food for life

IMPLEMENTATION ACTION PLAN

2021 Update

Contents

Foreword for the 2021 update

The 2018 Implementation Action Plan (IAP) was created to detail the execution steps of the 2016 Strategic Research and Innovation Agenda (SRIA). Following the SRIA update earlier this year, we have worked with the experts in the Scientific Working Groups to translate the Changes to the SRIA into new actions, and update the existing actions as needed.

In addition, the sections on consumer and citizen engagement, digital technologies were updated, and new sections on the National Food Technology Platforms and measuring impact were added.

We believe that with this update we can continue to provide important actionable guidance to the European Commission, Member States, the food industry and the wider research community interested in food, to make a real difference to the Food and Drink Sector.

Prof. Dr Gert Meijer, Chair

Prof. Dr Tim Hogg, Co-Chair

Foreword for the first 2018 Edition

During 2016, the European Technology Platform (ETP) 'Food for Life' worked with five expert Scientific Working Groups to develop a Strategic Research and Innovation Agenda (SRIA). After a number of consultations and revisions, the final version of the SRIA was published in December 2016. The SRIA lays out a vision and strategy of how to transform the European food sector to become more successful in an increasingly globalized, competitive market. In the SRIA, specific actions are proposed to make this vision a reality.

Taking the SRIA as a starting point, the ETP 'Food for Life' subsequently developed a detailed Implementation Action Plan (IAP) presented in this document. The IAP defines how the action items listed in the SRIA should be executed, and what tools and instruments should be utilized to make this possible. Although the focus of the ETP Food for Life is primary on food design and manufacturing, in defining the IAP we have taken a food systems approach. We have adopted the Food 2030 characterization of the food system which defines it as a system that (a) integrates the entire 'food value chain' from inputs, to primary production (agriculture, aquaculture & fisheries), harvesting, storage, processing, packaging, distribution, waste streams, to consumer intake – and back,[1,2] (b) connects actors across sectors in the food system and recognises it as part of a wider bio-economy that overlaps with other systems, e.g. health, energy, climate; and (c) connects production and consumption to food system outcomes in the domains of nutrition, climate, circularity, and innovation.

For the development of the IAP, we relied on the guidance of experts that constitute our ETP, and in addition brought in outside expertise, especially on implementation actions required to grow and support small and medium-sized enterprises (SMEs). Moreover, consultations and joint workshops were held over the course of 2017 to collect additional input, especially as pertaining to the contributions and interests of European Union Member States. We strongly believe that progress towards our formulated vision for the European food and drink sector will only be made through a joint effort of different public and private stakeholders, at different geographical levels and from different sectors of activity. Together, these actors are able to execute the proposed actions in a coordinated manner to bring about the urgently needed transformation.

We are convinced that the work of the ETP 'Food for Life' represents a unique opportunity for all interested parties in the European food chain to increase their competitive strength and ensure the continuing well-being and welfare of consumers across Europe. Success will, however, require the long-standing commitment of all, and this Implementation Action Plan is therefore also a rallying call to support the proposed actions.

Prof. Dr. Gert Meijer, Chair

Prof. Dr. Jochen Weiss, Co-Chair

[1,2] Cash, D. et al. (2006). Scale and Cross-Scale Dynamics: Governance and Information in a Multilevel World, Ecology and Society 11(2): 8
Ericksen P (2008) Conceptualizing Food Systems for Global Environmental Change Research, Global Environmental Change 18(1): 234–245

LONG-TERM OBJECTIVES OF THE ETP 'FOOD FOR LIFE' SRIA

1.1 Introduction

This Chapter is a brief synopsis of the Strategic Research and Innovation Agenda (SRIA) 2016, updated in 2021, which can be accessed in full at the ETP website. The purpose of this Chapter is therefore not to repeat the SRIA, but to highlight the strategic elements and actions in the SRIA, which form the foundation of the Implementation Action Plan (IAP) proposed and updated in this document.

The EU food and drink industry is the largest manufacturing sector in terms of turnover

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and added value of

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In addition, it is a key job provider and a direct employer of

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people with jobs spread across all European Member States, mostly in rural areas; not counting the indirect but associated jobs.

1.2. ETP 'Food for Life' and the Future of the European Food and Drink sector

The European Technology Platform (ETP) 'Food for Life' mobilises stakeholders to help deliver solutions for the EU food and drink industry through research and innovation (R&I). After the publication of its 'Vision for 2020 and beyond' in 2005, the ETP 'Food for Life' has regularly developed R&I agendas and roadmaps in the food domain for actions at EU and national level to be supported by both private and public funding.

Until recently most R&I actions have successfully dealt with individual compartmentalised parts of the food system. However, it has been recognized that the societal challenges we currently face are interconnected. R&I in the food sector would therefore benefit from a more holistic, or 'systemic' approach, linking all elements and levels of the food system, i.e. from primary production to consumers, and fostering inter and transdisciplinary collaboration and a wide stakeholder engagement. Such a food system approach is the narrative around which the ETP 'Food for Life' has designed its SRIA and IAP.

The success of this exercise therefore relies on an effective collaboration with other partners of the rich European R&I landscape of initiatives, coming from sectors such as ICT/digitisation, agriculture, manufacturing, energy, transport, new materials, water, etc. and with the relevant research funding structures. In particular, better integration of the entire food chain linking agriculture, processing, retail and consumer is essential for a successful outcome of the IAP.

We believe that the whole food systems approach followed in the design of this IAP, especially in the concept for a public-private collaboration described in Section 3.5, can help foster the synergies between current and future initiatives and stakeholders, maximising efficiency gains

and impacts. For this reason, we also welcome the efforts of the European Commission to engage R&I policy makers, industry, researchers, and society in an open dialogue on how to best pool and organise EU R&I resources in order to future-proof European food systems, as practised in the FOOD 2030 events held since 2016.

The inclusion of a food-dedicated ETP as an important element in the EU innovation ecosystem is justified by the relevance of the sector and the challenges it currently faces. The EU food and drink industry is the largest manufacturing sector in terms of turnover (€1.205 Billion) and added value (1.9% of EU gross added value). In addition, it is a key job provider and a direct employer of 4.82 million people with jobs spread across all European Member States, mostly in rural areas; not counting the indirect but associated jobs. While there are many opportunities that could guarantee growth for years to come, there are also large threats that need to be addressed. The EU food and drink industry is now at a turning point due to economic, social and environmental challenges. As a consequence the sector needs to think of new ways of working, and step up its efforts to meet consumer demands in relation to nutrition, health and sustainability.

In its 2016 SRIA, the ETP 'Food for Life' has identified four critical global challenges for which the European food sector is required to develop solutions (Fig. 1).

Given this scenario, the ambition of the ETP 'Food for Life' is to bring about a step-change to foster a thriving European Food Ecosystem that builds on cultural diversity with consumers and industry working in partnership. The Food System of Tomorrow will use nature's resources in a responsible and sustainable manner, and be dynamic, flexible, fully transparent and accessible to all. Progress will be made by bridging modern social and natural science and technology approaches to benefit the greater public, making healthy and sustainable food alternatives not only effortless and affordable to all consumers, but also desirable and exciting.

Figure 1. Key challenges

CONSUMER ENGAGEMENT, CONSUMER BEHAVIOUR AND PERCEPTION OF FOOD

Consumers increasingly distrust the food sector as a provider of food solutions that they want or need. In addition to price, taste and appearance, new criteria such as sustainability or health are becoming more prominent in selection and consumption patterns.

DEMOGRAPHIC CHANGES

The global population is undergoing a rapid change, not only in terms of size, but also with respect to composition. It is estimated that by 2050, roughly 10 billion people will inhabit the planet with many of them having life expectancies that are longer than at any other time in human history.

SECTOR MATURITY

While the other three global challenges require significant investment in research, development and innovation, the maturity of the sector has brought about low profit margins along the chain. The past successes did not translate into increased resources to fuel future progress, but rather increasingly diminishing R&I investments. This makes finding the resources for the necessary changes, increasingly difficult.

RESOURCES

With the number of production of food becoming more difficult due to depletion of natural resources, competition with non-food uses, climate change and the global population continuing to increase, securing a continued supply of high quality raw materials will become one of the great challenges of the 21st century.

1.3. Overall Strategic Objectives defined by the ETP 'Food for Life'

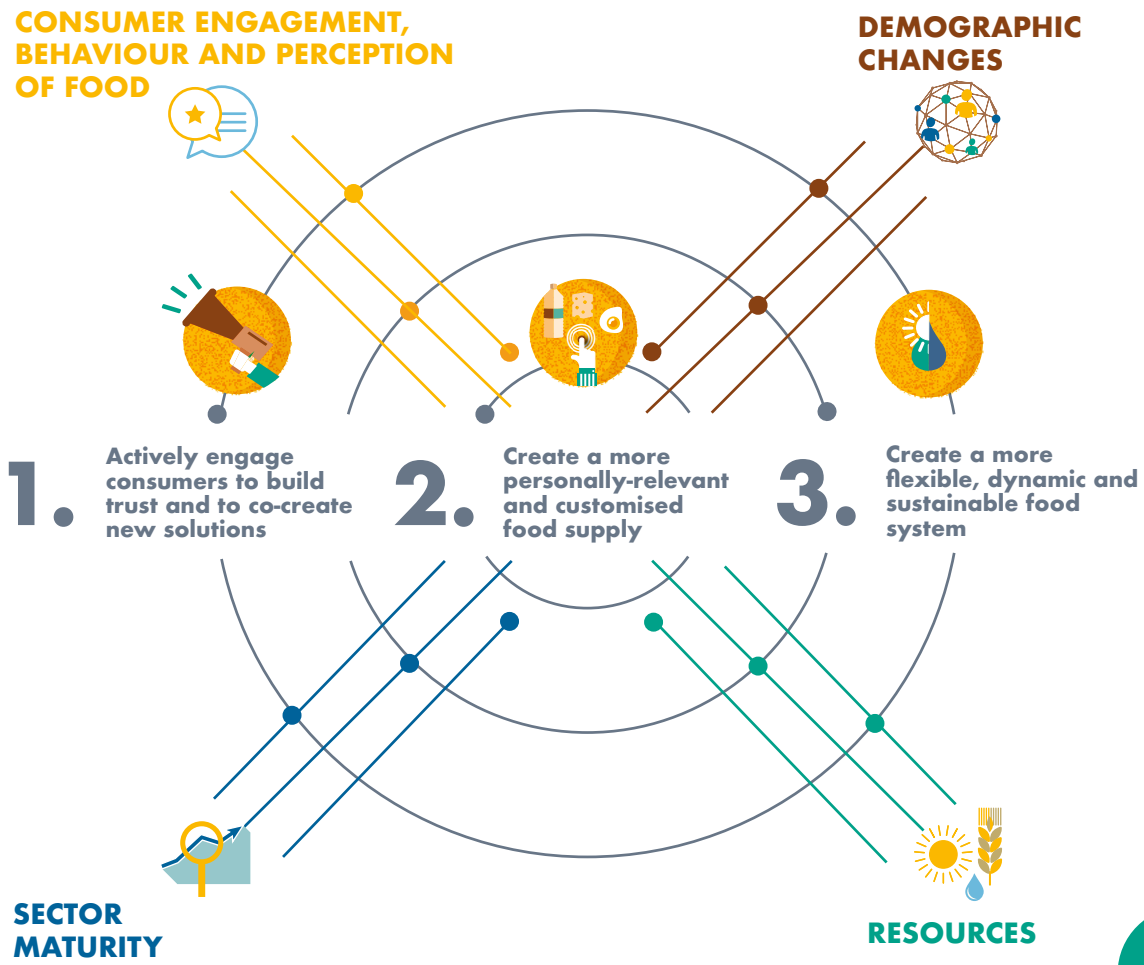
In the 2016 SRIA, the ETP 'Food for Life' described the urgent need for increased private and public investments in R&I in order to secure Europe's role as a leading global provider for safe and healthy foods produced in a sustainable manner. To realise its ambition, the ETP 'Food for Life' has identified three strategic objectives that will allow the food and drink sector to move forward as a whole (Fig. 2):

- Actively engage consumers to build trust and to co-create new solutions;
- Create a more personally-relevant and customized food supply;
- Create a more flexible, dynamic and sustainable food system.

The overall result will be a shift from a conventional mass production model to a more personalized and customized model involving and engaging consumers while simultaneously promoting flexibility and resource efficiency. In line with these objectives, the recent ETP 'Food for Life' SRIA highlighted 17 topics that are critical to the achievement of the three strategic R&I objectives (Fig. 3):

R&I Target 1, **Increase the engagement and involvement of consumers** centres on getting a better understanding of what consumers really

Figure 2. Strategic objectives identified by the ETP 'Food for Life'



expect and value when it comes to food (1.I). Based on this understanding, consumers could be engaged actively in the overall supply and preparation of their foods: leveraging modern data sciences, one can now communicate with individual consumers (1.II), or even explore completely new ways of producing and distributing foods (1.III). At the same time it is important that individual consumers can easily find the information that they personally understand on, for example, sustainability (1.IV). Ultimately, the goal is to create a food system that can be customized to fulfil consumers' diverse expectations (1.V).

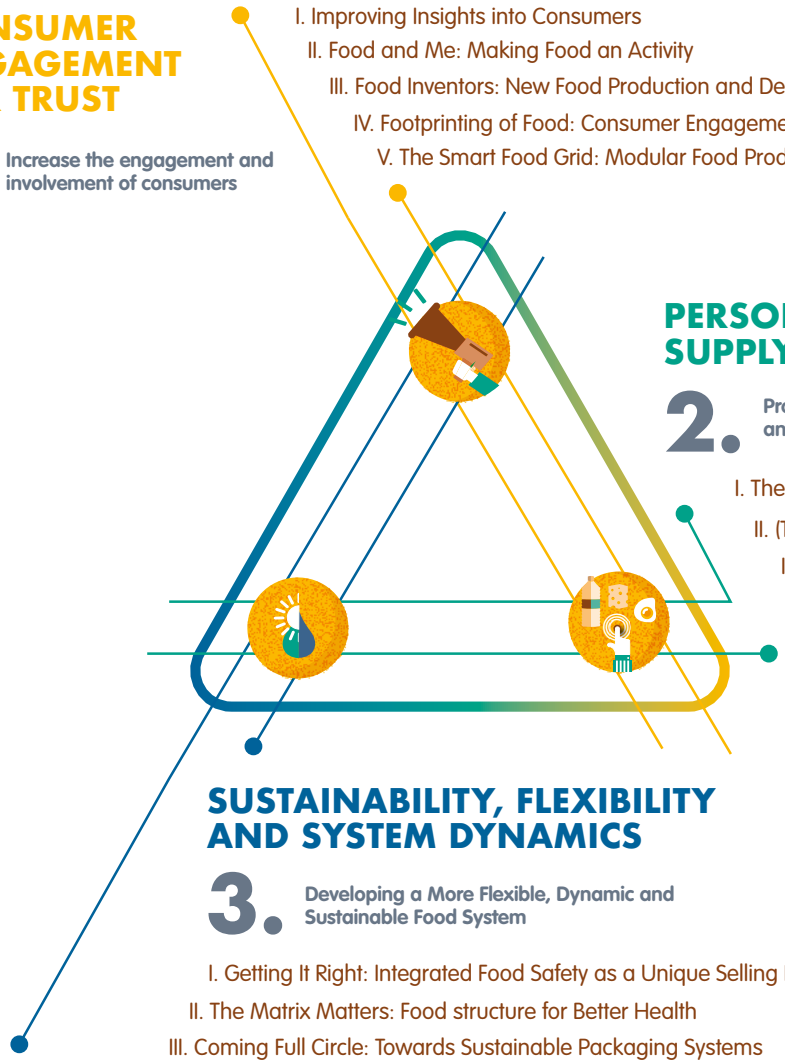
We obtain ever more insight into our needs, and we find that every individual has specific and differing needs. Technology also gives us more and more possibilities of customization to address specific individual's requirements. Therefore, R&I Target 2, **Providing the Basis for a More Personalized and Customized Food Supply**, aims at identifying needs and developing measures to fulfil them. For this, we need to better quantify and understand the appreciation of our food, in its wide spectrum of cultures and preferences (2.I), and to better identify the dietary requirements of European populations in their varying lifestyles, health status, cultures and environments (2.II).

Part of that information will be gathered via intelligent packaging leveraging Generation 4.0 technologies (2.III). This knowledge will be complemented by the use of modern sciences for the prediction of the complex behaviour of food in the digestive tract (2.IV and 2.V). Ultimately, all these dimensions have been incorporated in the Forerunner Project (2.VI), in which new concepts and technologies are integrated to assure overall well-being of the individual consumer/citizen.

While the first two Targets focus on the consumer, the third R&I Target, **Developing a More Flexible, Dynamic and Sustainable Food System** is about ensuring food security in our future. This comprises both the discovery and exploration of new foods while making sure that these foods are good for us and our planet (3.II - on understanding the role of the food matrix, 3.III - on truly sustainable packaging concepts, 3.IV - on new raw materials, and 3.V - on 'un-refining' our current foods), and ensuring that all the food we consume will not be bad for us (3.I and 3.V on ensuring food safety, now and with new food sources).

The overall programme will contribute to meeting the Sustainable Development Goals (SDGs) (Table 1) and will position the European food industry as a strongly innovative sector, by embracing the unique diversity that we have in European culture, and at the same time making use of the better understanding that we are gaining on the immensely complex system that consists of humans, foods and environment to guarantee that the production of our food will be ensured for the long-term future.

Figure 3. SRIA topics



CONSUMER ENGAGEMENT FOR TRUST

1. Increase the engagement and involvement of consumers

I. Improving Insights into Consumers
II. Food and Me: Making Food an Activity
III. Food Inventors: New Food Production and Delivery Models to Provide Better Access
IV. Footprinting of Food: Consumer Engagement in Sustainability
V. The Smart Food Grid: Modular Food Production and Distribution

PERSONAL RELEVANCE AND SUPPLY CUSTOMISATION

2. Providing the Basis for Personalised and Customised Food

I. The Food I Love: Appreciation of Diversity in Food and Eating
II. (Tr)Eat Me: Dietary Approaches for the Prevention of Non-Communicable Diseases
III. Packaging 4.0: Intelligent and Communicating Packages
IV. In Silico Food Design: Understanding Food Digestion
V. The Ecology Inside Us: Food Meets Gut Microbiome
VI. Foods for Tomorrow: Assure Consumer Health and Wellbeing

SUSTAINABILITY, FLEXIBILITY AND SYSTEM DYNAMICS

3. Developing a More Flexible, Dynamic and Sustainable Food System

I. Getting It Right: Integrated Food Safety as a Unique Selling Point
II. The Matrix Matters: Food structure for Better Health
III. Coming Full Circle: Towards Sustainable Packaging Systems
IV. It's All Food: Alternative Food Sources
V. Check It: Next Generation Strategies for Food Safety Assessment
VI. Simply Natural: Towards Less Refined, More Natural Food Ingredients

Table1. Link of the specific SRIA topics and the Sustainable Development Goals
(Table kindly provided by Gavin Milligan)

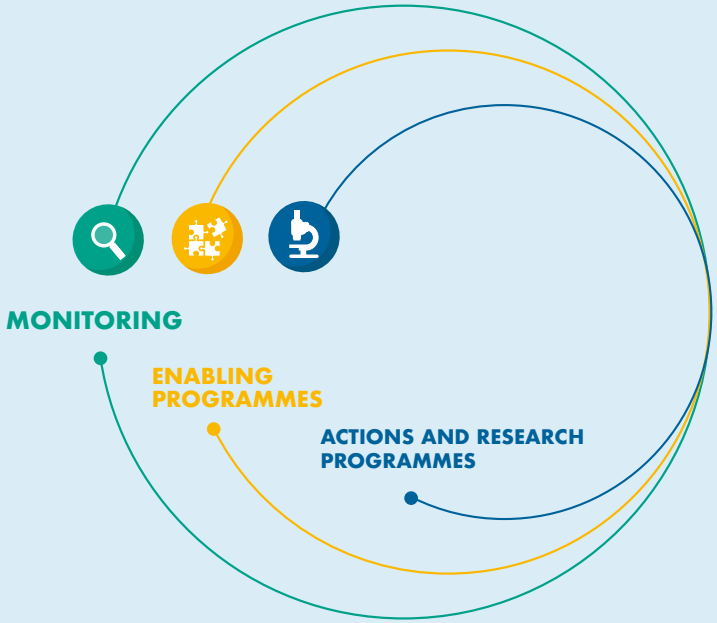
PILLAR	TOPIC IN THE SRIA	SUSTAINABLE DEVELOPMENT GOALS (SDGs)
INCREASE THE ENGAGEMENT AND INVOLVEMENT OF CONSUMERS	IMPROVING INSIGHTS INTO CONSUMERS	
	FOOD AND ME: MAKING FOOD AN ACTIVITY	
	FOOD INVENTORS: NEW FOOD PRODUCTION AND DELIVERY	
	FOOTPRINTING OF FOOD: CONSUMER ENGAGEMENT IN SUSTAINABILITY	
	THE SMART FOOD GRID: MODULAR FOOD PRODUCTION AND DISTRIBUTION	
PROVIDING THE BASIS FOR A MORE PERSONALISED AND CUSTOMISED FOOD SUPPLY	THE FOOD I LOVE: APPRECIATION DIVERSITY FOOD & EATING	
	(TR)EAT ME:DIETARY APPROACHES FOR THE PREVENTION OF NON-COMMUNICABLE DISEASES	
	PACKAGING 4.0: INTELLIGENT AND COMMUNICATING PACKAGES	
	IN SILICO FOOD DESIGN: UNDERSTANDING FOOD DIGESTION	
	THE ECOLOGY INSIDE US: FOOD MEETS GUT MICROBIOME	
	FOODS FOR TOMORROW: ASSURE CONSUMER HEALTH AND WELLBEING	
DEVELOPING A MORE FLEXIBLE, DYNAMIC AND SUSTAINABLE FOOD SYSTEM	GETTING IT RIGHT: INTEGRATED FOOD SAFETY AS A UNIQUE SELLING POINT	
	THE MATRIX MATTERS: FOOD STRUCTURING FOR BETTER HEALTH	
	COMING FULL CIRCLE: TOWARDS SUSTAINABLE PACKAGING SYSTEMS	
	IT'S ALL FOOD: ALTERNATIVE FOOD SOURCES	
	CHECK IT: NEXT GENERATION STRATEGIES FOR FOOD SAFETY ASSESSMENT	
	SIMPLY NATURAL: LESS REFINED, MORE NATURAL FOOD INGREDIENTS	

IAP: THE PLAN OF ACTION OF THE ETP ‘FOOD FOR LIFE’

2.1. Introduction

The IAP maps out how the action items listed in Section 1.3 (and in more detail in the SRIA) can be realised most effectively. The IAP therefore takes up the three aforementioned R&I targets and their 17 topics and focuses on the modalities of actions specific to each topic (in this Chapter), their enablers (Chapter 5) and the monitoring of their progress (Chapter 6) and how the impact of the actions could be assessed, as represented in Figure 4.

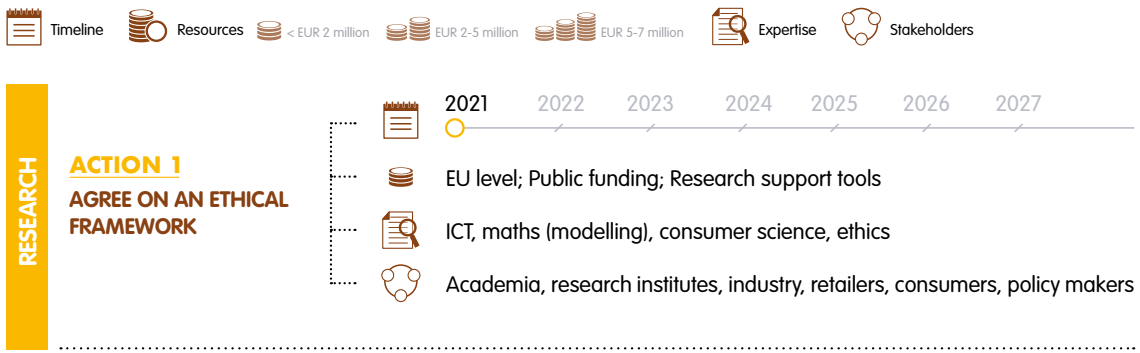
Figure 4 .Elements included in the IAP



The Actions of the Research and Innovation Programme are detailed in Appendix 1 in form of a comprehensive table. There, specific Actions have been defined for each of the 17 Topics referred to in Section 1.3. To illustrate the chosen tabular representation, an example of the illustration of an action is shown below in Figure 5.

