

Deliverable 3.4

R&I recommendations for targeted action in the Food2030 pathway areas

Work package number and title: WP3 Identification of Showcases

Relevant Task: Amended T.3.4

Lead-beneficiary: EIT Food

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Dissemination Level: Public

Due Date (month): M38

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Document History and Information

Version	Date	Description	Author
1.1	20 November 2020	First Draft	Tommaso Emiliani on behalf of WP3 partners
1.2	25 November 2020	Feedback from Reviewers	WP3 peer partners
2.1	30 November 2020	Second Draft Adapted	Tommaso Emiliani on behalf of WP3 partners
2.3	7 December 2020	Final version	Tommaso Emiliani on behalf of WP3 partners

Introduction

With the publication of the booklet “Food2030 Pathways for Action” on 16 October 2020 (World Food Day)¹, the European Commission officially started the operationalisation process of the Food2030 framework in view of deploying the R&I action, as well as the investments needed to achieve the objectives of the European Green Deal², the Farm to Fork³ and the Bioeconomy strategies⁴. The clustering exercise, led by DG Research and Innovation with contributions from DG SANTE, DG MARE, DG AGRI and from relevant food value chain stakeholders, has led the European Commission to identify ten focus areas which are considered ‘levers of change’: Governance & Systems Change; Urban Food System Transformation; Food from the Oceans & Freshwater Resources; Alternative Proteins & Dietary Shift; Food Waste & Resource Efficiency; The Microbiome World; Healthy, Sustainable & Personalised Nutrition; Food Safety Systems of the Future; Food Systems Africa; Food Systems & Data.

Each pathway corresponds to a sector where R&I action bears high potential for achieving impact across the four Food2030 priority areas, namely Nutrition for sustainable and healthy diets; Food systems supporting a healthy planet; Circularity and resource efficiency; Innovation and empowering communities⁵. The identification of systemic challenges; enablers and barriers to change; R&I action needed; and potential co-benefits in each pathway area will serve as a basis for targeted R&I calls and initiatives undertaken under the cluster “Food, Bioeconomy, Natural Resources, Agriculture and Environment” of the pillar II of the upcoming Horizon Europe framework programme⁶, as well to set up the guidelines for the action of the European Partnership for Safe and Sustainable Food Systems to be implemented in 2023⁷.

¹ [European Commission](#) (2020). Food2030 Pathways for action.

² [European Commission](#) (2019). The European Green Deal.

³ [European Commission](#) (2020). A Farm to Fork Strategy for a fair, healthy and environmentally friendly food system.

⁴ [European Commission](#) (2018). A sustainable Bioeconomy for Europe: Strengthening the connection between economy, society and the environment.

⁵ [European Commission](#) (2020). What is Food2030?

⁶ [European Commission](#) (2018). Proposing for a Regulation establishing Horizon Europe – the Framework Programme for Research and Innovation, laying down its rules for participation and dissemination.

⁷ Statements issued by John Bell, Director Healthy Planet, DG Research & Innovation at European Commission on the occasion of the [FIT4FOOD2030 Final Conference](#) on 25 November 2020.

The FIT4FOOD2030 project has reflected on the Food2030 pathway framework established by the European Commission through the project Deliverable 3.3: an in-depth, independent analysis aimed at expanding knowledge of the key issues affecting each pathway⁸. With Deliverable 3.4, the FIT4FOOD2030 project aims to take a step further. The object of Deliverable 3.4 is to build on the D. 3.3 analysis of the R&I action needed in each pathway and provide concrete R&I recommendations for policy makers at the EU and Member States level. Particular attention is dedicated to expose the interconnectedness of the pathways to identify the most relevant and urgent cross-pathway actions to adopt.

Methodology

The FIT4FOOD2030 research team developed a specific analytical framework to classify the R&I recommendations provided. Recommendations were clustered around five dimensions of innovation deemed particularly relevant to achieve the four Food2030 objectives:

- **Social innovation** refers to new initiatives addressing unmet social needs by creating social relationships and forming new collaborations. These innovations can be products, services or models tackling social, economic and environmental challenges. The focus of social innovation is on the creation of social value through participatory processes
- **Technological innovation** refers to new initiatives using emerging technologies to bring rapid and large-scale solutions to societal challenges and market demands. This dimension focuses on the transformational potential of technology as a 'means' to an end.
- **Organisational innovation** refers to initiatives changing the new rules and forms of interaction, values, drivers and (finance) structures that help actors to redefine their practices and bring together systems actors that have not traditionally worked together. The focus is therefore on social interaction, as organizational innovations entail new methods or principles in role allocation (new ways of attributing responsibilities among actors, including between departments of the same administration/company/institution).
- **Managerial innovation** refers to new initiatives developing new ways to codify knowledge to increase accessibility for relevant stakeholders; developing stakeholder competences and improving worker retention, such as education and training systems; improving management

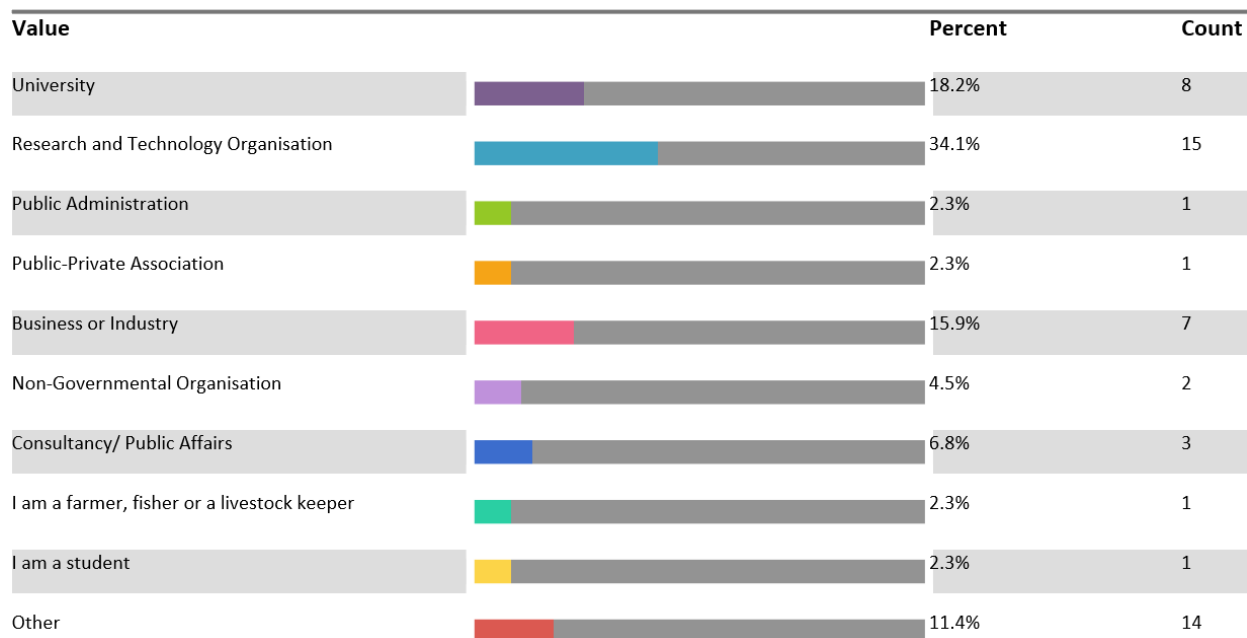
⁸ FIT4FOOD2030 (2020, forthcoming), Deliverable D.3.3. In-depth analysis of the Food2030 pathway areas for food systems transformation.

systems for general production or supply operations, such as supply chain management systems, business reengineering, lean production, and quality-management systems.

- **Policy innovation** refers to new initiatives taken by the EU and the Member States to achieve resilient and sustainable food systems, in line with the objectives of the European Green Deal, Farm to Fork, Biodiversity Strategy, Food2030, Paris Agreement on Climate Change and the UN Sustainable Development Agenda.

The process of identifying and issuing R&I recommendations happened in two phases. In the first phase, a structured survey was circulated among the participants to the World Food Day event organized by the European Commission on 16 October 2020. Survey participants were asked to provide one recommendation per each of the five dimensions of innovation listed above, in all the pathway areas they felt they could contribute to with relevant expertise. The FIT4FOOD2030 research team received a total of 53 sets of recommendations from survey participants. Survey statistics are reported below:

1.Type of organisation you are affiliated to:



2. In which of the 10 Pathway Areas for Food Systems Transformation do you wish to provide R&I recommendations?

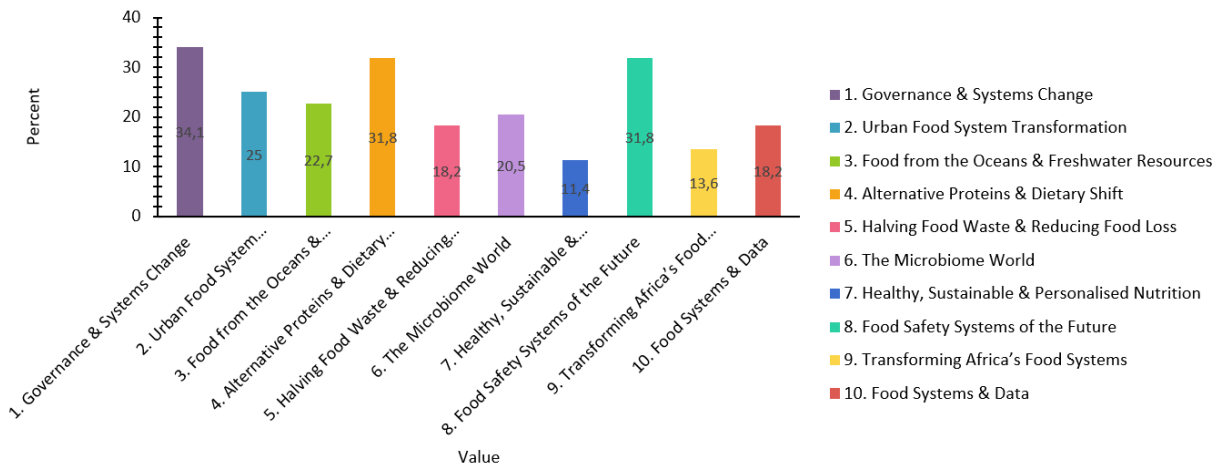


Figure 1: Survey statistics. Source: <https://www.surveymzmo.eu/s3/90277476/FIT4FOOD-Targeted-Consultation-Pathways>

In the second phase, the FIT4FOOD2030 research team made a qualitative selection of the survey responses and integrated them with their own analysis. The ensuing result is the R&I recommendations contained in this deliverable.

Governance and systems change



In order to steer transformation towards sustainable and healthy food systems, there is a need to adopt novel and systemic governance approaches, as well as Research & Innovation (R&I) approaches that are supportive of such arrangements. The many interlinked challenges in food systems require cross-sectoral governance interventions aimed to mitigate trade-offs, foster synergies and co-benefits, while taking into account the multiplicity of knowledge, values and perspectives involved. This requires multi-level interventions, policy experimentation and the creation of transformative spaces where policy makers, researchers and societal stakeholders can co-create and co-evaluate knowledge, innovations and policies needed for systemic change. Supporting such governance efforts also requires policy innovations such as the programming of more transdisciplinary and systemic R&I efforts that engage the wider society through Responsible Research and Innovation (RRI).

