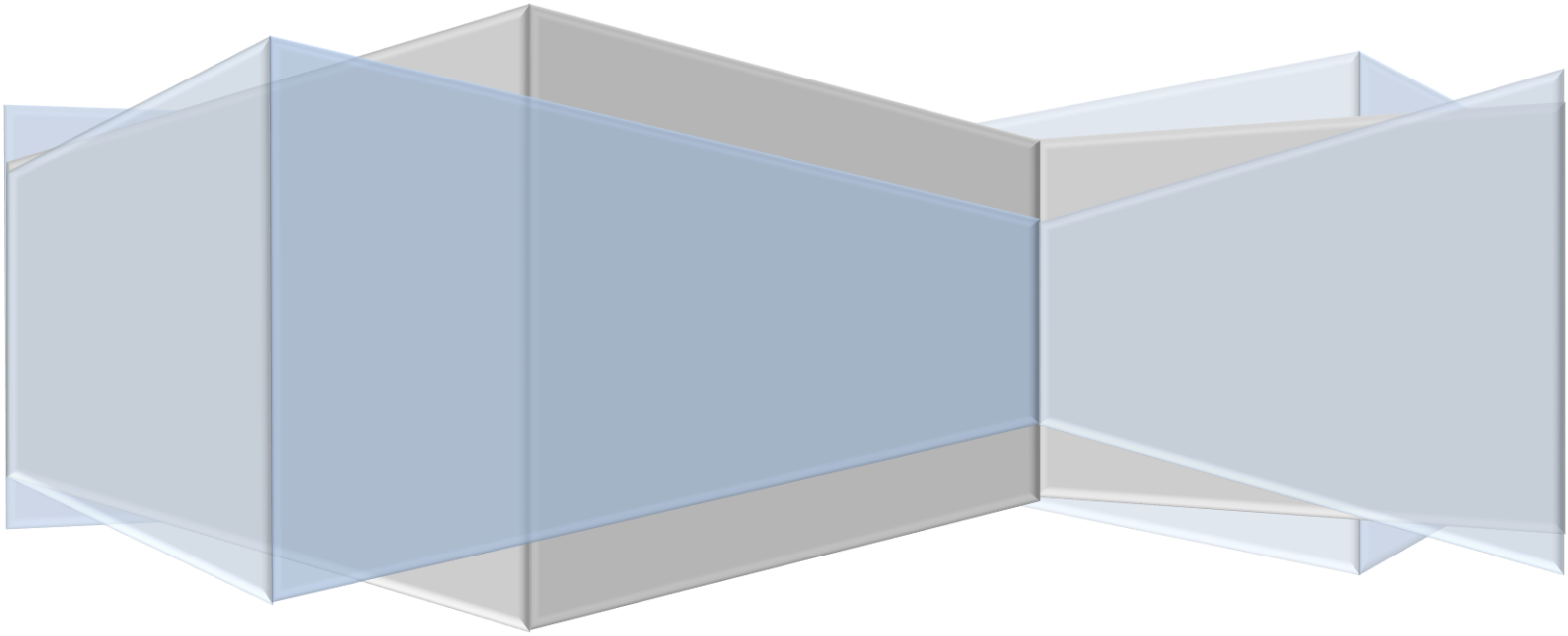
Rustat Conferences ◦ Jesus College, Cambridge

Food Security

Jesus College,
Cambridge
Thursday, 11 September 2014

Rapporteur: Nathan Brooker



Produced under the auspices of
Jesus College, Cambridge

Rustat Conferences

Food Security

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- **08.30 - 09.20**
  Registration and Refreshments - Prioress's Room, Cloister Court
  All move to Upper Hall by 09.30 for conference start

- **09.30 - 09.35**
  Welcome Note from Conference Chair - Upper Hall, Jesus College
  - Professor Ian White, *Van Eck Professor of Engineering, Master of Jesus College, and Chair, Rustat Conferences*

- **09.35-10.30**
  Session One: Introduction and Setting the Scene – Are there alternatives to growing more?
  Are there limits to the amount of food that can be produced and supplied globally? If we can't grow our way to food security we need to change the demand side and our patterns of consumption and waste. What are these limits, what are the critical policy challenges and how do we move forward?
  - **Chair: Professor Tim Benton** *UK Champion for Global Food Security and Professor of Population Ecology, Leeds University*
  - **Professor Chris Gilligan** *Chair, the Cambridge University Strategic Initiative in Global Food Security, Professor of Mathematical Biology, Head of The Epidemiology and Modelling Group, Department of Plant Sciences*
  - **Professor Tim Lang** *Professor of Food Policy, Centre for Food Policy, City University*