For each Action, a designated Number ("X" in the Figure below), an R&I Type (indicated in 4 different colours; see Section 2.2), a Description, an Implementation timeline (circled in red in the Figure below), required Resources and Expertise, and relevant Stakeholders to be engaged in the activity are depicted:

Figure 5 (below). Extract from the tables compiled in Appendix 1



2.2. Different Types of Actions

The experts of the ETP have identified 4 Types of action to realise the overall SRIA (on the right).

Synergies of training, education, communication and dissemination activities between the different topics have been exploited in designing several horizontal actions. Those activities require distinct approaches, but when effectively interlinked they will elevate the profile of the European food sector as a driver for European growth. To exploit these synergies several horizontal actions were designed to be worked out across individual themes. In addition, in Section 5.4 we have focused on strengthening the role of small and medium-sized enterprises (SME) in the food system R&I space, since the sector is in fact largely composed of SMEs. The Actions identified in Section 3.4 have also been included in the Tables in Appendix 1.

RESEARCH

Actions ranging from basic to applied, pre-competitive research, the primary aim of which is to generate new scientific and technical knowledge.

INNOVATION

Actions with the aim of adopting, assimilating and exploiting the newly developed and discovered knowledge with the explicit goal of creating products, processes or services. Value creation through innovative start-ups could be a part of this as well.

TRAINING AND EDUCATION

Actions to facilitate human resource developments and knowledge exchange by fostering mobility of researchers and innovators, developing novel educational programmes in Member States that go beyond the traditional offerings of academic institutions (e.g. with a focus on continuing and public education). Training and education are key components for the extension of knowledge and for its transformation into competitiveness through a well-trained, flexible and skilled workforce. It is important to leverage on new skills and entrepreneurship to take advantage of the huge opportunities.

COMMUNICATION AND DISSEMINATION

Actions focused on distributing and exchanging information to and with various audiences in forms that are appropriate to their needs. The aim is to engage effectively the multitude of stakeholders that make up the sector to foster greater mutual confidence and trust. The communication and dissemination elements of the ETP 'Food for Life' require a coherent and durable set of activities. An effective and bi-directional communication strategy relies on trust and confidence, and on the ETP 'Food for Life' having, and being perceived to have, independent credibility across all stakeholders. It is therefore key to establish a dialogue among the whole food system, consumers and policy makers, to explore together the potential of the research pathways described in the SRIA and in this IAP. For achieving an effective dialogue, scientific outcomes should be translated into simple and understandable messages and the communication strategy tailored to each specific group of stakeholders. In the medium term, a new stakeholder platform that truly brings together all concerned actors of the food system of the future will need to be created to facilitate this.

2.3. Implementation Timeline

While all actions are important, the experts of the ETP 'Food for Life' have given indications on the timescale necessary for the success of the action, prioritising those actions that were perceived as more urgent. Moreover, dependencies and synergies between projects have been considered.

The result is a logical flow of events where some projects exploit immediate opportunities while others are timed due to those dependencies or implemented over longer periods due their inherent complexity.

The Figure on the right depicts the timelines for each Type of Action for the five Topics that form R&I Target 1. 2 and 3 (Fig. 6).

Figure 6. Type of actions

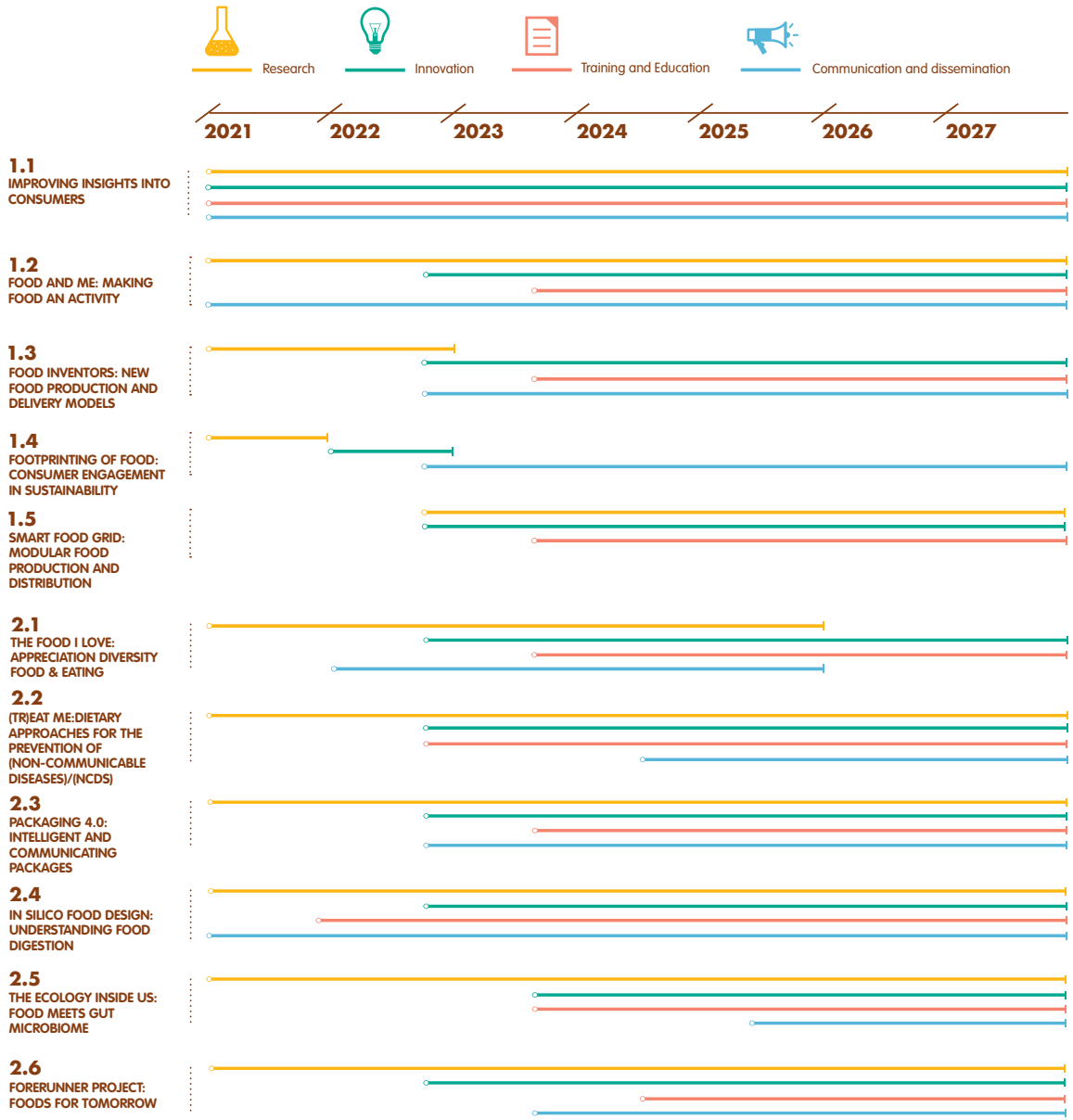
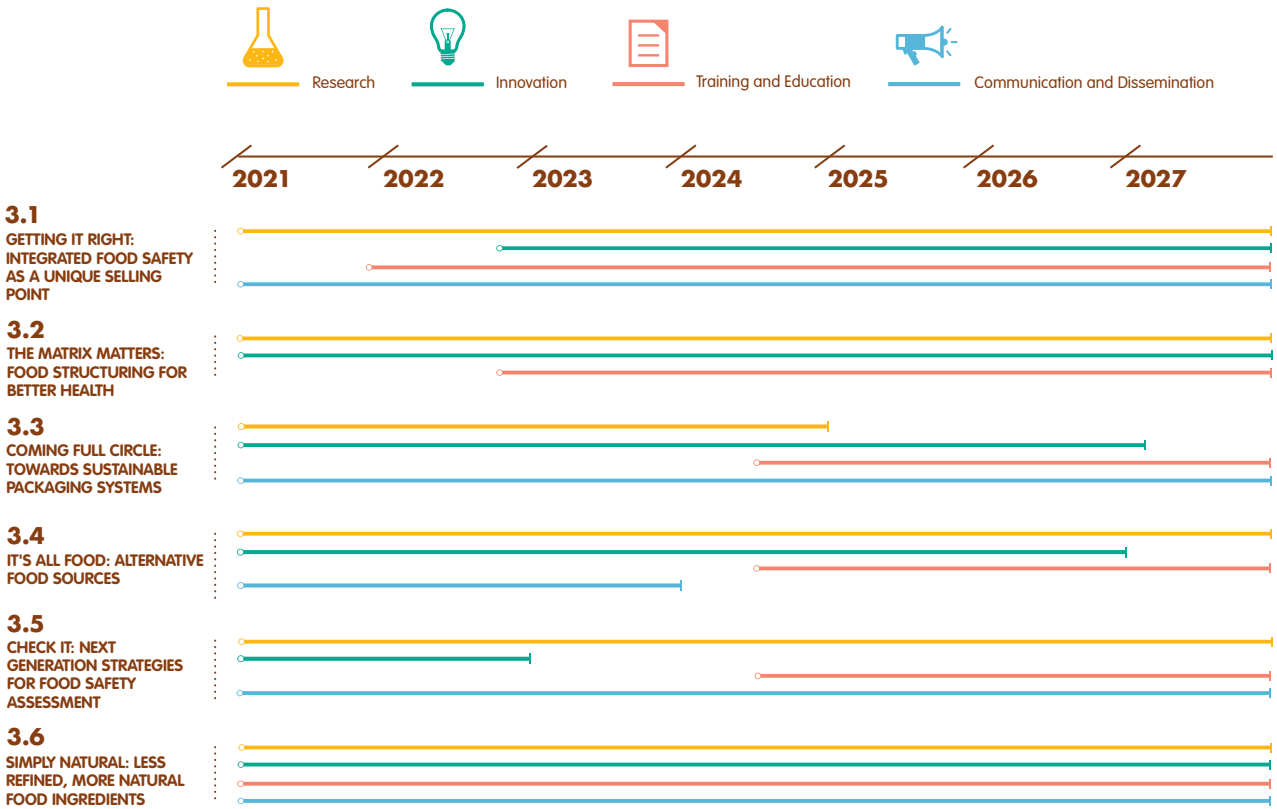


Figure 6. Type of actions



2.4. Analysis of Total Resource Needs

Since a significant part of the pre-competitive research identified has a strategic goal, it is expected that a large proportion of this work will be supported by the public sector in collaboration with private actors such as industry or investors, as appropriate. This support can materialise from novel funding instruments and sources but also from existing resources to be mobilised and directed more effectively.

The science necessary to achieve success requires inputs from several fields, including social, biological, physical, medical and ICT sciences. Research infrastructures will allow and encourage this transdisciplinary research, not only among scientists, but also among stakeholders.

ENABLING INSTRUMENTS

3.1. Introduction

In addition to the specific actions summarised in Chapter 1, and described in detail in Appendix 1, the success of this IAP will depend on several key enabling instruments and activities that need to be addressed or considered along all R&I targets and actions. Below, key enablers are listed that are of particular importance to the required integration for a sustainable food system (see Food Systems chapter in the SRIA update of 2021).

Responsibility and Openess in Research and Innovation (RORI)

- Engagement
- Equal Opportunities
- Open Science
- Open Innovation
- Open to the world
- Ethics

4.2. Responsible and Open Research and Innovation

According to the European Commission, 'Responsible Research and Innovation' refers to proceeding in R&I in a way in which all relevant stakeholders representing social, ethical and economic concerns, including researchers, industry, policymakers and civil society are engaged. At the same time this approach should enable easier access to scientific results and knowledge, consider gender and ethics in R&I processes and enhance formal and informal science education. To implement this in the food sector will also require a clear agenda on how to establish more openness within the sector itself. As reflected upon by the Research, Innovation and Science Policy Experts high level group (RISE), 'Open Innovation', 'Open Science' and 'Open to the world' (the 3 O's) are the crucial mechanisms to be considered to ensure openness in a way that will positively impact innovation, growth and international competitiveness. Therefore, in order to tackle the challenges and opportunities outlined in the current SRIA we suggest combining Responsibility and Openness in Research and Innovation (RORI) in one approach for the specific development needs of the food sector.

Within the food sector a RORI approach will make it possible to enhance the impact and acceptance of the R&I activities as well as to allow for a more dynamic R&I environment, which, in line with our SRIA, will foster more co-creation and creative thinking. Furthermore, an early engagement of stakeholders can provide better focus, enabling identification of topics and the prioritization of their execution. RORI will be a cross-cutting approach that is implemented across all IAP activities and

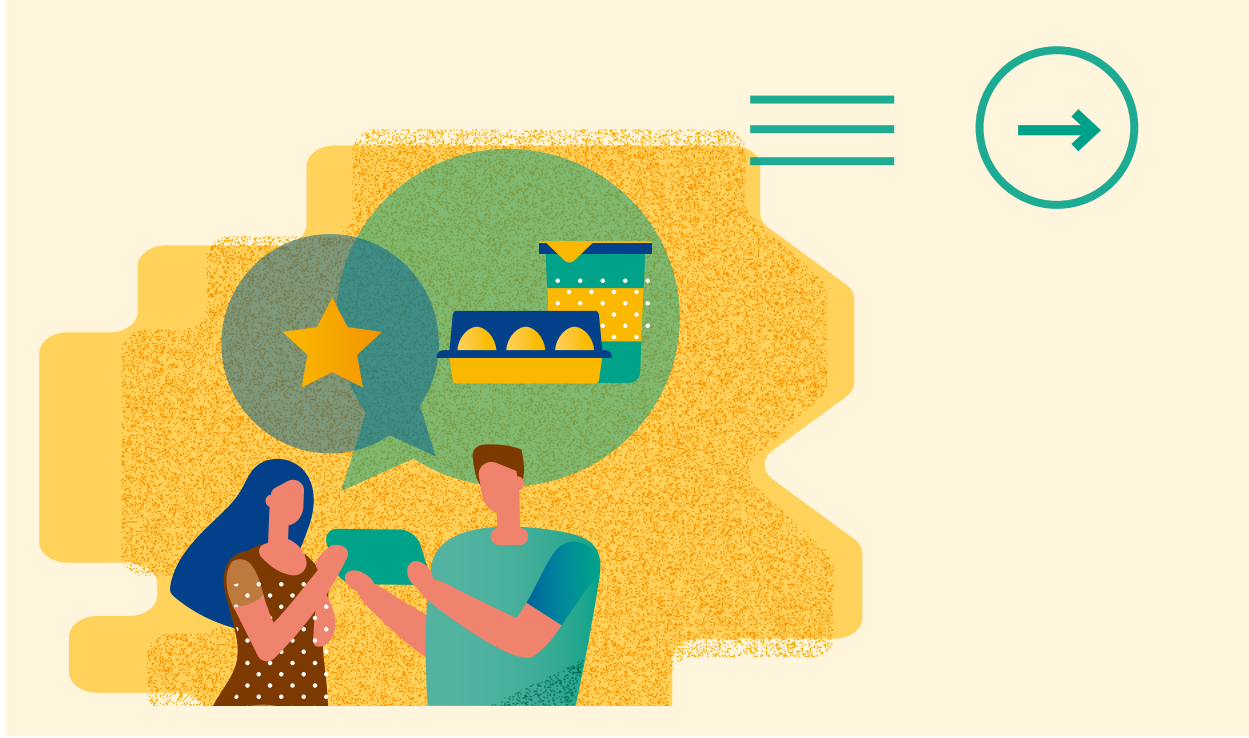
embrace several key enablers. This is essential to ensure that the three SRIA objectives create the intended shift from a more conventional mass production to a more personalized and customized production model, engaging consumers while simultaneously promoting flexibility and resource efficiency.

As part of the RORI approach several key enabling elements needs to be addressed.

ENGAGEMENT

Engagement of all relevant stakeholders should be ensured through their early involvement, by creating an environment of trust, where stakeholders can talk freely and discuss challenges and opportunities without risking their own position, competitive advantage, etc. It is also important that all stakeholders see their own relevance and role in a given activity and feel actively involved and engaged. All IAP action modes will require a description of how to involve the relevant stakeholders, their role and importance for execution of the activity. It is also important that each individual stakeholder understands its relevance in transforming the R&I activities into societal solutions.

While all IAP activities seek to engage stakeholders in its broadest sense, a particular focus will be on the consumer as the understanding and the dialog with the consumer is key to ensure the conversion from mass production to personalized and customized production. A more detailed description of consumer involvement is described in Section 3.3.



EQUAL OPPORTUNITIES

Equal Opportunities are particularly relevant in the food sector. The sector employs people covering the entire scale and range of educational backgrounds, from low to high level educations, employees from all socio-economic categories and from all parts of Europe and also from outside of Europe. Equal opportunities for employees need to be offered in terms of personal development and further education, gender, social status, location, age, etc. While these opportunities may be relatively easy to offer in large companies, they are more complicated to implement in SMEs where the resources and opportunities for personal development are more limited. Therefore, the R&I IAP, among others, addresses the development of open structures that enable employees to transition more freely from one company to another, or from the private to the public sector, e.g. from a company to an academic or policy institution, and vice versa, and also suggest instruments for companies to collaborate more easily on personnel educational activities.

OPEN SCIENCE

Open Science responds to the social consensus that scientific discoveries and new knowledge are public and they must be made available to everybody in order to accelerate developments and to make citizens understand why investment in science is important. The establishment of a kind of Open Science ecosystem is important in order to build trust with society and maximise the impact of research. It promotes new ways of conducting science in which many collaborate and contribute, aided by the use of digital technologies and new collaborative tools. As described by the RISE group, Open Science should at least include

public accessibility and full transparency of scientific communication, public availability and reusability of scientific data, transparency in experimental methodology and complete scientific collaboration.

In order to create such an Open Science ecosystem relevant to the food sector, actions are needed at several levels. First, infrastructures, such as the future European Open Science Cloud, need to be established and their performance optimised for the food sector. This will require development of the proper e-infrastructures, digital tools and services and most probably also changes in the legal tools and policy requirements. Secondly, researchers involved in food related research must be encouraged to engage with Open Science at all stages of their career. The European Commission is already trying to create a policy framework that will set common principles and rules by respecting European citizens' rights and by helping European companies to grow in a fair environment. Researchers should be encouraged to make their research data findable, accessible, interoperable and reusable (FAIR), and systems need to be put in place to ensure that they are soundly managed, which will require education in data administration and data integrity. Universities are encouraged to establish educational programmes to integrate this concept in the curricula of researcher's and research support staff, most probably as a life-long-learning element.

In addition, the current assessment of a researcher's output, which relies almost exclusively on scientific publication and/or patent production, would need to be revised, as in an Open Science model other criteria, like the extent of knowledge use by other parties, becomes more important than a single point-of-exit-measure.

Finally, other aspects of a food researcher's activities, e.g. carrying out dialog with consumers, opening access to publications and knowledge transfer to stakeholders (academia's third mission) will gain increasing importance. This change in the paradigm poses new challenges, such as the design of the right tools and training support for researchers to improve their communication skills, or solving possible technical interoperability and legal issues with respect to data sharing.

OPEN INNOVATION

Open Innovation has become more and more widely discussed in the EU and, over the last decade or so, many companies have developed strategies for open innovation. This tendency is equally reflected in the food industry. Open Innovation is defined as the use of purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation, respectively.*

Although Open Innovation is in principle an agenda operated by companies, it has a strong influence on the public research agenda and also the way the food sector operates in general. Moving from conventional mass production to a more personalized and customized production model, the food industry will benefit from a higher degree of open innovation where all stakeholders in the food

* Chesbrough, H., Vanhaverbeke, W., West, J. (2006) Open Innovation: Researching a New Paradigm. Oxford University Press, London

system engage and interact across the entire sector. Therefore, several considerations related to research need to be made: First, how can public and private research be better integrated for the benefits of all? Second, how can data be shared between public and private companies? Third, how can networks be formed between private and public R&I staff creating a trustful environment that is beneficial for all? And fourth, how can Intellectual Property Rights (IPR) be shared and easily handled between different stakeholders and across countries, while at the same time essential IP and trade secrets are still kept within the individual companies?

In recent years, many larger food companies have adopted an open innovation strategy in their firm, whilst SMEs are lagging behind. Shortage of resources is certainly partly to blame, but the lack of competences and lack of trust also limit the ability of SMEs to allow knowledge to flow in and out of the company. SMEs (see Section 3.4) are a major and integral part of the food sector and it is essential that they are major beneficiaries of the ETP 'Food for Life' SRIA as they are essential gatekeepers of the overall its implementation. It is therefore important that initiatives are developed to facilitate the introduction of open innovation in food SMEs and the R&I IAP also contains means to address this issue.

OPEN TO THE WORLD

The ETP 'Food for Life' SRIA requires an Open to the world approach as without this many of the action items cannot be executed. The global food related challenges identified require solutions to better engage consumers, as well as to solve increasing problems due to demographic changes, increasing competition for natural resources and an increasing "tiredness" of the sector due to its maturity. These challenges can only be solved if all societal actors/stakeholders in the food arena (researchers, citizens, policy makers, business, third sector organisations, etc.) work together across borders during the whole R&I process in order to better align their activities with the values, needs and expectations. The research carried out should not be seen as a standalone process for the benefit of only acquiring new knowledge. Rather, it is as an integrated part of a larger picture that can function as an enabler to provide advice for policy and decision making, including global governance, as well as being seen as a tool to build and improve relations between nations either to address shared problems or to provide mitigations.

ETHICS

Finally, ethical considerations are of the highest priority in all R&I activities carried out. All developments must be carried out in accordance to the highest ethical standards. A particular focus will be on the involvement of consumers in research and innovation activities. E-based infrastructures to create dialog with consumers and allow them to interact with companies will require significant focus to be made on data protection, anonymity issues etc. At present different countries may have different regulations concerning these issues and therefore, specific means needs to be addressed to solve these important ethical aspects across European borders. Development of specific governance structures to prevent harmful and unethical developments in R&I should be considered.

As part of the ethical issues, Research Integrity is also considered. Research Integrity is the basis that safeguards science against particular interests, whether ideological, economic or political. A basic responsibility of the research community is to formulate the principles of research, to define the criteria for proper research behaviour,

to maximise the quality and robustness of research and to respond adequately to threats to, or violations of, research integrity. These are all established in the European Code of Conduct for Research Integrity (revised in 2017), which makes clear this responsibility and to serves as a framework for self-regulation for the research community . The European Code of Research Conduct for Research Integrity is relevant and applicable to both publicly funded and private research and should, in principle, be adopted by all relevant stakeholders involved in the IAP. It is also recommended that all universities involved in execution the ETP 'Food for Life' SRIA have implemented specific means to adhere to the European Code of Research Conduct. In line with this code, the food and drink sector had already developed in 2015 their set of Principles of Research Conduct.

