Global Food Security

Strategic Plan 2011-2016

Global Food Security

Sustainable, healthy food for all

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Global Food Security Programme Strategic Plan, 2011 – 2016

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Global Food Security is a multi-agency programme bringing together the main UK public sector funders of research and training related to food. For further information and updates see the programme web site: www.foodsecurity.ac.uk

Foreword

Addressing the challenge of global food security through the twenty-first century is linked with other global issues, most notably climate change, population growth and the need to sustainably manage the world's rapidly growing demand for energy and water. Our progress in ensuring a sustainable and equitable food supply chain will be determined by how coherently these long-term challenges are tackled. This will also determine our progress in reducing global poverty and achieving the Millennium Development Goals.

The challenge is to deliver nutritious, safe and affordable food to a global population of over 9 billion in the coming decades, using less land, fewer inputs, with less waste and a lower environmental impact. All this has to be done in ways that are socially and economically sustainable. It is clear to me that research is vital to meeting this challenge.

I am pleased to see the UK's main funders of food-related research rising to this challenge by coming together through the Global Food Security programme. By working together, taking a global perspective and aligning their goals, the partners from Government and the Research Councils will be able to maximise the impact of their work, promote more interdisciplinary work and increase efficiency. Furthermore the programme will help to ensure that UK research contributes significantly to the international effort to increase food security in developing countries. It will also provide a good opportunity for collaboration in taking forward the findings from the Global Food and Farming Futures Foresight[1] project, addressing how a future global population of 9 billion people can all be fed equitably and sustainably.

This strategy outlines how the Global Food Security programme will combine the partners' strengths and add value to meet one of the greatest challenges I believe we face in the coming years.

Professor Sir John Beddington
Government Chief Scientific Adviser

[1] http://www.bis.gov.uk/Foresight

1 Executive Summary

The UK's main public funders of food-related research and training are working together through the Global Food Security programme. The programme aims to help meet the challenge of providing the world's growing population with a sustainable and secure supply of safe, nutritious and affordable high quality food. That food will need to be produced and supplied from less land and with lower inputs, and in the context of global climate change, other environmental changes and declining resources. The programme aims to provide evidence to enable food producers and processors, retailers, consumers and government to respond to and manage the challenges facing the UK food system and related global issues, including the many challenges confronting the developing world.

The Global Food Security programme will take interdisciplinary and whole systems approaches to research on UK and global food supply systems, from both a consumer and producer perspective. The scope of the programme includes: food production and resource management; food economics, markets and trade; food processing, manufacture and distribution systems; food safety and nutrition; consumption habits and practices; and waste in the food system.

The programme will coordinate research supported by the programme partners across Government departments, the devolved administrations, Research Councils and the Technology Strategy Board. It will build on the partners' existing activities, aiming to add value to their current and future investments, and complementing rather than replacing their individual strategies. It will bring additional coherence by acting as a focus for joint activities and helping to ensure alignment of individual activities with shared goals.

The programme comprises four cross-disciplinary themes based on those set out in the *UK Cross-Government Food Research and Innovation Strategy*. All themes (but especially Themes 2 and 3) will take into account the sustainability of ecosystems related to food production (including land use, biodiversity and other ecosystem services) and the overarching challenges of reducing greenhouse gas emissions and reducing losses and waste throughout the food system.

1. ***Economic resilience*** – securing a better understanding of how poor economic resilience leads to hunger, poverty and environmental degradation across the globe and how this might be addressed

2. ***Resource efficiency*** – including water, energy, nutrients and other inputs; land use and soils, with particular focus on the sustainable use of resources; increasing competitiveness, profitability, efficiency and reducing waste

3. ***Sustainable food production and supply*** – including farming systems, food production from crops and animals (including fish), food processing, manufacture and transport

4. ***Sustainable, healthy, safe diets*** – including food safety throughout the supply chain, nutrition, consumer behaviour, food choice and accessibility.

As well as research, the programme will support cooperation among the funding partners on issues such as infrastructure, horizon scanning and skills. The effective translation of research findings into practical application and policy will be central to the programme from the outset, and will be achieved through promoting improved interactions and partnerships among the research community and with users (including the many relevant sectors of industry and consumers), policy makers and international partners.

2 Introduction

1. The UK's main public sector funders of food-related research and training have joined forces to develop, design and implement a programme to coordinate research and associated activity on Global Food Security. It will take interdisciplinary and whole systems approaches to research on UK and global food supply systems. The programme is intended to help meet the global challenge of providing the world's growing population with access to environmentally, economically and socially sustainable, safe, affordable and nutritious diets, which will need to be produced and supplied from the same or less land and with lower inputs of finite resources.

2. Meeting the challenges of our future food supply is not just an issue for government: it involves everyone across the food system. Therefore, the Global Food Security programme will provide knowledge and evidence for policy development (both nationally and locally) and to enable food producers and processors, retailers, consumers and civil society to respond to and manage the challenges facing the food system. Food security for the UK is inextricably linked to global production, demand and supply and must be considered in this broader context. This programme will address these challenges and will contribute to addressing related global issues, including the many challenges confronting the developing world in the face of environmental and demographic change.

3. The programme is broad in scope: it will integrate research in topics ranging from food production and processing to markets and distribution, consumption patterns, human nutrition and environmental sustainability. A key aspect will be adding value to current and future research, through greater coordination to improve the design, delivery and translation (into policy, regulation and practice) of research across many disciplines. Translation will entail knowledge exchange and other engagement with a broad range of stakeholders including the agri-food and all other relevant industrial sectors. As well as enhancing coordination among the UK funding partners, the programme will help to provide a focus for UK contributions to wider international efforts.

4. This Strategic Plan summarises the background and context for the programme, outlines how the programme is organised and managed, and describes its scope and some main objectives for the initial five-year period, 2011 – 2016. The plan will be refreshed as the programme develops over that period and beyond.

[2] For a definition of food security, see paragraph 5

3 Context

5. This section outlines the context for the programme in terms of the main challenges and drivers, including both UK and global issues. The Food and Agriculture Organization of the United Nations (FAO) has stated[3]: "*Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life*."

6. Around a billion people globally do not have adequate food to meet their basic nutritional needs[4]. The world faces a potentially even greater crisis in food security as the global population is expected to grow from about 6.9 billion (late 2010) to more than 9 billion by mid-century. The FAO has predicted[5] that demand for food will grow by 50 % by 2030 and 70 % by 2050. However, global supply of food calories per person[6] rose from 2254 kilocalories per day in 1961 to 2809 kcal in 2003. Therefore the challenge, in essence, is to meet the rising demand for food in ways that are environmentally, socially and economically sustainable, and in the face of evolving world-wide markets and distribution mechanisms, and global climate and demographic changes.

7. In future, food supply (including production, processing and distribution) must – as far as possible – use the same or less land and fewer inputs, produce less waste and have a lower environmental impact. Food must be safe, nutritious and affordable, and available to all, with improved equity of distribution, and reflect social and cultural needs.