- **10.30-11.30**
  Session Two: Health, Nutrition and Hunger – Balancing Public and Private Interests
  Who should take responsibility for food security and the provision of healthy diets? Should private sector supply chains be harnessed to provide affordable and nutritious food to the most needy? Who should pay the costs of public ill health from poor diet?
  - **Chair: Professor Sir Peter Lachmann** *Emeritus Professor of Immunology, University of Cambridge, former President, Academy of Medical Sciences, and former President, Royal College of Pathologists*
  - **Dr Chris Brown** *Senior Director, Sustainable Business, ASDA*
  - **David Northcroft** *Category Varietal Development Manager, Waitrose*

- **11.30-11.50**
  Break - Upper Hall

- **11.50-12.50**
  Session Three: Climate Change and Food Security
  What impact will Climate Change have on global food security? Are mitigation and de-carbonisation solutions? Will lower crop yields and higher prices lead to lower levels of consumption? Is sustainability the issue?

  - **Chair: Dr Aled Jones** *Director, Global Sustainability Institute, Anglia Ruskin University*
  - **Professor Doug Crawford-Brown** *Director, Cambridge Centre for Climate Change Mitigation Research*
  - **Professor Allan Buckwell** *Senior Research Fellow, Institute for European Environmental Policy*

- **12.50-13.50**
  Lunch – Master's Lodge

- **13.50-14.50**
  Session Four: The role of GM in Food Security
  Are societal views on GM wrong? Is current GM regulation aligned to maximise the public good? Under what circumstances could we imagine the adoption of GM technology in the UK and the rest of Europe? Should an Innovation Principle – recently voted for in France – run alongside the Precautionary Principle?

  - **Chair: Professor Janet *Bainbridge*** *Head of Agricultural Technologies, UKTI*
  - **Professor Dale Sanders** *Director and CEO, John Innes Centre*
  - **Mark Driscoll** *Head of Food, Forum for the Future*

- **14.50-15.05**
  Break - Upper Hall

- **15.05-15.45**
  Session Five: Policy-Focused Discussion Panel
  What are the policy messages for industry, not just government?

  - **Chair: Professor Tim Benton** *UK Champion for Food Security*
  - **Professor Chris Gilligan** *Chair, the Cambridge University Strategic Initiative in Global Food Security*
  - **Professor Ottoline Leyser** *Director and Professor of Plant Development, Sainsbury Laboratory, University of Cambridge*
  - **Eugene Philhower** *Councillor for Agricultural Affairs, US Embassy*
  - **Rowan Douglas** *Chairman, Willis Research Network*

- **15.45: Conference Close**

Speaker Biographies

Professor Janet Bainbridge

Janet Bainbridge is Head of Agricultural Technology for UK Trade & Investment (UKTI) with responsibility for delivery of the investment imperatives within the UK agricultural technology strategy. In the past two fiscal years, Janet has been named top investment specialist for new investments into the UK. She is also a member of the Synthetic Biology Leadership Council and was awarded the OBE in 2000 'For Services to Science and Technology'. She is a UK expert and adviser to government in the regulatory framework relating to genetic modification and of the regulation of novel and functional foods and chemicals.

Professor Tim Benton

Tim Benton is the "Champion" for the UK's Global Food Security (GFS) programme, leading, facilitating and coordinating its activities. GFS is a partnership of the UK's main public funders of research in food security, including the research councils and government departments. The role of GFS is to ensure that strategically important research in this area is undertaken, and to add value to research via interdisciplinary collaboration, alignment and engagement of different communities of stakeholders. He is also a leading researcher, based at the University of Leeds, on agri-environment interactions and finding ways to make agricultural production more sustainable.

