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THE ROLE OF SCIENCE, TECHNOLOGY, AND INNOVATION FOR TRANSFORMING FOOD SYSTEMS IN EUROPE

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ABSTRACT

The UN FSS provides an important stimulus to develop new momentum to tackle shared challenges for achieving food and nutrition security. For this Brief, EASAC provides an assessment of the science to update our previous contribution to the IAP global project. European farming systems are diverse and food has traditionally played a central role in the shaping of individual and cultural identities. In this Brief taking a food systems approach, we examine European issues for the interrelationships between agriculture, environmental sustainability, nutrition and health, considering all steps in the food value chain from growing through to consumption and recycling.

There are multiple policy objectives and instruments to coordinate but, although the challenges are unprecedented, so too are the scientific opportunities. A wide range of issues are covered, including those for: agro-ecology and the implications for ecosystem assessment, other new production systems, linking soil structure and health both with environmental sustainability and novel products of the bioeconomy, and microbiomics. However, capitalising on scientific advances is not sufficient, there must also be flexibility in regulatory systems to encourage innovation. EASAC recommends that it is the products of new technologies and their use, rather than the technology itself, that should be evaluated according to evidence-based regulatory frameworks.

There are major opportunities for developing climate-resilient food systems while, at the same time, reducing the

contribution that agriculture makes to climate change, and the implications for food policy. The COVID-19 pandemic has also brought significant adverse pressures on food systems but planning for a sustainable economic recovery after the pandemic can facilitate efforts to make food systems more resilient, nutritious and environmentally sustainable.

We make three core recommendations for ambitious action to generate and use research:

1. Promoting transdisciplinary research to fill present knowledge gaps.
2. Continuing to strengthen the research enterprise in the EU: this requires public engagement to build trust, developing better linkages between public and private sector research objectives, and recognising that EU scientists have crucial roles to play in building global critical mass in food systems science.
3. It is very timely to reaffirm the use of science to inform innovation, policy and practice. In particular for the EU, the Farm-to-Fork policy has important objectives but must be fully informed by the scientific evidence, well aligned with objectives for the Common Agricultural Policy and with the biodiversity, circular economy and bioeconomy strategies, and transparent in communicating the consequences both for the domestic consumer and for the rest of the world.

1. Introduction: the transformation of European food systems

Combating malnutrition in all its forms – undernutrition, micronutrient deficiencies, overweight and obesity - is a problem faced by all countries. Recent data confirm that undernutrition and food insecurity are present in vulnerable groups in Europe (Loopstra, 2018; Pollard and Booth, 2019; Leij-Halfwerk et al., 2019) at the same time as an increasing public health burden of obesity (Pineda et al., 2018; Krzysztoszek et al., 2018). There is still much to be done to ensure access to safe and nutritious food for all (UN FSS Action Track 1[1]). Europe has a rich diversity in food cultures in close proximity to each other, and this diversity is mirrored in the structure of the EU farming sector: very small farms (< 2 hectares) make up nearly half of the agricultural holdings, while very large farms (> 100 hectares) make up just 3% of the total but cultivate half the farmland (Kania et al., 2014). Small farms themselves differ widely and include high value and specialised production systems (Guiomar et al, 2018). Food has also traditionally played a central role in the EU in the shaping of individual and collective identities (Anderson et al, 2017), and it is also central in current discourses on economic, social and environmental justice and of cultural recognition (e.g. Coolsaet, 2016; Šūmane et al, 2018). There is large variation in food and nutrient intakes across Europe, between and within countries (Martens et al., 2019).

