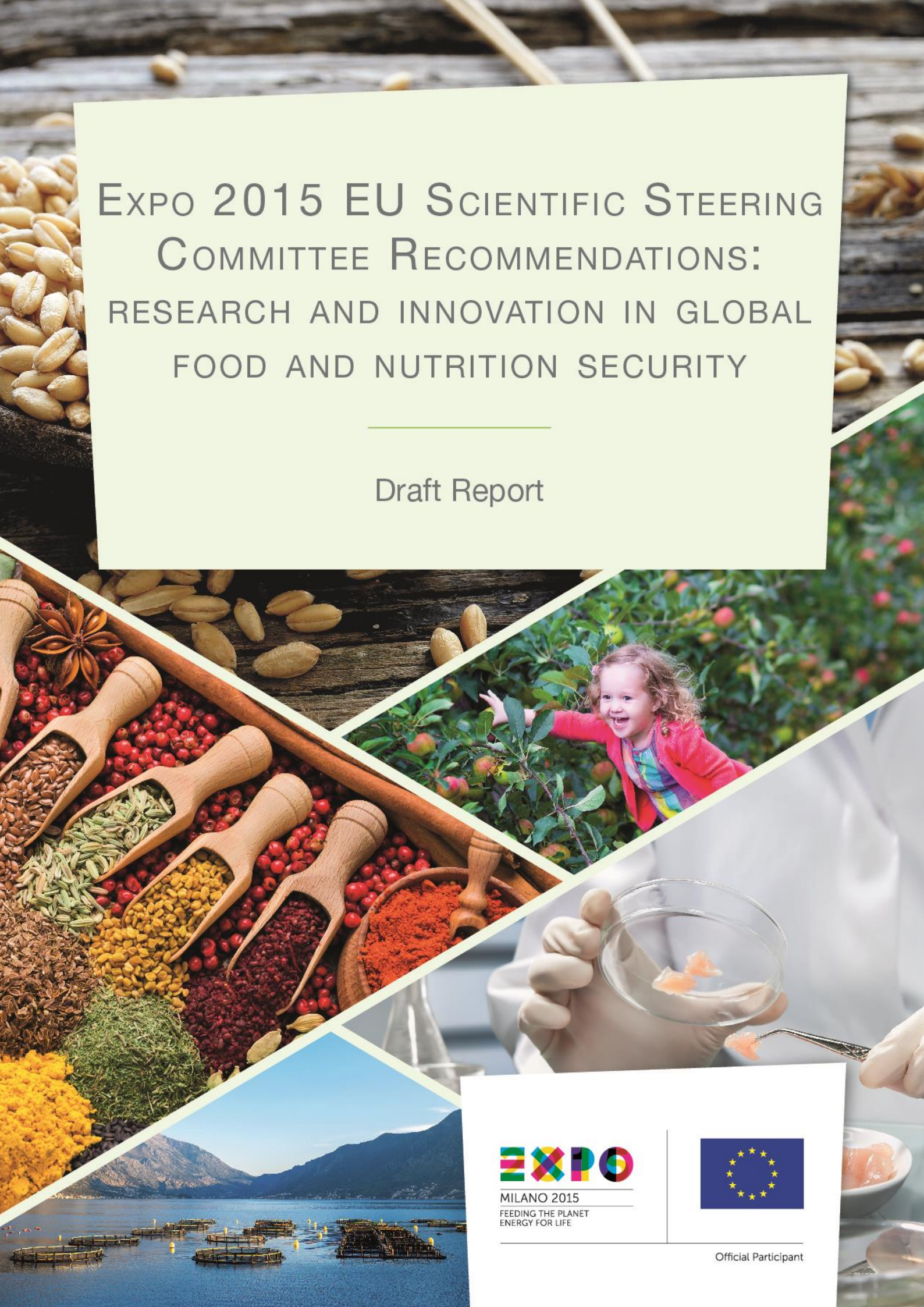

Expo 2015 EU Scientific Steering Committee Recommendations: research and innovation in global food and nutrition security

Draft Report

MILANO 2015
FEEDING THE PLANET
ENERGY FOR LIFE

Official Participant

Foreword

by Franz Fischler

Together with the EU Scientific Steering Committee for EXPO 2015, I am looking back over a very intense one and a half years. When the EU Scientific Steering Committee for EXPO 2015 was launched on 21 March 2014 its mandate was to ensure that the European Union takes full advantage of this world Expo to establish its role as a key player in a global scientific debate on the role of research in global food and nutrition security. Its task was to produce a discussion paper as a contribution of the European Union's participation at EXPO Milano 2015. This discussion paper considers those areas where European research can add most value. It identifies seven key research themes to be addressed if we are to overcome the many challenges associated with hunger and malnutrition. It also addresses structural and crosscutting issues and the transfer of knowledge into use.

On the 13 April 2015, together with Commissioner Tibor Navracsics I launched an online consultation on the Committee's discussion document. Only 3 weeks later, on 8 May, we had a fruitful discussion at our conference "Toward a research agenda for global food and nutrition security", which brought together more than 200 scientists, policy makers, business representatives and civil society partners to discuss the seven research challenges presented in the paper. This was the kick-off for a scientific debate on the various aspects entailed in the theme of Expo "Feeding the planet – energy for life" taking place during more than 200 events in the framework of the EU Scientific Programme for Expo. This summer, many of us, myself included, have come several times to Milan to attend these events as panellists or in the role of rapporteur in order to further contribute to the debate and collect input for this document.

While the previous document was the culmination of over a year's work of the 11 scientific experts and five stakeholder participants and advisors of international repute, that form the Committee, this time we had less than six months to develop the document *"The European Research and Innovation agenda for Global Food and Nutrition Security"*. Also there was a collective agreement in the Committee that this document should not be a revised version of the previous one, but rather take into account the discussion during Expo at events and the responses to the online consultation, at the same time coming up with a limited number of clear and straightforward recommendations for European policy makers. Thus, in addition to the time constraints the Committee faced, it also had to cope with the challenge of integrating contributions of an on-going discussion.

We have chosen to focus on four recommendations addressed to the European Commission and the European Parliament, three of them focusing on improvements in European politics, while the fourth one is a proposal for the EU to take the initiative as a global player, given that global food and nutrition security can only be achieved collectively. In this spirit the paper, now no longer to be considered a think piece, is still open for improvement in order to

take on board the discussion of the conference "Strengthening Global Food and Nutrition Security through research and innovation - lessons learned from Expo 2015" on 15 October in Milan, when it will be presented for the first time to the public.

Last but not least, I would like to thank all members of the Scientific Steering Committee for their commitment and valuable contributions over the last one-and-a-half years and especially during the last six months. I would also like to thank the EU Expo Commissioner General, David Wilkinson. This paper, would also not have been possible without the countless efforts of his staff of the Expo Taskforce in the Joint Research Centre, in particular Amy-Louise Dent and Julia Beile, who have supported the Committee not only logistically but have been crucial for the evaluation of the event outcomes and the consultation process.

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Executive Summary

The EU Scientific Steering Committee for Expo published a discussion paper, 'The Role of Research in Global Food and Nutrition Security' in May 2015. This set out the challenges of meeting sustainable global food and nutrition security, in the face of significant population growth, demand growth and climate change. The discussion paper outlined many of the research needs, grouped across 7 major themes, providing example areas for investigation. In addition, the paper highlighted some cross-cutting issues such as the need for interdisciplinary research, and ways to stimulate the use of knowledge.

Following the publication of the discussion document, an online consultation was undertaken. In addition, a series of events were hosted at the Expo, which contributed to the debate about how the EU should address the food and nutrition challenge. Broadly, the consultation and sequence of events reinforced many of the messages raised in the first report.