Dr Chris Brown

Chris Brown is Senior Director, Sustainable Business at ASDA. Before this, he held appointments with MAFF and the Meat and Livestock Commission as consultant and beef strategy manager before he joined Marks & Spencer as technologist. In his current role, Chris guides the ASDA business with responsibilities for sustainable sourcing, customer/colleague/stakeholder engagement and waste/recycling. He is also part of ASDA's parent company, Walmart's activities in sustainable business. He participated in several industry activities most recently the Dairy 2020 future scoping study for GB dairy.

Professor Allan Buckwell

Allan Buckwell is a Senior Research Fellow for the Institute of European Environmental Policy. An Emeritus Professor of the University of Reading, Allan Buckwell joined IEEP in January 2012. Two thirds of his career has been as an academic agricultural economist specialising in agricultural and rural policy. This involved 14 years at Newcastle University and then from 1984-1999 as Professor of Agricultural Economics, Wye College, University of London. During this period, he specialised in teaching and researching into all aspects of European rural policy, dealing especially with the Common Agricultural Policy, trade issues and technology and structural change in farming and its impacts. He joined the Country Land and Business Association (CLA) as Policy Director in 2000. Since then, he has been involved in debates on how to balance the CAP as a policy for Food and Environmental Security.

Professor Doug Crawford-Brown

Douglas Crawford-Brown is Director of 4CMR, Emeritus Professor of Environmental Science and Policy at the University of North Carolina at Chapel Hill, and Director of the Cambridge Field Site in International Energy Policy and Climate Change Risk. His research, teaching and engagement are primarily in environmental risk assessment, sustainable design, environmental policy analysis and philosophy of science in policy.

Rowan Douglas

Rowan Douglas is Chairman of the Willis Research Network (WRN) and leads the Capital, Science and Policy Practice at Willis Group. The Practice confronts large-scale challenges of risk, resilience and sustainable growth at global and local scales through public, private and mutual mechanisms. The WRN has grown to become the world's largest collaboration between public science and the finance sector supporting around fifty universities and science institutions to support improved policy making and capital management. More widely, Rowan chairs the Private and Financial Sector Working Group at the UN International Strategy for Disaster Reduction, preparing the second UN Hyogo Framework for Action Agreement in 2015; and the World Meteorological Organisation Expert Advisory Group on Financial Risk Transfer, preparing for the UN Agreement on Climate Services in 2015.

Mark Driscoll

Mark Driscoll is Head of Food at Forum for the Future, a global sustainability non-profit organisation. He is responsible for the development and delivery of Forum's strategy in food, working with businesses, governments and others with the aim of creating a sustainable, fair and equitable global food system. Having graduated from Wye College, London, with a degree in Agriculture and Environmental Science, Mark has worked in the fields of sustainable development and sustainable food for more than 25 years. He led WWF's One Planet Food programme, worked in Thailand as an Environmental Advisor to the Royal Forestry Department and has worked for the National Trust.

Professor Chris Gilligan

Chris Gilligan holds a personal chair in Mathematical Biology in the Department of Plant Sciences at the University of Cambridge, where he leads the Epidemiology and Modelling Group. He is a professorial fellow at King's College, Cambridge, and recently completed a term of office as head of the School of Biological Sciences, also at Cambridge. He is currently working at the interface between botanical epidemiology, economic modelling and evolutionary genetics to develop models for the epidemiology and control of disease in changing landscapes.

Dr Aled Jones

Aled Jones is the inaugural Director of the Global Sustainability Institute (GSI) at Anglia Ruskin University. His research explores the impacts of global resource trends on political stability and the finance sector. Dr Jones recently chaired a working group on climate finance within the Capital Markets Climate Initiative on behalf of Greg Barker, the Minister for Climate Change in the UK Department for Energy and Climate Change (DECC). He regularly presents on climate change issues to corporates and governments and sits on the UNEP FI insurance sector working group.

Professor Sir Peter Lachmann

Sir Peter is the Emeritus Sheila Joan Smith Professor of Immunology at the University of Cambridge.
He was an assistant director of research in the Department of Pathology in Cambridge between 1964 and 1971 and foundation professor of immunology at the Royal Postgraduate Medical School between 1971 and 1975. Since 1976, he has worked in Cambridge as Director of the MRC Molecular Immunopathology Unit and professor of Immunology. He retired in 1999 but ran a laboratory till 2005 and reopened a small lab in 2011. Sir Peter was also the founder President of the UK Academy of Medical Sciences between 1998 and 2002, the Biological Secretary of the Royal Society between 1993 and 1998 and President of the Royal College of Pathologists between 1990 and 1993.