In 2017, EASAC published a report on food and nutrition security and agriculture in Europe as part of the InterAcademies Partnership (IAP) global project. That report followed an integrative food system approach to cover inter-related issues for resource efficiency, environmental sustainability, resilience and the public health agenda while also addressing opportunities for local-global connectiveness and for the bioeconomy. EASAC emphasised that an earlier food security emphasis on agricultural

[11] https://www.un.org/en/food-systems-summit/action-tracks.

production now has to be replaced by the food systems approach to encompass all of the steps in the food value chain to deliver accessible and affordable food for all, from growing through to processing, trading, consuming and disposing of, or recycling, waste. Food systems must include both supply-side and demand-side considerations for sustainability. Yearly food losses in the EU have been estimated at about 15% of the emissions of the entire food supply chain (Scherhaufer et al., 2018). An increase in agricultural productivity would likely increase the environmental footprint without necessarily delivering healthy and nutritious diets accessible to all, unless embedded in a profound transformation of food systems (Benton and Bailey, 2019).

One issue increasing in importance is the role of public procurement in the demand for sustainable, healthy food (Sonnichsen et al., 2020, WHO, 2021): provision of sustainable, healthy diets in hospitals and other public services can help to change consumer behaviour in the longer-term (EASAC and FEAM, 2021). European Union interest in the sustainability of the food systems approach is increasing (e.g. SAPEA, 2020) and the recent Farm-to-Fork policy initiative covers all the food chain, together with protection of the environment.

Much of the EASAC 2017 report focused on scientific advances in agriculture but there was also significant attention to food science and technology, e.g. for food safety and food processing to reduce food losses, extend distribution and seasonal availability, and for food fortification. The comprehensive recent work of the International Union of Food Science and Technology[2], based partly on evidence presented by IAP and its regional work streams, reviewed scientific opportunities relating to diverse and sustainable primary production; sustainable process and system engineering; eliminating waste in production, distribution and consumption; and traceability and product safety (see also Lillford and Hermansson, 2020). An additional issue, brought into prominence by the COVID-19 pandemic, is the potential of the improved food value chain to address poverty by increasing entrepreneurial activity and other employment (an issue that should be highlighted in UN FSS Action Track 4, Advance equitable livelihoods).

Transdisciplinary policy making and governance are required to make food systems more nutrition-sensitive. Food and nutrition security and food sustainability must now be considered as part of formulating European dietary guidelines. Some of the research priorities are described subsequently but there is also need of a better definition of what a sustainable diet is and how it can be measured, so that these metrics form part of national surveys and inform policies and interventions to educate consumers on sustainable behaviours and diets.

Innovation is central for delivering the required transformation of food systems, and must be based on transdisciplinary science, new financing and business models, and policy development. This topic has received renewed attention recently. For example, Herrero et al. (2020) developed an inventory of innovations organised according to their position in the value chain (i.e. production, processing, packaging, distribution, consumption and waste) and their 'readiness score': from basic research all the way to proven implementation under real-world conditions. The dissemination and uptake

[2] Global challenges for food science and technology, 2019, https://iufost.org/global-challenges-and-critical-needs-2/).

of these innovations should be considered a priority, and research is urgently needed on how to make options available in current food systems with minimal disruption.

In this EASAC brief the following sections update selected priorities from the EASAC 2017 report in order to demonstrate how science, technology and innovation can provide major contributions to the UN FSS Action Tracks. There are multiple implications for EU policy, summarised in Figure 1.

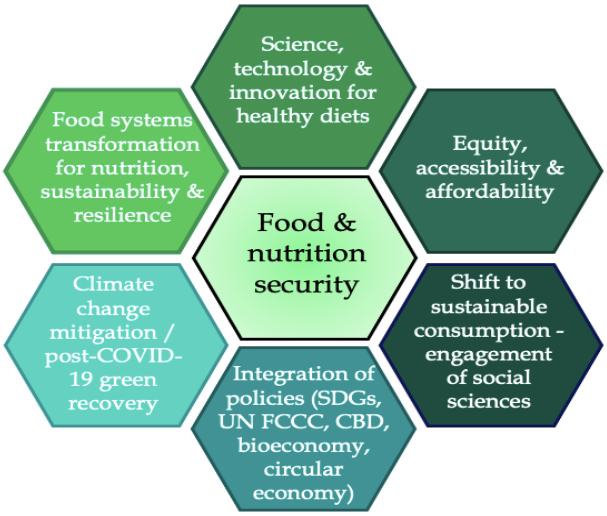

Figure 1: *Matrix of European policy objectives for food and nutrition security. Links with international policy development are particularly relevant in 2021 because of the UN FSS and also COP26 of the UN FCCC (Framework Convention on Climate Change) and COP15 of the UN CBD (Convention on Biological Diversity).*