Social Innovation

Stimulate multi-stakeholder processes of knowledge creation and transformative innovation that engage a wide diversity of stakeholders in Living Labs at and across multiple governance levels. In order to facilitate transformation towards sustainable and healthy food systems, it is important that governance efforts combine bottom-up and top-down policy instruments in order to stimulate the potential for transformation⁹. It is crucial to provide (socio-physical) spaces and methodological support to further engage societal actors in R&I processes. Therefore, it is highly recommended that governance arrangements provide (financial and political) support for transformative Labs that serve as spaces for co-creation and experimentation¹⁰. For these social innovations, several aspects are to be taken into account:

- 1) They should implement the principles of Responsible Research and Innovation (RRI), which prescribe that all relevant stakeholders need to be included in the Labs R&I processes from the outset and share responsibility of process and outcomes. This also requires the uptake of marginalized stakeholders, perspectives and knowledge (including local and indigenous knowledge).
- 2) Bottom-up and local experimentation in Labs requires flexibility, not blue-prints. This means that change processes take time, and funding mechanisms to provide long-term commitment and provide space for co-designing pathways to impact beyond formal a-priori objectives and Key Performance Indicators (KPIs).
- 3) Both private and public funders and (local) governments should shape the systemic context supportive of Lab activities and their potential scale-ups: for instance, through developing action-plans to stimulate Public-Private Partnerships (PPPs) and providing long-term financial and political commitment.

Technological Innovation

Develop a digital platform that supports shared knowledge production and mutual learning, provides open-access data on EU food systems as well as tools, apps and methods for a wide variety of stakeholders to apply in food system transformation. Developing multi-stakeholder collaboration is an intensive process that requires expert facilitation and robust methodologies in order to create meaningful

⁹ [FIT4FOOD2030](#) (2019). D.4.3. Research and Innovation Policy for Future-Proofing the Food System.

¹⁰ [McCrory et al.](#) (2020). Sustainability-oriented labs in real-world contexts: An exploratory review. *Journal of Cleaner Production*, 277(20) 123202.

knowledge-production and co-innovation. Stimulating the successful development of such EU-wide platform(s) requires the following actions:

- 1) Provision of open-access and transparent data(sets) on trends, showcases, policies; but also food systems data including ecological, geographical, socio-economic indicators and relevant apps that could benefit stakeholders in and across sectors. This includes decision support tools for policy makers such as provided by the SUSFANS project¹¹.
- 2) Creation of concrete and transferable tools to support multi-stakeholder processes and competence building, as well as (online) courses, educational modules, decision support tools, and methodologies for supporting transformative Lab activities.¹²
- 3) Adoption of an approach based on mutual learning and knowledge co-creation. This also entails a focus on (digital) inclusion of marginalized stakeholders and non-usual suspects, for instance by providing clear guidelines on how to use the platforms and including end-users in platform development.

Organisational Innovation

Transform the structure of EU R&I systems so that they support the uptake of transdisciplinary knowledge production and transformative innovation. Current R&I systems do not sufficiently support the uptake of collaborative and systemic R&I efforts for food system transformation. This means that deep structural changes are required in the way R&I is conducted, organized, funded and programmed. It requires breaking down sectoral and disciplinary silos in order to support cultures of cross-sectoral collaboration, as well as different ways of funding R&I. Several concrete actions at different levels should support the new R&I systems:

- 1) Horizon Europe and future European Food Partnerships should provide increased funding for transdisciplinary and collaborative R&I, by setting explicit targets for multi-stakeholder collaboration in funding calls. This aligns with efforts to create long-term commitments to (public-private) multi-stakeholder collaboration in for instance the development of the European Partnership for Safe and Sustainable Food Systems.
- 2) Thematic policies (such as the reformed Common Agricultural Policy and agricultural, health and economic policies) should explicitly set green targets in line with Food2030, the Green Deal and the

¹¹ [SUSFANS](#) (2019). The SUSFANS toolbox for assessing EU Sustainable food and nutrition security.

¹² [FIT4FOOD2030](#) (2020). The Knowledge Hub.

Farm to Fork strategy and provide stronger financial incentives beyond voluntary schemes to foster local transformation and sustainable innovation, specifically for small and medium enterprises (SMEs).

- 3) R&I systems on EU and Member States-level should be developed towards mission-oriented food innovation systems in line with targets of the EU Green Deal and the Farm to Fork strategy, increase funding for cross-sectoral and transdisciplinary R&I programs and projects in Member States and regions to innovate and align current R&I policies – with sufficient long-term political and financial support.

Managerial Innovation

Boost transformative capacities across EU food systems through competence development and public-private partnerships. In order to accelerate transformation there is an urgent need to boost competence development across public and private sectors. Several key actions should guide this process:

- 1) Develop competences of students and professionals in transformation Labs (on for instance systems thinking and multi-stakeholder collaboration) and support development of transformative capacities of those actors involved in setting up transformative networks and Living Labs.
- 2) Institutions providing education should be encouraged to critically assess the educational curricula at schools and universities on healthy and sustainable food, as well as on systems thinking and cross-sectoral collaboration and sustainable entrepreneurship. Inspiring and transferable (online) educational modules (for instance as developed by the FIT4FOOD2030 City Labs¹³) could serve as hands-on materials to implement transformative education programs for sustainable food systems.
- 3) Targeted training on innovation capabilities can help SMEs to overcome existing skill gaps and thus unlock untapped market opportunities. For example, the EIT Food Accelerator Network (FAN) is an accelerator program delivered across Europe, supporting high impact agri-food start-ups to maximize their success. Over a four-month acceleration period, selected start-ups have access to a wide array of tools, connections, mentors and expertise to help them succeed in the market.¹⁴

Policy Innovation

Radically transform and align policies across governance levels and sectors, so that policies can leverage and accelerate the transition to healthy, sustainable and just food systems. It is evident that systemic

¹³ [FIT4FOOD2030](#) (2020) What are City Labs and Policy Labs?

¹⁴ [EIT Food](#) (2020). EIT Food Accelerator Network.

transformation requires multiple policy innovations and interventions at many different governance levels. Such specific policy innovations too can be co-created through multi-stakeholder collaborations in Policy Labs, such as the 11 FIT4FOOD2030 Policy Labs. In particular, and amongst others, the following four elements are important to take into account to create policy-frameworks that support transitions:

- 1) Implementing transformative innovation policies requires breaking incumbent policy silos. On the EU level, this requires increased collaboration and alignment between different DGs (including DG AGRI, DG SANTE, DG ENVI, DG RTD and DG MARE), parallel to required alignment within Member States. This requires fostering a culture of collaboration, cross-sectoral network building and the identification of cross-sectoral co-benefits¹⁵.
- 2) On the EU-level, it is important that policy frameworks and directives are aligned in terms of visions, goals, targets and processes. The reformed CAP should be a leverage for food system transformation, developing towards an integrated common food policy, and setting explicit and ambitious targets in line with the EU Green Deal, the Farm-to-Fork Strategy, the Biodiversity Strategy and the UN Sustainable Development Goals. A common food policy should include targets on agricultural production, health and nutrition, soil quality and biodiversity, environmental sustainability, empowerment of communities and social justice.
- 3) Member States and societal actors should co-develop and implement transition strategies for agri-food systems in line with the EU Green Deal. This requires redirecting funding towards transdisciplinary R&I; stimulate and fund multi-stakeholder experimentation and mainstreaming of sustainable practices in and beyond transformative Labs; stimulate private sector innovation through incentives, regulation and taxation of start-ups, scale-ups, SMEs and the agri-food industry.
- 4) Mitigate side-effects of agri-food system transformation for those negatively impacted, in particular vulnerable and marginalized stakeholders. This means meaningfully involving all relevant stakeholders in (local) development and implementation of transition strategies and the EU Just Transition Fund from the outset. The EU Just Transition Fund should expand its focus beyond being an economic instrument, and support community building, social resilience and rural development in disproportionately affected social groups, communities and regions.

¹⁵ [World Health Organisation - WHO](#) (2018). Connecting food systems for co-benefits: How can food systems combine diet-related health with environmental and economic policy goals?

Urban Food Systems Transformation



Food systems in most of European cities generate deep social and economic inequalities, over-exploit natural resources and jeopardise the nutrition and health of vulnerable groups of citizens. As EU cities are currently not well-endowed to produce the food needed to sustain their own population, they are forced to rely on imports of processed goods and commodities from afar. Dependence on external markets increases the susceptibility to supply chain disruptions, including those caused by climate-related events and global shocks, such as the COVID-19 pandemic. Immediate action is needed to reverse the current situation and scale up efforts to ensure that emerging innovative practices and technologies receive the necessary support to enable EU urban food systems to become environmentally sustainable, socially inclusive, as well as spatially and economically connected with their rural surroundings.

Social Innovation

Encourage community buy-in and support local empowerment by understanding the community context.

EU city governments need to create mechanisms to allow an appropriate mix between bottom-up, community-led social innovations (including community fridges, food banks, collective kitchens, Community-Supported Agriculture, etc.) and top-down innovations (including responsible urban planning foreseeing the establishment of vertical gardens, organic markets, and 'Green Tech Hubs'). The inclusion of bottom-up social innovations designed at civil society level in urban food strategies is essential to promptly identify emerging issues and response gaps, and also to build capacity between and across government agencies, policy sectors, and governance levels¹⁶. To this extent, it is important to increase urban resilience by promoting the re-connection of citizens with food. Public authorities should promote food literacy among citizens by supporting interest in food and competence-building through fairs, seasonal markets, cooking demonstrations, etc. While education activities are necessary to enhance citizens' understanding of the impact of their food choices, it is also crucial to establish the practical infrastructures and access to land where the urban population can harness the potential of social innovations to improve physical access to healthy and sustainable food.

Technological Innovation

Establish food-tech hubs in all EU capitals to boost investments and catalyse technological innovation.

Food-tech is the ecosystem made up of all the agri-food entrepreneurs and start-ups across the food chain innovating on products, distribution, marketing and business models for food products and services. European food-tech is still dominated by few unicorns, with 7 start-ups accounting for 43% of the total market value and 72% of total investments made in the EU in 2019 located in 8 cities¹⁷. To support EU food systems transformation, all European capitals should establish their own food-tech hub, understood as organisational and socio-economic platforms interconnecting technology providers with agri-food actors, potential investors, civil society representatives and public authorities. Food -tech hubs will allow for enabling regulatory environments to develop context-specific technologic solutions designed from a scaling up perspective. The issue of financing and supportive regulation is crucial for the development of food-tech hubs as real accelerators for economic growth and consumer-oriented technological innovation. To address these issues, European cities should explore the development of purpose-driven

¹⁶ [EUROCITIES and Cardiff University](#) (2017). Food in cities: study on innovation for a sustainable and healthy production, delivery, and consumption of food in cities.

¹⁷ [DigitalFoodLab](#) (2020). 2020 State of the European FoodTech report: Investments in European FoodTech 2014-2019.

(risk-sharing) financial instruments dedicated to digital agri-food innovators, support the broader roll-out of field labs to increase the take-up of promising innovations, and liaise with the European Digital Innovation Hubs (EDIHs) to further receive support in promoting the digitalisation of their supply chains in the sense of sustainability and competitiveness¹⁸.

Organisational Innovation

Establish inclusive food policy councils to design cross-cutting, comprehensive urban food strategies. Food policy councils are multi-stakeholder fora where actors from different departments of the city government, civil society, and the local agri-food private sector come together to connect all the aspects of an urban food system. A review of the food policy councils currently existing in Europe reveals that most of them is established through a city ordinance but is formally independent from city governments¹⁹. Due to the acquaintance of the actors involved with the specific issues related to local food landscapes and cultures, food policy councils are well positioned to examine local food systems, monitor, address food issues and suggest policy changes. City authorities around Europe should consider the establishment of food policy councils to strengthen local food systems by expanding networks and collaboration on projects between food sectors; tackling critical issues for vulnerable groups in the urban community; leveraging resources to mainstream food security issues at the city level.

