

INRAE contribution to the EU Life Sciences Strategy

Preamble

We are at a time when the EU needs to close the innovation gap to increase its competitiveness, while maintaining its leadership in dealing with climate, environmental and health emergencies. Research, especially in the domain of life sciences, has a key role to play. Indeed, regardless of the sector considered, research is most often at the origin of innovations of all kinds (practices, products, markets, services, process, technical, societal, etc.).

An ambitious EU Life Sciences Strategy (LSS) combining the generation of new knowledge and high-throughput technologies with the intensification of innovation pathways is key to address current and future challenges in many sectors, whether related to competitiveness, sustainability or resilience in the various dimensions of global change.

[INRAE](#), the French National Research Institute for Agriculture, Food and Environment, is one of the top European research-performing organisations in its field. We are convinced that research - at every stage of the continuum that ranges from fundamental research to innovation and across the whole sequence of TRLs - is a major lever for European competitiveness in all sectors linked to life sciences. In particular, the EU urgently needs to produce cutting-edge actionable knowledge for transforming agricultural and food systems. Indeed, facing increasing uncertainties, the agri-food sector is urgently looking for solutions that will enhance its competitiveness while preventing or at least minimising the impact of external shocks on food production and thus increasing its resilience and sustainability.

Life sciences constitute a very broad scientific field encompassing a wide range of disciplines (e.g., molecular biology, biochemistry, genetics, ecology & evolution, etc.), spanning multiple scales (from molecules to ecosystems) and application domains (agriculture, food, environment, health, bioeconomy, etc.). This is why in this contribution, we call for an ambitious EU LSS that **should not be limited to some specific areas** (e.g., biotechnologies for health) but should embrace the whole of this broad scientific field, including the complexity of the interconnections between climate change, agricultural and food systems, biodiversity, natural resources and health.

Without neglecting the potential of all the fields covered by life sciences, this document focuses on the contribution of agricultural, food and environmental sciences - INRAE's areas of expertise – to the EU LSS. Finally, as a research institute, INRAE's contribution focuses mainly on the role of research in the future EU LSS, again without neglecting the other components of this future strategy.

1. Life Sciences for competitiveness, long-term sustainability and resilience of the agri-food sector

Combining competitiveness, sustainability and resilience calls for more far-reaching changes to agricultural production systems than ever before, with significant opportunities for the whole agri-food sector. This involves producing and disseminating knowledge about the different components of cultivated ecosystems: soils, plants, and animals, as well as their pathogens or symbiotics. The transformation of raw agricultural products is also a matter of concern. Innovative and cutting-edge activities in life sciences are required to support these changes and to tackle the challenges the agri-food sector is facing. Information and data sharing, dissemination activities, capacity building and contribution to the development of solutions are all complementary and highly relevant issues.

a) Life Sciences for competitiveness

As stated in the recently issued EU Vision for Agriculture and Food, the agri-food sector is strategic for the EU and a key asset for EU competitiveness. The agri-food system, anchored in the EU Single Market and in its diversity of enterprises, scope, scale and production methods, generated an added value of more than €900 billion in 2022, providing employment to around 30 million people, representing around 15% of total EU employment.

From input suppliers to consumers, the agri-food value chain encompasses a wide variety of actors across Europe, making up the vitality of rural areas and also contributing to Europe's global competitiveness through a few major players. Thus, innovations in this sector, including those based on life sciences, hold a great potential for deployment due to the size and the geographical distribution of the market.

Life sciences are driving innovation in strategic technologies/fields for tomorrow's economy, and in particular for a circular bioeconomy that develops innovative low-energy transformation processes (biorefineries, advanced biotechnologies, cell factories...), low-input agricultural practices, decarbonisation of the industrial sector... Life sciences also provide the basis for system transition/transformation, for example building on agroecological practices for more resilient production systems.

Collaborative research is key in getting all the players on board and disseminating knowledge and solutions throughout Europe to build competitiveness in the sector. Research in life sciences therefore has the potential to nourish the whole of Europe, disseminating actionable knowledge to ensure the competitiveness of the agri-food sector as well as food safety.