Here, we do not revisit the research challenges grouped within the seven themes. The discussion document highlights the range of research required. Instead we report on the discussions held since the launch of the paper, and from these, we develop 4 major recommendations for the EU. These are aimed to guide how knowledge is generated and used in order to meet the challenges previously set out. The recommendations are:

1. Promote systems approaches, via both conducting foresight exercises and in research, to identify the best leverage points where interventions will have the greatest impact. This may be from minimising trade-offs, or identifying synergies. Based on these leverage points, invest in interdisciplinary research to develop integrated solutions.
2. Synthesise both new, and the body of existing, knowledge and use it better to engage with citizens about the impacts of food choices on nutrition and the environment. This dialogue can empower and underpin necessary societal change.
3. Stimulate an innovation environment by incentivising a greater degree of co-designed and co-executed work with stakeholder groups with an interest in adopting innovations (where "innovation" is defined broadly to include political, institutional, social and business, to effect positive change via economic growth or reducing economic costs, or cost-neutral changes in social well-being).
4. Finally, the EU as a global actor should support a new science based global assessment mechanism for global food and nutrition security: an International Panel on Food and Nutrition Security (IPFN). This will provide synthesis of scientific knowledge, help to set research agenda on contentious issues, stimulate problem solving new research, and contribute to transparent public discourse on instruments, synergies, trade-offs and risks.

From the Discussion Paper to the Recommendation Document

When launched in March 2014, the EU Scientific Steering Committee for Expo was tasked to develop a document that should stimulate a global discussion with stakeholders and the general public, ultimately contributing to the EU's legacy from the Expo. The Committee therefore developed a discussion paper, entitled 'The Role of Research in Global Food and Nutrition Security'. This was the culmination of over a year's work and provided expert advice on the challenges of food and nutrition security giving guidance on the programme of events for Expo 2015. The paper considered those areas where European research can add most value, highlighting priorities for research, development and innovation on the theme of global food and nutrition security. The breadth of research needs was grouped under seven key themes. These must all be addressed if we are to overcome the many challenges associated with under-nutrition, hunger and diseases associated with poor food choices. For each theme a series of examples of research questions were listed. The paper also addressed structural issues related to new knowledge and the transfer of knowledge into use. The paper was drafted as 'think piece', not specifically aiming to make recommendations for policy, but to trigger a discussion of where research and innovation can contribute most to solving the challenge of achieving global food and nutrition security.

The paper was officially presented on 13 April 2015 in Brussels by Tibor Navracsics, Commissioner for Education, Culture, Youth and Sport, and responsible for the Joint Research Centre, together with Franz Fischler, Chairman of the Expo 2015 EU Scientific Steering Committee. On that same occasion, an online consultation on how science and innovation can help the EU ensuring safe, nutritious, sufficient and sustainable food globally was launched. In addition to the online consultation, discussions were continued during the numerous events organised in the framework of the EU scientific programme.

There has been broad agreement that the Discussion Document was on the right track in suggesting the need for research across many fronts and, in particular, emphasising the need for more systems analysis and inter- and trans-disciplinary[1] work. Given the many examples of research that could contribute to meeting the challenges the Committee has avoided attempting to make the example research areas more comprehensive or prioritise the areas (though below are suggested ways it could be done). Instead, given the unifying elements of the discussions from both the online consultation and the calendar of events, the Committee agreed that at the end of the six months of discussion, the final document should concentrate not on the research areas but make some targeted recommendations for policy makers. The focus of this current document, beyond reporting on the discussions over the last 6 months, is therefore not on the areas in which research is needed, but the

[1] Broadly: multi-disciplinary research is where parallel and independent research occurs across multiple disciplines; inter-disciplinary work is where this work is integrated into a conceptual whole borrowing from all the disciplines; and, transdisciplinary work goes beyond pure academic endeavour, involving co-design and working with non-academic stakeholders

way research is commissioned to generate knowledge and how this knowledge is used, irrespective of the research area.

The Recommendation Document: overview

The first part of this document summarises the scientific programme organised at the Expo, and the input received from the consultation and the events, focusing particularly on where there is consensus. We briefly report comments which specifically highlighted research areas that had not been covered by the previous document. The second part of this paper builds on the discussions arising from the Discussion Documents, consultation and events, to make four policy recommendations about the commissioning and use of knowledge. As this Committee was established by the European Commission and the European Parliament, the recommendations are addressed to these institutions; taking into account both what the EU should tackle itself and where it could take the lead as a global player.

Part 1

Expo 2015: a unique discussion platform

Introduction to the Scientific Programme

From its inception, the European Union recognised the potential importance of the universal exhibition, Expo 2015 Milano, to make a significant contribution to the global debate on sustainable food and nutrition security. In addition to using the Expo to present a positive image of the European Union and communicating its core values to over 3500 daily visitors to the EU Pavilion, the European Union also organised an ambitious B2B[2] program. This gave the opportunity for businesses from non-EU countries to meet potential partners in Milan from EU member states, with approximately 2700 individual brokerage meetings. The third objective of the EU participation in Expo has been to foster global research and policy development through international academic conferences, workshops, exchanges of best practices and joint declarations on actions by stimulating a policy debate among the 148 participating countries and international organisations.

More than 200 events took place in the framework of the EU Expo Scientific programme, either in the EU Pavilion, in JRC Ispra, Milan universities and other locations in the city centre organised by a great number of Commission services (JRC, AGRI, MARE, DEVCO, GROW, SANTE, RTD, DGT, ENER, ECHO), the European Parliament, the Economic and Social Committee and the Committee of Regions. These reflected the wide EU interest and commitment to the theme of Expo. Among other stakeholders, the EU Pavilion also provided a basis for official delegations of EU Member States which did not have their own pavilion and was also host to external countries and institutional business organisations such as Confindustria, Coldiretti and others for events linked to EU policies, but also cultural events such as the promotion of Aarhus as EU Culture capital in 2017.

The scientific programme started with a conference "Towards an agenda for global food and nutrition security" on 8 May in Milan bringing together key stakeholders from within and outside Europe to discuss in three panels the seven research challenges presented in the discussion document and the documents emphasis on the importance of systems approaches.

Thirty-five events were organised under the special patronage of the EU Scientific Steering Committee for Expo, either because of their particular importance to the Expo theme, or because the Committee felt they added usefully to the event programme. Each of these events was attended by a 'rapporteur' (either a Scientific Steering Committee member or a scientist of the JRC) with the objective of gaining new insights to further develop the discus-

[2] "Business-to-business"

sion document. The following section outlines the main matters which emerged from this reporting back along with the public consultation. A full overview of the events that took place with information on further online resources can be found in the Annex 1.

Feedback from the Online Consultation

In order to give interested stakeholders an opportunity to contribute their views on the discussion document – without having to go to Expo - an online consultation on the document took place between April and September. This was launched on 13 April 2015. Participants were asked:

- should Europe play a key role in research and development (R&D), science and technology(S&T) and innovation for global food and nutrition security?
- to rank in order of importance the seven challenges identified by the scientific steering committee as well as highlight additional big research challenges;
- to comment on the need for more cross-cutting trans- and interdisciplinary research; and,
- how global food and nutrition security could be achieved through better mechanisms enhancing research into use.

By the final day of the consultation, 1 September 2015, 306 contributions were received, including 30 qualitative responses. These contributions came from a wide variety of respondents from universities and research institutes mostly across Europe and a few from private individuals. A detailed report on the results of this consultation can be found in annex II of this paper.

