

METROFOOD-RI UNSTOPPABLE IN THE PURSUIT OF BECOMING A FULLY OPERATIONAL RESEARCH INFRASTRUCTURE ADDRESSING KEY CHALLENGES IN THE AGRI-FOOD SECTOR

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Abstract

The purpose of this article is to provide an insight of a distributed research infrastructure and its roadmap in the pursuit of becoming fully operational. The article presents an overview of the stages in which IBA Bucharest was involved in the creation of METROFOOD-RI. METROFOOD-RI is a distributed pan-European research infrastructure listed in the European Strategy Forum on Research Infrastructures (ESFRI) Roadmap in 2016 as an Emerging Project and subsequently, in ESFRI Roadmap in 2018 as an Active Project, sustained in this way, to make progress in legal, technical and financial terms so that it could reach the maturity level necessary to be implemented. METROFOOD-RI fits perfectly in the ESFRI domain of Health & Food, tackling the pressing societal challenges, especially in the agri-food sector by providing high-quality metrology services in food and nutrition. The document describes the path that METROFOOD-RI had to follow so far, its structure, vision, mission, and objectives, as well as the infrastructure architecture and its role in the research landscape. At present, METROFOOD-RI has completed the Preparatory Phase and its partners are about to submit the 1st application form for becoming a legal entity METROFOOD ERIC (European Research Infrastructure Consortium).

Key words: research infrastructure, agriculture, agri-food, metrology, food safety

INTRODUCTION

METROFOOD-RI “Infrastructure for Promoting Metrology in Food and Nutrition” was created as a distributed research infrastructure (RI) aimed to promote scientific excellence in the field of food quality and safety. It provides high-quality metrology services in food and nutrition, comprising an important cross-section of highly interdisciplinary and interconnected fields throughout the food value chain, including agri-food, sustainable development, food safety, quality, traceability and authenticity, environmental safety, and human health.

At present, 48 partners from 18 countries (IT - Italy, BE - Belgium, CH - Switzerland, CZ – Czech Republic, DE - Germany, ES - Spain, FI - Finland, FR - France, GR - Greece, HU - Hungary, MO – Moldova, MK – Republic of North Macedonia, NL - Netherlands, NO - Norway, PT - Portugal, RO - Romania, SI –

Republic of Slovenia and TR - Turkey) are involved, bringing their contribution in the preparation of METROFOOD-RI upon the H2020-INFRADEV-2019-2 METROFOOD-PP project (GA 871083) (Fig. 1).

The construction of such a large and complex RI takes time (up to 10 years) and it is made in several subsequent steps according to the lifecycle of a RI under the ESFRI approach [2] which consists in passing through the following phases: concept development, design, preparation, implementation, operation, and termination (at some point, in the future, if the case).

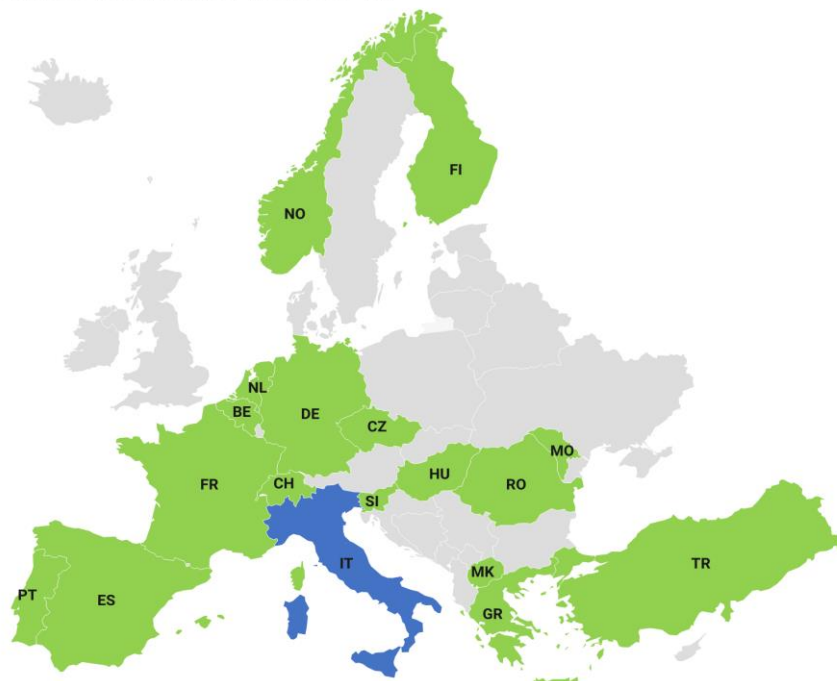
Each phase corresponds to the status of a RI in terms of research landscape needs, mission, strategy, targets, costs and so on.

