e. promotion of digital technologies, internet of things, use of technologies and data from remote sensing, use of robotisation and features of precision agriculture. Another phenomenon that will undoubtedly develop quickly are biotechnologies, from new breeding techniques to production of various materials in bioreactors.

The R&D&I Strategy of MoA 2023+ also builds on research in agrarian history that preserves and interprets the values of agriculture for future generations through knowledge of its history and traditions, underlines the importance of landscape, rural areas and agriculture for the lives of today’s people, helps to develop a relationship of the society to agriculture, rural areas and their tradition, or enhances the relationship of farmers to their profession and of rural inhabitants to the countryside.

2.4 Research and technology trends

An apparent technological trend is the gradual spread of automation, robotisation, internet of things, autonomous machines, remote sensing means, use of satellite images etc. in the agri-food sector, forestry and water management. A specific form of that spread is the development of smart agriculture together with precision agriculture, both in crop and animal production. Although it is a form of the Industry 4.0 concept, the agriculture equipped this way loses its industrial characteristics and is environmentally friendly.

A fast development is seen in the genomics of livestock, allowing for a better selection of animals and more targeted decisions on the breeding and subsequently the economy of farming. A similarly great progress is being made in plant genetics. Genomics targeted at examining the adaptive features is developing also in forest-tree species.

Technologies of cultivation in greenhouses and indoor vertical farming are improving.

Significant investment (both public and private) is directed to developing novel foods, mainly replacing foods from traditional livestock/fish farming and fishing. At the top of these efforts is the production of meat using stem cells, so-called synthetic meat (or cultured or cultivated meat).

Biotechnologies include technologies in the production chain, new breeding techniques up to the production of various materials in bioreactors.

The development and promotion of technologies mitigating climate change in plant and livestock production has long been pursued in research.

Digital technologies develop in trade and marketing, both in wholesale and retail. In retail, significant progress was made at the time of the COVID-19 pandemic. One of the specific digital technologies is the blockchain, originally associated with virtual currencies. At present, a decentralised structure of the blockchain is being promoted in production and distribution of quality food to enhance transparency, price coordination and quality management.

2.5 Zero variant scenario

The adoption of no measures to mobilise research can cause a failure to capture the current technological trends that have the potential to achieve the MoA objectives within the required timeframe (in line with the EU and UN goals). A direct consequence would be a delay in meeting the goals, a deepening unsustainability of production and lagging behind in the efficiency and competitiveness of the Czech agri-food sector, forestry and water management. The lower effectiveness of spending public and private resources would translate into a decreased wellbeing of the Czech population compared to other developed economies. The zero variant would jeopardise the development of research as such and of ROs. Instead of synergy, some research activities would be duplicated, the transfer of knowledge into practice would be slow and the scientific community could be deprived of the reflection of its research results both by the production practitioners and the decision-makers. That would necessarily reduce the motivation of researchers and cause their gradual outflow. ROs would lose the capacity to generate and provide results for the application and decision-making spheres. It would have a negative impact on cooperation with high-quality foreign research teams and on participation in projects of European importance.

2.6 Long-term vision up to 2050

The vision, or the desirable state to be achieved in the long term (by 2050), is an efficiently managed and financed research in the agri-food sector, forestry and water management, which:

i) achieves excellent scientific results in an international comparison;

ii) provides relevant knowledge and technologies for practice and applies them effectively. This applies both to domestic private and public sectors, and to the European area and the global society;

iii) develops cooperation with scientists and research entities in related fields so as to achieve synergies in knowledge and development of technologies;

iv) focuses on priority areas that correspond to the trends named in Chap. 2.4, monitors trends and adapts its exploration areas to them;

v) responds flexibly to the needs of practice, communicates with practice and involves practitioners in research;

vi) builds multi-disciplinary and trans-disciplinary research teams to address complex problems. This applies especially to applied research and development that aspires to a fast transfer into practice;

vii) actively projects the R&D results into consultancy and education, allocates sufficient attention and capacity to their use in practice, incl. their promotion;

viii) is attractive for young as well as experienced staff and motivates researchers to grow professionally and work on socially important topics and in high quality, including on an international scale;

ix) has transparent and quality working conditions in place through advanced human resources management that applies the principles of diversity and gender equality;

x) is beneficial for all groups of the population and takes into account their specificities and needs (biological and socio-cultural).

In terms of the specific focus of research in the agri-food sector, forestry and water management, the vision is to address challenges in response to the societal and global changes, namely to:

xi) Maintain or increase the productivity of agriculture while:

a. optimising the intensification inputs in order to reduce the residues in soil and water;

b. reducing the production of greenhouse gases and other environmental pollution;

c. halting the degradation of soil and improving its condition and increasing the content of long-term stored carbon in soil;

d. minimising the impact of the agri-food sector, forestry and water management on nature and biodiversity, enhancing the natural balance and stability of relationships among all components of the environment in the landscape;

e. ensuring necessary and high-quality water sources;

f. increasing the production of biomass for non-food use - for bioenergy and bioeconomy, incl. optimising the use of waste in all production phases.

xii) maintain healthy livestock breeding while reducing the use of antimicrobials.

xiii) Maintain or increase the share of forest soil while ensuring:

g. genetic, spatial, age and biological diversity of forest stands, leading to their higher resilience, better health and the corresponding production;

h. the fulfilment of non-production functions of forests and the benefits provided by forest ecosystems including carbon sequestration.

xiv) Maintain and increase the production of availability of high-quality and healthy food for all groups of the population while:

i. enhancing responsible production and consumption with regard to resources; i.e. reducing wastage in the whole food value chain;

j. strengthening responsible consumption with regard to health;

k. supporting the quality of food with reducing the residues of pesticides and natural toxins.

2.7 SWOT analysis of the research system in the agri-food sector, forestry and water management - capacity of the system to fulfil the vision

	Supporting the achievement of goals	**Threatening the achievement of goals**
	Strengths	***Weaknesses***
Internal environment - evaluation of experience	• Long-term tradition of agricultural science and research in CZ, producing above-average number of results compared to the other fields and achieving good quality. • Enterprises involved in R&D&I are mostly owned by domestic capital. • A large portfolio of ROs covering a wide spectrum of topics of basic and applied research. Those ROs have strong ties to MoA, some are directly coordinated and financed by MoA. New regional research infrastructures supported from ESIF. • Many ROs focus on research activities for practice and provide consultancy in the application of modern technologies and innovations. Moreover, they are distributed also in rural areas and are not concentrated exclusively in large towns. • The openness of competitive biddings in R&D&I and the equal terms encourage the interest of ROs in taking part in research in the agri-	• Research shows low competitiveness and low collaboration. • Insufficient feedback on publicly accessible research results from end users. • Insufficient use of research results achieved in the agri-food sector, forestry and water management both in private and public practice. • Insufficient involvement of the private sector in the co-financing and financing of research in the agri-food sector, forestry and water management. • Varying level of research in priority topics and low level of multi-disciplinary approach. • Insufficient experience of ROs with the preparation and submission of quality international grant applications, inability of ROs to effectively use European grants. • Lack of experience with the application and conditions of the new methodology of RO evaluation, with assessing the quality of ROs and

	food sector, forestry and water management. • Improving organisational and technical arrangements of competitive biddings and administration of projects by NAAR. • Existence of a separate budget chapter for research in the agri-food sector, forestry and water management under the responsibility of MoA. • Involvement of the research community and research actors in decision-making on purpose-tied aid programmes, project selection and evaluation of impacts through CAAS. • The gradually increasing quality of national scientific journals in the agri-food sector, forestry and water management creates a (communication) bridge between Czech science and the international community of scientists in that field.	evaluation of applied results in practice. • Excessive emphasis on short-term problems and little attention paid to long-term topics with a timeframe of 10 to 20 years. Absence of long-term projects (5 years and more). • High administrative burden on ROs. • Low share of research projects recommended for financing out of the total number of submitted projects (e.g. purpose-tied aid of NAAR) due to a low financial allocation for the competitive biddings. • Uncertain continuity of financing destabilises the personnel policy of ROs and reduces the involvement and retaining of specialists in some areas.
	Opportunities	***Threats***
External environment - system conditions	• Possibility to use talents - quality graduates of universities (mainly ending doctoral candidates) and researchers working abroad as a source of new impulse in research. • Deepening the partnerships between the aid providers and representatives of applied research, greater coherence between information, coordinated approach and cooperation among R&D entities (including R&D infrastructures) and with foreign entities in addressing common topics (e.g. the African swine fever). • Greater involvement of the research sector in international programmes and committees (BIOEAST,	• Reducing the volume of public and non-public funds allocated to applied research (e.g. due to extraordinary expenses of the state to combat the COVID-19 pandemic) and reducing the support for the research management system with an impact on both the long-term and short-term staffing of ROs with professional staff. • Societal and legal regulation restricting the search for innovative solutions as a response to climatic change and current societal trends (e.g. prioritising economic interests over the protection of natural resources, restricting new techniques of genome editing etc.).

	HORIZON EUROPE, SCAR, JPI FACCE etc.). • The new system of RO evaluation based on Methodology 17+ offers the MoA ROs a reflection on their performance and so can be used as a tool for effective RO management. • The potential of foreign firms, either processing Czech raw materials from agriculture and forestry or supplying inputs into agriculture and forestry, to use Czech ROs to meet their research needs. • A higher use of existing research capacities and strategic focus of research topics related to addressing current societal and technological challenges by increasing the funding for research from public and non-public sources (e.g. the programme of purpose-tied aid for research and institutional funds of MoA) and, as a result, increasing the share of research projects recommended for financing out of the total number of submitted projects.	

The SWOT analysis shows that the national system of research in the agri-food sector, forestry and water management has a broad base of specialists in most areas and of knowledge allocated in many ROs with a long tradition. Many ROs (mainly public research institutions) carry out quite extensive basic research while another large group of ROs is close to practice and, apart from research, provides technical services and technological consultancy. Despite the mostly positive structure, there is a lack of systematic cooperation with practice and the share of primarily business research is low.

A specific problem is the evaluation of ROs, from which the public budget financing of ROs is derived. That evaluation emphasises excellence that primarily lies in professional publication activity and does not take into account the need of permanent involvement of experts in various research areas as core staff and causes personnel instability and indirectly also reduced performance. The excessive and still prevailing pressure in this sense has been transferred to the individual workers in the same degree regardless of their abilities, capacities and past merit, and it negatively affects the division of labour, cooperation and mainly the attention paid to the relevance of results for practice and to the transfer that can be capacity- and time-demanding same as the previous research.

The pressure on excellence is not compensated by pressure and mainly willingness of the business sector to invest private funds in research. This is partly because even relatively large

agricultural and forestry enterprises cannot afford to finance research in the needed extent, moreover, with the risk that there will be stowaways who will reap the results in the form of new, publicly accessible technologies. The low willingness of businesses to use research results due to contradictory (mainly market) interests and risks entailed by the implementation of innovative solutions.

The search for innovative solutions as a response to technological, societal challenges and climatic change requires a setting of the conditions of R&D&I support that will encourage such solutions and create a suitable organisational framework supporting cooperation of the actors across sectors and scientific disciplines and, inter alia, will enable a longer-term research in strategic thematic areas.

Undoubtedly, a strength is the establishment and operation of large research infrastructures and other research infrastructures such as the South-Bohemian research centre for aquaculture and biodiversity of hydrocenoses (CENAKVA), SoWa (Soil and Water) for comprehensive monitoring of soil and water ecosystems in the context of sustainable use of landscape of the Biological Centre of CAS, METROFOOD-CZ focusing on research in environmental sciences, health and food, or the Czech Plant Phenotyping Network (CzPPN) that succeeded in the international peer-review evaluation of large research infrastructures of CZ in 2021, and regional science and research centres such as the Centre for Advanced Microbiology & Immunology Research in Veterinary Medicine (AdmireVet), the Fruit Research Institute (OVI), or the Center of the Region Haná for Biotechnological and Agricultural Research (CRH), of which some are linked to the MoA ROs. Despite the potential and goal of those infrastructures to support cooperation and synergy among research activities, the involvement of R&D staff of MoA ROs is only partial. Moreover, the interconnection of ROs in the agri-food sector, forestry and water management with biological science infrastructures that deal with very closely related topics is negligible.

Many ROs also require significant coordination if the system is to achieve the policy objectives (by responding to challenges). A positive role could be played by large and other research infrastructures but, so far, that opportunity has not been translated into a strength of the system.

3. Implementation of the R&D&I Strategy of MoA 2023+

The situation analysis and SWOT analysis show that greater attention of the research sector needs to be paid to some priority topics for society and to technological trends, and conditions need to be created for streamlining the research work and the knowledge and technology transfer into practice. And to focus on measures for strategic management of R&D&I support.

3.1 Key areas - thematic priorities

In response to societal and technological trends and climate change, the R&D&I Strategy of MoA 2023+ defines three thematic key areas of R&D&I.

Key areas of the R&D&I Strategy of MoA 2023+:

1. Bioeconomy
2. Smart agriculture
3. Global changes in the biosphere.

3.1.1 Bioeconomy

Climate change as a global and regional problem is the basis for formulating a new EU growth strategy, the Green Deal, based on the fundamental pillars of maintaining high competitiveness, achieving carbon neutrality and an efficient, sustainable use of natural resources. EU Member States should now integrate those goals into their socio-economic development plans. The development of bioeconomy is one of the tools. A new European bioeconomy (BE) strategy understands this field as a direction with the potential to ensure supplies of safe food, reduce dependence on non-renewable sources, mitigate the climate change impacts, develop rural regions and diversify activities and create new jobs.

BE is winning an increasing attention as a sustainable way of economic growth and competitiveness, an opportunity to support innovation, create jobs in rural and industrial areas, reduce dependence on fossil fuels and improve economic and environmental sustainability. BE should be perceived as a transformation of the society towards a more sustainable development. BE can be seen as multi-field economic sector, the development of which is conditioned by high-quality R&D&I. Bioeconomic topics are very closely linked to other national strategic documents such as the proposed Strategic Framework of Circular Economy of the Czech Republic 2040 (Circular Czechia 2040) under the responsibility of the Ministry of the Environment.

BE as a key area of the R&D&I Strategy of MoA 2023+ can be viewed both from the broader perspective of the agricultural sector economy, i.e. the economy of agriculture, forestry and the related sectors, and from the macroeconomic perspective expanded with the environmental and institutional aspects and economy of rural areas, mainly focusing on the comprehensive development of rural regions.

For the above reasons, research should focus mainly on the following lines:

- *New technologies for the use of biological waste and a maximum use of by-products and residual products from agriculture, forestry and food processing (carbon recycling).*
- *Development of bio-fertilisers, bio-pesticides and biological pest control.*
- *New methods and techniques of using materials based on bio-materials - for building insulation etc.*
- *Development of the concept and pilot introduction of circular economy that is based on primary agricultural and forestry production, and connecting such entities to the production chain with an emphasis on higher added value.*
- *Analysis and a proposal of a BE training system and BE application in agriculture and forestry.*
- *Application of BE opportunities in the comprehensive development of rural regions.*

BE is a great opportunity for ROs and businesses in research, development and application of new solutions and development of new business opportunities in biomass processing. A great opportunity is the processing of the current by-products or waste to produce sources of biological active substances for nutrition or products with a higher added value. That way, BE interconnects with circular economy, which brings higher synergies. To identify these new opportunities, information is required about the flows of biomass that is available for further processing.

It is estimated that BE in connection with circular economy can create in Europe up to 400 000 new green jobs by 2035.

The Bioeconomy key area has strong links to the majority of research directions (RDs) defined herein. The strongest link is to the RD forestry and agricultural economy and policy (RD XI) but the link to most other RDs is also not negligible. Research and development of new technologies for processing by-products is connected with plant and livestock production (RD V and RD VII) and agricultural machinery (RD X). Development of new phytosanitary inputs is linked to RDs VI and V. An important link is also to directions focused on fundamental natural resources (RDs I, II and IV).

3.1.2 Smart agriculture

Smart agriculture concerns all agricultural, forestry and food activities that apply digitisation, automation, robotisation, precision agriculture, remote sensing technologies and identification of the condition of forests and use of sensors. In this context, the priority of the R&D&I Strategy of MoA 2023+ is support for the development of precision agriculture.

In the historical sequence of qualitative changes, the term Agriculture 4.0 has also been introduced. It differs from its predecessors, which primarily influenced production techniques and technologies in the farm or enterprise, in that it influences all parts of the value chain in agriculture, including outside the farm. The roles of a farmer or forester will certainly require more knowledge in information technologies and data analysis. The importance of agricultural research will grow along with that as a new dimension is opening up for it in fields that were typical for industrial activities. This key area strongly reflects the objectives of the Coordinated

and Comprehensive Digitisation Strategy of the Czech Republic 2018+ (Digital Czechia), specifically its pillar 3 - Digital economy and society.

Smart agriculture - application in research directions: plant and livestock production, soil, agricultural machinery

The current development of sensorial systems and information and communications technologies means that, in farming and forestry, a great amount of useful data can be obtained not only on the activity of the vehicles but also on the characteristics of the surrounding environment (soil, plants etc.). Such data may be used to improve the work of the farming and forestry vehicles but also to improve the whole production process in the farm. It is a new level of information on agricultural production, not available before. There is also a large amount of information usable in agricultural production, available through sensors collecting data during the work of agricultural vehicles, and from other sources, typically the remote sensing. That provides in particular aerial photographs from unmanned or manned aerial vehicles and satellite images. However, such raw data can be used for managing agricultural production to a very limited extent. They must be processed so that they are usable. The development of precision agriculture plays an irreplaceable role in this process.

On the other hand, there are already in common use some means facilitating the introduction of the latest technologies into agricultural production. Also the deployment of fast 5G transmission networks is a matter of the near future. Moreover, tools of the internet of things (IoT) are becoming available. The combination of all of the above creates good conditions for introducing the technologies of smart agriculture.

An increasingly important role in agricultural production will be played by autonomous or robotic systems. Their importance lies in further replacement of human labour for economic or social reasons. It is the economic reasons that drive farmers to use larger and more powerful vehicles. But robotic systems may also contribute to addressing some serious problems of the current agriculture, associated, e.g., with the technogenic compaction of soil caused by the operation of heavy farming vehicles. Robotic systems enable the development of entirely new structures in which the labour of one large vehicle driven by a human operator can be replaced by the labour of multiple autonomous robotic systems that are only supervised by humans. The use of technologies in smart agriculture can quite quickly and significantly contribute to improving the current situation e.g. by introducing technologies of controlled driving on farming land or by targeted monitoring of soil compaction.

In order to exploit the potential of technologies in smart agriculture, some obstacles need to be overcome. All technologies used must communicate with each other smoothly, which is currently true to a very limited extent. The use of information and communications technologies in agricultural production still often requires time-consuming setting or management, the architecture for its deployment is not sufficient. There is no adequate standardisation taking into account the fact that the end user of these modern and fast developing technologies is always the farmer. An example of good practice is the MoA Farmer’s Portal that has been providing, for two years already, conversion files for four kinds of GPS, used currently by new farming vehicles (mainly tractors), and thanks to those files, farmers can transfer their data on agricultural parcels or portions of land blocks into their vehicles as well as back to the MoA Farmer’s Portal.

For the above reasons, research should focus mainly on the following lines:

- *The possibilities of implementing technologies for robotisation and automation of plant and livestock production, including the application of the precision agriculture approach.*
- *Mapping the state of agricultural and forest stands using unmanned aerial vehicles and satellite images.*
- *Processing available data for the needs of the management of crop and forest production, including big data.*
- *Internet of Things (IoT) with the potential of use for precision and smart agriculture.*

Smart agriculture - application in research direction Food production

The potential of existence and growth of Czech food industry is necessarily connected to intensive research and development of new types of foods with a high share of added value. That added value is connected, for consumers, with health benefits, consumption comfort, speed of food preparation etc. As all sectors of the food production mainly deal with the processing of the relevant agricultural commodities, food research is inseparable from agricultural research of those commodities.

In the food industry, research must respond to new technological procedures that will, in line with the precision agriculture approach, optimise the inputs of raw materials, energies and labour, and will ensure a minimal environmental impact. That is connected with an effective use of by-products of food production, new techniques, useful microorganisms and natural bioactive substances.

The food industry has already started to use robotic installations to manipulate with raw materials and products, to use in-line sensors for effective management of technological processes, or to process secondary raw materials and waste from food production. Other examples include automatic monitoring of expiry dates, of storing conditions, batch numbers and factory data in order to reduce waste, or, in a combination with temperature sensors, building a verifiable system for product quality and higher safety of food.

For the above reasons, research should focus mainly on the following lines:

- *The composition of food raw materials, foodstuffs and their bioactive components, and their impact on human health.*
- *New foods and production procedures and special foods for defined groups of the population.*
- *Developing modern methods of hygiene and sanitation in the food chain.*
- *Technologies for the production and preparation of food.*
- *Developing nanotechnologies and products on their basis.*
- *New methods of analysing the composition of raw materials for foodstuffs, foodstuffs and their properties.*

Smart agriculture - application in research direction Forestry and the related sectors

Forestry is increasingly applying new technologies for identifying the state of forests, for digital processing of data in the evaluation of their state, and in forestry production and inventory of both environmental and production factors.

For the above reasons, research should focus mainly on the following lines:

- *Identifying the state of the environment, production conditions and recording the forestry production.*
- *Inventory of the condition of stands in terms of cultivation and conservation.*
- *Utilising the methods of remote sensing, production records, and data transfer and processing.*

3.1.3 Global changes in the biosphere

Global changes in the biosphere increasingly affect and to some degree even threaten the development of global human society. The agricultural sector including forestry and the natural resources (biodiversity, water, soil) belong to the most threatened spheres. The share of human activity is decisive in some aspects (desertification, erosion, water sources), and considered significant in other aspects (climate change).

The agri-forestry sector is, in the front line, exposed to the consequences of global changes but it has significant potential to adapt and mitigate their impacts. Therefore, research is used to address the climate change consequences and their prevention. A newly announced programme of the EU framework programme Horizon Europe strongly reflects that topic. The cluster important for agriculture is No 6 „Food, Bioeconomy, Natural Resources, Agriculture and Environment“, which takes into account the Green Deal principles in its research topics. This key area reflects the expected trends in adaptation and mitigation, mainly in a link to climate change.

Leading experts in the relevant field in the Czech Republic assume that our geographical area will be significantly affected by climate change. Negative impacts are expected on farming both on agricultural and forest land due to more frequent events of meteorological, agricultural and hydrological drought. It will be necessary to prevent the negative impacts of climate change on farming, manifesting mainly by temperature rise during all seasons of the year and by growing climate extremities. As a result, we will have to, for example, review the occurrence of production types on the national scale. This applies also to changes in forest ecosystems with a subsequent need to change the species composition and forestry procedures.

Forest stands in Central Europe are under strong pressure due to climate change manifestations. The dry periods in the years 2014-2018 were one of the causes of the unprecedented bark beetle calamity on spruces and of the extensive damage to pine stands. Some wood species - e.g. alder and ash-tree - are under strong pressure of pathogens that are partly developing due to climate change. The cultivation of wooded plants in extensive monocultures, broadly applied to date, appears to have little prospects.

For the above reasons, research should focus mainly on the following lines:

- *Suitable farming methods and efficient agri-technical and cultivation measures including carbon farming. Continuing the development of soil protection technologies. Using the results of long-term experiments to design cultivation system that increase production stability and reduce soil degradation.*
- *Developing suitable crop rotation using crops better resistant to abiotic stress.*
- *Breeding plants, mainly agricultural crops more resistant to abiotic stress.*
- *Selecting a suitable species and genetic composition of the renewed forest stands, their cultivation and impacts on carbon sequestration and other ecosystem services.*
- *Modifications in landscape to increase its retention capacity. Revitalisation of watercourses and the building of wetlands or windbreaks reducing wind erosion. Developing a methodology for land consolidation, targeted at reducing the negative impacts of dry periods and at optimising the share of forest ecosystems in agricultural landscape.*
- *Maintaining and increasing biodiversity in agro-ecosystems and in forest ecosystems.*
- *The issue of revitalising and building retention ponds and modern irrigation systems.*
- *Identifying the existence and condition of draining systems, eliminating them in unsuitable locations or adapting them to regulation drainage.*

3.2 Research directions of the R&D&I Strategy of MoA 2023+ and their links to the key areas

The key areas are presented in the R&D&I Strategy of MoA 2023+ as thematic research directions essential for the agri-food sector, forestry and water management. There are 11 of them and they are listed in the table below. The table also shows the weights of the research directions for achieving the goals of the key areas of the R&D&I Strategy of MoA 2023+, the strength of the link is expressed by the number of Xs (the higher the number of Xs, the higher the importance of the research direction for the key area).

Research directions	Key areas		
	Bioeconomy	Smart agriculture	Global changes in the biosphere
I. Soil	XX	XXX	XXX
II. Water	XX	X	XXX
III. Biodiversity	X	XX	XXX
IV. Forestry and the related sectors	XX	XX	XXX

V. Plant production	XX	XXX	X
VI. Plant health	XX	XXX	XX
VII. Livestock production	XX	XXX	XXX
VIII. Veterinary medicine	XX	XX	XXX
IX. Food production	X	XXX	X
X. Agricultural machinery	XX	XXX	XX
XI. Forestry and agricultural economy and policy	XXX	XX	XX

3.2.1 Soil

Research in the use and protection of soil is a key topic for agriculture and forestry. It has a long tradition in CZ and it received attention also in the last five-year period. The main causes of soil degradation in CZ are known and the research topics to date have targeted those problems (water and wind erosion, soil organic matter, technogenic compaction, contamination, acidification, landscape structure, climate change etc.). In its global prognoses, OECD expects, on the one hand, the necessity to enlarge arable land by about 10% by 2030, to increase the yield of agricultural crops and to triple the input of nutrients into the soil (mainly in developing countries), and, on the other hand, problems associated with the growing human population and climate change. The growth of areas affected by drought and desertification, expansion of settlements into the countryside mainly in the fast-growing developing countries, and the increasing requirements of the population on food consumption in terms of quantity and quality (higher share of animal products in the diet), continuing environmental pollution with existing as well as new types of pollutants including microplastics, will put a rising pressure on the soil and other natural resources.

It must be noted that soil is an integral part of all terrestrial ecosystems, not only of agro-ecosystems but also forest and grass ecosystems. It is the basis of productivity of both natural and anthropogenically influenced terrestrial ecosystems, and it influences water and urban ecosystems. It is, inter alia, the main carbon capturer in the terrestrial ecosystem, has a significant share in water retention and circulation in the landscape. In the ecosystem approach, the living and non-living components of the environment always interact.

The condition of the soil is also the basis of all agricultural activity. Organic farming with its environmentally friendly practices has a positive impact on the fertility of soil and its functions.

In the European environment, an increasing emphasis will be placed on the quality of soil and its functions in a “healthy” landscape. It will be necessary to concentrate on areas that are more threatened by climate change and the growing drought. The availability of water for plants during their growing season is becoming one of the most limiting factors of the yield and quality

of crop production and a decisive factor of the health condition and production of forest stands. EU policy will put greater emphasis on agro-ecological knowledge and its application in agricultural systems that will be able to retain more water in the landscape and will contribute to preserving biodiversity while producing sufficient amount of quality production. A healthy soil environment is a precondition for achieving such visions. A certain compromise will have to be reached among the economic, environmental and social objectives. Precision agriculture is one of the alternative approaches to addressing that challenge.

The Czech Republic has traditionally belonged to countries with a high-performing agriculture and production-oriented forestry, which are now facing some defined problems (unbalanced plant and livestock production, high share of rented farming land, dependence of certain agricultural production areas on subsidies, inadequately low farm-gate prices of some commodities, the species and age composition of forest stands etc.). Those problems reflect directly in the farming on soil (unsuitable crop rotation, lack of soil organic matter, risk of water and wind erosion etc.). Forestry is currently combating the bark beetle calamity, the consequences of which (extensive deforestation, planned change of the species, spatial and age structure of forests) will significantly affect the condition of forest soil and its functions, such as carbon sequestration. The above problems are addressed not only by research, but some specific measures have already been introduced in practice (e.g. reducing the size of land blocks to a max. of 30 ha, applying soil protection technologies of tillage, amending the decree on the contamination of agricultural land, preparing a proposal for an anti-erosion decree etc.). Increased efforts were devoted in recent years to the issue of drought, which reflected in developing a new methodology of land consolidation, revitalisation of drainage and irrigation systems etc. A growing problem is the decrease in the agricultural land fund and the impermeable surface coverage (sealing).

Research priorities in RD "Soil". For a specification of the research areas (up to the level of specific research topics) see Annex 1:

1.1. Increasing the volume of water in the soil profile.

1.2. Soil degradation and the options to eliminate it including research of the impacts of dual use of land (e.g. agrivoltaics).

1.3. Nutrients in soil and bio-based materials as soil substrates with an emphasis on circular economy and carbon storage.

1.4. Agroforestry systems (including linear farming) and their impact on erosion and water runoff.

1.5. Digital sources and systems of information on soil, mapping, remote sensing.

3.2.2 Water

The weight of global warming and climate change falls mainly on "WATER" and the related floods and droughts, which is the subject of a wide range of research in water management, not only in CZ. Precision agriculture brings knowledge of the possible savings and efficient use of water in the agricultural production process.

From the perspective of water managers, environmental improvement and mitigation of climate change impacts can be supported by R&D projects directed mainly at optimisation of the

production and non-production functions of the landscape, such as preventive measures that include, in general, improvement of the absorption capacity of the whole landscape.

A significant contribution to maintaining the quality of water and retaining it in the landscape is made by organic farming. Projects on increasing the effectiveness of organic farming and so enabling its expansion will enhance the effect of that farming method on water quality.

The issue of water retention in the landscape must be addressed by both preventive and subsequent measures that will often have to include technical measures.

Research priorities in RD "Water". For a specification of the research areas (up to the level of specific research topics) see Annex 1:

2.1. Mitigating the climate change impacts.

2.2. Optimising the production and non-production functions of the landscape, sustainability of agriculture, development of organic farming and efficient use of water resources.

2.3. Minimising the impacts of torrential rain and soil-erosion phenomena.

3.2.3 Biodiversity

Biodiversity as a biological basis of the natural heritage of the landscape[4] and the development of agroforestry complex is rightly set apart as a separate research direction. Great space is open for research to address partial as well as comprehensive topics by the Commission communication in the EU Biodiversity Strategy for 2030: Bringing nature back into our lives.

Loss of biodiversity is a global problem affecting the natural conditions of CZ, Europe and the world as a whole. The priority areas focus both on agroecosystems and forest ecosystems. A great emphasis is placed on learning about all components of the ecosystems, including microorganisms in the aboveground and underground environment. Other important types of ecosystems are aquatic and wetland ecosystems that critically integrate the production role and protection of specific communities while representing a significant factor for increasing water retention in the landscape.

Biodiversity in CZ is relatively high thanks to the geographical location and temperate climate zone, but is currently changing at a fast pace. New species are arriving, either through spontaneous spread (mostly from the south with the climate warming) or in connection with human activity (these are often invasive species). The protection and regeneration of biodiversity and the well and naturally functioning ecosystems are the key for sustainable agricultural and forestry production. Investment in natural capital, utilisation of the latest research results and bioeconomy features rank among the most important challenges of the present day. Farmers and foresters as the managers of our countryside play a crucial role in

[4] Natural heritage of the landscape is understood here within the meaning of Art. 2 of the Convention concerning the Protection of the World Cultural and Natural Heritage (Communication No 159/1991 Coll.). It means natural features consisting of physical and biological formations or groups of such formations, which are of outstanding universal value from the aesthetic or scientific point of view; geological and physiographical formations and precisely delineated areas which constitute the habitat of threatened species of animals and plants of outstanding universal value from the point of view of science or conservation; natural sites or precisely delineated natural areas of outstanding universal value from the point of view of science, conservation or natural beauty.

preserving biodiversity through their farming activities. They must produce a sufficient amount of safe and affordable foodstuffs and raw materials while observing sustainable practices. For that reason it is important to develop the organic method of farming that applies environmentally friendly practices, without using synthetic plant protection products and mineral fertilisers. An analysis of biodiversity and its dynamics in connection with land use is a basis for protecting and creating the production part of the landscape.

The knowledge of the developments, changes, degradation and regeneration processes of ecosystems co-determines the stability of landscape, its diversity, productivity and quality of life of the people, both residents and visitors, as well as its natural value. Research and innovation are the key to understanding the impact of biodiversity management on the whole food production chain, production of natural raw materials, impact on the water regime (including the drinking water resources and water retention in the landscape) and on its importance for the ecosystems as a whole. Agroecosystems represent artificial systems with fully influenced processes and with the highest impact on biodiversity. To maintain their functions and ecosystem services, it is necessary to innovatively modify the technologies including the approaches to the living component as the bearer of biodiversity. Forest ecosystems are a climax type of biomes in the majority of CZ territory. Due to the long-term human activity, their genetic, species, age and spatial structure is now changed, with a positive effect on the forestry and timber production and the technological characteristics of the wood raw material, but also with a negative effect on their stability and vitality and on the overall diversity of forest habitats. The regeneration of aquatic and wetland ecosystems represents a great challenge for their integration into the bioeconomy concepts on the one hand, and into a functional landscape on the other hand.

Research priorities in RD "Biodiversity". For a specification of the research areas (up to the level of specific research topics) see Annex 1:

3.1. *Biodiversity in agroecosystems.*

3.2. *Biodiversity in forest ecosystems.*

3.3. *Biodiversity of aquatic and wetland natural and artificial ecosystems.*

3.*4 Tools for the study and evaluation of biodiversity.*

3.2.4 Forestry and the related sectors

The strategic and continual objective of the national forestry policy is the sustainable use of the production function of forests and of the set of ecological and environmental functions of forest ecosystems in the landscape (ecosystem services). The goal of forestry is the ability to fulfil, at present and in the future, the appropriate environmental, economic and social functions at local, national and global level, not harming the other ecosystems. The forest and its ecotone are also significant bearers of biodiversity spilling over to the surrounding countryside.

The importance of the stability, vitality and production capacity of forest ecosystems is growing in the current situation of climate change and the necessity to take part in carbon neutrality, but also as the society focuses on renewable sources, their rational and sustainable use, as

well as their integration into the bioeconomy concept. The technological development of forestry disciplines and the related sectors is taking place in a strongly globalised environment. Its applications must be appropriately integrated into the regional and local conditions so as to maintain the quality of the landscape, the forestry services, and a modern use of the forest production, and to maintain and develop the downstream industrial sectors and the rural space.

An extraordinary challenge is the current breakdown of forest stands, primarily the spruce, as the base of the wood-processing industry. Within a very short time, it is necessary to respond to large fluctuations in the offer of the wood raw material, to change technologies and approaches to wood processing. The effects of the forest in the landscape and the renewal of structural, age, species and genetic diversity of forest stands pose many opportunities for innovative approaches to forest monitoring and inventory, cultivation and use. Wood as a renewable raw material plays an irreplaceable role in circular economy (bioeconomy), represents an economic base for the rural space and an indispensable source for the downstream processing industries. With its capacity, even regardless of the forest ecosystem services, it surpasses multiple times the actual forestry. The non-production functions grow in importance in the life of the society that is increasingly urbanised. Society's requirements for further ways of forest use pose a large set of problems that must be researched in advance.

The research priorities in research direction Forestry and the Related Sectors should, therefore, adequately reflect the needs of the relevant human activity sectors. First of all, they should focus on a relevant evaluation of the condition and dynamics of forest ecosystems and the sector, and monitor the trends in the natural, economic and social conditions. The monitoring and inventory activities are necessary for any competent decision-making. The requirements placed on the sector can be met only if forest ecosystems remain stable and resilient, and so research in the dynamics of the forest health condition and ecological stability in the changing environment is a logical next step. The turbulently changing conditions in the biosphere require an increased attention paid to forest protection and the adaptation and mitigation aspects of forest heritage conservation, and to meeting the many-sided and often conflicting requirements of the society. The utilisation of the production function of forests requires an innovative approach to their cultivation, the use of logging and transport technologies, and also to the whole complex of utilising the produced wood raw material. Precision agriculture in forestry can provide valuable input in this respect. All of the above plays a key role in the sector's bioeconomy and in the related issues highlighted in the European and world context. Further development of hunting, mainly in monitoring the occurrence and searching for tools to combat dangerous diseases and to generally care for the wild game in the changing natural and societal conditions requires more attention of the sector research that must be significantly supported. It is also necessary to reflect the change in the European hunting paradigm, mainly by expanding its scope in the regulation of selected native, non-native and mainly invasive non-native species of fauna in response to the developing needs of natural diversity, maintaining farming and thereby the rural settlement and other national or European Community priorities.

Research priorities in RD "Forestry and the related sectors". For a specification of the research areas (up to the level of specific research topics) see Annex 1:

4.1. Evaluating the dynamics of forest ecosystems - monitoring and inventory.

4.2. Stability and health condition of forests.

4.3. Adaptation and mitigation measures associated with the change of climate and the society.

4.4. Bioeconomy, forest ecosystem services and the related fields.

4.5. Game management and conservation in the landscape.

3.2.5 Plant production

Plant production is the fundamental sector of the whole agriculture, it directly or indirectly secures human nutrition, feed for livestock and raw materials for further industrial processing. A part of the production returns to the soil as an irreplaceable source of organic substances in the system of soil fertility sustainability. Plant production has to meet no small requirements to produce sufficient amount of quality foodstuffs and feed while applying sustainable farming systems.

However, there are shortcomings. The care for the soil is often insufficient, the systems of farming on agricultural land are unbalanced, a regular and sufficient input of organic matter is not ensured, crop rotation is not respected, the soil is compacted unnecessarily by the excessive use of heavy machinery, the specificities of pedological conditions in specific production areas are not taken into consideration. Plant production is largely focused on cultivating marketable crops, i.e. crops with a high economic effect (winter wheat, winter rape, maize) which, however, place high demands on observing the basic principles of agronomic practices such as a regular input of organic matter and nutrition into the soil, adjusting the soil pH etc. A failure to comply with such principles has very unfavourable impacts even on the basic components of the environment. Climate change with longer drought periods and uneven precipitation also has a significant impact.

The priority goals of research in the research areas below is to respond to the known shortcomings, to find remedy for them, to ensure technological development while respecting the principles of sustainability, production quality, biodiversity and environmental protection. It is also necessary to take into account and, based on research, implement in practice the principles of the Common Agricultural Policy Strategic Plan and of important EU strategies, mainly the European Green Deal and the follow-up 'Farm to fork' strategy for a fair, healthy and environmentally-friendly food system. The suitable and needed tools to achieve the objectives will include the use of new breeding techniques and molecular biology, the constantly developing technologies of smart agriculture and precision agriculture with an emphasis on automation and robotisation, or the use of circular economy and organic farming principles.

