

Game-changing developments in the context of food security and future research priorities



Executive summary

To effectively address the food security challenge our research priorities must be continually reshaped according to the changing scientific and global landscape. In 2018 the Global Food Security Programme's Science Advisory Group (SAG) met to conduct a research prioritisation exercise. They discussed the latest contextual developments and research advances relevant to the food system and drew up a list of priority research questions for food security that could be addressed through interdisciplinary research.

This paper details the priority research questions for food security in the context of the current landscape. Outputs from this exercise have provided the Global Food Security (GFS) programme with a cutting-edge view of the food system, as well as an overview of the most urgent challenges that need to be addressed. These research questions will inform the future activity of the GFS programme.

Summary of key discussions

Session 1: Game-changing events and scientific advances over the past year

During the first session the SAG discussed various global events and scientific developments that are likely to significantly change the global food and nutrition security landscape over the next few years. The game-changing events included political changes, updates on global agreements, major reports and papers, new data on the evolving food security challenge and changes to the funding landscape. Scientific advances, ranging from novel genetic editing technologies and agricultural methods, to improved economic-, ecological- and climate modelling techniques, have also advanced the agenda across food system risk, sustainability, environmental protection, climate change, public health and nutrition. This knowledge is continuing to enter the mainstream, being more widely accepted and integrated across the food sector by policy-makers and practitioners.

Session 2: Priority research questions

As the food and nutrition security challenge evolves in response to physical, political and scientific changes, the research questions the GFS programme aims to address are changing too. Although there are a plethora of questions that need to be answered with regards to our food system, the SAG was tasked with creating a list of priority research questions that are central to developing a robust and resilient food system that delivers sufficient, safe and nutritious diets for all, now and in the future.

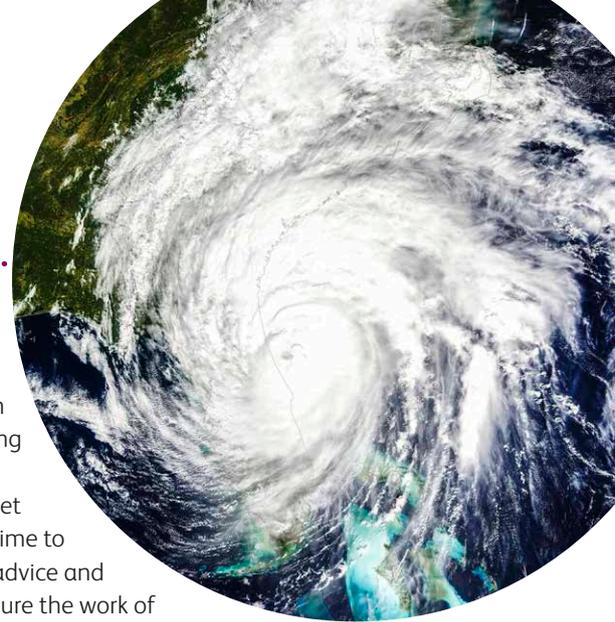
The top priority questions, in no particular order, were as follows:

- A. What are the drivers of the UK's future food system and how might they interact to influence national food and nutrition security?
- B. How will Brexit affect the UK food system?
- C. What is a "food systems approach" and how can it be implemented in policy-making to help deliver against government priorities?
- D. How can we achieve equitable and healthy consumption in the food system?
- E. What are the risks and benefits of integrating new technologies (e.g. gene editing) in current and future food systems?
- F. How do we ensure that nutrition-sensitive interventions (e.g. fortification) in the food system benefit the consumer?
- G. What business models can make healthy and sustainable diets accessible and acceptable, while still profitable?
- H. How can stakeholders work together to achieve mutual benefits whilst delivering food security?
- I. How will participatory democracy and a greater societal call for wider ownership of strategic assets (e.g. food and energy systems) change the way that food systems are governed?

To ensure that the outputs of the GFS programme directly contribute to promoting future food security in the current biophysical, economic, social, political and scientific landscapes, these questions will inform the activities and publications of the GFS programme, as well as the research it funds.



Introduction



The food security challenge is highly dynamic, continually changing in response to a variety of local and global drivers. Examples of these drivers include a global population that is projected to reach 9.8 billion by 2050, as well as increasing wealth and shifts towards more resource-intensive diets. Health demographics are also changing, with one in three people now suffering from some form of malnutrition² and more people now overweight and obese than underweight³. Other drivers include climate change, with global warming currently on a trajectory to reach 1.5°C above pre-industrial levels within the next 12 years. The ongoing global temperature increase is predicted to trigger a greater incidence and severity of extreme weather events that will disrupt many natural, managed and man-made systems, such as the global food system⁴. At the same time, 193 countries continue to strive to meet the UN's Sustainable Development Goals (SDGs), which include sustainable food production and consumption alongside ending poverty and hunger⁵.