The RI can move from one phase to another subject to the ESFRI evaluation and its decision to include it in the ESFRI Roadmap depending on the gaps identified in the landscape analysis and the so-called maturity

level of the RI from a legal, technical and financial point of view (Emerging/ Projects/

Landmarks) [2].

Countries involved in METROFOOD-RI



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Fig. 1. Countries involved in METROFOOD-RI

Source: METROFOOD-RI - Infrastructure for promoting metrology in food and nutrition, www.metrofood.eu, Accessed on 30.05.2022 [9].

Once a RI is included in the ESFRI Roadmap, it has the opportunity to access funds under the European Commission funding programs (e.g., Horizon 2020, Horizon Europe) which include dedicated calls for such RIs about the RI's development stage, i.e., design, preparation or construction phase. Consequently, ESFRI supports the development of such RIs in different key domains that it considers a top priority for action, as follows: energy (EN), environment (ENV), health & food (H&F), physical sciences & engineering (PHSC & ENG), social & cultural innovation (S&C INNOV) and digitalization (DIG) [5, 6].

Most of the RIs sustained by ESFRI are distributed-RIs because the aim is to enhance collaboration and integration among various research institutions/organizations, so pushing forward scientific excellence and also, in this way, generating a wider impact, not only at the European level but also worldwide.

Timeline of METROFOOD-RI

The concept of METROFOOD-RI has started to be developed step-by-step, more than 7 years ago and at present, it finally completed the Preparation Phase, which means that it is entitled to prepare the application for the next phase, i.e., the Implementation Phase.

The timeline of METROFOOD-RI [9] can be summarized as displayed in the below diagram (Fig. 2).

PRO-METROFOOD (Progressing towards the construction of METROFOOD-RI - GA 739568) [13] represented the first step in shaping METROFOOD-RI. The project started after the inclusion of METROFOOD-RI as an "Emerging project" in the ESFRI Roadmap 2016, Domain "Health & Food" [2]. During that phase (2017), METROFOOD-RI performed a detailed design and feasibility study, including a detailed inventory of the pre-existing facilities (physical and electronic), an analysis of the potential services, and an analysis of users and stakeholders, cost book analysis, etc.

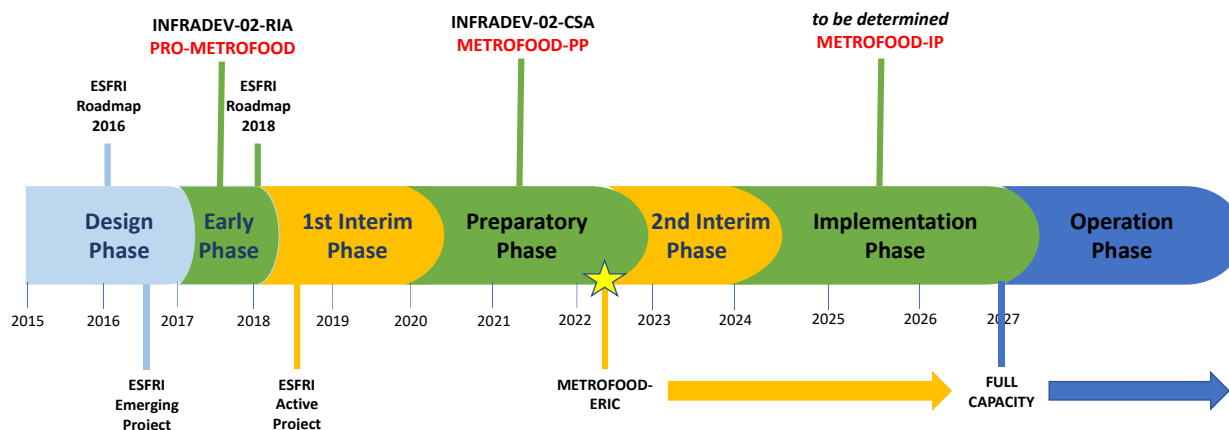


Fig. 2. Timeline of METROFOOD-RI

Source: METROFOOD-RI - Infrastructure for promoting metrology in food and nutrition, www.metrofood.eu, Accessed on 30.05.2022 [9].