Managerial Innovation

Switch to place-based food systems to shorten supply chains and revitalise urban-rural linkages. European cities are increasingly experiencing the vulnerability of modern industrial food supply chains, which are characterised by the spatial and psycho-social separation between the production, the distribution and the consumption of food. Potential disruptions in the globalised supply chains due to climate change and pandemics confront European cities with the need to reconnect urban food systems with their rural surroundings, so as to enhance urban resilience and minimise threats to food security of all citizens, including the most vulnerable groups²⁰. Public authorities should support the establishment of short supply chains as a complement to longer food chains to diversify food networks and produce positive impacts on health (e.g. switch to healthy diets with less processed food), sociality (e.g. establishment of direct producer-consumer relationships ensuring fairness and trust), the economy (e.g. reduction of

¹⁸ [EIP-AGRI](#) (2020). Digital Innovation Hubs.

¹⁹ [European Committee of the Regions](#) (2020). The role of local and regional authorities in making food systems more sustainable.

²⁰ [FOODLINKS](#) (2013). Short Food Supply Chains as drivers of sustainable development.

uncertainties) and the environment (e.g. minimisation of the use of fossil fuel and packaging). Public authorities should facilitate local sourcing in public procurement by applying the existing EU green public procurement criteria for food and catering services²¹, and introducing social considerations within the broader framework of a socially responsible purchasing policy. At the EU level, policy makers should consider the creation of an inter-DG Commission Task Force for shorty food supply chains to provide detailed examination of potentially supportive policy and facilitate a Europe-wide structure for information exchange.

Policy Innovation

Design comprehensive urban food policies and expand the exchange of best practices through trans-local networks. Until recently, policy makers have addressed urban dwellers' food issues through a patchwork of fragmented, sectorial policies mainly designed at the national level. Over the last few years, however, European city authorities have been starting to recognise that inter-related food challenges need a policy approach bridging several areas and establishing new governance bodies²². As examples of European cities with coherent food policies do already exist, more city governments should seek to integrate targeted actions with specific health or environmental goals (e.g. switch to healthy diets, reduction of food waste) into integrated policies producing co-benefits and addressing potential trade-offs. Learning from the experience of other cities with comparable food cultures and challenges is crucial to evaluate, design, implement and improve viable urban food policies. Many networks and collaborations have been established to foster cooperation and cross-learning between cities in policy areas related to food, and to promote their activities. The Milan Urban Food Policy Pact (MUFPP), for instance, gathers 210 cities (as of November 2020) which have committed to implement a series of policy actions with the objective to achieve sustainable food systems that are inclusive, resilient, safe and diverse²³. To this extent, reinforcing trans-local networks that allow for exchanges of best practices and formulation of shared commitments should be a priority for policy makers.

²¹ [European Commission](#) (2020). EU green public procurement criteria for food, catering services and vending machines.

²² [IPES-Food](#) (2017). What makes urban food policy happen?

²³ [Milan Urban Food Policy Pact](#) (2015). The Milan Urban Food Policy Pact.

Food from the Oceans & Freshwater Resources



Aquatic food production bears a high potential to contribute to EU food systems transformation. The food needed to feed a growing EU population can be produced sustainably in the oceans and freshwater resources, without putting further stress on ecosystems. Sustainable food systems transformation in the oceans and freshwater necessitates not only technical innovation, but also innovation in public policy. Public policies are crucial for enabling circular economy business models and restorative practices and determine the conditions which either enable or prevent certain ocean-based activities. Food systems transformation will happen through fostering the conditions needed to enable the sustainable harvesting of food from the oceans and freshwater resources, for it to become a significant proportion of the overall food for human consumption.

Social innovation

Realise the foreseen dietary shift through a mix of bottom-up and top-down initiatives. It is crucial to create platforms for co-operation and involve citizens and other relevant stakeholders in planning processes and awarding social licenses to operate. The average EU citizen consumed 24.35 kg fish and seafood in 2017²⁴, but the number hides large variations between Member States. The change in dietary habits towards more food from the sea could also produce the secondary effect to help consumers turn to even more sustainable foods from the ocean and freshwater resources like algae, filter feeders and other lower trophic level organisms. Dietary shifts must be tailored to local conditions, both environmental and cultural. Consumers need to trust the product they are paying for, if the objective to increase demand for seafood is to be achieved. Sustainability certifications such as ASC (Aquaculture Stewardship Council), MSC (Marine Stewardship Council), and CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora), and validation of seafood species are available to provide consumers with the essential information to change their diets and be able to change business community standards.²⁵.

Technological innovation

Technological innovation that supports aquaculture, aquaponics techniques or regenerative ocean farming processes must be encouraged and supported at national and EU level. Innovation-driven technological breakthroughs include aquaculture techniques or regenerative ocean farming processes like Integrated Multi Trophic Aquaculture (IMTA) or repairing the kelp forest by harvesting sea urchins. Aquaponics use the excess nutrients in water from aquaculture to achieve more food production and in practice create a whole circular ecosystem, which is especially relevant for freshwater aquaculture. Projects contributing to the circularity objective include AQUABIOPRO-FIT, that is reducing waste and creating nutrient supplements among other things, developing high-quality proteins and bio-actives from European aquaculture, fisheries and agriculture side streams for applications as diverse as health integrators, fitness supplements and animal feed. There have been great changes in feed composition in salmonid feed production from more than 50% fish meal in addition to almost 30% fish oil in 1995, to less than 30% of the two combined in 2016. More innovations are expected in aquaculture feed, where

²⁴ [European Market Observatory for Fisheries and Aquaculture Products](#) (2019). The EU fish market 2019.

²⁵ [Standing Committee on Agriculture Research – SCAR](#) (2019). Non-paper Horizon Europe cluster on Food, Bioeconomy, Natural resources, Agriculture and Environment- an ocean of opportunities for aquatic science and for developing the blue bioeconomy.

fisheries and aquaculture by-products have a remarkable potential to supply the protein required by aquafeeds over the next 10–20 years.

Organisational innovation

Redefine sustainable practices and bring together food systems actors that have not traditionally worked together in innovation clusters. Europe's seas, coasts and maritime sectors and regions are drivers for the European economy, with a potential of 5.4 million jobs and a gross added value of just under EUR 500 billion per year. Stakeholders, including policy makers, researchers, businesses and citizens, can be brought together through innovation clusters. Social hubs such as The Ocean Opportunity Lab, Creative Cities Alliance and Katapult Ocean that invest in ocean start-ups, having a positive impact on the oceans, should be duly supported in view of scaling up the most successful interventions. Targeted support should also be directed at innovation clusters on seafood that are currently being established ²⁶, as well as at technological initiatives for ocean sustainability through transparency, data-sharing and collaboration²⁷. Research institutions, research institutions and public bodies need common platforms, like innovation cluster infrastructure, to improve food systems.

Managerial innovation

Sharing knowledge and best practices is essential to improve capture fisheries and aquaculture to increase food production and reduce waste in aquatic food systems. An impressive number of innovations are improved fishing methods to enhance quality, reduce waste and increase fishers' incomes, best practices and lessons learned must be shared. Competence building can be business-to-business, through industry meeting places and exhibitions, through Cofunded calls or regional initiatives. Public authorities should provide enabling regulatory spaces to allow innovative technology and services to thrive, as well as guidance and support for start-ups on how to design successful business models for commercial applications of innovation. Open access and knowledge sharing allows all stakeholders to contribute to the food systems transformation, whether it is through technologies allowing for the location of fish stocks with data models indicating where fishers should go, smart farming in aquaculture or close collaborations between research groups and industry partners.

²⁶ [Norwegian Centres of Expertise](#) (2020). Seafood Innovation.

²⁷ [Global Fishing Watch](#) (2020). Map and Data Technology.

Policy innovation

Streamline and harmonise the patchwork of multiple policies regulate fisheries and aquaculture. There is an urgent need to integrate the food systems approach and sustainability objectives underlying the European Green Deal and the Farm to Fork Strategy with the existing legislation such as the Water Framework Directive (WFD), Marine Strategy Framework Directive (MSFD), Maritime Spatial Planning Directive (MSPD), the Common Fisheries Policy (CFP) and the Common Agricultural Policy (CAP). Food systems transformation in aquatic food systems requires close coordination between DG AGRI, DG MARE and DG RTD. Alignment of national agendas is necessary to achieve safe and sustainable ocean and freshwater food systems, and strong support should be provided to trans-national frameworks such as the Joint Programming Initiatives (JPIs) that work on alignment of national agendas, connect scientists and investigate the impacts of climate change on the nutritional value of food and the impacts on diets.

Alternative Proteins & Dietary Shift



The current high levels of animal protein consumption in the EU has a detrimental impact on both human and planetary health. Indeed, red and processed meats are high in cholesterol, as well as in saturated and solid fatty acids which has been found to increase risk of colorectal cancer. In parallel, based on recent life-cycle assessments, meat and dairy products contribute to about 24% of the negative environmental impacts caused by the total food consumption in the EU. A drastic change in the dietary habits of European consumers is needed to achieve more healthy and sustainable food systems in the EU. Innovations leading to changes in consumer behaviour, will be critical to achieve the foreseen dietary shift through increased consumption of healthier and environmentally sustainable alternative proteins.

Social Innovation

Stimulate new incentives that accommodate culture, traditions, food choice motives, familiarity, attitudes, taste, acceptance and social norms towards dietary transition including alternative proteins. New incentives are needed to increase EU consumer acceptance and trust in new protein sources and boost alternative protein consumption over meat protein. To achieve such a dietary shift, it is necessary to promote the adoption of social norms centred around shifting ratios of plant protein to animal protein from 1:2 (current situation in the EU) to a 2:1 ratio (desired situation in the EU)²⁸. To this end, socio-economic factors such as cultural differences, social inequalities and access to information and education should be considered. National dietary guidelines need to be considered and adopted. One example is the consumer's expectation of a 'good meal'. Currently, meat dishes are predominantly featured in restaurants across the EU, regardless of the socio-economic status of clients²⁹. We must shift from limited vegetarian options to limited meat options. This could be realised by changing the default (e.g. restaurant clients must actively ask for a meat option instead of a vegetarian option) or by changing the proportions by menu engineering. Some consumers are more open to reduced portion sizes, others prefer to have meatless meals occasionally. Some consumers search for meat-analogues (e.g. vegetarian burgers), whereas others prefer to use different types of products (e.g. pulses)³⁰. Consumers should be supported with various familiarising strategies targeted at their personal preferences, such as trying and tasting and developing products that fit with known products and dishes.

Technological Innovation

Diversify and scale up the production of alternative proteins, while maintaining high food safety standards (especially regarding allergenicity), nutrition value and taste. There is a need to strongly support (further) research and technological innovations, leading to sustainable business models for food products based on alternative proteins. This will allow more variety in the consumer's food choice and more cost-effective production and processing methods. Technological innovations, such as hybrid burgers that combine meat with plant-based proteins³¹ and 'beyond burgers' that only use plant proteins reproducing the taste and appearance of meat offer good prospects and lessons learned for the development of other and

²⁸ [SUSFANS](#) (2019). Geographic and socioeconomic diversity of food and nutrient intakes: a comparison of four European countries.

²⁹ [Vaan, J. M., de, van Steen et al.](#) (2019). Meat on the menu? How the menu structure can stimulate vegetarian choices in restaurants. *Journal of Applied Social Psychology* 49(12), 755-766.

³⁰ [Verain, M.C.D., H. Dagevos et al.](#) (2015). Sustainable food consumption. Product choice or curtailment? *Appetite* 91, 375-384.