The Global Food Security (GFS) programme aims to reflect this constantly changing landscape in its activity, working to stimulate, commission and integrate cutting edge research from across the food system that will be influential in supporting food security goals. In 2018 the GFS Science Advisory Group (SAG),

consisting of prominent researchers with interests planning food system (Appendix 1), met for the second time to provide expert advice and guidance to ensure the work of the GFS programme continues to be at the forefront of the food security challenge.

The SAG was tasked with conducting a refresh of the knowledge gaps around food security based on recent developments. This exercise reflected on changes in the external environment (e.g. political change, global agreements and new funding mechanisms) as well as advances in scientific research. In this context, the SAG developed an up-to-date set of priority research questions for food security, which has provided a cutting-edge view of the food system and the priority challenges that need to be addressed. These questions will be taken forward alongside the programme's strategic priorities to inform the future activity of GFS and its partners.

The future research priorities exercise

To fully understand our food system, we need to recognise that it is continuously changing in response to a range of drivers, some of which are predictable (e.g. global population size), and some of which are not (e.g. the degree of multilateral cooperation in future). The complex nature of this system highlights the need to regularly re-evaluate the game-changing events and scientific advances that are acting on the system. Monitoring these factors allows us to anticipate the general direction of the food security challenge and manage the global food system more effectively.

The first phase of this exercise required members of the SAG to complete a pre-meeting questionnaire (Appendix 2) identifying:

- The major game-changing events in (approximately) the last year that have the potential to shape the research agenda, including (but not limited to) changes in the political environment, major reports or papers, new data or trends on the evolving food security challenge, or changes to the funding landscape.

- The major scientific advances in (approximately) the last year that have shaped the research agenda in their field.
- With the identified events and advances in mind, the most important research questions that we need to address for food security.

Responses were then collated, merged where appropriate, and clustered by topic area.

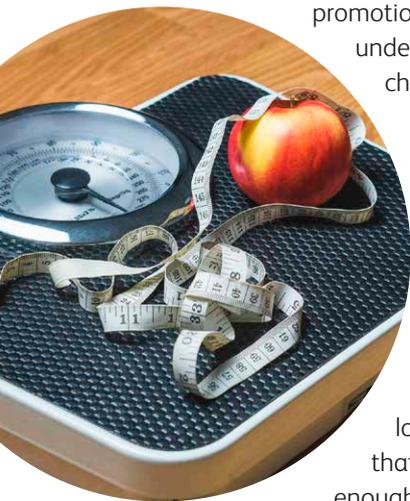
The collated responses provided stimulus material for a one-day workshop. The SAG met to discuss the identified game-changing events and scientific advances, merging or removing less relevant items and addressing any gaps. A list of research questions were then drawn up, discussed and agreed. Following the workshop, narratives based on group discussion were developed for each question and sent to the SAG for feedback. The feedback was subsequently incorporated to provide the final list of priority research questions.

Game-changing events and scientific advancements

The GFS SAG were tasked with identifying the game-changing events and key scientific advances that have changed the context of, identification of, and approach to food security research over the past year. These developments generally centred on the following five themes:

Changes in food security status and diets

The food security challenge is rapidly changing in response to societal shifts. The increase in diet-related non-communicable diseases is an example of such a shift, driving interest in interventions that facilitate healthier eating. These interventions include obesity-related taxes like the sugar tax, but also changing the food environment to make healthier food more available and reducing the availability of unhealthy food. Recent health demographics have also highlighted the presence of 'food deserts' in some urban areas⁶ and triggered proposals to ban the promotion of junk food on the London underground, near schools, and on children's TV.



The rapid increase in diet-related diseases is also shifting the focus of the food security challenge from technical efficiency towards systemic efficiency. With more people now obese than underweight and one third of food produced

lost or wasted, it is evident that we are currently producing enough macronutrients to feed the 821 million people suffering from chronic hunger, were it not for systemic inefficiency across the food system⁷. Furthermore, it is estimated that 2 billion people worldwide consume diets that are deficient in the essential micronutrients that allow the body to develop and function optimally⁸. Micronutrient deficiency (also known as "hidden hunger" due to its lack of visible signs) has been attributed to a lack of access to nutritious foods and an increasing abundance of nutrient-poor foods.

In the UK, poverty-related food insecurity is associated with hidden hunger and obesity, as foods that are high in calories and low in nutrients are often cheaper and more convenient than nutritious, fresh foods. With a third of UK children now growing up "below the breadline" and increasing food bank usage, there is growing recognition that food insecurity is an urgent national issue^{6,9}.