2. AGRICULTURE-ENVIRONMENT NEXUS AND AGROECOLOGY IN EUROPE

Linkage of food systems to sustainable development objectives is a core part of the integrated transformations required to attain the Sustainable Development Goals (SDGs, see GSDR 2019; Sachs et al., 2019; EASAC, 2020a). Concomitantly, there is great potential for new business opportunities and economic value (WEF, 2020), but also need to understand co-benefits and trade-offs for coupling nutritional and environmental objectives for SDGs (McElwee et al., 2020) and these also need to be taken into account in UN FSS Action tracks 2 (Shift to sustainable consumption patterns) and 3 (Boost nature-positive production).

The concept of regenerative agriculture (Newton et al., 2020; Schreefel et al., 2020) embraces farming principles and practices that enhance biodiversity and ecosystem services and increase carbon capture and storage, helping to tackle climate change and improve agricultural resilience and yield. This can be viewed as a core feature of the EU's Farm-to-Fork strategy but the scientific basis needs to be clarified in order to improve farming systems (Davies et al., 2020). Agroecology is an important part of regenerative agriculture innovation (HLPE, 2019): scientific advances here will also help to clarify links between human and livestock health and their dependencies on the environment.

Assessing the relative contribution of different production models to sustainably deliver healthy and nutritious diets and provide important ecosystems services is an important research priority. For example, using life cycle assessments (LCAs) it was estimated that a complete switch to organic cultivation in England and Wales lowers production emissions but also decreases yields, and the increased reliance on land use elsewhere to make up for the shortfall would result in higher emissions overall (Smith et al., 2019). However, organic agriculture can decrease the reliance on chemical inputs, improve soil carbon sequestration and soil quality, reduce the contamination of water bodies and increase biodiversity. LCAs do not accurately reflect these benefits because of their focus on the product, whereas ecosystem services from agricultural systems are not duly considered. Deploying an integrated approach requires research to quantify the economic value of ecosystems (Dasgupta, 2021), as part of the improvement and standardisation of methodologies to assess and compare the sustainability of food systems. In addition, estimates of the levels of food production required to fulfil demand often fail to take into consideration the effects of a switch to more sustainable diets, lowered consumption patterns, and reduction of food waste.

Research for improving the environmental assessments of production systems should include clarification of additional indicators, such as for land and soil degradation and loss of biodiversity; broadening the scope to include the provision of ecosystem services; and improving the assessment of indirect effects within a comprehensive food systems perspective, as opposed to a narrow focus on yield (van der Werf et al., 2020). Organic agriculture should also embrace innovation to improve its performance (Seufert et al., 2019; Clark, 2020) and may require multiple policy interventions to realise its potential for food systems sustainability (Eyhorn et al., 2019). Communicating effectively to consumers the relative environmental footprints of different foods must also be a priority (Potter and Röös, 2021).

Diverse farming systems depend on soil structure and health. In discussing how to manage competition for land use and other resources, EASAC (2017) highlighted the critical role of soil, particularly with respect to its biological functions. More recent EASAC assessment (2018) further emphasised the multiple roles of soil sustainability, and implications for its management to inform policy development, relatively neglected recently in the EU. This neglect needs to be corrected. Among soil's biological functions EASAC (2017) discussed emerging knowledge about the contribution of soil microbiomics (bacteria and fungi) to sustainable agriculture, e.g. in strengthening of root systems and carbon sequestration. There is another link to the bioeconomy: the soil microbiome can be a resource for generating novel antibiotics and other high-value chemicals. Rapid progress continues, to ascertain the linkages between microbial diversity and ecosystem functions, including plant health under climate change; in particular the role of soil microbial taxa in biogeochemical cycling, plant growth and carbon sequestration (Dubey et al., 2019; Wei et al., 2019).