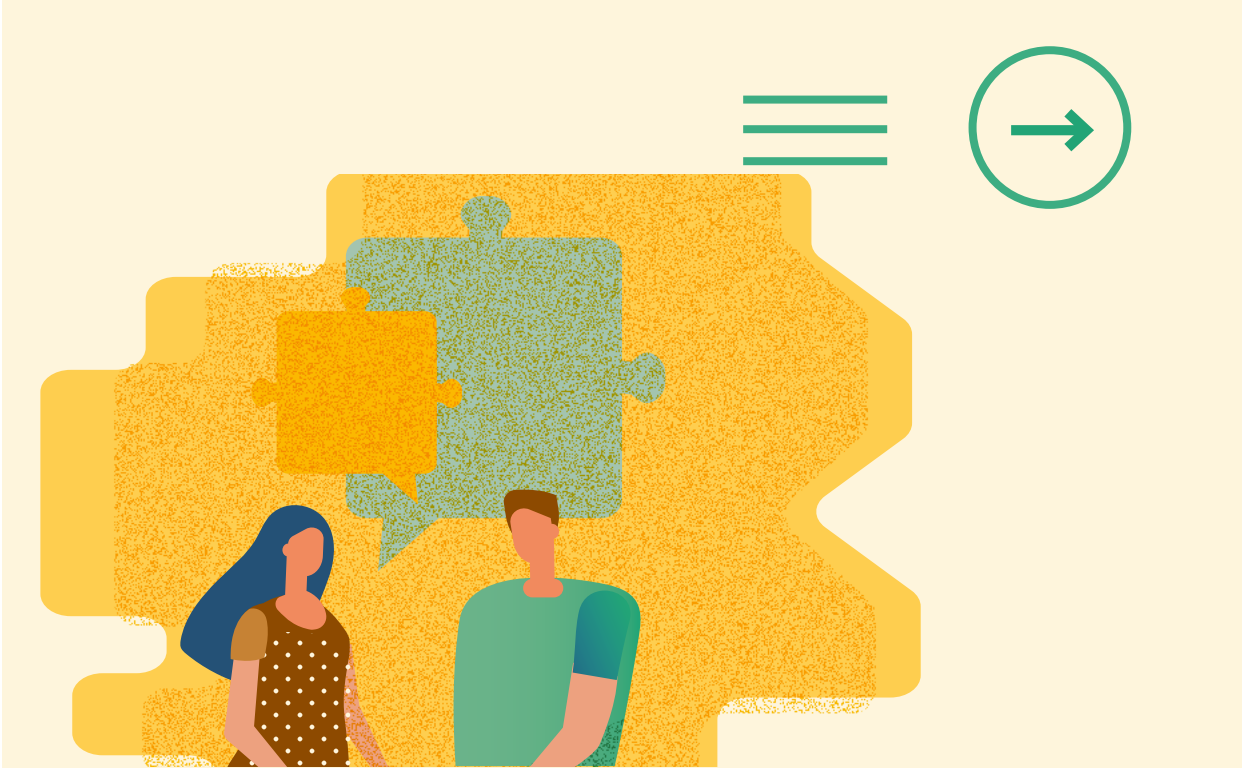
In conclusion, in order to successfully implement the RORI approach several key enabling instruments and activities need to be addressed or considered. These instruments and activities need to be integrated, as much as possible, in the actions proposed in this IAP in order to maximise its impact. For example, by involving all stakeholders in research and improving the communication of research outcomes, we can spread awareness on the necessary changes, particularly those that affect lifestyles and behaviour. By delivering more societally relevant and acceptable outcomes, market uptake of R&I developments could be significantly increased. And only by fostering strategies and instruments addressing the 3 O's (Open Science, Open innovation and Open to the world) can research outputs be effectively made accessible to all stakeholders in the food sectors.

3.3. Consumer/Citizen Engagement

Consumers as end-users of food and civil society organisations (CSOs) are increasingly interested in the way their food is produced and not only actively seek information about food, but also alternative, new options to become part of food production and distribution. Digital communication systems facilitate this information search and exchange by making the information easily accessible regardless of the time and place. Food, nutrition security and health are topics that have high potential to cause concern among consumers. Especially the novel production methods are questioned by consumers and CSOs representing different citizens' interest groups. In order to gain acceptance for new technologies or products, the views of these various organisations and end-consumers should be better integrated in the research agenda and innovation processes allowing consumers and citizens to become active agents in the future development of the food supply system. This implies that consumers will gain a more prominent role as a driving force in R&I activities, such as research on new technologies, developing product solutions, small-scale productions systems, alternative distribution models, and business models making the new innovations feasible. Enabling consumers and CSOs' engagement and thereby creating transparency and openness in R&I is also a way to increase trust in food supply system, which has been contested in recent years. The move from current interdisciplinary approach to transdisciplinary approach that acknowledges the active role of citizens and society in R&I, has several challenges that need to be tackled in order to make this transition in how we think about R&I and how it is practiced.

CONSUMERS/CITIZENS AS ACTORS

Consumers' opinions or CSOs' views are typically probed at the late stages of R&I when technologies and solutions are close to adoption, although there is an acknowledged need to progress from this "doing things for end-consumer" to "doing things with end-consumer" and even further to "things done by end-consumers" approaches. Improving consumers and CSOs' possibilities to take part in early stages of R&I processes would enable to identify new solutions that are not acceptable to consumers and find out what the challenges in the suggested technologies are from the consumer perspective. Recognising the challenges can help to avert from developing technologies would be difficult to adopt due to consumer resistance and guide the processes towards solutions that consumers welcome as a response to their needs and desires. Consumer input can relate to the way we define problems, set research questions, select theories and methodological approaches, collect and analyse data, and/or how to interpret the findings and draw the implications of the R&I, as different models are required at different stages of these processes. In problem definition and setting research questions, consumer engagement should reach the funding bodies. Allowing open commenting on research agendas can be used to gather feedback from different CSOs representing different consumer interests and even individual consumers. In individual research initiatives, the consumer/citizen engagement needs to be planned as part of the process: e.g. whether and how to engage consumers at planning stages and whether the engagement should be a continuous dialogue with same participants or include different actors at planning and interpretation stages. In innovation processes in the private sector, crowdsourcing of ideas and design thinking approaches with consumers are common, but



for independent research initiatives, this requires inclusion of strong social science components that complement research and innovation processes in a manner that allows the stakeholder and end-consumer input. To promote consumer/citizen engagement, the research initiatives must include detailed plans how and at which stages the consumers and CSOs participate in the process. The engagement activities can widely differ between different types of research activities and they should support reaching the best outcomes. Having a social science expertise included in research proposals facilitates the stakeholder engagement and resources specially allocated to this kind of tasks should be earmarked. Providing guidelines for consumer and CSO engagement will benefit scientists when planning their research activities. Consumers can further be engaged in research as partners gathering and providing data in a systematic manner. Many citizen science initiatives rely on samples gathered by a range of actors who can produce a wide set of information from various contexts, including geographical and socio-demographic variance. Engaging consumers in R&I in food domain in this sense has not yet been widely used, but offers a potential to be exploited, especially when considering the diversity of food-related behaviours across Europe.

OVERCOMING DIFFERENT WORLDVIEWS

One of the challenges in increasing consumer engagement is the different worldviews consumers and scientists have. Even well-educated consumers may lack basic understanding of the principles in which science works, which is important in creating a constructive dialogue between consumers/citizens

and scientists. Including principles of scientific thinking in school curricular for those who have vocational or other medium-length education would facilitate consumer/citizen engagement. The above- mentioned citizen-science activities could support achieving this goal. Similarly, in science training, understanding the society and end-consumers worldview is important and training should include a module on stakeholder engagement: why and when it is important, and how it can be achieved. Consumers' understanding of what science can do and why evidence-based solutions are looked-for and scientists' understanding of what consumers deem important in their everyday life would help to build more positive attitude toward engagement among the different parties.

As science and stakeholder worldviews can differ widely, the engagement activities will be assigned to parties who are experts in bridging the different viewpoints and can offer an impartial platform for presenting these viewpoints. The alternative option for funding these engagement activities is to have special funding tools that can be applied separately to support the on-going research. This would give flexibility to the ways stakeholders are engaged and enable the engagement of consumers in issues that rise during the research process, if the additional funding decisions can be made fast.

Consumers and citizens active in CSOs are diverse in their interests and finding the relevant party to engage with can be a challenge. Furthermore, even relevant parties have different viewpoints which need to be integrated and negotiated. This requires expertise that is often not in the science domain. Bridging the gaps between consumers' and scientists' worldviews in order to create dialogue requires time and willingness from both parties to overcome the communication challenge. Scientists may fear that the basic self-correcting autonomy principle in science will be compromised if research is opened to ordinary citizens allowing them to have a say in what is studied. From the consumer and stakeholder point-of-view, the challenge is to have the required knowledge on the content of the research in order to make a meaningful contribution in their engagement. The topics and issues where consumers and stakeholders are involved should be the framed in a way they can relate to, e.g. not in technical terms but in terms of the relevance of the research to consumers and stakeholders everyday life.

FACILITATING COMMUNICATION

Digital communication technologies are among the enabling forces for increased consumer/citizen engagement. They allow access to a vast amount of information, but they also enable two-way communication between consumers and scientists or innovators. Organising stakeholder workshops or focus groups is important in certain topics, but they are both expensive and difficult to organise due to the time required. The adoption of engagement methods using on-line platforms and digital communication had taken a leap during the COVID-19 pandemic of 2020, but they are still relatively used in research activities. Development of these methods together with digital communication experts would facilitate stakeholder engagement systems that could be used flexibly throughout the R&I processes. As the channels enable two-way communication and dialogue, they can be used to elicit consumers' opinions, needs and wants and thereby support R&I that better responds to these needs and desires. This will also require a change from thinking consumers' role as providing consumer insight as an input in research to thinking about consumers' input as a co-creation activity that is based on dialogue. Digital two-way communication permits to clarify any questions consumer may have and furthermore, these channels can be used in consumer-to-consumer (C2C) communication allowing consumer to respond to others' comments as well.

Thus, these channels empower consumers to form rapid consumer communities around specific topics and thereby even social movements that can

Engagement methods using online platforms and digital communication are still rarely used in research activities and development of these methods together with digital communication experts would facilitate stakeholder engagement systems that could be used flexibly throughout the R&I processes.

contribute to the research and innovation, or pressurise other actors in the food chain. However, it is important to keep in mind that consumers' willingness to take part in these online activities depends on, not only how involved and interested consumers are in food but also in their willingness to engage in online activities.

COVERING DIVERSITY

Finding the relevant and interested consumer and CSO groups can be a challenge. Consumers and CSOs may not be willing to invest their time in engagement, unless they can see the benefits or outcomes of this engagement in terms of being heard and taken into account when research agendas are decided, research approaches discussed, or findings implemented. Finding the relevant groups can be facilitated by creating databases where different CSOs and interest groups can register and express their interest to engage in R&I activities as stakeholders. The database should be vetted and relevant information about the goals, membership principles and numbers is included in the register to guarantee that they are open groups working on democratic principles. CSOs can be sensitive about linking their name with certain research activities even when they have an interest in the topic. Their willingness to engage often depends on whether they feel that their contribution is based on open interest, mutual respect and transparency rather than just used to warrant the research in question. Creating follow-up systems where the consumer and CSO engagement is explicitly acknowledged and allowing to follow the further developments in the research will provide feedback to those who have been involved in earlier stages of research activities. This will require opening up the research process to external parties, which may be a challenge if intellectual property rights or ability to publish results in scientific journals need to be considered. When the innovation and research aims to find solutions for specific target groups (e.g. people with a certain disease or age group) the engagement must include representatives from these groups.

PROVIDING RESOURCES AND INCENTIVES

From the scientists' point of view stakeholder engagement is often considered as an add-on in the ordinary activities; not necessarily because scientists are unwilling or uninterested in the topic, but because they are mainly rewarded on criteria that is related to scientific input. To facilitate consumer/citizen engagement, there should specific resources allocated to do this in research activities: this will enable scientists to contribute to the content of the dialogue without needing to learn and execute activities than are not their core expertise. Participation of scientists in the engagement activities is a crucial part in constructive dialogue, but other resources can facilitate the practical organisation of the engagement processes, whether face-to-face events, online communications, or even running continuous stakeholder platforms. These resources should be made available as an essential part of the research projects, but retain flexibility in the use of these resources as the relevance of engagement evolves with research findings.

3.4. Digital Technologies as an Enabler for Transformation of the Food System

The development of new digital technologies has changed, and continues to change, the operations of many industrial sectors, amongst these also increasingly the agri-food sector. What began in the middle of the 20th century as a simple shift from doing operations and computations by mechanics and analogue electronics, to these being done by digitally-operating devices (initially vacuum tubes, then transistors, and eventually complex logical circuits with increasing miniaturization), eventually led to what we now call the 'digital revolution'. The term suggests a scale of change similar to that of the earlier technologically-induced revolutions such as e.g. the agricultural and industrial revolutions. Its effects are extremely broadly occurring at economic, social, cultural, and political levels, giving rise to an information or networked society and a new digital age.

As outlined in the ETPs Strategic Research and Innovation Agenda, the food sector is facing historical changes caused by various global drivers, such as an increasing world population (10 billion in 2050), an

increasing shortage of food commodities, especially animal feedstocks, changes in consumer behavior (partially linked to digital technologies), especially in developed countries with new terms giving importance such as regional, organic, 'free from', and an increased importance of food for the health and well-being of consumers. In order to meet these new requirements, the food value creation system relies on its actors (producers, processors, distributors, consumers) working together in a novel, networked way to collaborate effectively to develop new approaches and design principles. The use of digital technologies is enabling this transformation to allow actors to address these challenges. For example, the translation of production systems into virtual spaces (the so-called digital twinning) makes it possible to adapt processes and material flows for foodstuffs to the emerging diverse and individual usage scenarios of the consumers while saving valuable resources. Informatics approaches allow also for an increased transparency and traceability of raw materials and the food produced thereof via e.g. the use of the blockchain technology that is currently used for the digital currency Bitcoin. A personalized transformation of raw materials through automated recipe design can make it possible to respond to individual needs. Digital transformation is thus transforming the way the entire sector works, and will therefore be an indispensable element of education, research and innovation in the future (see also the AIOIT document on Digital Innovation Hubs in Food and Agriculture).

New digital technology trends that in the near future are having an influence on the operation within the food systems are as follows:

BIG DATA AND MINING

An increasing amount of data is being generated at every point in the food system, from the farm to the fork and beyond. New ways of data collection by novel miniaturized sensors allow for a previously unprecedented recording and analysis of various operations and behavior of elements and actors within the food system. The analysis of these increasingly large data sets fuelled by new approaches to data management, data reduction and data presentation yields a great many new insights that are not only of scientific, economic, but also of social importance. In this context, the protection of personal data and rights (ownership, accessibility) will play an increasingly important role.

DIGITAL TWINNING

The mapping and efficient controlling of processes, material flows and uses in the digital domain is just now beginning to be implemented in the food sector. New developments in automation and data exchange in manufacturing technologies including cyber-physical systems, the Internet of things, and cloud computing allow not only for an increased efficiency when designing new products and processes but also offer an increased ability to record material tracks thereby improving transparency.

MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE

Probably the largest change that can be expected to come from digital technologies is the increasing ability of computing devices to intelligently analyze data i.e. to recognize patterns and to use this then to develop predictive capabilities. Deep learning algorithms are universal learning procedures which on a theoretical basis, given enough time and data, may lead to the discovery of any pattern. Experts have thus predicted that almost half of all jobs in the industrial and service sectors may be lost over the next 20 years to these cognitive computing devices. At the very least, cognitive assistants serving as new support tools to humans will increasingly be deployed in all aspects of life. A simple example of this, the Alexa system from Amazon, is already taking root in many households. It is just a matter of time until such tools will also be implemented in many aspects of operations in the food system.

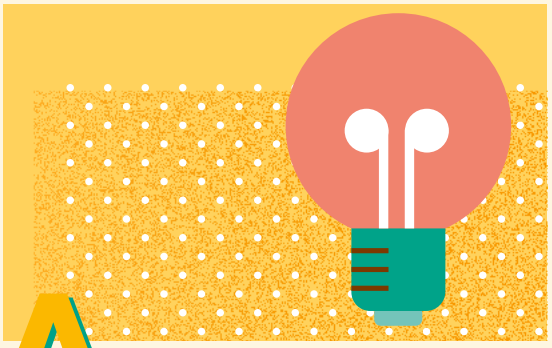
Actions laid out in this Implementation Action Plan will therefore increasingly involve the above mentioned digital technology approaches. Due to the rapid pace of development, it is however not yet clear which aspects of the food system will be more or less, and slower or quicker affected. Clearly, there are new business opportunities and models emerging and there is a significant potential for societal well-being to improve due to the use of digital technologies. The food sector in particular has to pay attention that this is done in the right way not leading to a concentration of power and control over the system, but to an increased transparency and choice. This calls for actions to be carried out, not only by industrial actors, but by many stakeholders including consumer and citizen representatives, policy makers, and regulators.

3.5. Specific Actions towards SMEs

The disruptive, novel research and the new types of technology described in detail in the ETP 'Food for Life' SRIA and the IAP presented here, will have a beneficial impact on all food and drink companies, independent of their size. It is well recognised, however, that SMEs in the food sector face particular challenges in embracing R&I and it is considered essential that they are brought into the R&I cycle in a manner tailored to their specific needs. While their thematic needs are obviously likely to be very similar to those of large companies, their interests and priorities are strongly influenced and controlled by their limited resources, and their specific business and innovation cultures.

It is often the case that SMEs are also often more vulnerable to the effects of their exposure to external factors. Hence, research based innovation activities that require less resources and enable faster implementation and return on investment (e.g. from TRL 5 and above) are typically more relevant and applicable for food and drink SMEs, than those that need more resources, investment, a long return time and more complex knowledge beyond their core competence. In this scenario, SMEs usually prefer to follow successful examples and to learn from each other.

A group of experts of the ETP 'Food for Life', the European Collaboration of National Platforms and the European Federation of Food Science and Technology have identified a number of recommendations that would enable SMEs to better exploit the full potential that R&I offers. These are developed in detail in a **separate document** and are summarised below:



A.

MAKE CONSUMER, SOCIAL AND BUSINESSES SCIENCES ACCESIBLE TO SMEs

The integration of consumer and social sciences into innovation and research activities is a challenge even for large companies with their own, dedicated personnel and resources. Most SMEs simply do not have currently the mechanisms by which they can access this area of skill and knowledge that is so crucial to the type of R&I presented in the SRIA. The following measures will lower the barriers of entrance:

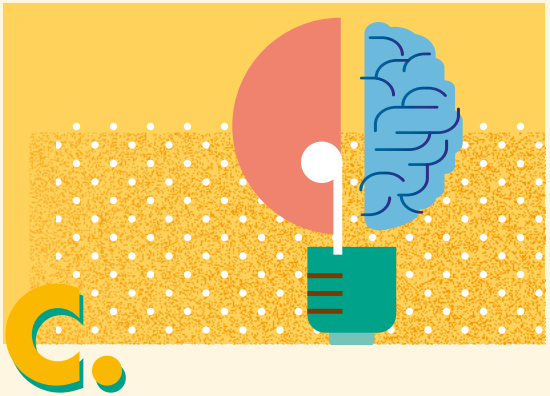
- Design training activities targeting SMEs on understanding and applying consumer and market analysis into their innovation activities;
- Provide incentives for SMEs to hire young people educated in consumer and social sciences to support their innovation activities;
- Offer consulting and coaching services to SMEs to expand and actively exploit their own innovation capacities in these areas;
- Establish and maintain a bi-directional dialogue between social scientists and SMEs based on a clear description of the capabilities and enabling functions of social sciences and the real needs of food sector users.

B.

PROVIDE FUNDING AND FINANCIAL TOOLS TAILORED TO SMEs

The size and relative vulnerability of SMEs often makes them reluctant to enter into the large scale and capital rich commitments required by many R&I programmes. Factors such as these, coupled with the societal imperative that this segment of companies be an active beneficiary of public R&D, means that specific tools be offered, once again to lower the barriers to access:

- Create specific financial tools dedicated to SMEs that are flexible, stable, fast and not so bound to fixed deadlines;
- Ensure the stability of successful funding schemes that allow SMEs to take more risks, cover all steps of the innovation process seamlessly and are differentiated to meet the different innovation behaviour and risk-taking capacity of diverse segments of SMEs. This should include public co-funding of bottom-up projects and collective research;
- Design complementary funding schemes at the national and European level and create mechanisms for their articulation;
- Enrich the database of the project proposals evaluators with more elements coming from industry;
- Develop training modules and easily accessible and understandable information that enable SMEs to understand the full range of the financing instruments. Ensure that intermediates that can provide SMEs with all the necessary information for the existing opportunities are available and accessible - including financially;
- Provide fiscal incentives for SMEs to develop R&I activities and to hire staff with experience in project management.



CREATE SYNERGIES BETWEEN START-UPS AND SMEs

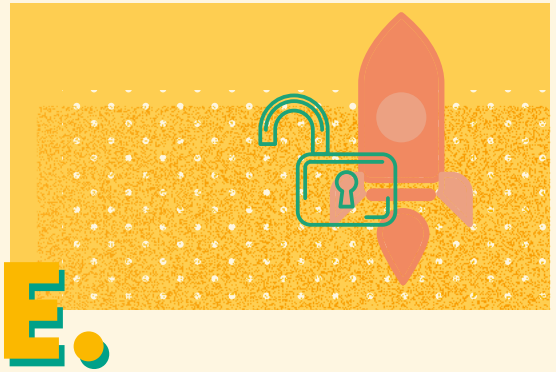
Start-ups often have knowledge based technologies or approaches that require development in real company environments. SMEs could provide such environments with mutual and shared benefits providing that the pairing between the companies is optimised. Specific mechanisms need to be developed in order to accelerate the collaboration of these types of company:

- Organise platforms and matchmaking events that facilitate the collaboration between start-ups and SMEs with complementary competences;
- Provide easily understandable information to SMEs about innovative start-ups among users' and solution providers' communities;
- Establish neutral, trusted intermediaries at the national level who can match the problems and needs from SMEs with enabling concepts of service providers from other disciplines.

EXPLOIT COMPLEMENTARITIES WITH OTHER DICSIPLINES

Opportunities for innovation can come about from knowledge of other disciplines and other sectors and many companies make use of structured technological vigilance to identify possibilities. SMEs do not have the resources to make use of such developments individually and so conditions need to be created in order to give them access to this important route to innovation:

- Collect the problems and challenges of food and drink SMEs and the enabling functions of other disciplines, making use of the networking structures already in place;
- Design small, modular educational programs, gathered in easily accessible inventories that are kept up-to-date by maintaining a constant dialogue between users' and solution providers' communities;
- Establish a mandatory task for publicly funded R&I projects to convert non-competitive information into a clear, understandable, user-friendly, concise educational formats focused on the aspects of benefits and practical applicability;
- Ensure an appropriate knowledge dissemination by intermediaries or suppliers, taking into consideration national and regional needs (e.g. language, culture);
- Design new facilitation instruments that combine the knowledge of the food sector with other disciplines for joint interest and benefits.



ACCELERATE THE DIFFUSION OF ENABLING SOLUTIONS TO SMEs, AND CREATE ACCESS TO ENABLING FACILITIES, TOOLS AND SERVICES

Independent of the specific nature of the enabling solutions being made available to SMEs the need for specific and dedicated agencies and structures to manage and channel these remains. The following structural changes are proposed:

- Establish mediator/facilitator organisations at national level that assist SMEs to find the appropriate solutions and to identify partners for jointly applying for National and European funds;
- Develop industry best-practice guides and inventories of successful cases to help SMEs understand the opportunities, benefits and principles of application of new methods. Ensure that these are available in accessible languages;
- Employ successful approaches for knowledge transfer to SMEs coming from other sectors of activity (e.g. FI-PPP);
- Facilitate collective research, marketing and chain management activities to help reduce the financial barrier for SMEs.

DEVELOP HUMAN RESOURCES THROUGH ENHANCED KNOWLEDGE TRANSFER AND TRAINING PROGRAMMS FOR SMEs

The expressed ambition to make the execution and the outputs of the SRIA relevant and useful to SMEs will require significant investment in the development of human resources capable of operating in the new knowledge-rich environment. Making the workforce appropriate for this environment will require a broad range of interventions:

- Design knowledge transfer instruments that deliver information in each local language and in a form that makes the science readily understandable and uses commonly-used terms;
- Create open experimental and pilot plant facilities and services with skilled staff for food applications for hire, or as contracted services;
- Establish intermediaries to make the exploitation process more effective. They will also be relevant for collecting users' needs, problems of the food industry SMEs on a targeted area and match them with the available knowledge and solutions;
- Foster the dialogue with SMEs, farmers producing food and other stakeholders relevant in R&I for the food sector, by combining conventional methods with new digital and collaborative tools;
- Implement new methods of operating multi-stakeholder platforms for R&I ensure a sound balance of stakeholders and protect intellectual property rights;
- Design and implement financial tools that support SMEs to hire staff with strong research background and capable to develop R&I projects and / or make use of their outputs;
- Train the existing staff of SMEs in skills necessary for all the steps of the R&I process;
- Provide financial and tax incentives to SMEs to create R&I departments;
- Facilitate staff mobility programmes (especially from Universities to SMEs and reversely, temporary placement of industry staff to research organisations).