Broad consensus on the need for trans- and interdisciplinary research

There was broad consensus on the need for more trans- and interdisciplinary research given the complexity of the global food system, 93% of respondents agreed with this statement. When asked how could this approach to research be organised and supported several respondents cited the following options through inter-disciplinary groups; through establishing an interdisciplinary food authority; and through establishing public private partnerships.

Measures to Transfer Research into Use

The majority of respondents (82%) agreed that global food and nutrition security can be achieved through better mechanisms enhancing research into use. Respondents also highlighted that there is increased public demand for evidence-based policy, this demand should somehow be met. There is a need for some kind of formal linking between policy and science and the answer to this could be modelled for example on the Inter-Governmental Panel on Climate Change (IPCC) model or the Consultative Group on International Agricultural Research (CGIAR). For the majority of respondents the most important routes that can be used to transfer knowledge into use were through education and communication.

Feedback from the Events

The opening of the scientific debate at the Expo conference on 8 May, focused exclusively on the content of the discussion document, and it received very encouraging reactions. The overall importance of research to achieve global food security was confirmed and participants called for new funding sources for food systems research, a specific EU platform for collaborative/international research in agriculture/food sciences with open access data, an open place for experimentation and improving agricultural statistics. Also it was stressed that we have to constantly review our mechanisms for defining research priorities and the importance of business-science cooperation to advance food security. Beyond the event on the Discussion Document, events attended by the rapporteurs have not specifically had food security research as such as a topic, but covered a broad range of topics related to the Expo theme. It was clear however the cross-cutting issues mentioned in the discussion document had wide support.

Stimulating Interdisciplinarity

As outlined in the discussion document, the discussion in various events confirmed that Global Food and Nutrition Security is a "meta-challenge" that cannot be tackled by only one discipline but needs be approached holistically. There were many terms used to convey this message: ‘comprehensive’, ‘holistic’, ‘integrated’, ‘food systems approach’, and even a ‘one-health approach’ (considering human, animal and plant health). But the key was a strong consensus on the need for interdisciplinary research and a systems thinking. Claims for more research on the circular economy or bioeconomy similarly can be considered as confirmation for the need of the ‘big picture’ and to beyond ‘silo thinking’. This need has been justified by the lack of analytical models and eventually solutions integrating economic and ecological principles in the light of climate change and scarce resources but also considering the non-economic values of agriculture and nature. Another aspect where interdisciplinary approaches might bring benefits is for developing methods to understand consumer behaviours and choices, which needs insights from behavioural sciences, economics, biology, and consumer studies.

Education and Communication

It was stressed that there is a need to better communicate research outcomes to non-academic audiences as well as amongst the experts. In addition to this, education is important for various target groups in order to achieve food security: First of all better education of consumers will play an important role in influencing their food choices. It can also make them more sensitive towards food waste and help to reduce misconceptions with regards to the environmental impacts and the real price of food (including the environmental costs incurred in food production). But there is also a need for more education of farmers, both in the developed and the developing world, teaching them about new technologies and there is a need for capacity building in developing countries i.e. in the field of food safety. Last but not least the education system itself has to adapt fostering more integrated re-

search and education on innovation, making the science of food more attractive and develop new offers e.g. for multidisciplinary engineers who can in the future delver better and more integrated solutions.

Transferring Research Knowledge into Innovation and Practice

A third cross-cutting issue that recurred during various events was the aspect of knowledge transfer. There was a broad consensus that there is a need to reduce the time taken to progress from research to the market, and to scale up innovation. In the conference on 8 May it was suggested that there could be a case for a dedicated innovation trust fund in Europe. Apart from this the increased exchange of knowledge and best practises between stakeholders in particular farmers, researchers, educationalists, and consumers was pointed out. Multi-stakeholder approaches are considered important. These should reflect farmers' needs as well as those of consumers and citizens, but it is often difficult to facilitate this due to lack of the actors competences and resources to engage in research. Also there is a large gap between individual initiatives by front runners and the willingness of many stakeholders in the food sector to engage in innovative steps to improve, for example, their energy efficiency and overall sustainability. There is also often a lack of knowledge of existing initiatives. Examples that have been given are that conventional farming could learn from the lessons of organic farming with regards to agriculture in Europe and there is the need for knowledge transfer impeding a feasible creation of value chains in Africa with little investment.

A need to highlight the importance of "information and communications technology" (ICT)

While many of the events suggested additional examples of research areas to supplement those in the Scientific Committee's report, there was one new aspect that was highlighted in several events, this is the importance of collecting, processing, analysing, sharing and accessing data (This concern was also flagged in the responses to the online consultation, see Annex II). This could be considered as an additional cross-cutting issue, given that it was mentioned in quite different contexts from nutrition and food consumption, to food safety, microbial diversity, food losses and food production sustainability. Data can also play an important role to better understand, assess and monitor resources, the impacts of agriculture on climate change and to better measure resilience. It stands in close connection with another aspect, which is the role of ICT and the digital revolution that has helped to make more data available sometimes even for (almost) free. There are many more benefits connected to this 'big data' that should be further explored such as utilising high-resolution satellite imagery, drones, robotics, and computer-based advisory tools to enhance precision agriculture, as well as crowd-sourcing to fund innovation.

Part 2

Recommendations arising from the discussions

Introduction

The Scientific Committee's first report highlights the many challenges of reaching global food and nutrition security in a sustainable[3] way. It is not simply about growing more calories, but providing nutrition for a healthy life, in a way that reduces environmental burdens with a local impact (through for example nitrogen pollution) or a global one (via greenhouse gas emissions) in a way that promotes social and economic wellbeing. Excessive waste, and over consumption, put extra pressure on natural systems, as well as the latter creating significant costs to public health; in the EU and globally. The twin burdens created by under-consumption and over-consumption need addressing, as do the negative environmental impacts of food production on land, water and atmosphere. The opportunities from addressing these challenges provide the potential for significant benefits for human well-being, for economic prosperity, for meeting environmental goals especially the reduction in greenhouse gas emissions and biodiversity[4] loss and for reducing the pressure on the food-water-energy nexus.

Dealing with the challenges demands significant changes: politically, from industry and from societies around the world. To date, policy frameworks at national and international level to promote public health, to manage land- and water-use sustainably, to improve the efficiency of food production, to reduce greenhouse gas emissions, to address food security and to reduce poverty and promote economic growth have largely been developed in isolation. Responsibility for each policy area tends to fall within the remit of a distinct government ministry or public interest group.

In order for governments to develop strategies that harness the opportunity for realising multiple benefits, it will be important to break down such policy silos and to foster multi-sectoral, multi-interest and cross-government dialogues that allow for the cross-pollination of expertise and policy experience. In turn, this further requires breaking down academic and disciplinary silos and developing more holistic, integrated "systems views". For example, there is an important, and often under-recognised, interplay of the land, water and atmosphere that collectively provides equitable climate, access to fresh water, the foundations of livelihoods and access to food (not only crops and livestock, but also fish and seafood providing a significant component of animal protein for over 4 billion people[5]). Many

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[3] "sustainable" implies environmental, social and economic dimensions. However, environmental sustainability underpins the other dimensions.

[4] Biodiversity includes genetic resources

[5] The state of the world's fisheries and aquaculture 2012 http://www.fao.org/docrep/016/i2727e/i2727e01.pdf

rapidly growing mega-cities are coastal, relying as much on the oceans as the land for food, livelihoods and habitation. Despite this interplay between land, water and atmosphere, academic discussions typically fragment along disciplinary lines.