There are continuing opportunities to link food systems and environmental objectives with bioeconomy policy: impetus and coordination has been imparted to the European Bioeconomy Strategy by recent introduction of an EU-wide monitoring system[3] to track the

[3] EU Bioeconomy Monitoring System, 2020, https://knowledge4policy.ec.europa.eu/bioeconomy/monitoring_en.

balancing of bioeconomy contributions to food and other outputs, in order to reduce environmental pressures. Systematic review of the literature suggests the need to prioritise biomass strategies to increase food production over those for animal feed or biofuels (Haines, 2021). Scientific advances are bringing new opportunities to drive the bioeconomy of future foods (such as mycoproteins, algal feedstocks, cultured meat, Fanzo et al., 2020; Haines, 2021).

3. DELIVERING SUSTAINABLE AND HEALTHY DIETS UNDER CLIMATE CHANGE

Climate change is already affecting the yield and quality of crops with the potential for adverse consequences in terms of malnutrition (undernutrition, micronutrient deficiency, obesity, EASAC, 2017). Systematic reviews of the literature have documented declines in yield of starchy staple crops (Wang et al., 2018b) and in yield and nutritional quality of vegetables and legumes (Scheelbeek et al., 2018) and fruits, nuts and seeds (Alae-Carew et al., 2020). Developing climate-resilient food systems should be a core part of UN FSS Action Track 5 (Build resilience to vulnerabilities, shocks and stress).

It is important to evaluate how the agricultural sector can adapt to climate change and, at the same time, reduce its own contribution to Greenhouse Gas (GHG) emissions. Agriculture currently accounts for about 30% of total GHG emissions if including land conversion and production-linked direct environmental costs (EASAC, 2019). A key objective, therefore, for the UN FSS when developing environment-health-climate change policies is to reduce the triple burden of malnutrition at the same time as reducing the contribution that food systems make to climate change and other environmental changes. The accumulating evidence indicates that 1.5^{o} and 2^{o} C targets cannot be attained without rapid and ambitious changes to food systems (Clark et al., 2020). A combination of measures is necessary to reduce GHG emissions from agriculture, including improved agronomic practices, reducing waste, and increasing sustainable consumption patterns. The evidence base indicates significant health benefits from reducing red meat consumption (where that is excessive) and increasing vegetables, fruits, nuts and seeds in diets (EASAC, 2019; Willett et al., 2020). The impact of changes to dietary guidelines on micronutrient intakes must be considered, especially for vulnerable groups. A recent systematic review of environmental footprints and health effects of "sustainable diets" (Jarmul et al., 2020), concluded that although co-benefits are not universal and some trade-offs are likely, when carefully-designed and adapted to circumstances, diets can play a pivotal role in climate change mitigation, sustainable food systems and future population health. Unfortunately, in proposing recommendations for policy solutions, issues for accessibility and affordability of proposed healthy and sustainable diets are often overlooked (Hirvonen et al., 2020).

Policy implications for the promotion of sustainable food systems that reward good management practices include the introduction of sustainable stewardship, food labelling and certification schemes. Current food policy in many countries concentrates more on how to protect consumer health from contaminated food than the degree to which the State should use health and environmental considerations to regulate the supply of foodstuffs (Godfray et al., 2018). Resolving this role of the State has significant implications for rebalancing consumption by introducing incentives/disincentives for carbon and biodiversity costs of populations at risk of over-consumption, while protecting vulnerable groups. At the same time, governments must consider how best to measure and monitor policy changes for their impact on food production, consumption and health.