All life sciences research and applications must be used responsibly. As stated by the World Health Organisation, advances in life sciences and technologies can bring enormous benefits in many fields. However, the same scientific information and technologies that can generate potential benefits could also accidentally (or deliberately) be misused and potentially cause harm to humans, animals, plants, agriculture and the environment. Therefore, scientific and technological advances in the life sciences and associated technologies can also raise significant ethical, legal, societal, safety and security risks. The EU LSS should therefore address the challenge of how to develop and implement governance tools and mechanisms that mitigate the risks posed by life sciences research, without hampering the development and use of such research. In the current international context, it will be even more important to ensure that the EU continues to provide independent expertise on these issues.

b) Life sciences for long-term sustainability and resilience

Food and agriculture underpin the well-being of Europeans. Although food security has not been an issue in Europe in decades, the current geopolitical context puts European food security again as a key priority. Life sciences have a key role to play in building the resilience and sustainability of European agri-food systems to ensure the EU's long-term competitiveness and food security and sovereignty.

Life sciences provide fundamental knowledge on how ecosystems work, how they evolve and how they interact with agricultural and food production, energy, biomass, etc., thus ensuring that the economic system based on these innovations is well adapted to major current challenges such as climate change, biodiversity loss, global health or social inequalities. It should also be remarked that resilience is not only a matter of resistance to current shocks. It is also the capacity to react and adapt to future challenges such as more extreme climate conditions, new pests or pathogens, etc. Implementing a

strategy with a long-term vision is absolutely necessary to ensure that the competitiveness and sustainability of the agricultural and food sectors will be anchored in the long term, with an enhanced competitive potential as compared to other systems designed for the short term.

2. What do we need to support the development and deployment of Life sciences for the agri-food sector?

a) Supporting research in life sciences

Research in life sciences must be supported through a continuum from fundamental research to market and consumers. This of course covers the entire innovation path from transfer to industrial deployment. Through a voluntary policy of support to this continuum, the EU may generate added value in many different sectors, including agri-food.

Being critical for European competitiveness, research in life sciences requires efforts in:

Investments in research in the Life Sciences domain (funding, human resources, data...)

Funding:

- There is a clear need for support for life sciences research activities in **FP10** through different instruments and programmes, including collaborative research on major societal challenges, thus providing continuity and stability for researchers in this field. It is also key for exploiting the added value of the EU (doing things together rather than alone) in order to achieve a critical mass of resources and capacities enabling the necessary investment in strategic life sciences and technologies, and their deployment on an EU scale.
- We also see a need for the EU to put various kind of resources (regulatory framework, facilitating tools, etc) into the process of **coordinating national initiatives**, especially for life sciences, where the issues are cross-border or even global. The outcomes and impacts of research may be amplified through synergies with national programmes such as, for example, the French France 2030 plan (see box 1 below) with massive public investments in research on societal challenges. In addition to improving the process of coordinating national initiatives, EU funding for the coordination of (large) national programmes, such as France 2030, could also be investigated; this would bring European added value and contribute to a strengthened European Research Area.

Box 1. France 2030 Plan:

Since 2021, the [France 2030 Plan](#) has been a flagship initiative of the French government designed to support innovation and its leading actors across the nation. Among other tools, Priority Research Programmes and Equipment (PEPR) and Acceleration Strategies (AS) aim to bolster French research and innovation in strategic scientific fields that are pivotal/crucial to technological, economic, social, health and environmental change. These programs are completed by applied programs with a deployment capacity (e.g. the strategic plan “PARSADA”¹). INRAE currently leads/co-leads 10 PEPR and 2 AS (see details in Annex 1).

- **Start up and scale up Strategy.** There is a need to better support start-ups to allow them to stay in Europe and to grow. This implies financial support as well as simplification and changes in regulation (see below).

¹ National strategic plan to anticipate the potential European withdrawal of active substances and develop alternative methods for crop protection, co-designed by supply chain actors and research actors. Covers transfer and industrial / in farm deployment – [PARSADA website](#) (in French). Overall budget 2024 = 146M€ ; INRAE overall budget = 26M€. INRAE leads 5 major projects launched in 2024 (5 to 7M€ each).