Subsequently, in 2018, METROFOOD-RI was included in the ESFRI Roadmap 2018 [4], as the evaluation panels (ESFRI Strategy Working Group and Implementation Group) stated that it clearly fills a gap in the Health & Food domain and it was mature enough to proceed with the next steps for its implementation. As such, in 2020 METROFOOD-RI moved forward to the next stage, i.e., the so-called METROFOOD-PP which was specifically dedicated to the realisation of the Preparatory Phase of METROFOOD-RI. Under this phase, a wide consortium of 48 institutions/organizations have worked further, over a 30 month-period, to organize the infrastructure as a ready-to-implementation and ready-to-operation service-oriented organization [10].

MATERIALS AND METHODS

The presentation of the global stringent challenges and the research landscape relies on the ESFRI reports, as well as on official webpages and documents from the EC, FAO, Eurostat, and other relevant organizations, networks, and initiatives active in the Health and Food domain and cross-domain, including relevant stakeholders of the agri-food system. The description of METROFOOD-RI (history, vision, mission, structure, architecture) is based on the publicly available data and insights from the METROFOOD-PP project.

Diagrams were created for a visual representation of the key aspects related to METROFOOD-RI.

RESULTS AND DISCUSSIONS

Key challenges and gaps

Grand societal challenges represent very complexly, multi-level (macro, meso and micro levels) and interdisciplinary problems that the global society faces including environmental, economic and social problems. All actions and efforts of the EU and other various actors are focused on dealing with these major constraints to successfully mitigate them.

Agri-food, comprised of agriculture and food processing, is a significant economic driver for many EU countries. It emerged as one of the most prominent domains with the EU region's smart specialization strategies. According to the Europe 2020 strategy for smart, sustainable, and inclusive growth, the objective is to make the agri-food sector more competitive while also striving toward more sustainability.

According to the Food and Agriculture Organization of the United Nations (FAO), to meet the increasing food demand, global food production must be increased by 70% by 2050 [8].

Besides this increase in food production, there is a need for more food controls and testing to pass the strict regulations on food safety and their possible evolutions according to

emerging and new food products, new processing techniques and new environmental conditions.

According to the European Cluster Observatory - Priority Sector Report: Agrofood, issued in February 2017, food remains a central need of all human societies. Key global trends are shaping the demands that modern agriculture and food production have to meet: a rising global population requires access to safe and reliable sources of nutrition.

To meet the challenges of the coming years, the EU and the Member States require ambitious policies that unlock the great potential of the European agri-food chain and maintain its place as a world leader. The main challenges are:

-Providing food security as Europe is a major global food importer and exporter and it has some of the world's most fertile arable land. It must use these advantages to play its part in feeding the growing population in Europe and the world as a whole.

-Ensuring food safety - ensuring the highest standards of food safety, all along the chain from farm to fork is essential.

-Creating jobs and growth as the agri-food sector accounts for about 30 million jobs (13.4% of total employment) and 3.5% of total Gross Value Added in the EU-28.

-Safeguarding the environment as agriculture is closely linked with nature and the environment. Innovative technologies, products and practices can help make the most efficient and sustainable use of natural resources, and thereby improve farming's environmental footprint [1].

Agriculture contributed 1.3% to the EU's GDP in 2020 (Eurostat) and, according to Data & Trends 2020 (Food Drink Europe, 2020), the EU food and drink industry employs 4.82 million people, generates a turnover of 1,205 billion euros and 266 billion euros in value-added, making it the largest manufacturing industry in the EU and the biggest manufacturing employer in half of the EU's 28 the Member States plus the UK [12].

Agroecological transition plays an essential role in sustainable agriculture and food

systems that enhance food security and nutrition.

Current research landscape at the EU level

RIs in the Biological, Agri-food and Medical Sciences – i.e., Health & Food domain – continue to be established as a key driver for economic impact.

Food-related diseases are increasing and very costly. The EU national health systems are the most under pressure. Regulatory demands relating to health and novel foods impose comprehensive safety assessment procedures and scientific evidence.