³¹ [Food Navigator](#) (2019). Hybrid burger helps meat-eaters overcome 'mindset gap': "It tastes 100% like beef".

further improvement of alternative protein sources³². A next generation of meat substitutes might no longer mimic meat and instead be rooted in vegetarian or vegan concepts meals. Technological innovations in food processing and novel foods require consumer acceptance. Furthermore, increased consumption of non-animal alternative proteins may raise increased safety concerns, especially potential allergenicity of meat alternatives, which could hinder the large-scale adoption of these alternatives. In order to increase the market uptake of food products based on alternative proteins, there is a need for technological development and innovation such as genetic engineering, cellular agriculture (artificial meat, or “clean meat” production), tissue engineering and reverse engineering of tissue. This should ensure high nutritional and organoleptic qualities of alternative protein food so that consumers perceive them as equal or better than meat-based competitive foods.

Organisational Innovation

Support multi- and interdisciplinary public-private partnerships to develop local, regional and European strategies, favouring alternative protein production and consumption. Continuous and effective interaction, knowledge exchange and coordination between public and private actors, are required to join competences and expertise in the transition towards more alternative proteins, on both the supply and consumption side (primary producers, food processors, retailers, restaurants/caterers/chefs, research, education, advisors/consultants, consumer organisations, NGOs, governments, managing authorities and others). Living lab settings such as the FIT4FOOD2030 city and policy labs could be utilised or formed to collaborate and support different perspectives and facilitate the creation of such public-private partnerships. A promising example of public-private partnership that should be expanded and scaled up is brought by the PlantPROMISE platform, which aim at producing alternative plant-based meat analogues, while working on pre-competitive technology and know-how in cross value-chain collaboration to translate basic insights into concrete implementation³³. Multi-actor projects under Horizon Europe could foster these public-private collaborations by involving end-users and multipliers of research results such as businesses and innovation brokers, throughout the whole project period. Specifically, these partnerships should focus on filling in R&I gaps on:

- nutrition and nutritional profiles such as essential amino acids, salt, saturated and unsaturated fats, the impact on the microbiome, prevalence of non-communicable diseases):

³² [New Yorker](#) (2019). Can a burger help solve climate change?

³³ [PlantPROMISE](#) (2020). Plant PROtein Meat alternativeS using Extrusion.

- safety aspects and allergenicity:
- consumer behaviour such as lifestyle changes and the organoleptic quality:
- environmental impacts e.g. the life cycle analysis.

An EU central database on alternative proteins should be created to stimulate multidisciplinary R&I and exchange of data, knowledge and best practices at both member state and EU level, acting as a data hub. Ultimately, this database will allow for cost-effective comparative analyses on the impact of both conventional and alternative proteins, including the calculation of environmental footprints using the new Product Environmental Footprint (PEF) based categories on health, nutritional and food safety aspects.

Managerial Innovation

Create and support platforms to enable and expand businesses, meeting consumers' demands in the transformation towards alternative proteins. Present and future suppliers of alternative proteins should be supported in the further development of technologies, specific applications, novel food, consumer products, services and marketing innovations, taking into account competitiveness, as well as nutritional and environmental benefits, targeting various consumer groups. These platforms should focus on networking between businesses and other actors such as researchers, education, advisors/consultants, marketing, consumer organisations and policy makers, to exchange and acquire what new and ready existing business need as knowledge, skills and competences, and by matchmaking between supply chain partners. These platforms should focus on demonstrating and showcasing innovation, accelerating the protein shift and organise networking events and activities such as webinars, business acceleration sessions, thematic events on e.g. legal aspects and upscaling possibilities, summits, and expert sessions. The Protein Cluster (TPC) could serve as an exemplary platform, supporting and bringing together ingredient suppliers, food manufacturers, retailers, caterers and other relevant stakeholders in plant-based, vegan or vegetarian solutions, at regional, national and international level³⁴. TPC is an initiative by a regional innovation ecosystem network, including innovation brokerage, business acceleration, a development agency, research, education, and governments.

Policy Innovation

Reduce the overall protein consumption, while promoting production and consumption of alternative proteins. Under its current setup, the Common Agricultural Policy (CAP) offers limited potential as an

³⁴ [The Protein Cluster](#) (2020). A foodvalley business network.

instrument to push EU consumers for protein shift and whole-diet transition. This is largely due to a lack of consumer-targeted instruments and measures in the EU. Effects of pure supply-side policies, such as reducing animal densities or higher welfare standards, on consumer demand for meat and dairy would be neutralized by trade flows in EU's open trading system. Subsidies should be moving away from income support into innovation support, incentivizing livestock farmers to shift to more sustainable protein production and fostering an innovation ecology for the scaling of alternative proteins. Experimentation on more consumer-oriented measures and policies are needed. Prospects of achieving impacts with financial incentives are larger when targeting consumers rather than producers, yet there is no agreement among consumers on the appropriate modalities. The need for changing dietary habits encompasses the reduction of EU citizens' overall protein intake, in general. The replacement of meat protein intake with other sources, should be promoted by increasing the availability of alternative protein foods, while lowering the overall meat supply and supporting shifts in social norms. The introduction of EU-wide dietary guidelines recommending the reduction of protein intake from traditional livestock animal-derived foods and the switch to alternative proteins, should be considered. In addition, new guidelines for public procurements should include both health and environmental sustainability criteria, including the need to reduce the amount of proteins served in public institutions' canteens, schools, workplaces, hospitals, and senior-caring facilities, while taking into consideration specific deviating target groups. Methods of alternative protein production and processing showing clear environmental benefits, while also ensuring the production of safe and highly nutritious foods, should be promoted in view of achieving the objectives of the EU Farm to Fork Strategy and the European Green Deal. In parallel, incentives should be provided for livestock farmers to shift towards more sustainable protein production. Laws regulating the conditions for development, sale and marketing of novel foods should be adapted and harmonised and simplified across the EU.

Food Waste & Resource Efficiency



The amount of food loss and waste (FLW) currently produced in Europe is causing negative social, economic and environmental impacts. FLW contributes to food insecurity and represents an obstacle to nutrition. As food production is a resource-intensive process producing remarkable carbon, land and water footprints, FLW aggravates the effects of climate change. FLW also represents a financial burden for producers, consumers and national economies as it sensibly reduces incomes, purchase and investment power. As a global leader in promoting food security, climate protection and a competitive green economy, the EU is expected to lead new efforts to close the knowledge and research gaps still existing in FLW measurement, set clear targets and scale up innovative initiatives to meet its Farm to Fork objective to halve FLW by 2030 and build a circular food production-to-consumption model.

Social Innovation

Identify existing impactful solutions, boost funding, and expand the social innovation network to stimulate the multiplication of new FLW reduction initiatives. Social innovation applied to FLW reduction efforts has the potential to achieve remarkable social impact in the areas of: redistributing surplus food; providing alternative markets for food products that would otherwise go to waste; contributing to circularity by transforming leftovers into valuable products; and changing social attitudes towards food waste. Two aspects are crucial to achieve impactful results:

- 1) *Create comprehensive databases to identify existing social innovations with a proven track of positive results at the local level and scale them up*³⁵. EU Member States should centralise the efforts to set up national databases with clear criteria to determine the impact achieved by specific actions and their potential scalability. The EU Platform on Food Losses and Food Waste should promote the creation of a publicly available EU database for FLW reduction social innovations;
- 2) *Set up national social innovation agendas to stimulate and leverage financing.* Lack of funding poses a constant challenge to the survival of successful social innovation projects and constrains opportunities for scalability. Inconsistencies in local funding between Member States make replication of successful actions at the European level difficult³⁶. Member States should establish dedicated fora to connect innovators with public authorities and private actors and stir a common agenda between potential donors and social entrepreneurs. The EU Platform on Food Losses and Food Waste should promote the creation of guidelines on how to apply for EU funding.

Technological Innovation

Leverage technology and digital solutions to rethink and better coordinate key processes across the food value chain. As most of FLW in Europe happens close to the consumption stage of the chain, enhancing product shelf life through better food processing should rank among the top priorities for policy makers, together with improving food handling and storing methods, data-marking and labelling, and providing effective bio-based solutions for packaging. All relevant research and innovation as well as financial instruments should be utilized to support development and implementation of technological innovation

³⁵ A patchwork of several European databases with a limited number of recorded initiatives and different eligibility criteria already exist, see for example the [EU FUSIONS](#) (2016) inventory that gathered 53 initiatives from 2013 to 2016.

³⁶ [EU REFRESH](#) (2016). Socio-economic implications of food waste: Economics of innovation.

to prevent FLW (Horizon Europe, FOOD 2030, future Single Market Programme, EIP-AGRI, EIT Food, the Digital Europe Programme)³⁷. Two promising paths for action are the following:

- 1) *Ensure safety standards and transparency of innovative technological solutions to tackle FLW.* In spite of the increasing availability of potentially impactful solutions, EU consumers remain wary of new technologies partly due to perceived risks for their health and lack of perceived benefits. Public authorities should address this issue by upholding the highest food safety standards whenever producing dedicated risk assessments, while also communicating transparently about the positive impacts of technological uptake on household incomes and the environment;
- 2) *Pledge resources to scale up technological innovations undertaken by small & medium enterprises (SMEs) to produce high returns of investment.* As the EU agri-food industry is largely shaped by SMEs often lacking the required resources to adopt the available technological solutions³⁸, public authorities should consider contributing the transitions towards technological solutions that provide clear positive impacts for society and the environment.

Organisational Innovation

Overcome the data deficit through a comprehensive approach including the establishment of National Strategies and Voluntary Agreements. The 2018 EU Waste Framework Directive calls upon Member States to take action to reduce FLW, monitor food waste levels and report on the progress achieved. However, the process is currently hindered by a high degree of uncertainty concerning the drivers and relevant data gaps in measurement and reporting schemes at the level of public institutions, businesses and households. Relevant organisational pathways to address these challenges are the following:

- 1) *Set up National Strategies to establish collaborative frameworks to act on FLW.* All Member States should put forward high level plans including the establishment of National Dialogue Fora and Working Groups where stakeholders from all across the food chain convene to align on actions and methodologies, report sector-specific challenges, and update on progress.
- 2) *Scale up and expand Voluntary Agreements (VAs) between public authorities and agri-food businesses to overcome gaps quickly and cost-effectively.* VAs are policy measures that can drive food waste reduction by bringing supply chain stakeholders together in FLW monitoring and reduction efforts. The voluntary and non-legal characteristics make their structure flexible as

³⁷ [EU Platform on Food Losses and Food Waste](#) (2019). Recommendations for Action in Food Waste Prevention.

³⁸ [EU REFRESH](#) (2016). Socio-economic implications of food waste: Economics of innovation.

targets and objectives can be quickly and easily adjusted in response to changing policy contexts. Public authorities should provide the incentives and support needed to motivate private sectors actors to enter into such agreements³⁹. However, public authorities should also carefully monitor industry actors' commitment and consider regulatory instruments to mandate performance should VAs not deliver on the foreseen objectives.

Managerial Innovation

Focus on improving agri-food practices in selected Impact Circles to maximise FLW reductions results.

FLW proliferation in Europe happens at all stages of the food value chains, but especially “close to the fork”⁴⁰. For this reason, it is especially important to improve agri-food practices close to the consumption stage at the consumer and household levels by promoting systemic change involving all relevant actors. To this extent, it is crucial to focus on Impact Circles based on the Food Recovery Hierarchy including food processing and preservation methods; packaging; animal feed; redistribution of surplus; and consumer behaviour. Crucial managerial innovations should take place in the following area:

Improve supply chain management systems and invest in capacity building of workers and citizens. In all the Impact Circles identified, relevant stakeholders should work together to improve key processes. These include: reengineer production processes and product design to reduce waste during product line changeovers; adopt low-cost storage and handling technologies that prevent spoilage and increase shelf life; invent, design, produce, and mainstream packaging options that extend a product's shelf life while also respecting the environment; develop new food products or secondary uses (e.g. animal feed) from food products or ingredients that cannot be marketed; remove physical, information and regulatory barriers to food redistribution so as to make it easier for food suppliers to trade and donate surplus; encourage consumers' social norms shift and relevant skills building, so that FLW proliferation becomes unacceptable and citizens possess the relevant skills to avoid it.