Food insecurity is also growing on a global scale. In 2017, almost 125 million people across 51 countries and territories required immediate emergency action due to crisis levels of food insecurity to safeguard their lives and livelihoods, up from 80 million in 2015⁷. This trend is likely to continue, given that climate change-associated extreme weather events were identified as one of the leading causes of food crisis situations in 2017, and have doubled in frequency since the early 1990's.

Another notable trend is the continued rapid growth of the European meat alternatives market. Over half of UK chefs have said to have added vegan options to their menus over the past year, and 34% of UK consumers reported reducing their meat consumption for health, financial or environmental reasons¹⁰. This shift towards plant-based alternatives has also been supported by a growing number of institutions (including the FAO, the IPCC, the IAP, the GBD and the WEF) recognising that reducing the global demand for livestock products will help to mitigate climate change.

Changing dietary patterns is also necessary in order to transition from curative healthcare towards preventative healthcare.

Finally, a study published last October argued that a global transition towards plant-



based diets could help to keep the food system within planetary boundaries, if combined with other measures such as closing the yield gap and reducing food loss and waste across the food system¹¹. However, research by Muller et al. suggests that livestock products could be produced more sustainably if their consumption was reduced and ruminants were able to graze instead of being fed food that is suitable for human consumption¹².

Political changes

With the UK importing approximately half of all its food (~30% from EU countries and 20% from non-EU countries), our food system is sensitive to national, EU and global political changes. Political shifts can alter international relations and trade patterns, as well as affect the number of people facing multiple forms of food insecurity within a country. Practitioners and policy-makers are currently responding to a number of ongoing geopolitical tensions which could impact the stability of our food system.

For example, a No-Deal Brexit has the potential to disrupt the UK food system and compromise national food and nutrition security¹³. New trade deals cannot be negotiated until the UK has left the European Union, and the UK may be required to lower its food standards in order to strike trade deals outside the EU. However, if the UK maintains its high food standards, UK producers could be at a competitive disadvantage and there is the risk of a race to the bottom. If lower food standards were adopted, this would prevent UK producers from continuing to export food to the EU.

Furthermore, the implementation of border checks are predicted to cause widespread congestion at UK ports post-Brexit, which could lead to the loss of many perishable food items. It remains unclear how Brexit will affect the cost of food items and the type of foods available in the UK in the short- and long-term, however, any increase in the price of fruit and vegetables could widen the gap in health inequalities and nutrition security across the population.



There is growing national populism around the world, which is changing the debate on the trade-off between economic growth and natural capital. In addition, the architecture of international rules-based cooperation (the UN, the WTO etc.) is changing. Political destabilisation has been fuelling conflict both nationally and internationally, with negative impacts on food and nutrition security. North-eastern Nigeria, Somalia, Yemen and South Sudan are at risk of famine due to ongoing conflict and climate change, which has implications for food aid and other humanitarian systems¹⁴.

Food-related commissions, panels and groups

A number of commissions, panels and groups focused on food security issues have played key roles in synthesising knowledge and driving food-related research, as well as encouraging wider national and international activity. Their outputs have advanced our understanding of the food security challenge, stimulating new ways of working. These groups have also been important in bringing stakeholders from across disciplines together on shared issues.

Last October the IPCC's 1.5 degrees special report warned that climate-related risks to food security are projected to increase in the face of 1.5°C global warming, and will rise even further if temperatures rise to 2°C above pre-industrial levels⁴. Other examples include Defra's "Health and Harmony" consultation, which will shape the country's future agriculture policy and science strategy¹⁵; the publication of the McKinsey-WEF report on the role of technology innovation in accelerating food systems transformation¹⁶; and the launch of the first edition of the UN's Global Land Outlook, which emphasises the intimate link between global land degradation and global food insecurity¹⁷.

Finally, a Defra-Royal Society workshop acknowledged that demand management (both in terms of diet and waste) will be necessary to transition towards a sustainable and healthy food system.

Science funding

Changes to the scientific funding landscape are influencing the research agenda for global food security research, giving insight into the scientific areas that are likely to play key roles in addressing current and future food and nutrition security challenges.

In 2017 it was announced that the UK government's Industrial Strategy Challenge Fund has allocated £90 million to the Transforming Food Production programme, which funds UK research in precision farming and nutrition, pollution reduction, waste minimisation and the prevention of soil erosion. The government's Global Challenges Research Fund and the Wellcome Trust's 'Our Planet, Our Health' programme are continuing to fund research that aims to improve agricultural food systems in developing countries and integrate health and sustainability, respectively. The recent establishment of UK Research and Innovation could provide more opportunities for interdisciplinary research to tackle food security challenges, and characterise their interconnections with the challenges of water-, energy-, land-, climate- and national security.