8. This section is not intended to be a comprehensive or detailed analysis. Further detail on these issues can be found in other publications[7] including *Food Matters*[8] (2008) and *Food* 2030[9] (2010). A framework for food research was set out in the *UK Cross-Government Food Research and Innovation Strategy*[10], published in 2010 alongside *Food* 2030. In 2009, the (then) UK Government published its *UK Food Security Assessment*[11] with associated indicators. Also in 2009, the Scottish Government published its *Recipe for Success – Scotland's National Food and Drink Policy*[12]. In 2010, *Focus on Food – A Partnership Strategy for the Food Industry in Northern Ireland*[13] was published. In the same year, the Welsh Assembly Government produced its food strategy *Food for Wales: Food from Wales 2010-2020*[14] and DFID published its nutrition strategy[15]. The OECD has published an analysis with trends in the wider 'bio-economy'[16]. The Foresight report on Global Food and Farming Futures[17] (and the associated publications from that project) provides a wealth of further detailed background and analysis.

[3] *Rome Declaration on World Food Security* and *World Food Summit Plan of Action*. World Food Summit, Rome (FAO, 1996).

[4] *The State of Food Insecurity in the World* (FAO, 2010), accessed January 2011

[5] *OECD-FAO Agricultural Outlook 2009-2018* (FAO, 2009), page 52

[6] World Resources Institute EarthTrends data, accessed January 2011

[7] Note: documents are cited as sources of useful background information and analysis. Some of the documents cited were published under the previous UK Government and do not necessarily reflect the current Coalition Government's policy position

[8] *Food Matters* (Cabinet Office, 2008)

[9] *Food 2030* (HM Government, 2010)

[10] *UK Cross-Government Food Research and Innovation Strategy* (GO-Science, 2010)

[11] *UK Food Security Assessment* (Defra, 2009 & 2010)

[12] *Recipe for Success – Scotland's National Food and Drink Policy* (Scottish Government, 2009)

[13] *Focus on Food - A Partnership Strategy for the Food Industry in Northern Ireland* (Northern Ireland Executive, 2010)

[14] *Food for Wales, Food from Wales 2010-2020* (Welsh Assembly Government, 2010)

[15] *The Neglected Crisis of Under-nutrition: DFID's strategy* (DFID, 2010)

[16] *The Bioeconomy to 2030 - Designing a policy agenda* (OECD, 2009)

[17] Foresight project on Global Food and Farming Futures: see also footnote 18 and 27

Global food security challenges and drivers

9. Some of the main **drivers**[18] underlying the challenge of ensuring food security (for the UK and globally) are summarised in brief in the following points.

- **Global population growth**, coupled with demographic change, increasing affluence and urbanisation, will lead to growth in demand for food and changing patterns of demand – rising affluence is associated with increases in food consumption, especially of meat and dairy products. Much (but not all) of the expansion in population will occur in developing countries: improving food security (especially affordability, access and availability) is closely linked with the need to reduce poverty[19].

- **Global climate and other environmental changes** that will have direct or indirect impacts on food production and supplies include rising carbon dioxide and other greenhouse gases, leading to rising temperatures, changing rainfall patterns and increasing incidence of extreme weather events (such as storms, floods, heat waves and droughts), rising sea level and ocean acidification. Changing climate may also lead to changes in the distribution and/or severity of pests and diseases (in crops and animals, including zoonotic infections where disease organisms transfer from vertebrate animals to humans) and has the potential for severe impacts on food production and animal welfare. As well as threats, changes in climate may offer new opportunities for food production in some parts of the world.

- **Environmental impacts** of farming and food: negative impacts can include increasing water and land use, soil erosion and degradation, loss of biodiversity, as well as greenhouse gas emissions and water pollution.

- **Key resources** for agriculture are limited, notably land, fresh water and energy, but also sources of other inputs such as mineral phosphate (an essential plant nutrient). Shortages of resources may be exacerbated by increasing competition, for example from urban and industrial development.

- **Social** drivers include urbanisation, demographic change, issues of land tenure, governance and international security, changing patterns of consumer needs, preferences, choices, tastes, habits and practices affecting the demand for and consumption of different foods and patterns of waste.

- **Economic** drivers include issues of trade, land tenure, food markets and their volatility, supply and distribution, regulation, affordability and accessibility (particularly in the developing world) with associated globalisation.

[18] See also reviews of the major drivers of change in the global food system: Phil. Trans. R. Soc. B (Sep 2010) , produced by the Foresight project on Global Food and Farming Futures

[19] Millennium Development Goals: www.un.org/millenniumgoals/bkgd.shtml

- There is a need to ensure adequate **nutrition**, including not only calories but all necessary macro- and micro-nutrients for healthy and balanced diets for populations throughout the world[20]. At the same time as increasing numbers of people globally are inadequately fed, the over-consumption of high-calorie diets[21] adds to the rising demand for food, with all the associated economic, social and environmental impacts.

10. The following points summarise some of the most important **challenges** arising from these drivers.

    - The world will need to produce more food while using less land, water, fertiliser, energy and other inputs, and distribute that food more effectively, efficiently and equitably.

    - There is a need to reduce losses and waste, greenhouse gas emissions and other adverse environmental impacts – throughout the food supply chain, from production to consumption and waste management.

    - Food must be safe, nutritious and affordable, and be supplied and distributed in ways that meet the needs and aspirations of consumers in different economic, social and cultural contexts around the world. People need to be well informed and helped to make healthy choices.

    - There is a need to balance different uses of land and seas, often with competing priorities, such as sustainably increasing food production while maintaining ecosystem services on which food production critically depends.

    - There is a need to balance increased productivity from food producing animals with their welfare, recognising that absence of disease and high productivity do not always equate with high welfare standards and outcomes.

11. The complex and inter-related problems outlined above can only be tackled through coordinated and integrated interdisciplinary research, coupled with its effective translation into practice and policy. A main aim of the Global Food Security programme is to facilitate that research and its translation, and so help to improve the sustainability and security of UK and global food supplies.

12. The challenges range from those with a local or UK national focus to more wide-ranging European and global issues. Food security for the UK is inextricably linked to global production, demand and supply and must be considered in this broader context. There is a key role for UK research (which is world-leading in various relevant fields) in helping to address the global challenges, especially those of developing countries. The benefits from such research often accrue to both developing and developed countries, for example through new research insights and opportunities, from mobility of researchers and through exchange of technologies and know-how.

[20] See also: *The Neglected Crisis of Under-nutrition: DFID's strategy* (DFID, 2010)

[21] For example, see WHO information

4 The Global Food Security Programme

i. Operating principles

13. The programme will operate under the innovative principles set out in the *UK Cross-Government Food Research and Innovation Strategy*[22] – principles that aim to strengthen coordination across funders and enable them to cooperate more closely. Mechanisms for working together through this programme will include:

    - collaborative joint design and delivery of research and joint funding of sub-programmes of research (this may include co-designing calls for responsive mode proposals through the Research Councils, for example as highlight notices);

    - cooperation in future strategy development so that funders' own programmes are aligned with shared goals;

    - joint horizon scanning activities to identify and respond to emerging challenges and priorities;

    - collaboration on cross-cutting issues such as provision of training, skills and infrastructure for research, routes for translation of research, international partnerships, public engagement and dialogue.