The measures proposed here are required in order to bring the food sector SMEs to a position in which they can best participate in and benefit from the initiatives detailed in the SRIA. Food SMEs have received a great deal of attention over the last years both in European and national programmes in order to ensure that they continue to play their crucial role in the agri-food ecosystem. However the disruptive research proposed in the SRIA will require all segments of the system to re-tool to a certain extent and it is crucial that SMEs receive particular attention in this respect.

As mentioned above, the participation of SMEs in the next phases of the development of the ETP was considered so important that a working group was convened with the European Collaboration of National Platforms and the European Federation of Food Science and Technology in order to develop detailed recommendations.The reader with particular interest in this material is directed to the original report from which these considerations here are taken.

3.6. Public-Private Collaboration

The ETP 'Food for Life' proposes to establish a public-private collaboration programme. The programme will aim to enable, encourage and empower every consumer in the EU to attain a

safe
affordable
healthy
sustainable

DIET
in
2030

There is a clear opportunity in establishing a new type of public-private collaboration as an instrument that could be used for the SRIA execution. The experience gained so far shows that public and private collaboration on R&I in a food system wide approach can help to overcome hurdles to growth by considering potentially limiting factors early on, including the potential impact as explained in Section 4. A collaborative approach between public and private partners can prevent that research efforts are applied in a scattered and unstructured manner and that gaps or overlaps result from a fragmented research coverage. Moreover, awareness of ongoing efforts and incentives to translate them into tangibles is present from day one.

In addition, by bringing together different technologies and expertise from public and private partners across Europe, it will enable identification of technological barriers, gaps and synergies in the food sector. One of the main assets of the food and drink sector, but also a challenge, is its diversity, since it is spread across Member States and areas of activity. This restricts the exchange and pooling of knowledge and experience unless it is facilitated. Food and drink operators are also diverse in size, being 99% of them SMEs. A public-private collaboration must be highly inclusive for SMEs providing an opportunity to work in coalition with major business operators and research organisations. The role of National Food Technology Platforms (NFTPs), national and regional food clusters, and/or food industry dedicated Research Centres might help to materialise this implementation. Further reference to the NFTPs is explained in Section 3.7.

Throughout the years, the EU has actively supported research in the food and drink sector. This has led to the deepening of our knowledge in food-related topics, the establishment of research infrastructure and the foundation of networks that facilitate the sharing of information and best practices among the EU. The EU has gained a strong knowledge infrastructure and leading food companies have a strong research base in the EU. Europe is leading in the field of food and nutrition.

However, despite the progress made the EU is still not performing at its full potential. There is limited investment in research in the food industry compared to other industries; on average less. In addition, traditionally companies have focused on small innovations on product development, such as new flavours or new packages, which could be

done through in-house research and which for years turned out to be a successful model. This situation has now reached a turning point. The food sector is one of the last industries that is now in a process of changing its innovation approach from a traditional all in-house small steps model, to an open multi-partner model embracing step change innovations.

As part of the ETP 'Food for Life' SRIA an ambitious public-private collaboration programme will help to further boost this changing process. By establishing a structured partnership programme it will also ensure that the SMEs become a part of this process.
More specifically the ETP 'Food for Life' proposes to establish a public-private collaboration programme with the ambitious goal to ensure that all Europeans will have access to a balanced diet in 2030. The programme will support the realisation of the Farm to Fork Strategy, aiming to enable, encourage and empower every consumer in the EU to attain a safe, affordable, healthy and sustainable diet in 2030, which is produced with 40% less resources and half the food waste over the whole food chain. The three major areas of focus would be:

- Improving the trust and transparency between producers and consumers;
- Improving the energy balance while ensuring appropriate desired nutrient density;
- Maximising the efficiency in the use of our resources and reducing waste.

Priorities

In order to achieve these ambitions we need the active involvement of all key stakeholders: manufacturers (large and small), retail, academia, technological institutes, NGOs, consumers, governments and regulation authorities. Equally important will be that we leverage and align existing initiatives at local, regional, national or EU level. In addition, the food sector will coordinate with other sectors of activity, such as the seed producers, providers of ICT solutions and the bio-based (non-food) industries among others, but also retailers as appropriate. The programme we envisage will have several priorities:

- Understanding and building consumer motivation, diversity and trust. Central here is to identify what people value in foods and food-related behaviour in different cultures in Europe and subpopulations (age, gender, lifestyle), and to identify what empowers and engages consumers in their dietary choices. This can be partly done through research into consumer behaviour, partially also by an open discussion amongst the different partners, and creation of active, two-way communication between consumers, producers and all other partners in the chain, using modern communication instruments and big data approaches.

- Creating the right regulation and legal instruments both at European and national level to create incentives along the chain to come to the general availability of balanced diets. This may include regulations, but may also involve guidelines.

- Understanding and enabling the use of new raw materials and alternative protein sources for foods that are genuinely sought after by consumers all over Europe. This will induce the development of a whole new economic sector: that of sustainable, healthy and balanced protein foods that are inexpensive enough to make them overall very attractive to consumers throughout Europe.

- Maintaining the current high-level safety standards for the food produced and consumed in Europe and globally. Public food safety crises create a high degree of concern among consumers, and cause huge economic losses. Increasing our knowledge of food safety and new emerging issues and risks is paramount to increase our ability to prevent, predict and respond to food safety incidents.

- Specifying and quantifying and specifying the nutritional demands not just of average consumers, but of different groups in different regions over Europe. Food intake is very strongly influenced by tradition and cultural conventions. We should not fight these traditions, but rather build on them to create products that support balanced diets with great cultural diversity, which can be an attractive feature for consumers throughout all EU member states and bolster service and tourist industry in Europe.

- Specifying and quantifying the use of resources, to make sure that better balanced diets are sustainable in the long term, do not reduce the access of non-EU people to healthy diets, and will be sufficiently inexpensive to be attractive to consumers to buy and continue buying.

The knowledge generated in the Sustainable Food Systems programme will allow us to:

- Make sure that every consumer in the EU can choose a safe, affordable, healthy and sustainable diet (micro- and macronutrient intake; energy balance) as a default option in 2030;
- Develop and execute a strategic approach that enables consumers' engagement with the food value chain and empowers consumers' to become active agents in developing new solutions for improving food choices;
- Develop and execute a strategic approach to effectively reduce food wastage over the whole chain (manufacturers, retail, consumers) by 50% and food losses by up to 30% in 2030 vs. 2015 (Sustainable Development Goal 12.3);
- Develop and execute a strategic approach to effectively reduce the use of resources by up to 40% in 2030 vs. 2015;
- Develop and execute a strategic approach to effectively increase the sales of protein from alternative sources to European consumers by up to 50% in 2030 vs. 2015 (related to Sustainable Development Goals 12 and 14);
- Develop a deep understanding of what European consumers value in foods and food-related behaviour, as the common enabler for the previous 5 targets.

Achieving this ambitious plan is only possible through the establishment of a truly open and engaged public-private collaboration, which will contribute to strengthening the European industrial base, since food businesses will be able to operate more efficiently. This will represent a new boost for jobs, growth and investment in the region and position Europe as a stronger actor at the global level. Through new collaborative models the strong European food science and technology foundation is to be leveraged and translated more effectively into innovation and growth. This will lead to reinforcing EU's position as a major centre of excellence and the revalorization of research and will enable the European food industry to be more competitive on a global scale. In joining forces we not only stand a better chance to tackle the problems, but also we further empower the position of Europe as a leading innovation engine in the food and drink sector. Even if it might not be the ultimate solution that fully achieves all aforementioned targets, it will represent the first necessary step to link everything which will be instrumental to reach the ambition.

The programme of this public-private collaboration will be aligned with the ETP 'Food for Life' SRIA and IAP, and will have to be substantially funded under the European Framework Programme for R&I, and therefore subject to its rules for participation and dissemination. The activities of the platform will be based on a continual stakeholder dialogue between the private and the public bodies involved in the initiative. The research objectives are guided by the roadmap, developed by the research and industrial stakeholders and validated in a Europe-wide open consultation process.

3.7. The role of National Food Technology Platforms

+36.000 SMEs

and

4.800

national stakeholders are involved in the NFTPs through industry, farmers, universities, research centres, consumers, National Public Bodies, retailers, and financial institutions

93 *strategic documents visible and published on ETP website (Strategic Research Agendas, Implementation Plan, Vision document etc.)*

€2,5 million

yearly availability of public national funds specifically for NFTPs

€690 million

yearly availability of of public national funds for agri-food industry research

When the European Technology Platform 'Food for Life' was first established in 2005, it came together with an agro-industrial network, fostered by national institutions engaged on research, development, and innovation on food, and supported by several national federations of the Food and Drink Industry. The National Food Technology Platforms (NFTPs) operate at national level in all the countries of the European Union and some other non-EU countries.

The NFTPs provide National Strategic Research and Innovation agendas that are shared with policy makers at national level. They have different organisational sizes and structures, but all have in common that they act as a network of agri-food industries, Academia, research centres, financial institutions, public authorities, at national and at regional level. The close interaction of NFTPs with Small and Medium Enterprises (SMEs) is particularly relevant, as well as the involvement in larger companies, retailers and sectorial associations. Companies of all sizes, representative bodies, Academia, research centres, national and local authorities, develop and agree on Research and Innovation Agendas applied at the agri-food sector of the country. The NFTPs are organised collectively, and also exchange regularly with the ETP 'Food for Life' on strategies relevant at European level.

The NFTPs could be specifically instrumental in some of the current actions of the Horizon Europe programme of the European Commission. NFTPs can promote a bottom-up approach acting as a nexus between national and EU level providing coordination of activities, such as national local events and fairs promoting dissemination of European programmes (e.g., Ecotrophelia), establish a dialogue between the European Commission and the national based companies, providing educational, vocational training, technology transfer at national level, or promoting the implementation of Food Systems Living Labs as a new concept to develop for the near future.

For further information, the following names present a non-exhaustive list of the current NFTPs per country (Fig. 7) and current website of reference to the leading institution at each country representation.

NFTPs EU Coordination
Françoise Gorga (ANIA)
Eduardo Cotillas (FIAB)

Austria NFTP
LVA (Lebensmittel Vertrauen Analysen)

Belgium NFTPs
Wagralim (Wallonia)
Flandersfood (Flanders)
FEVIA (Belgium)

Bulgaria NFTP
Advanced Chemistry Development – ACD Food Labs (Argo.Bulgaria)

Czech Republic NFTP
Foodnet

Denmark NFTP
University of Copenhagen

Finland NFTP
Helsinki Business and Science Park (HBSP) Viikki Food Centre (VFC)

France NFTP
Food4Life France - ANIA and ACTIA

Germany NFTP
FEI (Forschungsreis der Ernahrungs Industrie)

Greece NFTP
SEVT (Federation of Hellenic Food Industries)

Hungary NFTP
Campden BRI

Iceland NFTP
The Agricultural University of Iceland

Ireland NFTP
FDI (FoodDrinkIreland)

Italy NFTP
Cluster Agrifood CIAN (Federalimentare)

Kazakhstan NFTP
Nazarbayev University

Latvia NFTP
Latvia University of Life Sciences and Technologies

Norway NFTP
NOFIMA

Portugal NFTP
FIPA (Dederacao das industrias portuguesas agro-alimentares)

Romania NFTP
National Institutte of R&D for Food Bioresources

Slovenia NFTP
GZS (Chamber of Commerce and Industry of Slovenia)

Spain NFTP
FoodforLife Spain - FIAB (Federacion de Industrias Alimentarias y Bebidas)
Food For Life-Spain | #PTF4LS

Sweden NFTP
LI (Livsmedelsforetagen)

Switzerland NFTP
Swiss Food Research

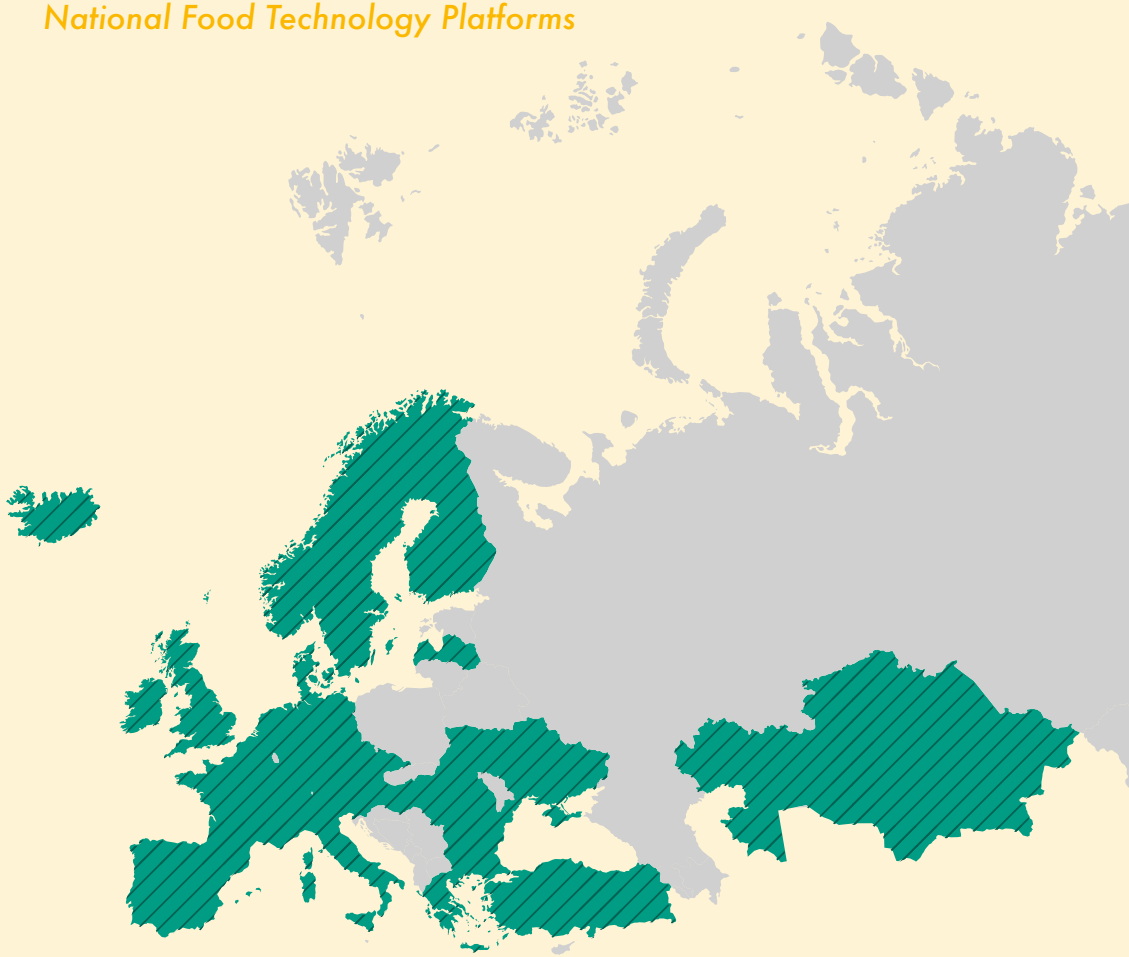
The Netherlands NFTP
TKI Agrifood

Turkey NFTP
Hacettepe University

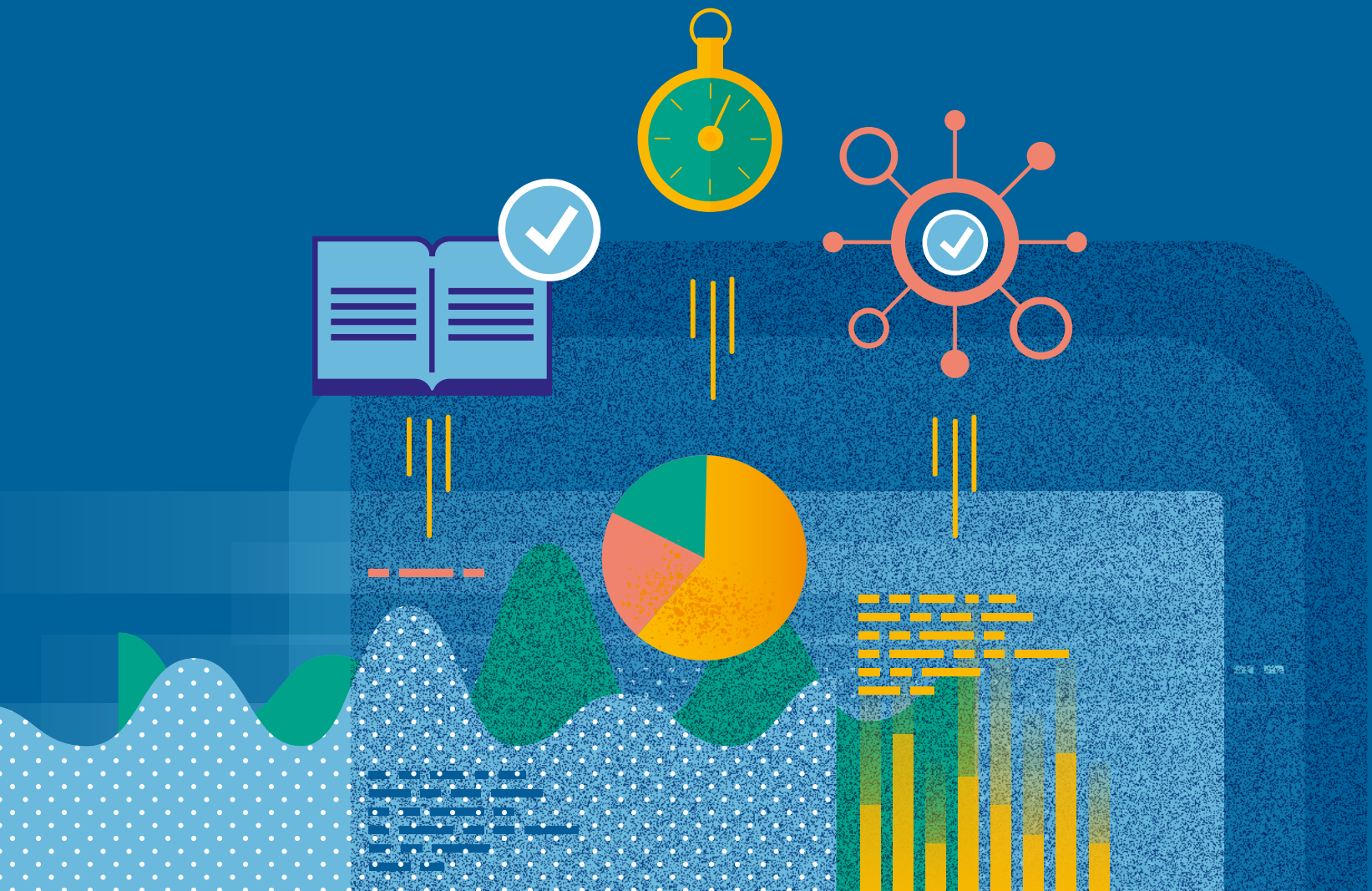
Ukraine NFTP
Uzhhorod National University & Cassovia Life Science

United Kingdom
BBSRC (Biotechnology and Biological Sciences Research Council)

Figure 7. Map of countries involved in the National Food Technology Platforms



MONITORING PROGRESS AND IMPACT ASSESSMENT



4.1. Introduction

In this section we suggest ways to assess the progress of the actions listed in this IAP and their impact, taking as a starting point our vision of an effective execution of the IAP when compared with business as usual. It is highly relevant to consider the process of impact assessment from the beginning of setting an R&I strategy, programme or activity, so that the outcomes of the strategy have a clear monitoring process where the progress towards a specific vision can be measured. In this chapter we discuss some of the approaches that could be followed to achieve this goal.

It should be mentioned here that the development of this chapter had two stages. In the first stage, an impact assessment methodology was developed with the ETP LT and SWG members, which was published in the first version of the IAP in 2018. Most of the elements of that work have been kept in this version. In the second stage, this 2021 version has incorporated the insights of a specific workshop performed with external experts from relevant European organisations and institutions that are knowledgeable on impact assessment and monitoring. This workshop was organised with the intention of improving the content of the IAP. The setting of this workshop and the experts involved are summarised in section 4.5.

4.2. Effectiveness of the IAP

This Table compares our expectations of what would have without the execution of the IAP ("Business as usual") with the benefits that "execution of the IAP" would bring:

BUSINESS AS USUAL	EXECUTION OF THE IAP
Although progress has been made, societal challenges are not fully addressed and solved. The ambitious SDGs have not been met and the occurrence of non-communicable diseases continues to rise.	A major step towards the ETP vision for a future proof Food System.
Scattered research efforts across different EU, national and funding schemes and thematic areas with limited overall impact on the sector.	Reinforced synergies across Member States and research areas, by the development of coordination mechanisms and tools between the Member States and EU funding schemes e.g. Web Platform for the national and European funding projects, common research agendas, etc. Comprehensive, well-timed actions that together create impact.

BUSINESS AS USUAL	EXECUTION OF THE IAP
Short-term perspective of the funding schemes due to the annual-based nature of the research funding programmes.	The multi-annual perspective of the IAP leads to a long-term continuity of the programme, hence diminishing the risk of fragmentation and development of technology gaps.
Work programme topics decided annually lead to budget uncertainty and pulls back industry investments.	The defined plan for a long-term horizon raises confidence in private sector investors and allows industry to make long-term investment plans.
Lack of industry cooperation in research projects, due to the perceived lack of opportunities directly addressing their needs and requirements.	Industry (large companies and SMEs), jointly with research institutions and universities, participate in the definition of the ETP 'Food for Life' SRIA and IAP.
The stringency of regulatory procedures appears to have a direct and significant impact on the rate of return and viability of investing in the development of new products.	By promoting an RRI perspective in the IAP activities, which aim at involving a wide set of stakeholders (e.g. consumers, policy makers, etc.), the market uptake of R&I developments could be increased.
Projects commonly are stuck or slowed once the basic research ends, resulting in limited commercial exploitation.	The actions suggested in the IAP address all stages of the R&I processes, from pre-competitive research to demonstration, ultimately bringing research outputs closer to market. In addition, proof of concept projects will be developed.
Assessment of research results mainly relies on scientific quality and technical excellence.	Besides scientific/technical excellence, other dimensions of researchers' activities, with a special focus on Open Science, gain more importance.

4.3. Measuring impact

R&I impact is not limited to economic or commercial aspects; it can also be societal, environmental, technical, educational, or scientific. The currently available R&I impact assessment approaches are usually based on single methodologies either quantitative or qualitative. These methodologies evaluate impacts at a specific governance level (EU, national, regional) for a reduced set of impacts, from which economic impact is predominantly evaluated. The quantification of impacts remains a challenge. The analysis of KPIs is expected to give valuable information on areas such as economic growth and business performance, citizen/consumer involvement/satisfaction, sustainability and research and policy environment.