Interesting research trends are emerging in the science funding landscape. For example, research funding seems to have focused on characterising and adapting to the consequences of climate change on food systems, instead of climate change mitigation, despite the IPCC 1.5 degrees report highlighting that mitigation is urgently needed. Gene-edited crops have also entered the mainstream and are now supported by the US after endorsements from Bill Gates, amongst others. This has created a host of new funding opportunities that are likely to impact the food security challenge in the future.

New scientific knowledge and mainstreaming of ideas

Advances in scientific knowledge, whilst adding to the evidence base, can change our interpretation of food systems challenges, inspire new ways of working and develop new pathways and priorities for research. A recurring theme over the past couple of years is the call for systems-thinking in research and policy-making. Breaking silos and embracing interdisciplinary collaboration has the potential to revolutionise how research is conducted, decisions are made and change is implemented. This approach could rapidly transform our food system for health and sustainability, however more needs to be done to integrate systems-thinking into mainstream decision-making.

The notion that our food system needs to remain within planetary boundaries and adhere to the Sustainable Development Goals (SDGs) has come to the fore, with the International Panel on Climate Change currently developing a special report that focuses on the food system, land degradation, desertification, sustainable land management and climate change. There is also increasing recognition in the literature that demand management and dietary change are key to meeting the Paris Agreement and the SDGs.

The field of genetics has encountered major breakthroughs over the past year, including new gene-ecosystem modelling methodologies and great strides in applying gene editing techniques such as gene knock-in and allele replacement. Combined with accelerated growth conditions, these





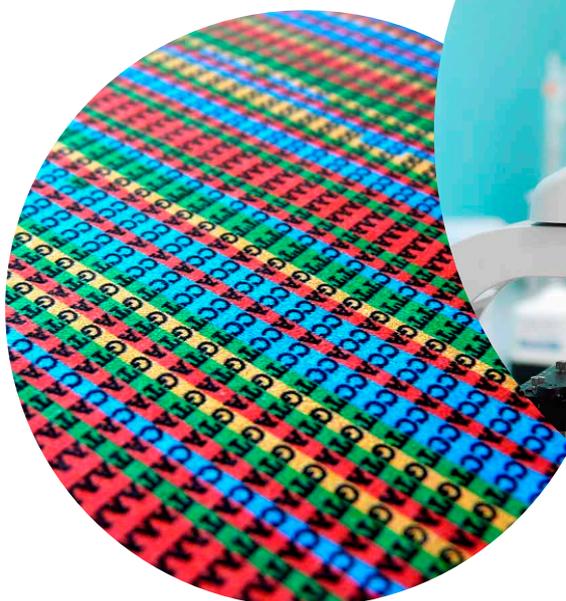
advancements are shortening the generation time for many different crop species, allowing breeders to release new crop varieties more quickly. The pace of population genomics research is also accelerating, improving our understanding of the link between nutrition and health outcomes. Cutting-edge agricultural research is aiming to transform the future of food production. Examples include the Bill and Melinda Gates Foundation-funded RIPE, which is redesigning plant photosynthesis, and ENSA, which is improving nitrogen fixation in plants. Both projects aim to boost smallholder farmers' crop yields in areas that are prone to or experiencing food insecurity. Other research projects aiming to improve photosynthesis and water use efficiency in model plants are now transitioning into crop plants, which could further increase yields.

Domestic and international food and nutrition security landscapes are changing in response to technological advances such as packaging that incorporates nanotechnology to prevent food waste. Improved resolution of remote sensing technologies and machine learning developments are currently providing new opportunities in

insurance, early warning of famine, precision agriculture, crop-monitoring and forest protection. Harnessing technology and data-driven innovation solutions such as blockchain also have the potential to radically transform chains of custody and sustainability certification schemes, increasing authenticity and traceability in the food system.

Other areas of scientific interest include the emergence of a growing body of research on the scale of negative emissions and the opportunities and trade-offs associated with different technologies and approaches. Continued advances in the use of biological materials to produce building components and plastic substitutes are also transforming the food security landscape, as well as the evolution of traditional economic models to capture heterogeneity in citizen behaviour.

Finally, global agricultural chemical companies like Bayer-Monsanto and BASF have been showing an increased interest in addressing soil health, which could influence the research agenda. The interest extends beyond industry, with initiatives such as the Sustainable Soils Alliance raising the profile of the threat to UK soils in the public eye, and a new government bill proposing targets to improve soil health by 2030.



Priority research questions

To effectively address the food and nutrition security challenge, our programme's priorities must take into account the dynamic nature of the scientific and global landscape and respond accordingly. Based on the aforementioned game-changing events and scientific advancements, the GFS SAG devised a list of priority questions for future food and nutrition security research.