Policy Innovation

Set clear targets for FLW reduction and monitor progress of local authorities, private actors and households towards the achievement of EU objectives. Europe is currently not on track to meet the EU Farm to Fork Strategy objective to halve food waste by 2030⁴¹. While the establishment of National

³⁹ [Champions 12.3](#) (2020). SDG Target 12.3 on food loss and waste: 2020 progress report.

⁴⁰ [World Resources Institute](#) (2019). Reducing Food Loss and Waste: Setting a Global Action Agenda.

⁴¹ [Champions 12.3](#) (2020). SDG Target 12.3 on food loss and waste: 2020 progress report.

Strategies and Voluntary Agreements can help overcome the data deficit regarding the FLW levels currently produced in different Member States and in specific sectors of the food chain, it is essential that national and EU authorities set mandatory targets and context-sensitive key performance indicators (KPIs) to increase the accountability of relevant stakeholders. To this extent, two important policy developments are needed:

- 1) *EU Member States need to set up FLW Task Forces which will mandate the creation of technical regulations determining the reduction targets for each sector national food value chain.* The mandate of such Task Forces should also include the capacity to propose and assess relevant incentives, support programs, financing instruments and training modules to help all stakeholders meet the foreseen objectives.
- 2) *The EU should include clear FLW reduction targets in the Farm to Fork Strategy Action Plans and link Member States' FLW reduction action to the EU commitment to the Paris Agreement.* The new Farm to Fork Strategy – with the related impact and risk assessment studies that will follow in the next months and years – offers an excellent opportunity to establish mandatory targets related to FLW reduction objectives. The EU has often led the way in providing technical legislation in previously unregulated policy areas, and the identification of clear benchmarks and red lines in FWL proliferation would represent a cornerstone for its ambition to act as a global leader in the transition towards healthy, sustainable and resilient food systems. As the Paris Agreement on Climate Change now occupies the center of the EU “Green Deal” policy framework, the EU should discuss with Member States the introduction of FLW reduction targets into the Nationally Determined Contributions that each Member State is expected to provide to the United Nations Framework Convention on Climate Change (UNFCCC).

The Microbiome World



The Covid-19 pandemic has acted as a strong reminder that we do not exist outside the microbiome as our health and food security depend on it. The microbiome plays an important role in the wholeness of ecosystems, such as the human body, the earth, the oceans and the environment, and its study has the potential to produce breakthroughs in the fields of human medicine, food systems transformation and the adaptation to climate change. A systemic approach to the microbiome entails a focus on standardisation, collaboration and system thinking both within and between the scientific, industrial and political/ regulatory domain. The microbiome needs to be recognised for the crucial role it can play in the delivery of nutritious foods through environmentally sustainable production methods while also creating health, economic and environmental benefits for farmers, businesses, and consumers. R&I strategies need to address the whole system considering microbiomes in different environments from human beings and animals to plants, soil, oceans and the whole environment and through a holistic, inter- and transdisciplinary approach.

Social Innovation

Create an international Microbiome Network to support public-private collaboration and multi-disciplinary research. Fostering the dialogue and cooperation on the microbiome among key actors of the food value chain ranks high in the European R&I agenda, as proven by recently founded Horizon2020 projects such as MicrobiomeSupport, SIMBA, CIRCLES, MASTER or HoloFood. The establishment of an international Microbiome Network is necessary to foster co-creation of initiatives among public authorities, private and civil society across scientific disciplines to find innovative solutions to pressing challenges. Such a network should be grounded on system thinking and transdisciplinary approaches and should be the expression of a joint effort between the European Commission, the European Institute of Innovation and Technology (EIT), Higher Education Institutions (HEIs) and industry. The first action of the Microbiome Network should be to improve the awareness of the transformational potential of the microbiome among civil society stakeholders. Citizen engagement in targeted R&I actions and integration of the microbiome subject in study curricula at all educational levels are essential steps towards building knowledge and familiarity with the microbiome and its practical implications for society. HEIs should actively participate in the Microbiome Network by organizing hackathons and establishing multi-disciplinary research teams which would work together with industry on the development of new technologies and services. The contribution of the Microbiome Network will enhance the knowledge, competences and abilities of civil society actors and young scientists, support industrial innovation informed by systems thinking, and produce positive impacts on EU's economic growth.

Technological Innovation

Apply systems thinking to microbiome R&I and expand open access to scientific evidence. Strong interconnectedness between research disciplines is necessary to realise the full potential of the impact that microbiome innovation could have to address health, environmental and economic problems. The increasing availability of microbiome data driven by advances in -omics technologies has led to remarkable increases in our understanding of the potential of microbiomes in specific ecosystems through the analysis of microbial cells, DNA, RNA, proteins and metabolites. It is however necessary to address the whole system by integrating the study of microbiomes in different environments through a multi-disciplinary approach. A crucial R&I action is to enhance our understanding of host-microbe, environment-microbe, and microbe-microbe interactions, as well as their reactions to changes and influences from their

environment⁴². Such an R&I multi-disciplinary approach should be designed to go also beyond the mere description of the system in order to address functional aspects of microbiome activities and the complex network of interactions. Better understanding of microbiome interactions between humans, animals, and the shared environment will furthermore require continued development of improved statistical and ecological modelling approaches. Further integration of new technologies, new detection methods, Artificial Intelligence and new linkages with data sciences will be highly beneficial for microbiome research. Such enhanced understanding could lead to innovative interventions to prevent and manage a variety of human health and disease states⁴³. It is also necessary to make certified reference materials available to the scientific community and civil society, in view of setting global R&I standards to set benchmarks for testing and evaluating microbiome innovations. By making accompanying meta-data and results from technological advancements in metabolomics, meta-transcriptomics, proteomics and imaging available, the principle of Open Access allows members of the scientific community to replicate, confirm and build on the results of others. The use of these datasets for meta-analyses and data mining will enable microbiologists to ask and answer new questions, develop new bioinformatics tools and speed up research. The principle of Open Access, which will be embedded in the new Horizon Europe framework programme⁴⁴, should be also followed by EU Member States and other actors sponsoring microbiome studies and technologies, within the limits of public interest and the respect of business secrecy.

Organisational Innovation

Establish a network to build on large-scale research cooperation and mobilise Europe's best researchers around an ambitious microbiome R&I roadmap. Microbiome research should make the object of a dedicated network such as the Future Emerging Technology (FET) Flagships implemented by the European Commission and Member States, with the aim to support alignment of policies and research agendas at the national and EU level to work towards a holistic approach. Furthermore, this would allow to build an infrastructure connecting research projects and other R&I initiatives, as well as a forum for improved dialogue and cooperation between university, industry, the public sector and civil society. Such a dialogue is essential to manage expectations and identify needs and barriers. A holistic approach similar to the One Health concept – frequently used in the context of the battle against antimicrobial resistance – can highlight the interconnectedness of the human, animal and environment (land, water and sea) dimensions

⁴² [Berg, G., et al.](#) (2020). Microbiome definition re-visited: old concepts and new challenges. *Microbiome* 8(1): 103.

⁴³ [Trinh, P., et al.](#) (2018). One Health Relationships Between Human, Animal, and Environmental Microbiomes: A Mini-Review. *Frontiers in Public Health* 6(235).

⁴⁴ [CESAER](#) (2020). Open Access in Horizon Europe.

and can prove useful when designing targeted interventions. A Microbiome FET Flagship should be informed by the strategic microbiome R&I agenda currently under development in the framework of the MicrobiomeSupport project. The FET Flagship should seek to encourage stakeholder involvement, support data exchange, and provide momentum for the creation of standardised reference materials, as well as for the alignment of regulation and policies at Member States level.

Managerial Innovation

Invest in scientific and professional competence building through training modules for food supply chain actors with a focus on primary producers. Sector specific science-industry partnership training models and knowledge exchange platforms have to be established to ensure successful adoption of systemic microbiome approaches and their translation into products to match skills to needs and to support upskilling. A better integration of microbiome-based concepts in soil and primary production of plants and animals is an important required action towards more sustainable production of healthy food through the reduction of dependence on chemical input. The fundamental scientific advances in the area of metagenomics, meta-bolomics and pro-teomics need to be translated rapidly and effectively to applied research, industrial research and product development. New educational initiatives should allow agri-food start-ups to benefit from Business Accelerators and Innovation opportunities. More attention should be given to supporting innovative start-ups through mentoring programmes held in partnership with established companies and matching exercises with businesses offering complementary services⁴⁵. Targeted training on innovation capabilities should allow start-ups and Small and Medium Enterprises (SMEs) to overcome existing skill gaps and thus unlock untapped market opportunities. Public-private partnerships (PPP) should be expanded as they can facilitate the commercialisation of scientific discoveries and boost impactful innovations needed to bring microbiome applications to the market.

Policy Innovation

Establish an EU High-Level Expert Group on the Microbiome to support the modernization and standardization of regulation. An EU High-Level Expert Group on the Microbiome should be established pooling experts from DG RTD, DG SANTE, the European Food Safety Agency (EFSA), representatives of the national food safety authorities and external experts. Their main task would be to ensure that food safety standards are continuously improved and microbiome innovation is constructively included in policy action towards the establishment of sustainable food systems. Currently, competences in key areas for

⁴⁵ [EIT Food](#) (2020). MICROBIOME-PUSH: Into the Microbiome Exploitation in Food Systems.

the microbiome are scattered across Member States and across EU Directorate Generals and agencies. For instance, the procedure for microbial products registration is currently very complex and conflicts of competences sometimes arise between concurring regulatory agencies. The High-Level Expert Group would have the necessary legitimacy to promote a debate on a harmonized, coherent and updated regulatory framework for novel scientific and technological innovations in order to support the development of evidence-based models for healthy and sustainable choices. Other priorities for the High-Level Expert Group should include promoting technical competence building within policy departments and an improved policy-science dialogue both at the EU and the national level. The High-Level Expert Group could build on and support the work carried out by EFTA by researching the impact of various substances under EFSA assessment on microbiomes, and gathering more data on the impact of microbiomes on human, animal and plant health⁴⁶. Synergies between the High-Level Expert Group, and future Horizon Partnerships on Chemical Risk Assessment, and on Sustainable Food Systems for People, Planet and Climate should be duly explored and exploited.

⁴⁶ [Merten, C. et al.](#) (2020). Exploring the need to include microbiomes into EFSA's scientific assessments. *EFSA Journal* 18(6) 18061.

Transition Towards Healthy, Sustainable and Personalised Nutrition



Unhealthy diets are associated with an increased prevalence of obesity, cardiovascular diseases, diabetes, cancer and other lifestyle-related diseases and bear enormous costs associated with health care, loss of labour productivity and quality of life. At the same time, nearly 10% of the EU population is not able to afford a regular quality meal every second day. Furthermore, food production accounts for roughly 25% of global greenhouse gas emissions (GHG) and around 70% of the global freshwater use. Innovative solutions should support EU citizens in achieving successful lifestyle change. There is a need for targeted nutrition advices considering the social, psychological, and biomedical aspects driving the dietary patterns of (groups) of individuals. Therefore, a better understanding of the processes that help preventing lifestyle-related diseases and strengthen health, in combination with innovations in the food processing and novel foods, are key elements towards personalised and precision nutrition. There is also a need for more data on the impact of the different dietary patterns on the environment, as well as new initiatives to integrate those data into strategies to enable consumers to move towards healthy and sustainable diets.