Research priorities in RD "Plant production". For a specification of the research areas (up to the level of specific research topics) see Annex 1:

5.1. Genetic diversity, plant breeding.

5.2. Sustainable production of non-hazardous and high-quality raw materials, foodstuffs and feed of plant origin.

5.3. Quality and safety of plant production.

5.4. Non-food production.

5.5. Climate change adaptation of plant production and mitigation measures.

3.2.6 Plant health

Plant health is an integral part of plant cultivation and of the whole agricultural practice. It introduces, develops and improves methods to regulate harmful organisms, i.e. pathogens, pests and weeds infesting crops, orchards, forests, stored commodities, both on agricultural and non-agricultural land. To that end, it uses organisational and agronomic measures, both biological and chemical plant protection products. In addition to common and known harmful organisms, new non-native species appear, and the intensity and range of occurrence of pests or weed species is changing. The gradual climate change and the effects of warming and whether conditions are manifesting. An important factor in the development of pathosystems is the extent and structure of crop cultivation and the method of farming.

All of those factors must be considered in the plant health research also in the upcoming period. At present, the civil society wrongly believes that farmers do not contribute to the good environment and that they adversely affect the quality and safety of plant products by chemical inputs. One of the tasks of research is to correct such statements with rational arguments. The reducing availability of active substances in plant protection products increases the risks of resistance of the harmful organisms against them, and so a crucial task of the plant health research is to develop suitable methods of monitoring such resistance and find available anti-resistance strategies.

The priority objectives of research direction Plant Health are to find new environmentally acceptable methods of reducing the occurrence and harm of harmful organisms by biological and chemical products, to research the bionomy and methods of monitoring and diagnosing the harmful organisms in order to improve the systems of integrated plant protection and sustainable use of plant protection products. A benefit will certainly be the use of new breeding techniques (NBTs) to reach resilience and tolerance of new varieties to harmful organisms. By integrating protective mechanisms into the genome of the crops it is possible to create varieties resistant or tolerant to diseases and pests.

The research solutions must guarantee that their application will meet the basic goal of the plant health field, i.e. to ensure the production of safe raw-materials and foodstuffs of plant origin. The research solutions involve a whole range of new knowledge from biotechnologies, nanotechnologies or IT skills including experience with applying precision agriculture, or smart agriculture in general. Biological methods play one of the key roles in the non-chemical plant protection and thanks to that the research in cultivation systems will focus on the intentional use of natural enemies and antagonists that are the most important group of organisms

involved in a natural suppression and regulation of harmful organism populations in the natural environment. Those methods of plant protection are essential for plant protection in organic farming and it is equally important to focus on introducing new plant protection products usable in organic farming and to research the options of using existing products against other pathogens and for a different group of crops. The research direction responds to the objectives of new European Commission strategies, mainly the 'Farm to fork' strategy for a fair, healthy and environmentally-friendly food system, and will bring new knowledge that will enable the implementation of those objectives that appear rational for the Czech environment.

Research priorities in RD "Plant health". For a specification of the research areas (up to the level of specific research topics) see Annex 1:

6.1. Plant protection management.

6.2. Innovation of Integrated Plant Protection methods.

6.3. Biological and non-chemical means and methods of plant protection.

6.4. Plant resistance to harmful organisms.

3.2.7 Livestock production

In the Czech Republic, Europe and worldwide, the rearing of all kinds of farm animals, including fish and bees, plays an important role. Optimised and correctly managed production systems of animal husbandry, contributing to a safe and healthy nutrition of humans, help to improve the quality of their lives and to develop both rural communities and the whole society, are an integral part of ecosystem services and the circular economy. If animal husbandry is to cope with the coming challenges of the changing economic, natural and social environment, it must develop and change.

Research and development significantly contributes to increasing the competitiveness and effectiveness of the whole area of livestock production. The result of R&D are not only healthy animals in farms but also the related safety and quality of animal products as well as the economic prosperity of the farms that goes hand in hand with improving the environment and developing a living countryside. Domestic livestock production should produce a maximum share of foodstuffs of animal origin for the needs of the Czech population. R&D will have to focus not only on the most frequently reared kinds of animals (cattle, pigs, poultry, small ruminants) used in the current livestock production, but also on fish, bees, rabbits, farmed game and other kinds of farm animals, as well as on the non-production functions of animal husbandry or on rearing animals for sport, assistance activities (animal-assisted therapy) and leisure. The focus on organic farming covers a large part of those topics because, apart from producing quality food, organic farming emphasises the welfare of farmed animals. Precision agriculture provides knowledge and approaches to economical livestock production.

Same as in other areas, also livestock production research needs quality management, a financing perspective and objective evaluation. It is very demanding in terms of the availability and sharing of new findings and knowledge, and the related high need for innovation (devices, methods and techniques for analytical procedures at molecular and sub-molecular level, new mathematic models etc.). It is also demanding because of the necessity to experiment often with large farm animals that cannot be replaced with smaller model species. Apart from

ensuring the production of quality and safe foodstuffs in connection with the growing requirements of current consumers, it will be necessary to address current problems such as adaptation of the animals to the changing climate, reducing the environmental burden, feed instability, the future deficit of proteins in the diet, reducing the dependence on import of feed from non-European countries, preserving biodiversity in agricultural systems or the increasing prices of agricultural production inputs.

A growing emphasis will be put on ensuring the highest possible welfare and health of the farmed animals. The research activities in research direction Livestock Production will be increasingly inter-disciplinary, requiring close cooperation of research teams of various specialisations as well as the participation of a wide range of future users of research results such as farmers, agricultural entrepreneurs, the processing industry, consumer organisations etc. It is necessary to enhance scientific cooperation and experience sharing by participating in joint scientific projects of regional, European or global importance.

Research priorities in RD "Livestock production". For a specification of the research areas (up to the level of specific research topics) see Annex 1:

7.1. Genetics and genomics, breeding and reproduction of farm animals, use of biotechnologies in livestock production.

7.2. Systems and technologies of animal husbandry, welfare of farm animals and livestock production economy.

7.3. Nutrition and feeding of animals, quality and safety of feed and of animal products.

3.2.8 Veterinary medicine

Research in veterinary medicine is key for sustainable agriculture and intensive production of quality and non-hazardous foodstuffs of animal origin. Its greatest achievements include the diagnosis and prophylaxis of many serious infectious diseases and in the protection of the territory from their introduction. CZ has a long tradition in studying the impairment of fertility, reproduction and embryo-transfer, the veterinary aspects of animal nutrition, dietetics and veterinary toxicology. Great attention is paid to the contamination of food and food chains with chemicals, mycotoxins and radionuclides, the alimentary diseases of bacterial and viral origin, food allergies as well as adulteration of foodstuffs.

The current focus of veterinary research covers the basic areas of goal-oriented and applied research and monitors modern trends in veterinary medicine and pre-clinical research. Veterinary research is prepared to implement difficult science and research projects targeted at future threats of new and recurring infection diseases impacting both the veterinary and human sphere, mainly zoonotic diseases and diseases causing extensive economic damage.

An important factor that can influence the likelihood of the above threats is also climate change which, apart from a direct threat of drought and desertification to some production areas, will lead to the introduction of new infectious diseases typical so far for subtropical and tropical zones.

In the near future, it will probably be necessary to focus research also on the production health of animals, an acceptable welfare and zoohygienic conditions in mass production. Without intensive research in this area, it will be difficult to produce sufficient amounts of quality and safe foodstuffs.

A precondition for achieving the above visions is conserving the environment and keeping it in an acceptable condition. The European Green Deal and other strategic documents - EU Biodiversity Strategy for 2030: Bringing nature back into our lives, the 'Farm to fork' strategy for a fair, healthy and environmentally-friendly food system - envisage, apart from reducing the use of pesticides and mineral fertilisers, also cutting the consumption of antimicrobial and hormonal substances for farm animals and aquaculture by 50% of the active substances and reducing the impact of livestock production on the environment and climate, and decreasing greenhouse gas emissions. The introduction of such administrative measures in combination with the above threats can lead to a number of new challenges for veterinary research.

The reduced consumption of antimicrobial substances for farm animals and aquaculture will have to be replaced with many measures, some of which have not been adequately researched. This will include the use of biotechnological procedures in the production and testing of traditional and/or technologically more advanced products for active and passive immunisation, development and validation of diagnostic methods including the use of artificial intelligence and bid data processing, introduction of biotechnological principles in reproduction procedures and techniques, changes in the production of feed for farm animals - probiotics, prebiotics, nutritional enzymes, yeast cultures, replacement of animal protein in nutrition and advanced detection of resistance to antimicrobial substances, and search for alternatives. Precision agriculture is one of the approaches to addressing such issues.

Veterinary research leading to solutions for the above problems and threats is essential for agricultural production and will be crucial for achieving and maintaining food self-sufficiency.

Research priorities in RD "Veterinary medicine". For a specification of the research areas (up to the level of specific research topics) see Annex 1:

8.1. Animal diseases (diagnosis, immunology and immunotherapy, pharmacology and toxicology).

8.2. Production and preventive medicine, antimicrobial resistance control.

8.3. Animal diseases and zoonoses, alimentary diseases.

8.4. Quality and safety of food and protection of food chains from xenobiotics.

8.5. Quality and safety of feed for farm animals.

3.2.9 Food production

Food production is always tied to the quality and quantity of input raw materials and must follow the requirement of better lifestyle, health and the environment. If a favourable food environment is created, making the choice of healthy and sustainable eating easier, it will enhance the health and quality of life of consumers and will reduce the cost of healthcare in the whole society. People are increasingly interested in issues of the environment, health, society and ethics and more than ever they are searching for values also in food, the origin of the raw materials, the manner of their processing and in the diet. The potential of existence and growth of Czech food industry is necessarily connected to intensive research and development of new types of foods with a high share of added value. That added value is connected, for consumers,

e.g. with health benefits, consumption comfort, speed of meal preparation etc. As all sectors of the food production mainly deal with the processing of the relevant agricultural commodities, food research is inseparable from agricultural research.

The changing lifestyle and civilisation phenomena require and will require changes in eating habits, a continuation of healthy inputs into the food chain and the related development of food technologies. Very important for the society is organic food produced by organic farming which is a sustainable way of growing crops and rearing animals. That production method is also favourable for the environment and human health. The circular economy will put an emphasis on non-waste technologies, processing and usability of waste and by-products in the whole lifecycle of food and on development of new types of packaging such as eco-friendly packaging or edible packaging. The diet composition and communication of the public with experts can significantly prevent civilisation diseases that are on the rise and this problem can be expected to have a longer-term perspective as a result of technical development. It is desirable to ensure quality nutrition for population groups with specific needs, such as various age categories and consumers with specific nutrition requirements. The topic of suitable nutrition for the quality of life is comprehensive, covering a number of aspects related to the application of the latest findings of research in food science and medicine and their integration into traditional production of food and its innovation.

Food production in CZ must draw on EU policy, i.e. to:

- ensure that the food chain, which includes the production, transport, distribution, marketing and consumption of food, has a neutral or positive impact on the environment,
- ensure food security, nutrition and public health – ensuring that everyone has access to enough wholesome and sustainable food that meets strict safety and quality standards,
- maintain food availability while generating a fairer economic return in the supply chain so that the most sustainable food is ultimately the most affordable, support the competitiveness of the EU supply sector, promote fair trade, create new business opportunities while ensuring the integrity of the single market and health and safety at work.

Research priorities in RD "Food production". For a specification of the research areas (up to the level of specific research topics) see Annex 1:

9.1. Food and human health.

9.2. Food safety.

9.3. Technologies.

9.4. Food analysis methods.

9.5. Organic food production and quality.

3.2.10 Agricultural machinery

The mechanisation of agricultural production is generally considered one of the greatest achievements of the 20th century. These are technologies that improve the agricultural production procedures thanks to a more efficient use of labour, timeliness of operations and more effective management of inputs and outputs, focusing on the overall sustainability of the high productivity systems. The benefits of precision agriculture in optimising the agricultural production inputs are not negligible in this respect.

Also in the context of the 21st century, the technology and machinery development reflects in all sectors of human activity, including agriculture. The professional and scientific community calls this trend smart agriculture, and in a narrower sense also precision agriculture. The main features are automation and robotisation elements with a direct link to bioeconomy. The interconnection of the whole system and the application of the latest science and research findings alone can enhance the development of environmentally friendly technologies, ensure food sustainability and self-sufficiency, lower the consumption of mineral raw materials and fossil fuels while maintaining the rate of economic growth. An irreplaceable role in the implementation of these processes is played by the state-of-the-art machinery and mechanisation. However, for its correct use, it is important to optimise the standards based on minimisation and elimination of its negative impacts, mainly on the environment.

Out of all sectors of human activity, agriculture is probably affected by climate change the most. The applied technologies and the mechanisation used will have to respond to that in the 21st century.

Agricultural machinery will, undoubtedly, continue to be a key factor in ensuring sustainable agricultural production, mainly in the conditions of the changing climate. Already today, agricultural machines are turning into systems for sensing and monitoring a large amount of useful data on the activity of the vehicle itself but also on the characteristics of the surrounding environment (soil, plants etc.). Such data may be used to improve the work of the agricultural machines themselves but also to improve the whole production process in the farm. Agriculture can now use entirely new information not available previously. The data obtained can also be used for evaluating the compliance with EU directives.

In order to exploit that potential, the technologies integrated into agricultural machinery must communicate smoothly with the other systems, which is currently true only to a very limited extent. There is still no adequate standardisation taking into account the fact that the end user of these modern and fast developing technologies is always the farmer.

In practical terms, it is necessary to support Czech agriculture and the related fields in ensuring food safety and competitiveness, and to help with adaptation to changes in the approach to farming at national and international level. In this context, we can expect pressure on meeting the strategic objectives of the European Green Deal and of the Common Agricultural Policy Strategic Plan. In CZ, we should also strive to achieve the strategic goals of the Action Plan for Organic Farming Development 2021-2027.

The fundamental vision of RD Agricultural Machinery is, for the above reasons, to take part in overcoming all obstacles preventing a better exploitation of the potential of modern agricultural machinery for the needs of sustainable agricultural production with a view to minimising and eliminating the negative environmental impacts.

Research priorities in RD "Agricultural machinery". For a specification of the research areas (up to the level of specific research topics) see Annex 1:

10.1. Uptake of smart agriculture technologies.

10.2. Eliminating negative environmental impacts of using agricultural machinery.

10.3. Technologies for livestock production.

10.4. Improving the quality of agricultural products, post-harvest processing and storing.

3.2.11 Forestry and agricultural economy and policy

The Czech forestry and agricultural economy (Czech bioeconomy) spills over to the related processing industry, infrastructure of the whole vertical (flow) of the agrarian market up to the consumer behaviour. The research in this research direction, the outputs of which will be implemented mainly after 2030, will in more general terms fulfil or respond to the principles and growing requirements of bioeconomy and circular economy, in which the expected development trends and problems at the global, regional and national level will concentrate.

First of all, it will be the world population growth and the related rise in demand for food in contrast with the progressing climate change and the fast growing and intensifying requirements of the society for careful use of natural resources and with the effects of food consumption on the health of the population.

The European Union and, therefore, CZ will see the promotion of the current and, in the future, more ambitious European Green Deal that will focus in the agrarian sector on strategic goals linked to a more significant reduction of selected production inputs (mainly the current pesticides, industrial fertilisers and antimicrobial biotics) and to a wider uptake of environmentally friendly production systems (e.g. organic farming).

Such approach is expected to be widely supported not only in the form of adequate payment for public goods from the agrarian sector (for environmental services) but also in the form of a growing interest in and appreciation of the production methods by consumers of food and other agrarian private goods. Moreover, such production methods can be ensured by stricter legal conditions and by promoting the polluter pays principle.

The growing population will go hand in hand with the rising importance of food and, increasingly also, energy security (of countries, regions, the world) that will build on a higher resource efficiency and competitiveness while respecting the above-mentioned growing societal and consumer requirements on production methods in the conditions of climate change.

Economic research in the agrarian sector (Czech bioeconomy) must be prepared to address the economic, social and institutional conditions and impacts of all the necessary technology changes arising from the new requirements and currently also concentrated in the smart agriculture concept. That will be accompanied by a much wider interconnection of economic research, mainly in policy, with the other research directions, with promoting the principles of a multi-disciplinary solution for research problems and issues.

The economic research will continue to be oriented on developing its own information and methodology base for an objective, multi-criteria evaluation of agricultural and forestry activities, which can be used for policy-making and, through a better enterprise advisory system and management, for meeting the societal requirements.

Within the main directions above, Czech bioeconomy will be oriented on the multi-sectoral approach and on a substantially wider involvement in international research, mainly in the EU research programmes.

Research priorities in RD "Forestry and agricultural economy and policy". For a specification of the research areas (up to the level of specific research topics) see Annex 1:

11.1. Economic, social and structural impacts of institutional measures and agricultural policies.

11.2. New technologies and circular economy within bioeconomy.

11.3. Competitiveness of the forestry and timber sector in the conditions of the ongoing climate change.

11.4. Agrarian market.

11.5. Developing the information base, analytical methods and approaches to improve management in the agrarian sector.

3.3 Priorities in managing the implementation of the R&D&I Strategy of MoA 2023+

The R&D&I Strategy of MoA 2023+ sets out 4 priority areas in the management of R&D&I in the agri-food sector, forestry and water management.

Priority 1 Strategically managed system of support for research, development and innovation in the agri-food sector, forestry and water management at the sector level, expanding to the related fields of science.

Priority 2 Effective management and financing of R&D&I in the agri-food sector, forestry and water management.

Priority 3 Enhancing the research capacities of ROs - human factor.

Priority 4 Developing international cooperation at all levels of research in the agri-food sector, forestry and water management.

Priority 1 Strategically managed system of support for research, development and innovation in the agri-food sector, forestry and water management at the sector level, expanding to the related fields of science. Strategically managed system of support for research, development and innovation in the agri-food sector, forestry and water management at the sector level, expanding to the related fields of science.	Priority goal 1 A) Strengthening the strategic orientation of agricultural research utilising feedback based on a systematic monitoring of trends in research and technologies, and utilising the capacities of ROs and research infrastructures and the changes in societal priorities.	1.A.1 Focus of the support on the defined priorities arising from a foresight study, and further utilising the results of assessment at all levels of the R&D&I support system, evaluations and technical expertise for strategic management of the R&D&I system in CZ.
		1.A.2 Developing the measures/activities of regular monitoring, assessment (newly also of impacts of purpose-tied aid, RO evaluation in institutional aid) of paid-out aid and evaluations of the Concept. Development of the needed tools, the option of data processing and recording in the information systems and internal databases used.
	Priority goal 1 B) Intensifying cooperation with strategic partners (such as TACR, GACR, CAS, other ministries - mainly MoE and MIT, representatives of the application sector) in the R&D&I support system in order to share information, support synergies and prevent duplications.	1.B.1 Coordination of the targets of the purpose-tied aid programme and of the competitive biddings with the relevant aid providers to prevent duplications and using synergies in financing the aid programmes.
		1.B.2 Cooperation with strategic partners to prepare and implement relevant sectoral strategic and conceptual documents of MoA (incl. the follow-up documentation) in R&D&I.
	Priority goal 1 C) Involving the recipients of research results (the business sector, state administration, civil society institutions etc.) directly in research.	1.C.1 Introducing measures within the aid provision conditions to strengthen the involvement of actors (business sector, state administration, NGOs etc.) in research - trans-disciplinary approach.
Priority 2 Effective management and financing of R&D&I in the agri-food sector, forestry and water management.	Priority goal 2 A) Streamlining the management and administration of R&D&I aids. Creating conditions for financing long-term research and development.	2.A.1 Cooperating with the other R&D&I support providers in the introduction of common measures to reduce the administrative burden within the single methodological environment.
		2.A.2 Stabilisation, predictability and support for the performance of the R&D&I financing system by setting an adequate amount of institutional aid and increasing it for the ROs who produce quality results with regard to the implemented international cooperation and cooperation with the application sector (implementation of Methodology 17+).
		2.A.3 Creating conditions for the financing of strategic longer-term projects.
	Priority goal 2 B) Enhancing the transfer of research results to practice.	2.B.1 Introducing measures within the aid provision conditions to enhance the involvement of enterprises (primary producers, processors and suppliers of inputs) in research - intensifying the partnership with an active financial co-participation and an active involvement in the project management.

Priority 3 Enhancing the research capacities of ROs - human factor.	Priority goal 3 A) Creating an environment encouraging researchers to pursue a research career.	3.A.1 Supporting a transparent and open environment in the aided ROs (selection procedures, career system); training the researchers in a lifelong learning system, emphasising the development of competences for cooperation in research and in managerial skills.
	Priority goal 3 B) Creating conditions for equal opportunities and reconciliation of work and private life in ROs.	3. B.1 Measures in the system of providing aid (both purpose-tied and institutional) for the development of equal opportunities of researchers in ROs, including support for beginning researchers at the start of their career and persons caring for dependents.
Priority 4 Developing international cooperation at all levels of research in the agri-food sector, forestry and water management.	Priority goal 4 A) Promoting CZ interests through participation of a representative sent to the Horizon Europe Programme Committee.	4.A.1 Functional networking with representatives of the Horizon Europe Programme Committee.
	Priority goal 4 B) Development and strategic orientation of MoA initiatives on systemic support of international cooperation.	4.B.1 Supporting the involvement and active participation of MoA representatives in the meetings of international initiatives.

For the implementation periods, links of measures of the R&D&I Strategy of MoA 2023+ to measures of the National R&D&I Policy 2021+ and indicators see Annex 3 .

3.4 Management structure of the R&D&I Strategy of MoA 2023+

To ensure successful implementation of the R&D&I Strategy of MoA 2023+, structures will be set up for the management, coordination, monitoring and evaluation of its priorities, goals, measures and trends in the achievement against indicators.

The implementation management falls within the competence and activities of the following management systems: (i) Steering Committee of the R&D&I Strategy of MoA 2023+ implementation, (ii) CAAS and (iii) the MoA body responsible for R&D.

i. **The Steering Committee of the R&D&I Strategy of MoA 2023+ implementation** discusses the mission, visions, goals and activities of the R&D&I Strategy of MoA 2023+, it has an advisory and expert role in its management. It associates relevant actors in research and practice in the agri-good sector, forestry and water management and representatives of the relevant ministries (e.g. Ministry of the Environment)

   The Steering Committee acts according to its own statute and rules of procedure, its members are appointed by the Deputy Minister of Agriculture responsible for R&D. The Steering Committee:

   a. *consults proposals for the setting of conditions and the state of implementation of the purpose-tied aid programme,*

   b. *discusses the evaluations (interim, final) of the purpose-tied aid programme,*

   c. discusses and approves the Long-term Concepts of RO Development and the Periodical Reports of ROs based on expert opinions,

   d. at strategic level, regularly evaluates the progress in achieving the priorities of the R&D&I Strategy of MoA 2023+ based on outputs of regular monitoring, RO evaluation according to Methodology 17+ and evaluation reports, and may make recommendations for the next phase of the R&D&I Strategy of MoA 2023+ implementation.

ii. **CAAS** is an advisory body of MoA and a partner in the preparation and implementation of the R&D&I Strategy of MoA 2023+, mainly in its focus. The CAAS:

   a. co-creates, discusses and comments on the implementation of the R&D&I Strategy of MoA 2023+,

   b. is the main advisory partner in the monitoring of societal and technological trends in research in the agri-food sector, forestry and water management,

   c. takes part in the regular meetings of the Steering Committee of the R&D&I Strategy of MoA 2023+ Implementation by means of a selected representative,

   d. acts as a platform for cooperation of ROs.

iii. MoA body responsible for R&D

This body is an executive component of the management system, it is the provider of institutional and purpose-tied aid for R&D&I, it provides conceptual and methodological

guidance to MoA research organisations, is responsible for implementation of the National R&D&I Policy 2021+, in cooperation with the other actors it guarantees the preparation and implementation of the R&D&I Strategy of MoA 2023+ and, from the ministry level, it develops international cooperation in R&D&I in the agri-food sector, forestry and water management.

3.5 Instruments for implementation of the R&D&I Strategy of MoA 2023+

The R&D&I Strategy of MoA 2023+ will be implemented by means of the following instruments:

- Financial instruments:
    - institutional aid for Long-term Concepts of RO Development,
    - purpose-tied aid for research in priority topics and support for cooperation among ROs, disciplines and practice.
- Non-financial, managerial tools:
    - MoA support for international cooperation in the agri-food sector, forestry and water management,
    - systemic measures to reduce the administrative burden: harmonising the administrative system of purpose-tied aid with the administrative systems of other providers, sharing some information on applicants,
    - information and awareness-raising measures (e.g. issuing methodological guidelines, training for managers, sharing good practice).

3.6 Interim and final evaluation of the implementation of the R&D&I Strategy of MoA 2023+, and strategic management support

The priorities of the R&D&I Strategy of MoA 2023+ are implemented mainly through the Long-term Concepts of RO Development in terms of the institutional aid, and through the portfolio of projects in the purpose-tied aid. The successful implementation of the priority areas of the R&D&I Strategy of MoA 2023+ will be monitored and evaluated through:

- evaluation of the expected results of programmes and research plans,
- ongoing monitoring and evaluation of the implementation of institutional and purpose-tied aid in line with Methodology 17+,
- interim and ex-post evaluation of the R&D&I Strategy of MoA 2023+.

3.6.1 Ongoing monitoring and evaluation in line with Methodology 17+

The institutional aid is monitored through evaluation of the periodical and final reports of ROs on the implementation of their Long-term Concepts of Development. The achievement against indicators in the Long-term Concepts is evaluated on an interim basis for each of the supported research organisations. Such monitoring is carried out annually and its outputs are submitted to the Steering Committee for discussion. The ROs supported by MoA with institutional aid are evaluated, since 2022, in five-year cycles in all five modules defined in Methodology 17+ (modules 3-5 are further specified by the MoA methodology of RO evaluation). The supported ROs are evaluated annually in modules 1 and 2 at the national level.

The physical and financial monitoring of purpose-tied aid is carried out through evaluation of interim and final reports on purpose-tied aid projects for the past year and through interim evaluations. In line with Methodology 17+, the impacts of the EARTH programme will be evaluated in 2030, for the EARTH II programme it will be in 2037. The programmes will be evaluated according to the methodological recommendation of the RDI Council.

3.6.2 Interim and ex-post evaluation of the R&D&I Strategy of MoA 2023+

The implementation and achievement against the goals of the R&D&I Strategy of MoA 2023+ will be evaluated in the middle of its period, i.e. in the fifth year. The evaluation will be made by an independent professional company in cooperation with the provider of the R&D&I support. The aim is mainly to evaluate the direction of the R&D&I Strategy of MoA 2023+, the achievement against the set goals, indicators (for indicators of the R&D&I Strategy of MoA 2023+ see Annex 3) and the schedule, an independent assessment of the functioning of the management structure, the use of the research results in practice, and to make recommendations for the next phase of the implementation and strategic direction of the R&D&I Strategy of MoA 2023+. A separate topic is evaluation of the impacts of the implementation of the R&D&I Strategy of MoA 2023+ but that can only be made after a certain time period following the implementation, as part of the ex-post evaluation of the R&D&I Strategy of MoA 2023+, it is expected to be commissioned in 2033, with the completed evaluation report (ex-post evaluation of the R&D&I Strategy of MoA 2023+) delivered at the end of 2034.

3.6.3 Foresight study

To support the strategic focus of the R&D&I Strategy of MoA 2023+, to provide background for any update and revision, a foresight study will be made of the current societal and technological trends in the agri-food sector, forestry and water management. It is expected to be drawn up in the last third of the period of the R&D&I Strategy of MoA 2023+ so that its conclusions can be used for preparing the follow-up R&D&I Strategy of MoA or for reviewing its strategic focus in response to the current trends.

3.7 Indicative schedule

The achievement of the set measures and goals of the R&D&I Strategy of MoA 2023+ will be continuously monitored and evaluated at the regular meetings of the Steering Committee for the R&D&I Strategy of MoA 2023+ Implementation based on interim reports on the values of indicators and their dates. Those will be discussed in the context of experience with the setting of rules and management mechanisms of aid provision and the ongoing monitoring of the achievement of commitments made by the beneficiaries in purpose-tied aid projects or in the Long-term Concepts of RO Development.

An important feedback mechanism will be expert evaluations and recommendations based on the interim and ex-post evaluation of the R&D&I Strategy of MoA 2023+ implementation.

The R&D&I Strategy of MoA 2023+ will be implemented through instruments set out in Chap.3.5, of which the most important are the financial ones and for which it is possible to set a framework schedule of implementation of the steps that are standardised and defined by the legal framework and binding rules - i.e. the provision of purpose-tied and institutional aid for R&D&I.

The non-financial and managerial tools are measures with a supporting effect and of ad hoc nature such as participation in meetings; information transfer and sharing, synchronisation of procedures and steps with the other actors; issuing methodological opinions that will respond to the current situation and needs of the R&D&I support system.

In the implementation of institutional aid for ROs and purpose-tied aid programmes, these are essential procedural steps and indicative time milestones in implementing the R&D&I Strategy of MoA 2023+.

	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035-37
Administration of Long-term Concepts of RO Development I													
Final evaluation (approved by SC)	X												
Administration of Long-term Concepts of RO Development II													
Initial evaluation (approved by SC)	X												
Interim evaluation (approved by SC)		X	X	X	X								
Final evaluation (approved by SC)						X							
Administration of Long-term Concepts of RO Development III													
Initial evaluation (approved by SC)						X							
Interim evaluation (approved by SC)							X	X	X	X			
Final evaluation (approved by SC)											X		
Implementation of the EARTH I programme													
Aid provided based on competitive bidding in 2022	X	X	X										
Final evaluation of the programme				X									
Evaluation of the programme's impacts								X					
Implementation of the EARTH II programme													
Programme implementation		X	X	X	X	X	X	X	X	X			
Announcing competitive biddings in the EARTH II programme	X	X	X		X	X	X						
Interim and final evaluation of the programme				X							X		
Comprehensive evaluation activities, evaluation and foresight studies													
A comprehensive evaluation of ROs in all 5 modules according to Methodology 17+					X					X			
Foresight study									X				
Evaluation of the programme's impacts												X	
Interim and ex-post evaluation of the R&D&I Strategy of MoA 2023+					X	X						X	

4. Lists of charts, tables, figures and diagrams

List of charts in the R&D&I Strategy of MoA 2023+

List of tables in the R&D&I Strategy of MoA 2023+

List of figures in the R&D&I Strategy of MoA 2023+

List of diagrams in the R&D&I Strategy of MoA 2023+

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6. List of abbreviations

AKIS	Agricultural Knowledge and Innovation System
ASF	African swine fever
BE	Bioeconomy (also an abbreviation for a key area of the R&D&I Strategy of MoA 2023+)
CRP of R&D&I IS	Central Record of Projects (one of the modules) of the Information System of Research, Experimental Development and Innovation
CAAS	Czech Academy of Agricultural Sciences
CZ	Czech Republic
Long-term Concept	Long-term Concept of a RO's Development
DG AGRI	Directorate General for Agriculture and Rural Development
DG RTD	Directorate General for Research and Innovation
EC	European Commission
ERC	European Research Council
ERDF	European Regional Development Fund
ESF+	European Social Fund 2021-2027
ESIF	European Structural and Investment Funds
EU	European Union
EU-12	So-called new EU Member States excluding CZ (Bulgaria, Cyprus, Estonia, Croatia, Hungary, Lithuania, Latvia, Malta, Poland, Romania, Slovenia, Slovakia)
EU-13	So-called new EU Member States that joined the EU on 30.04.2004 and later (Bulgaria, Cyprus, Czech Republic, Estonia, Croatia, Hungary, Lithuania, Latvia, Malta, Poland, Romania, Slovenia, Slovakia)
EU-15	So-called old EU Member States, i.e. states forming the EU up to 30.04.2004 (Austria, Belgium, Germany, Denmark, Greece, Spain, Finland, France, Ireland, Luxembourg, Italy, the Netherlands, Portugal, Sweden, the United Kingdom)
EURAGRI	European Agricultural Research Initiative
EAFRD	European Agricultural Fund for Rural Development
FTE	Full Time Equivalent
GACR	Grant Agency of the Czech Republic
GBER	Commission Regulation (EU) No 651/2014 of 17 June 2014 declaring certain categories of aid compatible with the internal market in accordance with Articles 107 and 108 of the Treaty, the so-called General Block Exemption Regulation
GERD	Gross domestic Expenditure on Research and Development. In relation to GDP it expresses the R&D&I intensity
GMO	Genetically modified organism
GC	Global changes in the biosphere (an abbreviation for a key area of the R&D&I Concept of MoA 2023)
FA	Farm animals
IoT	Internet of Things
Interim evaluation of the 2016-2022 Concept	Interim evaluation of the Applied Research Programme of the Ministry of Agriculture 2017-2025 called EARTH, and of the

	Research, Development and Innovation Concept of the Ministry of Agriculture for the period 2016–2022
IA	Institutional aid
IS SANI	State aid notification software, an information system of the European Commission for recording notified aids by the EC
TACR IS	Information system of the Technology Agency of the Czech Republic
R&D&I IS	Information system of research, experimental development and innovation
R&D&I Strategy of MoA 2023+	Research, Development and Innovation Concept of the CZ Ministry of Agriculture for the period 2023 -2032
Methodology 17+	Methodology for evaluation of research organisations and evaluation of programmes of purpose-tied aid, research, development and innovation
MEP	moderately erosion-prone (soil/area)
bil.	billion
MIT	Ministry of Industry and Trade
MEYS	Ministry of Education, Youth and Sports
MoA	Ministry of Agriculture
MoE	Ministry of the Environment
National RIS3	National Research and Innovation Strategy for Smart Specialisation of the Czech Republic
NAAR	National Agency for Agricultural Research
NBT	New breeding techniques
National R&D&I Policy 2021+	National research, development and innovation policy of the Czech Republic 2021+
NPGOR	National priorities of goal-oriented research, experimental development and innovation up to 2030
OECD	Organisation for Economic Cooperation and Development
UN	United Nations organisation
OP	Operational programme
OP JAC	Operational Programme Johannes Amos Comenius
OP EIC	Operational Programme Enterprise and Innovation for Competitiveness
WRPZ	Water resource protection zones
OP TAC	Operational Programme Technologies and Applications for Competitiveness
OP RDE	Operational Programme Research, Development and Education
RES	Renewable energy sources
PeR	Periodic report on the use of aid for implementing the Long-term Concept of a RO’s Development in a defined five-year period
CSS Programme	Programme of Comprehensive Sustainable Systems in Agriculture 2012-2018
RRR	Register of Research Results (part of the Information System of Research, Experimental Development and Innovation - R&D&I IS)
RDI Council (OG)	Research, Development and Innovation Council (under the Office of the Government of the Czech Republic)

SC	Steering Committee for implementation of the R&D&I Strategy of MoA 2023+
MA	Managing authority
SCAR	Standing Committee on Agricultural Research
HEP	Highly erosion-prone (soil/area)
TFEU	Treaty on the Functioning of the European Union 2012/C 326/01
SA	Smart agriculture (an abbreviation for a key area of the R&D&I Concept of MoA 2023)
CAP	Common agricultural policy
TACR	Technology Agency of the Czech Republic
CAS TC	Technology Centre of the Czech Academy of Sciences
ths	thousand
PTA	Purpose-tied aid
R&D	Research and development
R&D&I	Research, development and innovation
RO	Research organisation
RD	Research direction
RI	Research institute

7. Annexes

Annex 1 Overview of research directions, research priorities and research areas, definition of their priorities and links to key areas

Key:
Research directions are divided into research priorities and those are divided into research areas.
Research areas within research priorities were **ranked on scale 1-3**, where **1 = highest importance, 2 = medium importance, 3 = low importance**. **Links** have been identified between the research areas and the **key areas of the R&D&I Strategy** of MoA 2023+. The links are expressed with the X symbol in columns Link to ... key area. In those columns, the key areas (KAs) are abbreviated as **BE = Bioeconomy, SA = Smart agriculture, GC = Global changes in the biosphere**.

Research direction I: Soil

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
I.1. Increasing the volume of water in the soil profile	**1**			X	I.1.1. The role of land consolidation, supporting water retention in the landscape and reduction of climate change impacts (mainly short-term droughts and floods), modification of the land consolidation methodology.
			X	X	I.1.2. Regenerating the retention capacity of degraded soil (soil eroded by water, compacted, lacking a stable organic component) by applying modern practices, mainly soil improvers and new tillage technologies.
			X	X	I.1.3. Developing methods of soil moisture monitoring to prevent agricultural drought and floods.
I.2. Soil degradation and the options to eliminate it including research of the impacts of dual use of land (e.g. agrivoltaics)	**1**		X	X	I.2.1. Research of measures increasing erosion control, water retention and landscape connectivity. Potential of agri-technical and organisational measures including new methods (strip till, no till etc.) of protecting arable land against erosion, and their benefits.
			X	X	I.2.2. Research/innovation of new agri-technical procedures and organisational measures to increase soil fertility in organic farming (strengthening the retention capacity of soil, using new tillage

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
					technologies (no till, strip till etc.), using modern practices including soil improvers etc.
			X	X	I.2.3. Green infrastructure and landscape connectivity as a systemic approach to protecting soil from erosion
			X	X	I.2.4. Research and development of new practices and technologies to combat soil compaction. Increasing the accuracy of maps, using advanced technologies, mainly remote guidance systems to control the in-field traffic of agricultural vehicles.
		X	X	X	I.2.5. Research area supporting the setting of standards for good agri-environmental practice.
				X	I.2.6. Soil contamination by emerging pollutants. Research of soil pollution by pharmaceuticals for human use and by pharmaceuticals (mainly antibiotics) used in livestock production. Research of soil contamination by other types of substances from various sources (hormonal products, fire retardants, fuel additives, cosmetic products etc.).
			X	X	I.2.7. Impact of clearcutting due to bark beetle and of changes in the species and age structure of forest stands on the carbon sequestration capacity in forest soil.
				X	I.2.8. Ecosystem services and their benefits in protecting soil from erosion.
			X	X	I.2.9. Crops and crop rotation as a tool in combating agricultural soil compaction.
				X	I.2.10. Research of soil compaction impacts on the biological condition of the soil, the root distribution and the nutrient cycles.
			X	X	I.2.11. Development of new technologies and the setting of conditions for

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
					erosion-risk crops on moderately erosion-prone (MEP) and strongly erosion-prone (SEP) areas.
			X	X	I.2.12. Conditions for setting soil-protection technologies, possibilities of using soil-protection technologies for a wider range of crops (special crops) - Use of sorghum, maize, sunflower in summer catch crops on erosion-prone land in combination with other catch crops.
			X	X	I.2.13. Research and technology development for using under-sowing in organic farming as erosion control measures, 100% soil cover, using under-sowing by permanent plants or soil cover for sowing SEP crops. Technological practices, methodologies in MEP and SEP, use of zero tillage systems in organic farming.
	2		X	X	I.2.14. Innovation of soil-protection technologies due to the reduction of plant protection products including non-selective herbicides.
		X	X	X	I.2.15. Application of modern views of the dynamics of soil organic matter, a study of the factions of soil organic matter, various accessibility of microbial decomposition and taking into account the dynamics of microbial communities. The issue of carbon storage depending on the properties of soil organic matter. Reducing the climate change impacts by stabilising the soil organic matter. Searching for optimal practices to increase the organic carbon in soil - carbon sequestration, depending on various soil-climate conditions, assessment of the carbon sequestration potential for different soils and different types of farming.