Up till now, such integrative dialogues – especially at the policy level - have been hindered by a number of issues. One has been dealing with the complexity, not just of individual aspects such as nutrition, safety, or sustainability which are themselves multi-dimensional, dynamic and interactive and thus complex, but of the totality of the food system. Another has been whilst recognising that consumer demand drives the food system there is a wariness of intervening in an issue as personal as diet, whether for promoting health or lowered environmental impacts, given our individual and cultural attitudes. As a result, debates, policy and recommendations, often develop in isolation: until recently, advice on human nutrition paid no heed to advice on what can be sustainably be produced leading to notions of "sustainable diets" differing from "healthy diets", creating significant confusion for consumers aiming "to do the right thing". Likewise, on the production side, the impetus has been to produce more, whilst in parallel, on the consumption side, the debate around tackling waste has been growing. Whilst these debates have been independent, they should not be; producing more without tackling the causes of waste may simply lead to more waste, whilst conversely, reducing waste may reduce the need to produce more.

The expert committee cannot emphasise enough the urgency and importance of addressing the challenges of sustainable food and nutrition security. In today's world, more people than not are likely to suffer ill-health via having poor diets (the twin burdens of undernutrition and over-consumption of calories), with the often life-long consequences this has. Similarly long-term, developing new ways of producing food that are climate smart and lower environmental impacts may take decades to go from lab to field at scale; and the greenhouse gases emitted from agri-food today will take 30-40 years to impact fully on the climate. Action is needed now to create positive change for the decades ahead.

The role of research and researchers

The challenges of creating a sustainable food system that provides food and nutrition security for a significantly larger population, whilst the climate changes, requires significant structural and systemic change. A forthcoming report from Chatham House (on reducing global GHG emissions by dietary changes[6]) highlights the need for a societal change in attitudes to food in order to improve global public health and drive sustainability. In the report, they present evidence there is low awareness, across the world, of the breadth of the issues around food and its environmental impact. The report argues that public awareness is the first and necessary step in producing systemic change as it creates the space for policy and industry intervention. Further, evidence suggests that independent researchers (i.e. those

[6] *Public understanding and policy options for addressing greenhouse gas emissions from the livestock sector, case examples of Brazil, China, UK and US (in review) Chatham House*

not funded by interest groups) remain a main source of public trust in developing understanding of complex and contested issues. These same researchers also provide a pivotal role in reducing the "known unkowns[7]" to "known knowns" and thereby creating the grounds for innovation to effect change. Of course, research also provides space for discovering the "unknown unknowns". In order to systematically address these challenges the Committee's first report on 'The Role of Research in Global Food and Nutrition Security' called for developing models of governance for delivering sustainable agriculture and nutrition from local to supra-national scales, and that entails appropriate design of the research – policy interface.

Thus, our four recommendations are to use research funding and capability to target the levers of change[8]. At its core, this requires better integrated thinking across traditional silos. This means "systems thinking" – across the whole food system and more widely how food interacts with water, energy, land, biodiversity and climate and their intrinsic feedback loops) (Recommendation 1). In turn, such thinking and analysis can be used to effect societal change, and policy coherence, by raising awareness of the issues and, through engagement and debate, to obtain social license (Recommendation 2) and, via synthesising complex knowledge, and stimulating problem solving new re-search, political license to tackle them (Recommendations 4). These social and political licenses in turn will open up new opportunities for business innovation which will reinforce the speed of change (Recommendation 3). The core of the "integrated thinking" is research and the active agents, and human capital, are researchers who, in addition to creating new knowledge, perform the roles of experts, horizon scanning, early warning and stimulating innovation.

Recommendation 1: systems thinking

The challenge : scoping the knowns and the unknowns through systems thinking

The challenges of meeting sustainable food and nutrition security, in the face of adverse environmental change, are considerable (see Discussion document). The time is also limited: given the drivers of demand growth, global ill-health from poor diets, and the impact of agriculture and fisheries' intensification and extensification on the environment, action is needed now to enable a response-at-scale over the coming decades.

Innovations[9] driven from mono-disciplinary or mono-sectoral perspectives may compound, rather than reduce, the challenges. For example, in the past, the use of salt or sugar to in-

[7] Donald Rumsfield famously partitioned knowledge into what we know ("known knowns") what we know we don't know ("known unknowns") and what we don't yet realise we don't know ("unknown unknowns")

[8] To re-emphasise, the research areas needed are covered in the Discussion Document. Here we are concerned with how the cross-cutting issues of how knowledge is created and used.

[9] Throughout we use "innovation" to mean new ways of doing things, this includes institutional, political, legislative, social change, as well, of course, as the development of new processes within industry.

crease shelf-life and taste has helped the development of the food system, but, it turns out, to have substantial negative health consequences. Focussing on single attributes or targets, for example yield or disease resistance, can lead to systems, practices or products with lower quality and which may be associated with environmental damage such as nutrient surpluses and damage to water quality and biodiversity. Many potential solutions aimed simply at increasing production have the potential to impact negatively on other parts of the system via trade-offs. In addition, many parts of the systems are potentially more strongly connected in a sustainable bioeconomy than has been recognised in the past, and this provides scope for positive interventions. Understanding the trade-offs between different interventions and their systemic impact is a first step to identify points of leverage for change. Sectoral approaches therefore must be set within an interdisciplinary understanding.

In-depth analysis of the whole food system is needed to identify the "leverage points" that will create the synergies and maximum positive impact on the challenges requires. Such systems research remains a relatively new way of doing research and needs greater support. Any leverage points identified as areas where innovation may result in change will also require funding, so investments in different areas of research need to be tensioned against each other. Promoting inter- and trans-disciplinary research (Recommendation 3) is not to argue mono-disciplinary research is not needed. Following identification of a leverage point, relevant innovations may sit within single disciplines, and of course, "discovery science" is always needed to build the foundations of knowledge. We are, however, arguing that strategic research is most likely to provide impact when it is set within an interdisciplinary framing.

Greater systems' thinking requires interdisciplinary[10] – and inter-sectoral – expertise. It also requires incentivisation to reduce disciplinary, sectoral and geographic boundaries. This can come about through promoting greater research at a systems level (e.g. within Horizon 2020 and the Joint Programming Initiativess), rewarding "discipline hopping", promoting more inter-disciplinary degrees and training and so on. However, we perceive a need to create both a change in the level of encouragement of interdisciplinary research and a broadening of the approach.

A greater "pull" to developing an interdisciplinary research culture can come from policy communities demanding inter-disciplinary answers to policy questions[11]. One useful exercise, for example, is undertaking inclusive, cross-sectoral, cross-disciplinary foresight and horizon scanning exercises that scope out collective and integrated views of the future and

[10] Implicitly, as in the main report, we are inclusive across academic disciplines, whether social, natural, biological or environmental sciences.

[11] E.g. an analysis of the innovation needs of agriculture looks very different if current market trends continue, vs if agriculture was implemented for the purposes of nutrition. If the former situation specifies the research and innovation funding, it will contribute to further systems inertia ("business as usual"), whereas if the latter specifies research needs, it would lead to greater disruptive innovation.

the potential routes to meet the challenges[12]. Such exercises have the potential to drive changes in thinking if they engage a sufficient range of stakeholders from policy, industry, civil society and academia.

With such inclusive foresighting the challenge space is articulated. When well done, it provides further incentives for action-oriented research. For example, several recent reports have highlighted the systemic risk coming from changing weather patterns. These risks affect production, transport and logistics and the international supply chain. To address how best to manage these risks requires expertise jointly from climate science, agricultural science, sustainability, transport, trade, food safety, industry and policy. A foresighting exercise on this topic could identify leverage points, as well as trade-offs[13], that may reduce the systemic risk in a way that any one discipline may not. Once the leverage points have been identified, targeting research and innovation effort is likely to be more effective.