The top priority questions, in no particular order, were as follows:

A. What are the drivers of the UK's future food system and how might they interact to influence national food and nutrition security?

In a rapidly changing food security landscape, this question seeks to identify the diverse spectrum of interconnected drivers that influence our food system, and model their interactions to better understand how they could affect our food and nutrition security in the future. This question encompasses global and national events, such as political instability, environmental disasters and extreme weather or other 'shocks', as well as known and emerging 'trends', ranging from changing health demographics and increasing inequality, to loss of biodiversity and recent technological advancements.



Some reports have already been produced outlining how specific events and emerging trends may impact our food system in the future. However, to provide the strong evidence base necessary to effectively manage and monitor our future food system we need to be able to model the interactions between these drivers.

B. How will Brexit affect the UK food system?

The UK currently imports 30% of its food from the EU and is 52% self-sufficient, so Brexit will likely affect the UK's food system in the short- and long-term. The impact of Brexit will depend on trade, regulatory standards, agricultural policy and the economy as a whole. For example, changes in food prices could impact on public health, changes to land use could affect the farming economy, and changes to agricultural policy could alter consumer and citizen's values through the associated impacts on GHG emissions or the UK landscape. How the multitude of food system factors are likely to interact in response to Brexit is uncertain, therefore it is vital to

monitor and analyse the post-Brexit changes to our food system and consider the possible political, economic, social, health and environmental consequences.

Previous work has begun to characterise how Brexit could impact farming and business in the UK. However, the consequences will extend across the whole food system, so understanding the potential scale of post-Brexit changes requires a systems approach that covers all aspects of the food and nutrition challenge.

C. What is a "food systems approach" and how can it be implemented in policy-making to help deliver against government priorities?

A food systems approach identifies and interactively links the multiple drivers, actors and their activities, and the outcomes of their activities for food security, as well as other socioeconomic and environmental goals. Therefore this approach is useful when developing strategies to meet multiple government priorities (e.g. the Childhood Obesity Plan, Eatwell Guide, 25-year Environment Plan, Agriculture Bill, Clean Growth Strategy, SDGs and the Paris Agreement) and has the potential to greatly increase the effectiveness and efficiency of policy interventions. A food systems approach considers the risks and trade-offs across the food system to maximise the benefits for stakeholders and minimise (or ameliorate) the negative impacts, thereby also helping to prevent interventions in one area of the food system having unintended knock-on effects elsewhere in the food system, or beyond.

While there is increasing recognition of the connections between our food system and various government priorities, these relationships are typically studied in silo. More work is needed to map the impacts of food system interventions against a wider range of government priorities to identify 'win-win' interventions and provide an evidence base for transformative and joined-up food policies.

D. How can we achieve equitable and healthy consumption in the food system?

With a global population that is set to increase to 9.8 billion by 2050, it is estimated that we will need to produce 60% more food, use 120% more water, farm 42% more arable land, whilst emitting 77% more greenhouse gases by 2050 if diets continue to change as projected¹⁸. Besides dwindling resources, the global



obesity epidemic and rise in diet-related non-communicable diseases highlights an urgent need for interventions that could reduce over-consumption and poor dietary intakes to promote health and sustainability.

The drivers of unhealthy and unsustainable food consumption are already well-characterised, ranging from price and marketing to social and cultural norms, education and accessibility. The external costs of poor diet on our national healthcare service and the environment have also been widely reported. However, interdisciplinary research is required to identify the strategies that could acceptably and effectively create beneficial change in the population's diet to promote a healthier and more sustainable food system.

E. What are the risks and benefits of integrating new technologies (e.g. gene editing) in current and future food systems?

Technological advances such as gene editing are aiming to fundamentally change food production, primarily through increasing yield, sustainability, nutritional content, disease resistance and resilience to climate change. By shortening breeding cycles and delivering science-based solutions to agriculture at an unprecedented rate, gene editing has the potential to play a major role in addressing the global food security challenge. However, integrating these novel technologies into our current food system comes with risks and benefits, as well as trade-offs that may be biological, social, economic, environmental, political or health-related in nature. Considering the food system risks and benefits across these different disciplines provides an opportunity to maximise the impact of these new technologies for society.

Some reports have already highlighted the risks and trade-offs of emerging technologies for our future food system. This question aims to characterise the full complement of positive as well as negative effects of adopting technologies such as gene editing across the whole food system.