- **Making room for public-private partnerships.** The interactions between the two sectors may allow innovation in life sciences to reach the market more rapidly. It could be especially interesting to develop public-private partnerships for pre-industrial demonstrators to mitigate risks: co-financing, with public funding for the riskiest upstream part, and private access to demonstration modules [see e.g., [Ferments du futur](#); [IBISBA](#)].

Capacity building and mobility:

- **Skills and competences.** There is a need for continued investment in building and upgrading skills and (novel) competences, including initial training and long-life learning. Initiatives supported by the European Skills Agenda may help in implementing the LSS.
- **Mobility.** Programmes that allow researchers to move between countries (such as MSCA Staff Exchange) foster research capacity and therefore improve the creativity, efficiency and quality of research in life sciences. They should be promoted in support to the implementation of the LSS (as well as other strategies).

Data and Infrastructures:

- **Artificial intelligence (AI)** has immense potential in life sciences, from drug discovery and development to personalised advice in medicine, agricultural practices or ecosystem management. But AI integration is often hampered by technical complexities, a lack of standardised data, or difficulty in accessing data. There is also the issue of how data are formatted, cleaned and labelled so that they can easily be used to train a new AI model or feed an existing one. By fostering initiatives and policies that make AI accessible, foster collaboration and adhere to open science and FAIR principles, the LSS would accelerate transformative advances in life sciences research across Europe.
- Although life science research is being conducted in a multitude of scientific disciplines, individual scientists and labs often lack the expertise they need to tackle all aspects of a research question. They need to be able to use multiple, highly complex technologies and access both services and resource collections to carry out high-quality, comprehensive research. **Research Infrastructures (RIs)** are facilities that provide resources and services for research communities to conduct research (whatever the TRL level) and foster innovation. When considering the place of RIs in the field of life sciences applied to the agri-food sector, several RIs appear as key assets that need to be supported and further developed in the frame of the LSS, such as the distributed European research infrastructure for biotechnology [IBISBA](#), [Emphasis](#) for plant phenotyping, [MIRRI](#) for the preservation, systematic investigation, provision and valorisation of microbial resources and biodiversity or [ELIXIR](#) for the coordination, integration and sustaining of bioinformatics resources.

Ensuring a balance between investments in knowledge / innovation / transfer / industrial deployment

A balanced vision is key to maintain the EU's scientific excellence in life sciences and to expand the knowledge base, while taking steps to close the investment gap in strategic technologies (in comparison with the US and China). It is essential to strike a balance between the production of actionable knowledge and the deployment of innovation, so as not to 'dry up' the innovation pipeline. For reconciling the objectives of production, human and environmental health, life sciences are of paramount importance.

Supporting emerging areas of life sciences research with the potential to revolutionise the agri-food sector

The emerging research areas listed below are partly inspired by the French experience (France 2030 Plan, see box 1 above) and could be integrated in the LSS to speed up the transformation of the agri-food sector toward long-term competitiveness.

Biotechnologies for bioeconomy, agroecology and food systems:

- Development of **synthetic biology**, e.g. in the food and feed industry to control the production of specific molecules (proteins, peptides, vitamins, etc.) at high yields by micro-organisms (precision fermentation, i.e. a more advanced kind of metabolic fermentation, where living organisms convert organic chemicals from the feedstock into usable components).
- Development of **biocatalytic systems** and their coupling with physical and chemical operations to improve biomass and biowaste processing (e.g., biorefineries, bioenergy production) and support the development of green chemistry (e.g., bio-based and renewable materials, solvent substitution, bio-catalysis).
- In addition to other levers, the genetic lever is a major one for meeting the needs of agro-ecological systems: various tools are currently mobilised to ensure the **selection of new animal breeds and plant varieties** to support transitions. Among these tools, genome editing could be a complementary tool to speed up crop breeding programs and provide additional genetic diversity for characteristics already identified such as resistance to pathogens and diseases, tolerance to abiotic stresses (water deficit, high or low temperature) or growth cycle length, but also for new crop characteristics that will be necessary for economic and environmental performance.
- Combining **genomics, high-throughput phenotyping and digital technology** for the functional characterisation of plant and animal genetic resources in order to increase the intra- and inter-species diversity of crops and livestock for the diversification of production systems.
- Mobilising **genomics** and artificial intelligence to design new molecules for biocontrol (e.g. agonists based on genetic sequence of olfactory receptors of insects).