4. RESPONDING TO COVID-19

The ongoing COVID-19 pandemic has affected all components of the food system. Long-term implications are hard to predict as they will depend on the length and severity of the pandemic. The effects may be also compounded by shocks to production (such as drought and the interruption of seasonal labour supply for planting and harvesting), and by factors influencing the distribution, access and affordability of food (e.g. disruptions to global food trade and food price speculations; Moran et al., 2020). To date, global supply chains continue to function in spite of isolation policies (Galanakis, 2020; Moran et al., 2020), although production problems that resulted in an increase in the price of fresh and perishable products have also been reported (Coluccia et al., 2021). In Europe there has been an increase in food wastage, partly as a result of the shutdown of restaurants, schools and other community facilities. The pandemic has affected the ability to access sufficient and health food by vulnerable groups of the population due to rising unemployment and enforced self-isolation, in particular for families with young children, and is exacerbating diet-related health inequalities (Power et al., 2020). Consumption related challenges reported during lockdowns include a small increase in the intake of calories and a decrease in the intake of vitamins, minerals and plant-based protein and fatty acids, in particular by the elderly as a group (Batlle-Bayer et al., 2020; IUFoST, 2020). Combined with reduced physical exercise during lockdown these dietary changes may increase the incidence of obesity and related NCDs. Hoarding and panic buying during pandemics, also reported, could distort the food supply chain and need to be better managed (IUFoST, 2020; O'Connell et al., 2020).

Planning for a sustainable economic recovery after the pandemic provides a window of opportunity to make food systems more resilient, nutritious and environmentally sustainable, avoiding a return to business-as-usual. (EASAC, 2020b; Benton, 2020; IUFoST, 2020; Rowan and Galanakis, 2020; Sarkis et al., 2020). Because the pandemic exposed vulnerability of the overreliance on just-in-time and lean delivery systems, globalised food production and distribution systems based on complex value chains should be re-examined not only in terms of economic efficiency but also for their environmental sustainability and climate change mitigation potential. Opportunities for the increased localisation of production systems should be explored. Research priorities also include the development of food safety measures and bioanalytical protocols for food and environmental safety along the food chain; and the development of nutritional foods to promote immune function, which may include foods for medical use by the elderly population as well as other vulnerable groups. Further areas for innovation to capitalise on scientific opportunities comprise digitisation and the implementation of smarter logistics systems, including reverse logistics for secondary materials and waste products (IUFoST 2020; Rizou et al., 2020; Rowan et al., 2020; Sarkis et al., 2020). The generation of robust baseline data on malnutrition levels in the EU Member

States remains an important knowledge gap, in particular for vulnerable sectors of the population (EASAC, 2017).

5. NEW BREEDING TECHNIQUES: A CASE STUDY IN SCIENCE, TECHNOLOGY AND INNOVATION

Improved breeding of plants and animals for agricultural production is a key component of an integrated transformation of food systems to deliver healthy and nutritious diets sustainably in the face of climate change. For plants, key target traits for improvement include increased tolerance to drought (including soil water use efficiency), heat, and salinity, with a focus on the development of multiple traits; improved use of soil nutrients (nitrogen, phosphorous and essential elements) to reduce dependency on fertilisers; pest and disease resistance; and healthier nutrient composition (EASAC, 2017; 2020c). Animal breeding priorities comprise animal health (disease resistance and stress tolerance, in particular heat); and nutrition, including strategies to mitigate enteric gut methane emissions (Pryce et al., 2020). Achieving these objectives will require the use of the full tool box of breeding technologies available, from conventional breeding assisted by advances in genetics and genomics, through to the use of a set of technologies collectively referred to as new breeding techniques (NBTs) and, in particular, genome editing.