14. As part of the process for enhancing coordination, the funding partners will explore a range of mechanisms to bring together researchers with users for mutual benefit. Such mechanisms may include interdisciplinary workshops to encourage academics (including those currently supported by the funders) and others with expertise in different research topics to work together, as well as building on existing relationships and networks as many of these are already established. In addition such mechanisms will promote interactions between researchers and relevant users of research, such as industry, government policy makers and other stakeholders, in the UK and internationally. Benefits will include improved communication among these groups and helping researchers gain greater awareness of the context in which their research is used.

ii. Partners and sponsors

15. The Global Food Security programme is jointly developed, designed and implemented by the UK's main public sector funders of food-related research and training. The partners and sponsors of the programme are:

    - five of the UK Research Councils
      - Biotechnology and Biological Sciences Research Council
      - Economic and Social Research Council
      - Engineering and Physical Sciences Research Council
      - Medical Research Council
      - Natural Environment Research Council
    - Department for Business, Innovation and Skills
    - Department for Environment, Food and Rural Affairs
    - Department for International Development
    - Food Standards Agency

[22] *UK Cross-Government Food Research and Innovation Strategy* (GO-Science, 2010), section 6.4

- Government Office for Science
- Scottish Government
- Technology Strategy Board

It is anticipated that additional funding partners may join the programme as it develops.

iii. Added value of working together

16. The funders recognise the continuing importance of food security as a major global challenge and aspire to maintain significant support[23] for research within the constraints of the overall funding available to them. This programme is the result of that shared recognition and joint aspiration.

17. The programme builds on the activities of each of the funding partners and aims to add value to their existing and future investments. The current economic climate gives added impetus to working together to achieve best value from limited resources. The programme does not replace the partners' individual goals and priorities; rather, it aims to recognise and complement them and bring additional coherence by acting as a focus for joint activities and alignment of their individual activities with shared goals. The synergies created by this approach, coupled with the enhanced opportunities to engage with a wider range of stakeholders, are expected to bring considerable added value to the funding partners' investments, maximising the impact of the funding and the extent to which it contributes to improvements in global food security.

18. The programme is being designed within the context of complementary multi-partner and multidisciplinary programmes[24] including those in **Energy**, **Global Uncertainties**, **Lifelong Health and Wellbeing**, and **Living with Environmental Change**. The Global Food Security partners will also engage wherever appropriate with relevant stakeholders (including agriculture, aquaculture, consumers and other food-related industrial sectors, the public, non-governmental organisations, charities and international partners) in order to facilitate and encourage research that addresses the important challenges and to promote effective translation and use of the research (see also Delivering impact: section 4v, below).

19. The programme will provide added value through:

    - **improved cohesion** between funders, end users and researchers – including sharing of views and strategy development at early stages, improved awareness of each others' strategies and priorities, and better coordination of the spectrum of funding to promote more efficient knowledge exchange, translation and commercialisation of research outputs.
    - **providing leadership** – helping to build a more integrated community of researchers and users (in the UK and overseas); acting as a focal point for the diverse research communities, industry, politicians, policy makers and consumer groups; helping to maximise the value and impact of food security research across government, and to make a strong case for that investment; providing a platform to promote wider partnerships, including as a means to lever additional (non-UK exchequer) funding from the private sector and from international partner organisations.

[23] *UK Cross-Government Food Research and Innovation Strategy* (GO-Science, 2010): see its Annex 2 for summary information on remit and activities of all the funders and Annex 4 for detail of research investments (total £415M) in 2008/09.

[24] RCUK multidisciplinary research themes

- **increased impact** through: better coordinated and more effective dialogue with, and stronger links to, wider stakeholders/users (such as agriculture and other industrial sectors, policy makers, the markets, third sector and the public); increased UK-international interactions; linking research priorities and outcomes better to the development agenda, G8 commitments and Millennium Development Goals; a more coherent UK approach to the European Union food security agenda; increasing the impact of research findings on public policy, including regulatory frameworks; use of appropriate mechanisms for evaluation of the success of the programme.
- **increased innovation** through new knowledge leading to new products, processes and policy/regulatory approaches that support and encourage innovation, as well as through novel interdisciplinary approaches to address the challenges of delivering sustainable future food systems. This will include protecting and respecting intellectual property rights to encourage innovation and investment in research.
- **improved horizon scanning and foresight** to identify and respond to emerging priorities, for example by joint analyses and exploiting opportunities to recognise and address gaps and weaknesses in research, skills and facilities.

Some examples of successful collaborations among funding partners

This box summarises some notable examples of joint activities among research funders and the benefits of them working together.

The cross-funder **Rural Economy and Land Use** (RELU) programme supported innovative research projects at the interface of natural and/or environmental science with social and economic research. RELU established new collaborations across these multiple disciplines and enabled ground-breaking research that would not otherwise have occurred.

Current UK initiatives in **agricultural research for international development**[25] promote new collaborations between researchers in the UK and developing countries. The focus is on development and transfer of new technologies and capacity building.

The multi-partner **Living with Environmental Change** programme (LWEC) includes 22 public funding partners who have cooperated in different combinations on a wide variety of activities.

The Technology Strategy Board's **innovation platform in Sustainable Agriculture and Food** was established with core funding from BIS, substantial co-funding from Defra and BBSRC and strategic contributions from the Scottish Government. The aim of this platform is to support business-led collaborative research and development to find innovative solutions to enable industry to respond to the societal challenges affecting the agri-food sector.

The **ESRC-DFID joint scheme for research on international development** is helping provide a more robust conceptual and empirical basis for development and the achievement of the Millennium Development Goals.

The Foresight project on **Global Food and Farming Futures** is a significant collaboration jointly sponsored by DFID and Defra. Its outputs include a collection of reviews of the major drivers of change in the global food system[26], a paper on 'Top 100 questions of importance to the future of global agriculture'[27] and the Foresight report[28] itself.

The Research Councils UK **Energy Programme** aims to position the UK to meet its energy and environmental targets and policy goals through world-class research and training. The Energy Programme brings together the work of EPSRC with that of BBSRC, ESRC, NERC, and the Science and Technology Facilities Council.

The **Joint Programming Initiative** for **agriculture, food security and climate change** is a new activity being developed by European Union member states (see also paragraph 33).

[25] SARID initiative; CIDLID initiative; SCPRID initiative

[26] See footnote 18

[27] Pretty et al (2010) *International Journal of Agricultural Sustainability* 8: 219-236

[28] Foresight: *The Future of Food and Farming* final project report (GO-Science, 2011)

iv. Programme governance and management

20. The overarching principles for the governance of the programme are that management arrangements should:

    - be simple and transparent;
    - be able to deliver added value from the partners working together;
    - provide clear lines of responsibility, accountability, decision making and reporting;
    - be inclusive and responsive to stakeholder/user needs;
    - allow the programme to be agile and action-orientated.

21. A **Programme Coordination Group** will coordinate the research themes with each other and maintain awareness of and links with other relevant programmes (such as LWEC). This group will comprise the leaders for the programme's themes (section 5) and will oversee the delivery of specific work packages that will be developed under the themes. The group will co-opt or draw on the advice of others to bring in additional scientific, stakeholder or other expertise as required. The group will be responsible for managing risks to the programme and for reporting on key activities.