Professor Tim Lang

Tim Lang has been Professor of Food Policy at the Centre for Food Policy at City University in London since 2002. He was a hill farmer in Lancashire, England, in the 1970s. This formed his interest in the policies shaping the relationship between food, health, the environment and culture. He has been engaged in public and academic research and debate about food policy at local, national and international levels ever since. Tim has been an advisor to Parliamentary Committees, the WHO and the EU, and was a member of the UK Government's Council of Food Policy Advisors between 2008 and 2010, and Commissioner on the Sustainable Development Commission between 2006 2011. He is co-author of many papers and reports, and with Michael Heasman of *Food Wars* (2004, Earthscan), with Geof Rayner of *Ecological Public Health* (2012, Routledge) and with David Barling and Martin Caraher of *Food Policy* (2009, OUP). He is currently working on a book on sustainable diets, and chairing the Food Research Collaboration which seeks closer working on food matters by academics with civil society.

Professor Ottoline Leyser

Ottoline Leyser is the Director and Professor of Plant Development at the University of Cambridge's Sainsbury Laboratory. She is the President of International Plant Molecular Biology, a member of the Council of the Royal Society, and Deputy Chair of the Nuffield Council on Bioethics. She is also Co-Editor in Chief of Current Opinions in Plant Biology and an Editor of Development. Ottoline received her BA in 1986 and gained a PhD in 1990 in Genetics from the University of Cambridge. After post-doctoral research at Indiana University and Cambridge, she built an independent research programme at the University of York, where she worked from 1994-2010. Among her honours are the Society of Experimental Biology's President's Medal (2000), the Royal Society Rosalind Franklin Award (2007), and the International Plant Growth Substance Association's Silver Medal (2010). Ottoline was awarded a CBE in the 2009.

David Northcroft

David Northcroft is the Category Varietal Development Manager at Waitrose, working across all areas of fresh produce. In this role, he works collaboratively with the Buying & Technical teams at Waitrose and across all its global fresh produce supply base, focusing on New Product Development across all categories. In 2005, David was awarded the Bob Matson Young Nuffield Farming Scholarship and studied "Consumer Pressures in Soft Fruit Production". He began his career in the Fresh Produce industry at KG Fruits in 2000. In 2013 he was awarded the Frank Arden Nuffield Farming Scholarship together with Caroline Drummond in 2013 and studied "How can farming use science to improve the nutritional value of food". His study took him to New Zealand, Canada, Belgium, Holland, Spain and Sicily.

Eugene Philhower

Eugene Philhower is the Agricultural Counsellor at the US Embassy in London. A career Foreign Service Officer with over 30 years' experience in international agriculture trade and development, he has served at the US Mission to the European Union in Brussels, the US Mission to the World Trade Organization (WTO) in Geneva, the US Embassy in Lima, Peru, and the US Mission in Kathmandu, Nepal. Eugene has had detail positions with the World Bank's China Department and the Millennium Challenge Corporation (MCC). Most recently, he was responsible for USDA's capacity building efforts in Afghanistan and Haiti.

Professor Dale Sanders

Dale Sanders was appointed Director of the John Innes Centre, an internationally-leading centre in plant sciences and microbiology, in 2010, and where he continues to run an active research programme. Dale graduated with a BA degree from the University of York and went on to obtain a PhD in Plant Biophysics at Cambridge University in 1979. He spent five years at Yale University School of Medicine using fungi as model systems for understanding how plants absorb mineral ions. Dale returned to York as a lecturer in 1983. His research since that time led to insights – through physiological, biophysical, biochemical and genetic approaches - into the fundamental mechanisms by which plants absorb and distribute inorganic ions. These mechanisms have key roles in the control of crucial crop traits such as nutritional value of foods, seed germination, and how plants cope with toxic elements in the soil. Discoveries in Sanders' Lab led to awards that included the Koerber European Science Prize and election as a Fellow of the Royal Society.