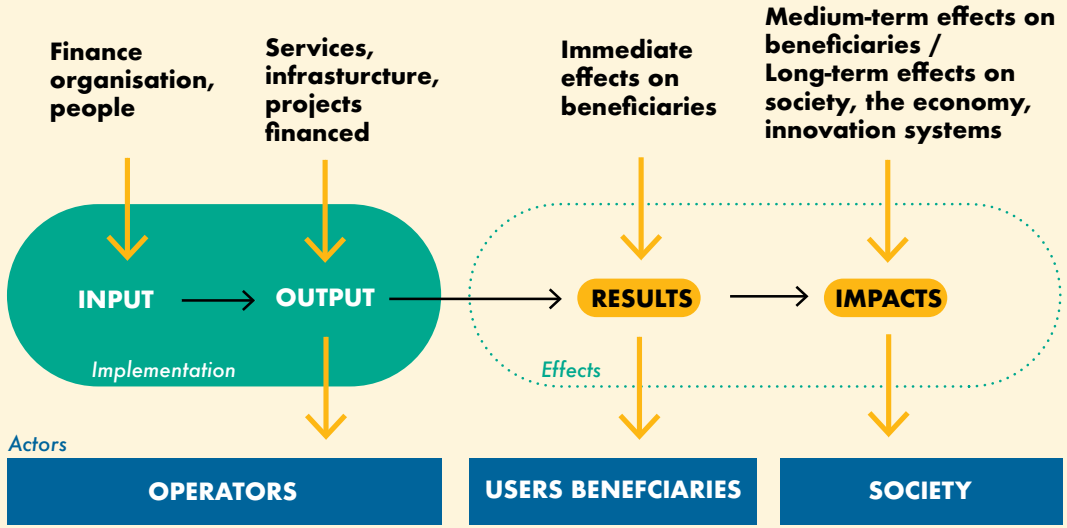
These KPIs should be monitored on the basis of a systematic follow-up of the actions considering the research priorities, challenges, and the enabling technologies that they address. Experts in the field have defined the objective of impact assessment as the identification and measurement of the impacts based on a thorough understanding of the socio-economic effects of a policy (Fig. 8).

They require:

- A customised method (no 'one-fits-all'): Key performance indicators are different from collaborative R&D projects, etc.
- Impact pathways help find the different steps needed and the desired objective. The socio-economic impacts of research are not obvious and therefore it is recommended to include conceptual methods.
- Methodological approaches combining qualitative and quantitative aspects to better understand the mechanisms that generate impact.
- Interdisciplinary expertise, sufficient time and budget for reflection and exploration
- Systematic use of data collection and analysis tools for ambitious and comprehensive studies.
- The integration of impact assessments into a wider policy learning process: "impact analysis is a policy-driven activity, not a science".

Several experts pointed at the Sustainable Development Goals and the quantitative targets therein as the starting point for an impact assessment setting and the design of indicators.

Figure 8. Socio-economic effects of impact regarding policy (source: Technopolis Group)



They are also a useful way to cluster possible impacts. Taking the SDGs/societal impact as the basis, the first step to identify impact pathways would be to identify and understand the problem and the trends and factors that could help or hinder progress towards the desired goal. After the problem definition developing a scenario offers a narrative and perspective of plausible outcomes. Some aspects to consider for building plausible scenarios are the objectives societal impact pathways, the theory of multi-level perspective of transitions*, the time and horizon and the resources this is financial means as well as human capital.

Finally, once we have an overview of the most likely scenario and outcomes across the functional areas, we will need to assess the robustness and appropriateness of our KPIs in the given organisational ambitions through a back-casting/future-proofing exercise.

* F.W. Geels, J.W. Schot (2007)Typology of sociotechnical transition pathways. Res. Pol., 36), pp. 399-417

KPIs FOR OUTPUTS

A first set of KPIs measures the project outputs (Table 3). These can be categorized the in a similar way as the actions of the IAP:

- Scientific and technological: number of scientific papers/citations, patents;
- Innovation: new products, services, processes, business models;
- Training and education: new forms of training, HR skill increases;
- Entrepreneurial activities;
- Communication and dissemination: awareness of specific target groups on topics of importance, stakeholder activation.

KPIs FOR OUTCOMES

The projects also develop concrete exploitation plans, to be presented with the final report, specifying, how the project outputs will lead to concrete developments of economic / societal relevance. Such exploitation plans should specify expected increase in turnover, number of new markets and jobs and competitiveness. In this way, a second level of KPIS is developed, related to outcome. At the end of the projects, these KPIs measure the expected outcomes. The possibility exists for projects to be re-contacted sometime after (e.g. 2-4 years), in order to check how these exploitation plans have been implemented. New KPI values can be determined on the basis of actual figures, describing the actual outcomes. Explaining any differences between actual and expected KPIs will give very valuable feedback to programming. There are some preconditions for the monitoring system to be successful. The project participants commit themselves undertake to provide the corresponding data (contractual obligation), analyse and report the data in a transparent way, and the means exist to develop the necessary infrastructure (physical and ICT) and mobilise resources.

KPIs FOR IMPACT

The broader effects (impact) can be measured by:

- Stakeholder interviews/surveys that are designed to determine perceptions of key target groups; and
- Data analysis (e.g. policy documents and statistics providing evidence on the evolution of market trends, level of competitiveness and other larger scale effects).

These two methods enable to detect variations over certain periods of time. For surveys (e.g. Eurobarometer), it is necessary to conduct several waves, one prior to the Programme, one mid-term or close to completion, and one or more after completion, since the development of effects typically takes time, with change rates varying depending on the nature of the action that was giving rise to the change. In this way, one can determine changes for example in the perception of the public on issues related with safety, trust and availability of food.

REFINEMENT OF KPIs

The KPIs for outcomes and impact can be further adapted taking into account the specific impact dimensions defined in SRIA (please refer to Appendix 2 for more details). As an example of this adaptation, impact KPIs can take the following form:30% reduction of food waste in 2030 when compared to 2015;

- 40% reduction in the use of resources (water/ energy) in 2030 when compared to 2015.
- In addition, the list shown in Table 1 should be complemented with KPIs referring to the composition of stakeholders and actions involved in IAP, for instance:
- Number of running projects;
- Number of participating organisations;
- Share of geographical coverage;
- Level of industrial participation in projects (above 50%);
- SME participation in projects (above 30%).

ANALYSIS OF KPIs

It is of a paramount importance, to ensure the credibility and reliability of the collected data, to use tools already available (Euromonitor, etc.) and that the very accurate and detailed analysis of the collected KPIs have to be performed from experts. The analysis of the KPIs it is expected to give valuable information on the following themes:

A. ECONOMIC GROWTH & BUSINESS PERFORMANCE

- The fate of the products, processes, services, patents, tools, developed by projects (the projects may generate products, services, etc. but how many of these are really reach to the market?)
- The real economic benefit for the EU generated by:
  - Turnover of the new products, services, patents;
  - New job positions;
  - Cost savings from new processes, technologies, methods, etc.;
  - Development of high skilled educated staff;
  - Leverage of new investments;
  - Development of new collaborations.
- The type of collaborations between the food sector stakeholders.
- The building of high or tailor-made skills on the food sector staff.

B. CITIZEN/CONSUMER INVOLVEMENT/ SATISFACTION

- Include consumer trust and satisfaction with food supply in Eurobarometer surveys with representative samples from EU countries and use same items to measure the trust at constant intervals annually/bi-annually;
- Survey food industry about their R&I activities and involvement of consumers and external stakeholder in these activities at different stages.

C. SUSTAINABILITY

- The alignment with quantified targets set by the EU (e.g. targets for reduction of the energy efficiency, food wastage, unemployment, etc.);
- A reduction in the fluctuation and price inflation of resources indicating stable supplies.

C. RESEARCH & POLICY ENVIRONMENT

- The success of the different type funding schemes in relation to their ability to lead to products, processes, services, patents, tools, etc. with real economic benefit. This will contribute to the final evaluation of the funding schemes and to the development of corrective actions for their improvement or new targeted funding schemes;
- The success of the EU funding system to ensure the inclusion and the equal representation of all stakeholders within the food sector;
- The effectiveness of the knowledge transfer process from research providers to industry;
- The success of the SRIA to identify the real R&I needs of the food sector;
- The type of the funding schemes;
- The methods followed by ETP to identify the research priorities of the sector;
- The handling of the post-project period which is critical for the exploitation of the research results.

These KPIs will be monitored on the basis of a systematic follow-up of the actions considering the research priorities, challenges and the enabling technologies that they address. As a general rule, the follow-up will be based on data received by:

- The project reports, for the KPIs related to outputs;
- Periodic surveys organised in the framework of IAP, for KPIs related to outcomes and impact; and
- Policy papers, official statistics and other related publications for KPIs related to impact.

The Coordination and Support Action FIT4FOOD2030 , in which the ETP 'Food for Life' participates, supports the European Commission to further develop and implement the FOOD 2030 policy framework and its action plan. FIT4FOOD2030 will also be an essential tool to evaluate the impact of the R&I actions and to suggest impact assessment tools.

In addition, there are additional challenges when addressing R&I impact assessment. As highlighted in the literature,* there are certain intrinsic characteristics of R&I that pose those additional challenges when evaluating the impact of a specific R&I programme, such as:

- Impacts do not have a linear behaviour.
- Attribution and the high possibility of multiple and/or circular causality.
- Including 'endogeneity' in econometric analysis.
- Difficulty and hence unreliability of making valid effectiveness comparisons.
- Non-substitutability of interventions, so searching for the one with the biggest Return of Investment (RoI) rarely helps determine policy.
- Timing of impacts: impact can have a very long timespan.
- Subsequent time lag on evaluation (e.g. when looking into an R&I programme from which some of the projects are still ongoing).
- There are different impact assessment methodologies using different indicators: it is therefore necessary to use the right mix.
- More than a single project shall be evaluated for a specific impact assessment on a given challenge. The multi-disciplinary, multi-actor character of recent projects makes it even more difficult to analyse their impact.
- Counter-factual beneficiaries: There is a danger of overestimating the impact of funds received by beneficiaries if we look at the whole set of possible applicants. A more useful baseline for comparison would be the non-successful applicants (i.e. those who applied to the programme but did not received funds).
- Datasets: Impact assessment is an empirical science and therefore the datasets must be robust and from trustful sources while often there are not enough datasets available.

* Arnold, E. (2013). A Trace of Hindsight: Evaluation and the Long-Term Impacts of R&D (Presentation). OECD Evaluation Conference. Paris: OECD.

Table 3. Proposed KPIs to measure standard project outputs, outcomes and impact. (GERD, Gross domestic expenditure on R&D; BERD, Business enterprise expenditure on R&D)

LEVEL OF EFFECTS	DIMENSIONS	PROPOSED KPIs
OUTPUTS	RESEARCH AND TECHNOLOGY OUTPUTS	• Number of Publications in (high-impact) peer-reviewed journals per 1,000,000 EUR of research grants • Number of large-scale pilots to test prototypes for new processes/food products/services • Number of patent applications and number of patents granted • Number of new processes/food products/services brought to the market • Share of joint public-private publications • Number of prototypes and testing activities • Outreach of dissemination and promotion actions (e.g. degree to which target audiences have been reached)
	INCREASED SKILLS AND CAPACITY IN NEW SCIENTIFIC AND TECHNOLOGICAL DEVELOPMENTS	• Share of resources in the EU receiving training formal and on-the-job training in the Programme advances • Share of PhDs in related fields through participation in the programme • New curricula developed • Percentage of employer satisfaction • Share of employees with initially sector-extrinsic experience • Share of graduates creating own businesses • Number of training programs promoting new knowledge/know-how and developing new skills for food professionals are established with participation of at least a number of participants across the EU • Number of formal training programmes driven by the SRIA thematic priorities in EU Universities at undergraduate / graduate level in food engineering and related disciplines
	COMMUNICATION AND STAKEHOLDER ENGAGEMENT	• Increased number of R&I projects with consumers as partners as indicated by participation in R&I activities, including early stages • Raised level of food system knowledge in the general public (as assessed by surveys) • Increase of vertical integration of stakeholder cooperation
OUTCOMES	NEW SCIENTIFIC AND TECHNOLOGY FIELDS AND INNOVATIONS ADOPTED BY COMPANIES AND INTRODUCED TO THE MARKET	• Number of products designed from progress made in adjacent fields (material science, nanotechnologies, ICT) • Number of approaches/methodologies to exploit Big Data for probing consumer insight and satisfaction • Number of information systems for personalised consumer queries in the area of food sustainability and health Number of private companies introducing innovations • Share of participating SMEs introducing innovations new to the company or the market
	ECONOMY GROWTH AND BUSINESS PERFORMANCE	• Turnover of new products and services , patents and/or cost savings • SMEs participating in the Programme under this initiative represent at least a number of participant organizations • Number of innovative companies / start-ups are created, using Big Data for promoting interaction among consumers and food chain participants • Increase (%) of private sector R&I investment increases at the end of the Programme • Increased turnover share of European food industry from new products/services • Increased share of European food industry added value • Increased share of European food industry exports

OUTCOMES	STRONG RESEARCH AND BUSINESS NETWORKS DEVELOPING AND PROMOTING INNOVATIONS WITH AN EU (AND GLOBAL)OUTREACH	• Number of market alliances developed to promote new innovative products and services • Number of new value chains created • Number of new business models
	HIGHLY TRAINED WORKFORCE	• New high-skilled profiles • Number of jobs with increased qualifications
	INCREASED PUBLIC AND PRIVATE R&D INVESTMENTS	• R&I investments in the food sector (GERD, BERD)[10] • Share of project results taken up for further investments
IMPACT	EUROPEAN LEADERSHIP IN SCIENTIFIC FIELDS AND TECHNOLOGY AREAS	• Share of EU publications in top citation indices in new scientific and technology fields.
	MORE JOBS IN AND HIGH-ADDED VALUE CONTRIBUTION OF FOOD SECTOR TO THE EU ECONOMY	• Growth rates and job creation in the food sector of the EU • Increase (%) of the number of Full Time Equivalent positions in the food and drink industry
	BETTER LIVING CONDITIONS AS A RESULT OF SUCCESSFULLY ADDRESSING KEY SOCIETAL CHALLENGES	• KPIs related to citizen satisfaction e.g. from Eurobarometer • Citizen's health status as related to food intake • Number of legislative actions creating incentives for availability and use of balanced diets • KPIs to measure effects of healthier diets
	CONSUMER ENGAGEMENT	• Number of consumer organisations participate in the Programme actions • Increased share (%) of citizens showing trust in the European food industry • Number of new products based on consumer insight • Consumer satisfaction on quality of new foods.
	INCREASED SUSTAINABILITY ASSOCIATED WITH A CIRCULAR FOOD PRODUCTION	• Reduction (%) of the energy footprint by the food sector energy • Increase (%) of the recycling of by-products by the food sector

4.4. IAP Management and Follow-up

Setting up a Programme Management Team (with the participation of programming and funding bodies) will help undertake the implementation and follow-up of IAP.

Management entails project procurement and actions related to monitoring, evaluation and impact assessment. The proposed set of KPIs can be used to support management of IAP as briefly discussed on the right.

PROCUREMENT

At the procurement phase, applicants are informed of:

- The expected impacts of each action (depending on the R&I target and topic the action belongs to, specified in the SRIA and in Appendix 3);
- The output indicators they are obliged to include in the project progress reports and the final project report;
- Their obligation to provide outcome and impact related information for a period of 3-5 years following project completion.

MONITORING

The Programme Management Team will collect on a regular basis (e.g. quarterly or biannually):

- The project portfolio characteristics: participants types and corresponding budget allocation for each R&I target, topic and action, enabling to determine the composition KPIs;
- The project outputs as specified in the project progress reports, enabling to determine the output KPIs.

These data are used to prepare regular monitoring reports that are focused on the project composition analysis and nature/volume of outputs produced.

EVALUATION AND IMPACT ASSESSMENT STUDIES

The widely accepted standards to be applied in evaluation/impact assessment are the five standard criteria as defined by OECD/DAC:

- Relevance – the extent to which the objectives set are pertinent to the needs, problems or issues to be addressed;
- Efficiency – A measure of how economically resources/inputs (funds, expertise, time, etc.) are converted to results;
- Effectiveness – the extent to which the objectives set are achieved, or are expected to be achieved, taking into account their relative importance;
- Impact – the positive and negative, primary and secondary long-term effects expected to be produced by a development intervention, directly or indirectly, intended or unintended;
- Sustainability – the extent to which the (positive) effects (are likely to) last after an intervention has ended.

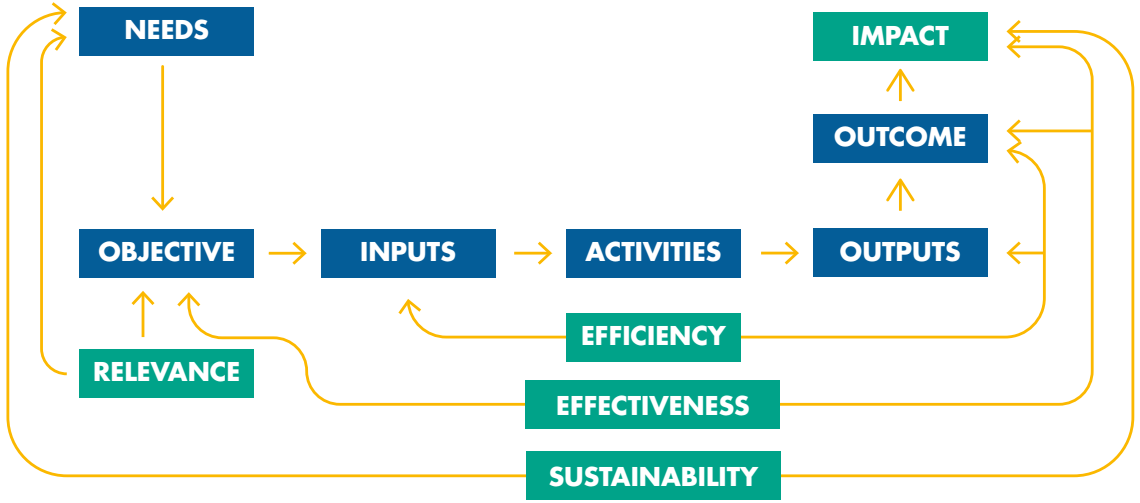
Figure 9 represents the relations between needs, objectives, activities and the different levels of effects (outputs, outcomes, impact) and how implementation progress is reflected by the evaluation criteria. As shown, the evaluation dimensions refer to different levels of effects, so it is important to have KPIs for each level of effect as proposed above.

Evaluations and impact assessments are carried on the basis of data collected through document analysis, surveys, and case studies. It is with these research methods that the outcome and impact KPIs can be determined, taking into account that these methods are meaningful if used sometime after the end of the corresponding actions.

As an example, the output KPIs that can be derived from project report data providing numbers of publications, technological achievements, patents, persons trained, etc. How these are converted to longer-term benefits can be determined by:

- Interviews/surveys/case studies with project participants after the end of the project (innovations to the market, higher R&I investments, increased economic performance, increased market shares, more qualified personnel);
- Stakeholder interviews/surveys (e.g. better customer awareness out of a series of dissemination actions or influence of programme on policy makers and related legislation);
- Data analysis (e.g. of policy documents and statistics providing evidence on the evolution of market trends, level of competitiveness and other larger scale effects).

Figure 9. Diagram of the relations between needs, objectives, activities and the different levels of effects (outputs, outcomes, impact)



The Programme Management Team can also commission evaluation and impact assessment studies at critical stages of IAP.

OTHER IMPORTANT CONSIDERATIONS

Impact assessment is not so much about developing tools and methods as it is about taking a pro-active empirical approach. Impact pathways are a relevant tool with different interpretations from different actors (e.g. researchers, business, etc) and therefore all should be involved. It should be continuous activity, focusing on processes and not just products. The SDGs are the starting point on developing impact pathways, which lead to a specific macro-economical level for food system transformation.

From a business perspective the actions on impact assessment have to be concrete, practical, and follow a business decision process. Business should look at two different, parallel workstreams: those more mature indicators that could be immediately applied in business, and those less mature that need to be more worked on. From the perspective of business operators.

We need better datasets to improve the existing methodologies. In addition to developing stronger datasets, a better integration of quantitative and qualitative methods can also help. The evaluation of impact must be specific to the context. An econometric analysis does not always fit the specific impact pathway and there is the need for systematic intermediary information. Objective impact evaluation is relevant, but also the incentives for R&I have an influence.

Responsible Research and Innovation (RRI) has to be linked to the impact evaluation. Foresight exercises and scenarios should be incorporated on the funders' decisions, addressing the end-users. Policy related impact and the process that policies have on the evaluation of impact have to be addressed.

In addition, to assess the progress made in executing the formulated vision of the ETP 'Food for Life', it needs to respond to further challenges: The development of new methods for the impact measurement in sustainability regarding food systems; the methods to collect the baseline data; and set up an analysis working groups addressing a quantitatively methodology to measure the impact of R&I activities in the food sector as a continuous monitoring exercise.

4.5. Authors of the section on impact measurement

Developing a broad impact assessment strategy of public and private funded R&I projects is crucial to assess the progress made in executing its formulated vision. With this aim, the ETP 'Food for Life' organised a workshop on 'Impact pathways in the Food System: How to measure impact of R&I' on 3 June 2020 with a group of experts in the field of impact assessment.

The focus of the workshop was to discuss the most appropriate instruments to be used, or developed, for measuring the impact of R&I actions in the agri-food sector, particularly in the areas of health, food safety, economic growth, environment (with a focus on sustainability), and job creation, by answering three fundamental questions:

1. **What do we need to measure impact of R&I in these areas?**
2. **Are there methods (e.g. tools) available and are they adequate to measure impact?**
3. **What is needed to improve existing methods and develop new ones?**

The key points of the discussion were incorporated in this chapter.

Here there is the list of participants of the workshop, and contributors to this chapter:

- Barbaros Corekogu (EIT-Food)
- Davide Viaggi (UniBo)
- Dimitris Ladikos (ETP 'Food for Life' Leadership Team, YIOTIS S.A.)
- Elisabeth Zaparucha (Technopolis)
- Gábor Kátay (Joint Research Centre of the European Union)
- Gert Meijer (Chair of the ETP 'Food for Life)
- Gianluca Brunori (UniPi)
- Jonas Lazaro-Mojica (ETP 'Food for Life' Secretariat)
- Marco Rupp (BIC)
- Mireille Matt (INRAE)
- Nelo Emerencia (BIC)
- Odysseas Cartalos (Independent expert and advisor)
- Rebeca Fernandez (FoodDrinkEurope)
- Tim Hogg (Vice-chair of the ETP 'Food for Life')
- Urs Schenker (Nestlé)
- Wim Haentjens (European Commission DG RTD)

APPENDICES

APPENDIX 1

The following Table lists the suggested Actions to implement the SRIA. See Chapter 2 of the main file for more information on how to read this Table.

Timeline | Resources | < EUR 2 million | EUR 2-5 million | EUR 5-7 million | Expertise | Stakeholders

A. INCREASE THE ENGAGEMENT AND INVOLVEMENT OF CONSUMERS

TOPIC 1.1

IMPROVING INSIGHTS INTO CONSUMERS

During the last decades, the field of consumer science has grown and led to a better understanding of consumer and societal issues related to food and eating. Simultaneously, new technologies have become available and new tools have been developed. Furthermore, it has become possible to collect and store large amounts of data easily. This volume and type of data was previously unavailable. These developments are very promising as they can make new and deeper insights possible. However, the possibilities offered by these new developments have yet to be fully exploited.