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
				X	I.2.16. Effects of farming systems, including the organic, on the diversity of selected groups of soil invertebrates important in soil organic matter transformation and in plant protection.
	3			X	I.2.17. Non-production functions of extensive orchards with an emphasis on anti-erosion and retention functions.
				X	I.2.18. Agroforestry systems and intercropping in erosion control.
				X	I.2.19. Erosion processes (by water and wind) in the non-vegetation period.
			X	X	I.2.20. A study of the effect of erosion processes on the degradation of the physical, chemical and biological properties of the soil, associated mainly with changes in its structure and the formation of the soil crust, its infiltration capacity, a study of changes in the content and redistribution of organic carbon and nutrients due to erosion.
			X	X	I.2.21. Assessment and prediction of potential erosion and redistribution of organic matter using digital relief model data and digital soil mapping methods.
			X	X	I.2.22. Research of mobile anti-erosion measures.
			X	X	I.2.23. Erosion on forest/non-agricultural soils related to bark beetle calamity and drought; optimization of the forest road network to reduce water erosion of forest soils.
				X	I.2.24. Identifying relationships between soil structure stability and the actual soil loss through wind erosion.
			X	X	I.2.25. Measuring the effectiveness of existing and alternative wind barriers for real planning of these elements in agricultural landscapes
			X	X	I.2.26. Possibilities of area-limited planting of fast-growing trees as a tool to combat wind erosion on agricultural soils.

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
			X	X	I.2.27. Description of how the in-field traffic of new agricultural and forestry vehicles impacts the physical state of the soil and the biological processes taking place in it.
			X	X	I.2.28. Identifying the effectiveness of declared measures against soil compaction (low-pressure tires, tracks, tire width, crab steering, etc.) in order to recommend suitable management for a specific soil type/class and different soil moistures.
				X	I.2.29. Assessment of soil pollution caused by contamination from various sources. Behaviour of soil pollutants: accumulation, substance transformation, transport with flowing water.
				X	I.2.30. Soil contamination by pesticide residues, especially the synergistic effect of "cocktails" of residues of various active substances on the soil environment with an emphasis on soil biota and the quality of plant production.
				X	I.2.31. A study of the complex effect of pollutants in the environment in the area of basic soil functions, soil biota, the pollution of food chains and human health protection.
				X	I.2.32. Research of micro-plastics and nanoparticles, their sources, occurrence in the soil and the risks of their action.
			X	X	I.2.33. Contamination of forest soils with potentially hazardous elements, especially in connection with transformations of humus forms as a result of bark beetle clearcutting and changes in the species composition of forests.
		X	X	X	I.2.34. Remediation of soils contaminated with potentially hazardous elements and organic pollutants, including "modern pollutants", ways and methods of degradation, removal

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
					and stabilization of such substances in the soil.
				X	I.2.35. Application of mathematical simulation models to estimate the behaviour of hazardous substances in the soil environment and in the soil-water-plant system and to assess their current and potential hazard of contaminating groundwater and surface water and entering the food chain.
		X		X	I.2.36. Analysis and evaluation of the impacts of impermeable soil covering on agricultural production, water retention in the landscape, carbon retention, nutrient cycle, thermal conditions, etc., including economic evaluation.
		X		X	I.2.37. Analysis of the possibilities of using brownfields, green roofs and other alternatives to land grab and their benefits and consequences.
		X		X	I.2.38. Research of soils reclaimed after mining and other human activities and the processes that take place in such soils, depending on the type of the deposited material, the method of reclamation and other factors. Design of optimal reclamation procedures for different conditions.
				X	I.2.39. Methods of evaluating anthropogenic soils and research into their potential use in agriculture and forestry.
			X	X	I.2.40. The relationship of soil biota to agri-technical measures and forestry management, accumulation of soil organic matter and soil degradation.
			X	X	I.2.41. The importance of bioturbation in the accumulation of soil organic matter, a study of technologies supporting this activity of soil biota.
				X	I.2.42. Ratios of key enzymatic activities of soil microorganisms as indicators of N and P limitation in soil.
				X	I.2.43. Landscape/land use change: Impact on ecosystem services provided by soil organisms.

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
			X	X	I.2.44. Optimizing the establishment of bio-belts in the landscape. The response of edaphon to the methods of establishment, composition, management and isolation of the established bio-belts.
			X	X	I.2.45. The impact of the dual use of land, mainly agrivoltaics (concurrent production of food or feed and electricity) on the soil condition.
I.3. Nutrients in soil and bio-based materials as soil substrates, with an emphasis on circular economy and carbon storage	**1**		X	X	I.3.1. Sustainable nutrient management. Rational and justified application of nutrients (primarily N). Reduction of nutrient (N, P) losses while maintaining soil fertility.
		X	X	X	I.3.2. Innovative approaches and sustainable management of nutrients in organic farming: consideration of the dynamics of soil organic matter, introduction of an integrated plan / optimization of crop fertilization from the point of view of fertility (active mobilization of nutrients in the soil, especially nitrogen and phosphorus, use of alternative sources of nutrients (composts, vermicomposts, soil improvers, extracts, biochar, etc.). Development of cultivation practices considerate in terms of carbon leakage and nitrogen mineralization in organic farming.
		X		X	I.3.3. Use of alternative sources of nutrients, such as waste material and assessment of its effect on soil fertility. Defining the effect and possibility of using waste material (from industry, agriculture, sludge, sediments, technological waters, etc.) on the structure and fertility of the soil and the biological properties of the soil.
			X	X	I.3.4. Research on optimal practices for increasing the content of organic carbon in the soil - carbon sequestration under organic farming conditions (possible systems for long-term carbon sequestration in the soil).

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
	2		X	X	I.3.5. Research on the long-term effect of the envisaged decrease in the consumption of mineral fertilizers on the agrochemical and biological properties of soils.
		X	X		I.3.6. Sustainable management of nutrients on forest soil, especially in relation to the use of forest logging residues and the possibility of chemical amelioration, including the use of wood ash, slowly soluble fertilizers and liming; the effect of such interventions on the components of the forest ecosystem.
	3	X	X	X	I.3.7. An integrated nutrient management plan. Nutrient regime of soils from the point of view of the soil-plant system. Focusing research in optimizing crop fertilization not only on securing plant nutrition, but paying more attention to soil quality and water protection. Balanced use of fertilizers, soil supplements and any alternative fertilizers (composts, vermicomposts, digestates, etc.) to improve the soil properties and leading to an efficient use of nutrients by plants.
		X		X	I.3.8. Use of growing substrates. Growing substrates created from waste materials from the food industry, agriculture, etc. Processing (technology) and using these substrates as growing media.
		X			I.3.9. Alternative sources of phosphorus for fertilizing agricultural soils, mainly in connection with the use of materials within the circular economy (e.g. wastewater treatment).
		X		X	I.3.10. Possibilities of increasing carbon sequestration in the soil, including the use of biochar as a source of carbon for the soil, a study of changes in soil properties (holding water, nutrients, hazardous substances; biological properties) after the application of biochar.

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
					Research into the possibilities of targeted carbon storage in the soil and its environmental evaluation, including the production and application of biochar in operational conditions.
I.4. Agroforestry systems (including linear farming) and their impact on erosion and water runoff	**1**		X	X	I.4.1. The impact of agroforestry and linear farming on reducing soil erosion by water. Technical conditions for the interruption of runoff paths, the effectiveness of reducing blanket and concentrated surface runoff and reducing soil loss, the setting of the parameters for agri-technical systems also in relation to other soil protection and anti-erosion measures.
			X	X	I.4.2. The impact of agroforestry and linear farming on reducing soil erosion by wind. Setting the conditions for optimal routing of the agroforestry system on the plot of land. Suitability of species composition for effective wind speed reduction with respect to the agricultural system.
		X		X	I.4.3. A study of the cycle of carbon and nutrients in the agroforestry system, the interrelationships and influence on woody plants and agricultural crops.
			X		I.4.4. Machinery and technical equipment of agroforestry systems taking into consideration the principles of precision agriculture.
			X	X	I.4.5. Follow-up application in practice and the necessary integration into legislation.
I.5. Digital sources and systems of information on soil, mapping, remote sensing	**1**		X	X	I.5.1. Development and use of advanced technologies and means for spatial estimation and mapping of soil properties (satellite systems, aerial photography, drones, ground sensors) using new methods for data analysis and processing and model creation, including machine learning and deep learning; comparison, combination and fusion of data from different sources.

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
			X	X	I.5.2. Development and use of modern technologies (precision (smart) agriculture, digital soil mapping, yield maps, crop rotation etc.), recommendations for their use in organic farming/ in practice.
			X	X	I.5.3. Development of methodology for spreading organic fertilizers (manure) and use of yield maps, connection with navigation and control of the application rate by the spreader according to yield maps.
	3		X	X	I.5.4. Creation, development, updating, filling/addition and harmonization of databases and maps of soils and soil properties using modern database and mapping tools (digital soil mapping).
			X	X	I.5.5. The design, development and integration of a modern soil information system for the assessment of productive and non-productive soil functions and for the protection of soil ecosystem services, which would be widely used both in research and in practice, and which would be compatible with similar systems in the EU.
				X	I.5.6. Development and selection of appropriate indicators for assessing the different soil ecosystem services.
			X	X	I.5.7. Evaluation of spatial and temporal variability of soil properties at different scales for the purposes of precision agriculture, soil protection, land consolidation, spatial planning, etc.
			X	X	I.5.8. Establishment and expansion of a soil spectral library for better use of soil spectrometry data and remote sensing data in soil investigation and monitoring.
			X	X	I.5.9. Development of models for spatial estimation and prediction of the development of key soil properties in accordance with international

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
					programmes (Global Soil Partnership, European Soil Partnership, Global Soil Map, etc.), such as estimation of soil organic carbon stocks, estimation of the carbon sequestration potential in soils, etc.; providing the results of these estimates to international programmes and databases.
			X	X	I.5.10. Development of dynamic models of soil and landscape development in space and time with an emphasis on the evaluation and provision of soil ecosystem functions.

Research direction II: Water

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
II.1. Mitigating the climate change impacts	**1**			X	II.1.1. Research into the possibilities of utilising strategic water resources and their protection in the conditions of climate change.
				X	II.1.2. A system of comprehensive protection and use of surface and underground water resources for supplying the population with drinking water, especially in situations of hydrological extremes.
				X	II.1.3. Securing drinking water supplies in relation to future climate scenarios.
				X	II.1.4. The impact of climate change on the quality of water in agricultural areas, especially the issue of deteriorating water quality in times of drought.
				X	II.1.5. Possibilities of water accumulation and infiltration to retain and slow down runoff from agricultural, forest and urbanized landscapes and subsequent use of water for agricultural and forestry melioration systems.
				X	II.1.6. Support for the development of pilot areas to demonstrate a system of measures mitigating the negative

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
					impacts of climate change on water resources in the areas.
				X	II.1.7. The potential for the development of small water bodies in the landscape; the relationship of ponds (and small reservoirs) and minimum residual flows to the hydrological balance.
				X	II.1.8. Quantifying the hydrological functions of wetlands and peatlands in mitigating the impacts of climate change.
		X		X	II.1.9. The effect of wetlands and peatlands on the quality of surface and underground waters.
				X	II.1.10. Support for the reuse of wastewater in agriculture and forestry, including the setting of criteria for the suitability of such water in relation to climate change; innovation focused on the circular economy in agriculture with an emphasis on smart management of water resources.
			X	X	II.1.11. Development of automated irrigation systems, identification of water sources for irrigation, development of technologies and optimization of irrigation operations.
			X	X	II.1.12. Monitoring and minimizing the input of specific micropollutants into water sources (pesticides, pharmaceutical residues and their metabolites, antibiotic resistance genes and microplastics).
II.2. Optimising the production and non-production functions of the landscape, sustainability of agriculture, development of organic farming and efficient use	**1**		X	X	II.2.1. Analysis of the effect of organic farming on water quality in areas of drinking water sources (water resource protection zones), assessment/valuation of ecosystem services (development and selection of suitable indicators) - impact on policy.
	2	X			II.2.2. The effect of forest management practices on the water balance.
	3	X		X	II.2.3. Optimizing the design of measures in the landscape, taking into

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
of water resources					account their production and non-production (environmental) functions; the use of freely accessible remote sensing products in the design of a system of near-natural retention measures.
			X		II.2.4. Support for the long-term sustainability of farming on agricultural land based on the interpretation of digitized territory-oriented databases.
			X		II.2.5. Development and application of the principles of smart farming and water management using modern technologies.
				X	II.2.6. Analysis of the need to amend legal regulations in the field of water management with the aim of climate change adaptation.
II.3. Minimising the impacts of torrential rain and soil-erosion phenomena	**3**		X		II.3.1. Integrated protection of the territory within the collection areas of critical points (profiles) in land consolidation.
		X		X	II.3.2. Evaluation of the effectiveness of near-natural protective measures in the river basin, including protective reservoirs, to reduce peak flows in the basin - flood flows caused by regional rainfall.
			X	X	II.3.3. Identification and stabilization of the paths of concentrated runoff on arable land.
		X			II.3.4. Protection of agricultural land from erosion and prevention of nutrients leaching into waterways.
		X		X	II.3.5. Improving the rainfall absorption and permeability of the soil profile.
				X	II.3.6. Improving water retention by the soil during the application of stabilized sewage sludge - options for eliminating risks.

Research direction III: Biodiversity

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
III.1. Biodiversity in agroecosystems	**1**			X	III.1.1. Analysis of the diversity of landscapes and communities in relation to the type of agricultural use and the level of biodiversity (communities, populations, genotypes). A study of factors affecting the change or reduction of biodiversity.
				X	III.1.2. Evaluation of natural and anthropogenic factors affecting the dynamics of biodiversity as a result of climate change and the intensity of farming.
				X	III.1.3. Continually ensuring the preservation and expansion of collections of genetic resources of plant species and genera as a basis for further genetic-breeding applications.
			X	X	III.1.4. Research into the possibility of increasing biodiversity in the current agricultural landscape (fallow land, establishment of species-rich meadows, cultivation of old and regional varieties, organic farming, agro-environmental measures), increasing the proportion of scattered greenery in the landscape, creation of refugia, restoration of biocorridors.
			X	X	III.1.5. Monitoring and management of biodiversity and ecosystem services in natural systems and in primary production depending on the farming system.
		X	X	X	III.1.6. Evaluation of the share of the natural component of diversity in agroecosystems depending on the type and intensity of land use.
			X	X	III.1.7. Evaluation of the impact of organic farming on biodiversity (landscape, species composition of communities, occurrence of invasive species, preservation of the gene pool of wild species, etc.), production of the sector (value chains, quality and level of production), preservation of the gene pool of wild species, preservation and use of traditional and old regional

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
					varieties, application of modern varieties.
		X			III.1.8. Valuation of public goods of organic farming and other eco-friendly agrosystems.
		X	X	X	III.1.9. Studying interactions between biodiversity, agriculture, health, food, water and climate.
				X	III.1.10. Studying the influence of individual substances used by humans (pharmaceuticals, antibiotics) on the biodiversity of various groups of microorganisms, the role of microorganisms in the ecosystem and on the relationships between microorganisms and macroorganisms, e.g. pollinators.
	2	X		X	III.1.11. Continuously ensuring and expanding the conservation of genetic resources of microorganisms as a basis for biotechnology and for the study of biodiversity, ecology and epidemiology in agricultural ecosystems and the development of conservation procedures for difficult-to-preserve taxa.
			X	X	III.1.12. Studying the diversity of microbial communities and the diversity of other groups of organisms linked to the spectrum of cultivated crops.
				X	III.1.13. Research on the impact of non-native and invasive plants, trees and animals on biodiversity. Studying the factors limiting the spread of invasive species of organisms.
		X	X	X	Evaluating the effect of the management of permanent grasslands on the biodiversity of permanent grasslands in areas with a specific regime (Natura 2000, Agroenvi, etc.).
		X		X	III.1.15. Analysing the use of the gene pool of wild, traditional and regional varieties of taxa used in agriculture and landscaping.
	3			X	III.1.16. The use of traditional and non-traditional plants that bind atmospheric

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
					nitrogen to increase the agrodiversity and biodiversity of meadow communities.
		X	X		III.1.17. Involvement of agricultural production in the concept of bioeconomy and value chains in the agri-food sector.
			X		III.1.18. Use of alternative crops (e.g. C4 plants) and mixed cultures to increase agrodiversity.
III.2. Biodiversity in forest ecosystems	**1**	X	X	X	III.2.1. Analysing the possibilities of near-natural forestry in the area of protection and restoration of the biodiversity of forest ecosystems.
			X	X	III.2.2. Analysing the spontaneous dynamics of forest ecosystems and their importance for the biodiversity of stands and landscapes in connection with global and regional climate trends and depending on the socio-economic conditions.
		X	X	X	III.2.3. Application of measures to preserve and use the gene pool of forest trees through a system of differentiated measures and genetic studies (protected areas, gene bases, breeding plantings, clone archives, breeding programmes, provenance research).
			X	X	III.2.4. Analysing the relationship between the structure of forest ecosystems (genetic, species, age, spatial) and their biodiversity using traditional and modern forest management technologies.
		X	X	X	III.2.5. Analysing the impact of cultivating tree species not native for the habitat and geographical area on biodiversity, prevention and protection in the field of invasive species in forest ecosystems.
	2		X		III.2.6. Evaluation of forest protection measures, including analysis of the impact of applied plant protection products on the biodiversity of forest ecosystems.
				X	III.2.7. Evaluating the importance of cultivation systems for the diversity of

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
					ecosystem components with application in the field of climate change adaptation and mitigation.
		X	X	X	III.2.8. Evaluation of existing management practices in applying sanitation measures and interventions in terms of minimizing their impact on biodiversity.
				X	III.2.9. Evaluation of the genetic structure of forest tree populations in terms of loss of genetic diversity and rescue of local populations.
	3	X	X	X	III.2.10. Evaluation of the impact of management conservation measures (nature and environmental protection) on the biodiversity of forest ecosystems in individual types of specially protected areas (outside the forests of national parks), on forests in the protection zones of specially protected areas and on forestry in the affected forests, including an assessment of leaving dead trees in the forest, so-called dead wood, etc.
		X		X	III.2.11. Analysis and synthesis of biodiversity aspects with regard to the concept of bioeconomy.
III.3. Biodiversity of aquatic and wetland natural and artificial ecosystems	**1**		X	X	III.3.1. Evaluation of water and wetland ecosystems in terms of landscape biodiversity and protection against drought and floods, as well as in terms of water retention in the landscape.
		X	X	X	III.3.2. The use of genetics and genomics to more closely monitor the genetic integrity and level of genetic variability of defined aquatic genetic resources preserved in situ, and further research in reproductive physiology, cryopreservation of gametes, germ cells and embryonic stem cells for ex situ preservation and transplantation.
				X	III.3.3. The influence of foreign substances originating from municipal wastewater on the biodiversity and ecological functions of aquatic ecosystems.
			X	X	III.3.4. Finding optimal methods of fish seed production, which can be effectively

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
					applied in the support of wild fish populations.
			X	X	III.3.5 Evaluation of the hydrological situation of trout fishing districts in the Czech Republic.
	2		X		III.3.6. The impact of pesticides used in agriculture on the biodiversity and biology of organisms in aquatic and wetland ecosystems.
			X	X	III.3.7. Research on changes in the diversity of organisms in aquatic and wetland ecosystems due to climate change (higher temperature, higher CO_2 content, etc.).
				X	III.3.8. Analysis of the impact of aquaculture technologies and their management on the biodiversity of aquatic ecosystems and water quality.
		X	X	X	III.3.9. New approaches in fishery management in trout districts as a response to current factors fundamentally affecting fish communities.
	3	X	X	X	III.3.10. Introduction of aquaponics technology to the Czech Republic and its optimization.
		X	X	X	III.3.11. The use of algae as feed for other aquatic organisms, including the possibility of using wastewater or nutrient recycling for their cultivation.
		X	X	X	III.3.12. Possibilities of increasing the diversity of organisms used in aquaponic systems used for nutrition and for the production of materials important for industrial production.
III.4. Tools for the study and evaluation of biodiversity	**1**	X		X	III.4.1. Capacity building for conservation, characterization and management of genetic resources of plants, animals and microorganisms.
			X	X	III.4.2. Genomic and taxonomic technologies for inventory and faster identification of organisms incl. pollinators, migratory species, predators, disease vectors or animal pests.
		X	X	X	III.4.3. Increasing knowledge and understanding of functional biodiversity

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
					above (vegetation, microorganisms, insects, animals) and below the soil surface (microorganisms, soil fauna) and how the sustainable management and primary production affect ecosystem factors.
	2	X		X	III.4.4. Strategies and policies for biodiversity in agriculture and forestry supporting its development, analysis of the economic effects of maintaining or increasing biodiversity.
		X	X	X	III.4.5. Development of system elements for targeted support of pollinators in the landscape, deeper knowledge of interactions at the local or landscape level, including knowledge of their biology and interaction with microorganisms.
		X		X	III.4.6. Assessment of natural capital - from macroeconomic models to the decision-making sphere. Economic analyses, funding, bioeconomic modelling. Methods, criteria and standards for evaluating ecosystems to demonstrate the benefits that biodiversity conservation and ecosystem conservation bring to the economy.
	3	X		X	III.4.7. Proposal for the restoration of landscape structures following historical development in the context of land consolidation.
		X		X	III.4.8. Research on the impact of implemented joint land consolidation measures fulfilling environmental functions for biodiversity, ecological stability and aesthetics of the agricultural landscape.

Research direction IV: Forestry and the related sectors

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
IV.1. Evaluating the dynamics of forest ecosystems - monitoring and inventory	**1**		X		IV.1.1. Ensuring the continuity and development of current monitoring programmes, supplementing them with parameters capturing current changes in forest ecosystems, including their increasing variability.
				X	IV.1.2. Assessing the dynamics of forest soils in terms of threats, climate change and the potential for mitigating climate change.
	2		X		IV.1.3. Harmonization of data outputs and partial databases, expansion of data usability, creation of automatic data processing methods, preparation of application outputs and making them available to forestry operations.
	3		X	X	IV.1.4. Development of technical means, remote monitoring methods and tools for continuous inventory of forest ecosystems.
IV.2. *Stability and health condition of forests*	**1**		X	X	IV.2.1. Research into the effect of abiotic and biotic factors on the vitality of forest trees and the stability of forest stands even in the context of climate change, research into the relationship between the physiological state of stands and the quality of the environment.
			X	X	IV.2.2. Research into the possibilities of eliminating the impact of cloven-hoofed game as one of the factors limiting the options of modifying the species, age and spatial structure of forest stands in connection with adaptation measures.
	2		X	X	IV.2.3. Analysing the impact of historical pollution of forest ecosystems on the current and future health condition of forests, on the properties of forest soils and on forest communities.
				X	IV.2.4. Research of the potential threat and economic impacts of the spread of invasive insect species, fungal pathogens and plants, including woody plants, and the design of corresponding protective, preventive and regulatory measures (plans); preparation of technical documents for the meeting of the inter-ministerial commission (in connection with

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
					activities resulting from Regulation (EU) No 1143/2014 of the European Parliament and of the Council.
				X	IV.2.5. Analysing the risk of a more intensive activity of pests on economically important trees and defining the options for protective and preventive measures on the principles of integrated forest protection, with a focus on alternatives to chemical protection.
			X	X	IV.2.6. Research into the issue of forest fires and research into the possibilities of their minimization or optimization of the extinguishing system.
			X	X	IV.2.7. Analysis and research of the impact of the applied economic measures on forest health (effect of abiotic and biotic harmful agents).
			X	X	IV.2.8. The importance of ectomycorrhizal symbiosis with regard to organic products increasing the defence against biotic agents.
IV.3. ***Adaptation and mitigation measures associated with the change of climate and the society***	**1**		X	X	IV.3.1. Research on variant restoration procedures using different types of reproductive material, its modifications, different tree species, including introduced tree species, their populations and mixtures. Establishment and maintenance of an extensive network of semi-operational verification areas in forest stands managed by state enterprises (demonstration areas). Preservation and use of the genetic pool of native forest trees.
			X	X	IV.3.2. Development of the dynamics of forest ecosystems in time and space, analysis of the effect of forestry on the genetic constitution of populations of forest trees, analysis of the genetic basis of adaptation processes, prediction of development in determined time horizons.
			X	X	IV.3.3. Evaluating the potential of using introduced tree species and assisted

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
					migration of tree species and their populations in the conditions of the Czech Republic with regard to climate change, production potential and stability of forest stands.
			X	X	IV.3.4. Research focused on optimizing the cultivation practices used in regeneration and tending of forest stands to strengthen their stability and adaptability, analysis of the quantity and quality of production and the provision of ecosystem services.
			X	X	IV.3.5. Research on cultivation options for increasing the vitality and resistance of woody plants to drought stress, research on the possibilities of strengthening the hydric function of forests.
			X	X	IV.3.6. Analysis of measures increasing carbon sequestration in forest stands and forest soils, monitoring the carbon footprint in forestry.
	2		X	X	IV.3.7. Optimizing the formation of the vegetation structure of forest stands with regard to their water balance and the hydric function of the landscape, research focused on the process of rebuilding forest stands.
				X	IV.3.8. Research into the biodiversity of forest ecosystems (species and genetic) and its changes depending on the climate, forest management practices and other factors, optimization of the genetic, species, spatial and age structure of forest stands, importance for the stability and vitality of forest ecosystems.
			X	X	IV.3.9. Research of the growth, vitality and health status of forest trees and their populations in provenance experiments and comparative semi-operational plantings in different habitat conditions, determination of suitable transfer rules.
			X	X	IV.3.10. Assessing the economic consequences of cultivation practice variants used in the formation and cultivation of a forest.

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
			X		IV.3.11. Analysing the methods and procedures of economic forest management planning, determining the elements of dynamic tools of economic forest management for changed conditions, research on logging forest management, simplifying and streamlining the economic forest management procedures using modern technologies, capturing the dynamic development of forest ecosystems (stands and habitats) in changed conditions.
			X		IV.3.12. Research of the potential of strategic, tactical and operational planning models in forestry, analysis of the costs and benefits of the proposed adaptation measures, including the costs of inactivity.
IV.4. *Bioeconomy, forest ecosystem services and the related fields*	**2**	X			IV.4.1. Formulation of tools for forest bioeconomy, application of circular economy in forest bioeconomy.
		X			IV.4.2. Research into the possibilities of increasing added value in forestry and related fields, the use of wood from less common species, modification of its properties, material development from the point of view of application and recycling.
		X	X		IV.4.3. Optimization of technologies and machinery in forest production from the point of view of environmental burden, economy of operation, technical innovations, especially with regard to the rationalization of forest production, greenhouse gas emissions and protection of the retention capacity of forest ecosystems.
		X	X		IV.4.4. Cascading use of wood, especially use in construction and furniture production, production of agglomerated materials, chemical processing of wood, production of biopolymers, biocomposite materials and in bioenergy.
			X		IV.4.5. Acquisition and evaluation of operational, biometric and economic

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
					data with new technologies in forest production, wood assortment sorting and trade, automation of operations and processes. The priority will be the updating of assortment tables according to current and future needs.
		X		X	IV.4.6. Determining the forest interest rate for various purposes of its use.
	3	X	X	X	IV.4.7. Research on the potential of applying artificial intelligence in the forest bioeconomy.
			X		IV.4.8. Applying the Industry 4.0 trend in forest bioeconomy.
		X	X		IV.4.9. Research into the applied forestry measures affecting the provision of forest ecosystem services, including a comprehensive assessment of the impacts of applied forestry measures on forest owners and forestry.
		X	X		IV.4.10. Optimizing the working conditions, qualification requirements and care for the health of workers in forestry and downstream production.
		X	X		IV.4.11. Communication of the forestry sector and the related sectors.
IV.5. *Game management and conservation in the landscape*	**1**		X	X	IV.5.1. Analysing the management of animal species, their bionomics, and developing a strategy to limit invasive (native and non-native) species as a significant factor threatening biodiversity in line with the European Union directive on invasive species.
	2	X	X		IV.5.2. Development of methods for assessing the state of the ecosystem as an important indicator for determining the appropriate populations of game and determining a methodology for deriving optimal management.
			X		IV.5.3. Research on the effect of the use of landscape formations and the farming system on small game populations, and testing the principles of good agricultural practice (the so-called Good Agricultural and Environmental Condition of the Soil - GAEC) and suitable methods of forest management.

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
		X	X		IV.5.4. Research on reducing conflict situations between animals and humans, e.g. reducing collisions with animals on roads and railways, reducing collisions in built-up areas, return of specific species of game and animals to Czech countryside.
				X	IV.5.5. Research on zoonoses and other significant diseases occurring in game animals and determination of measures to mitigate the impact and spread of diseases.
			X		IV.5.6. Research on the behaviour (ethology) of individual game species in the context of the cultural landscape and the types of farming in it, the response of individuals and populations to currently widespread infectious diseases in game (ASF, avian influenza), research on game orientation.
	3	X	X		IV.5.7. Research on preventive and protective measures used in forestry and agriculture to control damage to game and caused by game.
		X	X		IV.5.8. Research into the possibilities of identifying game individuals on the basis of unique identifiers for the purpose of their records or selection from the population (cloven-hoofed game, "bolt" individuals among predators).

Research direction IV: Plant production

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
V.1. Genetic diversity, plant breeding	**1**		X	X	V.1.1. Research and use of new breeding techniques to create starting materials and varieties tolerant or resistant to abiotic and biotic stresses.
			X	X	V.1.2. Breeding and evaluation of varieties resistant or tolerant to harmful organisms and their introduction into integrated plant cultivation systems.
			X	X	V.1.3. Breeding new organic varieties and testing suitable conventional varieties

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
					for organic farming conditions with the aim of eliminating differences in yields between organic and conventional farming: breeding for nutritional quality, for weed suppression, for adaptation to climate change - abiotic and biotic stressors, and ensuring the availability of bioseeds.
	2		X	X	V.1.4. Breeding and use of crops and varieties with increased tolerance to abiotic stresses, capable of more thrifty water management and more rational use of nutrients.
			X		V.1.5. Breeding of crops with higher nutritional and other added value for the nutrition of the population and for feeding farm animals.
	3		X		V.1.6. Crop breeding for local, non-food and other special production.
V.2. *Sustainable production of non-hazardous and high-quality raw materials, foodstuffs and feed of plant origin*	**1**		X		V.2.1. Sustainable farming systems in different socio-economic and natural conditions – conventional, integrated, organic and other alternative farming systems.
			X	X	V.2.2. Agri-technical practices for growing plants and measures aimed at protecting the soil from degradation processes (e.g. wind and water erosion, compaction, etc.).
			X		V.2.3. Optimizing production systems with the aim of minimizing the risks of environmental pollution with pesticide residues.
			X	X	V.2.4. Sustainable cultivation systems focused on efficient use of water.
	2		X	X	V.2.5. Increasing the effectiveness of plant production in organic farming and introducing new practices.
		X	X		V.2.6. The carbon and soil organic matter cycles, practices leading to carbon sequestration and higher content and quality of organic matter in the soil.
		X	X		V.2.7. Technology of production, use and application of fertilizers and conditioners to optimize plant nutrition and reduce nutrient losses.

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
			X	X	V.2.8. Cultivation practices and measures increasing the level of agrobiodiversity and methods of monitoring and evaluating agrobiodiversity as an indicator of the sustainability of soil and land management.
			X		V.2.9. Introduction of precision agriculture practices in technological systems of plant cultivation in the conditions of Agriculture 4.0. - use of robotisation and automation.
	3		X		V.2.10. Development of detection methods, collection and processing of data and development of algorithms for the needs of Agriculture 4.0 technologies.
		X	X		V.2.11. Use of energy in production systems, energy balances and ways to increase the energy efficiency of plant production, emissions from growing systems.
		X			V.2.12. Applying the principles of circular economy in the processing and use of waste in plant growing technologies.
		X	X		V.2.13. Sustainable management of permanent grassland and forage on arable land to ensure production and non-production functions.
			X		V.2.14. Alternative growing systems using hydroponics and aeroponics, vertical farms.
V.3. *Quality and safety of plant production*	**1**		X		V.3.1. Crop cultivation technology leading to an increase in the nutritional value and safety of raw materials and foodstuffs of plant origin.
			X		V.3.2. Development and use of methods for screening and prediction of nutritional, technological and hygienic quality of raw materials and foodstuffs of plant origin.
	2		X		V.3.3. Technology of long-term storage of plant products minimizing losses and maintaining high nutritional value.
			X		V.3.4. Development of reliable and rapid methods for the detection of biological, chemical and physical contamination of

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
					raw materials of plant origin intended for the food industry.
	3		X		V.3.5. Genetic and physiological basis of plant production quality.
		X	X		V.3.6. Production of high-quality feeds (feeds with high nutritional value, without the content of anti-nutrients and hazardous contaminants).
			X		V.3.7. Development of methods of physical and non-chemical sanitation and disinfection of storage and processing operations.
V.4. Non-food production	**1**	X			V.4.1. The use of waste from agriculture and the food industry as inputs and raw materials for new technologies according to the circular economy principles.
	2	X			V.4.2. Crops, cultivation systems and technologies for the production and subsequent use of renewable, recyclable and degradable biomaterials.
		X			V.4.3. Bioenergy production of biomass for energy use and biomass conversion.
	3	X	X		V.4.4. Production of substances utilisable in pharmaceutical industry, special chemicals and enzymes, polymers and fibres.
V. 5 .Climate change adaptation of plant production and mitigation measures	**1**		X	X	V.5.1. Changes in the species spectrum of agricultural pests, weeds and plant pathogens due to climate change and their impact on agricultural production.
			X	X	V.5.2. Research on the water and carbon balance of agri-systems as a basic prerequisite for the sustainability of plant production.
	2			X	V.5.3. Climate change and prediction of its impact on the cultivation of agricultural crops in the Czech Republic.
				X	V.5.4. Adaptation of agri-systems and technologies in plant production.
	3		X	X	V.5.5. Study of suitable species and varietal composition of crops for areas more often affected by drought.

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
			X	X	V.5.6. Research, development and innovation in the field of irrigation technology, provision of water sources for irrigation and development of irrigation technology.

Research direction VI: Plant health

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
VI.1 Plant protection management	**1**		X		VI.1.1. Development and verification of the effectiveness of new means and methods of protection.
			X		VI.1.2. Methods of diagnosis and monitoring of resistance of harmful organisms to plant protection products and proposals for anti-resistance strategies.
			X		VI.1.3. Development of modern methods for monitoring harmful organisms and of effective predictive and epidemiological models of harmful organisms in crop protection systems, including methods of assessing the major outbreaks of harmful organisms.
		X	X		VI.1.4. Development and verification of new technologies such as precision agriculture, robotisation and digitisation in the field of plant protection.
	2	X	X		VI.1.5. Development and updating of economic thresholds for the harmfulness of harmful organisms in economically important agricultural crops.
			X		VI.1.6. Methods of diagnosis of disease agents and harmful organisms with a focus on faster, more sensitive and highly specific diagnostic methods.
	3	X	X		VI.1.7. Biology, ecology and epidemiology of harmful organisms as a basis for strategies for their effective control.
		X	X	X	VI.1.8. Methods of assessing and managing the risk (pest risk analysis – PRA) of the introduction and spread of officially regulated harmful organisms or those that are new for CZ.

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
VI.2 Innovation of Integrated Plant Protection methods	**1**	X	X		VI.2.1. Development, innovation and verification of the effectiveness of integrated systems of agricultural crop protection for systems of conventional farming, systems of integrated production and for organic farming.
	2	X	X		VI.2.2. Methods and means of integrated protection against harmful organisms in the field of forestry and stored agricultural stocks and commodities.
		X	X		VI.2.3. Methods of detection and monitoring of the occurrence of harmful substances such as mycotoxins in plant products, feed and food, and proposals for measures to minimize their occurrence.
	3	X	X		VI.2.4. Methods of evaluating the dynamics of pesticide residue degradation in plants and their products, especially in fruits and vegetables.
			X		VI.2.5. Assessment of the impact of plant protection products on non-target organisms, biodiversity and environmental components and proposals for measures to minimize their impact.
VI.3. Biological and non-chemical means and methods of plant protection	**1**		X		VI.3.1. Development, innovation and verification of the effectiveness of biological and biotechnological means and methods of protection against harmful organisms.
		X	X		VI.3.2. Development and verification of the effectiveness of the plant protection system for organic farming.
	3	X	X		VI.3.3. Evaluation of the importance of natural enemies of harmful organisms and proposing measures to support them and increase the control of pest and pathogen populations.
VI.4. Plant resistance to harmful organisms	**1**	X	X		VI.4.1. Research on the usability of varieties with resistance to harmful organisms in Integrated Plant Protection.
	2		X		VI.4.2. Research into the mechanism of plant resistance to pathogens, pests and weeds using molecular and biotechnological methods.

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
	3		X		VI.4.3. Etiology of plant biotic stresses and analysis of the genomes of their agents to identify the nature and factors determining virulence or pathogenicity.

Research direction VII: Livestock production

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
VII. Genetics and genomics, breeding and reproduction of farm animals, use of biotechnologies in livestock production	**1**		X	X	VII.1.1. Genomic assessment of populations, individuals and individual traits, with particular regard to health indicators.
			X	X	VII.1.2. Breeding practices to improve reproductive performance and longevity indicators in high-yield livestock breeds.
			X	X	VII.1.3. Breeding practices to improve disease resistance in high-yield livestock breeds.
		X	X		VII.1.4. Economic and genetic optimization of breeding goals.
		X	X		VII.1.5. A knowledge system elucidating genome-trait relationships and integrating multiple levels of data (genome sequencing, transcriptomics, proteomics, metabolomics).
		X		X	VII.1.6. New strategies for in situ and ex situ conservation of animal genetic resources.
		X	X		VII.1.7. Development of reproductive biotechnologies for use in commercial breeding.
	2	X	X		VII.1.8. Evaluation of the possibilities brought by world research to date in the field of farm animal genome editing as a prerequisite for a qualitatively new approach to breeding in the future.
		X			VII.1.9. Using animal models to elucidate and address human reproductive problems.
		X		X	VII.1.10. Gene transfer between generations and genetic-economic optimization of the transfer in selection and hybridization programmes and in breeding genetic animal resources.

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
		X		X	VII.1.11. Using the complexity of phenotypic and genotypic data to create algorithms for the genetic evaluation of individuals and populations (prediction of breeding value).
		X	X		VII.1.12. Use of genomic technologies and bioinformatics tools to identify causative genes and quantitative loci and identify their relationship to productivity, health and welfare.
		X	X		VII.1.13. Functional annotation of genes based on genomic, transcriptomic and possibly epigenetic data for refining the estimation of genetic variability of a trait and for breeding.
			X	X	VII.1.14. Developing effective methods for regeneration of gene resources from cryopreserved material in gene banks.
			X		VII.1.15. Development of gametes and early mammalian embryos, including the etiology of disorders causing embryonic mortality and reproductive dysfunction.
	3		X	X	VII.1.16. Breeding in conditions of interaction between genotype and environment.
		X	X		VII.1.17. Development of new technologies and bioinformatics systems for obtaining high-quality phenotypic data from a large number of individuals (alive or post-mortem) and their use for the interpretation of omic information, and user-friendly advanced tools for the use, preservation and sharing of phenotypic and genomic data.
		X	X		VII.1.18. Use of newly defined phenotypic traits obtained from new technologies and bioinformatics systems in breeding systems.
		X	X		VII.1.19. Breeding practices to reduce inbreeding and maintain genetic variability in small populations and genetic resources using molecular genetics.
		X			VII.1.20. Husbandry practices in a small population of animals using biotechnological procedures.