22. It is intended that an independent **Global Food Security 'Champion'** will act as a high-profile ambassador and spokesperson for the programme and a link between the funders, research community, the public and users of research.

23. A **Strategy Advisory Board**, drawn from senior representatives of academia, industry and other relevant stakeholders, will provide independent advice and guidance on the strategic direction of the programme and on technical issues. The Government Chief Scientific Adviser will be a member of the Board and will provide an important link with the cross-government Food Research Group and the wider Food Research Partnership[29]. The programme will be informed by outputs from the Food Research Partnership and its sub-groups, for example on skills, international priorities and the translation of research. The programme will engage wherever appropriate with key stakeholders (both national and international and including NGOs) including those with interests in related areas such as the environment.

[29] These bodies were established in 2009 under the auspices of the Government Chief Scientific Adviser; the Food Research Partnership includes high-level expertise from industry, the research community and others outside government. See http://www.bis.gov.uk/go-science/science-in-government/global-issues/food

v. Delivering impact

24. This section sets out some overall aims and mechanisms for delivering beneficial impacts from the programme; for more about potential impact/outcomes see **Research Themes and Priorities**, section 5.

25. The programme aims to promote and facilitate integrated problem-based research, through encouraging the research community to develop interdisciplinary collaborations proactively and to seek new partnerships that will bring different perspectives and take novel approaches. The funders aim to minimise any potential barriers to supporting such cross-cutting research.

26. Researchers will be encouraged from the outset to consider the potential impact of their research. For example, the Research Councils have already taken steps such as requiring research proposals to include statements on 'pathways to impact', setting out what the researchers will do to explore and take forward the wider impact of their research. Research commissioned by government departments is inherently closer to impact since it is intended to address questions from users. DFID encourage all new projects/initiatives to engage users from the outset. An overall aim of the Global Food Security programme is to improve the interactions and communication among the full spectrum of the research community and with users and policy makers.

27. **Knowledge exchange, innovation and translation:** The translation of research outputs into practical use and application by consumers, the agriculture and food industries, policy makers and non-governmental organisations will be critically important in meeting the future challenges. The programme partners will work closely with users of research to encourage effective two-way knowledge exchange with researchers and so promote rapid and efficient translation into practice, thereby helping to deliver maximum impact from that research. The funders have in place a range of schemes to promote knowledge exchange and to engage with industry, policy makers and other stakeholders (including links with representative bodies such as the relevant Knowledge Transfer Networks and the Agriculture and Horticulture Development Board). The Global Food Security programme will build on existing mechanisms but additional activity will be needed and the programme will explore possible new mechanisms to encourage such interactions. These may include new ways to build effective partnerships with commercial sectors such as retail, with consumers through novel public engagement, and with the diverse range of organisations working in the developing world and elsewhere internationally.

28. Meeting the challenges related to global food security means drawing on knowledge and innovations in a wide variety of research disciplines including animal and plant sciences, applied agricultural science, environmental science, chemical engineering, process engineering, electronics and social science. This programme aims to draw on expertise across the entire food supply chain, encompassing businesses in agriculture, aquaculture and fisheries, food processing and packing, distribution and logistics, and food retailing. There is significant business strength in these sectors throughout the developed world with many organisations having a global presence, so innovative technological solutions will form an integral part of the strategy with a view to exploiting them on a worldwide basis.

29. A key issue for the agricultural sector is accessing the right information to drive their businesses forward competitively and sustainably. The Technology Strategy Board is a key partner in the programme and all the partners will work closely with the Board to build on mechanisms already in

place to promote interactions with a range of commercial sectors and to facilitate translation into practice. The programme will provide a means for exploring potential new public-private partnerships.

30. **Skills:** Addressing the interdisciplinary challenges posed by food security will require a range of high-level skills, in terms of research itself and its up-take by users. The Food Research Partnership's report[30] on high-level skills identified a range of key skills 'gaps' which have arisen in terms of the absorptive capacity of agri-food companies and other users to access, and make use of, emerging research findings. An integral part of the programme will be to ensure that public sector funders work together to support partnership across the wide range of bodies involved in addressing skills needs, such as universities and higher education colleges, agricultural colleges, research institutes, business and professional/trade bodies[31].

31. **Infrastructure for research:** The UK has world-class facilities and resources which underpin agri-food research, and which bring benefits not only to the UK but also internationally in addressing food security challenges. Major facilities and centres of expertise at research council, government and devolved administration institutes are key parts of the national capability, as are strengths in the university sector and private sector[32]. The funders will aim to adopt a strategic approach to coordinate support for research facilities, including cooperation with counterpart organisations in other countries as appropriate.

32. **International:** Food security requires international collaborations and global responses. The programme partners will actively engage in collaborations with overseas partners wherever appropriate. Interactions at various levels will be important, including among researchers but also among research funding bodies. The UK funders will cooperate with appropriate counterpart organisations in other countries and international programmes, building on the many interactions that already exist.

33. Within the European Union, opportunities afforded from the European Commission Framework Programmes are an important route to addressing the common challenges identified. Between national programmes, the emerging Joint Programming Initiative on 'Agriculture, Food Security and Climate Change' (FACCE-JPI)[33] – led by INRA (France) and BBSRC – is developing a shared research agenda and will explore options for joint actions for implementation. Likewise, there are opportunities for cross-talk between the Global Food Security programme (Themes 3 and 4 – see section 5) and the relevant programmes that are in development within the Joint Programming Initiative on 'A Healthy Diet For A Healthy Life' (led by The Netherlands with MRC as the UK Research Council partner).

[30] *High-level skills for food* (BIS, 2010)

[31] One model is the Advanced Training Partnerships scheme (launched by BBSRC in 2010) to bring together consortia of organisations with the aim of addressing the high-level skills needs of individuals employed in the food sector. Awards will be made in Spring 2011.

[32] *BBSRC/HEFCE study of land-based facilities and resources* (BBSRC/HEFCE, 2009)

[33] www.faccejpi.com

34. The Global Research Alliance on Agricultural Greenhouse Gases[34] has been established to help reduce the emissions intensity of agricultural production. It will coordinate research on agricultural emission reductions by linking existing and new research efforts across a range of sub-sectors and work areas. It will look for opportunities and gaps in existing research and find ways to create new collaborations. The heart of the Alliance is its Research Groups, currently covering three broad areas of croplands, paddy rice and livestock. The Alliance is addressing two key issues that cut across the Research Groups, namely soil carbon and nitrogen cycling, and inventories and measurement. The UK is a member of the Alliance and opportunities will be sought to add value to activities within the Global Food Security programme through this international initiative.

35. Strong links are developing between the UK and Brazil, and particularly Embrapa, the leading Brazilian agricultural research organisation, which has major domestic and developing world research programmes and a strong translation capability that is complementary to UK research strengths.