The Recommendation: enhance systems research

- **Innovate to create a culture of systems thinking embedded in universities, government and industry.** For example by framing disciplinary challenges within interdisciplinary thinking. In particular:
    - foster more interdisciplinary research through investments in research through programmes, projects and encouragement for interdisciplinary training, and discipline hopping
    - in conjunction with Recommendation 4, develop a funded programme of foresighting/horizon scanning exercises that are systemic and not sectoral to set the challenges jointly across policy, industry and academic communities and across sectors.
    - reflect the leverage points identified by such inclusive foresighting programmes in research funding programmes and, where appropriate via partnership with national and regional funders in the EU and internationally

[12] There exist a range of foresight reports, or research prioritisation exercises, and a joint analysis of them would be useful. Nonetheless, their conclusions crucially depend on the boundaries of the system being examined.

[13] At a recent discussion on responses to food price spikes there was a productive conversation about whether extensification of land use when food prices were high, through land use conversion, was a useful immediate strategy to mitigate food shocks. This discussion was sparked by one economist saying "I'll take future climate change over a current recession". The interdisciplinary debate was very fruitful, especially in terms of highlighting the assumptions made by different disciplines, and thereby indicating the underlying knowledge needs.

Recommendation 2: develop the debate to create engagement

The challenge: Set out the issues: inform and empower engagement and action

A more widespread understanding of the role of food in nutrition, equity and environmental impact will play a critical and preparatory role for the systemic changes necessary to develop sustainable food and nutrition security.

Policy or industry-led interventions are less resisted when the public, including food-chain actors and stakeholders, is aware of, and engaged with, the policy rationale and of the benefits to be reaped for the public good. Enhancing public awareness and engagement serve to cultivate the conditions for citizens and consumers to make individual changes to their behaviour, stimulating the development of new markets, and create the political space for the full range of government intervention necessary to bring about the scale of change required.

Such engagement can come about through a variety of means. These can vary from in-depth participation of a few citizens in research projects or dialogue, involvement of many in citizen science and interactive projects to awareness-raising campaigns targeting the population. For formal education, incorporating food systems into the curriculum or developing a greater understanding through other forms of engagement are possible. For example, the European Commission established the European School Fruit Scheme to increase the consumption of fruit and vegetables amongst children, for the dual benefits of improving nutrition and supporting local agriculture. This scheme supports Member State governments to develop national and regional strategies with health and education authorities to provide fresh and processed fruit and vegetables in schools, and to develop accompanying awareness-raising campaigns.[14] Another potential route is to develop EU-wide or for member states to be encouraged to produce national dietary guidelines (NDGs) which integrate nutritional and environmental aspects, and for these to be highlighted for public and industry discussion.

As the researcher community are widely trusted as independent experts, academics play an important role in developing the trust underlying effective communication and dialogue. However, for such communication to be effective, the messages have to be simple and synthetic and highlighting key leverage points for systemic change. This requires developing messages through systems analysis and consensus building (see Recommendations 1 and 4). At the moment, some inertia is created when individual studies, produced by individual academic groups, become noteworthy for highlighting heterodox views leading to significant confusion in citizen's minds (e.g. as to the benefit of eating X vs Y, or that, for example, a

[14] European Commission (2012): Report from the Commission to the European Parliament and the Council in accordance with Article 184(5) of Council Regulation (EC) No 1234/2007 on the implementation of the European School Fruit Scheme

particular way of farming is "better" or "worse" than another). Needless to say, how best to undertake systems analysis to identify and effectively use the levers for change is, in itself, an area of social science research endeavour.

The benefits of improving public engagement will arise from the opportunities it creates for beneficial change. For example, positive public attitudes to changing technologies, pro-healthy diets and behaviour, pro-environmental production and consumption will, in turn, drive the market and open up opportunities for new and innovative goods and services.

The Recommendation: innovating engagement in the "sustainable food challenge"

- Using syntheses developed by inter-disciplinary and systems analysis (Recommendations 1 and 4), **create increased societal awareness of, and engagement in, the importance of food for a healthy life and environment**, and the challenges to develop a sustainable food system in the face of climate change. These debates can be engendered via multiple mechanisms to engage both children and adults.
- It is implicit in this, and the Discussion Report, that changing attitudes and behaviour at a population level requires significant research across the spectrum of social and human sciences. Thus, in addition to the need for engagement and dialogue with the public, there is an academic need to understand the how behaviour can be changed effectively.

Recommendation 3: Implementation and Impact

The challenge: create positive innovations quickly

Impacting on the challenges requires innovation in science, policy, regulation, institutions, social attitudes as well as industry. Broadly, for innovation to have an impact, it requires social license (do people want it in the form proposed?) (addressed in Recommendation 2) and a supportive fundamental research base (from natural and, often, social sciences in tandem, addressed in Recommendation 1); including a sound independent evidence base that an innovation or change is necessary[15].

Given the urgency of the issues the traditional linear model of the "innovation pipeline" is not fit-for-purpose because fundamental research followed by applied research followed by uptake driving change at scale is inefficient and takes too long. Instead, following the identification of a leverage point for positive change, research aiming to deliver impact or innovation should be undertaken in partnership with stakeholders who would welcome innovation

[15] This is important as an innovation (in terms of novel food, or a proposed change in consumption patterns) is often justified in response to a wider agenda on food prices, global food security or environmental sustainability.

in that space. Such stakeholders can help steer and guide the "upstream science" in such a way as to deliver solutions with speed and utility. This is transdisciplinary research, and has been significantly fostered via EC research and innovation instruments in recent years.

However, given the scale of innovation needs, there is a requirement for (a) more transdisciplinary research[16], (b) that is built on broader-based systems analysis, and (c) that maintains the perceived independence of the research (see Recommendation 2), as solutions perceived to be for the benefit of industry risk the trust that they are also a public good. Responsible Research and Innovation (RRI)[17] requires that researchers, citizens, policy makers, business, third sector organisations and so on work together during the research and innovation process in order to better align both the process and its outcomes with the values, needs and expectations of society. Ensuring public trust requires RRI fully to engage with civil society throughout, and to ensure innovation is not seen only as for the benefit of business.

The EU has developed a range of important instruments for fostering innovation. For example, the recent development of European Innovation Partnerships (EIPs), have had success, in particular, at driving innovation applicable to industry. However, some of the innovation needs may require institutional, political or social innovation which may impact on economic growth indirectly (e.g. via reducing healthcare or environmental costs) rather than directly by creating new markets for products; and such innovations also need stronger support. Additionally, many of the leverage points may require action targeted outside the EU, and it is therefore crucial that partnerships with stakeholders (and funders) internationally are welcomed.

Fostering an innovation environment requires incentives (for researchers and for some businesses) and also takes time. Incentives create a pull to stimulate early engagement in innovation, and can arise from ensuring the transmission of ideas into practice takes a greater part in research projects, and it may justify dedicated innovation funding. It can also come through incentivising engagement in other ways. For example, as for Denmark's Innovation Fund and France's ANR, the UK's Research Excellence Framework[18] judges both academic excellence and academic impact on society and this is significantly changing academic culture towards ensuring research is used more widely. A further incentive is to develop the infrastructure for innovation, which perhaps crucially relies on processing, analysing, sharing and accessing data. Encouraging open access data, whilst investing in the infrastructure to allow its use (repositories as well as bandwidth) is key.

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[16] This is clearly not a recommendation for all research to fit in the mould; rather research specifically aiming at developing innovations addressing strategic challenges. There is also a need to assess the success of such investments.