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
				X	VII.1.21. Determination of molecular genetic indicators of biodiversity for the characterization and protection of genetic resources.
		X	X		VII.1.22. Genotyping at the embryonic level.
		X	X		VII.1.23. Study of the etiology, prevention and diagnosis of genetic disorders in animals.
		X			VII.1.24. Development of methods for obtaining and routine use of stem cells for further research, for genetic modifications and methods of RNA blocking/knockdown of genes.
			X		VII.1.25. Artificial reproduction in fish including transfer of germ cells.
		X	X		VII.1.26. Extending the useful life of insemination doses and maintaining their quality in pigs.
VII.2. Systems and technologies of animal husbandry, welfare of farm animals and livestock production economy	**1**		X	X	VII.2.1. Increased resistance of animal husbandry systems to impending climate change.
			X	X	VII.2.2. Efficient production of farm animals (FA) raised in organic farming systems.
			X	X	VII.2.3. Production systems of livestock farming with regard to product quality and the environment.
			X		VII.2.4. The use of digital technologies in livestock farms with the aim of improving the animal performance, health and welfare parameters.
		X	X		VII.2.5. Research and quantification of meeting the basic needs of FAs in relation to breeding technologies, especially the full provision of social needs and basic biological requirements of the particular FA type, corresponding microclimatic conditions (heat, light, air), space, feed and water.
		X			VII.2.6. Economic models for evaluation and optimization of animal husbandry management.
	2	X	X	X	VII.2.7. New technologies and procedures for creating animal products in organic farming.
		X	X		VII.2.8. Research into the effects of the rearing environment and biotechnology

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
					on individual behaviour and mutual relationships between animals, and the use of mechanisms by which the organism copes with stress.
		X			VII.2.9. The use of non-traditional breeds and species of animals in animal and human nutrition (insects, game).
		X	X		VII.2.10. Development of sustainable agricultural systems with a closed cycle of nutrients and a favourable impact on the environment.
			X		VII.2.11. Interaction between cryptoclimate (microclimate of indoor spaces) and macroclimate.
			X		VII.2.12. Innovation and development of technological procedures for new types of livestock farming, including aquaculture, the use of automated livestock herd management systems ("precision livestock farming") with a focus on the level and quality of production, health and on satisfying the physiological needs of animals.
			X	X	VII.2.13. Development of technical elements and technological systems to increase the level of environmental protection and welfare of FAs with regard to the farming system and climate change.
			X	X	VII.2.14. Toxic substances in stable environment and animal production, control of greenhouse gas emissions in animal production.
		X	X		VII.2.15. Research on the influence of the rearing environment, genetic, physiological and behavioural factors on the optimization of reproduction of livestock and animals raised in farms and laboratories.
				X	VII.2.16. Long-term sustainable fish production in ponds while ensuring non-production functions of ponds.
	3	X		X	VII.2.17. The effect of thrifty management on the quality and economy of production in barren areas, the harmonization of the economic and landscape-forming functions of husbandry and the protection of biodiversity, including the

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
					possibility of using non-traditional livestock farming.
			X		VII.2.18. Early prediction of health problems in dairy cows using extended laboratory analyses of milk.
		X	X		VII.2.19. Minimization of health and behavioural problems of FAs in production systems (lameness, coat/plumage quality, etc.).
		X	X		VII.2.20. The effect of prenatal and postnatal stress on changes in the behaviour and physiological parameters of animals during their ontogenesis and the possible intergenerational transmission of such changes in different species of FAs.
		X			VII.2.21. Research of interactions between humans and FAs and the approach of humans to animals, the use of learning theory and positive motivation in daily husbandry practice.
		X			VII.2.22. Research on the relationships of social behaviour and feedback of physiological indicators that determine the performance of FAs.
		X	X		VII.2.23. Research into the cognitive abilities of FAs, which are a prerequisite for a given type of FAs to adapt to established and new technologies.
		X			VII.2.24. Clarifying the role, value and possibility of using animals (local populations) in non-market and ecosystem services.
				X	VII.2.25. Non-productive functions of FAs and other species of animals - rearing conditions and handling of animals in accordance with their welfare and with respect to the environment.
		X			VII.2.26. Research of the economic context in livestock farming and the development of practices and technologies for competitiveness in the conditions of the EU's Common Agricultural Policy.
		X			VII.2.27. Defining the minimum requirements for the profitability of livestock farming and examining the effect of factors

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
					affecting the overall economic efficiency of livestock farming.
VII. 3. Nutrition and feeding of animals, quality and safety of feed and of animal products	**1**	X		X	VII.3.1. Application of domestic sources of protein and nutrient-rich feeds in the nutrition of FAs.
			X	X	VII.3.2. Ensuring the feed base using coarse fodder from alternative crops resistant to drought or with an anti-erosion function.
			X	X	VII.3.3. Conservation and storage of fodder - use of silage additives and technologies, reduction of losses, preservation of quality, stability and nutritional value in relation to the FA production.
		X	X		VII.3.4. Nutrition of high-yield FAs, especially dairy cows, and its risks during the entire life cycle.
			X		VII.3.5. Application of precision agriculture elements in the nutrition of FAs.
		X	X		VII.3.6. Refining the prediction of the nutritional value of feed and standards for FAs, including new assessment methods.
		X	X		VII.3.7. Evaluation of degradability and intestinal digestibility of protein and carbohydrates, digestion of individual amino acids (nitrogen metabolism) in FAs.
				X	VII.3.8. Limiting greenhouse gas production through FA nutrition.
	2	X	X		VII.3.9. Animal nutrition aimed at influencing the quality of animal products and obtaining so-called "functional foods" with a beneficial effect on human nutrition.
			X	X	VII.3.10. The use of crops with a positive environmental impact as fodder for FAs.
		X	X		VII.3.11. The relationship between nutrition, gene expression and the activity of encoded proteins.
			X		VII.3.12. Development of functional feeds and new substances to replace antibiotics in FA nutrition.
	3		X	X	VII.3.13. Aspects of FA nutrition as a result of changes in the farming system.

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
			X	X	VII.3.14. Introduction of new/alternative feeds and by-products of agricultural and food production in FA nutrition.
			X	X	VII.3.15. Feed utilization and nutritional requirements of FAs in alternative farming systems.
		X	X		VII.3.16. Development of new milk mixtures and their substitutes for sucklings.
		X	X		VII.3.17. Increasing the efficiency of energy utilization of nutrients (energy metabolism) in FAs.
			X		VII.3.18. Elimination of toxic substances and anti-nutrients from FA feed.
		X	X		VII.3.19. Effective use of nutrients in intensive aquaculture.
		X	X		VII.3.20. The use of alternative sources of fat in the FA nutrition.
		X	X		VII.3.21. The use of antioxidants for the oxidative stability of animal products, the interaction between the action of usable antioxidants and the possibility of extending the stability of products.
		X	X		VII.3.22. Nanomaterials in animal nutrition.
		X	X		VII.3.23. Application of external enzymes and yeast in FA nutrition.
		X			VII.3.24. Influencing the organoleptic properties of animal products.
		X			VII.3.25. Trends, consumer preferences and socio-economic influences with regard to the consumption of foods of animal origin.
		X	X		VII.3.26. Modernization and innovation of the system for evaluating the quality of slaughtered farm animals.

Research direction VIII: Veterinary medicine

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
VIII. 1. Animal diseases (diagnosis, immunology	**1**			X	VIII.1.1. Development of new types of vaccines and other biological products for prophylaxis and immunotherapy.
			X		VIII.1.2. Study of the relationship between the composition of the intestinal

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
and immunotherapy, pharmacology and toxicology)					microflora and the occurrence of important pathogens.
			X		VIII.1.3. Development of advanced in vitro and in vivo pharmacological and toxicological models (for toxicological and preclinical testing of pharmaceuticals, vaccines and biocompatible materials).
	2	X	X		VIII.1.4. Study of the emergence and development of economically significant livestock diseases.
			X		VIII.1.5. Development of new diagnostic and therapeutic methods and procedures.
			X		VIII.1.6. Development of new molecules of antimicrobials, including alternative methods and bactericides.
	3		X		VIII.1.7. Development of veterinary medicine focused on pet animals.
			X		VIII.1.8. Use of animal models in the research of human diseases.
VIII.2. Production and preventive medicine, antimicrobial resistance control	**1**		X	X	VIII.2.1. Development of predictive procedures for estimating the development of the health status of farm animals in conditions of intensive production systems and in conditions of organic farming.
			X		VIII.2.2. Development and innovation of preventive practices for maintaining animal health in conditions of intensive production systems and in conditions of organic farming.
	2			X	VIII.2.3. Study of the mechanisms of bacteria resistance to antimicrobials and the ways of their spread.
			X		VIII.2.4. Development of new diagnostic methods to monitor the occurrence of bacterial resistance to antimicrobials.
	3		X		VIII.2.5. Limiting the occurrence of bacterial resistance to antimicrobials in livestock farms.
			X		VIII.2.6. Utilizing the knowledge of nutrigenomics and metabolomics and influencing the microbiome in the prevention of livestock diseases and the increase of FA performance.

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
VIII. 3. Animal diseases and zoonoses, alimentary diseases	**1**		X	X	VIII.3.1. Study of epizootology and prevention of livestock diseases and of their spread.
	2			X	VIII.3.2. Emerging diseases, spreading as a result of climate change and other global changes.
			X	X	VIII.3.3. Study of significant zoonoses.
	3		X	X	VIII.3.4. Viral, bacterial and parasitic agents of alimentary diseases.
VIII. 4 .Quality and safety of food and protection of food chains from xenobiotics	**1**	X	X		VIII.4.1. Monitoring anabolic abuse in selected farm animals and studying its effects on the food chain.
	2		X		VIII.4.2. Development of rapid bioanalytical methods and screening tests for the detection of pharmaceutical residues, mycotoxins, chemical and physical food contaminants and environmental pollutants.
VIII. 5 .Quality and safety of feed for farm animals	**1**	X	X	X	VIII.5.1. Development of functional feeds for farm animals, development of new substances to replace antibiotics and preparations containing zinc in nutrition.
	2		X		VIII.5.2. Development of feed additives with immunomodulating effects.
	3		X		VIII.5.3. Reducing the content of anti-nutritional and toxic substances naturally occurring in feed.

Research direction IX: Food production

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
IX.1. Food and human health	**1**		X		IX.1.1. Research and development of foods with altered nutritional parameters.
			X		IX.1.2. Research and development of probiotics, prebiotics and synbiotics with the aim of preventing civilization diseases.
			X		IX.1.3. Research on hypoallergenic foods.
	2		X		IX.1.4. Food research for the nutrition of population groups with special nutritional requirements.
			X	X	IX.1.5. The use of food raw materials with a naturally increased content of biologically

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
					active substances. Use of alternative sources of nutrients/proteins, e.g. algae, insects.
			X		IX.1.6. Reformulation of foods with regard to new nutritional requirements for foods.
IX.2. Food safety	**1**		X		IX.2.1. Shelf-life of packaged foods.
			X		IX.2.2. Research and management of new and non-traditional agents in the food industry (e.g. tissue cultures, natural essential oils, GMOs).
	2		X		IX.2.3. Research of microbial communities in food operations and their targeted influencing to increase the quality and safety of produced food.
			X		IX.2.4. Research and use of enzymes in the food industry.
	3		X		IX.2.5. Monitoring of contaminating agents in the food chain, e.g. antibiotic residues, pollutants, microplastics, etc.
IX.3. Technologies	**1**		X		IX.3.1. Membrane processes.
			X		IX.3.2. Development of biotechnologies.
			X		IX.3.3. Nanotechnologies.
			X		IX.3.4. Automation and robotisation.
	2		X		IX.3.5. Smart packaging.
			X		IX.3.6. New antimicrobial agents as possible preservatives.
	3		X		IX.3.7. Systems of reducing losses, from the production of raw materials for food production up to losses in meal preparation.
IX. 4. Food analysis methods	**1**		X		IX.4.1. Indirect methods of food quality monitoring.
			X		IX.4.2. Methods for identifying selected food allergens.
	2		X		IX.4.3. Development of selected rapid methods for detecting (physical, chemical, biological and microbiological) contamination of feed and food.
			X		IX.4.4. Development of portable devices for immediate on-site food analysis.
	3		X		IX.4.5. Development of molecular-biological methods for detection, quantification and identification of pathogenic,

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
					technologically undesirable and cultural microorganisms.
IX. 5. Organic food production	**1**	X	X		IX.5.1. Reformulation of the requirements for organic food (use of additives) and the composition of the raw material (product of organic farming).
	2	X	X		IX.5.2. Modernising the technological procedures of organic food production.

Research direction X: Agricultural machinery

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
X.1. Uptake of smart agriculture technologies	**1**	X	X	X	X.1.1. Research, development and implementation of technologies for robotisation and automation of plant and animal production. Comparison of the advantages and disadvantages of robotic technologies in plant and animal production compared to traditional technologies. Introduction of modern technologies into the teaching process of secondary schools, post-secondary vocational schools and higher education institutions with sector-oriented educational programmes.
		X	X	X	X.1.2. Research focused on mapping the condition of stands using unmanned aerial vehicles and satellite images. Processing of images obtained from such sources for the needs of plant production management.
	2				X.1.3. Research focusing on the Internet of Things (IoT) with the potential of being used for the needs of precision or smart agriculture. Options of using mobile phones and other means for uptaking such technologies. Research into the possibilities of using modern technologies that may be seemingly unrelated to agriculture, such as augmented reality and others, and

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
					assessing the potential of their use for the needs of agricultural production.
X.2. Eliminating negative environmental impacts of using agricultural machinery	**1**		X	X	X.2.1. Support for research into techniques and technologies with soil protection potential, research and introduction of technology-controlled in-field traffic of machinery, research into anti-erosion technologies, application of mulching materials and soil additives, application of alternative organic fertilizers. Support for research, development and introduction of low-emission plant production technologies.
			X	X	X.2.2. Research into irrigation systems and water management in cultural landscapes, support for research into the use of catch crops or so-called "strip cropping", or various forms of agroforestry systems, support for technology research in special crops with high added value such as fruit, vines, vegetables and hops.
	2	X	X		X.2.3. Research and development of ways to reduce the emissions of plant production and the application of alternative sources of organic matter as a means of improving soil quality. Research focused on a comprehensive identification of the effects of the technologies used in terms of environmental aspects and the circular economy principles.
		X	X		X.2.4. Monitoring the operation of agricultural machinery and technology in terms of the efficiency and economy of operation and environmental impact. Support for research of knowledge databases, including environmental aspects, impacts on the quality of agricultural land, biodiversity and the environment. Research of technologies, effective methods of surveying and monitoring the state of soil and plants from the point of view of low-residual food production, and identifying the effects of the technology used.

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
	3	X	X		X.2.5. Research into modern methods of production and use of energy from renewable sources, oriented towards sustainable development with regard to the quantification and search for options for reducing the carbon footprint in the agriculture and food sectors. Research into materials and technologies for the production of advanced biofuels. Support for research, development and uptake of low-emission technologies. Development and research of methods of using residual and waste raw materials.
		X	X	X	X.2.6. New technologies in organic farming.
X.3. Technologies for livestock production	**1**	X			X.3.1. Research, development and introduction of automated and robotic systems of livestock production (including technological equipment of buildings) in order to address the lack of human resources.
	2	X	X		X.3.2. Research and development of new or innovation of existing technologies in order to increase or at least maintain the competitiveness and quality of livestock production while meeting the requirements arising from changes in legislation, especially in relation to welfare and environmental protection.
	3		X	X	X.3.3. Support for research, development and implementation of low-emission livestock production technologies.
X.4. Improving the quality of agricultural products, post-harvest processing and storing	**2**	X	X		X.4.1. Research and development of new technological processes in the storage of basic crops intended for human nutrition, fodder and energy purposes. Designing verification tools and developing a system of post-harvest processing and storage of selected products to preserve their quality. Research and development of appropriate methods and procedures for checking all processes in the post-harvest treatment and long-term storage, including an assessment of the energy intensity of the processes.

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
		X	X		X.4.2. Research, development and introduction of waste-free technologies and the use of waste products in the context of a circular economy.
			X	X	X.4.3. Research and development of options for reducing the environmental burden generated by the operation of technological units used in harvesting and post-harvest operations and storage.
			X		X.4.4. Research focused on increasing the strategic security of agricultural production, the possibilities of using the agrarian sector as a strategic source of supplies in case of unexpected events, and logistics in agricultural production.

Research direction XI: Forestry and agricultural economy and policy

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
XI.1. Economic, social and structural impacts of institutional measures and agricultural policies	**1**	X		X	XI.1.1. Economic (competitiveness), social (income and workforce) and structural (land market) impacts of policies on reducing negative externalities, or expanding ecosystem services (as public goods) in the agricultural sector; new perspectives on shadow prices of externalities in the agricultural sector; institutional and economic prerequisites for the development of ecosystem services as public goods, accompanying the production of private goods or produced independently.
		X		X	XI.1.2. Economic evaluation and possibilities of supporting the positive water and carbon balance of the landscape. Institutional prerequisites for the potential introduction of an agricultural emissions market. Specific institutional and economic-market issues related to the drinking water market in relation to the agricultural sector.
	2	X	X	X	XI.1.3. The position of individual stakeholders in relation to the main pressures for change, issues of barriers/stimulation of desirable physical strategic changes, development of

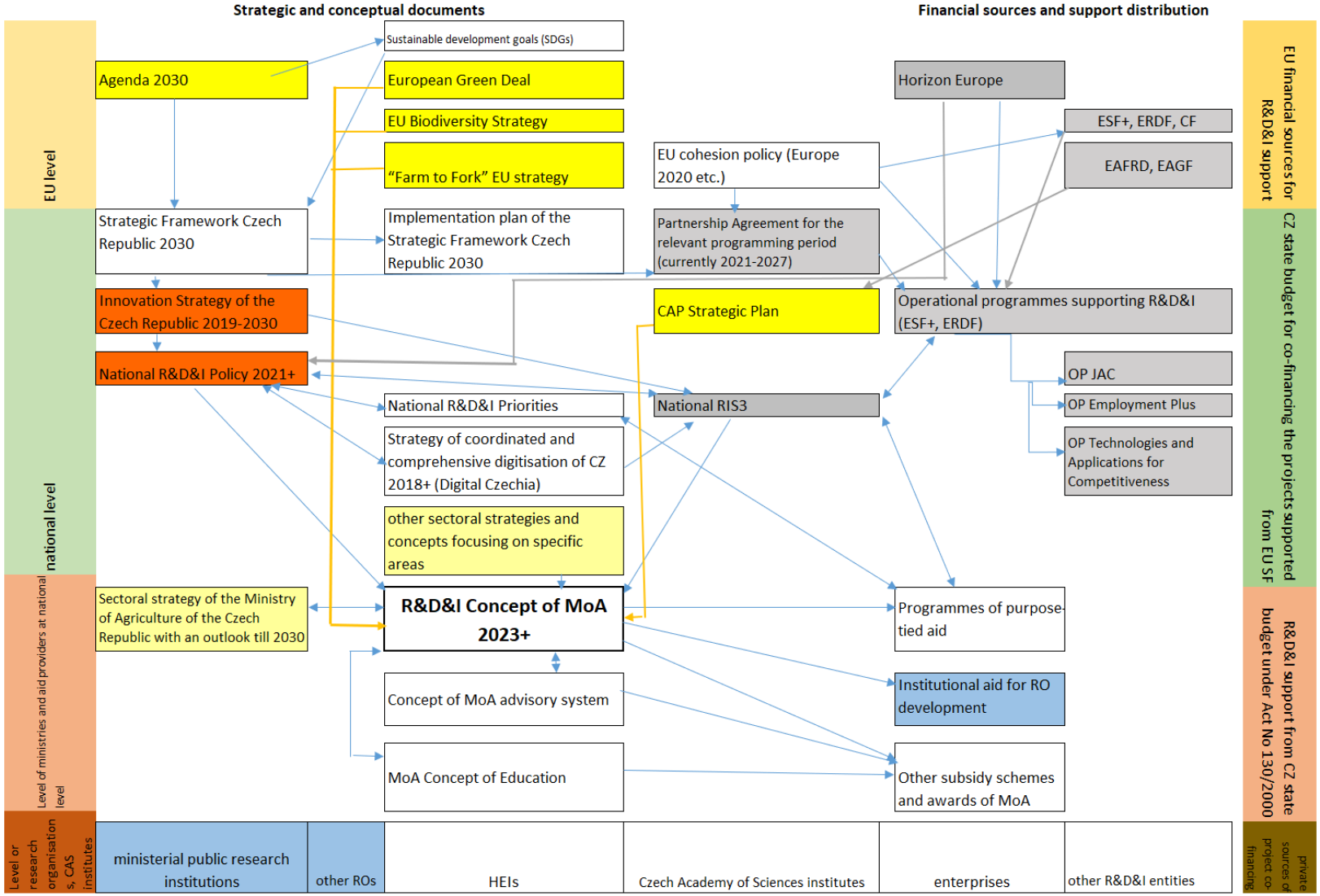
Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
					more complex methods of identifying the behaviour and positions of individual stakeholders (e.g. using the game theory). Incl. by motivating new owners/users of property (land) to internalize the desired changes, and addressing the preemptive right institution.
	3	X			XI.1.4. Creating measurable indicators for evaluating bioeconomy measures.
XI. 2. New technologies and circular economy within bioeconomy	**1**	X	X		XI.2.1. The development of Agriculture 4.0 – digitization, robotisation, etc., its institutional prerequisites and impacts on the private sector economy, or on the economy, efficiency and effectiveness of state administration performance. The relationship between Agriculture 4.0 and the structure and sustainability of resources (factors of production) in the agrarian sector.
		X		X	XI.2.2. Institutional prerequisites and economic impacts of measures to reduce losses and waste in the agri-food sector (not only food-related); increasing the resource efficiency in product chains (e.g. extending the useful life of biomass materials).
	2	X		X	XI.2.3. Institutional and economic issues of biomass production within agricultural and forestry bioeconomy and circular economy, a paradigm shift in the understanding of the tying and the tied products, and the design of new value chains in the use of biological resources in industry.
		X	X	X	XI.2.4. The economy of precision agriculture and agri-technical measures to increase/maintain soil fertility and as an adaptation/mitigation measure against soil erosion or climate change impacts.
	3	X			XI.2.5. Resilience, integrity and sustainability of the food value chain. Substitution and complementarity of so-called bio-based products, produced outside the agrarian sector, with agricultural and forestry production - farming.
	1	X		X	XI.3.1. Multi-criteria optimization of forestry management according to ownership

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
XI.3. Competitiveness of the forestry and timber sector in the conditions of the ongoing climate change					structures, increasing the diversity of species, age and spatial structure of the forest for long-term support of meeting the requirements of sustainable forestry.
		X		X	XI.3.2. Economic assessment of the provision of forest ecosystem services, including a comprehensive economic assessment of the impacts of the services provided on the forestry sector, and institutional conditions for payments to forest owners for ecosystem services provided to the public.
		X		X	XI.3.3. Economic and forest-policy starting points for strengthening a balanced full-fledged fulfilment of all forest functions for future generations based on the development of sustainable forestry as part of the protection of values, care and use of the landscape; motivation and financial support of forest owners to sustainably manage their forests and to provide services to the public.
	2	X			XI.3.4. Assessment of the costs and benefits related to compliance with the normative requirements of sustainable forestry at the national and transnational level of trade in wood and wood products.
		X		X	XI.3.5. Institutional and economic prerequisites for supporting the use of wood as a renewable raw material and supporting the increase in competitiveness and viability of the entire value chain based on forestry and domestic processing and use of wood.
	3	X	X	X	XI.3.6. Optimizing the use of communication tools and strategies, differentiated with respect to target groups of the public, which will help to strengthen the importance of forestry and the resolution of its conflicts.
XI. 4. Agrarian market	**1**	X			XI.4.1. Food security and self-sufficiency in the global conditions of growing world population and in the conditions of the EU single market. Impacts of climate change on agricultural production and the agrarian market.
		X			XI.4.2. Institutional issues and market impacts of using regional and local food markets.

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
	2	X			XI.4.3. Asymmetry/equity in all components of the food vertical under expected structural changes in the agrarian sector.
		X			XI.4.4. Supply/demand changes in favour of foods with higher added value (i.e. including organic foods) versus the availability of these foods at reasonable prices for the majority of the population.
	3	X			XI.4.5. The effects of changes in consumer preferences and the effects of demographic, economic and social changes in society on the structure of food consumption and the agricultural market, incl. taking into account measures to reduce food waste.
		X			XI.4.6. Impacts of (new) EU regional agreements on internal and external trade of the Czech agrarian sector and on the competitiveness of the Czech agrarian sector.
		X		X	XI.4.7. Organic food market and competitiveness of the organic farming sector.
XI. 5. Developing the information base, analytical methods and approaches to improve management in the agrarian sector	**1**	X	X	X	XI.5.1. The use of "big data" and the linking of databases to analyse the transformational functions and relationships and causalities in the functioning of the agrarian sector.
		X			XI.5.2. Identification of stimuli and barriers to the introduction of new systems in food distribution and consumption (improvement of food traceability, development of e-shops based on the individualization/"tailoring" of demand and its projection into the production vertical.
	2	X	X	X	XI.5.3. Development of research approaches and methods to support investments and effective use of R&D results in the agrarian sector, optimization of relations between grants and financial instrument type measures (leverage and revolving effects), support of the shared economy, etc.
			X	X	XI.5.4. Development of tools promoting more sustainable and healthier food consumption behaviour, optimization of organic food supply chains and facilitation of more responsible, more sustainable and healthier eating beneficial to the whole society, and

Research priority in the RD	Priority rank	Link to KA BE	Link to KA SA	Link to KA GC	Research area
					thus contributing to the achievement of sustainable development goals (labelling systems and devices, applications and other software, official guidelines, etc.)
	3	X			XI.5.5. Development of analytical methods and models for the overall assessment of the impacts of agricultural and forestry policy in relation to the development of micro-, small and medium-sized enterprises, minimization of deadweight loss, moral hazard, subsidy leakage and profit effects (profit indicator based on soil quality).

Annex 2 Diagram of basic links between the main relevant documents and the sources of R&D&I financial support from the perspective of research in the agri-food sector, forestry and water management



Annex 3 Indicators of progress towards goals and measures of the R&D&I Strategy of MoA 2023+

Indicators of progress towards goals and measures of the R&D&I Strategy of MoA 2023+, incl. the timeframe of their achievement and the relevance level of the indicators and their links to measures of the National R&D&I Policy 2021+

Priorities of the R&D&I Strategy of MoA 2023+	Priority goals of the R&D&I Strategy of MoA 2023+	Measures to achieve the goals	Link to measures of National R&D&I Policy 2021+	Implementation timeframe	Indicator	Indicator target value	Indicator level
1 . Strategically managed system of support for research, development and innovation in the agri-food sector, forestry and water management at the sector level, expanding to the related fields of science.	1.A) Strengthening the strategic orientation of agricultural research utilising feedback based on a systematic monitoring of trends in research and technologies, and utilising the capacities of ROs and research infrastructures and the changes in societal priorities.	1.A.1 Focus of the support on the defined priorities arising from a foresight study, and further utilising the results of assessment at all levels of the R&D&I support system, evaluations and technical expertise for strategic management of the R&D&I system in CZ.	2	2023+	Focus of the aid based on the conclusions and findings of evaluations, assessments, technical background documents for strategic management of the R&D&I system in CZ in a PTA programme and RO evaluation	YES	R&D&I Strategy of MoA 2023+, purpose-tied aid programme, institutional aid
		1.A.2 Developing the measures/activities of regular monitoring, assessment (newly also of impacts of purpose-tied aid, RO evaluation for institutional aid) of paid-out aid and evaluations of the R&D&I Strategy of MoA 2023+. Development of the needed tools, the option of data processing and recording in the information systems and internal databases used.	2, 3, 17	2023+	- Number of introduced and revised measures/activities of monitoring/evaluation, incl. tools under preparation (in the form of monitoring the implementation of the R&D&I Strategy of MoA 2023+, trends in the form of foresight studies, evaluation of PTA programmes, RO evaluations, evaluation of the implementation of the R&D&I Strategy of MoA 2023+)	3	R&D&I Strategy of MoA 2023+, purpose-tied aid programme, institutional aid
					- Existence of criteria set for the given programme to evaluate its impacts and benefits (a slightly adjusted MI of the National R&D&I Policy 2021+)	YES	

Priorities of the R&D&I Strategy of MoA 2023+	Priority goals of the R&D&I Strategy of MoA 2023+	Measures to achieve the goals	Link to measures of National R&D&I Policy 2021+	Implementation timeframe	Indicator	Indicator target value	Indicator level
	1. B) Intensifying cooperation with strategic partners (such as TACR, GACR, CAS, other ministries – mainly MoE and MIT, representatives of the application sector) in the R&D&I support system in order to share information, support synergies and prevent duplications.	1.B.1 Coordination of the targets of the purpose-tied aid programme and of the competitive biddings with the relevant aid providers to prevent duplications and using synergies in financing the aid programmes.	2	Continually, along with the proposals of the purpose-tied aid programme and its competitive biddings	Number of measures for coordination and strategic targeting of the aid	8	Purpose-tied aid programme, institutional aid
		1.B.2 Cooperation with strategic partners to prepare and implement relevant sectoral strategic and conceptual documents of MoA (incl. the follow-up documentation) in R&D&I.	17, 19	2023+	Number of consulted conceptual documents prepared by MoA for R&D&I with relevant partners (documentation for IA - MoA Methodology of RO Evaluation 1, the purpose-tied aid programme and partial bid specifications) (a MI of the National R&D&I Policy 2021+)	5	R&D&I Strategy of MoA 2023+, institutional aid, purpose-tied aid programme
	1. C) Involving the recipients of research results (the business sector, state administration, civil society institutions etc.) directly in research - transdisciplinary approach.	1.C.1 Introducing measures within the aid provision conditions to strengthen the involvement of actors (business sector, state administration, NGOs) in research.	MoA's own measure	2023+	Number of introduced measures in PTA projects, reflecting the transdisciplinary approach	4	Purpose-tied aid programme
2. Effective management and	2. A) Streamlining the management and	2.A.1 Cooperating with the other R&D&I support	7	2023+	Number of measures introduced	10	Purpose-tied aid programme

Priorities of the R&D&I Strategy of MoA 2023+	Priority goals of the R&D&I Strategy of MoA 2023+	Measures to achieve the goals	Link to measures of National R&D&I Policy 2021+	Implementation timeframe	Indicator	Indicator target value	Indicator level
financing of R&D&I in the agri-food sector, forestry and water management.	administration of R&D&I aids. Creating conditions for financing long-term research and development.	providers in the introduction of common measures to reduce the administrative burden within the single methodological environment.					
		2.A.2 Stabilisation, predictability and support for the performance of the R&D&I financing system by setting an adequate amount of institutional aid and increasing it for the ROs who produce quality results with regard to the implemented international cooperation and cooperation with the application sector (implementation of Methodology 17+).	7, 15	2024 at the latest	- Relative change in the share of IA received by individual ROs compared to 2017 and its correlation with the evaluation results (a modified MI of the National R&D&I Policy 2021+)	YES	Institutional aid
					- MI relevant for the monitoring of the individual ROs as they implement their Long-term Concepts and evaluated according to the MoA Methodology of RO Evaluation. The set MIs are projected into the RO evaluation so that ROs are motivated to implement the relevant goals of the R&D&I Strategyof MoA 2023+.	Not relevant for the R&D&I Strategy of MoA 2023+	Institutional aid (MoA Methodology of RO Evaluation)
		2.A.3 Creating conditions for the financing of strategic longer-term projects.	MoA's own measure	2023+	Created conditions for the financing of strategic longer-term projects.	YES	Purpose-tied aid programme

Priorities of the R&D&I Strategy of MoA 2023+	Priority goals of the R&D&I Strategy of MoA 2023+	Measures to achieve the goals	Link to measures of National R&D&I Policy 2021+	Implementation timeframe	Indicator	Indicator target value	Indicator level
	2. B) Enhancing the transfer of research results to practice.	2.B.1 Introducing measures within the aid provision conditions to enhance the involvement of enterprises (primary producers, processors and suppliers of inputs) in research - intensifying the partnership with an active financial co-participation and an active involvement in the project management.	MoA's own measure	2023+	Number of measures introduced within R&D&I support, enhancing the cooperation of enterprises (primary producers, processors and suppliers of inputs) with the research sector	3	Purpose-tied aid programme Institutional aid (MoA Methodology of RO Evaluation)
3. Enhancing the research capacities of ROs – human factor.	3.A) Creating an environment encouraging researchers to pursue a research career.	3.A.1 Supporting a transparent and open environment in the aided ROs (selection procedures, career system); training the researchers in a lifelong learning system, emphasising the development of competences for cooperation in research and in managerial skills.	10	2023+	Number of introduced supporting measures within the aid provision rules to develop a transparent and open environment in the ROs at the level of the beneficiary organisation	2	Purpose-tied aid programme Institutional aid (MoA Methodology of RO Evaluation)
	3.B) Creating conditions for equal opportunities and reconciliation of work and private life in ROs.	3. B.1 Measures in the system of providing aid (both purpose-tied and institutional) for the development of equal opportunities of researchers in ROs, including support for beginning researchers at the start of their career and persons caring for dependents.	10, 12	2023+	Number of introduced supporting measures creating conditions for equal opportunities and reconciliation of work and private life in ROs.	2	Purpose-tied aid programme Institutional aid (MoA Methodology of RO Evaluation)

Priorities of the R&D&I Strategy of MoA 2023+	Priority goals of the R&D&I Strategy of MoA 2023+	Measures to achieve the goals	Link to measures of National R&D&I Policy 2021+	Implementation timeframe	Indicator	Indicator target value	Indicator level
4. Developing international cooperation at all levels of research in the agri-food sector, forestry and water management.	4. A) Promoting CZ interests through participation of a representative sent to the Horizon Europe Programme Committee.	4.A.1 Functional networking with representatives of the Horizon Europe Programme Committee.	16	2021+ sending a representative for the area of agriculture to the programme committee of the EU FP for development and innovation Horizon Europe in cooperation with the relevant CZ stakeholders	Ensuring at least 70% participation of the selected representative for agriculture at meetings of the Horizon Europe programme committee	YES	International cooperation
	4. B) Development and strategic orientation of MoA initiatives on systemic support of international cooperation.	4.B.1 Supporting the involvement and active participation of MoA representatives in the meetings of international initiatives.	MoA's own measure	Continually	Ensuring at least 70% participation of a MoA representative for the area of R&D&I in agriculture at meetings of SCAR, BIOEAST	YES	International cooperation

Annex 4 Overview of the main actors in the national system of R&D&I support and an analysis of their competences (in relation to the R&D&I Strategy of MoA 2023+)

Actor		Process with an impact on the implementation and management of the R&D&I Strategy of MoA 2023+	Strategic document or other material regulating/enshrining the process	The impact on the R&D&I Strategy of MoA 2023+
Research, Development and Innovation Council	Conceptual leadership and coordination of the R&D&I support system along the lines:	Designing the R&D&I policy in CZ in cooperation with MEYS and MIT	National research, development and innovation policy of the Czech Republic (National R&D&I Policy 2021+)	Providing a basic direction for the R&D&I Strategy of MoA 2023+ in terms of management and organisation
		Proposing framework conditions for R&D&I support as an advisor to the Government in R&D&I	E.g. amendment to Act No 130/2002 Coll.; National priorities of oriented research, experimental development and innovation	The proposal for an amendment to Act No 130/2002 Coll. sets out new elements of the framework conditions (see their analysis in Annex 6.I.a) for providing R&D&I aid, which are binding for the provider
		Designing the concept of and partly carrying out RO evaluation (in modules M1 and M2)	Methodology for Evaluating Research Organisations and Research, Development and Innovation Purpose-tied Aid Programmes (Methodology 2017+)	Determining the parameters, scope and focus of RO evaluation. Setting the process of RO evaluation and influencing its implementation schedule. The outputs of RO evaluation under M1 and M2 are an input for RO evaluation by the aid provider.
		Designing the concept of	The upcoming Principles of evaluating	A future specification of the parameters,

		evaluating PTA programmes and projects and assessing the compliance of the approach proposed by the providers with the concept	PTA programmes and groups of grant projects	scope and focus of evaluation of PTA programmes and groups of grant projects.
		Administering and operating the R&D&I IS	Concept of the Information System for Research, Experimental Development and Innovation for 2021-2025 (Concept of the R&D&IIS 2021-2025); Government Regulation No 397/2009 Coll., on the information system for research, experimental development and innovation	Framework conditions for the operation, data transfer processes and content of the R&D&I IS, binding for the provider. The provider also uses the IS data as an important input for RO evaluation, and PTA programme administration and evaluation. A source of input for monitoring, assessment and evaluation of the use of R&D&I aid.
		Coordinating the unification of the methodological environment of PTA providers	A new competence - not regulated so far	Cooperation at a partner level to simplify the administration of providing aid under purpose-tied aid programmes
		Monitoring and coordinating the implementation of National R&D&I Policy with the aid providers	Discussing the proposed conceptual and programming documents of R&D&I aid providers	Harmonising the perspectives of the designer of the National R&D&I Policy and other strategic documents with the aid providers.

	budgeting	Proposing the total R&D&I expenditure	Proposal of the total R&D&I expenditure; Proposal for the mid-term outlook of R&D&I support (an input for the preparation of the state budget)	Determining the financial framework for IA, PTA and systemic support for the sector.
CZ Government	Approving the RDI Council proposals discussed with aid providers for modifying the framework and MoA conditions for R&D&I support		Relevant Government resolutions (undergoing the standard legislative process)	Bringing into force the MoA programming and conceptual documents.
MEYS	Central administration body responsible for R&D, except for areas covered by the RDI Council		Conceptual and legislative documents in R&D&I	Depending on the nature of the document
	Supervisor and coordinator of international cooperation in R&D&I, including negotiations with EU R&D bodies		Strategic documents on international cooperation in R&D&I (e.g. the Action plan for international cooperation of CZ in research and development and internationalisation of the research and development environment in CZ for 2017-2020)	The possibility of MoA support for international cooperation in science and research, if endorsed by the supervisor.
	Managing authority of ESIF support for R&D&I		OP RDE in the 2014-2020 programming period OP JAC (Operational Programme Johannes Amos Comenius) in the 2021-2027 programming period	Possible synergies or duplications of the aid provided.