Social innovation

Create a multi-actor community of practice involving scientists, educators, consumers, businesses, policy makers and regulators. The establishment of a community of practice will help bridging the existing gap between knowledge and practice by sharing experiences and success stories between different ecosystems, in view of strengthening the policy-science⁴⁷ and science-society interface⁴⁸. The multi-stakeholder, interdisciplinary community will feed into the development of evidence-based policies and interventions promoting a shift towards sustainable, healthy and personalised diets. Low income and societal vulnerability are two major barriers to dietary transition towards sustainable and healthy diets. Therefore, a priority for such a community should be identifying experiences and success stories to mitigate differences in dietary quality between societal groups. Indeed, Furthermore, the community of practice should produce more insights on the economic and environmental trade-offs potentially emerging between maintaining the current production and consumption model and shifting towards a system that supports healthy and sustainable diets. This community could build on existing initiatives, such as the International Network for Food and Obesity/NCDs Research, Monitoring and Action Support (INFORMAS) which has established a network of researchers, policy makers, renowned experts in policy development, implementation and evaluation in 7 EU countries⁴⁹. The current INFORMAS focus on mapping public policies relevant for food governance and healthy physical activity environments should be expanded to include policies with an impact on the environmental sustainability of food systems, integrating amongst others the findings of the European project SUSFANS⁵⁰ and of the knowledge hub on Food and Nutrition Security funded by the three food-related Joint Programming Initiatives (JPI) OCEANS, FACCE and HDHL.

Technological Innovation

Leverage technology and digital solutions to improve the tools to measure and monitor a healthy and sustainable diet in individuals and groups. Objective measurements of dietary intake are needed to increase the quality of nutrition and lifestyle research and therewith the recommendations and guidelines on diet. Public authorities should develop a convergence approach to develop inexpensive combination

⁴⁷ A dialogue between scientists and policy makers to make sure that evidence feeds into policy making, while also ensuring that knowledge questions/ needs are addressed by scientists.

⁴⁸ A dialogue between science and the stakeholders such as health professionals, retailers, SMEs and citizens aimed to ensure that scientists are addressing the knowledge questions/ needs of society, while also taking into account the real world practice in the design of their research and interventions.

⁴⁹ [INFORMAS](#) (2020). Objectives.

⁵⁰ [SUSFANS](#) (2018). Deliverable 9.5 The SUSFANS toolbox for assessing EU Sustainable food and nutrition security.

tools that are easy to use, validated, precise, and accurate for estimates of intakes of food components (e.g., for nutrients, bioactive compounds, additives, and contaminants). Available technological capabilities should be used to develop biomarkers that can increase objectivity of the measures and customise them for specific population groups, with a special focus on vulnerable groups whose nutrition security is most at risk. An EU-wide infrastructure for the organisation and management of data and apps related to personalised diets should be set up. Such framework would serve as a one-stop-shop acquiring information and learning about the most successful technologic innovations; the research methods that leverage these technologies; and the theoretic basis for their use for decision making by individuals/patients, providers, and policy makers. To counteract the unintended consequences of increasing disparities that efforts aimed at devising 'personalised' dietary guidelines could create, tools for curating knowledge and resources must be carefully integrated into personalised technology infrastructures.

Organisational Innovation

Improve policy programming and funding to accelerate the creation of a (knowledge and) innovation ecosystem, increase the impact of R&I investments and boost the return of investment. Research and innovation investments on food, nutrition and health are scattered across the EU and Member States. There is a lack of integration and policy alignment, including of data and knowledge pertaining to the amount of R&I investments promoted by each Member State, which may lead to sub-optimal use of resources. The actual impact of policies favouring R&I investments needs further analysis, especially considering the low market uptake of R&I and the slow adoption of emerging technologies and new ways of doing science. To overcome this barrier, collaboration between funders, businesses, NGOs, policy makers, researchers, and educators should be stimulated at the regional, national, EU and international level. Public and private funders have a significant role in providing access and financial investments. Their agendas should be better aligned and there should be more coordination to build on/ follow-up on promising results. Such an ecosystem should be realised by increasing the collaboration between multi-actor platforms such as EIT Food, EIT Health, EIT Digital, the food related JPIs (FACCE, OCEANS, EC), the SCAR working group on Food Systems, DG RTD Planet, DG RTD Health, DG Sante and DG Agri. Funding institutions can take on a role in developing R&I programmes which connect several sub-systems, such as policy, business economics, biology and health, in order to bring about change in the entire EU food systems. Although collaboration among actors and different levels of governance is already taking place, action should be coordinated at a more strategic and structured level, and by acknowledging different

roles, strengths and added values in the ecosystem. Special efforts should be dedicated to ensuring that successful projects are identified and duly financed and scaled up. The establishment of a centralised EU database of R&I funding initiatives and national research agendas should be considered to address potential synergies and gaps at the European level.

Managerial innovation

Establish a European research infrastructure between the industry, technology developers, researchers, data scientists and citizens to expand the expertise of multiple actors within the EU. This infrastructure should foster capacity building, enabling scientific breakthroughs to emerge and steering the economic, social and environmental transitions; and facilitate the sharing of innovative research data, top-level lab facilities, as well as both academic and professional expertise. It would support FAIRification⁵¹ of data standards, search tools for available datasets, archiving services for research context, permissions and data, curation and annotation⁵², processing, matching, analysis and visualization of data and information. Another objective of the foreseen infrastructure should be to support the research community and the industry in generating and exploiting innovative data on foods, personalised diets, and consumer behaviour, and include advanced data analytic tools. Managerial innovation should be further fostered by ongoing and emerging projects and initiatives in data sciences and ICT, in regional R&I programmes and Smart Specialization Strategies (RIS3), via European Structural and Investment Funds (ESIF), community building and pan-European education and training programmes. An example of an ongoing EU project is the Food Nutrition Security-Cloud project⁵³ for food and nutrition security, to overcome fragmentation by federating FNS data on diet, health, and consumer behaviour as well as sustainable agriculture and the bio-economy. Another European initiative is the European Open Science Cloud (EOSC)⁵⁴ which brings together institutional, national and European stakeholders, initiatives and data infrastructures to develop an inclusive open science ecosystem in Europe. The implementation and valorisation of programmes aiming to overcome fragmentation and implement joint R&I-driven systemic solutions while simultaneously contributing to the development of key R&I-services should be strengthened. A broader

⁵¹ FAIR stands for Findable, Accessible, Interoperable and Reusable, with the long-term aim of making data findable and usable for various purposes.

⁵² Data curation is the process of extracting important details from scientific sources (journals, databases, spreadsheets, documents) and converting these into electronic formats, while data annotation is the process of adding metadata to a dataset.

⁵³ [Food Nutrition Security-Cloud](#) (2020). Cloud solution facilitates access to food and nutrition information.

⁵⁴ [European Commission](#) (2020). What the European Open Science Cloud is.

support from and a better connection with Member State programming, both at the regional and national level, is required.

Policy Innovation

A EU High-Level Expert Group should be established to draft a science-based framework for new front-of-pack nutrition labelling combining nutrition, health and environmental sustainability. This framework should be co-created with all members of the food system to ensure broad adoption of the new labelling system, including primary producers, the business sectors, regulators and consumers. As stated in the Farm to Fork Communication, consumers need - among others - clear information allowing them to compare food products and to understand the environmental, economic, health and social implications of their food choices. The High-Level Expert Group should also work to produce a balanced, harmonised and broadly supported methodology for food labels, which should combine criteria on the impact of a food product on the nutrition and health of the consumer, on the environment, as well as on the social production costs. In this light, there is a need for more data on the impact of the different dietary patterns on the environment, as well as new initiatives to integrate those data into strategies. The High-Level Expert Group would also benefit from new knowledge generated by R&I initiatives implemented under Horizon Europe to contribute, innovate and test new labelling prototypes. A network of R&I policy labs could be a tool to foster a broader support and increased alignment.

Food Safety Systems of the future



Food safety is a joint responsibility of farmers, producers, processors, distributors, regulators, policy makers, suppliers, Hotel Restaurant Café (HoReCa) services and consumers in the food system. Europe has one of the highest levels of food safety in the world thanks to a wide range of regulatory and self-regulatory measures ensuring that all products on the market meet the highest standards. However, food safety cannot be taken for granted. Food-borne bacteria, parasites, toxins and allergens cause hundred thousand of deaths globally every year, and EU consumers increasingly show decreasing levels of trust in the safety of the food supply chain. Furthermore, novel food components may cause allergic reactions and lead to other infections, which requires close monitoring and thorough food risks assessment to avoid potential epidemics in the longer term. In the framework of the current European food safety system, responsibility for risk assessments (mainly performed by the European Food Safety Agency) and for risk management (e.g. policy) are kept separate, which adds a layer of complexity to the EU food safety systems. The EU needs to streamline its risk assessment systems to strengthen its role of global leader in food safety and become the global standard for implementing rapid, robust, cost-effective, and trustworthy procedures establishing resilient food safety systems prepared for the challenges of the future.

Social Innovation

Move past passive information campaigns and support consumers in increasing their acquaintance with food safety standards. It is fundamental that public authorities and private agri-food businesses collaborate in supporting enhanced consumer awareness of the importance of food safety in ensuring access to high quality diets. EU citizens can have a great impact on the quality of food sold to them by asking for more nutritious and safer food choices. In articulating these demands, they can become levers for quality control themselves. However, to become agents for change and participate in food safety risk governance, they need to be empowered with the necessary tools to raise their risk perception. Public information campaigns should promote active citizenship by providing a greater focus on community-level nutrition education efforts on food safety as a diet quality and nutrition concern⁵⁵. Awareness campaigns should also target greater dietary diversification with a view to reducing exposure to some foodborne contaminants, while enhancing diet quality. For maximum reduction of foodborne hazards, consumers should be encouraged to get acquainted with the basic principles of food safety, understand the linkage between food quality, handling, and health outcomes. Public authorities should especially invest in transparency campaigns aimed at increasing consumer awareness of potential risks associated with novel food products and technologies, especially if products marketed as safe in the short-term lack solid evidence excluding potential risks in the longer term⁵⁶.

Technological Innovation

Ensure the validation and regulation of microbial intervention technologies that reduce, control or eliminate foodborne pathogens from food products and contact surfaces. Innovative collaborative efforts are needed by industry, regulators and researchers to improve food safety strategies and tools that can be applied successfully throughout the food supply chain. Scientists' work in the area of intervention technology development must be taken up by the food industry to make better decisions about how to reduce or eliminate foodborne pathogens in food processing operations. Regulators should mandate science-based impact assessments of new technologies and provide appropriate framework for realising the full potential of technologies with a positive impact on society. Particular emphasis should be put on combining multiple intervention technologies to inactivate pathogens in foods, commonly known as the hurdle approach⁵⁷. Intervention technologies, whether thermal, nonthermal or chemical in nature, can be

⁵⁵ [SAFE](#) (2020). We Value True Natural. Ensuring proper food information to consumers.

⁵⁶ [De Boer A. and A. Bast](#) (2020). Demanding safe foods –Safety testing under the novel food regulation. *Trends in Food Science & Technology* (72), p. 125-133.

⁵⁷ [Mogren, L. et al.](#) (2018). The Hurdle Approach—A Holistic Concept for Controlling Food Safety Risks Associated with Pathogenic Bacterial Contamination of Leafy Green Vegetables. *Frontiers in Microbiology*. 9 (1965).

designed to provide a significant inactivation or inhibition to a microbiological population and may be used as a kill step to enhance or ensure the safety of foods. Furthermore, smart technologies can help predict food safety challenges in a rapidly changing world. DNA sequencing, for instance, can provide rapid traceability and testing of food products for food safety purposes⁵⁸.