One Health:

Advances in life sciences should lead to improved productivity and mitigated negative impacts on health and environment through e.g.: advanced waste management, refined use of antimicrobials and pesticides, vaccination, biosecurity, ...

- **Harnessing the development of European microbiota innovation for health:** microbiota (and beneficial microbes in general) for human and animal health, the development of biocontrol, biostimulation and fertilisation in crops.
- Shedding light on the physiological and pathological functions of **extracellular vesicles**. These vesicles play a crucial role in facilitating substance and information transfer not only between cells from a given organism but also across different species, including between multicellular organisms and microbes. Molecular trafficking is essential for host defense and pathogen virulence. Extracellular vesicles appear as promising candidates for therapeutic agents (incl. RNAi-mediated crop protection), drug delivery systems, and disease biomarkers.
- Prevention and anticipation of **zoonoses**, including advanced methods for the detection of pathogens' emergence/spillover and vaccines.
- Prevention and anticipation of **pest invasions** through high-throughput detection methods.
- Support for One Health strategies through **advanced health monitoring and surveillance** for humans, animals, plants and the environment, including the implementation of (eco)epidemiological surveys using high-throughput molecular tools (metabolomics, proteomics...) and AI-based systems biology approaches.

Climate change and low-carbon systems:

The EU aims to be climate-neutral by 2050, meaning an economy with net-zero greenhouse gas (GHG) emissions. Life sciences have enormous potential to contribute to the identification and implementation of advanced creative solutions that promote greater sustainability and accelerate the transition to a low-carbon society. Relevant issues for the agricultural sector, which contributes to 10,8% of the EU's anthropogenic GHG emissions², include, among others, **breeding** for crop varieties and livestock breeds adapted for future climate conditions, with a lower contribution to GHG emissions (e.g., reduced methane emissions, lower fertiliser needs) and/or improved carbon storage capacities. Opportunities to tackle the challenges of a sustainable transformation also lie in the convergence between basic life sciences and engineering to drive rapid innovation.

Multi-targeted approaches using Nature-based Solutions:

The LSS should address also highly integrated systems such as **ecosystems** and **landscapes**. When considering competitiveness and sustainability of the EU economy, Nature-based Solutions³ (NbS) are of increasing interest. They can be used to sustain or enhance the jobs and productivity of those working in sectors such as farming, fisheries, forestry and tourism, and they are also relevant for cooling and greening cities. The socio-economic benefits created by NbS, make these cost-effective solutions to address multiple societal challenges while generating economic opportunities, a wide range of jobs from low-skill entry level to high-skill jobs and many more jobs per investment than traditional infrastructure projects. So far, NbS are mostly designed and implemented based on empirical knowledge. Gains in terms of cost-efficiency and performances may be expected from more innovative approaches using for example remote sensing and AI combined with information on processes occurring at different levels of biological integration.

b) Beyond research – improving regulations and raising public awareness towards life sciences

Improving regulations

Europe needs to balance innovation and regulation in a new way. It is essential to speed up marketing authorisation procedures for innovations from the life sciences (biocontrol, novel foods (e.g., precision fermentation), microbiome-based therapeutics, etc.) while guaranteeing safety for end-users. This implies providing sufficient resources (financial and workforce) to European agencies to speed up product assessment. At the same time, the EU must provide the means to control the safety of products imported from outside the EU, particularly those resulting from innovations in life sciences that are not yet authorised or in the process of being authorised in the EU.