	Central administration body responsible for the state educational policy	Inter alia, Act No 111/1998 Coll. on higher education institutions	Support for higher education institutions
	Administering the list of research organisations	Act No 130/2002, Government Regulation No 160/2017 Coll. on the collection of documents for the list of research organisations and the method of reporting income from knowledge transfer The list is maintained on the MEYS website	MoA is a user of the list of research organisations, it uses the data kept in the list.
MIT	Responsible for and designing the conditions of innovation support and coordinating international cooperation in that area	RIS3 strategy	The possibility of MoA support for international cooperation in innovation, if endorsed by the supervisor.
	Managing authority of ESIF support for innovation	OP EIC in the 2014-2020 programming period OP TAC (Operational Programme Technologies and Applications for Competitiveness) in the 2021-2027 programming period	Possible synergies or duplications of the aid provided.

R&D&I support providers (as per the national legal framework - Act No 130/2002 Coll. and per the Partnership Agreement and the EU legal framework for ESIF)	Supervising the targeting and setting of rules for R&D&I aid provision and coordinating the aids with the other relevant providers. Setting the rules for aid implementation by final beneficiaries and checking compliance with them.	Ministerial conceptual and methodological documents, aid rules, programming documentation (e.g. competitive biddings and public contracts in R&D&I, operational programmes and aid provision rules)	Possible synergies or duplications of the aid provided. Bodies relevant for the R&D&I Strategy of MoA 2023+ include TACR, Managing Authority of the Rural Development Programme, MEYS (provider of IP for HEIs) And, the goal of creating harmonised rules for PTA provision or ESIF projects under the so-called single methodological environment.
Representation of key groups of applicants and beneficiaries of R&D&I aid and representatives of the application sector (associating representatives of R&D&I aid applicants and beneficiaries)	Coordinating the viewpoints and activities of its members	Viewpoints in the form of proposals and recommendations on the conceptual issues and development of research in CZ	A partner for negotiating the targeting of aid and a feedback for setting the aid provision conditions
	A partner for discussing the proposals for aid programmes and appraisal of projects (e.g. in working groups)	Nominations to the working and programme committees; minutes and opinions of those bodies	A need to create a framework for ministerial cooperation with representatives of the application sector etc.
European Commission	Aid provider and a managing authority of Community programmes	Horizon Europe etc.	Possible synergies or duplications of the aid provided. The participation of beneficiaries in the programme is a significant indicator of development of international

			cooperation and its quality.
	Designing and supervising the framework conditions of R&D&I aid at EU level. A system of recording the applied exemptions from the prohibited provision of State aid according to the relevant legislation.	Relevant for R&D&I: the current versions of the Framework, GBER, ABER, FBER, regulation of ESIF support, international cooperation in R&D&I	They must be correctly incorporated into the conditions of providing and checking the use of the aid, and must be continuously updated based on the developing legal framework at EU level. Aid beneficiaries need to be advised on how to correctly spend and report eligible expenditure so that the eligibility is not at risk, should the provided R&D&I aid be used unlawfully.
	Notification of R&D&I support (in line with Art. 108(3) of TFEU)	Commission decision with a specific reference number of the SA. Aid is notified through the electronic system SANI; annual report on the use of the aid is submitted to IS SARI.	Compliance with the State aid rules in R&D&I.
Central bodies of state administration	Specialised strategic documents	Relevant for the technical content and focus of the R&D&I Strategy of MoA 2023+	Crucial strategic documents for targeting the specific part of the R&D&I Strategy of MoA 2023+ For a list of the most important ones see Annexes 6.I and 6.III.

Annex 5 Executive summary of the final report on the Interim evaluation of the Applied Research Programme of the Ministry of Agriculture 2017 - 2025 called EARTH, and of the Research, Development and Innovation Concept of the Ministry of Agriculture for the period 2016–2022

The “Interim evaluation of the Applied Research Programme of the Ministry of Agriculture 2017–2025 called EARTH, and of the Research, Development and Innovation Concept of the Ministry of Agriculture for the period 2016 – 2022” was implemented through a public contract in 2019.

Part A: Evaluation of the Programme

The evaluators examined the intensity of implementation to date of the research directions, the EARTH Programme adequately supports the research projects in a range of topics that correspond to the key national strategic documents. However, it would be suitable to focus more, in the next calls, e.g. on some new research issues linked to climate change, water regime in the landscape, standardisation and access to data, Agriculture 4.0, behavioural research issues such as the behaviour of farmers, cooperation of farmers, or topics related to Pillar II of the EU’s CAP. An empirical survey has identified additional themes and topics in the needs of the Czech research and application sectors, which should be included in the aid from the EARTH Programme. These include the management of resources and ensuring water for all productions in the sector, distribution of value in the agri-food vertical up to trade, new sub-topics linked to food quality, research in cooperation support, data and database improvement (e.g. FADN), the need to strengthen research topics related to Pillar II of the CAP.

On the whole, the EARTH Programme currently shows implementation of 29.7% of the application results, 68.9% (151) of the planned number of projects are under implementation. The above data cover partial results of 52 projects from biddings in 2016 and 2017. The sub-programmes are being implemented continuously, but with regard to the short time since the start of implementation of most projects and the fact that none of the projects has been completed yet, the progress documented to date is not very large. The achievement of indicator values in the EARTH Programme will be better assessed continually, e.g. in 2022 when most projects, under implementation now, will be completed. Nevertheless, it is already apparent that the planned results in the currently committed projects will exceed the minimum numbers set for the indicators of the EARTH Programme.

In total, 301 results have been reported so far in the EARTH Programme. The greatest achievement is shown in the Other project results category (134), representing mainly publications, in many cases there results were not originally planned in the projects. The next most achieving category is Publication results with application potential for agricultural practice (73) and results of the type article in a specialised periodical contained in the Web of Science database (49). The achievement in the other categories is below 10. The number of created results corresponds to the number of projects in the research directions. The most results were created in research direction I Soil, VI Livestock production and veterinary medicine, and V Plant production and plant health. The unplanned results most often mean creating a higher number of publication outputs than originally planned - additional publications describing new knowledge and information, publications promoting interim results produced during the project

implementation, more scientific articles than planned. Other unplanned outputs are presentations at seminars, workshops or conferences.

As the indicator types (criteria of meeting the goals) in the EARTH Programme are publication and applied results and are defined in the EARTH Programme, they are unambiguously measurable. However, their informative value for the purpose of measuring the achievement of the Programme goals is only in their quantification. The achievement of the EARTH Programme goals and indicators will be evaluated by monitoring other indicators related to the transfer of project results into practice. The evaluation will be carried out according to the Methodology for Evaluating the Results of Research Organisations and Evaluating the Results of Completed Programmes, in force at the time of evaluating the EARTH Programme, according to the conditions set by the provider and according to the requirements of EU documents.

The main factors affecting the progress of the EARTH Programme have been identified as the management and implementation, the course of the competitive biddings (including ensuring sufficient financial allocation), the success of the implemented projects (including the created high-quality, usable results).

Based on investigations, the management and implementation of the EARTH Programme is considered effective, although further improvements can be made in some areas. Details are provided in the relevant parts of the report, suggestions for improvement are summarised in recommendations. The future management and implementation of the Programme could consider the suggestions from unsuccessful aid applicants, aid beneficiaries or evaluators.

It is positive that the EARTH Programme has a stable popularity, the demand largely exceeds the allocation. It is also open to more applicants, the former applicants were mainly the R&D institutions of MoA, now other institutions, such as universities or CAS institutes, are getting involved. As a result, knowledge from other sectors is being used and there is interconnection with other fields of science.

As the vast majority of results, applicable in practice, has not been developed in the projects yet, the level of introduction of the results to practice can be evaluated only indicatively based on a small sample of results already achieved. The investigation shows that the implementation in practice is significantly more successful for research results that are focused on improving the quality of products and production, and are applicable in private enterprises functioning in the market environment. Those producers actively search for possibilities of cooperation with R&D organisations and are more willing to implement the results in practice. For projects with results in the form of information sources for the activity and decision-making of public administration, the implementation in practice is slower and the project holders are usually not able to provide evidence for it. That translates into the fact that the results most successfully implemented in practice are those in plant and livestock production, which are also the focus of the highest number of projects. Most often, the results are introduced into practice 12 months after the start of the project.

The investigation has verified that cooperation between research organisations and enterprises, users of the results, is strengthening. In both surveyed groups (beneficiaries and other research organisations), the intensity of cooperation grew by around 15% against 2016.

Part B: Evaluation of the Research, Development and Innovation Concept of the Ministry of Agriculture for the period 2016 – 2022

Level of implementation of the key areas and research directions of the Concept

The key areas and research directions of the Concept are primarily implemented by R&D programmes provided by MoA (i.e. the EARTH Programme and the previous CSS Programme) and through providing a clearly targeted institutional aid to selected research organisations.

In the EARTH Programme (i.e. 151 projects and CZK 2.1 bil. in the reporting period), three research directions at rank 1 of their importance are being implemented predominantly, both in terms of the percentage of the number of supported projects and in terms of the allocated budgets. The research directions with the highest share in the number of supported projects were: 1. Soil (approx. 23%), 5. Plant production and plant health (approx. 21%) and 6. Livestock production and veterinary medicine (approx. 22%). The other research directions are implemented to a lesser extent. Minimum implementation has been recorded in research direction 8. Agricultural machinery, which is due to its cross-cutting nature. Under institutional aid, the research organisations contribute to the research directions of the Concept unevenly, depending on their focus within the sector. ROs prefer research directions that are more cross-cutting and have a greater impact on agriculture as a whole. This aspect is evident in direction 8. Agricultural machinery, which is addressed in the plans of only 4 ROs. On the contrary, research direction 5. Plant production and plant health is addressed by 14 ROs, or research direction 3. Biodiversity by 12 ROs. Relatively low interest has been in directions 2. Water and 9. Bioeconomy, each addressed by 7 ROs. This initial focus of the ROs influences the scope of their activities in the R&D programmes of MoA.

Apart from R&D programmes of MoA, there are other programmes of other ministries and institutions contributing to the implementation of the Concept[5]. In core field G - agriculture (according to data of the RDI Council), the most relevant projects were implemented in AP - Applied Research. The evaluation covered 106 projects started in the period 2012 - 2018, which obtained financial aid at CZK 1.47 bil. In this group of aid providers, the largest provider is MEYS both in terms of the number of projects and the volume of funding spent on research, i.e. basic and applied research and experimental development, as well as EU framework programmes and infrastructure and investment projects focused on the R&D facilities. The second largest volume of aid is provided by TACR (applied research), followed at some distance by the MIT, GACR and the Ministry of the Interior. In applied research, the research directions with the highest number of projects were 5. Plant production and plant health (27.6%), 6. Livestock production and veterinary medicine (23%), and 4. Forestry and the related sectors and 8. Agricultural machinery, both with the share of 18.4%.

[5] Based on Government Resolution No 287 of 26 March 2008 on the Reform of the research, development and innovation system in CZ, TACR took over the preparation and implementation of programmes of sector-specific R&D&I for specific ministries including programmes for the needs of state administration bodies. The identified research needs of the ministries have been met so far by the BETA programme and partly by the OMEGA programme. In the reference period 2012-2018, there were no other relevant ministries (e.g. MoE, Ministry of Regional Development) in the role of providers of research support programmes that would have a direct or indirect link to agriculture. In the next evaluation of the Concept, that situation will have to be reviewed because e.g. MoE started in 2019 a new Programme of Applied Research, Experimental Development and Innovation in the Field of the Environment - *Environment to Live In*, provided again by TACR, with the content supervised by the Ministry of the Environment.

Programme Horizon 2020 supported 53 projects in agricultural research as of 5 June 2019, involving 49 institutions from the Czech Republic. The projects focus largely on implementing two directions with a nearly identical level of importance, i.e. 5. Plant production and plant health (24.5%) and 7. Food production (26.4%).

Implementation of the strategic goals of the Concept including the measures and indicators

To evaluate the implementation of the Concept's strategic goals, extensive data were collected from the beneficiaries of institutional aid. The evaluation of the data brought a large amount of findings on the implementation of the goals, measures and indicators of the Concept. Above all, it is evident that many effective measures and mechanisms have been put in place for a more efficient use of public funding ad for subsequent development of Czech agriculture.

In "key area of change A: Legal framework", real changes have been made in improving the administrative processes of MoA (i.e. Goal A1, e.g. introducing advance notices, annual periodic reports on the use of institutional aid for Long-term Concepts etc.). The quality of managing the R&D&I Concept implementation has also improved (i.e. Goal A3, e.g. establishing Coordination Committees and a Steering Committee that assessed research plans of ROs receiving institutional aid). The cooperation with the other providers of purpose-tied aid is also strengthening (i.e. Goal A5, e.g. examining new grant programmes in inter-ministerial comment procedures). MoA is very active in getting involved in international R&D&I (i.e. Goal A6, e.g. the subordinated organisations are involved in 14 international organisations, in which they pay for their own membership, MoA pays for membership in 16 international organisations).

At the level of the organisations supported with institutional aid, the results in "key area of change B: Excellence in agricultural research" are very heterogeneous and cover specific objectives including both domestic and foreign cooperation in research. The evaluation of Goal B1, i.e. to improve the quality and change the orientation of agricultural research in research organisations supported by MoA, has shown that the values of all monitoring indicators are being achieved and indicate an evident emphasis on increasing the quality of agricultural research in CZ. Goal B2 to develop infrastructure for strategic research was abandoned due to sufficient support for start-ups from other national sources (e.g. the Czechia Team platform). In Goal B3 to optimise the benefits of public support for R&D&I in ROs, the number of businesses involved has been declining in the long term, nevertheless, the financial volume of funds provided by businesses for research activities of organisations has grown in total in the reporting period. Moreover, the number of results with legal protection and their application in practice is going up.

Some organisations show significant progress and changes in the area of important publications, international projects, cooperation with the application sector, etc., while other organisations are stagnating or even deteriorating in their results. Nevertheless, evaluation of the organisations with institutional support as a group has identified partial progress and achievement in many indicators in the reporting period 2014-2018 (e.g. getting involved in international projects, enhancing cooperation with the business sector etc.). Although progress has been recorded in most of the planned activities and actions, their evaluation is subjective to a certain extent because most of the goals do not have (officially) defined changes to be achieved and the timeframe for that achievement. It is, therefore, difficult to evaluate to what extent the identified changes can be considered a "success/failure". Along those lines, it would be suitable to set quantifiable criteria for assessing the progress in the future.

Relevance of the research directions and research topics

Analyses have shown that the set key areas and the relevant research directions correspond to the current trends of research topics, nevertheless, they could be expanded. The research directions could be complemented with only several research topics but research direction 8. Agricultural machinery should be enlarged more extensively, e.g. to *"8. Agriculture 4.0, new technologies, new machinery"*, which would put more emphasis on the current trends of digitisation of society, living space, countryside and also agriculture. The themes associated with digitisation of agriculture are mentioned in direction 8. Agricultural machinery only marginally. We suggest creating a separate research direction or modifying the existing direction.

Thematic areas highlighted at the EU level should also be added, i.e. data standardisation/access / databases, cooperation / mutual learning, and also research topics focused on motivation / behaviour of farmers. Although direction 9. Bioeconomy includes the topic of rural development, such research issues should be given more attention in the agricultural research. The Concept does not emphasise enough the cross-cutting themes concerning systemic approach, interdisciplinarity, or societal engagement of the agricultural sector in rural areas.

The evaluation of the Concept's relevance to national strategies and needs of the research and application sector has revealed that the Concept fully corresponds to the key national strategies and current trends of agricultural research and is fully in line with them, while also reflecting the current trends of agricultural research. The results of a questionnaire survey showed that the set research directions correspond to the expectations of the research sector representatives. The majority of the proposed additional research topics can be included under the existing topics of the Concept.

Relevance of strategic goals

In the context of all findings under this evaluation question and the findings under the implementation of the Concept's goals we can say that the majority of the Concept goals is still highly relevant and their implementation is long-term. Although it is evident that many measures and activities have been implemented, the set Concept goals are still valid and cannot be considered achieved. The only goal identified as irrelevant was Goal B2: Developing the infrastructure for strategic research in agriculture. The reason is the sufficient support for enterprises from other institutions and it would not be systematic to implement a new type of support from MoA.

Correctness of the Concept implementation and the activity of the Steering Committee and of the Coordination Committees

The analyses, surveys and evaluation show that the Concept is being implemented correctly. It has already been proven that the key areas and research directions of the Concept are being implemented by R&D programmes of MoA and through institutional aids provided to selected research institutions. But a contribution to the Concept implementation is made also by other projects financed by MEYS or TACR. It has also been proven that the research directions and research topics of the Concept are relevant to the current trends in the topics of agricultural research at the international level, nevertheless, they could be further expanded. A more extensive modification would be suitable in direction 8. Agricultural machinery, which could be expanded towards Agriculture 4.0. Topics such as more intensive use of sensors in various conditions or a greater emphasis on precision agriculture have been mentioned in direction 8.

Agricultural machinery only marginally. It would also be suitable to add some other thematic areas highlighted at the EU level. These include data standardisation and access, databases and cooperation or mutual learning, as well as research topics focusing on the motivation and behaviour of farmers. Evidence has been found that the Concept focus is fully in line with the national strategic documents. The only goal identified as irrelevant was goal B2: Developing the infrastructure for strategic research in agriculture. The reason is the sufficient support for enterprises from other institutions. Still, based on the surveys carried out, we can say that the Concept is being implemented correctly.

The Steering Committee represents a key body involved in the Concept's implementation, its activity fully corresponds to its mission stated in the Statute and the Rules of Procedure of that Committee. The Coordination Committees played an important role mainly in the evaluation of the research plans of research organisations, their role in the next phases of the Concept implementation is not quite clear. The Statute and the Rules of Procedure of the Steering Committee imply that their role should include verifying the implementation of the Concept and the measures, and evaluating the achievement of the goals of the Concept as such; however, that role has not been performed by the Coordination Committees so far. That also concerns another role of the Coordination Committees, i.e. monitoring the Concept implementation, but even that role has not been sufficiently performed by the Coordination Committees. On the other hand, the Coordination Committee members have stated their great willingness and readiness to continue to take part in activities related to the implementation of the evaluated Concept. With regard to the broad range of their members, involving relevant research organisations, it appears suitable to continue to support the activity of the Coordination Committees. It is an important platform that can help to transfer current information on the implementation of the Concept and on the next direction of R&D support by MoA in the upcoming period.

Annex 6 Overview of key background information sources for the R&D&I Strategy of MoA 2023+

6.I Information sources for defining the priorities in the management of the R&D&I Strategy of MoA 2023+

(a) Proposal for an amendment to Act No 130/2002 Coll. on support for research, experimental development and innovation from public resources and amending some related acts (the Act on support for research, experimental development and innovation), as amended

Changes in the system of R&D&I support, envisaged in the proposal for an amendment to Act No 130/2002 Coll., expected to take effect on 1 June 2021 based on the accompanying documents submitted for the interministerial commenting procedure. The proposed amendment was sent in May 2020 to an interministerial commenting procedure based on a resolution of the RDI Council, made at the 345th meeting on 26 April 2019, in connection with the implementation of the objectives of the Innovation Strategy of CZ 2019-2023 and according to the Plan of Legislative Work of the Government for 2020. The draft amendment was discussed but was not approved by the Chamber of Deputies. The legislative process has not been completed.

The main principles of the proposal for an amendment with an impact on the providers of financial aid in R&D&I according to the explanatory memorandum of the proposal:

1) introducing new tools of purpose-tied aid for innovation and proposing the relevant processes,
2) based on Methodology 2017+, introducing a systemic evaluation of purpose-tied aid programmes,
3) simplifying the administration in research, development and innovation and reducing the administrative burden on the applicants and beneficiaries,
4) aligning the provision of purpose-tied aid with the conclusions arising from the decision-making practice of administrative courts and with recommendations of the Ombudsperson,
5) ensuring open access to scientific information in line with the EU strategy for research, development and innovation,
6) simplifying and clarifying the breakdown of expenditure on research, development and innovation,
7) introducing the transferability of grants.

The proposed amendment of the legal framework will have the following impact on the providers of aid in R&D&I:

- New requirements and opportunities in the system of providing purpose-tied aid

Necessity to revise the procedure of providing purpose-tied aid in line with the principles introduced by the amendment to Act No 130/2002 Coll., aimed at simplifying the administration of the competitive bidding, introducing a system of evaluation also for the provision of purpose-tied aid and increasing the certainty of the provider in the provision of purpose-tied aid to beneficiaries:

- Confirming the existing interpretation of the public-law regime of providing purpose-tied aid, or the institution of public-law contracts according to the budget rules between the aid provider and beneficiary, with all consequences arising from it.
- New requirements for the system of evaluating purpose-tied aid, mainly introducing a system of evaluating the impacts of purpose-tied aid in line with the Principles of Evaluating PTA, determined in the future and continuously updated by the Government (its newly established competence in Section 35). The aid beneficiary is newly obligated to submit to the provider information on the use of the results of the project financed by the provider for a period of 5 years following the end of the aid provision for the purpose of the evaluation.
    - The programme draft includes a specification of the programme goals together with their justification and ways of their achievement, the method of monitoring the progress of the programme, the method and timeframe of the interim and final evaluation, evaluation of impacts, including indicators suitable for assessing the level of achievement of the programme goals, according to the principles of evaluating programmes and groups of grant projects, Section 5 par. 2 point d); point e) comparison with the current situation in CZ and abroad and the expected results and benefits of the programme.
    - The RDI Council will also assess consistency of the evaluations of programmes and groups of grant projects with the aim of increasing the overall quality of evaluating purpose-tied aid. The principles approved by the Government will serve as a guideline for the providers in drawing up the relevant part of the programme draft.
- Reducing the administrative burden in research, development and innovation
    - Opportunity to simplify the method of proving the eligibility of purpose-tied aid in projects of applied research and innovation (using the institution of flat-rate - indirect - costs). In the case of aids subject to the block exemption, the providers will be limited in setting the flat-rate costs by the definition of overhead costs stated in GBER. In the case of aids provided outside the block exemption regime, such limits will not be applied and the provider will decide and be responsible for which costs and in what extent will be included in the category of flat-rate costs and which costs will be declared in the category of direct costs.
    - The provider will have to consistently apply the principle of using data on the applicants available from public lists and registers (most of the data will be available for providers through the R&D&I IS in the future); there will be conditions and limits for using the institution of solemn declaration from applicants in competitive biddings.
    - In line with the intent to unify the environment for administration of project and programme proposals among the providers of purpose-tied aid, the RDI Council has been newly assigned with the task of harmonising the conditions for providing purpose-tied aid. The conditions of providing purpose-tied aid are expected to gradually converge so as to reduce the administrative burden for applicants in R&D&I.
    - Cancelling the two-step competitive biddings.

    - In the case of aid for innovation and applied research, the providers will have wider and simpler options for selecting the project proposals for later financing. Similarly to the EU framework programmes, it is expected that the programme proposals submitted to the Government for approval will include an implementation part where the provider will describe the implementation principles. For example, in the programme proposal, the provider can specify the procedure for receiving the project proposals including the time periods, the procedure for appraising the project proposals, the number of peer reviews and other requirements so that the projects of applied research and innovation are evaluated in a way adequate to the volume of aid provided in the shortest possible time. Incl. specifying the total volume of eligible costs per project.
    - Introducing the option of using a new form of support - repayable financial aid.
  - Newly introducing the conditions of transferability of a grant project.
  - Possibilities of using the peer reviews or the result of the project proposal appraisal which was carried out abroad as part of the implementation of an international programme of R&D&I cooperation or as part of the implementation of a Community programme according to Articles 180 and 181 TFEU.
  - Newly, the applicant has a right to learn about the process and result of the project proposal appraisal.

- New requirements and opportunities in the system of providing institutional aid
  - Research organisations are evaluated according to Methodology 2017+ and in line with the conceptual documents of the provider (Section 7 par. 6);
  - The proposed amount of expenditure submitted to the RDI Council is based on the National R&D&I Policy (not also on the evaluation of research organisations, as before the amendment), which emphasises the stabilisation function of institutional aid and the need to increase its share vis-á-vis the purpose-tied aid.
  - Emphasising the fact and the clearly defining institutional aid as support for conceptual development of research organisations that is long-term, is not competitive but requires periodical (e.g. in five-year intervals) evaluation according to a special methodology approved by the Government for those purposes, is not time-limited by law (it is limited only by the evaluation). So it is by nature a long-term financing of research organisations, representing a stabilisation element of the system.
  - The proposal of the expenditure amount, submitted by the RDI Council to the manager of budget chapters from which R&D&I is supported, newly contains in the IA support only a proposal of the amount of expenditure for institutional aid of research organisations in total.

- Common, systemic changes relevant for the R&D&I Strategy of MoA 2023+
  - Modified breakdown of R&D&I expenditure and its more precise definition: 3 types of expenditure; institutional, purpose-tied and systemic aid. Systemic aid is a new type of support, which was formerly included under the 2 types (IA, PTA) and it distorted the data on their amounts. The support is basically classified based on whether it is

provided through competition of project proposals in a competitive bidding in research, development and innovation (purpose-tied aid) or whether it is a long-term support of institutions or their parts based on a periodic evaluation and subsequent decision of the provider or even the Government (institutional aid), or expenditure necessary for ensuring the operation and correct functioning of the whole system (systemic aid).

- The systemic aid has a limit of 2.5% of the funding of the R&D&I aid provider in a given calendar year for ensuring the activities associated with the aid provision.
- Enabling the financing of membership fees in international R&D&I organisations for the provider who represents CZ in the given international cooperation of a sectoral nature. This extends the powers of the providers, in agreement with MEYS (or in agreement with MIT for international cooperation in innovation), to conduct international cooperation in R&D&I within their scope powers, usually bilateral. It opens new opportunities of cooperation at the level of ministries and agencies with their foreign partners. Specifying the powers of MEYS and newly also of MIT (in innovation) as the central administration bodies responsible for research, development and innovation. The proposed amendment assumes that MEYS will coordinate that cooperation in the interest of speaking with one voice.

- New requirements and opportunities in the options of using the information systems for formal checks of projects and for systemic evaluation and monitoring
  - The R&D&I IS has a new purpose as opposed to the previous period. The legal basis for building an interface with other ISs of public administration, from which the providers will be able to obtain, through remote access, information on whether the aid applicants meet the eligibility conditions. To that end, the law newly extends the powers of the IS administrator to take over data on applicants, beneficiaries and other project participants also from other systems of public administration.
  - A broader use of the R&D&I IS for sharing data among relevant participants in the system of providing R&D&I aid.
  - Shorter periods for data administration, enabling a simplified way of communication between the IS operator and the provider
  - Simplified access of aid providers to data on research organisations established or funded by them or on research organisations to which they provide institutional aid for their conceptual development.
  - Modified conditions for fulfilling the duty of open access to scientific information according to the National strategy of open access to scientific information for the period 2017-2020. The modification concerns the so-called green access to scientific information that covers only scientific communications, i.e. types of result J and D. The details will be specified in a government regulation on the R&D&I IS.
- Anchoring the cooperation with representatives of applied research
  - The Act newly establishes the representation of corporate research as an association bringing together entrepreneurial legal entities whose main object of activity is research, with the exception of organizations established under Act No 111/1998 Coll., on higher education institutions (HEIs), or HEIs established by a special law and organizations established under Act No 341/2005 Coll., which are funded by the Czech

Academy of Sciences that will act as a partner for providers and the RDI Council in discussing strategic and conceptual documents in R&D&I and is authorized to submit suggestions and recommendations in the area of R&D&I.

b) Starting points arising from the National research, development and innovation policy of the Czech Republic 2021+

Government Resolution No 759 of 20 June 2020 approved the National research, development and innovation policy of the Czech Republic 2021+ (the National R&D&I Policy 2021+), an umbrella strategic document at the national level for the development of all components of research, development and innovation in the Czech Republic.

The National R&D&I Policy 2021+ newly contains indicators of achieving the objectives and measures to achieve the objectives so that it is possible to evaluate the achievement. The indicators will be set either for the validity period of the National Policy with target values to be achieved within that period, or as relative indicators monitoring the changes in the given period.

The National R&D&I Policy 2021+ will contribute to the development and progress in the following key areas:

- management and financing of the R&D&I system - for the background analysis see the impacts of amendment to Act 130/2002 Coll.
- motivating people to pursue research careers and developing people's potential,
- quality and international excellence in R&D,
- collaboration between the research and the application sector,
- innovation potential of CZ.

For practical reasons, it is suitable for the indicator system of the R&D&I Strategy of MoA 2023+ to be compatible, consistent and logically interconnected as much as possible with the monitoring indicators of the National Policy.

Annex 2 to the National R&D&I Policy 2021+ **defines megatrends in R&D&I** and divides them to societal and technological.

The major **societal megatrends** influencing the future developments are defined in areas:

- demography, dominated by the trends of aging population and international migration;
- natural resources and energy, where the growing societal consumption collides with the stability and capacity of the ecosystem and there is a threat of water and food shortage;
- climate change, the environment - necessity to respond to the ongoing climate change with effective measures globally;
- globalisation - expecting a shift in the centre of gravity of the world economy and an increasing role of the fast developing countries;
- role of governments - necessity to respond to new trends and challenges;

- economy, labour and productivity - impacts of introducing digital technologies on the economy and society, or the labour market;
- society - a trend of changing family life associated with urbanisation;
- health, inequality and living standard - progress in medicine is accompanied by new threats with a global impact, such as pandemics of infectious diseases, civilisation-related diseases. Phenomena accompanying the growing inequality in society.

According to OECD prognostic processes, the major **technological megatrends** include technologies that will significantly influence the future developments:

- internet of things,
- big data analysis,
- artificial intelligence,
- neurotechnology,
- nano/micro satellites,
- nanomaterials,
- additive manufacturing (also 3D printing),
- advanced technology for energy storing,
- synthetic biology,
- blockchain (a distributed database maintaining an ever growing number of entries protected against an unauthorised intervention).

c) Innovation Strategy of the Czech Republic 2019-2030

Government Resolution No 107 of 4 February 2019 approved the Innovation Strategy of the Czech Republic 2019-2023, aimed at ranking CZ among the most innovative countries of Europe in the next twelve years and making CZ a country of technological future. The 9 pillars of the strategy include the pillar “Digital state, production and services” and “Smart innovation” covering also support for technological solutions and innovation in automation, robotisation, artificial intelligence, or investment in climate change adaptation, solutions for drought and food safety.

(d) National Research and Innovation Strategy for Smart Specialisation of the Czech Republic

The National Research and Innovation Strategy for Smart Specialisation of the Czech Republic (the National RIS3) is a comprehensive conceptual document backing the goal-oriented and applied research in the Czech Republic, in a close link to the National R&D&I Policy. The National RIS3 for the period 2021-2027 was approved by the CZ Government in its Resolution No 66 of 25.01.2021. It is a living document unlike its predecessors. The National RIS3 will reflect the dynamic development of the innovation environment and the newly emerging trends and opportunities by means of its ongoing updates. The most recent update was made in October 2021 to Annex 1 “Cards of thematic areas” (version 2). The R&D&I Strategy of MoA 2023+ fully reflects the strategic topics of the specialisation domain Green technologies, bioeconomy and sustainable food resources, backed by the National Innovation Platform VI Sustainable agriculture and the environmental sector. The specialisation domain covers four

application sectors - Sustainable management of natural resources, Sustainable agriculture and forestry, Sustainable food production and Ensuring a healthy and high-quality environment, biodiversity and ecology of natural resources.

The purpose of the National RIS3 is an effective targeting of funding - European, national, regional and private - in priority innovation specialisations so that the knowledge potential of CZ is fully exploited. The National RIS3 represents a precondition for implementing the interventions of the EU's cohesion policy in R&D&I.

Out of the 4 horizontal priorities (key areas of change) defined in the National RIS3, based on a detailed socio-economic SWOT analysis of obstacles in innovation, those relevant for the R&D&I Strategy of MoA 2023+ and formulated in its strategic goals are:

- "Increasing the quality of public research" with specific objectives of "Increasing the quality and social relevance of public research", "Increasing the quality of the environment for carrying out public research" and
- "Increasing the availability of qualified people for research, development and innovation" with the specific objective of "Increasing the potential and motivation of staff in research organisations" and
- "Increasing the use of new technologies and digitisation" with the specific objective of "Support for digitisation and use of new technologies in business and in the public sector".

(e) Sectoral strategy of the Ministry of Agriculture of the Czech Republic with an outlook till 2030

Government Resolution No 392 of 2 May 2016 approved the strategic document of the agricultural sector. Its main purpose is enhancing the common strategic framework for development of the whole complex of branches in the agrarian sector, and setting the principles and goals not only for formulating the conceptual approach to the application of the new EU common agricultural policy but also for the food sector, forestry and water management and rural development, including an update and addition of indicative indicators as desirable trends of further development, and the related optimisation of processes in the MoA strategic management.

It includes a strategy for science and research related to the education and consultancy in the sector, including indicative indicators of the set strategic goals.

Government Resolution No 838 of 29.11.2017 approved the Implementation Plan for the Sectoral Strategy of the Ministry of Agriculture 2017-2020, which elaborates the Strategy into sub-goals, measures and indicative indicators.

The Strategy defines four basic unifying long-term priorities within the perspective of sustainable development, which are then specifically and at an adequate level of comprehensiveness integrated into strategic priorities of the various branches and sub-areas:

- Competitive and sustainable agriculture, food sector, forestry and water management.
- Sustainable food security and adequate self-sufficiency.
- Sustainable management of natural resources and climate measures.

- Balanced territorial development of the economy and communities including the creation of jobs.

The document defines strategies for the following sub-areas:

- Agriculture and the food sector.
- Forestry, fisheries, apiculture and hunting.
- Water management.
- Science and research, with a priority focus on the areas of: plant production, livestock production, food sector, forestry, bioeconomy, agricultural machinery, basic natural resources - soil, water, air, climate, biodiversity and landscape. It also defines strategic goals to improve the quality, effectiveness and speed of applying the results in practice: I.1 Ensuring sufficient talent for research in research organisations supported by MoA; I.2 Promoting cooperation between research organisations and the application sector; I.3 Increasing the commercial use of R&D&I results and knowledge of research organisations.
- Developing the legal and administrative activity of MoA.

(f) the Advisory System Concept of the Ministry of Agriculture 2017-2025

The advisory system described in the Concept leans on three main pillars: consulting advice, individual advice and expert advice. The consulting advice covers initial consultation, expert consultation, special advice and mass consultations. The individual advice provides more depth and comprehensiveness. The expert advice promotes the transfer of research and innovation results into practice. All advisory measures of the above pillars are interlinked, they complement and support each other and so create a coherent advisory system. All three pillars of the advisory system are relevant for fulfilling the vision of the R&D&I Strategy of MoA 2023+, aimed at actively translating the R&D results into the advice and practice.

(g) the Education Concept of the Ministry of Agriculture up to 2026

The Concept has 4 main strategic objectives focusing on (1) the quality of the education process, (2) presentation of the agricultural schools, (3) further vocational education, and (4) reconciling the structure of the sector’s education and the number of school-leavers with the labour market requirements. The objectives are developed into measures leading to their achievement. The measures relevant for the goals of the R&D&I Strategy of MoA 2023+ in terms of supporting effective transfer of research results into practice and their promotion are: measure 1.1 R&D knowledge transfer to the instruction in secondary vocational and apprentice schools and post-secondary vocational schools, 1.2 Cooperation with employers, 1.3 Modern teaching aids and other innovative forms of education, 1.4 Improving the theoretical and practical learning, 3.2.1 Support for education in the Strategic Plan of the CAP/EAFRD, 3.2.2 Support for knowledge and information transfer as a tool for sharing experience and examples of good/bad practice, 4.1 Cooperation with stakeholder ministries, regions, employers and NGOs.

(h) Research, Development and Innovation Concept of the Ministry of Agriculture for the period 2016 – 2022

Government Resolution No 82 of 3 February 2016 approved the R&D&I Concept of MoA for the period indicated. The vision of the MoA support for R&D&I is “Support for innovative agriculture and forestry through advanced practices and technologies”. The mission and vision is to be fulfilled through three key areas: (1) Sustainable management of natural resources, (2) Sustainable agriculture and forestry, (3) Sustainable food production. The Concept defines research directions: soil, water, biodiversity, forestry and the related sectors, plant production and plant health, livestock production and veterinary medicine, food production, agricultural machinery, and bioeconomy, and these are elaborated into priority research topics. The research directions have a varying weight in the implementation of the defined key areas of the Concept.

The Concept also defines strategic goals that indicate the targeting of the systemic management tools in the area of utilising public funds invested in R&D&I, in key areas of change: A. Legal framework, B. Excellence of agricultural research.

In area of change A. Legal framework, the goals are:

A1: Improving the administrative processes in public administration of R&D&I,

A2: Improving the legal framework,

A3: Managing the quality of the R&D&I Concept implementation,

A4: Defining the content and strategic activities for the types of research aids,

A5: Cooperating effectively with the other providers of purpose-tied aid in designing and approving programmes.

A6: Cooperating actively in R&D&I at the international level and creating an international policy in cooperation with its supervisor - MEYS.

In area of change B. Excellence of agricultural research, the goals are:

B.1: Increasing the quality and changing the orientation of agricultural research in research organisations supported by MoA,

B.2: Developing the infrastructure for strategic research in agriculture,

B.3: Optimising the benefits of public support for R&D&I in research organisations supported by MoA.

(i) National priorities of goal-oriented research, experimental development and innovation up to 2030

The research in the agri-food sector, forestry and water management will use mainly the following priority areas of the “National priorities of goal-oriented research, experimental development and innovation”, approved in Government Resolution No 552 of 19 July 2012.