36. Developing countries face many of the most serious challenges. DFID is a key partner in the programme, and all research themes (section 5) will take account of the needs of the developing world for sustainable, safe, affordable and healthier food supplies. Investment in agricultural research is essential if we are to make faster progress to meet Millennium Development Goals. Poverty and hunger are intimately linked: 75 % of the world's poor will continue to depend on agriculture for their livelihoods for the foreseeable future. Continuing to increase agricultural productivity – and doing so sustainably – will be essential. Globally we need to scale up agricultural research in order to tackle animal and plant health and productivity, and the overarching food security challenges of the developing world: rising food prices, climate and other environmental change and drastically changing patterns of food consumption are exacerbating problems of hunger and poverty. The UK is a founding member and among the leading donors of the Consultative Group on International Agricultural Research (CGIAR), a global partnership that aims to harmonise funding for greater research focus on priority issues of climate change, poverty, food security and nutrition.

37. **Public engagement** will be an integral part of the programme. Food security raises many different and often inter-connected issues that are of high public interest in the UK and internationally, not least because it centres on that most emotive of issues: the food we eat.

38. Topics of public interest within the remit of the Global Food Security programme include production/ economics of farming; use of agrochemicals and new technologies; competing definitions of sustainability; equity and other ethical issues around access to food; the role of consumer choice, and the need for healthy diets and safety of food supplies.

39. The programme will adopt best practice methods to engage a wide range of stakeholder opinion on the issues. Engagement and dialogue with the public, including representative groups and NGOs, ensures that researchers can consider public aspirations, concerns and attitudes as they shape the scope and direction of their projects. Effective engagement and dialogue will be essential for building trust and confidence in the work of researchers by making sure that all interested parties have a voice and are listened to, as well as helping to indicate important factors in the application of the research outputs.

[34] www.globalresearchalliance.org

40. Global Food Security will have an integrated programme of communications and public dialogue that will be embedded within its overall governance. This activity will be steered by a Communications and Public Engagement Group comprising representatives of all Global Food Security partners and relevant professional disciplines, supplemented by representatives of proxies for groups within the public, for example research users and consumers. Its programme of work will be facilitated and delivered by dedicated resource within the BBSRC External Relations Unit, working closely with colleagues in the other partner organisations.

vi. Monitoring progress

41. Progress within the programme will be monitored and reported regularly, for example through annual reports, other publications and dissemination events as appropriate.

42. The funding partners will keep the operation of the programme (and its various mechanisms for joint working) under regular review, making adjustments and instigating modified arrangements as necessary. The Strategy Advisory Board (paragraph 23) will have a key role in maintaining an overview of the programme. It is anticipated that the programme's effectiveness will be formally evaluated prior to continued investment beyond 2016.

43. This Strategic Plan sets out some initial research priorities (section 5), and further priorities will be identified in due course as the programme and its themes are developed in more detail. The programme will also develop examples of potential outcomes from research under each theme. It is important to recognise that delivery of the outcomes in practice will also depend on effective take-up and successful implementation by industry and other users of research, including the public, and that this process can take a long time. For example, it can take more than 10 years to develop and market a new crop variety.

5 Research themes and priorities

44. Research in the programme will be coordinated in themes based on those in *Food 2030* and the *UK Cross-Government Food Research and Innovation Strategy*. The themes are deliberately interdisciplinary, bring together complementary research approaches, and cut across the remits of the funding partners.

45. All the themes are (to a varying extent) inter-related and synergistic (as summarised in Figure 1, below). All themes will address cross-cutting issues (indicated by the bars across the bottom of the diagram) such as: innovation and the translation of research; the provision of skills; infrastructure for research; international collaboration and cooperation; and user engagement and communication – see section 4(v) above. The *UK Cross-Government Food Research and Innovation Strategy* sets out more background on these important issues and some steps being taken to address them.

The Global Food Security programme's research themes are:

1. ***Economic resilience*** – securing a better understanding of how poor economic resilience leads to hunger, poverty and environmental degradation across the globe and how this might be addressed

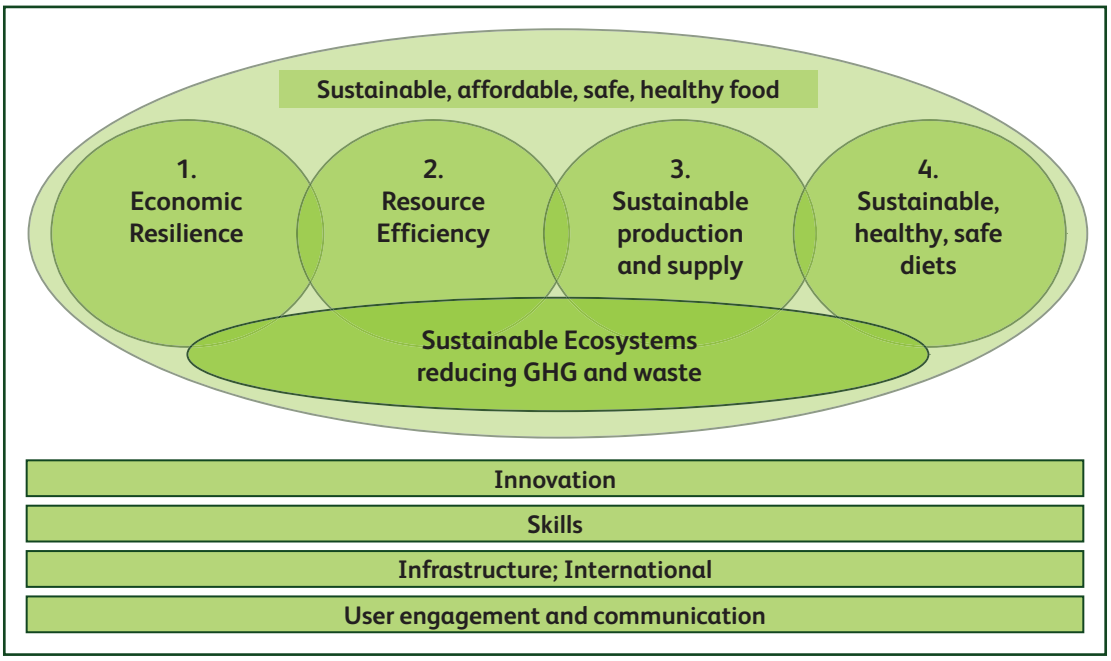
2. ***Resource efficiency*** – including water, energy, nutrients and other inputs; land use and soils, with particular focus on the sustainable use of resources; improving efficiency and reducing waste

3. ***Sustainable food production and supply*** – including farming systems, food production from crops and animals (including fish), food processing, manufacture and transport

4. ***Sustainable, healthy, safe diets*** – including food safety throughout the supply chain, nutrition, consumer behaviour and food choice and accessibility

All themes (but especially themes 2 and 3) will take into account the *sustainability of ecosystems* related to food production (including ecosystem services, land use and biodiversity) and the overarching challenges of *reducing greenhouse gas emissions* and *reducing waste* throughout the food system (shown centrally in Figure 1).