A **regulatory sandbox** is an interesting regulatory innovation of its own. If used smartly, it can benefit both consumers and the economy. However, regulatory sandboxes come with a risk of being misused or abused, and need the appropriate legal framework to succeed. Therefore, extreme caution is required when it comes to deploying regulatory sandboxes for innovations stemming from the life sciences, because lives are at stake. Past failures in downgrading existing regulations, such as the mad cow crisis or H1N1, demonstrate the need for the utmost precaution. It would be preferable to provide

² European Environmental Agency - EEA greenhouse gases — data viewer:

<https://www.eea.europa.eu/en/analysis/maps-and-charts/greenhouse-gases-viewer-data-viewers>

³ According to the EC definition, Nature-based Solutions are 'Solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions. Nature-based solutions must therefore benefit biodiversity and support the delivery of a range of ecosystem services.'

the necessary resources to produce a robust ex-ante risk analysis through research (economic analysis, health of regulations) to reduce risks.

Raising public awareness and understanding of innovations in life sciences in the agri-food sector

Innovations linked to life sciences can positively contribute to the development of healthier and more sustainable food products and practices in the agri-food sector among others. However, despite various benefits in terms of health and for the environment, innovations may generate some reluctance among parts of the population. Several factors explain this reluctance, such as distrust of new technologies or cultural habits. To improve the acceptability of innovations or innovative products that meet the challenges of tomorrow's food sector in terms of competitiveness, health or sustainability, it is necessary to better understand consumer reactions regarding these novelties and to highlight some possibilities allowing compensation for this reluctance.

Given the importance of research and innovation in reaching the EU's socio-economic goals, it is essential that citizens have a better understanding of the work of scientists. Bringing research and innovation closer to citizens brings benefits for both society and the research institutions themselves, as it promotes citizens being better informed and science more highly valued. It is important to help the public understand the issues at stake because these are complex subjects that are difficult for non-scientists to grasp. The European Commission could therefore consider deploying a scientific dissemination programme coordinated at EU level, capitalising on existing tools and actions such as those implemented in some Horizon Europe projects (open and participatory science activities, living labs, etc.).

Annex 1 – List of French Priority Research Programmes and Equipment led or co-led by INRAE

- **FairCarboN** (40M€ - 6yrs) aims to mobilise the entire French scientific community studying carbon in continental ecosystems. It should help to clarify the possible contribution of continental ecosystems to mitigating climate change.
- **OneWater** (53M€ - 10yrs) - aims to develop research in the field of water. It is designed to help accelerate transitions and measure the impact of global change on socio-ecosystems.
- **SOLUBIOD** (44M€ - 9yrs) explores the levers and trajectories for biodiversity and nature-based solutions to strengthen the adaptation and resilience of ecosystems to global change, including their sociological dimension.
- **Advanced Plant Breeding** (30M€ - 10yrs) mobilises all the knowledge and technologies available in plant breeding and will help to define the potential contribution of genome editing to the improvement of new species and new traits for innovative cropping systems adapted to climate change.
- **Food - Microbiomes** (58M€ - 7yrs) ambition is based on a better understanding of the microbiome and the links between food, microbiomes and human health, as well as the levers likely to modulate food consumption choices and facilitate the implementation of sustainable food systems. Ultimately, it aims to prevent and treat chronic inflammatory diseases by developing precision nutrition and personalised medicine, and to contribute to the design and evaluation of public policies on dietary behaviour.
- **Forestt** (40M€ - 7yrs) aims to remove the scientific barriers to the multi-scale functioning of temperate and tropical forest socio-ecosystems, as well as the services they provide, risk assessment and management, and the often-conflicting interdependencies between uses and short- and long-term management strategies.
- **Agroecology and Numeric** (65M€ - 8yrs) aims to produce innovative knowledge and build a multidisciplinary scientific dynamic to meet the challenges of the agro-ecological transition, using digital technology.
- **PREZODE** (Preventing Zoonotic Diseases Emergence; 30M€ - 5yrs) aims to strengthen the production of knowledge and the development of relevant tools to define innovative strategies for risk reduction and early detection of emerging diseases.
- **B-Best** (70M€ - 6yrs) aims to bring together an interdisciplinary community and tackle the main challenges linked to the conversion of biomass into biobased products for a sustainable transition to the bioeconomy and the circular economy.
- **Growing and Protecting Crops Differently** (30M€ - 6yrs) aims to produce knowledge, skills and tools to facilitate the transition towards pesticide use reduction and to develop new agricultural practices by identifying alternative pathways and mobilising agroecological, biocontrol and genetic approaches.