1. Relevant research goals of priority area Competitive knowledge-based economy

Area	Sub-area	R&D&I Goals
1. Use (application) of new knowledge from so-called General Purpose Technologies	1.1 GPTs for innovation of processes, products and services	1.1.1 Reaching new useful properties of products using new knowledge in GPTs
		1.1.2 Increasing the efficiency, security, sustainability and reliability of processes (including reducing the energy and material intensity) using GPTs
		1.1.3 Streamlining the offered services and processes in the services sector using GPTs
		1.1.4 Streamlining the services and processes in the public sector using GPTs
2. Enhancing the sustainability of production and other economic activities	2.1 Economy, effectiveness and adaptability	2.1.1 Increasing the economy, effectiveness and adaptability in transport - transport and manipulation systems, and in the manufacturing of vehicles so that these sectors are globally competitive
		2.1.2 Increasing the economy, effectiveness and adaptability in mechanical engineering to enhance global competitiveness in the sector
		2.1.3 Increasing the economy, effectiveness and adaptability in electrical engineering, including the IT industry and services, to enhance global competitiveness in the sector
		2.1.4 Increasing the adaptability of products through interdisciplinary research
	2.2 Useful properties of products and services	2.2.1 Innovating products in sectors decisive for export through joint activities of the manufacturing and research sectors
		2.2.2 Enhancing the competitiveness of products and services through increasing their useful properties
3. Strengthening safety and reliability	3.1 Safety and reliability of products and services	3.1.1 Introducing a comprehensive approach to the safety and reliability of products
	3.2 Safety and reliability of processes	3.2.1 Achieving a permanently high degree of data protection and communication security in a dynamically changing environment
		3.2.2 Expanding the use and improving the quality of automatic control and robotisation

		3.2.3 Increasing the quality of monitoring the early warning processes and systems
		3.2.4 Improving the safety and reliability of processes using simulation and virtual reality tools to significantly reduce direct and indirect costs related to their failure
4. Mapping and analysis of competitive advantages	4.1 Identifying new opportunities of competitive advantages	4.1.1 Timely identification of economic opportunities through continuous monitoring and evaluation of global trends

2. Relevant research goals of priority area Sustainability of the energy sector and material resources

Area	**Sub-area**	**R&D&I Goals**
1. Sustainable energy sector	1.1 Renewable energy sources	1.1.3 Developing a cost-effective use of biomass
	1.5 Production and distribution of heat/cold, including cogeneration and trigeneration	1.5.3 Distributed combined production of electricity, heat and cold from all types of sources
		1.5.4 Heat transfer and accumulation
		1.5.5 Effective management of indoor climate conditioning
		1.5.6 Alternative sources - use of waste
2. Improving the energy efficiency of the economy	2.1 Improving the energy efficiency of the economy	2.1.1 Energy balance of materials and fuels in full cycle times
		2.1.2 Research and development of new energy efficient industrial technologies
	2.2 New technologies and procedures with potential use in the energy sector	2.2.3 Biotechnology, bioengineering and genetics
3. Material base	3.1 Advanced materials	3.1.1 Long-term perspective of securing raw materials for the economy of the Czech Republic
		3.1.2 Advanced materials for Competitiveness
		3.1.3 Innovation and sustainability of traditional materials
		3.1.4 Use of nanomaterials and nanotechnologies

3. Research goals of priority area Environment for a quality life

Area	Sub-area	R&D&I Goals
1. Natural resources	1.1 Biodiversity	1.1.1 Increasing the long-term effectiveness of special territorial protection of nature and landscape aimed at supporting metapopulations of declining endangered species and species with a focus of occurrence in biotopes made or heavily influenced by humans
		1.1.2 Creating effective types of measures to maintain natural communities and natural habitats of species
		1.1.3 Evaluating the impact of plant and animal invasions and developing the tools to limit them
		1.1.4 Evaluation, mapping and categorization of ecosystem services, including the design of tools for evaluating their factual accuracy and practical usability
	1.2 Water	1.2.1 Reduction of water pollution from point and non-point sources and sustainable use of water resources
	1.3 Soil	1.3.1 Increasing the content of stable organic matter and supporting the functional diversity of soil organisms while maintaining the productive properties of soils
		1.3.3 Increasing the retention capacity of wetland soils and introducing retention belts
	1.4 Air	1.4.1 Limitation of pollutant emissions from anthropogenic sources
		1.4.2 Mechanisms of the spread and deposition of pollutants
	1.5 Mineral resources and the effects of mining on the environment	1.5.1 Strengthening the sustainability of the supply of mineral raw materials
2. Global changes	2.1 Methods of mitigation and adaptation to global and local changes	2.1.1 Design of adaptation measures in the individual sectors of the Czech economy and design of tools for reducing GHG emissions
	2.2 Biogeochemical cycles of nitrogen and phosphorus	2.2.1 Optimising the flows of reactive forms of nitrogen and phosphorus (Nr and Pr)
	2.3 Hazardous substances in the environment	2.3.1 Environment and health
3. Sustainable development of the landscape and human settlements	3.1 Green infrastructure - stable landscape structure	3.1.1 Designing conceptual tools for landscape planning
	3.2 Agriculture and forestry	3.2.1 Obtaining practically usable knowledge for efficient agricultural production in

		environmentally and economically sustainable land management systems
	3.3 Urbanism and smart human settlements	3.3.1 Design of modern methods and systems for building and operating smart human settlements with minimal environmental impact
4. Environmental technology and eco-innovation	4.1 Environmentally friendly technologies, techniques and materials	4.1.1 Technologies and products increasing the overall efficiency of the use of primary resources
	4.2 Biotechnology, materials, energy and emission efficient technologies, products and services	4.2.1 Obtaining qualitatively new primary products by using biotechnological methods
		4.2.2 Preparing biotechnological procedures for a comprehensive waste-free use of biomass
	4.3 Minimising waste generation, waste reuse	4.3.1 New recycling technologies, the output of which are substances comparable in quality to the initial raw materials
		4.3.2 New effective procedures of energy recovery from waste while minimising negative environmental impacts
	4.4 Removal of hazardous substances (old damage) from the environment	4.4.1 Increasing the effectiveness of remediation technologies and introducing new remediation methods
	4.5 Minimizing risks from chemicals	4.5.1 Technologies for minimizing the risks of POPs, toxic metals, hormonal disruptors, pharmaceutical and pesticide residues and other pollutants on the health of humans and living organisms
		4.5.2 Technologies for the replacement of hazardous substances that are subject to REACH legislation and the replacement of hazardous substances with less harmful ones
5. An environmentally friendly society	5.1 Consumption patterns of the population	5.1.1 Developing effective practices to change consumption behaviour in the direction of minimizing the impact of consumption on the stable functioning of natural resources and ecosystems services
	5.2 Tools for environmentally friendly growth	5.2.1 Designing innovative tools for environmental protection with the aim of minimizing the costs of their operation

(j) Evaluation of the results of research, development and innovation programmes closed in 2018, the Research, Development and Innovation Council Department of the Office of the Government of CZ

(the evaluation relevant for the R&D&I Strategy of MoA 2023+ is the one of the programme managed by MoA called Comprehensive Sustainable Systems in Agriculture 2012-2018 “CSS” approved in Government Resolution No 52 of 19.01.2011)

The main recommendations relevant for updating the R&D&I Strategy of MoA 2023+:

- The objectives of the Programme are considered very general, which affects their measurability.
- The target values of result indicators were exceeded nearly 15 times, which indicates their significant undervaluation in the Programme design.
- The final report of the provider shows that a large part of the programme participants (mostly enterprises) did not take part in any result according to data in the R&D&I IS. However, looking at the R&D&I IS data, the enterprises were involved in implementing the project but they were not recorded among the authors of the results. The absence of the enterprises’ share of cooperation in the results may be caused by the specificities of the result recording in the R&D&I IS.
- The RDI Council asks the provider to design the future R&D&I programmes with close attention to the motivation and way of involvement of enterprises in the R&D&I programmes and their share in the presented results.

(k) EU framework programmes for research and innovation (Horizon Europe for the 2021-2027 period)

The framework programmes (FPs) for research and innovation represent the EU’s science and technology policy. They are based on detailed analyses of the state of the economy, social, environmental conditions and needs and other circumstances in the EU with the aim of establishing such priorities in research and technological development that will ensure the necessary competitiveness of the EU in comparison with the most developed countries in the world. The EU's framework programmes for research and innovation also support international cooperation in addressing European-wide important research topics, as well as the mobility of researchers and the development of research capacities. The FP themes cover practically all fields of science.

The Czech Republic took part in the 7th FP (2007-2013) and the 6th FP (2002-2006). It fully joined the 5th FP (1999-2002) in May 1999. The 8th Framework Programme Horizon 2020 for the 2014-2020 period was launched in January 2014. Horizon Europe, the 9th Framework Programme for the period 2021-2027, started on 1 January 2021.

Horizon Europe, the 9th EU Framework Programme for research and innovation in the 2021-2027 period

Horizon Europe is the key EU programme for financing research and innovation. It helps in the fight against climate change, in achieving the UN's Sustainable Development Goals, and strengthens the EU's competitiveness and growth. The programme facilitates cooperation and strengthens the impact of research and innovation in the development, support and

implementation of EU policies and in addressing global challenges. It supports the generation and dissemination of cutting-edge expertise and technologies. It creates jobs, helps to fully engage the most talented, supports economic growth and industrial competitiveness, and optimises investment impact within a strengthened European Research Area. It can be joined by legal entities from the EU and associated countries. The programme budget is EUR 95.517 billion.

A novelty of the programme are missions that are linked to thematic clusters in the second pillar. The missions are defined as portfolios of projects with bold yet measurable goals. In addition to missions, the clusters are also connected to European Partnerships, i.e. initiatives implemented by the European Commission in cooperation with partners from the public or private sector. A great emphasis is placed on the openness of science. Open access to publications and research data is becoming a standard requirement and modus operandi of the programme. New possibilities are also opening up for the involvement of countries with good scientific, innovation and technological capacity.

Pillar I 'Excellent Science'

The first pillar of the Horizon Europe framework programme will focus on the support of excellent research, the development of human capital, i.e. scientific careers of researchers, and high-end research infrastructure. The implementation of the first pillar will be based on the bottom-up principle.

- European Research Council
- Marie Skłodowska-Curie actions
- Research infrastructures

Pillar II 'Global Challenges and Industrial European Competitiveness'

Addressing the socio-economic challenges of European society with knowledge-based solutions cannot be the exclusive domain of the research sector. It must naturally also include the sphere of innovation, in a general view this means all stakeholders from the educational, research and innovation environment, the public and private sectors and the wider civil society, i.e. scientists and innovators on the one hand and "end users" - i.e. citizens - on the other hand. The second pillar of the Horizon Europe framework programme will, therefore, be implemented through clusters creating platforms for the partnership of all stakeholders concerned, and the priority topics will be determined using the "top-down" principle. The clusters relevant for the implementation of the R&D&I Strategy of MoA 2023+ are: Health; Climate, energy and transport; Digitisation, industry and space; and especially cluster Food, bioeconomy, natural resources, agriculture and the environment. The implementation tools will also include "missions", i.e. time-limited and problem-oriented multidisciplinary research-innovation initiatives coordinating all relevant and affected stakeholders, with clearly defined goals, and a timetable for their fulfilment.

Pillar III ‘Innovative Europe’ (EUR 13.5 bil.)

A much more intensive application of research potential in innovative products and services with high added value remains a major challenge of the European Research Area. Not only the transfer of knowledge, but also the transfer of human resources from the research environment to the business sector, more intensive development of start-up enterprises, making risk capital available to innovators or the concentration of EU financial instruments supporting innovation under one umbrella institution are the main ambitions of the Horizon Europe framework programme.

This pillar includes the European Innovation Council (EIC), whose main instruments are EIC Pathfinder, EIC Transition and EIC Accelerator. It also covers the European Institute of Innovation and Technology (EIT) and the topic of European innovation ecosystems.

(l) Digital Europe Programme

On 29 April 2021, a regulation of the European Parliament and of the Council establishing the Digital Europe Programme for the period 2021-2027 to maximise the benefits of the EU's digital transition was approved. The Digital Europe Programme is the European Commission's comprehensive response to the current challenges of digital transition and is part of the proposal for the multiannual financial framework for the period 2021-2027. Its purpose is to provide, in the form of grants or financial instruments, support for the building and development of digital capacities and technologies in areas determined by the European Council.

The Programme has five specific objectives:

- increasing the EU's capacities in the field of high-performance computing,
- artificial intelligence,
- cyber security and trust,
- advanced digital skills,
- deployment, best use of digital capacity and interoperability.

The specific objectives of the Programme will be implemented through calls in work programmes, which will also state the specific conditions for obtaining support. The national body responsible for the Programme is the Ministry of Industry and Trade. The next call is planned in the work programme for the period 2021-2022 to support the establishment and development of a network of European Centres for Digital Innovation in EU Member States. In the coming years, the Czech Republic has a chance to obtain funding for up to 6 such centres.

The aim of building the network of European Centres for Digital Innovation is to provide support especially to small and medium-sized enterprises in their transition to digital technologies, procedures and management, e.g. by enabling the testing of digital technologies and artificial intelligence in the specific conditions of their business, or in meeting the requirements for cyber security or in analysing large amounts of data. From the perspective of the R&D&I Strategy of MoA 2023+, the Programme objectives are linked to key area Smart agriculture.

(m) Priority axes of the draft Operational Programme Johannes Amos Comenius for 2021-2027

Priority axis 1 Research and development, financed from ERDF, policy objective 1 (defined in the Common Provisions Regulation): A smarter Europe by promoting innovative and smart economic transformation, with measures targeted at:

- Development of the institutional environment of research organizations (support for obtaining the HR Award, establishing a welcome office, grant office, developing the RO’s strategic management)
- Internationalization of research (support of mobility to/from the Czech Republic, support of international cooperation in R&D)
- Excellence in research (support of multi-year R&D projects with high research potential and addressing societal issues, synergy with Horizon Europe (2021+)
- Development of R&D infrastructure (modernization of key research equipment)

- Development of human resources for R&D (education, support of existing and recruitment of high-quality foreign R&D staff, support of beginning researchers)
- Development of the application potential of research organizations (establishment and development of cooperation on research projects)
- Strategic and coordinated management of the R&D&I system at national and regional level
- Open science (open access, open data, EOSC)
- Visibility of the Czech R&D&I

Priority axis 2 Education, financed from ERDF and ESF+, policy objective 4: A more social Europe implementing the European Pillar of Social Rights

(n) the Research and Development Concept of the Ministry of the Environment for 2016-2025

The Research and Development Concept of the Ministry of the Environment for 2016-2025 is based on Priority 3 of the National priorities of goal-oriented research, experimental development and innovation - “Environment for a quality life”. That priority is broken down to five areas that are elaborated in the Concept into sub-areas:

1. Natural resources (with sub-areas thematically relevant for the R&D&I Strategy of MoA 2023+: 1.1 Biodiversity, 1.2 Water, 1.3 Soil),

2. Global changes,

3. Sustainable development of the landscape and human settlements (with sub-areas thematically relevant for the R&D&I Strategy of MoA 2023+: 2.3 Agriculture and forestry),

4. Environmental technology and eco-innovation (with sub-areas thematically relevant for the R&D&I Strategy of MoA 2023+: 4.1 Environmentally friendly technologies, techniques and materials; 4.2 Biotechnology, material-, energy- and emission-efficient technologies, products and services, 4.3 Minimization of waste generation and waste reuse, 4.5 Minimization of risks from chemical substances) and

5. Environmentally friendly society (with sub-areas thematically relevant for the R&D&I Strategy of MoA 2023+: 5.1 Consumption patterns of the population).

6.II Legal and methodological framework of R&D&I support - key legislation

Act No 130/2002 Coll. on support for research, experimental development and innovation from public resources and amending some related acts, as amended

Act No 341/2005 Coll., on public research institutions, as amended

Office of the Government of the Czech Republic, Research, Development and Innovation Council department: Methodology for Evaluating Research Organisations and Research, Development and Innovation Purpose-tied Aid Programmes, approved in Government Resolution No 107 of 8 February 2017

Government Regulation No 397/2009 Coll., on the information system for research, experimental development and innovation

Act No 2018/2000 Coll., on budgetary rules and amending some related acts (budgetary rules), as amended.

Commission Regulation (EU) No 651/2014 of 17 June 2014 declaring certain categories of aid compatible with the internal market in accordance with Articles 107 and 108 of the Treaty (GBER)

Commission Regulation (EU) No 702/2014 of 25 June 2014 declaring certain categories of aid in agriculture and forestry and in rural areas compatible with the internal market in accordance with Articles 107 and 108 of the Treaty on the Functioning of the European Union (ABER)

Framework for State aid for research and development and innovation (2014/C 198/01).

6.III Information sources for defining the priorities of the thematic focus of the R&D&I Strategy of MoA 2023+

(a) Key international strategic documents

1. **Agenda 2030 with 17 Sustainable Development Goals** (SDGs). The Concept mainly responds to sub-goals of SDGs: 2.4, 2.5, 2.a, 15.6, 15.b, to ensure systems of sustainable production of food and sustainable agricultural procedures, to maintain or increase genetic diversity, to increase investment in agricultural research and rural infrastructure and protect and promote sustainable use of terrestrial ecosystems.
2. **EU Biodiversity Strategy for 2030: Bringing nature back into our lives** (COM(2020) 380 final):
    a. resilient landscape, landscape features, tree planting, areas important for carbon storage, highly protected areas
    b. halting the decline in the number of species (animals, plants)
3. The **European Green Deal** (COM(2019) 640 final) and its sectoral transposition to the **'Farm to fork' strategy for a fair, healthy and environmentally-friendly food system** (COM(2020) 381 final):
    a. reducing selected inputs in agriculture and aquaculture, reducing the use of fertilisers and plant protection products, antimicrobials
    b. sustainable practices in farms - expanding the organic farming to cover up to 25% of agricultural land, supporting RES on arable land and in livestock farms, reducing emissions
    c. the food vertical and the market in the globalisation-localisation context
    d. healthy diet and consumption - nutrition, food safety, ethical codes of food producers, food frauds, informed consumers
4. Document **EC mission "Healthy soil and food":**
    a. at least 75% of agricultural land should be "healthy" by 2030, i.e. able to ensure basic ecosystem services with significant environmental, economic and social impacts (as opposed to the present where 60-70% of soil in the EU is "unhealthy").
    b. This main target concerns three levels: land lot, landscape unit, region/state, and increased requirements on the role of monitoring (digitisation)
5. **A Sustainable Bioeconomy for Europe: strengthening the connection between economy, society and the environment (COM (2018) 673 final.** It defines the bioeconomy according to Europe – sustainable and circular, and presents 5 strategic objectives (ensuring sufficient food and nutrition; sustainable management of natural resources; reducing dependence on non-renewable resources; mitigating the consequences of climate change and adapting to it; creating job opportunities and maintaining European competitiveness, and 3 main areas of intervention: 1. Strengthening and scaling-up the bio-based sectors, unlocking investments and markets ; 2. Deploying local bioeconomies rapidly across Europe; 3. Understanding the ecological boundaries of the bioeconomy.
6. **New EU Forest Strategy for 2030** - a legally non-binding document issued in July 2021 by the European Commission with the aim of helping to bridge the very different situation in forestry in the individual EU Member States and enabling better coordination of steps in

this area in accordance with the EU climate policy. The visions relevant for the R&D&I Strategy of MoA 2023+ are in the areas of wood use (strengthening the sustainability criteria for bioenergy; building on the principles of circular economy), regeneration of forests and forestry (enhancing the adaptability of forests and their natural ability of renewal; care of forest land; sensitive logging), forest monitoring and research, education.

7. **OECD Questionnaire for Council Recommendation of Assessing the Sustainability of Bio-based Products**:
    a. the share of agricultural (and forestry) biomass in (the different categories of) RES within the national economy, and the share of agricultural (and forestry) biomass dedicated to RES in the total production of agricultural (and later also forestry) biomass
    b. the share of agricultural (and forestry) biomass used in bio-based products (outside RES, food and feed)
8. **Priority areas analysis and identification of key policy measures for the new national circular economy strategic framework „Circular CZECHIA 2040“ – WASTE MANAGEMENT (OECD)“**
    a. the use of by-products and waste from agricultural and food production to increase organic matter in agricultural soil,
    b. a paradigm shift in the understanding of the relationship between the tying and the tied products in agriculture, the economy of the production of so-called tied products,
    c. reducing losses and waste in the agrarian vertical (up to 50% by 2030)
9. **A meta-analysis of recent foresight documents in support of the 5th SCAR Foresight Exercise.** Bisofi, S., SCAR 2019. https://scar-europe.org/index.php/24-scar/scar-organisation/11-foresight-group
10. **A long-term Vision for the EU's Rural Areas - Towards stronger, connected, resilient and prosperous rural areas** (Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions COM(2021) 345 final), which points to the megatrends and problems associated with globalization, urbanization and ageing, while highlighting the opportunities that are the development potential for rural areas:
    a. green and digital transition,
    b. lessons learned from the COVID-19 pandemic,
    c. measures and policies that take into account local specificities, specific needs and relative strengths.

(b) Key national strategic documents

11. **Strategic Framework Czech Republic 2030**, mainly in terms of the economic model and Czech landscape:
    a. Czech agriculture, forestry and water management will have to undergo a fundamental change in the sense of adaptation to expected changes in the water regime of the landscape.

b. Changed incentives and rules lead to better land use by agricultural and forestry enterprises.

c. The landscape of the Czech Republic is understood as a complex ecosystem, and ecosystem services provide a suitable framework for the development of human society.

d. The Czech landscape is varied and biological diversity is being restored.

e. The landscape is adapted to climate change and its structure helps to retain water.

f. Soils are protected from degradation and the landscape's potential is used to capture and store carbon to the maximum extent possible.

12. **Sectoral Strategy of the Ministry of Agriculture with an outlook till 2030**, focusing on ensuring food security and safety in the Czech agrarian sector, but also on:

    a. Increasing soil protection in times of climate change with regard to sustainable farming and comprehensive development and formation of the landscape.

    b. Sustainable management of forests with continuous improvement of their condition.

    c. Competitiveness of the forestry-based value chain.

    d. Optimizing the numbers of individual game species by age and sex in accordance with the natural conditions of the landscape, which enable natural development of populations and ecosystems without damage by game.

    e. Mitigating the consequences of drought related to climate change.

13. **Concept of the State Forestry Policy up to 2035 and its Action Plan, and the upcoming National strategy for research, experimental development and innovation in forestry**, which is in line with the R&D&I Strategy of MoA 2023+ also in terms of the defined priority research topics and has identified the following problems:

    a. Reduced resistance and deteriorated health of forest ecosystems with a calamitous occurrence of harmful biotic (insects, fungi, etc.) and abiotic (drought, damaging wind, etc.) agents.

    b. Low competitiveness of forestry compared to other sectors of industry and agriculture.

    c. Complicated and for the owners confusing system and performance of the state administration in forestry.

    d. Lack of public awareness of the complexity and importance of forests for society.

14. **Strategy for Adaptation to Climate Change in the Czech Republic (or also the Adaptation Strategy)** represents the national adaptation strategy of CZ for 2021-2030, with an outlook till 2050. The first update of the strategy for the period 2021-2030 was approved in Government Resolution No 785 of 13 September 2021. The aim of the Adaptation Strategy is, through the proposed measures and tasks, to “increase the preparedness of CZ for climate change - to reduce vulnerability and increase resilience of human society and ecosystems to climate change and so reduce its negative impacts”. It clearly summarizes the observed development and the expected development of the climate in the world and in the CZ territory, summarizes the analyses of risks, vulnerabilities

and impacts of climate change in the CZ territory, broken down to the main manifestations of climate change in CZ (which are long-term drought, floods and flash floods, heavy rainfall, extremely high temperatures, extreme wind, vegetation fires) and priority areas of interest (economic and environmental sectors) in relation to the predicted impacts of climate change. It also formulates the basic principles of adaptation, the vision and goals of adaptation until 2030 with a 2050 perspective.

The Adaptation Strategy is implemented through the **National action plan for climate change adaptation** for the period 2021-2025.

15. The **State Environmental Policy 2030 with a 2050 perspective** was approved by the Government on 11 January 2021. It defines the implementation of effective environmental protection in CZ until 2030. The main goal is to ensure a healthy and high-quality environment for citizens living in CZ, to contribute to the efficient use of all resources and to minimize the negative impacts of human activity on the environment, including impacts that go beyond state borders, and thus contribute to improving the quality of life in Europe and worldwide.

16. **Strategy of coordinated and comprehensive digitisation of the Czech Republic 2018+ (Digital Czechia)**

    Government Resolution No 629 of 3 October 2018 approved the programme (set of concepts) Digital Czechia intended to ensure the prerequisites of long-term prosperity of CZ in the context of the ongoing digital revolution. The programme is defined by three pillars: Czechia in digital Europe; Information System Concept of CZ (eGovernment); Digital economy and society (DES). DES covers Agriculture 4.0, support for agriculture digitisation, support for agriculture digitisation infrastructure etc.

17. **Proposal for a Strategic Framework for a Circular Economy of the Czech Republic 2040**

    The strategic document reflects the necessity of promoting the principles of circular economy in the Czech Republic and emphasizes the circular economy as a priority for the Czech Republic. Three defined main and strategic lines determine the direction of development of the circular economy in CZ: Life cycle/value chains; Sectors/systems and Horizontal initiatives. It establishes 10 priority areas, of which the following are relevant for the R&D&I Concept of the MoA 2023+: raw materials and energy; bioeconomy and food; consumption and consumers; waste management; water; research, development and innovation; education and knowledge; economic instruments; circular cities.

18. **Biodiversity Protection Strategy of CZ 2016-2025**

    The main goal of the Strategy is to prevent the ongoing overall loss of biodiversity on the territory of the Czech Republic and to implement measures and activities that will improve the state and sustainable use of biodiversity. The priority areas particularly relevant for the R&D&I Concept of the MoA 2023+ are 2. Long-term thriving biodiversity and protection of natural processes (including genetic diversity, species including invasive non-native ones, landscape), 3. Rational utilisation of natural resources (relating to agricultural landscapes, forest and water ecosystems, soil and sustainable use of genetic resources) and 4. Provision of current and relevant information (including in the areas of ecosystem services and international cooperation).

19. **Action plan of CZ for developing organic farming in the period 2021-2027**, defining 5 priority areas of development of organic farming in CZ (organic farms: economic viability and benefits for the environment and animal welfare, market, consumption, information

dissemination) and the strategic objectives and measures corresponding to them including indicators for monitoring.

20. **Concept of bioeconomy in the Czech Republic from the perspective of the Ministry of Agriculture for the period 2019-2024**, the main objective of which is, through systemic management tools, to increase the effectiveness of the already implemented activities so that they bring results currently usable for bioeconomy development.

(c) General changes and trends

- Food security/self-sufficiency of CZ in the EU single market in (very) turbulent conditions.
- Increased demand for the production of public goods in agriculture, including the promotion of economy of scale in this production and subsequent changes in agrarian structures.
- Development of Agriculture 4.0 (robotisation, digitisation) of the 4th industrial revolution, informatics (including FADN innovations) and IT technologies (including the use of the European data space and high-speed internet) and their impact on the transfer of the results of economic research, management of the sector and enterprises of the agrarian sector and on rural development.
- Adaptation of the agrarian sector including forestry and timber production to the global climate change, and the need for a balanced implementation of adaptation and mitigation measures.

The general (and specific) economic and social objectives, promoted in the long term by the **EU common agricultural policy and the related agricultural policy of CZ**, and forming the economic and social criteria for assessing changes in the agrarian sector:

- Competitiveness within the region (EU), or vis-á-vis third countries.
- Adequate standard of living of farmers/agricultural workers within the national economy.
- Reasonable prices of agricultural sector products for final consumers (food, energy).
- Balance/fairness (reduction of unjustified differences) in the vertical, between categories of enterprises, etc.
- Overall optimization of agrarian policy measures, especially minimization of demands on external resources compared to the expected policy effects, minimization of other negative impacts of policy measures (subsidy leakage and soil-based profit effects, deadweight loss, moral hazard etc.).

Taxonomy - a classification system of sustainability of economic activities, developed on the basis of Regulation (EU) 2020/852 of the EP and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment, and amending Regulation (EU) 2019/2088 (the Taxonomy Regulation). Taxonomy represents a robust framework of criteria under which an economic activity or investment can be considered fully environmentally sustainable. The Regulation represents a framework for issuing the criteria themselves in the form of delegated acts for 6 environmental objectives (mitigation of climate change; adaptation to climate change; sustainable use and protection of water and marine resources; transition to a circular economy; prevention and reduction of pollution; protection and restoration of biodiversity and ecosystems).

Annex 7 Analysis of excellence and of the application potential of the R&D&I outputs in agricultural sciences, and the identified priority tendencies of research directions in the application sector

7.1. Quantity and excellence of research results in agricultural and veterinary sciences

The Analysis of the R&D&I outputs in agricultural sciences complements the Analysis of trends in the development of financial support for agricultural research in CZ and abroad by source of support, which is also attached to the R&D&I Strategy of MoA 2023+ as Annex 8.

It drew on data from R&D&I IS, the RDI Council on the RO evaluation, and data from background analyses and the Summary report on the preparation of the National RIS3 from the spring of 2020 by the Technology Centre of CAS. The last mentioned source analyses the research activities in CZ mainly from the perspective of the National RIS3 sectors and specialisation domains, and brings interesting insights into the activity, strategies of key R&D&I actors by field of science and application area. The indicated analytical background documents put the data into the context of financial flows (in the structure: national public and private financing, international sources) in the areas concerned.

The R&D&I outputs in agriculture and veterinary sciences are analysed in Table 1 below in terms of their quantity compared to the other fields, their type distribution and then in terms of their quality.

The R&D&I IS registered 4 909 research results in the field of agriculture and veterinary sciences in 2019, which is 5.7 % of all registered results in the data collection year 2019.

The data in Table 1 below show that the structure of the selected application results of R&D&I in agriculture and veterinary sciences is dominated by results of type F (results with legal protection, N (methodologies, medical procedures and specialised maps), and Z (semi-operation, verified technology, plant variety, animal breed) - marked yellow in the table. Compared to the other fields of science, the representation of P type results (patent) and J type (peer-reviewed article) is average - marked blue in the table.

Table No 1: Numbers of selected R&D result types according to R&D&I IS by field, and their shares in the total number of results per field

Data collected for year 2019			Selected applied R and D results								Selected publication R and D results	
Scientific area (field group)	Number	Share %	P - patent, absolute number	Share in the total number of results in scientific area in %	F - Results with legal protection, absolute number	Share in the total number of results in the scientific area in %	N - methologies, medical and heritage conservation procedures, specialised maps, absolute number	Share in the total number of results in the scientific area in %	Z - Semi-operation, verified technology, plant variety, animal breed, absolute number	Share in the total number of results in scientific area in %	J - peer-reviewed article, absolute number	Share in total number of results in the scientific area in %
10000 Natural Sciences	28 755	33,5	180	0,6%	100	0,3%	173	0,6%	58	0,2%	20 244	70,4%
20000 Engineering and Technology	17 526	20,5	239	1,4%	395	2,3%	84	0,5%	244	1,4%	5 496	31,4%
30000 Medical and Health Sciences	12 222	14,3	64	0,5%	49	0,4%	12	0,1%	4	0,0%	10 484	85,8%
40000 Agricultural and Veterinary Sciences	4 909	5,7	28	0,6%	157	3,2%	290	5,9%	171	3,5%	1 973	40,2%
50000 Social Sciences	11 946	13,9	1	0,0%	1	0,0%	37	0,3%	2	0,0%	4 798	40,2%
60000 Humanities and the Arts	10 327	12,1	1	0,0%	1	0,0%	28	0,3%	2	0,0%	3 495	33,8%
Total	**85 685**	**100**	**513**		**703**		**624**		**481**		**46 490**	

With regard to the internationally low level of financial support for the given field of science (that ranges below 3% of all R&D&I expenditure), identified in the Analysis of trends in the development of financial support for agricultural research in CZ and abroad by source of support, attached to the R&D&I Strategy of MoA 2023+, the result of the comparison is very satisfactory, also regarding the fact that the results of agricultural and veterinary sciences make up 5.7% of all R&D results in the R&D&I IS.

The quality of research results is evaluated annually by the RDI Council of the Office of the Government in modules M1 and M2. Module 1 evaluates the registered research results according to criteria of social relevance and contribution to knowledge, Module 2 based on a bibliometric analysis in an international comparison and based on data in the Web of Science and Scopus databases.

In the field of agricultural and veterinary sciences, the social relevance was evaluated in the years 2017-2019 with grade 1 in 2.1% of the results, with grade 2 in 21.5% of the results, grade 3 in 44.9% of the results, grade 4 in 26.7% and grade 5 in 3.2% of the results. The remaining 1.6% of the results were left without the final grade. The first three grades that indicate high-quality results cover 68.5% of the results in the social relevance criterion over 3 years of evaluation (Odbor Rady pro výzkum, vývoj a inovace, 2020).

Chart No 2: Evaluation by field under Module 1 evaluated by the RDI Council in the years 2018-2020 (H17-H19)

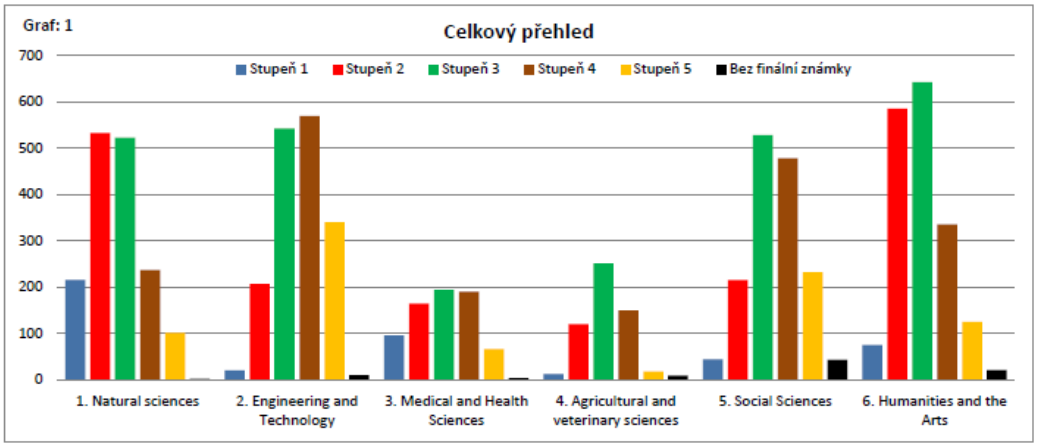
Selected results – evaluation by field group (grades):

Vybrané výsledky - oborové hodnocení

Období hodnocení: H17+H18+H19
Kritérium: (Vše)

Tab.: 1 - Celkový přehled

Finální známka	1. Natural sciences	2. Engineering and Technology	3. Medical and Health Sciences	4. Agricultural and veterinary sciences	5. Social Sciences	6. Humanities and the Arts	Suma
Stupeň 1	215	20	95	12	44	75	461
Stupeň 2	532	207	164	120	215	585	1 823
Stupeň 3	522	542	194	251	528	642	2 679
Stupeň 4	237	569	190	149	478	335	1 958
Stupeň 5	101	340	66	18	232	125	882
Bez finální známky	2	10	3	9	43	21	88
Suma	1 609	1 688	712	559	1 540	1 783	7 891



Taken from the RDI Council (R&D&I IS): Fields - overview_ of evaluation H17, H18, H19

The analysis of Czech R&D&I by field from April 2020, comparing the specialisation of publication activity of Czech ROs and its quality with developed countries of Europe (EU-15 states, Norway, Switzerland) based on data from the WoS database, finds about the quality of research results in agricultural sciences that “compared to those countries, the share of publications created in natural, technical and agricultural sciences in all Czech publications included in the WoS database is higher (p. 39).” The quality of the research results in agricultural sciences is shown in Table 2 below, in the red frame.

Table No 2: Numbers of publications and quality indicators of the publications created by CZ research organisations in sum for the period 2015-2018, divided by field according to the OECD Frascati manual.

Source: Clarivate Analytics Web of Science (an. tool InCites), taken from (Technologické centrum AV ČR, 2020a), p. 37

Kód oboru	Obor	Počet publikací	Oborově normalizovaná citovanost	Podí publikací v Top 10% světově nejcitovanějších	Podíl publikací ve spolupráci s průmyslem	Podíl publikací v mezinárodní spolupráci
	Přírodní vědy	**34 544**	**1,01**	**8,7%**	**2,0%**	**62,1%**
101	Matematika	3 130	0,82	6,6%	0,5%	57,0%
102	Počítačové vědy a informatika	1 865	0,73	5,8%	1,4%	49,8%
103	Fyzikální vědy	8 465	1,30	13,0%	4,6%	74,5%
104	Chemické vědy	8 938	0,73	5,0%	1,5%	53,1%
105	Vědy o Zemi a příbuzné vědy o životním prostředí	4 866	1,02	9,0%	0,9%	59,1%
106	Biologické vědy	11 348	1,06	9,7%	1,3%	62,9%
107	Ostatní přírodní vědy	123	1,08	9,8%	0,8%	71,5%
	Technické vědy	**13 896**	**0,80**	**6,0%**	**2,9%**	**51,8%**
201	Stavební a dopravní inženýrství	462	0,77	5,8%	1,5%	40,3%
202	Elektrotechnické inženýrství, elektronické inženýrství, informační inženýrství	1 643	0,86	7,2%	2,9%	52,0%
203	Mechanické inženýrství (Strojní, jaderné a audio inženýrství)	1 793	0,81	5,3%	9,0%	53,3%
204	Chemické inženýrství	895	0,78	5,1%	2,2%	46,0%
205	Materiálové inženýrství	4 994	0,69	4,7%	1,5%	58,3%
206	Lékařské inženýrství	790	0,70	5,3%	1,4%	37,1%
207	Environmentální inženýrství	1 529	0,83	6,3%	1,5%	53,7%
208	Enviromentální biotechnologie	872	0,99	9,4%	2,3%	51,9%
209	Průmyslové biotechnologie	258	0,92	7,0%	2,7%	57,4%
210	Nanotechnologie	1 038	0,75	5,2%	1,4%	68,2%
211	Ostatní technické vědy	2 681	0,87	6,2%	4,1%	48,0%
	Lékařské vědy	**12 836**	**1,58**	**13,7%**	**4,5%**	**56,6%**
301	Základní medicína	5 423	0,92	8,4%	2,5%	47,6%
302	Klinická medicína	6 992	2,04	18,0%	6,6%	59,0%
303	Zdravotní vědy	2 164	1,27	12,3%	1,9%	66,5%
304	Lékařská biotechnologie	-	-	-	-	-
305	Ostatní lékařské vědy	-	-	-	-	-
	Zemědělské vědy	**3 278**	**0,96**	**8,8%**	**1,8%**	**42,3%**
401	Zemědělství, lesnictví a rybářství	1 655	1,28	12,1%	1,9%	49,8%
402	Vědy o zvířatech a mléce	295	0,81	4,1%	1,0%	34,9%
403	Veterinární vědy	482	0,93	9,3%	0,4%	45,2%
404	Zemědělské biotechnologie	-	-	-	-	-
405	Ostatní zemědělské vědy	1 048	0,69	5,3%	2,6%	32,5%
	Sociální vědy	**4 047**	**0,97**	**7,7%**	**0,3%**	**35,0%**
501	Psychologie	730	1,15	7,4%	0,3%	46,0%
502	Ekonomie a podnikání	1 427	0,72	6,0%	0,8%	36,3%
503	Vzdělávací vědy	292	0,59	5,1%	0,0%	23,3%
504	Sociologie	584	0,84	6,8%	0,0%	29,1%
505	Právní vědy	93	0,79	9,7%	0,0%	26,9%
506	Politické vědy	535	0,70	5,0%	0,0%	21,9%
507	Sociální a ekonomická geografie	768	1,18	11,1%	0,0%	35,9%
508	Média a komunikace	132	0,86	9,1%	0,0%	27,3%
509	Ostatní sociální vědy	236	0,77	6,4%	0,0%	33,9%
	Humanitní vědy	**1 822**	**0,83**	**5,7%**	**0,1%**	**8,8%**
601	Historie a archeologie	455	1,65	13,4%	0,0%	15,4%
602	Jazyky a literatura	355	0,66	3,9%	0,3%	7,6%
603	Filozofie, etika a náboženství	703	0,55	2,8%	0,0%	3,1%
604	Umění (umění, historie umění, herecké umění, hudba)	305	1,52	10,2%	0,0%	16,1%
605	Ostatní humanitní vědy	132	1,07	11,4%	0,0%	9,1%

Translation explanation to Table No. 2:

First line: Field code/Field/number of publications/Field normalised citation rate/Share of publications in Top 10% of the world´s most highly citied/401 – Agriculture, forestry and fisheries, 402 – Animal and dairy science, 403 – Veterinary sciences, 404 – Agricultural biotechnology, 405 – Other social sciences

The field-normalised citation rate with value 1 indicates a global average of the citation rate of publications in the given field. The world average citation rate is achieved by publications in the natural sciences, from narrower scientific fields, above-average results are achieved only in physical sciences, agriculture and some fields of social sciences and humanities. The excellence of the R&D results in the field of agriculture, forestry and fishing, compared to the

other fields, is also illustrated by the indicator of the share of publications in the top 10% of the world's most cited, which reaches 12.1% for the field of agriculture, forestry and fishing. Almost half of the publications are created in foreign cooperation. A low rate is achieved in the co-authorship from the business sector (but this rate can be distorted by the method of entering data into the R&D&I IS where the monitoring of this parameter appears problematic, which is implied by the conclusion of the Evaluation of results of research, development and innovation programmes completed in 2018 where the MoA programme CSS 2012-2018 was also evaluated. (Odbor Rady pro výzkum, vývoj a inovace, 2020)).