[17] https://ec.europa.eu/programmes/horizon2020/en/h2020-section/responsible-research-innovation

[18] http://www.ref.ac.uk/

The Recommendation: driving the innovation environment

- Traditionally, innovation arose from applied research and was undertaken by different communities from the "blue-skies" researchers, with little connectivity between them. Although this culture is changing, **stimulating innovation should remain a high priority for the EC**. Dedicated innovation funding should remain available, and all research instruments should require the "impact and innovation agenda" to be addressed. The EU should also work with MS to encourage researchers, whatever their funding, to "make a difference". For this to happen, innovation needs to be broadly defined and encouraged beyond creating an immediate economic impact
- This, in turn, raises a separate research question about impact attribution. With some innovations (e.g. a new product) the impact of its development can be assessed in terms of sales. With other innovations (social, political, institutional) the impact is much more difficult to assess (for example, attributing the impact of policy on raising people out of hunger[19]). To manage investments in innovation requires better ways to measure their impacts.

Recommendation 4: Institutional Framework under which FNS Research should be organised: towards an International Panel on Food and Nutrition Security (IPFN)

The challenge

Establishing and maintaining the socio-economic, public health, environmental and political conditions for food and nutrition security is a high priority of societies and decision makers. As many people in the world are still deprived of sufficient access to nutritious food and healthy living conditions, the Sustainable Development Goals (SDGs) postulate for 2030 to "end hunger, achieve food security and improved nutrition and promote sustainable agriculture" (Goal 2). Achieving this goal is not possible in isolation, as it is closely connected to progress in other domains mentioned among the SDGs, e.g. "Ensure healthy lives and promote well-being for all at all ages"(Goal 3), "Achieve gender equality and empower all women and girls"(Goal 5), "Ensure availability and sustainable management of water and sanitation for all"(Goal 6), "Ensure sustainable consumption and production patterns"(Goal 12), "Take urgent action to combat climate change and its impacts"(Goal 13), "Conserve and sustainably use the oceans, seas and marine resources for sustainable development" (Goal 14), "Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodi-

[19] G7+1 Attribution Framework.

versity loss"(Goal 15), as well as the primary goal of "End poverty in all its forms everywhere" (Goal 1).

Achieving food and nutrition security will not only require strong commitment by policy makers but also solid scientific knowledge and transparent public discourse on instruments, synergies, trade-offs and risks. Even beyond 2030, the stability of the global food system will remain being exposed to environmental and health risks, population pressure, constraints in production, disruptions in trade or conflicts. Moreover, food systems are increasingly embedded in the larger economic and ecological context of the bioeconomy, and food and nutrition systems issues need to be assessed in the sustainability framework of the water, food and energy nexus. Tackling the food and nutrition science agenda is not a project or a study, but calls for a permanent mechanism that draws systematically on the global science capacities in new ways currently not available.

Scientific knowledge is a global public good, provided by a large diversity of individuals, local, national and global research institutions and financed at different scales by governments, donors, private enterprises or international organizations. An optimal provision of public goods requires coordination (Ostrom 1990), and needs to ask: How much knowledge should be provided? Who provides knowledge? What are research gaps and priorities? The current institutional arrangements for the policy and science interactions are not equipped to comprehensively address the huge task of guiding toward a world without hunger and malnutrition. An approach toward design such policy-science interaction, partly based on established building blocks of international organizations and science networks is proposed here. Some initiatives actually are already moving in this direction. To move the process forward more swiftly and less ad hoc needs high-level initiative. The Discussion document noted the limitations of current systems, as well as opportunities for innovations (some related sources, such as this one, are listed as references below).

The framework proposed here for improved policy and science interaction in food and nutrition security (FN) builds on the experience of the *Intergovernmental* Panel on Climate Change (IPCC), however, not simply copying this institutional arrangement, but merely aiming for an International Panel on Food and Nutrition Security.[20] It should operate efficiently at low administrative and organizational transactions costs. Such an institutional innovation to synthesize and assess knowledge relevant for decision makers would bring about four important advantages compared to the current system. It would

[20] A more detailed analysis of IPCC as a benchmark for IPFN is provided in a study by von Braun and Kalkuhl (2015) International Science and Policy Interaction for Improved Food and Nutrition Security: toward an International Panel on Food and Nutrition (IPFN). Working Paper, Center for Development Research (ZEF), Bonn

1. better reflect the **diversity and presence as well as lack of consensus** in international science insights and knowledge from different disciplines and countries, and may resolve key issues with new research,
2. improve **exchange and coordination** among science disciplines and research efforts at scale as well as between science and policy domain,
3. increase **transparency** in the synthesis and assessment process based on rigorous peer cooperation and peer review, and
4. increase the **legitimacy** of assessments and recommendations to governments and society.

These four advantages are particularly important for areas with high controversies either due to conflicting scientific findings or due to controversial ethical views in assessing and valuing different measures and options to achieve food and nutrition security. The proposed design adheres to best practices related to functional separation between risk assessment and risk management, as followed in the EU.

Besides regular assessments on the state of food security research (on academic advances and deficits – not on description of developments), the strength of such an institutional arrangement would be to deal with controversial and conflict-laden assessments, for instance on nutrition interventions, market stabilization policies, technologies and innovations (potential, risks, regulation), land use change, land ownership (incl. land investments) or multi-level governance structures and responsibilities that often paralyze decision-making. Moreover, an IPFN would be the appropriate entity to assess emerging opportunities such as bio-economy, and the role of agriculture and food systems in green growth strategies.

The institutional setting would help to improve coordination

- within the science domain,
- within the policy domain and
- between the two domains.

Policy-makers need a solid information base for decision making and the science domain can deliver parts of this knowledge. So far, policy-makers are confronted with a huge diversity on uncoordinated voices from scientists, disciplines, academic organizations and science bodies, often articulating without peer review based quality checks when it comes to policy advice. The proposed institutional innovation would help to coordinate the actors in the science domain in order to provide knowledge to policy makers – not with one voice, but within one institutional framework that can be legitimately considered as representing the scientific knowledge. But also the science domain needs the policy domain for identifying research priorities (which are related to societal goals) and the research gaps that lead to high social costs. This agenda and priority setting cannot be done by scientists as they lack the (political) mandate. Currently, scientists are confronted with many political institutions that translate their specific political agenda into research priorities. An institutional framework would help to coordinate supply and demand of knowledge, avoid redundancies of uncoor-

dinated research, clarify societies' demand for specific knowledge and provide transparent assessments of particular issues.

Before outlining options for the way forward, the current state of affairs in science and policy related to FN, shall be briefly visited.

Science Systems addressing FN

Science systems related to FN are embedded in national science systems but with a large and increasing sets of international linkages, as well as some international entities. The main building blocks are

- The university systems with FN and public health related faculties
- National Academies and international Academy networks in general and with a focus on FN and health
- National food, nutrition, and agriculture related research organizations
- Private sector research (mainly in high income countries)
- The Consultative Group on International Agricultural Research Centers (CGIAR) with its programs
- The Global Forum on Agricultural Research (GFAR)
- the High Level Panel of Experts on Food Security and Nutrition (HLPE)
- The professional academic associations related to FN, broadly defined (incl. e.g. international Nutrition, Food Science, Crop science, Soil Science, Animal science, Agricultural Economics associations etc.)

All these entities serve important roles in moving the science frontiers in FN, and selectively engage with policy, be it on demand by policy bodies or be it by soliciting policy advice. However, they do not come together as organizations to address key policy challenges in FN across disciplines. A particularly important role is played by the CGIAR in the field of FN related development issues, but the total science resources of the CGIAR cover not more than about 3 percent of total world science capacities in FN; the recently established Inter Academy Partnership (IAP), a new organization of world academies brings together established global networks of academies of science, medicine and engineering into a collaboration in which academies work together to support the special role of science and its efforts to seek solutions to address the world's most challenging problems, incl. an initiative on FN started in 2015. An IPFN would not duplicate any of these efforts but facilitate new divisions of tasks and efforts, and would help to overcome current duplications, as well as limited scale of science engagement. Overall transactions costs of many partial assessments would be reduced. The above mentioned entities could actually be considered as partners in a foundation process of an independent IPFN.