Recent advances using genome editing include the development of varieties with improved nutritional content, such as high protein wheat with increased grain weight, and more nutritious potatoes (Hameed et al., 2018; Zhang et al., 2018, 2020). In wheat, gene editing has also been used to derive low-gluten transgene-free plants (Sánchez-León et al., 2018). Gene editing allows developing crop varieties with multiple resistances to biotic and abiotic stresses (e.g., in tomato: Saikia et al., 2020). Looking ahead, research priorities include the (re)domestication of high-nutrient stress-tolerant crops by targeting known domestication genes in established crops (e.g. for the cultivation of quinoa in Europe; López-Marqués et al., 2020; and see also van Tassel et al., 2020; Zhang et al., 2020), and for the development of perennial grain crops to maximise sustained crop yields (DeHann et al., 2020).

Crops produced by genome editing techniques, including those with no foreign DNA, are regulated differently in different countries (Schmidt et al., 2020), with Europe holding the most restrictive regulatory regime. In 2018, the European Union Court of Justice ruled that crops produced by gene editing technologies are to be subjected to the same regulations as GM crops (Directive 2001/18/EC). The focus of this regulation is the process by which a crop is developed, not the breeding product, and as a result crop varieties which are equivalent from a scientific perspective but were developed by different methods will be regulated differently (Jansson, 2018). The legislation’s far-reaching consequences, include the stifling of innovation, since the cost of pre-market evaluations will deter investment in the technology, in particular in the public sector and by small and medium enterprises (SMEs; Ricroch, 2020; Jorasch, 2020). Around 40% of the SMEs and 33% of the large companies stopped or reduced their gene editing-related R&D activities after the 2018 ruling (Jorasch, 2020). The EU is also lagging behind in terms of generating innovation: while the United States and China have filed 872 and 858 patents for applications for gene editing applications, respectively, EU countries together have filed only 194 (Martin-Laffon et al., 2019). There has also been a very striking reduction in the number of EU countries carrying out field trials of crops improved by either GM or gene editing (Ricroch, 2020). In addition, the impossibility of distinguishing between edited and naturally derived varieties makes the law unenforceable, especially if the varieties are considered legal elsewhere (Martin-Laffon et al., 2019; Schmidt et al., 2020; Zhang et al., 2020).

EASAC advised (EASAC, 2020) that it is the products of new technologies and their use, rather than the technology itself, that should be evaluated according to the scientific evidence base, and that the legal framework should be revised. The potential costs of not using a new technology, or being slow in adoption must be acknowledged as there is no time to lose in resolving the problems for food and nutrition security.

6. STRENGTHENING RESEARCH AND ITS UPTAKE INTO POLICY AND PRACTICE

The purpose of this Brief has been to address three questions: How can scientific advances help to fill knowledge gaps in delivering food and nutrition security? What does Europe need to build its research capabilities and help build global scientific capacity and partnerships? How best can science-based evidence be used to inform innovation, policy development and practice? Our recommendations are as follows.

Filling knowledge gaps with new research

In the previous sections, we have exemplified how new research is of unequivocal value in addressing societal challenges. In addition to these examples, and referring back to other scientific priorities in EASAC, 2017, there have been recent advances in big data handling, robotics, artificial intelligence and mobile communications for precision agriculture (Klerkx and Rose, 2020; El-Gayar et al., 2020). There have also been substantial advances in the science of human gut microbiomics and linkages to diet and health. For example, methodological studies are rapidly clarifying characteristics of a healthy microbiome (Eisenstein, 2020) and intervention studies have demonstrated the health value of a Mediterranean diet in older cohorts in different European countries, explained in terms of gut microbiome alterations (Ghosh et al., 2020). Advances in social sciences research are increasingly important to understand determinants of inequity in food systems, mechanisms for empowerment of marginalised groups and models for entrepreneurial activity (Fanzo et al., 2020). Social sciences research is also helpful for evaluating specific instruments for promotion of sustainable food in EU policy, e.g. taxation schemes, consumer cooperatives, labelling and governance initiatives (Marsden et al., 2018; SAPEA, 2020).

