

# **Towards an e-infrastructure for Open Science in Agri-food: Vision 2030**

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In 2030 agri-food systems and businesses will produce healthy nutritious foods for all, through input-efficient methods and an environment that fosters collaborative networks that constantly seek to improve their economic, environmental, technological and social performance for all players.

Further, food systems will respond in an agile way to local, regional, and global needs, and contribute to achieving a wide range of objectives as framed in the Sustainable Development Goals <sup>1</sup>. These objectives include achieving food security, mitigating global warming, ensuring good health and preserving biodiversity.

To be effective, these food systems need to be inclusive, resilient and knowledge intensive. They must be supported by open science-based knowledge systems to stimulate further innovation and accelerate impact. Agri-food systems and businesses create and use knowledge on food production, environmental effects, food processing, distribution, nutritional values, production costs and the likely health benefits.

Delivering on this approach requires a perspective that looks beyond individual value chains, crops, livestock or farm types. In the 'open-science-based food knowledge cloud', researchers should be able to:

1. openly collaborate with relevant stakeholders to improve the functioning of the food system by sharing knowledge, including practitioners' know-how;
2. create novel systems approaches that harness research to address impacts on entire food system, that are multi disciplinary and engage multiple actors and on a range of related criteria;
3. put in action research that is fully knowledge-driven, and based on the principle of transparent data and information that allow researchers to rapidly discover, aggregate, integrate, and analyze different types of data and information sources to form a clear picture of the current situation and future needs and develop solutions that are agile and robust;

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<sup>1</sup> <http://www.un.org/sustainabledevelopment/sustainable-development-goals/>



## Challenges to realise Vision 2030

To realize this Vision 2030 the transition of the research approach toward a systemic, integrated, multidisciplinary and global approaches needs to be accelerated. As part of this transition, agriculture and food systems research must embrace *digitization, transparency and cooperation*.

The agri-food sector is very diverse. It relies on complex knowledge – both theoretical and experimental. For policy makers, planners and food producers to progress with the new thinking described here, they will need to take a view that integrates multidisciplinary, multi-scale, multi-actor and geo-location-based approaches. This will benefit from integrating a range of agricultural data, models and analytical and visualization tools, of which there are many to choose from.

This increase in available tools is driven by the emergence of systems thinking, coupled with the exponential growth of digital resources and global use of the Internet. Other key factors include: automated data collection (robots, Unmanned Aerial Vehicles, connected sensors, etc.); new tools in the “omics” fields and emerging new information and data sources (e.g. Internet of Things, crowd sourcing, text and data mining approaches). These trends are coupled to the fact that natural and societal phenomena are increasingly being described by massive data at different scales, from various sources and with different temporal-spatial resolutions. The ability to share, access and integrate heterogeneous data is a key to addressing climate change impacts on food security; to providing healthy and nutritious food for all; for developing sustainable food value chains; and supporting local agricultural adaptations and rural development. To best address these challenges in an agile approach, the research and innovation sectors need easy access to digital knowledge, data resources and technologies. This will be achieved with resources such as interoperable data, connected sensors, data sharing and exploration methods, modeling and coding frameworks, intensive simulation environments, or social networks – all fueled by shared information exchange standards and wide access to high-speed internet connections.

To make this happen, it is critical that the industry and the community of research and development agencies has a robust and open e-science framework and related facilities or e-infrastructures that operate following common standards. This will enable ethical, responsible and secure sharing of the ‘engine’ of this new approach – data and information, computing and storage resources, codes and data-mining algorithms, models and ontologies. To make the system work effectively, partners need to have relevant expertise, and access to examples and best practices and an ethical framework that underpins an open science approach for agriculture.

In this light, ensuring sustainable and nutritious regional and global food systems requires that we commit to ‘Open Science’. This requires that research and development institutions, and every stakeholder in the innovation process fully embrace a digital transition for each phase of the knowledge production cycle for innovation. This extends from research planning and design to collection, analysis and simulation of data and the dissemination of knowledge and the underlying data.



This will enable increased collaboration and efficient, ethical and secure data flow between all partners from R&D, farming, supply chains and consumers. The support of policy makers is vital to create an environment for open science that will speed the pace of development and innovation.

Agri-food science and innovation will benefit significantly from such a shared knowledge ecosystem. This shared knowledge will be produced and used by diverse users including academic researchers but also farmers, the industry, extension services and citizens. A shared global data space will help build the infrastructures that will open useful information to all these stakeholders and propel the agri-food sector forward.