7.2. Patent activity in the application sectors of the National RIS3

Important findings on the patent activity of actors in agriculture and the related fields are summarised in Table 3 below (Technologické centrum AV ČR, 2020a), in the red frame, which illustrates the number of submitted patents for the sector of agriculture, compared to the other application sectors. Also indicating the submitting entity. The segment of research organisations (mainly governmental and higher-education ones) is very active. But enterprises also show high activity. In the area of food production, the company with the highest number of patent applications in the years 2013-2018 was the Research Institute of Brewing and Malting (10 applications) (Technologické centrum AV ČR, 2020a).

Table No 3: Patent applications filed by applicants from CZ by application sector of the National RIS3, submitted in the years 2015-2017. The patent applications were classified under the application sectors based on their focus. A patent application was included as a whole in a sector if at least one of the applicants was from that sector. Source: EPO Worldwide Patent Statistical Database – autumn 2019, Czech Register of Economic Entities (RES). Taken from (Technologické centrum AV ČR, 2020a), p. 96

Aplikační odvětví	Celkový počet	Výzkumné organizace				Podniky a ostatní
		Celkem	Podniky a PNP	Vládní	VŠ	
Pokročilé stroje a technologie	**1 248,3**	**36,0%**	**5,7%**	**6,9%**	**25,3%**	**70,8%**
Strojírenství a mechatronika	772,2	33,0%	4,9%	3,6%	25,7%	72,2%
Energetika	0,8	41,9%	2,1%	5,2%	35,8%	73,1%
Hutnictví	52,7	58,5%	16,6%	6,1%	35,9%	51,7%
Průmyslová chemie	422,6	38,5%	5,8%	13,2%	23,3%	70,5%
Digitální technol. a elektrotechnika	**876,3**	**36,4%**	**3,1%**	**8,0%**	**27,8%**	**67,5%**
Elektronika a elektrotechnika	243,9	14,2%	0,5%	1,9%	12,0%	87,7%
Digitální ekonomika	632,3	44,9%	4,1%	10,3%	33,9%	59,7%
Dopravní prostředky pro 21. století	**211,0**	**11,3%**	**0,6%**	**1,5%**	**9,2%**	**91,0%**
Automotive	194,8	10,0%	0,6%	1,5%	7,9%	91,7%
Letecký a kosmický průmysl	8,1	26,6%	0,0%	1,2%	25,4%	83,3%
Železniční a kolejová vozidla	8,1	26,6%	0,0%	1,2%	25,4%	83,3%
Péče o zdraví a pokročilá medicína	**781,0**	**46,4%**	**0,8%**	**31,1%**	**21,7%**	**62,2%**
Léčiva, biotechnologie	781,0	46,4%	0,8%	31,1%	21,7%	62,2%
Kulturní a kreativní odvětví	**246,0**	**31,1%**	**2,9%**	**7,4%**	**22,8%**	**80,0%**
Tradiční odvětví	236,2	31,3%	2,7%	7,3%	23,4%	80,2%
Nová odvětví	9,8	24,7%	7,0%	10,2%	7,4%	75,3%
Udržitelné zemědělství a env. odvětví	**202,7**	**49,0%**	**6,7%**	**11,5%**	**34,7%**	**60,4%**
Hospodaření s přírodními zdroji	21,7	32,1%	0,0%	12,3%	19,8%	73,0%
Zemědělství a lesnictví	42,1	46,0%	5,8%	24,1%	20,6%	65,6%
Produkce potravin	33,0	72,7%	18,4%	29,4%	43,1%	57,8%
Životní prostředí a biodiverzita	0,0					
Výstavba a lidská sídla	105,9	46,3%	4,8%	0,8%	40,7%	56,5%
Ostatní obory	**17,7**	**31,0%**	**0,0%**	**1,1%**	**29,9%**	**78,9%**
VaV a vzdělávání	0,0					
Nezařazeno	17,7	31,0%	0,0%	1,1%	29,9%	78,9%
Celkem	**3 583,0**	**37,3%**	**3,5%**	**12,4%**	**24,6%**	**69,4%**

Translation explanation to Table No. 3:

First line: Application sector/Total number/Research organisations – total – Businesses and private non-private – HEIs/Businesses and other/Sustainable agriculture and Envi sectors/Agriculture and forestry/Food production

Another finding to be noted is shown in Table 4 below - the vast majority of the patent applications is submitted by domestic enterprises (this applies to all application sectors except Food production), i.e. not by enterprises under foreign control, the know-how contained in the patent applications is owned by Czech, domestic, enterprises.

Table No 4: Number of patent applications submitted by enterprises in the years 2015-2017 in the National RIS3 application sector 'Sustainable agriculture and environmental sectors'. The enterprises are divided by the ownership structure and by size. Source: EPO Worldwide Patent Statistical Database – autumn 2019, RES, CZSO. Taken from (Technologické centrum AV ČR, 2020a), p. 97

Aplikační odvětví	Podniky	Podniky domácí				Podniky pod zahraniční kontrolou		
	Celkem	Celkem	Malé	Střední	Velké	Celkem	MSP	Velké
Udržitelné zemědělství a env. odvětví	**227,0**	**78,9%**	**12,6%**	**31,7%**	**30,8%**	**23,2%**	**6,9%**	**15,9%**
Hospodaření s přírodními zdroji	14,2	79,8%	6,9%	32,0%	35,5%	23,2%	11,1%	12,0%
Zemědělství a lesnictví	12,6	95,5%	7,2%	69,3%	19,0%	8,7%	7,1%	1,7%
Produkce potravin	81,1	67,1%	18,6%	13,8%	31,5%	34,5%	8,7%	25,2%
Životní prostředí a biodiverzita	29,5	87,1%	8,3%	25,6%	45,4%	14,5%	5,7%	8,2%
Výstavba a lidská sídla	89,6	84,5%	10,2%	44,7%	26,3%	17,8%	5,1%	12,6%

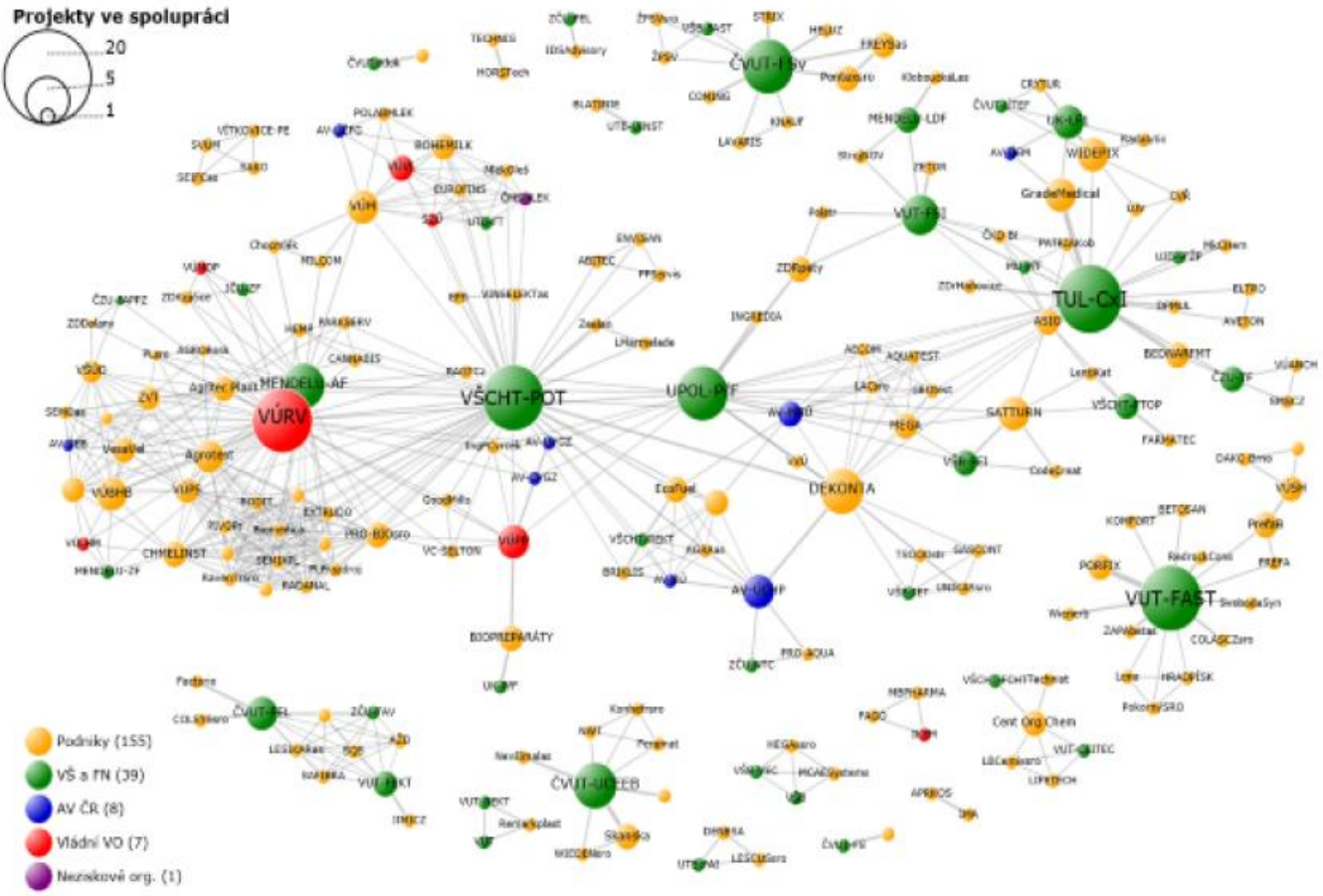
Translation explanation to Table No. 4:

First line: Application sector/Enterprises Total/Domestic enterprises – Total – Small – Medium-sized – Large/Foreign-controlled enterprises – Total – SMEs – Large/Sustainable agriculture and Envi sectors/Natural resources management/Agriculture and forestry/Food production/Environment and biodiversity/Construction and human settlement

The table demonstrates that in the application sector 'Sustainable agriculture and environmental sectors', domestic enterprises are the applicants in nearly 80% of the patent applications. Enterprises under foreign control have the highest representation in patent applications in application sector 'Food production' (approx. a third).

7.3. Map of the main identified actors of cooperation between ROs and enterprises

Figure No 1: Map of cooperation with enterprises in the key sector Sustainable agriculture and environmental sectors, in R&D&I projects supported in the years 2015-2018. Source: R&D&I IS Taken from: (Technologické centrum AV ČR, 2020a), p. *86*



Translation explanation to Figure No. 1:

Projects in cooperation: Enterprises (155)/HEIs and university hospitals (39)/CAS (8)/Governmental Ros (7)/NGOs (1)

The Summary Report of the CAS Technology Centre (Technologické centrum AV ČR, 2020b) states that: "Although a relatively small number of enterprises active in research and with not high R&D expenditure operate in the agriculture- and environment-focused application sectors, there is a relatively strong knowledge base for such R&D in ROs managed by the Ministry of Agriculture and in some ROs of the business sector. Another favourable factor for implementing R&D&I support tools in this vertical priority is the broad knowledge and research base in the public sector (mainly HEIs). As most projects involving enterprises are implemented in cooperation with ROs, there is potential for implementing R&D projects in which enterprises (including enterprises without experience in R&D) will cooperate with ROs and use the results of the R&D" (p. 58).

7.4. Summary of findings and the main trends in the application sectors

The following drivers have been identified as influencing the developments in the application sector (again narrowed down to the relevant application sector) (Technologické centrum AV ČR, 2020b):

- The expanding application of advanced technologies (including biotechnology) and materials (including biomaterials and nanomaterials) in agriculture, food production, environmental protection and other sectors;
- Development of digital technologies (including ICT and artificial intelligence) and their use in all application sectors of this vertical priority;
- Expanding implementation of systems using automation of agricultural activities (Agriculture 4.0, precision agriculture);
- Climate change and the impact of a changing climate on the landscape, farming, use of natural resources and the environment;
- Sustainable development, use of materials from renewable sources and secondary raw materials, minimization of negative impacts of human activities on the environment;
- Reducing energy consumption and optimizing energy consumption;
- Increasing demands on food safety and quality, expanding application of new digital technologies (including artificial intelligence and robotics) in food production and food supply.

The overview table below provides a summary of the most important findings regarding R&D activities in the key sector Sustainable agriculture and the environmental sectors - for the purposes of the analysis, only the application sectors relevant for the R&D&I Strategy of MoA 2023+ have been selected, i.e. natural resource management, agriculture and forestry and food production. The table also indicates significant research directions in these application sectors.

Summary of the most important findings of the R&D Sectoral Analysis (R&D&I of enterprises)

	Natural resources management		Agriculture and forestry		Food production	
	Strengths	**Weaknesses**	**Strengths**	**Weaknesses**	**Strengths**	**Weaknesses**
R&D focus and quality	- relatively high number of publications **- representation of publications in the total number is higher than abroad** **- publication activity is increasing** **- citation rate of publications at the global average**	- lower number of publications in cooperation with businesses	**- number of publications is rising** **- globally above-average citation rate and quality of publications**	- low number of publications - lower share of publications made in cooperation with businesses, their share is decreasing - relatively low share of publications made in international cooperation	- very high number of publications - citation rate is rising	- publication activity is decreasing - field normalised citation rate of publications is just below the global average
Public support for R&D and cooperation of businesses with ROs	- developed cooperation of enterprises with ROs (most projects with business participation are implemented in cooperation with ROs)	- businesses in the application sector obtain low public support for R&D&I projects	- developed cooperation of enterprises with ROs (most projects with business participation are implemented in cooperation with ROs)	- low public support for enterprises in R&D&I programmes	- relatively higher public support obtained by enterprises in the application sector - public support of enterprises in R&D&I projects is increasing - more than 80% of projects with business participation are implemented in cooperation with ROs	
Patent activity of businesses	**- patent applications in the area, originating in CZ, are filed by CZ entities that are mostly domestic enterprises**	- low number of patent applications, low patent activity of businesses	**- higher number of patent applications filed by ROs (HEIs and ROs of the governmental sector)** **- patent applications in the area, originating in CZ, are filed by CZ entities that are mostly domestic enterprises**	- lower number of pat. applications in the area - low patent activity of businesses operating in the application sector	- high number of patent applications focused on food production - higher number of patent applications focused on food production and filed by ROs (mainly HEIs) - more than 2/3 of patent applications of businesses in food production filed by domestic enterprises (mainly large and medium-sized) - number of pat. applications is growing	- more than half of pat. applications originating in CZ are filed by enterprises based abroad or foreign-controlled enterprises
Focus of R&D activities	Research directions in the application sectors from analyses: The R&D focus has several more prominent directions - water resources (management, water reserves, surface water, water protection); planting (seeds) and crops; forest plantations and their protection and regeneration; soil, tillage, soil erosion and its management; agricultural mechanisation and agricultural machinery. Attention is also paid to climate change. Research directions in the application sectors, defined by National Innovation Platforms: - R&D focused on sustainable use of natural resources and biodiversity - R&D of farming systems and land fund protection - R&D focused on environmental protection - R&D of adaptation measures to reduce negative impacts of climate change - R&D of non-food production (biomass, recycled and degradable materials) - R&D focused on precision agriculture - R&D of technologies for Agriculture 4.0.		Research directions in the application sectors from analyses: R&D in projects of enterprises operating in application sector Sustainable agriculture and forestry is focused on planting and seed production, fruit trees and fruit production, forest stands (trees) and forest ecosystems. Another R&D area is livestock and fish (carp) farming. The research directions include mechanisation, mainly machines for hop sorting, collecting and picking. R&D is also focused on genetics (molecular) and genetic resources. There is a growing number of R&D projects on climate change and soil erosion. Research directions in the application sectors, defined by National Innovation Platforms: - R&D focused on genetics and genomics, plant breeding - R&D of modern biotechnologies in agriculture and forestry and their use - R&D of forest ecosystems and forestry - R&D focused on plant and livestock production - R&D of systems of controlling agricultural vehicles, remote sensing and monitoring - R&D of climate change adaptation		Research directions in the application sectors from analyses: R&D of enterprises operating in this application sector is focused mainly on food products. Attention is paid to dairy products, wheat products and special foods such as gluten-free foods or healthy diet. R&D deals with production technologies (including the use of nanotechnologies), food supply, quality and safety. Research directions in the application sectors, defined by National Innovation Platforms: - R&D of technologies for food production and analytical methods for food production etc. - R&D focused on sustainable production of non-hazardous and high-quality food - R&D of nanotechnologies and products using nanotechnologies - R&D of food composition and its impact on human health - R&D focused on hygiene and sanitation.	

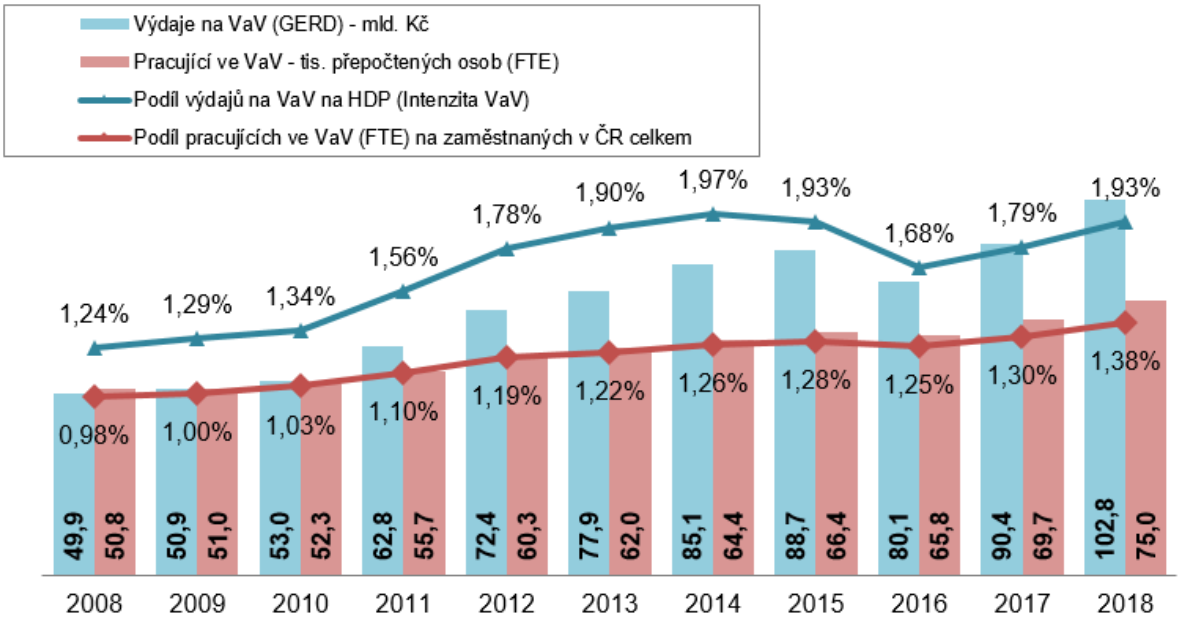
Annex 8 Analysis of trends in the development of financial support for agricultural research in CZ and abroad by source of support

8.1. Basic information on research and development in CZ for 2018

Total R&D expenditure in CZ, according to a summary analysis by CZSO for 2018 (ČSÚ, 2019), has grown in the mid-term perspective, in 2018, a record CZK 102.8 bil. was spent on R&D carried out in CZ. In relation to GDP, R&D expenditure increased to 1.93%, and CZ thus approached the EU average. Business resources contributed the most to the year-on-year increases in total R&D&I expenditure in the monitored period. R&D expenditure from business sources amounted to almost CZK 60 billion (i.e. a year-on-year increase by 11.3%), from public domestic sources it reached a record CZK 35 billion (i.e. a year-on-year increase by 11.2%). Most of the state's funds are directed to R&D&I support in the public sector. Almost 50% (CZK 16.8 billion) went to higher education research, the state contributed a total of CZK 13.6 billion to the government sector. The state spent over CZK 400 million more than in 2017 to support corporate research, the total in 2018 was almost CZK 4.5 billion.

The amount of public foreign resources reached CZK 6.6 billion in 2018, which accounted for 6% of R&D&I expenditure in CZ (there was a year-on-year increase by approximately 50%). The majority of EU funding went to the higher education sector, followed by the government sector. Less than a quarter (CZK 1.6 billion) was directed towards corporate research.

Chart No 3: Research and development in CZ - basic indicators of R&D&I expenditure according to CZSO



Translation explanation to Chart No 3:

R&D expenditure (GERD) - CZK bil/ R&D workers - ths of FTEs/ Share of R&D expenditure in GDP (R&D intensity)/ Share of R&D workers (FTE) in employed persons in CZ, total

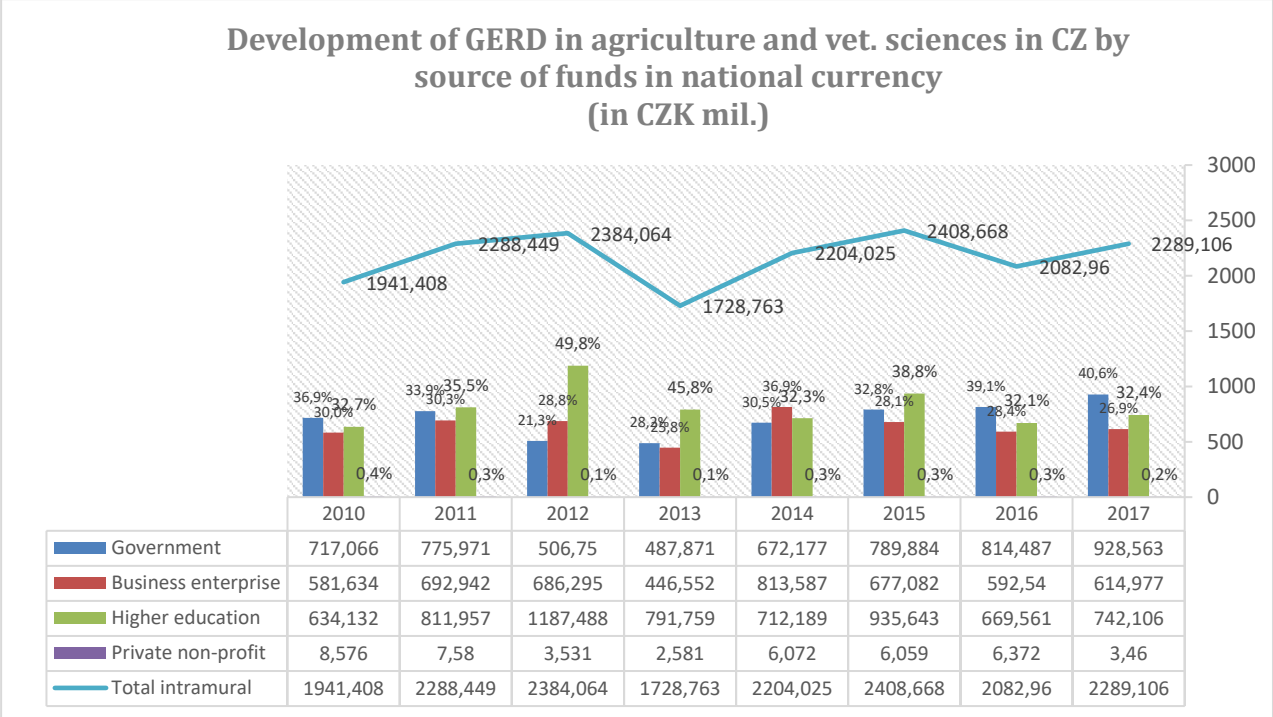
The increase in R&D spending in recent years was mainly reflected in rising wages. These make up more than half of the funds spent on R&D, in 2018 it was a total of CZK 54.3 billion.

While investment expenditure in recent years has only accounted for a tenth of the R&D expenditure.

8.2. GERD in agriculture and veterinary sciences in CZ and in an international comparison

According to the OECD database of statistical data in the field of science and technology (iLibrary, 2020), filtered specifically for the area of R&D&I in agriculture and veterinary sciences in the Czech Republic, the total GERD tends to fluctuate between a maximum of CZK 2,408.7 million in 2015 and a minimum of CZK 1,728.8 million in 2013. The data are available up to 2017, when GERD reached CZK 2,289.1 million. Chart 2 below shows the structure of the expenditure also by source of funds. The chart indicates that the spending of the sector of government research organizations has again been on the rise since 2013, corporate expenditure on R&D&I oscillates over time around the average level of CZK 630 million. The research expenditure by higher education moves around the average value of CZK 810 million per year.

Chart No 4: Total R&D&I expenditure in CZ in agriculture and veterinary sciences, in CZK mil., over the period 2010 - 2017 by source of funds



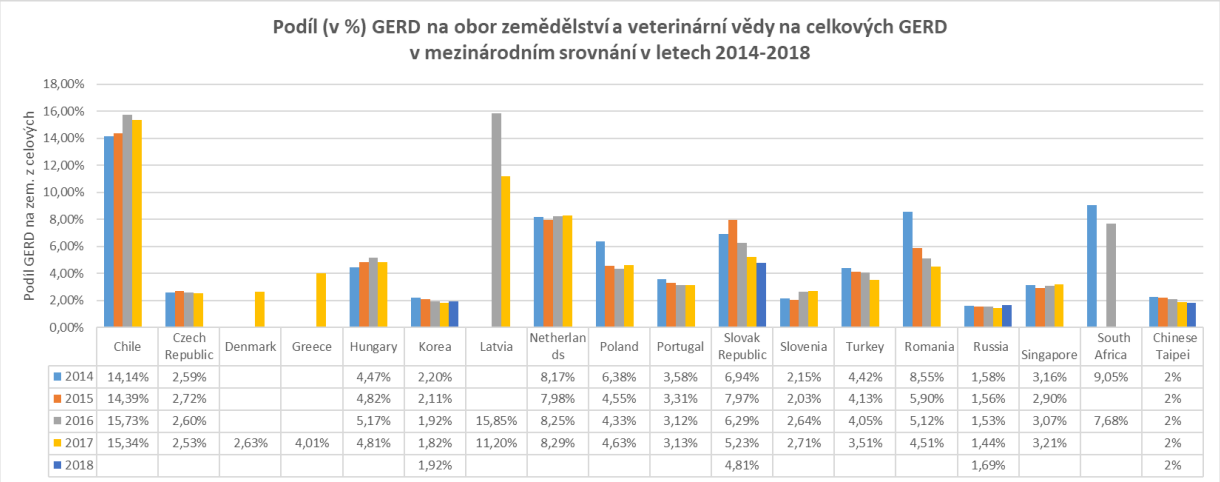
	2010	2011	2012	2013	2014	2015	2016	2017
Government	717,066	775,971	506,75	487,871	672,177	789,884	814,487	928,563
Business enterprise	581,634	692,942	686,295	446,552	813,587	677,082	592,54	614,977
Higher education	634,132	811,957	1187,488	791,759	712,189	935,643	669,561	742,106
Private non-profit	8,576	7,58	3,531	2,581	6,072	6,059	6,372	3,46
Total intramural	1941,408	2288,449	2384,064	1728,763	2204,025	2408,668	2082,96	2289,106

Chart 5 below, drawing on the same data from the OECD database (iLibrary, 2020), including own calculations, shows an international comparison (in countries where data are available specifically for GERD in agriculture and veterinary sciences) of the ratio of expenditure on this field of research to total R&D&I expenditure in the years 2014-2017 (where data are available, also in 2018).

The average ratio of the expenditures in 2017 for the countries below is 4.76%, the median is 3.51%. The Czech Republic with its expenditure on the given area of research at 2.53% of the

total R&D&I expenditure in 2017 ranks among the countries with the lowest GERD in the field of agriculture and veterinary sciences.

Chart No 5: Ratio of GERD on research in agriculture and veterinary sciences to the total GERD in an international comparison in the years 2014-2018



	Chile	Czech Republic	Denmark	Greece	Hungary	Korea	Latvia	Netherlands	Poland	Portugal	Slovak Republic	Slovenia	Turkey	Romania	Russia	Singapore	South Africa	Chinese Taipei
2014	14,14%	2,59%			4,47%	2,20%		8,17%	6,38%	3,58%	6,94%	2,15%	4,42%	8,55%	1,58%	3,16%	9,05%	2%
2015	14,39%	2,72%			4,82%	2,11%		7,98%	4,55%	3,31%	7,97%	2,03%	4,13%	5,90%	1,56%	2,90%		2%
2016	15,73%	2,60%			5,17%	1,92%	15,85%	8,25%	4,33%	3,12%	6,29%	2,64%	4,05%	5,12%	1,53%	3,07%	7,68%	2%
2017	15,34%	2,53%	2,63%	4,01%	4,81%	1,82%	11,20%	8,29%	4,63%	3,13%	5,23%	2,71%	3,51%	4,51%	1,44%	3,21%		2%
2018						1,92%					4,81%				1,69%			2%

Translation explanation to Chart No 5:

Ratio (in %) of GERD on research in agriculture and veterinary sciences to the total GERD in an international comparison in the years 2014 – 2018 – Share of GERD on agriculture in total GERD

8.3. Number of R&D facilities in the area of agriculture, and human resources in agricultural research

According to the latest CZSO data (for 2019) (ČSÚ, 2020a), provided in Table 5 below, there are 177 research facilities in CZ with agriculture as the prevailing area of their activities (which is 5.5% of all R&D entities in the CZSO statistics in 2019), of that 137 belong to the business sector (made up of 125 private domestic enterprises and 7 private foreign enterprises), 24 to the government sector and 8 to the higher education sector. The highest share (46%) of those entities spend annually less than CZK 1 mil. on R&D, 33% of the entities spend CZK 1-9.9 mil. on R&D, 15% of them spend CZK 10-49.9 mil. and 6% (10 entities in absolute terms) spend CZK 50 mil. and more. These are mostly small research facilities, nevertheless, there are also 10 large entities working on the area of agriculture and vet. sciences, with expenditure of over CZK 50 mil. a year. It is worth pointing out that the enterprises involved in R&D in agriculture are predominantly private domestic enterprises.

Table No 5: R&D facilities by type and by prevailing area of science (CZSO data for R&D for 2019)

rok 2019

Sektor provádění VaV, druh pracoviště	Vědní oblast					
	Přírodní	Technické	Lékařské	Zemědělské	Sociální	Humanitní
Podnikatelský	**539**	**1 904**	**83**	**137**	**41**	**-**
Veřejné podniky	15	36	2	5	1	-
Soukromé podniky domácí	433	1 397	58	125	29	-
Soukromé podniky zahraniční	91	471	23	7	11	-
Vládní	**57**	**11**	**24**	**24**	**15**	**79**
Pracoviště AV ČR	39	1	2	-	5	13
Ostatní veřejné výzk. instituce	5	1	2	19	3	2
Knihovny, archivy, muzea	2	1	-	1	3	60
Zdravotnická zařízení	1	-	19	-	-	-
Ostatní	10	8	1	4	4	4
Vysokoškolský	**43**	**52**	**29**	**8**	**61**	**32**
Veřejné a státní vysoké školy	41	52	17	8	43	31
Fakultní nemocnice	-	-	10	-	-	-
Soukromé vysoké školy	2	-	2	-	18	1
Soukromý neziskový	**17**	**13**	**3**	**8**	**31**	**3**
ČR celkem	**656**	**1 980**	**139**	**177**	**148**	**114**

Pozn.: Každé pracoviště VaV má přiřazenu pouze 1 vědní oblast, i když může provádět VaV ve více vědních oblastech.

Translation explanation to Table No 5:

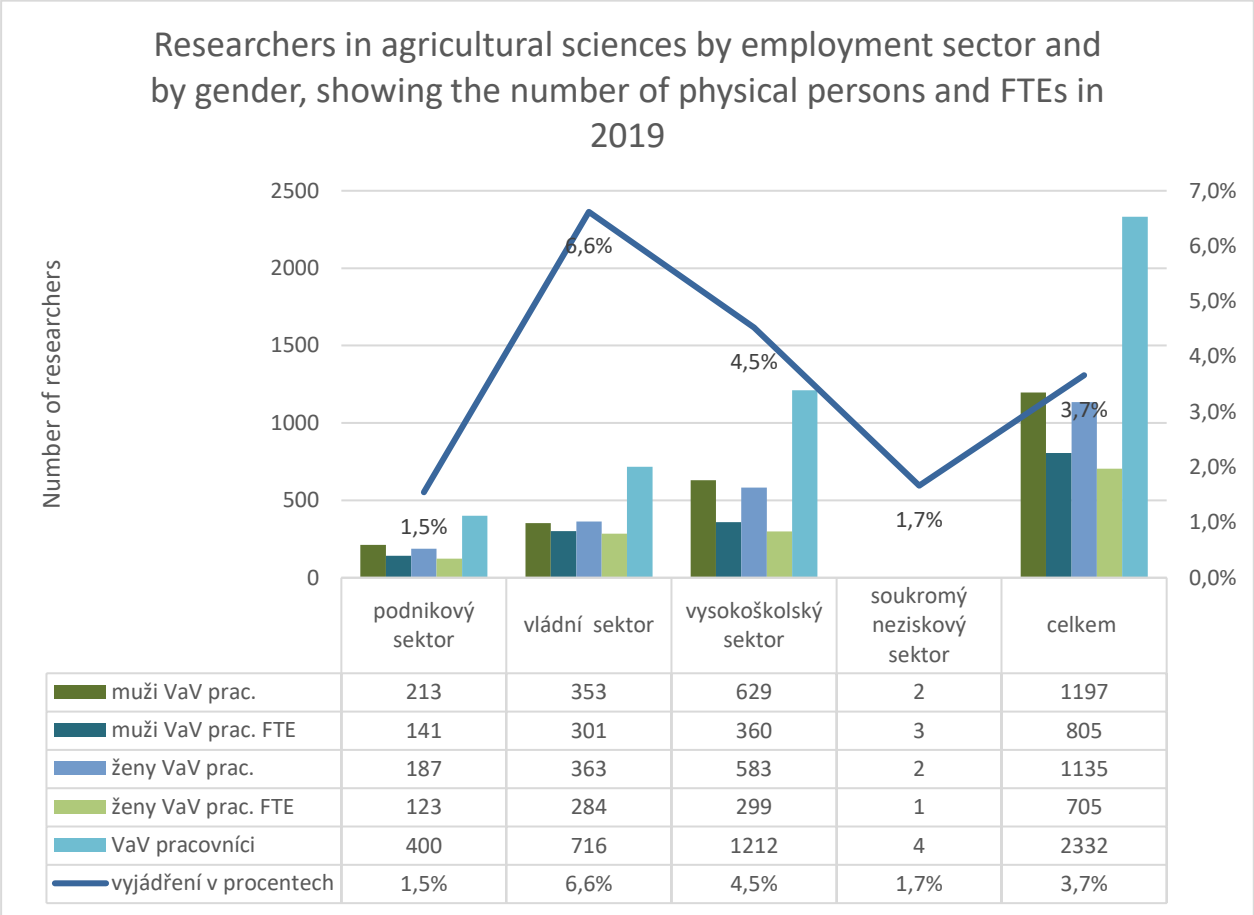
R&D sector, type of facility – Area of science/Natural/Technical/Medical/Agricultural/Social/Humanities

Business: Public enterprises/Private domestic enterprises/Private foreign enterprises/Governmental/CAS facilities/Other public research institutions/Libraries, archives, museums/Healthcare facilities/Other/Higher education/Public and state HEIs/University hospitals/Private HEIs/Private non-profit/CZ Total

According to data from the Register of Research Results, research results were registered in the period 2005-2020 in the scientific field of agriculture and veterinary sciences (according to OECD classification) by 128 entities, of that 34 were from the business sector, 37 from the government sector, 54 from the higher education sector (i.e. faculties of HEIs, if we look at HEIs as such, results were registered by 20 different HEIs) and 3 from the non-profit sector.

In terms of the number of researchers in the field of agricultural sciences according to the CZSO data for 2019 (ČSÚ, 2020a), the fields employs 3.7% of all researchers, in absolute terms this is 2 332 persons, which equals to 1 510 full-time equivalents (FTEs), as shown in Chart 6 below. Out of the number of researchers, 17% of them work in the business sector, 31% in the government sector, 52% in the higher education sector, and less than one percent in the non-governmental non-profit sector. The difference in the representation of men and women among researchers in agricultural sciences is not as prominent as in the other fields of science. Women make up 46.75% of researchers in the business sector, 50.69% in the government sector, 48.10% in the higher education sector, and 50% in the non-governmental non-profit sector.