RESEARCH

ACTION 1

AGREE ON AN ETHICAL FRAMEWORK

- Timeline: 2021 2022 2023 2024 2025 2026 2027
- Resources: EU level; Public funding; Research support tools
- Expertise: ICT, maths (modelling), consumer science, ethics
- Stakeholders: Academia, research institutes, industry, retailers, consumers, policy makers

ACTION 2

INTRODUCE NEW METHODS FROM COGNITIVE FIELDS

- Timeline: 2021 2022 2023 2024 2025 2026 2027
- Resources: EU level; Public funding; Research support tools
- Expertise: ICT, maths (modelling), data sciences, consumer science, ethics
- Stakeholders: Academia, research institutes, industry, retailers

ACTION 3

INCREASE THE UTILIZATION OF BIG DATA

- Timeline: 2021 2022 2023 2024 2025 2026 2027
- Resources: EU level; Private + public funding; Research support tools
- Expertise: Food science, ICT, data sciences, social sciences (consumer, marketing)
- Stakeholders: Academia, research institutes, industry, retailers, health practitioners

RESEARCH

ACTION 4

USE THE INFORMATION FROM RETAILERS FOR RESEARCH PURPOSES

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Food science, ICT, social sciences (consumer, marketing)

Academia, research institutes, industry, retailers, health practitioners

INNOVATION

ACTION 5

DEVELOP PERSONAL DEVICES TO STUDY CONSUMER BEHAVIOUR

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Innovation support tools

ICT, consumer science, health sciences

Academia, research institutes, industry, policy makers, retailers

ACTION 6

DEVELOP TOOLS TO USE BIG DATA IN THE DESIGN OF NEW PRODUCTS AND IN PUBLIC DECISION MAKING

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Innovation support tools

Food science, ICT, data sciences, social sciences (marketing)

Academia, research institutes, industry, policy makers

ACTION 7

DEVELOP A PROGRAM FOR CHANGING BEHAVIOUR - FOCUS ON WHOLE POPULATION

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Partnerships in education

Health sciences, consumer science, training, communication

Academia, research institutes, industry, policy makers, health practitioners

TRAINING / EDUCATION

ACTION 8

LEARN HOW TO DEAL WITH BIG DATA: WHERE TO FIND IT, HOW TO MAKE IT COMPARABLE

2021 2022 2023 2024 2025 2026 2027

EU level; Public funding; Skills and career development

Food science, ICT, maths, data sciences, consumer science

Academia, research institutes, industry, policy makers

ACTION 9

MAKE CONSUMER AND SOCIAL SCIENCES ACCESSIBLE TO SMES

2021 2022 2023 2024 2025 2026 2027

EU level; Public funding; Skills and career development

Food science, ICT, maths, consumer science, communication sciences, market analysis

SMEs, Academia (junior researchers), research institutes, industry, policy makers

ACTION 10

DEVELOP EDUCATIONAL PROGRAMMES INTEGRATING THE USE OF BIG DATA IN FOOD SCIENCE

2021 2022 2023 2024 2025 2026 2027

EU level; Public funding; Skills and career development

Food science, ICT, maths, consumer science, education, communication

Academia, industry (specifically SMEs), policy makers

COMMUNICATION / DISSEMINATION

ACTION 11

COMMUNICATE AND DISCUSS WITH RELEVANT STAKEHOLDERS

2021 2022 2023 2024 2025 2026 2027

EU level; Public funding; Coordination and networking tools

Stakeholder engagement, communication

Food value chain, consumers, policy makers

Timeline | Resources | < EUR 2 million | EUR 2-5 million | EUR 5-7 million | Expertise | Stakeholders

TOPIC 1.2

FOOD AND ME: MAKING FOOD AN ACTIVITY

Technological developments have led to unprecedented efficiency gains, but simultaneously to a situation in which consumers and food producers have little contact with, or understanding of, each other. This has contributed to the difficulty for food producers to read consumer preferences. From the consumers' side, the lack of understanding of how the food chain operates contributes to a lack of trust. Realigning consumers and the food chain requires engaging consumers and a change in the food industry, moving from developing products and services for consumers, to one in which they develop these with consumers.

RESEARCH

ACTION 1

DESIGN NEW FORMS OF COMMUNICATION CONSUMERS - FOOD PRODUCERS

Timeline: 2021 2022 2023 2024 2025 2026 2027

Resources: EU level; Private + public funding; Research support tools

Expertise: Food science, consumer science, ICT, communication

Stakeholders: Academia, research institutes, industry, policy makers, consumers

INNOVATION

ACTION 2

IMPLEMENT NEW BUSINESS MODELS FOR GENERATING AND DISSEMINATING CONSUMER INSIGHTS

Timeline: 2021 2022 2023 2024 2025 2026 2027

Resources: EU / regional level; Private + public funding; Innovation support tools

Expertise: Food science, ICT, data sciences, consumer science, ethics, math (modelling)

Stakeholders: Academia, research institutes, industry, policy makers

ACTION 3

DEVELOP NEW TOOLS TO BETTER UTILISE 'BIG DATA'

Timeline: 2021 2022 2023 2024 2025 2026 2027

Resources: EU level; Private + public funding; Innovation support tools

Expertise: Food science, data sciences, ICT, maths (modelling)

Stakeholders: Academia, research institutes, industry, policy makers, consumers

ACTION 4

DEVELOP MODELS FOR ENGAGING CONSUMERS

Timeline: 2021 2022 2023 2024 2025 2026 2027

Resources: EU / Regional level; Private + public funding; Innovation support tools

Expertise: ICT, social sciences, communication

Stakeholders: Academia, research institutes, industry, policy makers, consumers

TRAINING / EDUCATION

ACTION 5

TRAIN THOSE WORKING IN PRODUCT DEVELOPMENT IN CONSUMER SCIENCES

2021 2022 2023 **2024** 2025 2026 2027

EU level; Private + public funding; Skills and career development

Food science, consumer science, social science

Academia, research institutes, industry (especially SMEs), policy makers

COMMUNICATION / DISSEMINATION

ACTION 6

TAILOR COMMUNICATION TO CONSUMERS

2021 2022 **2023** 2024 2025 2026 2027

EU level; Public funding; Coordination and networking tools

Consumer sciences, data sciences, science communication, stakeholder engagement

Food value chain, Academia, research institutes, policy makers, consumers, experts in communication

ACTION 7

TRANSLATE SCIENTIFIC OUTCOMES INTO SOMETHING SIMPLE AND UNDERSTANDABLE

2021 2022 **2023** 2024 2025 2026 2027

EU level; Public funding; Coordination and networking tools

Food science, science communication

Food value chain, Academia, research institutes, policy makers, consumers, experts in communication

ACTION 8

ENHANCE THE INTERACTION WITH CONSUMERS VIA SOCIAL MEDIA AND OTHER INTERNET PLATFORMS

2021 2022 **2023** 2024 2025 2026 2027

EU level; Public funding; Coordination and networking tools

ICT, data sciences, consumer sciences, science communication

Food value chain, Academia, research institutes, policy makers, consumers, experts in communication (including bloggers, TV chefs, etc)

ACTION 9

VALIDATE THE INFORMATION AVAILABLE

2021 2022 2023 2024 2025 2026 2027

EU level; Public funding; Coordination and networking tools

Food science, ICT, consumer science, science communication

Food value chain, Academia, research institutes, policy makers, consumers, experts in communication (including bloggers, TV chefs, etc)

Timeline | Resources | < EUR 2 million | EUR 2-5 million | EUR 5-7 million | Expertise | Stakeholders

TOPIC 1.3

FOOD INVENTORS: NEW FOOD PRODUCTION AND DELIVERY MODELS

How people access and consume food is constantly changing, with new models of consumption on the rise leading to an increased diversity in the ways that consumers access, prepare, produce and consume food. New consumer-led channel models reflect a different type of engagement and involvement with food, characterizing consumers as co-producers or co-processors. Such new combinations of food production and delivery models have potentially large yet currently unknown implications for consumers, food companies and policy makers.

RESEARCH

ACTION 1

IDENTIFY AND DESCRIBE DIVERSITY AND KEY FEATURES OF ALTERNATIVE PRODUCTION AND DELIVERY MODELS IN EUROPE

Timeline: 2021 2022 2023 2024 2025 2026 2027

EU level; Public funding; Research support tools

Food technology, ICT, data sciences, social sciences, logistics, economics

Food value chain, Academia, research institutes

ACTION 2

ASSESS ECONOMIC AND INNOVATION POTENTIAL OF ALTERNATIVE MODELS

Timeline: 2021 2022 2023 2024 2025 2026 2027

EU / Regional level; Private + public funding; Research support tools

Food technology, logistics, economics

Food value chain, Academia, research institutes, investors

ACTION 3

ASSESS IMPLICATIONS FOR CONSUMERS AND OTHER DIMENSIONS OF THE FOOD CHAIN (INCL. SAFETY, SECURITY, WASTE) OF ALTERNATIVE MODELS

Timeline: 2021 2022 2023 2024 2025 2026 2027

EU / Regional level; Private + public funding; Research support tools

Food science, environmental sustainability, economics, social sciences

Food value chain, Academia, research institutes, investors

INNOVATION

ACTION 4

DEVELOP THE ALTERNATIVE MODELS WITH MOST POTENTIAL

Timeline: 2021 2022 2023 2024 2025 2026 2027

EU / regional level; Private + public funding; Innovation support tools

Food science, ICT, social sciences, logistics

Food value chain, Academia, research institutes, policy makers, investors

INNOVATION

ACTION 5

DEVELOP ICT TOOLS AND OTHER SUPPORT SYSTEMS

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Innovation support tools

Food science, ICT, data sciences

Food value chain, Academia, research institutes, policy makers, investors

TRAINING / EDUCATION

ACTION 6

TRAIN AND EDUCATE SMES IN POSSIBILITIES FOR NEW BUSINESS CREATION

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Skills and career development

Entrepreneurship, knowledge transfer, financing instruments, education

SME networks

COMMUNICATION / DISSEMINATION

ACTION 7

PROMOTE CONSUMER UNDERSTANDING (RISKS & BENEFITS)

2021 2022 2023 2024 2025 2026 2027

EU / Regional level; Private + public funding; Coordination and networking tools

Food science, consumer sciences, communication

Food value chain, Academia, research institutes, policy makers, consumers, experts in communication

Timeline | Resources | < EUR 2 million | EUR 2-5 million | EUR 5-7 million | Expertise | Stakeholders

TOPIC 1.4

FOOTPRINTING OF FOOD: CONSUMER ENGAGEMENT IN SUSTAINABILITY

Food products are sometimes labelled with different kinds of indicators, many of which are related to specific aspects of sustainability. To achieve an optimal consumer engagement, they should be able to decide which information should be aggregated into personalized reports on food products, which would allow the individualization of sustainability data without causing information overflow. Although there are intellectual property, competitiveness and ethical issues to be considered, this approach will greatly increase the transparency of the food chain and build and foster consumer trust.

RESEARCH

ACTION 1
MAP CONSUMER NEEDS

2021 2022 2023 2024 2025 2026 2027

EU level; Public funding; Research support tools

Environmental sustainability, consumer science

Academia, research institutes, industry, consumers

ACTION 2
MAP OPEN SOURCE DATA FROM THE WHOLE VALUE CHAIN

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Food science, ICT, data sciences, environmental sustainability

Food value chain, Academia, research institutes

ACTION 3
MAP PRIVATE SOURCE DATA FROM THE WHOLE VALUE CHAIN

2021 2022 2023 2024 2025 2026 2027

EU / Regional level; Private + public funding; Research support tools

Food science, ICT, environmental sustainability, industry commitment

Food value chain, Academia, research institutes

ACTION 4
ASSESS RELIABILITY AND ALIGNMENT OF DATA GENERATION

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

ICT, environmental sustainability, food technology

Food value chain, Academia, research institutes

INNOVATION

ACTION 5

ESTABLISH AN AGENCY RESPONSIBLE FOR SETTING UP THE SYSTEM

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Innovation support tools

Food science, ICT, environmental sustainability, governmental affairs

Food value chain, policy makers

ACTION 6

DEVELOP ALGORITHMS AND DATA FLOW

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Innovation support tools

Food science, ICT, data sciences, environmental sustainability

Food value chain, Academia, research institutes

ACTION 7

DEVELOP A SYSTEM ALLOWING FOR TWO-WAY COMMUNICATION

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Innovation support tools

Food science, ICT, data sciences, environmental sustainability, consumer science, communication

Academia, research institutes, industry, consumers, experts in communication

COMMUNICATION / DISSEMINATION

ACTION 8

DESIGN NEW TOOLS FOR COMMUNICATION

2021 2022 2023 2024 2025 2026 2027

EU / Regional level; Private + public funding; Coordination and networking tools

ICT, data sciences, communication

Food value chain, Academia, research institutes, policy makers, consumers, experts in communication

Timeline | Resources | < EUR 2 million | EUR 2-5 million | EUR 5-7 million | Expertise | Stakeholders

TOPIC 1.5

THE SMART FOOD GRID: MODULAR FOOD PRODUCTION AND DISTRIBUTION

Food production and retail sales have become centralized due to economies of scale. This has made the consumer a recipient of products made, sometimes, far away. There is now a demand for personalization and customization rather than mass production Therefore, flexible and agile processes are needed in order to allow a fast adaptation to changes in consumer demand. Modularization at various stages of the food value chain will also give the opportunity for new business models and will contribute to social, economic and environmental sustainability.

RESEARCH

ACTION 1

ASSESS IMPLICATIONS OF MODULAR AND LOCAL PRODUCTION AND DISTRIBUTION SYSTEMS

Timeline: 2021 2022 **2023 2024 2025 2026 2027**

EU / Regional level; Private + public funding; Research support tools and specific actions towards SMEs

Food science, ICT, data sciences, logistics, economics

Food value chain, SME networks

INNOVATION

ACTION 2

DEVELOP SMALL-SCALE PRODUCTION / DISTRIBUTION SYSTEMS (EFFICIENT AND QUALITY-CONTROLLED)

Timeline: 2021 2022 2023 **2024 2025** 2026 2027

EU / Regional level; Private + public funding; Innovation support tools and specific actions towards SMEs

Food science, ICT, logistics, economics

Academia, research institutes, industry (especially SMEs)

ACTION 3

DEVELOP STRATEGIES TO ENSURE END-USE ACCEPTANCE AND INVOLVEMENT

Timeline: 2021 2022 2023 **2024 2025** 2026 2027

EU / Regional level; Private + public funding; Innovation support tools and specific actions towards SMEs

Food science, ICT, consumer science, social sciences

Academia, businesses, research institutes, policy makers, CSOs

ACTION 4

PROVIDE FUNDING AND FINANCIAL TOOLS TAILORED TO SMES

Timeline: 2021 2022 **2023 2024 2025 2026 2027**

EU / Regional / National level; Private + public funding; Innovation support tools and specific actions towards SMEs

Financial tools, funding schemes, fiscal and tax incentives, economics

SMEs, financial experts

TRAINING / EDUCATION

ACTION 5

TRAIN AND EDUCATE ON NEW BUSINESS OPPORTUNITIES FOR FARMERS AND FOOD PRODUCERS AND PACKAGING PROVIDERS

2021 2022 2023 **2024** **2025** **2026** **2027**

Regional and National level; skills and career development

Knowledge transfer, education, agricultural, food science

SME networks

Timeline | Resources | < EUR 2 million | EUR 2-5 million | EUR 5-7 million | Expertise | Stakeholders

B. PROVIDING THE BASIS FOR A MORE PERSONALISED AND CUSTOMISED FOOD SUPPLY

TOPIC 2.1

THE FOOD I LOVE: APPRECIATION OF DIVERSITY IN FOOD AND EATING

Food consumption is central to human life, not only in terms of nutritional needs, but also in terms of social, emotional, enjoyment, and identity-related needs. Despite increasing similarities across Europe, the perceived value and satisfaction from food and eating shows intriguing and valuable, yet poorly understood, differentiation. Understanding and enhancing food appreciation will allow a better alignment of the food supply with the diversity of individual needs, increase consumer satisfaction and wellbeing, create and capture business value creation and improve policy level interventions.

RESEARCH

ACTION 1

MAP AND MODEL FOOD APPRECIATION CONCEPTS AND CRITERIA ACROSS EUROPE

2021 **2022** **2023** 2024 2025 2026 2027

EU level; Public funding; Research support tools

ICT, data sciences, maths (modelling), consumer science

Academia, research institutes, industry

ACTION 2

EXPLORE CONSUMERS INTERESTS IN DIVERSITY AND NEW CONCEPTS

2021 2022 **2023** **2024** **2025** 2026 2027

EU level; Private + public funding; Research support tools

Social sciences (consumer, marketing)

Academia, research institutes, industry

INNOVATION

ACTION 3

DEVELOP NEW PERSONALISED FOOD OFFERINGS AND DELIVERY MODELS

2021 2022 **2023 2024 2025 2026 2027**

EU level; Private + public funding; Innovation support tools

Food science, social sciences (consumer, marketing), logistics

Academia, research institutes, industry

TRAINING / EDUCATION

ACTION 4

TRAIN AND EDUCATE CONSUMERS AND FOOD DEVELOPERS IN BENEFITS BROUGHT BY DIVERSITY OFFERINGS

2021 2022 2023 **2024 2025 2026 2027**

EU level; Private + public funding; Skills and career development

Food science, consumer science, education, communication

Academia, research institutes, industry, consumers

COMMUNICATION / DISSEMINATION

ACTION 5

DISSEMINATE RESULTS TO SMES AND OTHER STAKEHOLDERS

2021 **2022 2023 2024 2025** 2026 2027

EU / Regional / National level; Private + public funding; Coordination and networking tools and specific actions towards SMEs

Stakeholder engagement, communication, education, data sciences

Food value chain, SME network, consumers, policy makers

Timeline · Resources · < EUR 2 million · EUR 2-5 million · EUR 5-7 million · Expertise · Stakeholders

TOPIC 2.2

(TR)EAT ME: DIETARY APPROACHES FOR THE PREVENTION OF NCDS

Working methods and the age structure of the population in Europe have significantly changed over the last decades. It is recognized that the role of nutrition is crucial for health and directly related to the health cost of society. The common underlying causes and pathways of the comorbidities associated with many NCDs urge the need for targeted hypothesis driven long-term intervention studies, not solely focusing on accepted biomarkers, but also on functional intermediate endpoints or even hard endpoints.

RESEARCH

ACTION 1

BUILD EVIDENCE OF TARGETED BENEFITS OF SPECIFIC DIETS

2021 2022 2023 2024 2025 2026 2027

EU level; Public funding; Research support tools

Nutrition, ICT, health sciences

Academia, research institutes, industry, health practitioners

RESEARCH

ACTION 2

IMPROVE PREDICTIVE MODELS LINKING BENEFITS TO MARKERS

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Nutrition, ICT, health sciences, economics, logistics

Academia, research institutes, industry

ACTION 3

DETERMINE CONSUMER DRIVERS FOR HEALTHIER CHOICES

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Social sciences (consumer, marketing), nutrition, health sciences

Academia, research institutes, industry, consumers, health practitioners

ACTION 4

DEVELOP MODELS FOR CONSUMER BEHAVIOUR CHANGE

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Social sciences (consumer, marketing), ICT, data sciences

Academia, research institutes, industry, consumers

INNOVATION

ACTION 5

DEVELOP NEW PERSONALISED FOOD OFFERINGS AND DELIVERY MODELS

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Innovation support tools

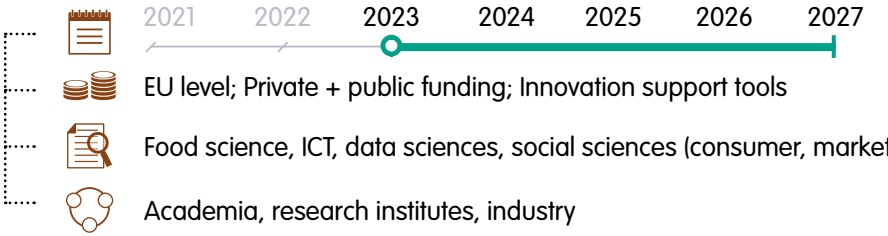
Food science, social sciences (consumer, marketing), logistics, data sciences

Academia, research institutes, industry

INNOVATION

ACTION 6

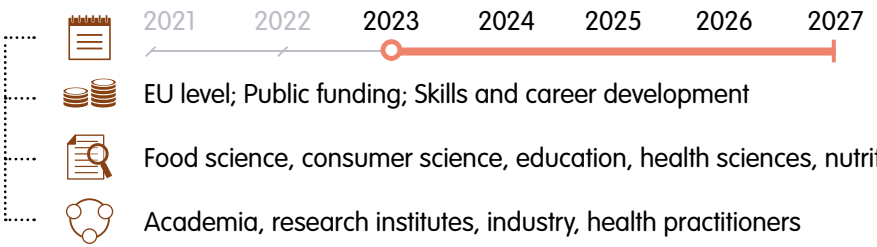
INTEGRATE FINDINGS FROM PERSONAL DEVICES



TRAINING / EDUCATION

ACTION 7

TRAIN AND EDUCATE HEALTH PRACTITIONERS



COMMUNICATION / DISSEMINATION

ACTION 8

DEVELOP NEW WAYS OF COMMUNICATION ABOUT SUPPORTIVE INTERVENTIONS

ACTION 9

COMMUNICATE TO CONSUMERS ABOUT NEW DIETARY MODELS

Timeline | Resources | < EUR 2 million | EUR 2-5 million | EUR 5-7 million | Expertise | Stakeholders

TOPIC 2.3

PACKAGING 4.0: INTELLIGENT AND COMMUNICATING PACKAGES

Industry 4.0 denotes the concept of a manufacturing system with full integration of cyber and physical technologies, wherein machines and devices communicate with each other, as well as with users. In the context of a rapidly evolving digital world, one can envision packages providing an interface to implement an Industry 4.0 concept in the food systems arena. This involves the exploration of technologies that go beyond classical active and intelligent packaging approaches and allow full leveraging of digital connectivity.

RESEARCH

ACTION 1

EXPLORE CONSUMER WISHES FOR INTELLIGENT PACKAGING

Timeline: 2021 2022 2023 2024 2025 2026 2027

Resources: EU level; Private + public funding; Research support tools

Expertise: Packaging, food science, ICT, data sciences, sensor technology, printing, nanotechnology, data management, marketing, consumer sciences, social sciences

Stakeholders: Academia, research institutes, industry (SMEs)

ACTION 2

DELIVERY VERY INEXPENSIVE, MASS-PRODUCED SENSORY AND COMMUNICATION SYSTEMS TO USE IN PACKAGING

Timeline: 2021 2022 2023 2024 2025 2026 2027

Resources: EU level; Private + public funding; Research support tools

Expertise: Packaging, ICT, data sciences, material sciences, printing, nanotechnology, sensors, electronics

Stakeholders: Academia, research institutes, industry

ACTION 3

DEVELOP ICT STRUCTURE TO LINK UP WITH INDIVIDUAL 'SMART' PACKAGES AND OTHER DEVICES, ALLOWING A DIVERSITY OF MANUFACTURERS AND PROTOCOLS

Timeline: 2021 2022 2023 2024 2025 2026 2027

Resources: EU level; Private + public funding; Research support tools

Expertise: Packaging, ICT, data sciences, material sciences, electronics, robotics, printing, nanotechnology, sensors, software development

Stakeholders: Academia, research institutes, industry

INNOVATION

ACTION 4

IMPLEMENT TOOLS AND PROCESSES TO MAKE RELEVANT INFORMATION ACCESSIBLE AND AVAILABLE

Timeline: 2021 2022 2023 2024 2025 2026 2027

Resources: EU level; Private + public funding; Innovation support tools

Expertise: Packaging, food science, ICT, data sciences, media, printing, nanotechnology, sensors, software development

Stakeholders: Academia, research institutes, industry

INNOVATION

ACTION 5

COMBINE AVAILABLE IT TECHNOLOGIES TO DELIVER INFORMATION NECESSARY TO ENGAGE THE CONSUMER WITH HIS FOOD

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Innovation support tools

Packaging, ICT, data sciences, consumer sciences, food science, nutrition, software development

Academia, research institutes, industry

ACTION 6

CREATE LINK BETWEEN INTELLIGENT PACKAGING, ICT AND SOCIAL MEDIA, SMARTPHONES FOR CONSUMERS TO LATCH ON TO

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Innovation support tools

Packaging, ICT, data sciences, social media, software development, augmented reality

Academia, research institutes, industry

TRAINING / EDUCATION

ACTION 7

TRANSLATE LARGE-SCALE SMART PACKAGING TECHNOLOGIES TO PRODUCERS OF NEW PACKAGING

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Skills and career development

Packaging, ICT, data sciences, electronics, materials and polymer technology, production technology, software development, technology transfer

Academia, research institutes, industry (SMEs)

ACTION 8

TRAIN 'FOOD INSPECTORS'

2021 2022 2023 2024 2025 2026 2027

EU / Regional level; Private + public funding; Skills and career development

Packaging, food quality, hygiene, nutrition, governmental affairs

Academia, research institutes, industry (SMEs), policy makers

ACTION 9

TRAIN FOOD SME AND MAKE THEM AWARE

2021 2022 2023 2024 2025 2026 2027

EU / Regional level; Private + public funding; Skills and career development

Packaging, technology transfer, training, education, communication

Academia, research institutes, industry, SME network

COMMUNICATION / DISSEMINATION

ACTION 10

COMMUNICATE POSSIBILITIES OF ACTIVE AND INTELLIGENT PACKAGING TO CONSUMERS

2021 2022 2023 2024 2025 2026 2027

EU / Regional / National level; Private + public funding; Coordination and networking tools and specific actions towards SMEs

Packaging, stakeholder engagement, communication, serious gaming, virtual and augmented reality

Academia, research institutes, industry, consumers

Timeline | Resources | < EUR 2 million | EUR 2-5 million | EUR 5-7 million | Expertise | Stakeholders

TOPIC 2.4

IN SILICO FOOD DESIGN: UNDERSTANDING FOOD DIGESTION

Nutrition and diet are essential for health and well-being. Increased intake of specific ingredients should lead to better health and quality of life. However, simply adding health promoting ingredients often does not work as the food matrix plays a key role in making specific ingredients available for our digestive system. Unrevealing the specific mechanisms that play a role during food digestion will enable us to understand how we can incorporate ingredients so that they will be taken up efficiently and, indeed, will have the desired health effects.