F. How do we ensure that nutrition-sensitive interventions (e.g. fortification) in the food system benefit the consumer?

This question aims to understand whether the nutrients in fortified foods are incorporated into the final food product, and whether these fortified foods deliver the intended health benefit when consumed. Food fortification has the potential to improve the nutritional security of a population, however, for nutrition-sensitive interventions to be successful, consumers must also have economical and physical access to foods containing essential nutrients. Therefore, this question also considers the socioeconomic



factors that limit consumers' access to nutrients, and the policy tools that could address these obstacles.

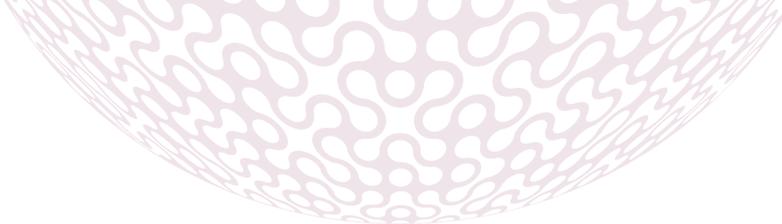
Further research is needed to test the scale of impact that nutrition-sensitive interventions could have on improving nutritional security, and identify solutions that make access to nutrients more equitable.

G. What business models can make healthy and sustainable diets accessible and acceptable, while still profitable?

The abundance of affordable but unhealthy foods that are typically high in salt, sugar or fat and appeal to our underlying biology can lead to overconsumption. There are many business models that centre on selling more calories than we need per capita, in foods that are readily available, cheap, convenient and heavily promoted. As a result, food accessibility for the poorest is often limited to energy-dense foods with little nutritional value. However, there are also new business models emerging that promote healthy and sustainable diets and a shift is needed in this direction alongside other measures to make this food affordable. This question asks how business models can be changed to promote the physical and economic accessibility of healthy and sustainably-produced foods.

H. How can stakeholders work together to achieve mutual benefits whilst delivering food and nutrition security?

The food system has a wide range of stakeholders with different, and often conflicting, interests. Identifying how an intervention may benefit multiple stakeholders across the food system could strengthen the evidence base supporting the intervention and encourage these groups to work together to create positive food system changes.



Retailers, manufacturers and primary producers working together to improve animal welfare is a successful example of this approach. Thus, generating support for food system changes that improve food security could be more effective when appealing to different stakeholders' individual goals, rather than appealing to the overarching goal.

Many reports describing food system interventions have focused on the risks and trade-offs of various interventions for the individual stakeholders. However, this approach can cause key players to reject change in favour of business-as-usual. This question seeks to deliver radical changes across our food system by identifying the interventions with “win-wins” for multiple stakeholders.

I. How will participatory democracy and a greater societal call for wider ownership of strategic assets (e.g. food and energy systems) change the way that food systems are governed?

Issues such as the environmental sustainability, genetic modification and nutritional content of food have fuelled the growing societal call for greater transparency and more equal capital ownership in the food system. These demands warrant novel systems of governance, however the mechanisms underpinning such governance systems, or indeed the transition to new systems, remain unclear. This

question aims to characterise changing societal attitudes towards the food system and investigate how current food system governance could be adapted to meet new societal demands.

National and international food policy and governance mechanisms are well-documented, as are the recent changes in public attitudes towards the food system. However, further work is required to understand how the current mechanisms of food system governance can be adjusted or replaced to respond to these changing societal demands. In particular, this question explores the role of subsidies, changes to taxation, monopolies, regulatory authorities, social media and digital transparency, internalisation of environmental costs, and alternative ownership models such as cooperatives in the future of food systems.



Conclusions

Due to a deeply complex and diverse food system with interlocking local-to-global, and short-to-long term elements, it is unsurprising that the food security challenge is continually evolving, and solutions may vary from place-to-place and over time. It is only through fully understanding our food system and what drives it that we can successfully address many of the key issues that lead to food insecurity around the world.

Of late, a wide variety of global events have transformed the external environment, from political changes that have introduced a great deal of uncertainty as to the nature of future international cooperation and policy, to a growing awareness of the dangers of climate change. This is compounded by change across the research landscape, with greater focus on and funding for interdisciplinarity and shared global issues. Our knowledge has also vastly expanded, advancing the agenda across food system risk,