Chart No 6: Overview of the number of researchers in agricultural sciences by employment sector and by gender, showing the number of physical persons and FTEs in 2019 (taken from CZSO data on R&D&I in 2019, own calculation for the agricultural R&D)



	podnikový sektor	vládní sektor	vysokoškolský sektor	soukromý neziskový sektor	celkem
muži VaV prac.	213	353	629	2	1197
muži VaV prac. FTE	141	301	360	3	805
ženy VaV prac.	187	363	583	2	1135
ženy VaV prac. FTE	123	284	299	1	705
VaV pracovníci	400	716	1212	4	2332
vyjádření v procentech	1,5%	6,6%	4,5%	1,7%	3,7%

Translation explanation to Chart No 6:

Business sector/Governmental sector/Higher education sector/Private non-profit sector/Total

Male R&D workers/ Male R&D workers FTE/ Female R&D workers/ Female R&D workers FTE/ R&D workers/ expressed as a percentage

8.4. Development of public national expenditure on R&D&I in agriculture in the Czech Republic, in relation to national expenditure on R&D&I in all fields

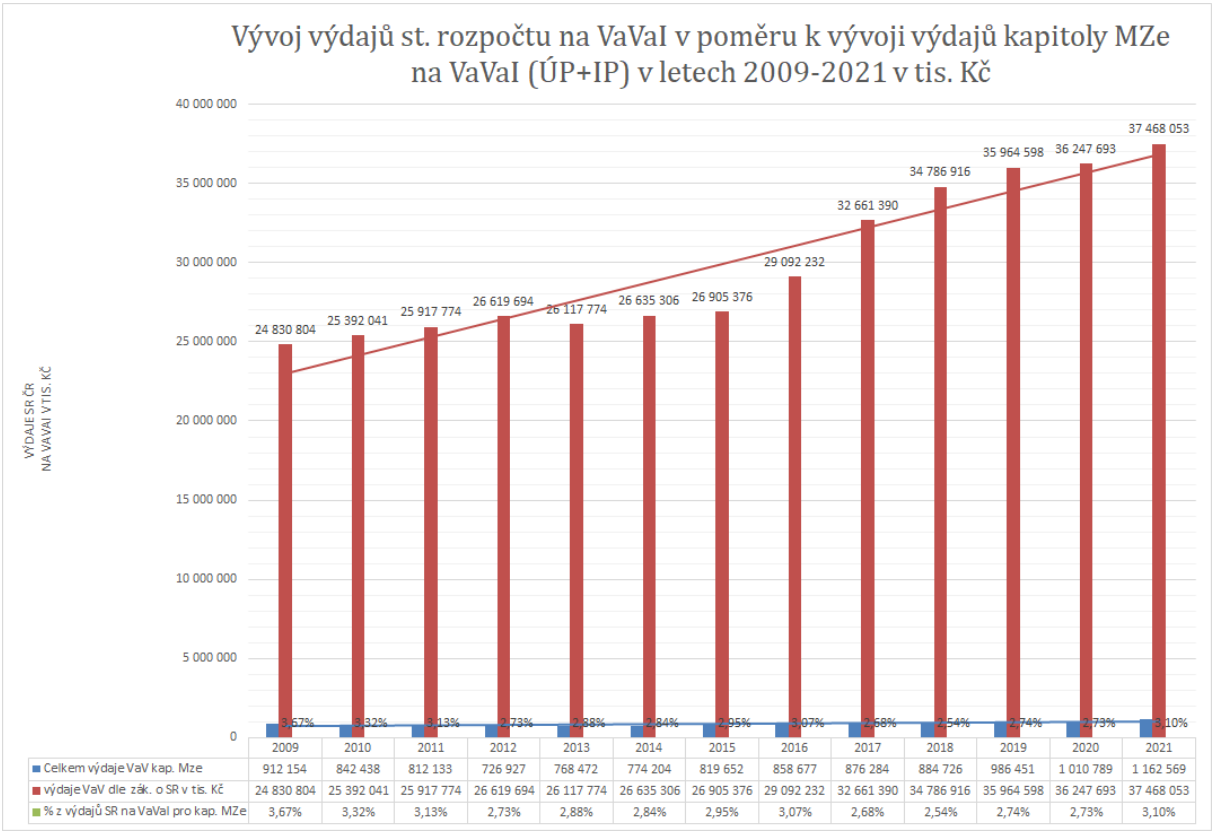
In 2018, total R&D **expenditure from public sources** represented 0.78% of GDP. In 2009-2018, the share of R&D expenditure financed from public sources in CZ ranged from 0.59 to 0.66% of GDP (ČSÚ, 2019).

According to CZSO data, state budget expenditure in the area of agriculture (broken down by the main socioeconomic objectives of NABS 2007) in 2009–2019 accounted for 4-5% of total budget expenditure on research and development. Specifically, in the period 2009-2010, it was 5%, and in the period 2011-2019 it was 4% of the expenditure.

8.4.1 Development of R&D&I expenditure by Ministry of Agriculture, in years

The **development of public national R&D&I expenditure** and the share of public national R&D&I expenditure from the budget chapter of the Ministry of Agriculture in the years 2009-2021 is shown in Chart 7 below. While public national R&D&I expenditure is continuously growing, the share of this expenditure on R&D&I of the Ministry of Agriculture fluctuates between 3.67% in 2009 (the highest share of the expenditure on agriculture in the last decade) and 2.54% in 2018 when the support reached its lowest level for the period under review. The current level of R&D support in the agricultural sector from national public sources is below the 3% share, with the prospect of exceeding this milestone in 2021 (for the first time since 2012).

Chart No 7: Development of state budget expenditure on R&D&I in a ratio to the total R&D&I expenditure of MoA, in the years 2009-2021, in CZK ths



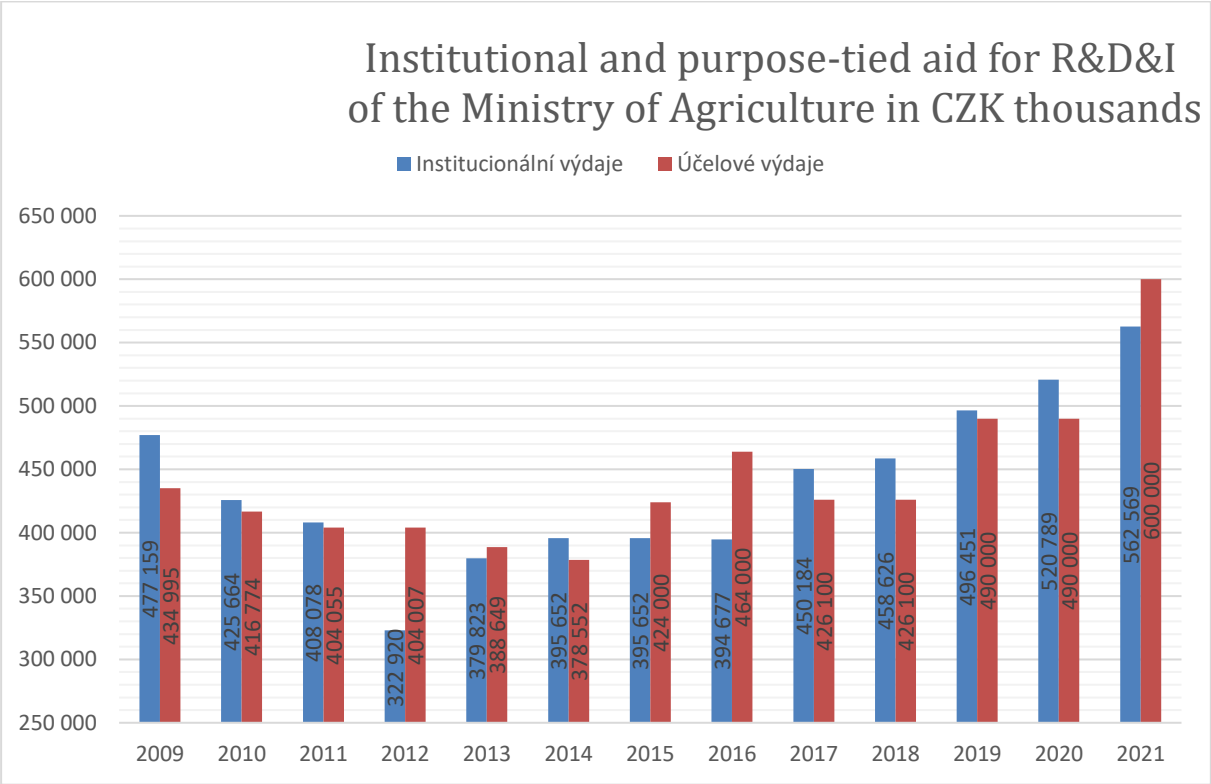
	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Celkem výdaje VaV kap. Mze	912 154	842 438	812 133	726 927	768 472	774 204	819 652	858 677	876 284	884 726	986 451	1 010 789	1 162 569
výdaje VaV dle zák. o SR v tis. Kč	24 830 804	25 392 041	25 917 774	26 619 694	26 117 774	26 635 306	26 905 376	29 092 232	32 661 390	34 786 916	35 964 598	36 247 693	37 468 053
% z výdajů SR na VaVaI pro kap. MZe	3,67%	3,32%	3,13%	2,73%	2,88%	2,84%	2,95%	3,07%	2,68%	2,54%	2,74%	2,73%	3,10%

Translation explanation to Chart No 7:

Development of state budget expenditure on R&D&I in a ratio to R&D&I expenditure of MoA (PTA+IA), in the years 2009 – 2021, in thousands of CZK

Chart 8 below illustrates the development of national public R&D&I expenditure of the MoA, broken down to purpose-tied and institutional aid of MoA in the years 2009-2021. Since 2018 (after a sharp decrease of the R&D&I expenditure in 2012), the expenditure on both instruments of R&D&I support has tended to grow slightly, with fluctuations.

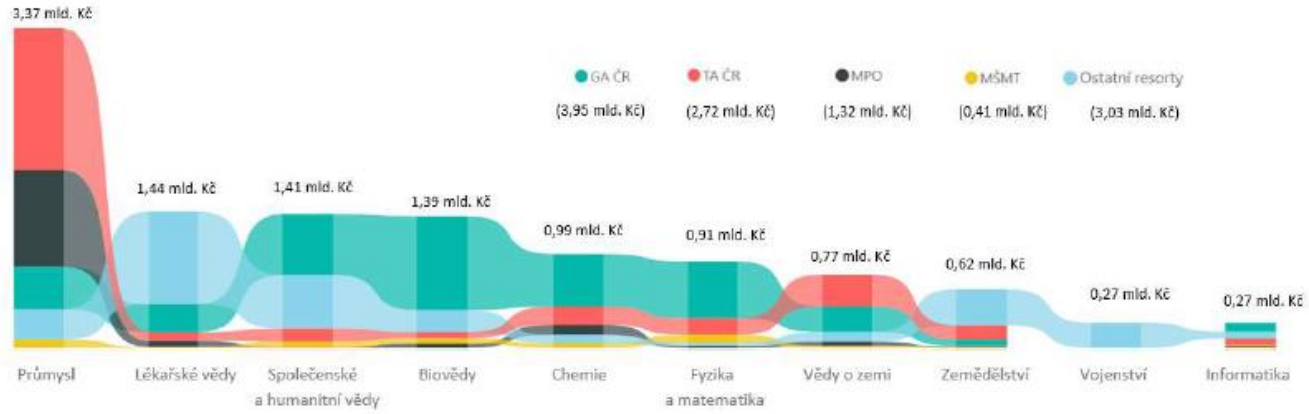
Chart No 8: Trend of institutional and purpose-tied aid provided by MoA in the period 2009-2021



8.4.2 Sources of purpose-tied aid in CZ for R&D&I in agriculture

Chart 9 below (RVVI, 2020) indicates that agricultural research is supported through national programmes of purpose-tied aid also by aid providers other than MoA, mainly the Grant Agency of CZ and the Technology Agency of CZ. It should be noted that purpose-tied aid provided by MoA thematically reaches beyond agriculture and overlaps with other areas (esp. bioscience, earth sciences, chemistry etc.). In 2018, purpose-tied aid for agriculture reached CZK 0.62 bil., the third lowest next to purpose-tied aid for the military and informatics.

Chart No 9: Purpose-tied aid from the state budget for projects in field groups in 2018 by provider (in CZK bil.)



Zdroj: IS VaVaI, export 1. 8. 2019

Translation explanation to Chart No 9:

Industry/Medical and health sciences/Social sciences and humanities/Biosciences/Chemistry/Physics and mathematics/Earth sciences/Agriculture/Military/Informatics

Source: R&D&I IS, exported on 01.08.2019

8.5. Foreign public sources for R&D&I support in agriculture

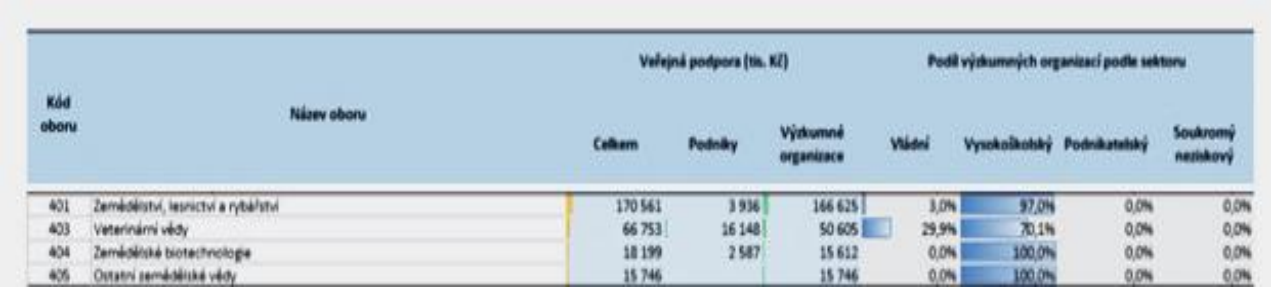
Foreign public sources represent a significant component of the financing of Czech research and development, in the case of CZ, they are made up mainly of income from EU Structural Funds used for financing through operational programmes. Public foreign sources also include other EU budget sources (these are mainly research framework programmes - currently Horizon Europe) and resources from international, governmental and public organizations outside the EU (CERN, ILL, ESA, NATO, OECD, UN, WHO, Norway funds/EEA, etc.) (RVVI, 2020).

8.5.1 Support for R&D&I in agriculture from operational programmes co-financed from the European Structural and Investment Funds (ESIF), used by Czech entities

For the period 2014-2020, the **European Regional Development Fund** earmarked EUR 2.4 bil. for CZ R&D&I to address key problems. The funding is distributed via operational programmes **OP Research, Development and Education (OP RDE), OP Enterprise and Innovation for Competitiveness (OP EIC) and OP Prague - Growth Pole of the Czech Republic** (RVVI, 2020)**.**

According to the Sectoral Analysis of the Technology Centre of CAS (Technologické centrum AV ČR, 2019), the field of agricultural sciences was supported with only 1.7% of the total volume of support for R&D from OP RDE and OP EIC in the period 2015-2018. Out of that amount, the vast majority of the funding went to higher education R&D&I if we do not consider support for veterinary sciences separately. Enterprises received only minimum support (0.3% for agriculture, forestry and fisheries, and 1.2% for veterinary sciences).

Figure No 3: Public support for R&D from OP RDE and OP EIC in the period 2015-2018 by fields of science (according to the Frascati manual) broken down to types of recipients. Source: CRP of R&D&I IS. Taken, and shortened for the field of agriculture, from the Sectoral Analysis of R&D in CZ by the Technology Centre of CAS, April 2020, p. 55



Kód oboru	Název oboru	Veřejná podpora (tis. Kč)			Podíl výzkumných organizací podle sektoru			
		Celkem	Podniky	Výzkumné organizace	Vládní	Vysokoškolský	Podnikatelský	Soukromý neziskový
401	Zemědělství, lesnictví a rybářství	170 561	3 936	166 625	3,0%	97,0%	0,0%	0,0%
403	Veterinární vědy	66 753	16 148	50 605	29,9%	70,1%	0,0%	0,0%
404	Zemědělské biotechnologie	18 199	2 587	15 612	0,0%	100,0%	0,0%	0,0%
405	Ostatní zemědělské vědy	15 746		15 746	0,0%	100,0%	0,0%	0,0%

Translation explanation to Figure No 3:

Public support (thousands CZK)/Share of research organisations by sector/Field code/Field name/Total/Enterprises/Research organisations/Governmental/Higher education/Business/Private non-profit

Agriculture, forestry and fisheries/Veterinary sciences/Agricultural biotechnology/Other agricultural sciences

8.5.2 Support for R&D&I from EU framework programme Horizon 2020, used by Czech entities

Another tool for supporting R&D&I from European funding is the **EU framework programme for research and innovation Horizon 2020**, implemented from 2014. Its budget is over EUR 77 bil., the EURATOM programme has a budget of EUR 1.6 bil. The applicants for funding from Horizon 2020 are exposed to global competition and so it is more complicated to obtain its funding than the funding from operational programmes co-financed by ESIF. Analytical studies of the European Commission and of the CAS Technology Centre show that CZ ranks among EU Member States with one of the lowest participations in Horizon 2020.

If we compare the financial and project success rate of CZ and Austria, both countries have similar levels of project success rate (CZ: 14.6%; AT: 16.7%). However, Austria submits for assessment nearly 60% more project applications than CZ, which reflects in the total amount recommended for financing, which is almost 4.3 times higher in Austria. According to the data available, Austria has obtained support of CZK 31.4 billion while CZ received only CZK 7.3 bil. The low participation of CZ in Horizon 2020 is caused by the low involvement in the preparation of project proposals.

A more detailed structural analysis of the CZ success in the priority areas and societal challenges of Horizon 2020 shows that the CZ participation in comparison with the other European countries is successful (or above average) in INFRA priorities (i.e. Horizon 2020 Pillar 1 Excellent science, its core area 4 European research infrastructures including e-infrastructures), and in ICT (i.e. Horizon 2020 Pillar 2 Industrial leadership, its area 1 Leadership in enabling and industrial technologies – development of the EU's global leadership in breakthrough and industrial technologies in the 1st direction, namely information and communications technologies) and in the societal challenges FOOD (Societal Challenges SC2 – Food security, sustainable agriculture and forestry, marine research and bioeconomy) and SOCIETY (SC5 – Climate protection, environment, resource efficiency and raw materials). This is illustrated by Figure 4 below.

Figure No 4: Participant and financial success rate of CZ compared to EU-12 and EU-15 in priority areas and societal challenges of Horizon 2020 (Technologické centrum AV ČR, 2019a)

Pilíř/horizontální oblast	Téma H2020	Oblast H2020	Účastnická úspěšnost (%)			Oblast H2020	Finanční úspěšnost (%)		
			CZ	EU-12	EU-15		CZ	EU-12	EU-15
EC	EU.0.	CROSST	4,6	2,7	5,8	CROSST	3,5	2,8	6,0
EXCELENTNÍ VĚDA	EU.1.1.	ERC	8,7	4,6	12,2	ERC	10,2	4,9	11,9
	EU.1.2.	FET	6,9	7,0	9,2	FET	5,5	5,1	9,0
	EU.1.3.	MSCA	8,5	11,7	11,9	MSCA	7,6	8,6	10,4
	EU.1.4.	INFRA	51,6	42,9	39,2	INFRA	45,5	30,1	41,9
VEDOUCÍ POSTAVENÍ V PRŮMYSLU	EU.2.0.	INDLEAD-CROSST	0,0	13,3	11,7	INDLEAD-CROSST	0,0	15,3	8,1
	EU.2.1.1.	LEIT-ICT	18,3	10,0	15,4	LEIT-ICT	13,9	9,5	15,3
	EU.2.1.2.	LEIT-NMP	3,5	6,7	11,9	LEIT-NMP	3,0	7,2	10,6
	EU.2.1.3.	LEIT-ADVMAT	21,3	29,1	33,1	LEIT-ADVMAT	21,5	28,4	31,7
	EU.2.1.4.	LEIT-BIOTECH	12,0	10,8	15,0	LEIT-BIOTECH	18,5	10,6	14,9
	EU.2.1.5.	LEIT-ADVMANU	12,9	12,0	15,9	LEIT-ADVMANU	8,5	11,2	15,3
	EU.2.1.6.	LEIT-SPACE	15,3	14,2	19,6	LEIT-SPACE	10,4	7,8	20,2
	EU.2.2.	RISKFINANCE	0,0	5,6	12,4	RISKFINANCE	0,0	10,8	12,6
	EU.2.3.	INNOSUPSME	11,0	17,0	13,3	INNOSUPSME	4,8	2,8	5,7
SPOLEČENSKÉ VÝZVY	EU.3.0.	SOCCHAL-CROSST			100,0	SOCCHAL-CROSST			100,0
	EU.3.1.	HEALTH	13,0	9,9	15,4	HEALTH	10,9	6,7	13,7
	EU.3.2.	FOOD	24,9	19,0	22,8	FOOD	20,6	15,0	20,3
	EU.3.3.	ENERGY	17,8	14,2	18,1	ENERGY	16,5	9,8	18,1
	EU.3.4.	TPT	30,9	21,3	33,1	TPT	39,0	16,5	35,0
	EU.3.5.	ENV	14,5	17,5	23,8	ENV	14,2	14,0	21,4
	EU.3.6.	SOCIETY	8,9	6,7	8,6	SOCIETY	7,4	5,6	8,4
	EU.3.7.	SECURITY	8,9	13,1	13,4	SECURITY	6,4	8,8	12,1
ŠÍŘENÍ EXCELENCE A PODPORA ÚČASTI	EU.4.0.	SEAWP-CROSST	40,0	81,3	81,4	SEAWP-CROSST	40,3	77,6	78,7
	EU.4.a.	WIDESPREAD	30,8	20,1	19,1	WIDESPREAD	31,6	26,7	29,0
	EU.4.b.	TWINING	8,4	7,9	9,3	TWINING	8,9	8,7	9,7
	EU.4.c.	ERA	16,7	13,0	17,4	ERA	18,0	13,4	17,4
	EU.4.e.	INTNET			100,0	INTNET			100,0
	EU.4.f.	NCPNET	100,0	100,0	100,0	NCPNET	100,0	100,0	100,0
VĚDA VE SPOLEČNOSTI A PRO SPOLEČNOST	EU.5.0.	SWAFS-CROSST	100,0	100,0	69,6	SWAFS-CROSST	100,0	100,0	49,0
	EU.5.a.	CAREER	9,8	8,5	7,5	CAREER	5,7	6,6	6,6
	EU.5.b.	GENDEREQ	14,0	8,7	14,7	GENDEREQ	16,7	8,4	15,7
	EU.5.c.	INEGSOC	4,1	9,3	10,3	INEGSOC	1,9	7,3	9,7
	EU.5.d.	SCIENCE	9,7	3,6	7,6	SCIENCE	8,2	2,7	6,7
	EU.5.e.	RESACCESS		0,0	21,1	RESACCESS		0,0	14,6
	EU.5.f.	GOV	27,8	17,2	20,5	GOV	37,5	15,9	19,5
	EU.5.g.	IMPACT		100,0	64,3			100,0	52,2
	EU.5.h.	KNOWLEDGE		50,0	60,0			47,0	50,2
EURATOM	Euratom	EURATOM	37,3	37,8	43,6	EURATOM	26,3	23,2	66,3

Státy EU-15 mají nejvyšší hodnotu účastnické a finanční úspěšnosti v porovnání s ostatními dvěma skupinami států (CZ a EU-12) ve většině společenských výzev a priorit programu H2020. **Výzkumné týmy z ČR jsou v celkovém porovnaní se skupinami států EU-12 a EU-15 úspěšné v prioritách INFRA, ICT a společenských výzvách FOOD a SOCIETY,** ve kterých zaznamenaly celkově větší účastnickou úspěšnost, než je souhrnná úspěšnost států EU-15 a EU-12. Vyšší finanční úspěšnost než obě skupiny států má ČR v prioritách INFRA a BIOTECH a ve společenských výzvách FOOD a TPT.

Tabulka 4 – Porovnání účastnické a finanční úspěšnosti českých žadatelů s žadateli z EU-12 a EU-15 v jednotlivých prioritních oblastech a společenských výzvách programu H2020

Nejvyšší úspěšnost v dané prioritní oblasti nebo společenské výzvě je vyznačena intenzivnějším podbarvením. Intenzita podbarvení rovněž určuje, do jaké míry jsou jednotlivé hodnoty úspěšnosti pro danou část programu H2020 a úspěšnost od sebe vzdáleny. Při porovnávání úspěšnosti v horizontálních aktivitách (Šíření excelence a Věda ve společnosti) je třeba mít na zřeteli, že se většinou jedná o porovnávání malého počtu týmů i projektů, což vychyluje vypočtené hodnoty s každým úspěšným či neúspěšným projektem na tu či onu stranu. V úvahu je nutné brát i další specifika, např. teritoriální preference a omezený rozpočet těchto horizontálních priorit. Údaje v tabulce se vztahují k datům o žadatelích, kteří se v roli partnerů a koordinátorů podíleli na přípravě úplných způsobilých návrhů projektů. Pole bez hodnoty znamená neúčast v dané části programu H2020, „0,0" – znamená nulovou úspěšnost v dané části programu H2020.

Zdroj dat: e-CORDA H2020 proposals and applicants – 2019/06/05, zpracováno TC AV ČR

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<u>*Translation explanation to Figure No 4:*</u>

Pillar / horizontal area

The EU-15 states have the highest value of participation and financial success rate compared to the other two groups of states (CZ and EU-12) in most societal challenges and priorities of H2020. CZ research teams are successful overall compared to groups EU-12 and EU-15 in priorities INFRA, ICT and societal challenges FOOD and SOCIETY, in which they recorded an overall higher participation success rate than the overall success rate of the EU-15 and EU- 12 states. The Czech Republic has a higher financial success rate than both groups of states in the INFPA and BIOTECH priorities and in societal challenges FOOD and TPT.

Table 4 - Comparison of the participation and financial success rate of Czech applicants with EU-12 and EU-15 applicants in H2020 priority areas and societal challenges

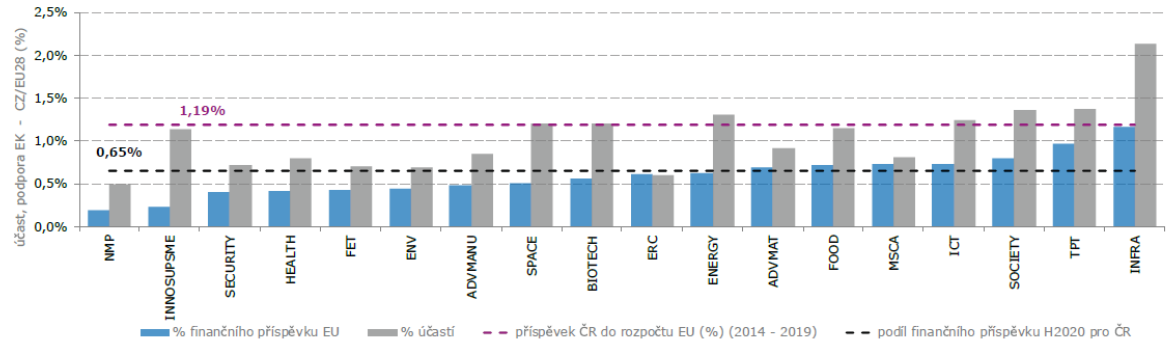
The highest success rate in the priority area or societal challenge is marked with higher-intensity colour of the cell. The cell colour intensity also shows how much the success rate values differ for the given part of H2020 and success type. It must be noted that the success rates in horizontal activities (Spreading excellence and Science in society) are mostly compared for a low number of teams and projects, which deviates the calculated values with each successful or unsuccessful project to one side or the other. Note must be taken of other specifics too, such as territorial preference and the limited budget of the horizontal priorities. The data in the table show applicants who took part as partners and coordinators in the preparation of complete eligible project proposals. Cells without a value mean non-participation in the H2020 part, the value 0.0 means zero success in the given H2020 part. Data source: e-CORDA H2020 proposals and applicants - 2019/06/05, processed by CAS TC.

Nevertheless, in terms of the share of the financial contribution of the Member State to the Horizon 2020 budget in proportion to the participation and financial success rate of CZ in

priority areas and societal challenges, Czech teams show a low success rate in the programme.

Chart No 10: Share of financial contribution and participation of CZ in priority areas and societal challenges of Horizon 2020 (CAS Technology Centre, 2019a)

Nárokovaný finanční příspěvek českých týmů se v prioritách a společenských výzvách programu H2020 jeví z mnoha hledisek jako podprůměrný. Týmy z ČR se v prioritách a společenských výzvách tří základních priorit H2020 ucházejí o **0,65** % z dosud alokovaného rozpočtu pro státy EU. U 11 priorit a společenských výzev je nárokovaná finanční podpora českými týmy pod touto hranicí. Pokud přijmeme hledisko, že ČR měla z dosud rozděleného rozpočtu H2020 získat stejný podíl, jakým přispívala do rozpočtu EU (který v letech 2014–2018 činil v průměru 1,19 %), pak fialová přerušovaná čára ukazuje, že v žádné části H2020 výše nárokovaného finančního příspěvku tohoto podílu nedosáhla. Populace ČR představuje asi 2% celkové populace EU-28, takže četnost českých týmů by se měla pohybovat v jednotlivých prioritách okolo 2% všech týmů z EU-28. Šedé sloupce v grafu 10 ukazují, že tuto mez ČR překračuje pouze v prioritní oblasti INFRA.



Graf 24 – Podíl finanční podpory a účasti ČR v prioritních oblastech a společenských výzvách programu H2020

Graf je založen na datech, která se týkají účastníků financovaných projektů v prioritách Excelentní věda, Společenské výzvy a Vedoucí postavení průmyslu programu H2020 v roli příjemců příspěvku EU. Modré sloupce grafu udávají procenta rozpočtu, které v jednotlivých prioritních oblastech a společenských výzvách získaly české týmy v každé prioritní oblasti či společenské výzvě (EU-28=100 %). Šedé sloupce ukazují, jakou část účastníků z EU-28 představují v jednotlivých prioritních oblastech čeští účastníci. V grafu jsou uvedeny pouze prioritní oblasti a společenské výzvy tří základních priorit H2020, kterých se ČR v dosavadním průběhu H2020 účastní.

Zdroj dat: e-CORDA H2020 projects and participants – 2019/06/05, zpracováno TC AV ČR

Translation explanation to Chart No 10:

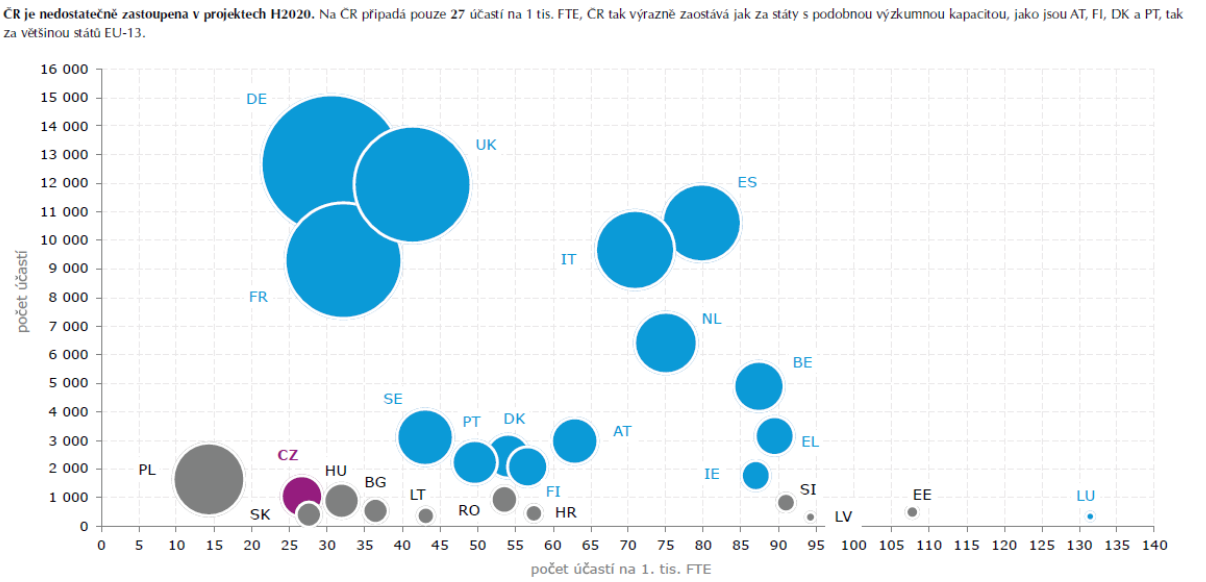
The claimed financial contribution of Czech teams in the H2020 priorities and societal challenges appears below-average in many aspects. In the priorities and societal challenges of the H2020 main pillars, CZ teams claim 0.65% of the budget for EU states, allocated so far. In 11 priorities and societal challenges, the financial support claimed by CZ teams is below that line. If we accept that CZ should obtain from the H2020 budget distributed so far the same share with which it contributed to the EU budget (1.19% on average in the period 2014-2018), the purple dashed line shows that the claimed financial contribution did not reach that share in any of the H2020 parts. CZ population represents around 2% of the total EU-28 population, so the number of CZ team members should range in the priorities around 2% of all EU-28 teams. The grey columns of Chart 10 show that CZ has crossed that line only in priority area INFRA.

Participation, EC support - CZ/EU-28 (%).

Chart 24 - Share of financial support and participation of CZ in H2020 priority areas and societal challenges. The chart is based on data on participants in financed projects in H2020 pillars Excellent science, Societal challenges, and Industrial leadership as beneficiaries of the EU contribution. The blue columns of the chart indicate the percentage of the budget, obtained by CZ teams in the different priority areas and societal challenges (EU-28 = 100%). The grey columns show what proportion of the EU-28 participants is represented by Czech participants in the priority areas. The chart displays only priority areas and societal challenges of the three main H2020 pillars in which CZ has participated so far in H2020. Data source: e-CORDA H2020 proposals and applicants - 2019/06/05, processed by CAS TC.

The analysis of the CAS TC indicates (Technologické centrum AV ČR, 2019a) that CZ is insufficiently represented in Horizon 2020 projects, with only 27 participations per 1 thousand researchers. CZ significantly lags behind states with a similar research capacity such as Austria, Finland, the Netherlands or Portugal, and behind most EU-13 states (see Chart 11 below). The total number of Czech teams seeking to participate in Horizon 2020 was lower in absolute terms not only compared to countries with a comparable population (Belgium, Sweden, Greece, Austria, Portugal, Hungary), but also with much smaller countries (Ireland, Slovenia).

Chart No 11: Activity and financial contribution of EU Member States in Horizon 2020



Graf 20 – Aktivita členských států EU v programu H2020

Graf je založen na datech, která se týkají účastníků financovaných projektů v roli příjemců příspěvku EU. Svislá osa prezentuje počet účastí daného členského státu v projektech H2020, vodorovná osa představuje počet účastí na 1 tis. vědeckých a akademických pracovníků daného státu EU (FTE). Velikost kruhu odpovídá počtu výzkumných pracovníků daného státu EU. Státy EU-15 jsou označeny modrou barvou, státy EU-13 šedou barvou, ČR je zvýrazněna fialově. V grafu chybí velmi malé evropské státy CY a MT, které mají specifickou strukturu systému VaV. Zdroj dat: e-CORDA H2020 projects and participants – 2019/06/05, Eurostat: počet výzkumných pracovníků – ekvivalent plného pracovního úvazku (FTE) – data z roku 2017, zpracováno TC AV ČR

Translation explanation to Chart No 11:

CZ is insufficiently represented in H2020 projects. CZ has only 27 participations per 1 ths FTE, and so it significantly lags behind the states with similar research capacity such as AT, FI, DK and PT, and behind the majority of EU-13 states.

Chart 20 - Activity of EU Member States in H2020. The chart is based on data on participants in financed projects as beneficiaries of EU contribution. The vertical axis represents the number of participations of the Member State in H2020 projects, the horizontal axis represents the number of participations per 1 ths scientific and academic staff of the EU state (FTE). The size of the circle corresponds to the number of researchers of the given EU state. EU-15 states are marked blue, EU-13 states are marked grey, CZ is highlighted in purple. The chart does not display very small EU states CY and MT that have a specific structure of the R&D system. Data source: e-CORDA H2020 projects and participants – 2019/06/05, Eurostat: number of researchers - full-time equivalent (FTE) - data from 2017, processed by CAS TC.

8.5.3. Participation of research organisations supported with MoA institutional aid in Horizon 2020

Research organisations supported with IA based on data from September 2020 (source: EC – eCORDA 20200918 database (provided by CAS TC)) have contracted and are using grants from Horizon 2020 at EUR 4 197 715.65. In the vast majority of cases, these are projects

supported under Pillar 3 of Horizon 2020, societal challenge SC2 - Food security, sustainable agriculture and forestry, marine research and the bioeconomy (FOOD). The Institute of Agricultural Economics and Information has 4 projects (of which in one it acts only as a third party without a financial contribution), the Fruit Research and Breeding Institute Holovousy has 1 project, the Research Institute of Forestry and Hunting 1 project, the Research Institute for Soil and Water Conservation 3 projects, the Food Research Institute Prague 2 projects (of which in one it acts only as a third party without a financial contribution. The project is financed from Pillar 1 of Horizon 2020 Excellent Science, area 4 - European research infrastructures including e-infrastructures.), the Crop Research Institute 7 projects, the Veterinary Research Institute 2 projects, the Institute of Animal Science 1 project (this project is financed under Pillar 2 of Horizon 2020 Industrial leadership, its area 1 Leadership in enabling and industrial technologies: information and communications technologies), Agricultural Research (company) 2 projects.

8.5.4. Identified barriers to the participation of Czech entities in EU framework programmes for research and innovation

In general, the success of a project proposal submitted to a framework programme is determined to a substantial extent by the project's coordinator. The share Czech coordinators in Horizon 2020 projects has been very low in the long term, which is due the fact that only few projects are initiated and coordinated by CZ facilities, but also due to the lower success rate of those projects (with a Czech coordinator). In the 7th framework programme, Czech coordinators represented only 9% of all Czech participants, in Horizon 2020 it is 11% so far. Both of the shares are among the lowest among EU Member States.

The involvement in framework programmes is one of the opportunities for Czech research teams to finance their R&D activities from public foreign financial sources and, at the same time, establish international contacts for further cooperation. Same as in the past, cooperation with the most important European research organisations is crucial and key for CZ. Analyses have shown that **cooperation with TOP10 institutions in the preparation of project proposals significantly increases also the participation success rate of any EU Member State, CZ including.** For CZ, the increase in the success rate is very significant. In the 7th EU framework programme for research and innovation, the cooperation with TOP10 institutions increased the participation success rate by 5.3% on average, for CZ it was 8.7%, which was the third highest value among all of the states. CZ teams exploited the opportunity of working with TOP10 institutions better than the majority of new EU Member States. The rate of cooperation of CZ research teams with TOP10 teams also proves that despite the generally low involvement of CZ in framework programmes, the selected Czech facilities are highly competitive.

The ***Analysis of the causes of the low involvement of EU-13 states in EU framework programmes for research and innovation*** has drawn the following conclusions (Technologické centrum AV ČR a Rathenau Institut, 2017):

1. Low participation is to some extent influenced by the size of research systems (the number of participations relative to the number of researchers is lower in the EU-13, the number of

participations per GERD volume expressed in €, on the contrary, is slightly higher); 2. The participation and success rate of coordinators from the EU-13 is low; 3. Projects prepared with TOP15 reduce the risk of failure in project appraisal; 4. The role of EU-13 partners in H2020 projects is less significant, reflecting the lower share of financial contribution per participant; 5. On the contrary, the production of results and their quality is comparable to the EU-15, but in the case of quality, the collaborating partner must be an organization from the EU-15; 6. The ability to use the results of H2020 projects is lower in the EU-13; 7. EU-13 participation in excellence-oriented activities (ERC, MSCA, RIA) is significantly lower, on the contrary, participation in CSA is relatively higher; 8. The EU-13 region is heterogeneous in terms of participation and success rate.

Identified barriers to submitting a project proposal

PREPAREDNESS:

1. Limited professional contacts and connections to existing cooperation networks; 2. A significant difference between the scientific and technological level of EU-13 and EU-15; 3. Limited research and innovation capacities; 4. Mismatch between the focus and capabilities of research teams and the demand for knowledge in FP work programmes; 5. Structure of EU-13 industry and position of companies in value chains; 6. Little experience with the implementation of research focused on the needs of society.

Identified barriers to the success of a project proposal

MOTIVATION: 1. Existing networks create barriers to the entry of new participants and new consortia

PREPAREDNESS:

1. Lower quality of research (number of publications, their citations, number of patents, cooperation with industry); 2. Insufficient project management experience and limited internal project management support in the organization; 3. Little involvement as evaluators in framework programmes; 4. Limited experience in writing projects.