Policy System addressing FN

The policy system on FN represents the demand side for science based insight. FN policies are national, regional, and international, with many interactions and externalities among

these levels. The SDGs emphasize national responsibilities for action. The roles and structures of the global organizations addressing food, nutrition / health, and agricultural issues have evolved over the past six decades. International civil society and governmental organizations also play increasing roles.

- national governments, mostly with multi-level structures
- civil society organizations
- G7 and G20 initiatives
- World Health Organisation (WHO)
- Food and Agriculture Organization of the United Nations (FAO)
- World Food Programme (WFP)
- International Fund for Agricultural Development (IFAD)
- Organisation for Economic Co-Operation and Development (OECD)
- United Nations Children's Fund (UNICEF)
- United Nations Environment Program (UNEP)
- United Nations Framework Convention on Climate Change (UNFCCC)
- Convention on Biological Diversity (CBD), and its mechanisms
- United Nations Convention to Combat Desertification (UNCCD)

All these organizations serve important public goods functions, and all make important contributions. Furthermore, they all draw in one way or the other on specific science communities for advice, but the science advice is thereby segmented and coherence of evidence based science advice cannot be assured, and conflicting evidence is not resolved.

International public goods provisioning increasingly occurs also through a complex global web of government networks, where a collection of nation states communicate via heads of states, ministers, parliamentarians and the UN, and where corporations and NGOs participate in various ways. Networks of national governments and even province level governments and of cities, whose officials come together on a regular basis to exchange information, co-ordinate activities, and adopt policies to address common problems at a global scale. They already play key roles in international policy domains such as public health, crime prevention, and energy but not enough in areas of food, and nutrition. Furthermore, civil society organizations at national and international levels are engaged in the policy process and play important roles in shaping policies, such as consumer groups, environmental organizations, farmers' organizations, etc. They also play a role in shaping science policy agendas.

Drivers of change

The science- and the political systems related to FN are both confronted with drivers of change of context in FN, which calls for new and more goal oriented forms of interaction among the two:

1. Demographic transformations with population growth, urbanization, rural aging in many parts of the developing world establish new structures and science challenges.
2. Behavioral change related to food consumption and life styles, partly resulting in the obesity and related health consequences.
3. The transformative roles of food and nutrition sciences, and food systems with new value chains, an increased role of processed food, supermarkets, integrate the food system ever more with the larger international economy in terms of labor markets, energy markets, and services, i.e. finance, and commodity markets and foreign direct investment.
4. The environmental aspects of agriculture and the increased scarcities of natural resources, i.e. water systems, fertile soils, biodiversity; and the huge risks of climate change, all with science challenges of growing complexities.
5. The protracted food and nutrition insecurity in about 400 million small farm households, which form the world's largest group of the hungry and malnourished, requires social science attention in conjunction with other sciences.

Obviously, these drivers of FN change are interlinked. Recognizing that science has a significant role to play for international economic development is an important first step toward results oriented science policy for food and nutrition security. Investment in science systems is part of any successful development policy. The science community today must rise to the challenge to connect to the debate on human and sustainable development goals. Some initiatives have been taken recently, such as Sustainable Development Science Network (SDSN), Green Growth Knowledge Platform (GGKN), and the emerging international network on Bioeconomy. Moreover, in the past two decades, information and communications technologies (ICTs) reduced transactions costs and improved the networking intensity in the international science systems, including with emerging economies. This will also facilitate more virtual approaches toward an international Panel on food and nutrition security, rather than any excessive meeting intensive arrangement.

A science based assessment mechanism for food and nutrition security: three options

The current and future challenges of food and nutrition security require a strong mechanism for science based assessment as a permanent institutional arrangement. An international arrangement tasked with this could be partly inspired by the Intergovernmental Panel on Climate Change (IPCC). While its medium-term focus for the coming two decades should relate to the SDGs to end hunger by 2030, it must have a long-term perspective on food and nutrition related risks and challenges beyond 2030.

An international arrangement that facilitates the peer reviewed assessments on food and nutrition security is needed for delivering evidence based analyses for action with foresight. This function goes far beyond any of the existing science advisory bodies for policy at na-

tional or international levels. The whole international science system related to food and nutrition security and agriculture needs to be engaged in inclusive ways for the purpose.

As both, the science system and the policy systems of FN sketched above, are complex and multi-layered, any choice of options for design of mechanisms for improved international science – policy interaction need to carefully consider a set of criteria such as

1. Contribution to improve the informed decision making process on food and nutrition security effectively and efficiently, in comparison with business as usual,
2. Political and organizational feasibility of action for implementation on both sides and jointly, the science component and the political / organizational component of an International Panel type mechanism,
3. Costs, including transactions costs, of implementation and of management of mechanisms.

Each of the three options considered below have their plusses and minuses in relation to each of these criteria. Table 1 summarizes the evaluation of the different options which differ in the degree of coordination within the science bodies and between the academic and political domain. Option 1 represents working just with the current system. Implementation of option 3 would be based on design principles of the IPCC and be embedded in the UN system. Option 2 would imply less political linkages, and could be initiated by the global science community (for instance facilitated by Inter Academy Partnership and CGIAR) with support by the EU. Below, the options are explained in more detail.

Table 1. Assessment of the different options for science-policy interaction

	Potential benefits	Transaction costs	Feasibility	Best suitable for
Option 1: Working with the current system	Fast and ad-hoc small-scale assessments or reviews possible but limited potential for large-scale issues	No additional up-front costs; Redundancies and gaps due to lack of coordination remain	High (business-as-usual)	Problems of limited disciplinary or regional scope, involving little controversies
Option 2: Establishment of an *International* Panel on Food and Nutrition Security **(Science in the lead)**	Better coordination and academic dispute settling than option 1. Global mobilization of science for FN. New problem solving research is triggered.	Lower coordination costs than option 3 (governments and International Organizations are invited and comment on findings, but no veto possible)	High political feasibility. Participation of scientists due to ISI listed publications, strengthened networks among scientists.	Issues where decision-making depends on comprehensive science base but not necessarily on consensus
Option 3: Establishment of an *Inter-governmental* Panel on Food and Nutrition Security **(Governments and international organizations in conjunction with science bodies in the lead)**	Increased legitimacy and credibility for controversial issues due to mandate by international community. Clarity on peer review of existing research (no new research). Enforced coordination among science and policy.	High transaction costs (time spent by researchers) due to broad participation, transparency rules and formal approval by governments.	Requires strong leadership and commitment of international institutions and governments. Participation of scientists based on reputation and policy impact.	Problems where consensus is necessary for decision-making (UN system)

Option 1: Working with the current system

- Perspective: Reliance on established and evolving science – policy interactions. Hope that global integration and enhanced science capacities in FN in middle income countries may facilitate some gradual improvement of science based actions that may improve international actions in FN.
- Limitations: Demand by FN policy for evidence based FN insights and science systems' supply of such insights may remain at a low level. International organizations and political bodies may continue to focus on defined subsets of FN agendas and synergies potentials and attention to trans-sectoral nexus issues between nutrition, health, sanitation, food and agriculture will hardly be captured. Lack of legitimacy for evaluating policy options that involve normative judgements.

- Potential contribution to enhance the achievement of the FN related SDG effectively and efficiently: limited potential;
- Political and organizational feasibility on both sides, the science component and the political / organizational component of an International Panel type mechanism: not only feasible but likely, as political costs of a no-action option are low in the short term.
- Costs, including transactions costs, of implementation and of management of mechanisms: no cost of implementation; continued high transactions costs of uncoordinated and duplicated science – policy interactions in multiple organizational settings.
- Implementation action: no action needed.