In this context, ESFRI Roadmap 2018 clearly states that new infrastructure efforts are needed at the EU level in the field of food, nutrition and processing. There is a need to connect RIs across the EU and globally, and across the entire food chain.

At present, at the EU level, 16 RIs are related to the "Health & Food" domain, including METROFOOD-RI, which is also connected to ENE, ENV, PSE, SCI and DGI.

Relevance

METROFOOD-RI aims at providing high-quality metrology services in food and nutrition all along the whole food processing and supply chain. Such a comprehensive approach along the supply chain, and the central focus on Metrology as an element of objectivity and impartiality, represent distinctive features of METROFOOD-RI giving it an element of uniqueness in the Landscape of RIs.

METROFOOD-RI will support the needs of the food industry, by establishing a strategy to allow reliable and comparable analytical measurements in the whole food value chain, starting from primary producers until consumers, combined with having access to advanced food metrology and safety testing labs.

Measurements related to food quality, safety, traceability, and authenticity are necessary for many purposes: for official control, quality control, research activities and for evaluating exposure through diet or prevent food contamination, as well as to promote sustainability of agri-food systems and circular bioeconomy.

Metrology is the foundation of any measurement system and provides the tools to make the measurement results reliable and comparable. Reliability of measurements is obtained through Reference Materials and methods and reference laboratories. A lot of standardization bodies dealt with this matter and the authorities at the National and European levels fix method performances and analytical procedures. Although in the last year many efforts have been made to harmonize and share standards and procedures, is still a long way to go. Quality of measurements plays an increasingly key role in technological and socio-economic development. To have a Metrological Infrastructure able to allow trade, demonstrate the quality of products and services and strengthen the knowledge base for decision-making in the environmental, health and forensic sectors is an essential factor [7].

Vision, mission and objectives

The **vision** of METROFOOD-RI is to become a distributed Research Infrastructure of Global Interest, using which it will be possible to find comprehensive, integrated and reliable measurement data on food products and processes and to carry out different activities supporting data collection and measurement reliability, as well as basic and frontier research in food and nutrition.

METROFOOD-RI **mission** (Fig. 3) is to promote metrology in food and nutrition & harmonization on a European and gradually global scale by enhancing quality and reliability at the measurement level and making available and sharing data, information and metrological tools, enhancing scientific excellence in the field of food quality and safety and strengthening scientific knowledge, promoting scientific cooperation and integration [11].

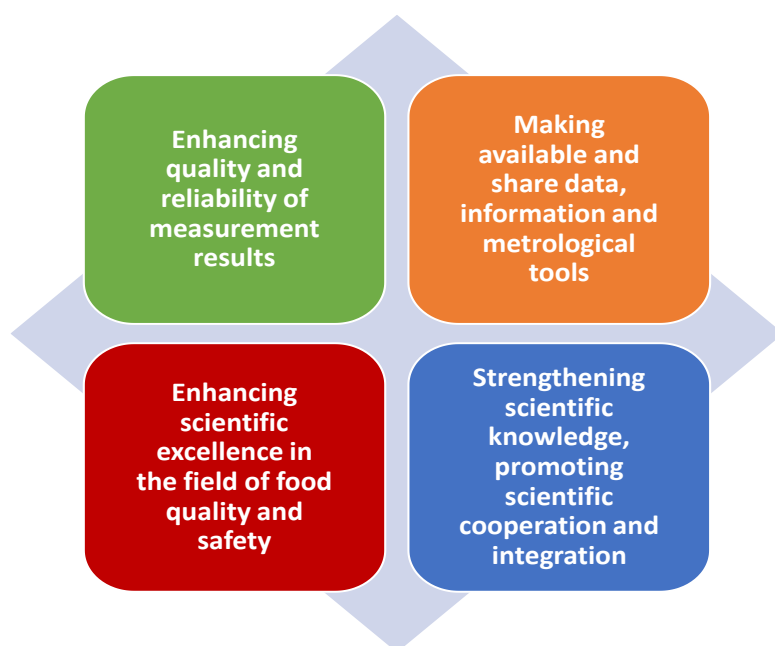


Fig. 3. Mission of METROFOOD-RI

Source: METROFOOD-RI - Infrastructure for promoting metrology in food and nutrition, Mission, <https://www.metrofood.eu/about-us/mission.html>, Accessed on 30.05.2022 [11].