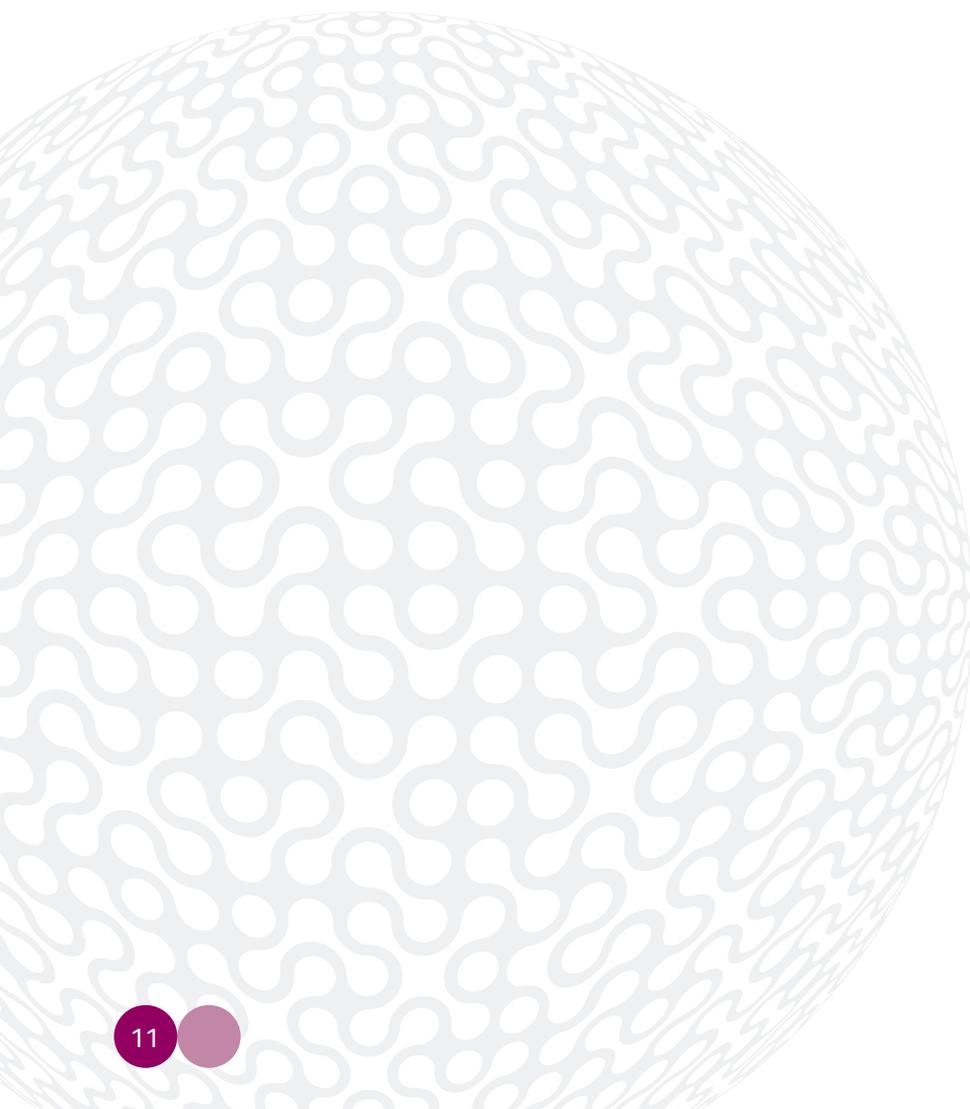
sustainability, environmental protection, climate change, public health and nutrition, to name but a few. Indeed, this knowledge is continuing to enter the mainstream, being more widely accepted and integrated across the food sector by policy-makers and practitioners.

Alongside this rapidly changing environment, there are a wide variety of questions facing food security and the food system that underpins it. While each of these will be of central importance to developing a robust and resilient food system that delivers sufficient, safe and nutritious diets for all, this report has drawn out a number of key priority questions in the context of the current landscape. These questions will be a strong driver for the future activity of the Global Food Security programme and will be taken forward alongside GFS' strategic priorities.



Appendix 1: GFS Science Advisory Group members 2018

Professor Tim Benton	Chair, University of Leeds
Rob Bailey	Chatham House
Professor John Crawford	Rothamsted Research
Professor Alan Dangour	London School of Hygiene and Tropical Medicine
Professor Corinna Hawkes	City, University London
Dr John Ingram	University of Oxford
Professor Aled Jones	Anglia Ruskin University
Professor Jennie Macdiarmid	University of Aberdeen
Professor Pete Smith	University of Aberdeen
Professor Cristobal Uauy	John Innes Centre