Embracing digitization, transparency and collaboration for this ambitious project will generate significant benefits:

- **Speeding the pace of knowledge circulation:** As for all sciences, open science for the agri-food development will stimulate the production and circulation of knowledge for farmers or extension services, private companies linked to the agri-food sector and for education. This is also a key issue for developing countries.
- **Increasing spill-over of useful new knowledge to the economy:** Globally, in the agri-food sector, open data helps shape best practices. Transparency around targets, subsidy distribution and pricing, for example, creates incentives which affect the behavior of producers, regulators, researchers and consumers. It also helps public authorities to make more appropriate decisions.
- **Promoting opening access to knowledge – the FAIR principles**<sup>2</sup>: When studying climate change and its impact on agriculture, food security and safety, free access to a worldwide pool of data and practical knowledge is of critical importance to the planet's sustainable development. For this to become a reality, it is critical that all publically funded research agencies in agriculture and environment adopt the 'FAIR' principles. This will ensure that all knowledge produced and published is Findable, Accessible, Interoperable and Reusable. FAIR supports open sharing of data and knowledge and open access to publications.
- **Promoting citizens' engagement in science and research to enable mass innovation:** As a science of observation, agricultural research disciplines will strongly benefit from 'citizen science' projects, for example where information is collected and produced from farmers, NGOs, and consumers, to help to better understand ecosystem functioning and to promote common vision of future agro-ecosystems. These common efforts will result in better welfare and production management for farmers and improve food security and safety in a sustainable way.

### **We believe the following actions will support this transformation:**

- We will assure universal knowledge access and promote a knowledge sharing culture at community level. While we recognise different levels of data openness and use, we see the FAIR principles as an effective guide. We recognize and foster diversity. Data, information and knowledge today exists as an unconnected ecosystem, whose power will be greatly magnified if similar efforts are linked in a commons approach, that allows for various degrees of openness, depending on the context – ranging for sharing the subject matter or title of information, to limited openness and full open access, with embargo where necessary. We see the need for regulations to avoid the establishment of data monopolies and we will support the implementation of these regulations.

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<sup>2</sup> <https://www.force11.org/fairprinciples>



- We emphasize the need to enable researchers to be able to easily explore, integrate and simulate their own data and data that have been produced by others – in or outside their community – that are complementary in terms of objects of study, scales and disciplines. There is also a need to regulate database management rates depending on if data are used by academic scientists, private firms or the non-profit sector. This is most important for potentially valuable data produced by NGOs, who cannot afford the cost of ongoing database management. Only if these links are made, will knowledge production be able to be accelerated.
- We need to harness the power of data produced by farmers and by land observation, which includes (but is not limited to) precision agriculture. Farms need to become laboratories linked to scientific research. As such, Farmers need to be recognized as partners in participatory research and not only as data providers.
- We strongly believe that data and information management start with research planning, data production – in the lab, on the field or at the observational level. We aim for a strong collaboration with equipment producers to introduce common data sharing principles and standards.
- We will support interoperability across data sources and agree on the adopting of ‘good sense’ standards, without reinventing wheels. Standards need to be; open and shared; inter and cross-disciplinary; and co-defined with communities to ensure their adoption.
- We will build on existing digital infrastructures within our field and with generic (i.e. technological) infrastructure and establish specific infrastructure and services to express our communities’ needs and requirements to ensure that the needs and requirements of our community are recognised.
- We will foster distributed efforts and flexible governance for long-term empowerment by and sustainability across the agri-food community. We will help develop appropriate business models for data sharing and related services, especially for our ‘common goods’ such as those supporting semantic interoperability for shared information and data discovery.
- We want to look beyond a European community, to build a global network. We recognise the importance of Big Agricultural Sciences in the Global South. We will link up our initiatives with those of G20 and G77 countries.
- We will adopt machine-parsable means for encoding licenses for data and information (to support value-chain legal interoperability) and for encoding provenance of data and information (to enable attribution and quality assessments for any part of the value-chain).
- We encourage the adoption of approaches to improve the semantic interoperability of data that will facilitate and improve reasoning on data and information.
- We will promote development of the necessary skills and capacity so that all partners and stakeholders in this endeavor can achieve this Vision 2030.

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