Option 2: Establishment of an International Panel on Food and Nutrition Security (Science in the lead)

- Perspective: Not following the IPCC approach and design. Establishment of a standing mechanism for science and policy related to FN to assess the state of scientific evidence on a set of well-defined FN policy challenges. Strong peer review based assessments. Policy bodies and civil society would be invited to comment on assessments that also reflect controversies (no need for consensus reports). Would bring FN science communities world-wide together with some focus. Evidence base around controversial FN issues would be openly stated, no principle to reach consensus needed, but identification for needed science on controversial issues.
- Limitations: Governments and international organizations would pick and choose as fit their circumstances and priorities. Civil society and media might engage more for identified opportunities and for avoidance of emerging risks related to progress in the SDG on end hunger.
- Potential contribution to enhance the achievement of the FN related SDG effectively and efficiently: some potential.
- Political and organizational feasibility on both sides, the science component and the political / organizational component of an International Panel type mechanism: feasible if proper incentive systems would be created for the global science communities related to FN to actually participate (reputation, funding). Political costs of the option are low. Private sector and NGOs might support the process if they *expect to influence* assessment.
- Costs, including transactions costs, of implementation and of management of mechanisms.[21]

[21] Direct costs for meetings of the plenary, bureau, expert panels ($1.5-$2.0 mln.) and for secretariat ($2.1 mln) plus indirect costs for working time of authors and reviewers plus additional implementation costs for specific objectives; reduced transactions costs due to less uncoordinated and duplicated science on specified themes.

- Implementation action: Starting the mechanism on the science side; political side is actively observing. Selected UN Agencies (possibly WHO and FAO) share observer roles and provide feedback to the science forum's assessments. National Governments are also serving as observers of the assessments and provide feedback.

Option 3: Establishment of an Intergovernmental Panel on Food and Nutrition Security (Governments and international organizations together with science bodies in the lead)

- Perspective: Basically following the IPCC design and approach. Establishment of a standing forum for science and policy related to FN to assess the state of scientific evidence on a set of well-defined FN policy challenges. Strong peer selection governs the peer-review based assessments. Formal interaction to conclude assessments with policy bodies. Would bring FN science and policy communities worldwide together with a clear focus on solutions for FN Security.
- Limitations: taking more time to establish such mechanism and assessment processes are also slower than on informal basis, even after governments and international organizations might agree on it. Because more policy driven in terms of themes, civil society and media would engage much more for identified opportunities and for avoidance of emerging risks related to progress in the SDG on end hunger and improved nutrition.
- Potential contribution to enhance the achievement of the FN related SDG effectively and efficiently: significant potential; also potential to overcome controversies that paralyze decision-making.
- Political and organizational feasibility on both sides, the science component and the political / organizational component of an International Panel type mechanism: political feasibility may be constrained by international organizations' turf interests. Political organizations such as G20 with EU could play a catalytic role for initiation (EU experience with JPIs on food security and on nutrition, etc.). Some private sector and NGOs might oppose the process because of formal rules based on scientific principles; other might support the process (depending on their *expectations on the outcome* of the assessments). Scientists willing to contribute if demanded by international community, academic quality is good and report has impact.
- Costs, including transactions costs, of implementation and of management of mechanisms: cost of similar to option 2, plus indirect costs of political coordination (full plenary UN-type meetings, additional coordination requirements within national governments & ministries); rigorous transparency and review rules increase

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Costs based on budget positions in the budget and expenditure arrangements of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES/3/10 http://ipbes.net/images/documents/plenary/third/working/3_10/IPBES_3_10_EN.pdf).

time and burden researchers have to spend for contributing to assessments. Much reduced transactions costs due to less uncoordinated and duplicated science on specified themes.

- Implementation action: Starting the mechanism simultaneously on the science and political side. Positioning with UN Agencies (possibly WHO and /or FAO) sharing lead roles could facilitate more global legitimacy on the policy sides, but probably entail a lengthy process. Feedback to the science body's findings are encouraged beyond government by civil society. To enhance knowledge transfer, a first assessment report by IPFN could include climate-change related FNS topics with some former authors / co-chairs of IPCC reports to benefit from their experience.

The Recommendation: toward action

The food and nutrition security issues loom large and need action. Science needs to play a key role to offer global and context specific local solutions. If steps in the direction of improved science – policy interaction are not taken, incoherent and uncoordinated actions for food and nutrition security, often lacking scientific evidence base, will continue to hamper needed progress toward a world to "end hunger, achieve food security and improved nutrition and promote sustainable agriculture"(SDG 2).

The IPCC can serve as a useful role model and reference point, but its strong emphasis on consensus is owed to the global public good characteristic of the climate problem which requires strongly coordinated decision making within the UN system. Food and nutrition, though being a global issue, provides much more scope for local, national and sectoral decision making. The need for a comprehensive science base and an objective science-policy dialogue as well as improved coordination to close research gaps is at the moment more important than to achieve consensus in all areas.

Considering the political and administrative (transactions) costs of the options 2 and 3, an Intergovernmental Panel on Food and Nutrition Security (option 3) is a long term scenario at best. Rather option 2 should be pursued for the time being, and option 3 kept as a future scenario.

Coming to a meaningful implementation of the option 2 will require science policy leadership. Leadership for change could come from the science community. Political and some financial support would be needed by the UN and the G20. EU is well placed to play the essential catalytic role to further develop the proposed initiative.

To move the process forward toward option 2 initially may need a high-level, broad based, legitimized time-bound dialogue forum that embraces the whole set of FN challenges, and addresses the organizational implications. Following political decisions based on a comprehensive implementation plan, the setup of the system could be done step by step, managed by a small task force supported by a secretariat.

Conclusion

This document will be presented and discussed on 15 October in Milan for the first time in the framework of the conference "Strengthening global food and nutrition security through research and innovation – lessons learned from Expo". Therefore the recommendations contained in this document will only be developed into a final text after the conference. The final version will also include more detailed annexes on the outcomes of the online consultation and the events.

Selected References

Committee on World Food Security, Reform of the Committee on World Food Security, Thirty-fifth Session, Rome, 14, 15 and 17 October 2009.

CGIAR Independent Review Panel (2008). Bringing Together the Best of Science and the Best of Development. Independent Review of the CGIAR System. Washington, DC.

EXPO 2015 Scientific Steering Committee. 2015. The Role of Research in Global Food and Nutrition Security. Discussion Paper. Brussels

Oosterveer, P. (2007). Global Governance of Food Production and Consumption: Issues and Challenges. Edward Elgar Publ. Cheltenham

Ostrom, E. (1990). Governing the Commons: The Evolution of Institutions for Collective Action. Cambridge University Press.

Slaughter, A.M. (2004). A New World Order. Princeton University Press.

Soussana, J.-F., E. Fereres, S.P. Long, F.G.M.J. Mohren, R. Pandya-Lorch, P. Peltonen-Sainio, J.R. Porter, T. Rosswall, and J. von Braun (2012). 'A European Science Plan to Sustainably Increase Food Security under Climate Change'. Global Change Biology, 18(11): 3269-71, November.

von Braun, J., M. Kalkuhl (2015). International Science and Policy Interaction for Improved Food and Nutrition Security: toward an International Panel on Food and Nutrition (IPFN). A concept paper. Center for Development Research (ZEF), Bonn University, August, 2015

Williamson, O. (1981). 'The Economics of Organization – The Transactions Cost Approach'. American Journal of Sociology, 87(3): 548-77.