Appendix 2: Pre-meeting questionnaire

GFS Science Advisory Group Workshop

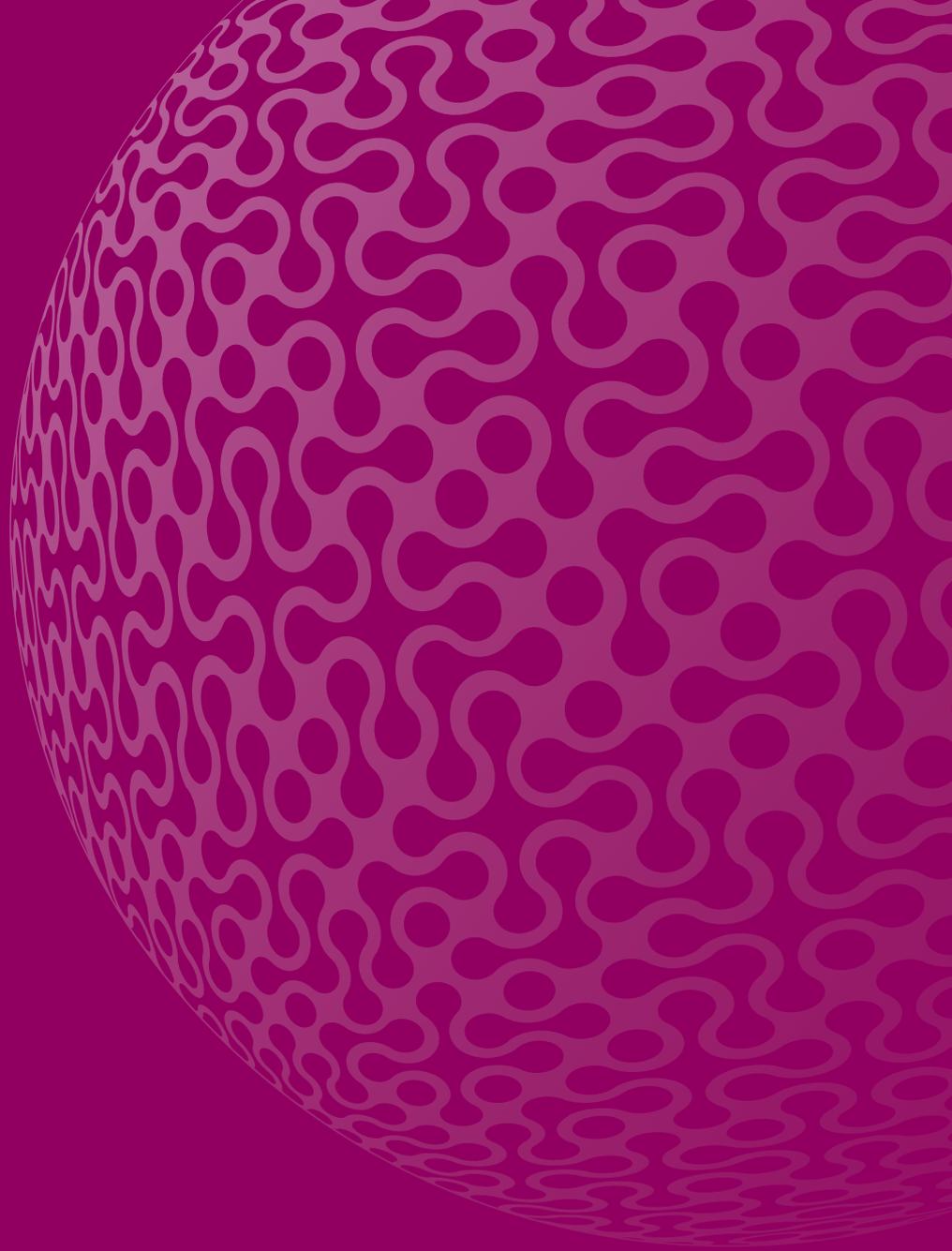
Re-evaluating the research priorities of GFS in light of recent developments

This is a pre-meeting questionnaire for the Global Food Security (GFS) programme's Science Advisory Group workshop 2018. While answering the 5 questions, please consider global food security in its broadest sense - occurring when all people have access to safe, affordable and nutritious food, all of the time and in ways the planet can sustain into the future.

- 1. Which major game-changing events have shaped the research agenda in your area over the last year?**
e.g. Changes in the political environment, global agreements, major reports or papers, new data on the evolving food security challenge, or changes to the funding landscape.
- 2. Taking these recent events and advances together, what are the most important research questions that we now need to address for food security?**
- 3. Taking these recent events and advances together, what are the most important research questions that we now need to address for food security?**
Please note that these research questions 1) can be novel - they do not have to feature in last year's report, 2) do not need to be ranked by importance, 3) should not be formulated as a general topic area, 4) should be of the scale that they could be addressed by a £5-10 million research programme rather than an individual project.
- 4. To what extent are these questions already being addressed?**
For each priority listed above, please provide a short description in the table below of any major work already being undertaken, as well as a rating on a scale of 1-5 indicating the extent to which this area is already being addressed (1 = not being addressed, 5 = largely being addressed).
- 5. How should GFS aim to address these research questions?**

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Game-changing developments and future research priorities

This horizon scanning report was prepared by Maia Elliott on behalf of the Global Food Security Programme.

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