Figure 1: Global Food Security programme themes



46. Each research theme will be co-ordinated jointly by a research council and a government department, but will involve all relevant funders and main stakeholders, and will be coordinated with the other themes. The lead organisations will be responsible for:

    - identifying and leading on activities to define the scope of the themes in more detail;
    - identifying and refining priorities (particularly in areas of interdisciplinary research) taking into account, for example, the output from Foresight projects[35];
    - mapping existing research and related activities across the funders and more widely to identify and address gaps and overlaps;
    - actively ensuring strong engagement with all other relevant funders and interested parties including users and the public, and with the other themes within the programme;
    - bringing together and promoting new interactions and transfer of new technologies among researchers currently supported by all the funders, wherever relevant to their theme.

47. In the following sections, some immediate cross-cutting priorities are identified within each theme, where there are leading topics of clear importance and/or pressing urgency. These may be refined and further priorities will be identified in due course as the detailed plans for research under each theme are developed.

Sustainable ecosystems, greenhouse gas emissions and waste

48. A sustainable food supply system depends critically on maintaining ecosystem services and preserving biodiversity. These help ensure (for example) healthy soils that can provide essential nutrients, a sufficient and clean water supply, pollination services and good air quality. It is imperative that the food system minimises any negative impacts on such essential services and resources. In addition, there is a clear and pressing need to reduce greenhouse gas emissions and to reduce waste throughout the food supply chain. These centrally important considerations will be taken into account across and within all the themes (as indicated by their position in Figure 1): research under each of the themes will address relevant aspects.

Theme 1. Economic resilience

49. Theme 1 covers trade, food markets, economic impact of food safety issues, competitiveness of farming and food businesses, and accessibility to food supplies (including political factors affecting trade and access).

50. It is critical that any research endeavour aimed at helping to address the global food supply challenge focuses at least some of its attention toward securing a better understanding of how poor economic resilience – particularly at the household level – leads to hunger, poverty and environmental degradation across the globe. Economic resilience here means the ability to absorb or respond to shocks in a way which protects food security. Equally important are efforts to ensure these understandings are brought to bear on market, governance policy and regulatory mechanisms through knowledge transfer to bring about beneficial change. This theme will address these important challenges.

[35] See footnote 17

51. The World Bank and the UN FAO have consistently shown[36] (from 1960 to the present day) that there is sufficient food produced across the world to feed everyone on the planet. However, the distribution of prosperity drives the way in which food is distributed, managed, supplied and used, and brings hunger, obesity and environmental damage. Some of these failures are a result of low levels of economic resilience at the individual producer and household level but they are also affected by regional, national and supranational institutions and infrastructures.

52. This theme will focus on developing insights to improve the economic resilience of poorer households and their ability to afford and access food. It will help identify and estimate the effects of both potential and actual disruptive shocks to the resilience of the global food production and supply system at all levels – from local subsistence producers to global markets and emergency response. The theme will provide research evidence to evaluate and inform the effectiveness of interventions which aim to protect against such shocks in the future. The theme will lead to recommendations regarding how to develop and secure economic resilience and recovery in the future.

Theme 1. Economic resilience - Some key priorities 2011 – 2016:

- Improve understanding of the critical factors affecting the economic resilience of households, world trade and the global food supply and show how economic drivers affect resilience.
- Develop and enhance economic models of trade flows, agriculture and hunger that capture the impacts of within-year shocks; also models of the impact of environmental change on agriculture and agriculture on the environment.
- Lead to policy recommendations regarding improvements in infrastructure (and other public goods), governance and broad economic development that contribute to food security in low-income countries.
- Provide a better understanding of the effects of existing markets and regulatory frameworks with a view to enhancing their effectiveness, in particular in relation to managing unexpected shocks.
- Assess international emergency preparedness and responses to international food crises and whether these are risk-based and effective for the least resilient households in the short and longer term.
- Develop insights that inform how policy might underpin risk management strategies to help build resilience for producers and suppliers in the developing world.
- Assess flows of global agricultural R&D, including extension and ethical transfers, their success in improving food security outcomes in low-income countries and lessons for future design.

53. An efficient and equitable food system that delivers the needs of all people in a sustainable fashion is dependent upon fit-for-purpose markets, regulatory frameworks and supply chains, which are flexible and have capacity to respond to and absorb shocks. A resilient food sector will ensure 'fair' prices for consumers and producers, whether they are in the developed or developing countries, while protecting against environmental degradation.

54. Research under this theme will help provide solutions to enhance trade; develop our understanding of access to reliable markets, particularly for the poorest communities and households; identify the relevant role of R&D, extension and knowledge transfer in improving global food security and the appropriateness of emergency responses to food crises (in part through evaluation). Research will need to identify any trade-offs that exist in relation to the above and have a focus on the household level of food security. Poor people in developing countries suffer the most as they often have limited economic capacity, detrimental exchange rates and limited infrastructure investment (e.g. in transport, irrigation and skills) to underpin recovery and resilience. Some such countries may

[36] *OECD FAO Outlook 2010-2019* (page 47) and P. Birch & D. Bigman. *Food security in developing countries.* 1993. CAB International

also suffer from corruption and poor governance. In addition, the least able to respond are often in a state of war or civil disruption, and those countries experience the most serious disruptions to food supply[37].

55. Developing countries have also historically suffered (and still suffer) the worst effects of economic shocks and these are frequently felt in the form of food poverty, hunger and starvation. Food markets have never been 'moral' or equitable ("*millions starve while the dogs and horses of the rich eat up the food of the poor*" – Malthus[38]) and those countries worst affected are also usually the poorest and least able to respond and recover.

56. For these reasons this theme will adopt a predominantly non-UK perspective with a view to finding research solutions to economic resilience in the food economy for those most at danger of disruption. This will emphasise both the role of infrastructure (and other public goods), governance, trade and broader economic development that contribute to food security in low-income countries over the medium term as well as the adequacy and effectiveness of more immediate emergency responses to emerging food crises, including those driven by weather patterns. Research could investigate the relative merits of interventions, in terms of securing better outcomes for the poorest, at different stages of the food supply chain in developing countries.

57. The leading economic models of agricultural markets used by international organisations such as the OECD-FAO are not always sensitive to analysing short-term price shocks. Given that such fluctuations often push many in the poorest countries into hunger, there is a need to develop better understanding of within-year price volatility, its drivers, mitigation and impact on the food insecure. Conversely, over a longer time horizon, it is imperative to improve understanding of the complex interactions between the changing global climate and agricultural supply and markets in order to improve adaptation and resilience.

58. A final issue regards the role of knowledge exchange for research and development in enhancing economic resilience and food security where it is needed most. Significant efforts internationally are being devoted to research, and to extending and transferring the fruits of research and technology into the developing world. An important area for this programme will be to understand what magnitude of commitment and effort is going into this, how this has changed over time, what effect it has had and is having on agricultural productivity and drawing lessons on how public and private research, technology and development can best be targeted and disseminated. In addition it will be important that knowledge exchange is contextualised in relation to variable levels of existing indigenous knowledge. Researchers should, for example, work with farmers during not only the end stage process of engagement following completion of research but should actively seek to understand farm-level needs through the co-design and production of research.

59. ***Relationships with other themes:*** This theme will provide evidence to inform Themes 2, 3 and 4 as part of the overall intention of the GFS programme to provide integrated or whole systems responses to the challenges of delivering a safe, nutritious and affordable diet for all. The focus on how best to translate R&D to enhance food security will also be of key relevance to the dissemination of findings in other themes.