The **general objective** is to enhance scientific excellence in the field of food quality & safety by promoting metrology in food and nutrition, allowing coordination on a European and increasingly Global scale [11].

The **specific objectives** are:

-Providing high-level metrology services in support of the agri-food

-Promoting excellent science, research and innovation on metrology in food and nutrition and support to the agri-food

-Developing the facilities owned by METROFOOD ERIC together with all facilities made available by the National Nodes (NNs)

-Integrating research, training, technology transfer and information dissemination activities.

-Promoting the digitalisation of the agri-food systems, open data and the application of FAIR principles

-Establishing connections with international initiatives relevant in the field

-Synchronising investment and operational funds, in a way to optimise national, European and international resources.

The research activities of METROFOOD-RI cover the whole food chain and related

services, from agri-food production up to final consumption, too:

-Support sustainability of food production and consumption;

-Improve food quality and safety;

-Achieve food traceability and authenticity demonstration;

-Optimize all steps from farm to fork with a holistic approach;

-Foster the digitalization of the agri-food systems.

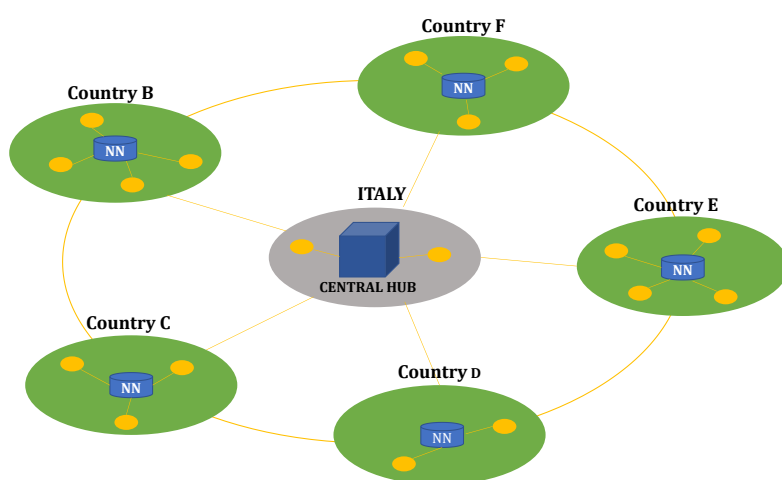


Fig. 4. METROFOOD-RI's structure as distributed-RI

Source: Based on the ESFRI Strategy Report on Research Infrastructures Roadmap 2021 Public Guide [3].