Building the research enterprise

Europe has mature systems for research funding at national and EU level (EASAC, 2017). Nonetheless, it is essential for the scientific community to continue making the case for investment in research, including fundamental science, and to recognise the value of involving other stakeholders in the design and conduct of research (SAPEA, 2020). Greater inclusivity depends in part on building public confidence in science and shaping public understanding of the challenges to food and nutrition security in a changing public landscape often characterised by less deference to authority and scientific experts (Fears et al., 2020). Strengthening research capabilities in Europe also depends on understanding the impact from the progressive loss of key skills in the EU (e.g. in plant sciences), and on reversing those losses while also developing new skills needed by the next generation of researchers (e.g. in transdisciplinary thinking). The EU also has an important role in developing global critical mass in research, e.g. by research partnerships, sharing data and infrastructure, and contributing to tackling those problems that can only be addressed at the global scale. The European Commission recently launched an important initiative to assess the need for an international platform for food systems science[4].

<u>Translating research outputs</u>

Ensuring the robustness, legitimacy and relevance of scientific evidence is vital if its impacts on innovation, policy and practice are to be realised. Overcoming obstacles in translation also depends on public confidence in science, on integrating outputs from across diverse disciplines (evidence synthesis for sustainability, Anon, 2020), taking account of new models (e.g. for open innovation) and of trade-offs between different goals, e.g. for nutrition and environment (Fears et al., 2019). Academies of science are well-placed to help lead the scientific community at the science-policy interfaces. The EU already has a relatively mature science-policy interface in place, whose operational characteristics may serve as a model for other regions (Fears et al., 2019) and, currently, there is active scientific engagement in a diverse range of public policies in development, including Farm-to-Fork (F2F), Common Agricultural Policy and Biodiversity strategy, bioeconomy, circular economy and the European Green Deal. The F2F strategy has important and comprehensive objectives but it remains important to clarify and resolve governance challenges, including the tangible links to Member State action (Schebesta and Candell, 2020). There is also ambiguity in defining food sustainability and, currently, a mismatch between F2F and the Common Agricultural Policy that must be resolved by developing compatible legal instruments and ensuring better coordination between the relevant Directorate-Generals (for health and agriculture). F2F highlights several controversies, e.g. on the objectives for food pack labelling, targets for pesticide use in farming, and nature-based farming solutions, all of which require a stronger evidence base. Moreover, modelling different scenarios for adopting the proposed F2F targets (Beckman et al., 2020) finds reductions in EU agricultural production and diminished competitiveness in both domestic and export markets. Modelling also predicted consequences for the rest of the world, driving up food prices and negatively affecting consumer budgets. While the F2F strategy is rather inward oriented and has given little explicit attention to external effects in the rest of the world, depending on how incentives/disincentives are applied in the EU, there is risk of pushing consumers towards import of food produced less sustainably than in the EU. Therefore, there must be much more assessment of the potential consequences of the F2F proposals within the broad context of food systems transformation.

The EU can also teach a cautionary lesson on the obstacles created by inflexible regulation delaying or impeding the translation of research outputs into innovation and practice. In the case study discussed previously, the EU GMO

[44] https://ec.europa.eu/info/news/new-high-level-expert-group-assess-need-international-platform-food-systems-science-2021-feb-17_en.

regulatory framework was found to be inflexible, disproportionate, not based on current scientific evidence and not fit for purpose. Urgent reform of the regulation of new plant (and animal) breeding techniques is essential for agricultural innovation to realise its potential in achieving SDG targets, for the EU to maintain its international competitiveness and to obtain value from its public investment in research (EASAC, 2020c). The current obstacles have implications beyond the EU: EU policy decisions have consequences for those LMICs who look to the EU for scientific leadership or as a market for their innovative exports.

In conclusion, the use of science and technology to transform food systems for health, nutrition, sustainable agriculture and the environment depends on progress across a transdisciplinary research agenda but also on facilitating the use of science by stakeholders, such as farmers, manufacturers, regulators and consumers, as well as policy makers. It is time to be more ambitious for identifying, investing in, and using, the scientific opportunities. Academies of science stand ready to play their part in catalysing the necessary actions for food systems in transition, and at the science-policy interface.

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