[37] P. Birch & D. Bigman. *Food security in developing countries.* 1993. CAB International

[38] T. Malthus. *An essay on the principle of population.* 1798. J. Johnson

[39] For example, see *The 2007/08 Agricultural Price Spikes: Causes and Policy Implications* (HM Government, 2010)

Theme 2. Resource efficiency

60. Theme 2 covers water, land, energy, nutrients and other inputs, and will focus on: the sustainable use of resources; increasing competitiveness, profitability and efficiency; and reducing waste.

61. Resource efficiency is achieved by the delivery of competitively priced goods and services that satisfy demands and bring quality of life, while progressively reducing ecological impacts and resource use intensity throughout the life-cycle to a level at least in line with the Earth's estimated carrying capacity. Key aspects of eco-efficiency include measures on output per unit input, waste, energy consumption, renewable energy usage and greenhouse gas emissions, as well as external costs (environmental, social and economic) of food transport and food imports.

Theme 2. Resource efficiency - Some key priorities 2011 – 2016

- Reduce greenhouse gas and other emissions from the farming and food sectors with more efficient use of resources and reduced waste.
- Optimise the use of resources (e.g., water, land, energy, nutrients and other inputs) while increasing crop and animal productivity (per unit input) and taking account of climate change.
- Improve sustainable soil management to deliver agricultural production and other ecosystem services.
- Improve understanding of the attitudes, habits and practices that affect current patterns of resource use in the food system, with a view to embedding more sustainable practices in the short and long term (including resilience to climate and other environmental change).

62. This theme will have a particular focus on efficient use of water and nutrients and on quantifying and reducing greenhouse gas emissions and waste. Research and stakeholder engagement will be promoted that is relevant to addressing policy drivers (in the UK and in developing countries) such as reducing diffuse pollution from farms and improving water use efficiency.

63. Tackling diffuse water pollution from agriculture presents several challenges. Research is needed to characterise the relative contributions of different sources, to understand catchment processes controlling pollutant transport and attenuation, and to develop approaches to reduce diffuse pollution. In the UK, the Defra-funded Demonstration Test Catchments provide a platform to host long-term research on pollutant mobilisation, transport, impact and mitigation at field to catchment scales.

64. Reducing greenhouse gas emissions from soils is an important target. In addition, research should explore ways to enhance carbon storage, especially in impoverished soils. Approaches could include modified farming practices, optimised management of crop residues and soils, increased plant root and other biomass in soils, and application of exogenous organic resources such as composts, sludges and pyrolised material (Biochar).

65. Research is needed to increase soil availability of water and nutrients to crop plants while minimising inputs, through for example modified agronomic practices and reducing water waste. Related to this is research to improve the efficiency with which crop plants use water, nutrients and other inputs through crop genetic improvement (see Theme 3).

66. Research is needed to improve energy efficiency and reduce energy use and associated greenhouse gas emissions throughout the food system, notably in food production, processing, refrigeration, transport, and storage, as well as through waste minimisation and utilisation. The programme will work closely with the RCUK Energy Programme to ensure synergies between the programmes are realised and lessons transferred.

67. ***Relationships with other themes:*** research in this Theme on (for example) availability of water and nutrients in the soil will be synergistic with optimising how crops use those resources (Theme 3).

Theme 3. Sustainable food production and supply

68. Theme 3 covers research on all aspects of food production, including farming systems, production from crops and animals (including farmed fish), food processing and manufacture. Integrated and whole systems-based approaches to research will be essential.

Theme 3. Sustainable food production and supply - Some key priorities 2011 – 2016:

- Enhance production and productivity of crops, farmed animals and fish while minimising losses and adverse environmental impacts, maintaining high standards of animal welfare and maintaining essential ecosystem services. In particular:
  - ◊ increase crop yields, and the resilience of yields, through genetic improvement, better crop management and maintaining healthy soils.
  - ◊ reduce greenhouse gas emissions from ruminant livestock through enhanced understanding of their biological processes, leading to improved management practices in agriculture.
  - ◊ develop sustainable approaches to fish farming, including sustainable sources of fish feed and management of pests and diseases.
  - ◊ minimise pre- and post-harvest losses of crops, farmed animals and fish to biotic and abiotic factors.
- Improve understanding of the attitudes and behaviours driving current methods of food production and supply (including associated waste), with a view to better understand how to embed more sustainable practices in the short and long term throughout the food production and supply system.

69. Research is needed to achieve sustainable increases in overall production and productivity of crops, farmed animals and fish. This will include research to tackle long-term challenges with the potential to offer a step-change in both crop and livestock production. In crops, examples could include improving the efficiency of photosynthesis or other long-term approaches to the sustainable intensification of crop production[40]. There is also the potential for major improvements in the efficiency with which crops use water and other resources or exploring the possibilities for nitrogen fixation in cereals.

70. Much can be done to increase crop productivity and production in the shorter term (in both high and low income countries) by closing the yield gap, that is, raising actual yields towards the full potential yields that should be achievable under the prevailing conditions (for example, as achieved on demonstration farms). Approaches could include improved crop rotations and improving soil management.

[40] *Reaping the benefits: Science and the sustainable intensification of global agriculture* (Royal Society, 2009)

71. For livestock, for which demand is increasing rapidly as global incomes rise, examples of research approaches may include increasing energy and protein conversion efficiency, improving herd health and reproductive efficiency, lowering maintenance requirements, as well as closed loop management systems. Reducing greenhouse gas emissions from ruminant livestock is an important and related priority and includes studies of animal nutrition and gut biology. Increased demand for animal-derived food products is likely to drive more farmers to employ more intensive farming methods. The specific welfare requirements of animals in new production systems need to be taken into account to ensure a sustainable food supply without compromising welfare standards. Questions relating to the economic and social effects of the increase in demand for meat and dairy production will be addressed under Theme 1.

72. Aquaculture is seen as being of increasing importance to food supplies globally, but there is a need to develop more sustainable approaches to aquaculture, including sustainable fish feed (to reduce dependence of aquaculture on wild-caught fish), management of fish diseases and pests (notably sea lice) and management of environmental impacts. Approaches could include sustainable exploitation of other marine sources such as algae, production of plant-derived fish feeds that provide necessary nutrients, and integrating aquaculture activities with land-based farms.

73. Losses need to be reduced throughout the food system. Research to reduce losses in food production from crops and farmed animals should aim to enhance resistance to and management of pests and diseases (including animal infectious diseases, many of which are zoonoses that can transfer to humans). Research on pest, disease and weed control for better crop protection would include integrated pest management and other approaches to reduce inputs of pesticides, as well as studies to understand more fully and mitigate the impacts of pesticide use on ecosystems associated with agriculture. Approaches such as intercropping can show marked benefits for pest control[41]. Research should also aim to enhance tolerance of abiotic stresses such as drought, flooding or high temperatures, and reduce post-harvest losses (from pests and diseases in the field, and losses/waste in storage and onwards through the supply chain until food reaches the consumer).