Organisational Innovation

Develop a food safety network including as many actors as possible across the food value chain. Ensuring safety and nutrition in food systems requires a cross-sectoral integrated approach that goes beyond regulations and standards. An integrated approach requires multidisciplinary research spanning agriculture, economics, nutrition, and health to identify the full costs and extent of foodborne diseases and to guide the development of cost-effective measures to mitigate or eliminate hazards in all across the food value chain. Mechanisms for testing foods at various points in the supply chain and providing information to consumers, for example, regarding sufficient heating of foods to kill pathogens, must be introduced and monitored for compliance. Institutional capacities for understanding and managing food safety risks will, of necessity, involve both public agencies and private organisations participating in the various segments of the supply chain. The current system has a structured top-down approach to food-safety where discussions are mainly held among national policy makers, scientists and private enterprises. A more inclusive, bottom-up approach should be deployed to incorporate more actors of the food systems, including regulators at local and national level, large and small food business operators, Higher Education Institutions, research centres, media, civil society and consumer organisations to enable them to access resources and data efficiently, synchronise food safety research strategies, share and exchange scientific knowledge and contribute to transparent communication regarding the food safety standards and practices⁵⁹.

Managerial Innovation

Promote the upskilling of food chain workers and consumers in view of the safety risks associated with new technologies and novel foods. Regulations for food safety, sanitation training, and effective and safe food handling and practice are vital to control food-borne diseases. While EU regulations have contributed to establish high levels of food safety in the agri-food business, important food poisoning events still occur due to improper handling of food by suppliers, kitchen staffs or customers, which should make public and

⁵⁸ [Food Navigator](#) (2020). “We are in the middle of a food safety revolution”. Tetra Pack talks the future of food safety.

⁵⁹ [FOODSAFETY4EU](#) (2020). A multi-stakeholder platform for food safety in Europe.

private actors reflect on the need for more training and educations⁶⁰. New technologies and novel foods bring opportunities for more sustainable food systems but also uncertainties about how to manage new risks. The European Commission is contributing to the overcome the knowledge gap with the programme Better Training for Safer Food (BTSF), which covers food and feed law, animal health and welfare, plant health rules and rules on plant protection⁶¹. Public authorities should provide financial and knowledge support to private actors in providing the training needed, as well as carry out regular inspections to verify worker upskilling. products in the following areas:

- implementation of new software, machines and equipment, including those for sustainable, ecological and energy efficient food production;
- changes in the market and consumer's requirements regarding healthy eating principles, the impact of new ingredients and substances on the quality of food and beverages and on the human health;
- safety implications on manufacturing of new products, including bio- and eco-products;
- implementation of new models and management systems in the production and processing chains due to the introduction of new technologies⁶².

Consumers also need knowledge and motivation to adopt good food safety practices. On the one hand, public authorities and education institutions should expand education initiatives related to issues such as how to interpretate food labels, understand the nutritional value and the ingredients contained in food products and differentiate between 'use by'/'best before' date marking to empower consumers in their relations with the agri-food business⁶³. On the other hand, regulators have a public safety interest in improving food safety practices for EU households, such as handwashing during food preparation, reaching necessary cooking temperatures, maintaining clean workspaces and learning about food conservation and stocking practices.

Policy Innovation

Create a truly holistic system of risk evaluation through a more inclusive governance of risk assessment within the European Food Safety Authority (EFSA) and risk management of National Food Safety

⁶⁰ [WHO](#) (2017). The burden of foodborne diseases in the WHO European region.

⁶¹ [European Commission](#) (2020). Better Training for Safer Food (BTSF).

⁶² [Topliceanu, L. et al.](#) (2015). Professional competences of the personnel working on quality control and food safety in the food industry. International Conference Edu World 2014 "Education Facing Contemporary World Issues".

⁶³ [EIT Food](#) (2020). Free Massive Open Online Course (MOOC) Understanding Food Labels.

Authorities. Translating scientific evidence into a harmonised policy framework is a high-priority challenge for EU food safety systems in light of the ongoing technological developments. The EU divides the feed and food risk analysis in risk assessment, risk management, and risk communication, where EFSA is responsible for risk assessment, the Commission for risk management and they share risk communication depending if it is an assessment or management issue. The creation of EFSA in 2001 aimed to provide independent scientific advice to the European Commission and clear communication to Member States and EU citizens on existing and emerging risks in the area of food and feed safety, animal health and welfare as well as plant health. However, EFSA's risk assessment opinions on food and feed biotechnology have been criticised, especially with respect to the transparency of the process (e.g. studies used for the assessment) and alleged politicisation elements⁶⁴. Recent Commission Regulation 2019/1381 on the Transparency and Sustainability of the EU Risk Assessment in the Food Chain produces positive improvements in increasing and improving communication and openness of risk governance⁶⁵. However, it does not fully address the issue of fair interest representation in the risk assessment process, which is crucial for creating trust in public opinion. Regulators should seek to increase the representation of scientists from all the Member States in the EU risk assessment system with the objective to make EFSA less vulnerable to political interests of specific countries and their national agri-food business sectors, which is crucial for creating trust in public opinion among EU citizens⁶⁶.

⁶⁴ [European Parliamentary Research Service](#) (2018). Authorisation of pesticides in the EU with a focus on glyphosate.

⁶⁵ [European Commission](#) (2018). Regulation on the transparency and sustainability of the EU risk assessment in the food chain.

⁶⁶ [Chatzopoulou, S. et al.](#) (2020). Improving Risk Assessment in the European Food Safety Authority: Lessons from the European Medicines Agency.

Food Systems Africa



The need to generate sufficient food, income and jobs to sustain Africa's people, while also avoiding putting further strain on the planet's over-stressed ecosystems, requires a radical transformation representing one of the biggest challenges of our time.

Although African countries are very diverse, some common issues include the sustainable transition towards new models of circular food economy, increased food safety, the promotion of healthy diets for all, the reduction of food loss and waste, and a more effective technology transfer to smallholder farmers. The EU-Africa partnership will be instrumental to face the challenges and seize the opportunities connected to the green transition, ensuring a shared commitment to food and nutrition security, natural resource stewardship, job creation and sustainable agri-food industry and markets.

Social Innovation

Enable and support the scalability of transformative small-scale social innovations. Social innovators and entrepreneurs in Africa are leading the charge to transform food systems by developing and deploying new solutions to tackle the inter-related economic and environmental challenges, where the value created accrues primarily to society. The Malabo Montpellier Panel has identified policies and practices that require attention, such as increasing the resilience of food systems to climate change, strengthening agricultural research, empowering women's groups, developing community gardens and improving data projects to understand and respond to crises⁶⁷. However, and in spite of new initiatives benefitting thousands of people, social innovations struggle to achieve impact at the necessary scale by reaching millions of Africans across the continent⁶⁸. Public and private actors in Africa and Europe should create the enabling conditions to allow for promising initiatives to be scaled up and replicated, sustaining them in the face of weak funding, unequal access to opportunities for women and men and intricate intellectual property frameworks, fostering cross-sector partnerships and measuring their impact. To do so, it is essential to design interventions that go beyond a narrow focus on agricultural production to also target actual improvements in the provision and quality of diets, leveraging the potential of the agriculture sector, and in other rural services such as health, water, sanitation, and hygiene.

Technological Innovation

Address the technological divide to enable smallholder farmers' uptake of innovative technologies benefitting both producers and consumers. Digital technologies offer unique opportunities for improving food production and trade, and in helping smallholder farmers to adapt to climate change and meet the UN Sustainable Development Goals (UN SDGs). Digitalization boosts connectivity in the agri-food system and reduces inefficiencies, with the Internet providing access to technical information, and stimulating cooperation and connection across the value chain. 'Big data' offers insights for improving productivity and decision-making through real-time alerts. Open sharing of information also helps to increase transparency and trust between otherwise disparate stakeholder groups in the agri-food system. However, it may increase 'digital divides' across the system and cause workforce displacement, data protection breaches and price spikes due to market concentration⁶⁹. With regards to digitalization and the agri-food system, multiple issues need to be examined including requirements for policymaking and

⁶⁷ [Malabo Montpellier Panel](#) (2017). Nourished: How Africa Can Build a Future Free from Hunger and Malnutrition.

⁶⁸ [Social Innovation Academy](#) (2018). Social innovation in Africa: 8 remarkable projects.

⁶⁹ [Food and Agriculture Organization – FAO](#) (2020). Realising the potential of digitalization to improve the agri-food system.

regulation, limited access to finance and digital skills among some actors, and the need to overcome existing digital divides which are limiting access to infrastructure and information. Public authorities, private actors and non-profit organisations that help facilitate access to proprietary agricultural technologies (e.g. African Agricultural Technology Foundation) should continue to strengthen their efforts, while new Horizon Europe projects should address the question of how to make widely available data relating to agriculture meteorology, the Internet of things, satellites and other data that could help optimize yields and support rural livelihoods. Furthermore, integrated innovations at farm level and nutrition/health level can ensure a more diverse production to realise not only sustainable but also healthy produce for consumers. Technological innovations should also be geared towards Nutrition-Sensitive Agriculture – a food-based approach to agricultural development that puts nutritionally rich foods, dietary diversity, and food fortification at the heart of overcoming malnutrition and micronutrient deficiencies. To harness the benefits of Nutrition-Sensitive Agriculture for the African population, targeted investments should be pledged towards increasing the productivity of yields to make more food accessible for all; increasing the diversity of food production to increase dietary quality; and enhancing the micronutrient content of foods through micro-processing, innovative plant breeding and improved soil fertility management⁷⁰.

Organisational Innovation

Expand Africa’s Public-Private Partnerships (PPPs) to boost investments, capacity and know-how across the supply chain. Against a background of limited government resources, innovative partnerships that bring together businesses, government and civil society bear a remarkable potential to improve productivity and drive economic growth while contributing to improve rural livelihood, as well as the overall transparency of the food chain. PPPs have the potential to modernise the agriculture sector and deliver benefits that can contribute to inclusive and sustainable agri-food development, with focus on smallholder farmers⁷¹. To this extent, PPPs should combine the operational and economic efficiency of the private sector with the public sector’s role as an enabling environment and regulator ensuring that food and nutrition security public goals are met through capacity building and policy development. Public institutions, no-profit organisations and international actors should facilitate access to finance, which is a pre-requisite for small and medium enterprises (SMEs) to engage in PPSs. With investments in the

⁷⁰ [Food and Agriculture Organization – FAO \(2014\)](#). Nutrition-Sensitive Agriculture.

⁷¹ [Food and Agriculture Organization – FAO \(2020\)](#). Public-private partnerships boost capacity and know-how in agriculture.

agricultural sector being widely perceived as a high-risk venture, coupled with reluctance of financial institutions to lend, there is the urgent need to deploy de-risking instruments for agri-food lending. This in turn is instrumental in attracting the required investment, skills and technical know-how that will help to deliver the expected co-benefits. The African Union-EU Agribusiness forum should be empowered to help identify challenges and opportunities for private investment and trade between the two continents.

Managerial Innovation

Improve smallholder farmers' soil and water management practices and invest in Africa's business and entrepreneurial talent. Land degradation is of special concern in Africa's drylands, where rainfall levels often do not permit agricultural production to grow to match high rates of population increase, which can lead to overuse. Improved land and water management practices such as agroforestry, conservation agriculture, rainwater harvesting, and integrated soil fertility management have the potential to sustainably increase crop yields while also reducing agriculture's impact on the environment⁷². Public authorities and public development agencies should work towards removing impediments to soil conservation measures and focusing on restoring fertility to small portions of farms through comprehensive programs including financial assistance to allow farmers to forgo the food production involved and adequate. Horizon Europe projects and EU investments should be geared towards facilitating peer-to-peer learning and using R&I and technology for information sharing. The development of talent remains a huge constraint for Africa's food systems transformation, given the overall weak education systems and the scarce appeal the agri-food sector has on the new generations. Public and private authorities should provide tailored training programmes, travel fellowships and significant job responsibilities for their team members and develop modular approaches for scaling training and upskilling opportunities.