RESEARCH

ACTION 1

DEVELOP DATA EXCHANGE PLATFORM 'OPEN SOURCE'

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Food science, ICT, data sciences, data analytics

Academia, research institutes, industry, policy makers

ACTION 2

DEVELOP TECHNIQUES FOR STUDYING MICRONUTRIENT DIGESTION

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Food science, analytical sciences, nutrition, data analytics

Academia, research institutes, industry

ACTION 3

EXECUTE MECHANISTIC IN SILICO MODELLING AND BIG DATA APPROACHES

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Food science, nutrition, bioinformatics

Academia, research institutes, industry

RESEARCH

ACTION 4

UNDERSTAND THE MATRIX INTERACTIONS

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Food science, nutrition, data analytics, material science

Academia, research institutes, industry

INNOVATION

ACTION 5

DEVELOP NEW FOOD CONCEPTS WITH IMPROVED FUNCTIONALITY BASED ON RESEARCH OUTCOMES

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Innovation support tools

Food science, nutrition, sensory science, material science

Academia, research institutes, industry

TRAINING / EDUCATION

ACTION 6

DEVELOP TRAINING TOOLS ON RESEARCH RESULTS TO SMES, FOOD COMPANIES, NUTRITION

2021 2022 2023 2024 2025 2026 2027

EU / Regional level; Private + public funding; Skills and career development and specific actions towards SMEs

Food science, nutrition, material science, technology transfer, training, education

Academia, research institutes, industry (SMEs)

COMMUNICATION / DISSEMINATION

ACTION 7

DEVELOP COMMUNICATION PLANS TOWARDS DIFFERENT STAKEHOLDERS

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Coordination and networking tools

Packaging, Stakeholder engagement, communication, training, education

Food value chain, Academia, research institutes, industry, consumers

COMMUNICATION / DISSEMINATION

ACTION 8

ENABLE AND COMMUNICATE DATA EXCHANGE PLATFORMS

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Coordination and networking tools

ICT, data sciences, Stakeholder engagement, communication, social media

Food value chain, Academia, research institutes, industry

Timeline | Resources | < EUR 2 million | EUR 2-5 million | EUR 5-7 million | Expertise | Stakeholders

TOPIC 2.5

THE ECOLOGY INSIDE US: FOOD MEETS GUT MICROBIOME

Ingested foods and drinks are "processed" in the gut, which serves two essential functions: digest and protect. The gut-brain-microbiome axis is a complex ecosystem shaped by the genetic background of the host but also largely influenced by environmental conditions, including diet and living conditions. To maximize economic and consumer benefits of a microbiome-optimized nutrition, an integrated research approach of the gut ecosystem and a better understanding of the role of food and nutrition in the gradient from health to disease during different periods of life is needed.

RESEARCH

ACTION 1

DEFINE FOCUS (POPULATION, MICROBIOME, DISEASE/HEALTH, FOOD)

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Nutrition, statistics, microbiology, health sciences, food science

Academia, research institutes, industry

ACTION 2

DEFINE 'PROPER' METHODOLOGY

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Nutrition, statistics, microbiology, health sciences, food science

Academia, research institutes, industry

ACTION 3

IDENTIFY PATHWAYS (ECOSYSTEM)

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Nutrition, statistics, microbiology and food microbiology, health sciences, food science

Academia, research institutes, industry

Topic 2.5

RESEARCH

ACTION 4
PROVE CAUSALITY

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Nutrition, statistics, microbiology, health sciences, food science

Academia, research institutes, industry

INNOVATION

ACTION 5
DESIGN AND TEST FOODS -> MICROBIOME -> NCD + BRAIN

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Innovation support tools

Nutrition, statistics, microbiology, health sciences, food technology

Academia, research institutes, industry

TRAINING / EDUCATION

ACTION 6
TRAIN, EDUCATE AND DEVELOP TRAINING TOOLS

2021 2022 2023 2024 2025 2026 2027

EU / Regional level; Private + public funding; Skills and career development

Nutrition, statistics, microbiology, health science, communication, ICT, training, education

Academia, research institutes, industry, consumers

ACTION 7
TRAIN AND EDUCATE SMES

2021 2022 2023 2024 2025 2026 2027

EU / Regional level; Private + public funding; Skills and career development

Nutrition, statistics, microbiology, health sciences, communication, ICT, technology transfer, risk assessment, training, education

Academia, research institutes, industry, SME networks, risk assessors

ACTION 8
TRAIN AND EDUCATE HEALTH PRACTITIONERS

2021 2022 2023 2024 2025 2026 2027

EU / Regional level; Private + public funding; Skills and career development

Nutrition, statistics, food microbiology, health sciences, communication, ICT, technology transfer, risk assessment, augmented reality, training and education

Academia, research institutes, industry, health practitioners

COMMUNICATION / DISSEMINATION

ACTION 9

FORMULATE AND DEVELOP COMMUNICATION PLANS

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Coordination and networking tools

Stakeholder engagement, communication

Food value chain, Academia, research institutes, industry, consumers

ACTION 10

PROMOTE PEOPLE TO UNDERSTAND AND USE

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Coordination and networking tools

Stakeholder engagement, communication, social media, augmented and virtual reality, MOO gaming

Food value chain, Academia, research institutes, industry, consumers

Timeline Resources < EUR 2 million EUR 2-5 million EUR 5-7 million Expertise Stakeholders

TOPIC 2.6

FORERUNNER PROJECT: FOODS FOR TOMORROW, NEW CONCEPTS AND TECHNOLOGIES TO ASSURE CONSUMER HEALTH AND WELL-BEING

New approaches for sourcing, processing and manufacturing, and delivery systems for foods and food ingredients are constantly on the rise. These may be specifically intended to add or enhance nutrition and health benefits, to improve the nutrition status, and to reduce costs and/or environmental impact. The economic and consumer benefits of future innovation will be supported by research ensuring that the nutritional impact of newly introduced materials and treatments are understood and managed, and that new opportunities to improve the nutritional quality of foods are identified and exploited.

RESEARCH

ACTION 1

IDENTIFY AND EVALUATE CURRENT AND NEW SOURCES/PROCESSES

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Food science, agriculture, biology, ecology, marine sciences

Academia, research institutes, industry, primary producers

RESEARCH

ACTION 2

ASSESS AND DEVELOP IMPROVED PREDICTIVE MODELS FOR EFFECTS ON CONSUMER HEALTH AND WELLBEING

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Nutrition, data sciences, food science, maths (modelling), health sciences

Academia, research institutes, industry

ACTION 3

ANALYSE THE IMPACT OF NEW SOURCES AND PROCESSES IN TERMS OF SUSTAINABILITY

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Food technology, process engineering, ecology, Life Cycle Assessment, environmental sustainability, nutrition

Academia, research institutes, industry

ACTION 4

UNDERSTAND SOCIETAL ACCEPTANCE OF NEW SOURCES AND PROCESSES

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Consumer science, social sciences, psychology, food science, biology

Academia, research institutes, industry, consumers

ACTION 5

CHARACTERISE THE NUTRITIONAL AND SENSORY ATTRIBUTES, SATIETY AND ALLERGENS

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Nutrition, health sciences, toxicology, sensory analysis

Academia, research institutes, industry

INNOVATION

ACTION 6

EXPLOIT NEW SOURCES OF FOOD, PROCESSING APPROACHES

2021 2022 **2023** 2024 2025 2026 2027

EU level; Private + public funding; Innovation support tools

Food science, process engineering, biology, consumer sciences, social sciences, health sciences

Academia, research institutes, industry

TRAINING / EDUCATION

ACTION 7

DEVELOP SPECIFIC KNOWLEDGE TRANSFER TOWARDS SMES

2021 2022 2023 2024 **2025** 2026 2027

EU / Regional level; Private + public funding; Skills and career development

Knowledge transfer, training, education

Academia, research institutes, industry, SME networks

COMMUNICATION / DISSEMINATION

ACTION 8

TAILOR COMMUNICATION STRESSING THE CURRENT LACK OF RESOURCES

2021 2022 2023 **2024** 2025 2026 2027

EU level; Private + public funding; Coordination and networking tools

Stakeholder engagement, communication, social media, MOOs, gaming

Food value chain, Academia, research institutes, industry, consumers, policy makers

Timeline | Resources | < EUR 2 million | EUR 2-5 million | EUR 5-7 million | Expertise | Stakeholders

C. DEVELOPING A MORE FLEXIBLE, DYNAMIC AND SUSTAINABLE FOOD SYSTEM

TOPIC 3.1

GETTING IT RIGHT: INTEGRATED FOOD SAFETY AS A UNIQUE SELLING POINT

Cutting-edge technologies in the field of "Omics", in combination with powerful computing capability, create tremendous volumes of data that need to be analysed. Within the food safety and quality area, there is great potential for the generation and utilization of this to obtain new biological insights, which will eventually lead to better approaches to mitigation and/or elimination of biological and chemical risks.

RESEARCH

ACTION 1

CREATE A NETWORKING ACTIVITY ON DATA EXCHANGE OF/AND COMPLEX FOOD DATA

2021 2022 **2023** 2024 2025 2026 2027

EU level; Public funding; Coordination and networking tools

ICT, data sciences, food safety

Academia, research institutes, industry, policy makers

RESEARCH

ACTION 2

CREATE AND OPERATE A VIRTUAL CENTRE FOR COMPLEX FOOD DATA

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

ICT, data science, food safety

Academia, research institutes, industry, policy makers

ACTION 3

EXPLOIT THE POTENTIAL OF BIG DATA ANALYTICS TO DEVELOP INSIGHTS INTO MICROBIAL AND CHEMICAL CONTAMINANTS IN FOOD SYSTEMS

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Coordination and support tools

ICT, data science, food safety, microbiological, nutrition

Academia, research institutes, industry

INNOVATION

ACTION 4

APPLY -OMICS TECHNOLOGIES TO INCREASE TRACEABILITY AND TO DEVELOP NEW METHODS

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Innovation support tools

Food safety, food science, omics, logistics, data sciences

Academia, research institutes, industry

ACTION 5

DEVELOP A FRONT-END FOR INDUSTRIES TO USE AFTER INTEGRATED SAFETY ASSURANCE

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Innovation support tools

Food safety, food science, governmental affairs, policy, internet technology

Industry, policy makers

TRAINING / EDUCATION

ACTION 6

ENSURE NEW GENERATION OF ACTORS TO IMPLEMENT RESEARCH AND USE

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Skills and career development

Food safety, education, MOOs, gaming, augmented reality

Academia, research institutes, industry

ACTION 7

TRAIN AUTHORITIES IN USING NEW TOOLS AND PREDICTIVE DATA

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Skills and career development

Food safety, education, nutrition, microbiology

Academia, research institutes, industry, policy makers

COMMUNICATION / DISSEMINATION

ACTION 8

INVOLVE AND ENGAGE CONSUMERS IN METHODS AND PROCEDURES

2021 2022 2023 2024 2025 2026 2027

EU / Regional level; Private + public funding; Coordination and networking tools

Stakeholder engagement, communication, data sciences, consumer sciences, virtual reality, serious gaming

Food value chain, SME network, consumers, policy makers

Timeline Resources < EUR 2 million EUR 2-5 million EUR 5-7 million Expertise Stakeholders

TOPIC 3.2

THE MATRIX MATTERS: FOOD STRUCTURING FOR BETTER HEALTH

There is a growing consumer awareness of the possible role of food as a direct source of health. In a more technical sense, simply adding beneficial ingredients is often insufficient, due to the key role the food matrix plays in making specific ingredients either available or unavailable (the latter in the case of caloric control) to our digestive system. A deliberate creation of food structures that maintain the nutritional function of ingredients will ensure that uptake is more efficient, and that the ingredients will indeed have the desired health effects.

RESEARCH

ACTION 1

SCREEN FOR ISSUES OF BIOAVAILABILITY THAT ARE RELEVANT TO COMBATING NCDS

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Coordination and networking tools

Food science, nutrition, health science, toxicology, microbiology, physiology

Academia, research institutes, industry

RESEARCH

ACTION 2

DEVELOP QUANTITATIVE INSIGHT IN THE ROLE OF THE MATRIX IN NUTRIENT BIO AVAILABILITY

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Food science, nutrition, material science, imaging, analytical sciences, health sciences

Academia, research institutes, industry

ACTION 3

DEVELOP QUANTITATIVE INSIGHT IN THE DIGESTION/DISINTEGRATION OF FOOD MATRICES

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Food science, nutrition, material science, imaging, analytical sciences, health sciences

Academia, research institutes, industry

ACTION 4

DEVELOP MORE NATURAL MATRICES FOR BETTER NUTRIENT UPTAKE, TO FACILITATE CONSUMER ACCEPTANCE SENSORY PROPERTIES

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Food science, nutrition, material science, sensory analysis

Academia, research institutes, industry

ACTION 5

USE KNOWLEDGE OF THE ROLE OF THE MATRIX IN DIGESTION FOR THE DESIGN OF FOODS TO COMBAT NCDS

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Food science, nutrition, physiology, material science, health science

Academia, research institutes, industry

RESEARCH

ACTION 6

DEVELOP PREDICTIVE INSIGHT IN RELATION BETWEEN MATRIX STRUCTURE AND SENSORY PROPERTIES

2021 2022 2023 **2024** 2025 2026 2027

EU level; Private + public funding; Research support tools

Food science, nutrition, physiology, sensory sciences, material science, sensory analysis

Academia, research institutes, industry

ACTION 7

CREATE AN OPEN SOURCE PORTAL FOR DIGESTION AND CONSUMER GUIDANCE

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Coordination and networking tools

Food science, ICT, data sciences, internet

Academia, research institutes, industry, consumers

INNOVATION

ACTION 8

PROSPECT ALTERNATIVE INGREDIENTS AND PROCESS METHODS

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Coordination and networking tools

Food science, biology, ecology, agriculture, marine sciences, nutrition, physiology

Academia, research institutes, industry, primary producers

ACTION 9

LINK UP PRIMARY PRODUCERS AND FOOD PROCESSORS TO GENERATE THE BEST MATRIX-NUTRIENT SYSTEMS FOR COMBATING NCDS

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Coordination and networking tools

Food science, agriculture, nutrition, physiology

Academia, research institutes, industry, primary producers

TRAINING / EDUCATION

ACTION 10

GENERATE NEW GENERATION OF FOOD DIGESTION ENGINEERS (INTEGRATE BIOLOGY, COLLOID SCIENCE, PROCESSING, PHYSICS, BIOCHEMISTS)

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Skills and career development

Food science, education, food processing, physics, biochemistry

Academia, research institutes, industry

Timeline | Resources | < EUR 2 million | EUR 2-5 million | EUR 5-7 million | Expertise | Stakeholders

TOPIC 3.3 COMING FULL CIRCLE: TOWARDS SUSTAINABLE PACKAGING SYSTEMS

The primary role of food packaging is to protect the quality and integrity of food products. Packaging typically also contains a lot of information relevant to the consumer and the supply chain players. At the same time, it is often perceived as generating unnecessary waste and polluting the environment. Therefore, packaging solutions must be adapted to new trends in order to yield the best performance in protecting food with minimal use of resources.

RESEARCH

ACTION 1

DEVELOP ECONOMICALLY VIABLE BIO-BASED PACKAGING MATERIALS WITHOUT COMPETING WITH FOOD

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Food science, packaging, environmental sustainability, economics, process engineering, chain specialists

Academia, research institutes, industry, primary producers

ACTION 2

ASSESSMENT OF THE OVERALL SUSTAINABILITY OF ALTERNATIVES TO FOSSIL-BASED MATERIALS

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Food science, packaging, environmental sustainability, economics

Academia, research institutes, industry

ACTION 3

SUSTAINABILITY OF POST-CONSUMER RECYCELD PLASTICS (PCR) FOR FOOD CONTACT APPLICATIONS

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Food science, packaging, environmental sustainability

Academia, research institutes, industry

RESEARCH

ACTION 4

ASSESSMENT METHODOLOGY TO UNDERSTAND FOR WHICH APPLICATIONS USE OF COMPOSTABLE/BIODEGRADABLE MATERIALS WOULD MAKE SENSE AND FOR WHICH APPLICATIONS IS NOT RECOMMENDED

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Food science, packaging, environmental sustainability

Academia, research institutes, industry

ACTION 5

HOW TO MAKE CHEMICAL RECYCLING A COMMONPLACE REALITY

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Food science, packaging, environmental sustainability, economics

Academia, research institutes, industry

INNOVATION

ACTION 6

DEVELOP TECHNOLOGIES FOR RE-USING AND RECYCLING PACKAGING MATERIALS AT THE END OF THE LIFE CYCLE

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Innovation support tools

Food science, packaging, environmental sustainability, logistics, economics, material sciences, process engineering, 'argent based' modelling

Academia, research institutes, industry

ACTION 7

DEVELOP PACKAGING MATERIALS, TECHNOLOGIES AND CONCEPTS WITH THE RIGHT FUNCTIONALITY AND DELIVERING SUPERIOR ENVIRONMENTAL PERFORMANCE IN THE TOTAL LIFE CYCLE

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Innovation support tools

Food science, packaging, material sciences, logistics, environmental sustainability

Academia, research institutes, industry, primary producers

INNOVATION

ACTION 8

GENERATE PACKAGING CONCEPTS THAT CAN REDUCE FOOD WASTE

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Innovation support tools

Food science, material sciences, ecology, logistics, packaging, environmental sustainability

Academia, research institutes, industry, primary producers

ACTION 9

OPTIMISE PACKAGING PERFORMANCE IN TERMS OF SHELF LIFE AND PROTECTION, STABILITY TO REDUCE WASTE AND ENHANCE RE-USE

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Innovation support tools

Food science, material sciences, packaging, environmental sustainability

Academia, research institutes, industry, primary producers

ACTION 10

ALIGNMENT ON CRITERIA TO ASSESS EMERGING RECYCLING TECHNOLOGIES AND THE NEED TO RUN COMMON BUSINESS CASES TO BE ABLE TO SELECT THE MOST PROMISING ONES

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Innovation support tools

Food science, packaging, environmental sustainability, economics

Academia, research institutes, industry, policy makers

ACTION 11

BETTER INFRASTRUCTURE AND TECHNOLOGY TO RECYCLE FLEXIBLE AND MULTILAYER PACKAGING

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Innovation support tools

Food science, packaging, environmental sustainability

Academia, research institutes, industry

INNOVATION

ACTION 12
DESIGN FOR RECYCLING

2021 2022 **2023** **2024** **2025** **2026** **2027**

EU level; Private + public funding; Innovation support tools

Food science, packaging, environmental sustainability

Academia, research institutes, industry, policy makers

ACTION 13
EFFICIENCY IN THE PLASTIC RECYCLING BUSINESS

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Innovation support tools

Food science, packaging, environmental sustainability, economics

Academia, research institutes, industry, policy makers

ACTION 14
EVALUATION OF ALTERNATIVE DELIVERY MODELS FOR RE-USE OR BULK DELIVERY MODELS

2021 2022 2023 **2024** **2025** **2026** **2027**

EU level; Private + public funding; Innovation support tools

Food science, packaging, environmental sustainability, economics

Academia, research institutes, industry, policy makers

TRAINING / EDUCATION

ACTION 15
TRAIN AND EDUCATE SMES

2021 2022 2023 2024 **2025** **2026** **2027**

EU level; Private + public funding; Skills and career development

Food science, packaging, technology transfer, education, training

Academia, research institutes, industry, SME network

TRAINING / EDUCATION

ACTION 16

CONSUMER ENGAGEMENT AND EDUCATION

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Skills and career development

Food science, packaging, technology transfer

Academia, research institutes, industry

COMMUNICATION / DISSEMINATION

ACTION 17

GAIN ACCEPTABILITY AND TRUST: PACKAGING TO INFORM AND ESTABLISH A DIALOGUE WITH CONSUMERS

2021 2022 2023 2024 2025 2026 2027

EU / Regional level; Private + public funding; Coordination and networking tools

Stakeholder engagement, communication

Food value chain, SME network, consumers, policy makers

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Timeline | Resources | < EUR 2 million | EUR 2-5 million | EUR 5-7 million | Expertise | Stakeholders

TOPIC 3.4

IT'S ALL FOOD: ALTERNATIVE FOOD SOURCES

The availability of food from environmentally-sustainable sources is a pre-requisite for feeding a growing population and preserving resources. New raw materials and processes to convert them into food products/ingredients need to be identified. Some examples are algae, seaweed and krill, and terrestrial non-chordate phyla. A third source of food remains also relatively untapped, i.e. food grown directly from waste, or manufactured through direct use of side streams. Overall, these approaches could alleviate raw material shortages provided that rigorous measures are in place to prevent challenges from a safety or quality perspective.

RESEARCH

ACTION 1

IDENTIFY NEW SOURCES FOR FOOD MATERIALS

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Coordination and networking tools

Food science, nutrition, food safety, sensorial analysis, knowledge transfer, biology, ecology, agriculture, marine sciences, process engineering

Academia, research institutes, industry, primary producers, SME networks

ACTION 2

EXPLORE UNDERUTILIZED FOOD SIDE STREAMS AS NEW SOURCE OF FOOD MATERIALS

2021 2022 2023 2024 2025 2026 2027

EU + Regional level; Private + public funding; Research support tools

Food science, nutrition, food safety, sensorial analysis, bio-fermentation, process engineering

Academia, research institutes, industry

ACTION 3

EXPLORE USE OF FERMENTATION AND OTHER BIOCONVERSION ROUTES TO CONVERT WASTE OR NON-FOOD MATERIALS INTO SOURCES OF FOOD

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Food science, nutrition, food safety, sensorial analysis, bio-fermentation, microbiology, bioprocesses

Academia, research institutes, industry

ACTION 4

EXAMINE WHAT INFLUENCES ACCEPTANCE BY CONSUMERS

2021 2022 2023 2024 2025 2026 2027

EU + level; Private + public funding; Coordination and networking tools

Consumer science, social sciences, food science

Academia, research institutes, industry

RESEARCH

ACTION 5

DEVELOP NEW FRACTIONATION METHODS TO EXTRACT AND ISOLATE FOOD INGREDIENTS FROM UNCONVENTIONAL SOURCES

2021 2022 **2023** 2024 2025 2026 2027

EU + level; Private + public funding; Research support tools

Food science, process engineering, biology, marine sciences

Academia, research institutes, industry

INNOVATION

ACTION 6

DEVELOP NEW END-PRODUCTS THAT INCORPORATE INGREDIENTS FROM UNCONVENTIONAL SOURCES

2021 2022 **2023** 2024 2025 2026 2027

EU + level; Private + public funding; Research support tools

Food science, product development, consumer sciences

Academia, research institutes, industry

ACTION 7

CREATE CONSORTIA OF SMES

2021 **2022** **2023** 2024 2025 2026 2027

EU level; Private + public funding; Coordination and networking tools

Food science, knowledge transfer, training, field labs

Industry, SME networks

TRAINING / EDUCATION

ACTION 8

TRAIN AND EDUCATE SMES

2021 2022 2023 2024 **2025** 2026 2027

EU / Regional level; Private + public funding; Skills and career development

Food science, packaging, technology transfer, training, field labs

Academia, research institutes, industry, SME network

COMMUNICATION / DISSEMINATION

ACTION 9

ENGAGE CONSUMERS AND FINDING NEW, UNCONVENTIONAL SOURCES OF FOOD MATERIALS

2021 2022 2023 2024 **2025** 2026 2027

EU / Regional level; Private + public funding; Coordination and networking tools

Stakeholder engagement, communication, social media, virtual reality, gaming

Food value chain, SME network, consumers, policy makers

Timeline | Resources | < EUR 2 million | EUR 2-5 million | EUR 5-7 million | Expertise | Stakeholders

TOPIC 3.5

CHECK IT: NEXT GENERATION STRATEGIES FOR FOOD SAFETY ASSESSMENT

The capacity to assess the risk that a food-borne hazard of any type presents to the consumer is fundamental. Risk is the basis for taking intervention measures and applying resources across the food system. In recent years, toxicology has undergone a paradigm shift in approach, steered by the rapid advances in science and technology and the emergence of Big Data. The integration of all these techniques into food safety strategies will permit new ways of approaching key aspects of exposure assessment in the risk assessment process.