74. Research is needed to improve our understanding of how markets and social drivers affect food producers' methods and technologies, with an aim of developing interventions that will embed production and process innovation practices that are more economically, environmentally and socially sustainable in the short and long term (see also Theme 1).

75. Reducing waste in the production, transport, storage and consumption of food would bring multiple benefits including increased food availability, reduced use of inputs (including energy), reduced greenhouse gas emissions (arising directly from waste food going to landfill and indirectly from all stages of the supply chain) and financial benefits to consumers. Innovative ways are needed to reduce the very large extent of waste in the food system, and to ensure that improvements are implemented in practice at all stages of the supply chain. This can be achieved through innovation in post-harvest technology (such as information and communication technologies, robotics and non-invasive sensors) to reduce storage losses and waste and maximise yield and quality through efficient utilisation of raw materials during processing. Innovation in intelligent/smart packaging technology can reduce spoilage and extend shelf life, including in the home. Flexible manufacturing, energy and water saving/use and re-use systems, and new technologies and management systems are needed to reduce energy and water consumption in food processing, manufacture and retail.

[41] see footnote 40

76. Management of agricultural systems can be improved through the development of decision-support and management systems at a range of scales (farm, catchment, regional) to optimise food production in ways that are reconciled with the delivery of other critical ecosystem services and maintaining biodiversity (see also Theme 2).

77. ***Relationships with other themes:*** food production is inextricably dependent on inputs and appropriate management of resources such as land, water, energy and nutrients (see Theme 2). Economic and social factors (also Theme 1) are critical in determining patterns of food production, supply, consumption and waste. Research aimed at reducing animal and crop diseases in food production and microbial contamination during processing will be important for maintaining food safety, an important component of Theme 4. There is also linkage with Theme 4 on the relationships between food quality, standards of animal welfare, welfare labelling of products and consumer choice. Similarly, research in Theme 3 on how the nutritional quality of foods can be improved sustainably and cost-effectively (e.g. through production practices, genetic improvement of crops or animals, modified processing or packaging) would link with research (in Theme 4) on the impact of such changes on consumer choice and health.

Theme 4. Sustainable, healthy, safe diets

78. Theme 4 includes food safety throughout the supply chain, nutrition, consumer behaviour, food choice and accessibility.

79. Ideally, food should be produced, processed, distributed and consumed in a society where people can access a safe, healthy diet – and are able to make informed choices about what they eat, the origins of their food, its nutritional quality and environmental sustainability. A reliable, safe food supply, which is accessible and affordable, needs to be developed, maintained and secured, with consumers having confidence in the safety of food available to them.

Theme 4. Sustainable, healthy, safe diets - Some key priorities 2011 – 2016

- Microbial and chemical food safety and food intolerance – including current priorities of reducing the incidence of key food-borne pathogens throughout the food supply chain (notably *Campylobacter*); identifying and addressing emerging and re-emerging food safety risks; and the challenges and opportunities (technological, social and economic) arising from the proposed application of emerging technologies.
- Nutrition and malnutrition – including improved understanding of how foods interact with the body; micronutrient requirements; and the differing nutritional needs of various groups who are subject to the challenges posed by food security-related issues.
- Developing a better understanding of what a healthy and safe diet is and how this can be achieved in the context of variable consumer access to resources and limited ranges of food stuffs.
- Food choices – including improved understanding of individual/group behaviour throughout the global food supply chain (from producers to consumption and waste management) in the context of a broad range of food security drivers, such as environmental change, government intervention, technology development etc., with a view to understanding which interventions work best to help people achieve safe, healthier, diets within a sustainable food system.

80. Major programmes of research[42] are in place outside Global Food Security to address topics such as diet and health, food safety and sustainability. It is anticipated that research in these related programmes will be valuable in informing developments in this theme and the Global Food Security programme more widely.

81. An example of the approach envisaged by, and supporting, this Strategy is already occurring in the area of microbiological food safety. To provide safe and nutritious food for a growing world population, it is important to reduce the incidence of food poisoning. *Campylobacter* species are responsible for more than 300,000 cases of food poisoning a year in England and Wales. Three of the signatories to this Strategy have come together to invite research proposals on *Campylobacter* and how best to control it, following the publication of a joint research strategy[43] specifically targeted at understanding and tackling *Campylobacter*.

82. Likewise, the MRC and the FSA have developed an initiative to bring together researchers from their respective communities, aimed at understanding the relevant immunological processes associated with food allergy/tolerance. This initiative will serve to pump-prime the field and provide a platform of expertise and knowledge that will support relevant aspects of the Global Food Security programme. In particular, findings from the MRC/FSA initiative will be informative when considering how changes in the food supply might impact on human health, and provide strategies on how to recognise and mitigate such changes should they occur.

83. ***Relationships with other themes:*** it is expected that much of the research in Theme 4 will be driven by developments under the other themes, and this might include issues around governance of the food system. For example, if research generates a new high-yield crop, the effects of its incorporation into the diet on health will need to be assessed. Likewise, its introduction may have effects on food safety (is it resistant or sensitive to fungal contamination, does it introduce new allergenic potential?) and on wider aspects of sustainability of the diet. Research on issues around food prices and food supply may give rise to concerns over increased drivers for food fraud with potential impacts on food safety, which may require further investigation. Theme 4 is therefore likely to be the most responsive of the themes.

84. In conclusion, the overall objective of this theme is to ensure that, when changes in the food pathway are made for reasons driven by other themes, the effects of those changes on safety and health within a sustainable food system are not neglected.

[42] Examples include:
MRC Human Nutrition Research, Cambridge
MRC International Nutrition Group, London School of Hygiene and Tropical Medicine
FSA food-borne illness research
FSA chemical contaminants research
BBSRC Institute of Food Research, Norwich; Diet and Health Research Industry Club (DRINC)

[43] *UK Research and Innovation Strategy for Campylobacter in the food chain, 2010-2015* (BBSRC, Defra and FSA, 2010)

Glossary and abbreviations

Partners in the programme

RCUK	Research Councils UK
BBSRC	Biotechnology and Biological Sciences Research Council
ESRC	Economic and Social Research Council
EPSRC	Engineering and Physical Sciences Research Council
MRC	Medical Research Council
NERC	Natural Environment Research Council
BIS	Department for Business, Innovation and Skills
Defra	Department for Environment, Food and Rural Affairs
DFID	Department for International Development
FSA	Food Standards Agency
GO-Science	Government Office for Science
SG	Scottish Government
TSB	Technology Strategy Board

Other abbreviations

FAO	Food and Agriculture Organization of the United Nations
GFS	Global Food Security (multi-funder programme)
LWEC	Living with Environmental Change (multi-funder programme)
INRA	French National Institute for Agricultural Research
LWEC	Living with Environmental Change (multi-funder partnership)
NGO	Non-governmental organisation
OECD	Organisation for Economic Co-operation and Development
RELU	Rural Economy and Land Use (multi-funder programme)
UK	United Kingdom
WHO	World Health Organization

Global Food Security is a multi-agency programme bringing together the main UK public sector funders of research and training related to food. For further information and updates see: www.foodsecurity.ac.uk

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