Policy Innovation

Include climate action as a core component of the new Africa-EU strategy. The EU Farm to Fork strategy's objective to support Africa in reaching the UN SDG of zero hunger and a transition towards safe and sustainable food systems needs to be upheld in consistency with the establishment of a 'green alliance' to mainstream climate goals into EU-Africa relations foreseen in the European Commission's Green Deal communication. The soon-to-be-established EU-Africa R&I Partnership on Food and Nutrition Security and

⁷² [World Resources Institute – WRI](#) (2019). Creating a sustainable future. A menu of solutions to feed nearly 10 billion people by 2050.

Sustainable Agriculture⁷³ should represent the ideal platform to agree on an R&I strategy fully compliant of the Paris Agreement on Climate Change. To this extent, the EU and Africa should support the action and capitalize on the work carried out by the Ecosystem-Based Adaptation for Food Security Assembly (EBAFOSA), established by the African Union Commission (AUC) and UN Environmental Programme (UNEP) as a policy and an implementation platform. In terms of funding, the EU should boost its R&I investment through two channels: the Development Smart Innovation through Research in Agriculture (DeSIRA) Initiative⁷⁴, which can help transforming Africa's food systems by supporting the Comprehensive Africa Agriculture Development Programme (CAADP) and the design of inclusive Horizon Europe project calls aimed at boosting the participation of African researchers, scientists, as well as public and private actors.

⁷³ [LEAP4FNSSA](#) (2020). Long-term EU-AU Research and Innovation Partnership for Food and Nutrition Security and Sustainable Agriculture.

⁷⁴ [Capacity4DeV](#) (2019). The DeSIRA Projects.

Food Systems and Data



New technologies have the potential to contribute to improve the safety and quality of food for EU consumers; foster a better management of natural resources; increase productivity while reducing the proliferation of food waste; and make life easier and more comfortable for food workers and consumers alike. The collection of data is at the core of the functioning and implementation of new technologies. While increased connectivity and data gathering techniques allow for an unprecedented capacity to analyse elements that are key to establish future-proof EU food systems, a Responsible Research and Innovation (RRI) approach is needed to ensure that sensitive data is collected and managed in ways and with objectives that are in line with the protection of EU citizens and the respect of EU regulations.

Social Innovation

Address the digital divide between actors in the food value chain, while preserving the rights of the most vulnerable stakeholders and the balance of power in the data economy. Tools that collect, store and share data along the food value chain can contribute to exponential income growth, better decision making and better services and products, as well as greater efficiency, productivity and profitability. But actors such as farmers, small and medium enterprises and consumers do not always benefit from this sharing and exchange of data. Several data-related risks may prevent novel food technologies from fulfilling their promise: uncertainty about data protection, ownership, security, access, and control; questions of veracity, validation, and liability, and the imbalance in value chains⁷⁵. To overcome such issues, it is indispensable to deploy innovative and coordinated action to address the so-called digital divide, e.g. the inequalities in access to, use of, and beneficial outcomes from Information and Communication Technologies (ICTs)⁷⁶. Social innovation is needed to ensure the fairness of data ownership but also to grant access to data from the less represented actors. Public authorities and researchers should collaborate to develop data technology through human-centred design approaches focusing on product development tailored to the needs and expectations of potentially vulnerable users. In order to achieve the goal of developing food products and technologies which are not only efficient and useful, but also acceptable, safe and satisfying, end- users need to be involved in the development process. Observing users interacting with prototypes and thereby collecting information in interviews or questionnaires can help developers and designers to understand the users' insights and to create new solutions⁷⁷. Public awareness campaigns should target improving data protection and clarifying data ownership, addressing unfair data practices in agricultural policies, and reducing imbalances in the value chain and related information asymmetries. Public advocacy should be also geared towards the promotion of data sharing by the private sector whenever data is of public interest, monitor and increase the impact of public data, and improve the governance of data sharing⁷⁸.

Technological Innovation

⁷⁵ [World Bank](#) (2020). Beyond the Pandemic: Harnessing the Digital Revolution to Set Food Systems on a Better Course.

⁷⁶ [Scheerder, A. et al.](#) (2017). Determinants of Internet skills, uses and outcomes. A systematic review of the second- and third-level digital divide. *Telematics and Informatics*, 34(8).

⁷⁷ [Jankowski, N. et. al.](#) (2017). User-centred design as an important component of technological development. *Current Directions in Biomedical Engineering*, 3(1).

⁷⁸ [World Bank](#) (2018). Does data mean power for smallholder farmers?

Leverage digital solutions through demonstrations enhancing transparency and traceability of data.

Moving towards sustainability in the food systems call for innovative solutions and appropriate technologies such as Information and Communication Technology (ICT). Transformative technologies are emerging, including applied sensors, advanced robotics, digital twins, the Internet of Things connecting different machines, augmented reality, blockchain technology, e-commerce and the Artificial Intelligence. A widely cited example of the use of ICT in agriculture in order to increase efficiency is that of precision agriculture, a farming model that consists in the utilization of sensors by making use of geographic information systems (GIS) and global positioning systems (GPS) to optimize the use of pesticides, fertilizers and water⁷⁹. Efforts to bridge the digital divide should focus on increasing the physical and material access to Internet broadband and hard infrastructure of food actors in rural areas (first level of the divide). Furthermore, in comparison with other sectors, the EU food systems are lagging behind in the uptake of digital technologies⁸⁰. A key factor discouraging more widespread adoption of ICTs in the agri-food business is the issue of profitability. More efforts should be geared towards demonstrating that uptake of ICTs improves economic, as well as social and environmental returns. For instance, food safety could be improved through the adoption of innovative technologies such as consumer food scanners that analyse a dish using spectroscopy and give users immediate information on its composition, and the Internet of Things could help improve environmental-footprint management by providing consumers with the means to trace a food product back along its entire chain of production, from farmer's field to supermarket shelf⁸¹. This could be boosted by Living Labs at local, regional, and national levels, and ultimately enhance the technological innovations that are already available for the full uptake in the agri-food sector.

Organisational Innovation

Improve coordination of food systems actors to ensure the benefits of digitalisation are well distributed across the value chain. New data technology bears the opportunity to improve access of farmers, small and medium enterprises and consumers to information and thus increase their bargaining power in the food chain, with far-reaching implications in terms of transitions towards sustainability in food systems. It could also imply new relations between producers and consumers that are based on more equity and transparency. Moreover, relatively simple data technology such as smart phones can shorten the distance

⁷⁹ [Balafoutis, A. et al.](#) (2017). Precision Agriculture Technologies Positively Contributing to GHG Emissions Mitigation, Farm Productivity and Economics. *Sustainability* 9(8) 1339.

⁸⁰ [European Commission](#) (2018). Digital Transformation Scoreboard 2018. EU businesses go digital: Opportunities, outcomes, and uptake.

⁸¹ [McKinsey](#) (2016). How big data will revolutionize the global food chain.

between food chain actors involved in producing, processing, transporting, and marketing food. To such end, rural farms need to coordinate their logistics and take-to-market activities as well as to understand where and when to obtain the best market price. Peri-urban farms need coordination to deliver their products to the correct market and customers. Urban farms need direct coordination with consumers or other small urban producers⁸². However, while data technology has the potential to dramatically reduce the cost of matching buyers and sellers in markets and therefore improving the conditions of all the food systems actors, greater efficiency in upstream and downstream markets could also result in higher prices for farmers and more competition between intermediaries. Public authorities should design comprehensive digital solutions considering production practices, communication in the food chain and consumer behaviour. The ownership of data is a key concern, as large companies are able to collect a large amount of data about producers and customers thanks to feedback loops on equipment they sell, with the potential to create monopolies on strategic markets⁸³. Public authorities need to make sure that big multinational companies do not exploit food data systems to gain access to illimited shopping data.

Managerial Innovation

Expand food actors' digital skills and build broadband infrastructure to achieve an equitable food systems transformation. The digitalisation of the EU agri-food system is a knowledge-intensive revolution requiring the uptake of new information, skills, technologies, and attitudes. Public authorities and the private sector can play an important role in educating farmers on how to utilise the opportunities these technological innovations bring. Such accessible technologies can support smallholder farms in improving their resource management and contribute to them becoming more competitive. In addition, this can lead to a stronger inclusion of youth by creating more appealing digital jobs in rural areas and preventing the migration of rural youth to cities. However, digitalization can also create risks. From the 300 million EU citizens living in rural areas, only 25% are covered by fast or ultra-fast broadband, compared to around 70% coverage in urban areas. Public authorities should address the digital divide across the agri-food system and particularly between actors disposing of the competences and resources to quickly adapt to the ongoing digital developments and those who risk being left behind (second level of the digital divide). Many farmers and small and medium enterprises remain unable to take full advantage of the opportunities due to a weak digital infrastructure, inequitable access, relatively high cost, lack of skills and limited capital. In

⁸² [El Bilali, H. and M. Sadegh Allahyari](#) (2018). Transition towards sustainability in agriculture and food systems: Role of information and communication technologies. *Information Processing in Agriculture* 5(4), 456-464.

⁸³ [Berti, G. and C. Mulligan](#) (2015). ICT & the future of food and agriculture.

addition, the introduction of robotics and Artificial Intelligence could cause workforce displacement unless workers adapt their know-how and specialize in new tasks⁸⁴. Data literacy is one of the main barriers the sector faces, so even when connected, farmers may not be sufficiently educated or empowered to take advantage of the new wealth of information. Therefore, education remains the key to access the new digital jobs that technology will bring, especially in rural areas, as well as assuring equitable access to digital infrastructure is essential to make sure digital innovations do not produce new unbalances and trade-offs in the EU food systems.

Policy Innovation

Create an enabling environment for the digitalization of EU food systems ensuring transparency, security, equality and efficiency. Data management, standardisation and regulations defining the criteria and limits to data collection are issues that should be proactively addressed at policy level by the EU and its Member States. Digital tools are often based on the availability of big data. To translate the information into valuable insights, actors are often required to share a large amount of data with third-party providers, raising risks of data ownership and privacy, especially for those less able to defend their interests such as smallholder farmers. The latest aspect is closely related to the need to bridge the third level of the digital divide, which implies empowering vulnerable food actors not only with the basic technical competences to operate digital technologies and food data systems, but also by creating an enabling political and economic environment that will allow all EU food systems actors to harness beneficial outcomes from Internet use and digital technologies (third level). Some existing policy instruments such as the European General Data Protection Regulation need further refinements and specific protocols tailored to the needs of the agri-food digital transformation. On the other hands, existing policy instruments focused on the agri-food systems need to be reformed to acknowledge the impact of the digital revolution and address the current digital divide. The Common Agriculture Policy, for instance, should allocate a substantial share of funding to build adequate rural broadband infrastructure across the entire EU, which is an essential precondition to achieving the successful and inclusive digital transformation needed to meet the objectives of the European Farm to Fork Strategy⁸⁵. At the same time, the impact of improved infrastructure will be limited without a strong educational push focused on providing high-tech skills to all

⁸⁴ [Food and Agriculture Organization - FAO](#) (2020). Realizing the potential of digitalization to improve the agri-food system.

⁸⁵ [EurActiv](#) (2017). Smart farming hinges on e-skills and rural internet access.

food systems actors⁸⁶. To avoid this, vocational training should be provided through the European Social Fund and other policy frameworks. Such an education push could also help to improve the image of jobs in farming, which is critical to ensure that younger people are attracted to the profession.

⁸⁶ [European Parliamentary Research Service – EPRS](#) (2016). Precision agriculture and the future of farming in Europe.