RESEARCH

ACTION 1

CREATE A NETWORKING ACTIVITY ON DATA EXCHANGE OF/AND COMPLEX FOOD DATA

Timeline: 2021 2022 2023 2024 2025 2026 2027

Resources: EU level; Public funding; Coordination and networking tools

Expertise: ICT, data sciences, food science, toxicology food safety

Stakeholders: Academia, research institutes, industry, policy makers

ACTION 2

CREATE A VIRTUAL FOOD SAFETY INSTITUTE

Timeline: 2021 2022 2023 2024 2025 2026 2027

Resources: EU level; Public funding; Coordination and networking tools

Expertise: ICT, data sciences, food safety

Stakeholders: Academia, research institutes, industry, policy makers

ACTION 3

MAKE OMICS AND COMPLEX ANALYTICAL (NON-TARGETED) DATA RELEVANT TO RISK ASSESSMENT - FUTURE PROOF

Timeline: 2021 2022 2023 2024 2025 2026 2027

Resources: EU level; Private + public funding; Research support tools

Expertise: Food safety, food science, data sciences, toxicology, omics, risk assessment

Stakeholders: Academia, research institutes, industry, authorities

ACTION 4

ASSESS CHEMICAL SAFETY IN COMPLEX MATRICES

Timeline: 2021 2022 2023 2024 2025 2026 2027

Resources: EU + level; Private + public funding; Research support tools

Expertise: Food safety, food science, toxicology

Stakeholders: Academia, research institutes, industry

RESEARCH

ACTION 5

INTEGRATE ALL DATA ANALYTICAL, FOOD CHAIN, CONSUMER, PUBLIC HEALTH GENERATED IN RISK ASSESSMENT

2021 2022 2023 2024 **2025** **2026** **2027**

EU + level; Private + public funding; Coordination and networking actions

Food safety, food science, health sciences, ICT, data sciences, nutrition, consumer sciences

Academia, research institutes, industry

ACTION 6

BRING TOGETHER APPROACHES TO REDUCE AND THEN ELIMINATE ANIMAL TESTING

2021 2022 **2023** **2024** **2025** **2026** **2027**

EU + level; Private + public funding; Coordination and networking tools

Food safety, toxicology, microbiology

Academia, research institutes, industry, policy makers

INNOVATION

ACTION 7

DEVELOP TOOLS TO EVALUATE ALLERGENIC POTENTIAL OF NEW INGREDIENTS

2021 2022 **2023** **2024** **2025** **2026** **2027**

EU level; Private + public funding; Innovation support tools

Food safety, toxicology, physiology

Academia, research institutes, industry

ACTION 8

DEVELOP RAPID RISK ASSESSMENT TOOLS AND METHODS

EU level; Private + public funding; Innovation support tools

Food safety, food science, toxicology

Academia, research institutes, industry

TRAINING / EDUCATION

ACTION 9

TRAIN AUTHORITIES TO USE DATA AND TOOLS FOR ENHANCING PREDICTIVE SECURITY

2021 2022 2023 2024 **2025** **2026** **2027**

EU / Regional level; Private + public funding; Skills and career development

Food science, packaging, technology transfer, governmental affairs, food safety

Academia, research institutes, industry, policy maker

COMMUNICATION / DISSEMINATION

ACTION 10

INVOLVE AND ENGAGE CONSUMERS IN METHODS AND PROCEDURES

2021 2022 2023 2024 2025 2026 2027

EU / Regional level; Private + public funding; Coordination and networking tools

Stakeholder engagement, communication, social media, virtual reality, gaming

Food value chain, SME network, consumers, policy makers

Timeline | Resources | < EUR 2 million | EUR 2-5 million | EUR 5-7 million | Expertise | Stakeholders

TOPIC 3.6

SIMPLY NATURAL: TOWARDS LESS REFINED, MORE NATURAL FOOD INGREDIENTS

In the past decades, the production of ingredients has become highly optimized to meet purchaser demands. Plant-based ingredients are often highly purified, which makes them universally applicable in many products. There is, however, an opposing consumer pull for natural ingredients due to perceived beneficial effects on health. While many less refined ingredients have excellent properties, they often differ from those of highly refined ingredients. Innovation in the use of less refined ingredients to allow manufacture of healthy, tasty and attractive products for consumers is therefore needed.

RESEARCH

ACTION 1

UNDERSTAND HOW CONSUMERS PERCEIVE NATURALNESS WITH FOOD ORIGIN AND PROCESSING

2021 2022 2023 2024 2025 2026 2027

EU level; Public funding; Research support tools

Food science, consumer science, data sciences

Academia, research institutes, industry, consumers

ACTION 2

DEVELOP NEW METHODS TO PRODUCE MINIMALLY PROCESSED FUNCTIONAL INGREDIENTS

2021 2022 2023 2024 2025 2026 2027

EU level; Public funding; Research support tools

Food science, process engineering

Academia, research institutes, industry

RESEARCH

ACTION 3

DEVELOP SCALED-DOWN PROCESSES TO ALLOW MINIMALLY PROCESSED INGREDIENT PRODUCTION TO BE DISTRIBUTED OVER THE CHAIN

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Food science, logistics, process engineering, economics

Academia, research institutes, industry

ACTION 4

DEVELOP CROP CHARACTERIZATION FOR OPTIMAL MINIMAL PROCESSING INTO FUNCTIONAL INGREDIENTS

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Food science, plant and animal sciences, food engineering

Academia, research institutes, industry, primary producers

ACTION 5

EXPLORE SENSORY AND TECHNICAL FUNCTIONALITY OF MINIMALLY PROCESSED INGREDIENTS

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Food science, sensory analysis, nutrition, data sciences

Academia, research institutes, industry

ACTION 6

UNDERSTAND INTERACTIONS BETWEEN MINIMALLY PROCESSED INGREDIENTS THAT YIELD THEIR PROPERTIES AND MAKE USE OF IT

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Food science, sensory analysis, nutrition

Academia, research institutes, industry

ACTION 7

CREATE UNDERSTANDING OF RAW MATERIAL MATRIX PROPERTIES

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Food science, material science, imaging, analytical sciences, chemistry

Academia, research institutes, industry, primary producers

RESEARCH

ACTION 8

EXPLORE BIOAVAILABILITY AND PHYSIOLOGY

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Research support tools

Food science, material science, physiology, microbiology, nutrition

Academia, research institutes, industry

INNOVATION

ACTION 9

COMPARE FULL CHAINS OF CONVENTIONAL INGREDIENTS WITH FUNCTIONAL, MINIMALLY-PROCESSED INGREDIENTS

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Innovation support tools

Food science, data analysis, economics, ecology, nutrition, logistics

Academia, research institutes, industry

ACTION 10

DEVELOP AN INVENTORY AND MAP COMPLEMENTARY FUNCTIONAL INGREDIENTS TO REDUCE DECLARATION LISTS

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Innovation support tools

Food science, data analysis

Academia, research institutes, industry

ACTION 11

EXPLORE FOOD SAFETY ASPECTS OF GENTLE, MINIMAL PROCESSING

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Innovation support tools

Food safety, food science, nutrition, toxicology

Academia, research institutes, industry

TRAINING / EDUCATION

ACTION 12

TRAINING AND EDUCATE SMES

2021 2022 **2023** 2024 2025 2026 2027

EU / Regional level; Private + public funding; Skills and career development

Food science, technology transfer, training, education, field labs

Academia, research institutes, industry, SME networks

ACTION 13

FORM CONSORTIA OF SMES

2021 2022 2023 2024 2025 2026 2027

EU / Regional level; Private + public funding; Skills and career development

Food science, packaging, technology transfer, knowledge transfer, training, education, field labs

Academia, research institutes, industry, SME networks

COMMUNICATION / DISSEMINATION

ACTION 14

DEVELOP COMMUNICATION STRATEGY AND EXECUTE TO COMMUNICATE BENEFITS OF MINIMAL PROCESSING

2021 2022 2023 2024 2025 2026 **2027**

EU / Regional level; Private + public funding; Coordination and networking tools

Stakeholder engagement, communication, social media, gaming, social sciences

Food value chain, SME network, consumers, policy makers

ACTION 15

EXPLORE AND UNDERSTAND THE ATTITUDE OF CONSUMERS TO PRODUCTS WITHOUT E NUMBERS, AND HOW TO PROVIDE CLEANER-LABELED FOODS SUSTAINABLY PRODUCED

2021 2022 2023 2024 2025 2026 2027

EU / Regional level; Private + public funding; Coordination and networking tools

Stakeholder engagement, environmental sustainability, communication, sensorial sciences, social media, social sciences

Food value chain, SME network, consumers, policy makers

D. SPECIAL ACTIONS FOR SMES

A number of vertical actions that would enable SMEs to better exploit the full potential that R&I offers.

RESEARCH

ACTION 1

CREATE SYNERGIES BETWEEN START-UPS AND SMES

2021 2022 2023 2024 2025 2026 2027

EU / Regional / National level; Public funding; Research support tools

Human resources, competencies matchmaking, knowledge engineering, data sciences

SME networks, Start-ups, Academia, research institutes, industry

INNOVATION

ACTION 2

ENABLE INNOVATION FOR SMES

2021 2022 2023 2024 2025 2026 2027

EU level; Private + public funding; Innovation support tools; Pilot plant facilities

Human resources, innovation assessment, R&I communication, food science and technology, finance and taxation, field labs

SMEs, Academia, research institutes, industry

TRAINING / EDUCATION

ACTION 3

TRANSFER ENABLING SOLUTIONS TO SMES

2021 2022 2023 2024 2025 2026 2027

EU / Regional level; Private + public funding; Skills and career development

Food science, other sectors, marketing, technology transfer, value chain management, field labs, integrating science and application

Academia, research institutes, industry, SME networks

TRAINING / EDUCATION

ACTION 4

DEVELOP HUMAN RESOURCES FOR SMES

2021 2022 2023 2024 2025 2026 2027

EU / Regional level; Private + public funding; Skills and career development

Human resources, knowledge transfer, education, IPR, finance, I&R, staff mobility programmes, exchange programmes

Academia, research institutes, industry, SME networks, multi-stakeholder platforms

COMMUNICATION / DISSEMINATION

ACTION 5

DEVELOP COMMUNICATION STRATEGY ABOUT ENABLING FACILITIES, TOOLS AND SERVICES

2021 2022 2023 2024 2025 2026 2027

EU / Regional / National level; Private + public funding; Coordination and networking tools

Stakeholder engagement, communication, networking, mediator/facilitator organisations, finance, human resources, digital tools, field labs, creating easy access to expertise centres, virtual reality

Food value chain, SME networks, start-ups, farmers

APPENDIX 2

The following Tables list the impact of the individual actions suggested by the experts of the ETP 'Food for Life', as described in the SRIA.

R&I TARGET/ACTION	IMPACT DIMENSIONS
R&I TARGET 1 **INCREASING THE ENGAGEMENT AND INVOLVEMENT OF THE CONSUMERS**	• Decentralized innovation ecosystem allowing for completely new business models in the food sector • Transformation from a mass market oriented production system to a more decentralized, consumer-run system • Alignment in goals of consumers and food solution providers.
TOPIC 1.1 **IMPROVING INSIGHTS INTO CONSUMERS**	• A selection of harmonized key consumer science tools in order to generate more effective consumer insights leading to higher success rates of new product launches and closer alignment with consumer and societal needs. • Development of important new tools based on (new) technologies in adjacent fields. • Innovative and standardized approaches to collecting, managing and analysing Big Data which will enable deeper consumer insight and sharing of data. • Improved possibilities to pool data from different studies and sources in order to conduct more powerful analyses and to avoid duplication of efforts. • Increased speed and effectiveness of consumer insight generation, resulting in more effective product and service development. • Improved consumer engagement. • Evidence-based recommendations for education programs increasing the skill and competence set needed to apply existing and new tools and Big Data in the food industry.
TOPIC 1.2 **FOOD AND ME: MAKING FOOD AN ACTIVITY**	• New flexible forms of communication between consumers and food chain participants in the form of social media platforms, app-based solutions, and integrated solutions in the kitchen. • New data streams both to and from consumers that can be used to generate insights into consumer preferences and their developments. • Business start-ups that deal with the generation and analysis of consumer data and with the dissemination of results to food chain participants. • New sources of consumer insights that both large and small food producers can exploit in the new product development process. • New tools for product development • Increased success rate in new product launches, especially for healthier products and products based on more sustainable production methods.

TOPIC 1.3

FOOD INVENTORS: NEW FOOD PRODUCTION AND DELIVERY MODELS TO PROVIDE BETTER ACCESS

- Credible inventory of consumer acceptance, trust and satisfaction and consumption behaviour impacts (health, safety, sustainability and waste) of the new and increasingly diverse production and delivery models.
- A map of the economic opportunities that the new production models represent, including, but not limited to, home appliances, ingredient and raw material supply and service solutions.
- Proposed sustainable business models for new-channel configurations allowing consumer or community driven food provision.
- Specific, critical issues of public interest or risk for consumers identified for these new approaches, including those in areas such as public health, food security and food waste issues.

TOPIC 1.4

FOOTPRINTING OF FOOD: CONSUMER ENGAGEMENT IN SUSTAINABILITY

- A practical information system for personalized consumer queries in the area of food sustainability and health
- Coverage of the consumer population by such system.
- Coverage of the relevant agri-food chain players.
- Number of new data-centric agri-food businesses.
- A measurable increase in the trust level in the agri-food system.

TOPIC 1.5

THE SMART FOOD GRID: MODULAR FOOD PRODUCTION AND DISTRIBUTION

- Reconfigured distribution channels and delivery modes (family and small businesses).
- Degree of food sovereignty - self-sufficiency.
- Reduced the carbon fingerprint.
- Sustained biodiversity of local ecosystems.
- Improved sustainability of local farms (rural areas) and local operations.
- Enhanced process efficiency.
- End-user acceptance of new productions and distribution modules.

R&I TARGET/ACTION	IMPACT DIMENSIONS
R&I TARGET 2 **PROVIDING THE BASIS FOR A MORE PERSONALIZED AND CUSTOMIZED FOOD SUPPLY**	• Societal strategy that ensures that consumers can eat the food needed to live life to the fullest extent and have the means to do so. • New knowledge that industry can use in the design of new intrinsically healthy and desirable products that fit into specific lifestyles and provide well-being to consumers. • Detailed description of the effects of diet and lifestyle on the development of Non Communicable Diseases (NCDs) enabling specific strategies to be designed, developed and communicated in order to attain positive changes. • Knowledge of the effects of foods on the human microbiome can be employed in positively affecting health via food and diet, bringing a new generation of ingredients and foods from alternative sources that are both sustainably sourced and welcomed by the consumer.
TOPIC 2.1 **THE FOOD I LOVE, APPRECIATION OF DIVERSITY IN FOOD AND EATING**	• Insight into the similarities and diversity across Europe in what consumers value in food and eating behaviour (mapping diversity in of food appreciation). • Assessment of the impacts of food appreciation on current food consumption practices in terms of consumers' health, sustainability, trust and food waste. • Identification of the economic potential of product and service innovation to better answer the diversity in consumer satisfaction at an individual or group level. • Identification of the opportunities for better food and eating appreciation in out-of-home situations, including institutional environments, and its impact on health and wellbeing. • Evidence-based recommendations for education programs to increase understanding and recognition of diversity in food appreciation within European culture.
TOPIC 2.2 **(TR)EAT ME, DIETARY APPROACHES FOR THE PREVENTION OF NON-COMMUNICABLE DISEASES**	• Availability of new, well-accepted and effective, sustainable dietary approaches to prevent NCDs and their related comorbidities. • Availability of behaviour change models to prevent NCDs and their related comorbidities. • Availability of an efficient integrated toolbox for identifying the most promising foods to be tested in specific population groups.

TOPIC 2.3

PACKAGING 4.0; INTELLIGENT AND COMMUNICATING PACKAGES

- Technologies which are relevant and directly applicable to business end use.
- Technology must be quickly and easily accessible, and its application by the consumer intuitive and acceptable.
- Technology must be affordable and deployable on a large scale.
- Technology must be compatible with packaging materials and formats and should be food application safe.
- Technology must be compatible with recycling packaging.
- Tools to measure packaging performance in terms of, shelf life, protection, durability, recyclability.

TOPIC 2.4

IN SILICO FOOD DESIGN; UNDERSTANDING FOOD DIGESTION

- Increased understanding of micronutrient functionality. This may lead to a new generation of ingredients capable of better addressing malnutrition (e.g., hidden hunger).
- Outcome of in silico modelling. This can reduce costs by limiting the extent of intervention studies. It may also reduce the number of animal studies required, thereby addressing animal welfare issues.
- Executed Big Data. These will lead to new insights with respect to synergistic or antagonistic actions of ingredients.

TOPIC 2.5

THE ECOLOGY INSIDE US: FOOD MEETS GUT MICROBIOME

- Provision of a convincing description of the microbiota function, its impact on health parameters and cause-effect mechanisms proposed or elucidated to underpin meaningful health effects for dietary interventions acting via microbiota.
- Development of a methodology to align preclinical research with small human intervention studies in order to "validate" preclinical assays.
- Building of coherent cases and performing sound experimental studies that address the impact of food structure, function and microbiota on the different components of the gut ecosystem.
- Identification of characteristics of the gut ecosystem (e.g., key microbiota consortia) that can be used to stratify subjects especially for the small-scale human studies.
- Meaningful estimates of the health impact of dietary interventions that act via modulation of the microbiota.

TOPIC 2.6

FOODS FOR TOMORROW: NEW CONCEPTS AND TECHNOLOGIES TO ASSURE CONSUMER HEALTH AND WELLBEING

- Standardized approaches and methodologies to characterize nutritional attributes of outcomes / raw material / foods generated by using new food sources and new processing.
- Validated improved predictive models for effects of (new) processing methods on the retention and transformation of nutrients, and impact on the digestion and bioavailability of micronutrients and macronutrients, and physiological effects.
- Consumer acceptance of new and alternative food sources including the valorisation of un-utilised side streams.
- Validated methods for evaluating the environmental implications of effects of large-scale changes in the supply chain.
- Advances in knowledge of new dietary approaches and promising foods that can be implemented by consumers on a daily basis as part of a sustainable diet.

R&I TARGET/ACTION	IMPACT DIMENSIONS
R&I TARGET 3 DEVELOPING A MORE FLEXIBLE, DYNAMIC AND SUSTAINABLE FOOD SYSTEM	• A decrease in the environmental impact of food production • European food is recognised as being completely reliable. • Increased trust in the food production chain may make people open to trying out new products and products from new raw materials. • Europe is the prime trusted region in the world for innovative, sustainable, tasty and healthy food.
TOPIC 3.1 GETTING IT RIGHT: INTEGRATED FOOD SAFETY AS A UNIQUE SELLING POINT	• A decrease in the number of food-borne disease incidences. • A decrease in the incidence of food-borne diseases. • A measurable decrease in food waste (or a measurable efficiency increase of the food system due to less food being lost due to microbial spoilage), and an increased use of side streams. • An increase in the availability of "more gently" processed food products. • Availability of new reliable, predictive models to forecast risk areas and hazard points.
TOPIC 3.2 THE MATRIX MATTERS: FOOD STRUCTURE FOR BETTER HEALTH	• Consumer perceived health benefits due to reduced negative impact of primary processing, optimized bioavailability and enhanced health active substances. • Consumer preferred food options enabling a lower caloric intake, thus facilitating a healthier lifestyle. • Increased pool of skilled and knowledgeable European food processing engineers. • Europe as a food brand: revenues from export of food products and technologies.
TOPIC 3.3 COMING FULL CIRCLE: TOWARDS SUSTAINABLE PACKAGING SYSTEMS	• Reduced food losses and waste. • Reduced leakage of packaging into environment. • Reduced packaging-driven environmental impact. • Improved recyclability of material and infrastructure. • Decreased proportion of packaging materials not re-cycled or valorised. • Increase use of biodegradable materials for food packaging use, maintaining sustainability on the making.

TOPIC 3.4

IT'S ALL FOOD: EXPECTED IMPACT ALTERNATIVE FOOD SOURCES

- Creation of intellectual property and new businesses.
- Number of viable new raw materials identified.
- Economic feasibility demonstrated.
- Consumer acceptance of new raw materials and production processes has been assessed.

TOPIC 3.5

CHECK IT: NEXT GENERATION STRATEGIES FOR FOOD SAFETY ASSESSMENT

- Quicker, less expensive routes for the assurance of food safety.
- A better understanding of human metabolic pathways and interactions that will allow the prediction of the safety of a food or new components by using in silico models.
- New methods that will enable the minimization or even elimination of animal testing without compromising on food safety.
- Integrated strategies in foodomics, including advanced analytical techniques like risk-benefit analyses and bioinformatics which will integrate food safety assessment into a better overall understanding of nutrition.
- More precise methods for the microbiological safety assessment of foods based on the real risk presented by an organism and not only its wider taxonomic status.
- Reducing food waste without compromising on food safety by risk driven food microbiology diagnostics.
- Transparency will increase consumer trust in the food value chain.

TOPIC 3.6

SIMPLY NATURAL: TOWARDS LESS REFINED, MORE NATURAL FOOD INGREDIENTS

- A new class of more natural food ingredients which will support the development of potentially health-promoting food based on preservation of natural functionalities and improved possibilities for individualized food and will have a potentially positive impact on public health systems.
- An increased integration of primary producers in the food production chain which will increase the livelihood opportunities of farmers by increasing the value of crops.
- A renewed focus on the functionality derived from many diverging raw material structures will shift agricultural practices towards an increased valuation of crop biodiversity rather than just yield.
- Support for new job creation and job retention in rural areas will be achieved through down-scaling of processing methods, which will be of particular importance to Eastern Europe, fostering an increased modernization of agri-food chain production methods.
- Consumer trust in the agri-food-industry through generation of a more transparent food system with minimally processed food ingredients and more cleanly labelled food.
- A more sustainable use of raw materials, energy, and water, thus positively impacting the environmental effects of food production.

APPENDIX 3

		Increase the engagement and involvment of consumers	Providing the basis for a more personalised and customised food supply	Developing a more flexible, dynamic and sustainable food
EU Framework Programmes R&I		✓	✓	✓
Knowledge and Innovation Communities (KICs)	EIT Food	✓	✓	✓
	EIT Health		✓	
	EIT Climate		✓	✓
	EIT Digital	✓	✓	✓
European Innovation Partnerships (EIPs)	EIP Agri			✓
Scientific Committee for Agricultural Research	SCAR WG on Food	✓	✓	✓
Smart Specialisation Platforms	S3P Agri-Food	✓	✓	✓
Joint Programming Initiatives (JPIs)	FACCE-JPI	✓		✓
	JPI HDHL	✓	✓	
	JPI Oceans			✓
ERA-Nets	SUSFOOD2	✓	✓	✓
	SusAn	✓		✓
	CORE Organic	✓		✓
European Technology Platforms (ETPs)	Plants for the Future	✓	✓	✓
	Organics	✓	✓	✓
	EATiP	✓		✓
	FABRE TP	✓	✓	✓
	Robotics	✓	✓	✓
	Manufuture	✓	✓	✓
European Innovation Partnerships (EIPs)	Bio-Based Industries		✓	✓

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