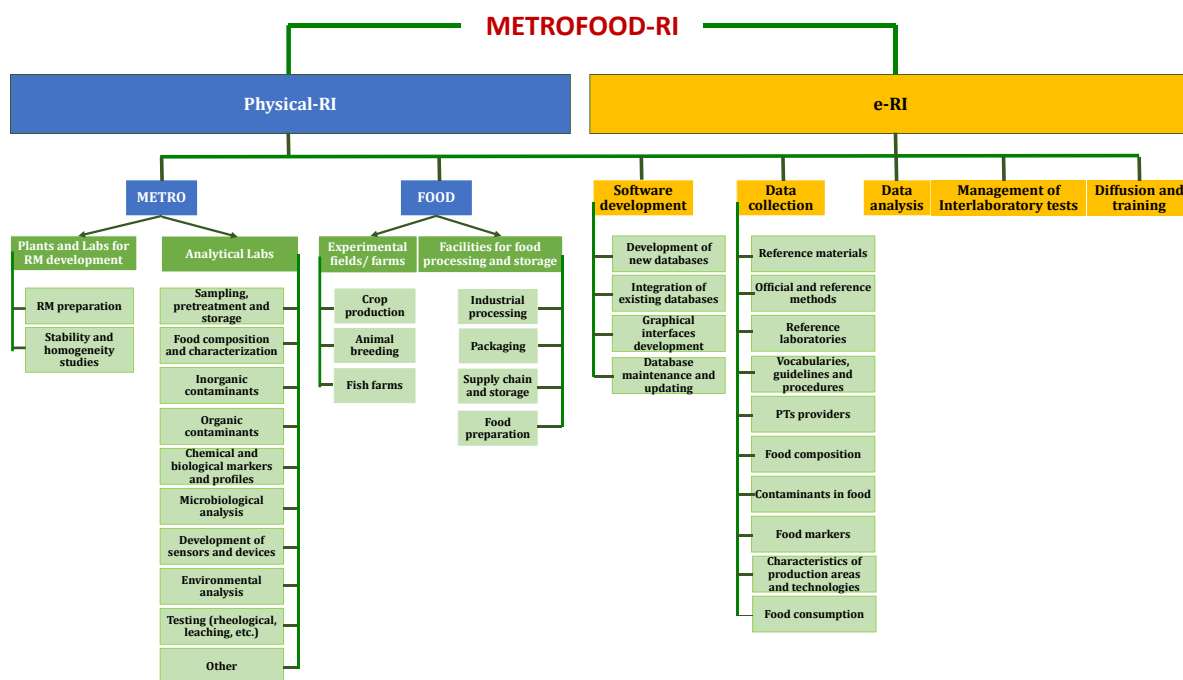


Fig. 5. Physical-RI and electronic-RI of METROFOOD-RI

Source: METROFOOD-RI - Infrastructure for promoting metrology in food and nutrition, <https://www.metrofood.eu/about-us/infrastructure.html>, Accessed on 30.05.2022 [10].

Structure

As a distributed-RI, METROFOOD-RI will be built on a Hub and Node model, formed by a Central Hub in Italy and a network of National Nodes, one for each country involved. Some National Nodes (NN) – typically those of the Countries with more Partners (e.g.: Italy, Romania, Republic of Macedonia, Slovenia), will be in turn organized in a network of Centres.

Infrastructure architecture

METROFOOD-RI includes a physical (P-RI) and electronic component (e-RI), as showcased in Fig. 4.

Physical-RI

METROFOOD-RI mainly counts on pre-existing facilities, its “Implementation” relies on the upgrading of the pre-existing facilities that each partner owns and the implementation of the Central Hub.

The physical infrastructure of METROFOOD-RI can be described in two main components, the “Metro side” and the “Food side”, depending on the different physical facilities. The “Metro side” consists of:

- plants for the development and production of new reference materials for the agri-food sector;

- analytical labs for the development and validation of new methods for the chemical, physical-chemical and (micro)biological characterisation of foods and any matrix of interest for the agri-food system,

while the “Food side” consists of:

- facilities for primary production of food (e.g., agricultural fields, greenhouses, livestock breeding, aquaculture, agricultural (by)products for bioenergy production, biotechnological production of foods/ingredients, etc.)

- experimental plants related to food processing, food storage, food packaging, treatment/reduction of food losses and waste, production of aids in food production/storage up to kitchen labs for reproducing and studying the effects of consumers’ domestic habits on food quality and safety.

e-RI

The objective of METROFOOD-RI is to create a unique platform providing access to a worldwide distribution network of scientific facilities and state-of-the-art services, data, information and metrological tools for the measurement and assessment of food quality and safety, covering the entire food chain from agri-food primary production up to final consumption.

The METROFOOD e-RI will cover two major areas, that is:

- The public resources (i.e., digital tools, services, and datasets) for external and internal users,

- Digital tools for internal management and administration of the Central Hub and its relationship with the National Nodes.

CONCLUSIONS

Agriculture has a vital mission in securing crop production and increasing crop yield to face the growing population fast pace. The agri-food sector faces growing concerns as the market demands more and more healthy, sustainable and safe products, made of natural ingredients, so that is another important reason for paying particular attention to the whole food value chain to ensure food quality, food safety, authenticity and traceability.

In this context, METROFOOD-RI aims to tackle consumers’ needs and expectations, help policymakers and local authorities in the decision-making process, as well as to help scientists and food business operators make excellent research related to food and nutrition, but also develop complex innovation ecosystems where industry plays an increasingly significant role. Improving the collaboration between the RI and industry is crucial in boosting competitiveness and innovation. RIs “constitute a powerful resource for the industry” as expressed in the ESFRI White Paper 2020 [11, 6].

METROFOOD-RI represents a cornerstone in the research ecosystem and not only, with a focus on the Health & Food domain and a look to cross-domain activities, covering a broad area of research activities and business sectors, with a high potential of widening at

the global level, bringing multiple long-term benefits to various stakeholders, addressing global complex challenges that need urgent solutions, all of these aspects highlighting METROFOOD-RI's relevance and imperativeness for an indefinite period.

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