Participants List

Prof Janet Bainbridge OBE	*Head of Agricultural Technologies (Investment);and specialist adviser*	*UK Trade and Investment (UKTI)*
Bojana Bajzelj	*FORESEER Project*	*Cambridge University*
Prof Tim Benton	*UK Champion for Global Food Security*	*Prof of population ecology at Leeds University, Faculty of Biosciences*
Nathan Brooker	*Conference Rapporteur*	*Rustat Conferences*
Dr Chris Brown	*Senior Director, Sustainable Business*	*ASDA*
Professor Allan Buckwell	*Senior Research Fellow*	*Institute for European Environmental Policy*
Dr Mike Bushell	*Principal Scientific Advisor*	*Syngenta*
Roger Calow	*Head of Programme, Water Policy*	*Overseas Development Institute*
John Cornwell	*Director, Rustat Conferences*	*Jesus College, Cambridge*
Jonathan Cornwell	*Director*	*Media Symposia*
Prof Doug Crawford-Brown	*Director*	*Cambridge Centre for Climate Change Mitigation Research (4CMR)*
David Croft	*Director of Quality and Technical*	*Waitrose*
Dr Julia Davies	*Plant Sciences*	*University Cambridge*
Rowan Douglas	*Chairman*	*Willis Research Network*
Mark Driscoll	*Head of Food*	*Forum for the Future*

Dr Ruth Eastwood	*Crop Wild Relative Project Co-ordinator*	*Royal Botanic Gardens Kew*
Dr Shailaja Fennell	*University Lecturer in Develoment Studies, Fellow, Jesus College*	*University of Cambridge*
Prof Chris Gilligan	*Chair, Cambridge University Strategic Initiative in Global Food Security; Professor of Mathematical Biology*	*Dept of Plant Sciences, Cambridge University*
Dr Ana Gonzalez Pelaez	*Fellow*	*Cambridge Institute of Sustainability Leadership*
Dr Liz Goodwin	*CEO*	*Wrap UK*
Regina Hansda	*PhD Candidate, Department of Geography*	*University of Cambridge*
Prof Sir Brian Heap	*Past President, European Academies Science Advisory Council*	*German Academy of Sciences Leopoldina, Halle, Germany*
Prof Ian Hodge	*Professor of Rural Economy*	*Department of Land Economy, University of Cambridge*
Dr Aled Jones	*Director, Global Sustainability Institute*	*Anglia Ruskin University*
Micky Lachmann	*Filmmaker and Director*	*BBC*
Prof Sir Peter Lachmann	*Emeritus Professor of Immunology*	*University Cambridge*
Prof Tim Lang	*Professor of Food Policy*	*Centre for Food Policy, City University London*
Jonathan Leake	*Environment Editor*	*The Sunday Times*
Prof Ottoline Leyser	*Director and Professor of Plant Development, Sainsbury Laboratory*	*Cambridge University*
Mark Linder	*Corporate Development*	*Cuadrilla*
Dr Julian Little	*Communications & Government Affairs Manager, Bayer; and Chair*	*Agricultural Biotechnology Council*
Martin Livermore	*Director*	*Scientific Alliance*
Thomasina Miers	*Author, TV presenter and co-founder*	*Wahaca*
David Northcroft	*Category Varietal Development Manager*	*Waitrose*

Dr Laura O'Connor	*Nutritional Epidemiologist, MRC Epidemiology Unit*	*University of Cambridge*
Hadyn Parry	*CEO*	*Oxitec*
Sumit Paul-Choudury	*Editor*	*New Scientist*
Janice Pedersen	*Resources Manager*	*Humanitarian Centre, Cambridge*
Eugene Philhower	*Councillor for Agricultural Affairs*	*US Embassy*
Roger Roberts	*Investment Services Team*	*UKTI*
Sir John Robinson	*Famer and Landowner*	*Cranford Hall*
Prof Dale Sanders	*Director*	*The John Innes Centre, Norwich*
Dr Lydia Smith	*Head of Innovation Farm*	*NIAB Innovation Farm*
Ed Tollemache	*Portfolio Manager*	*Sandaire - Lord North Street*
Adam Wethered	*Vice Chairman*	*Sandaire - Lord North Street*
Professor Ian White	*Master, Jesus College, Chair, Rustat Conferences*	*Jesus College, Cambridge*
Dr John Whittall	*Lead Technologist, Sustainable Agriculture & Food*	*Innovate UK*
Dr Paul Wilkin	*Head of Natural Capital*	*Royal Botanic Gardens Kew*
Dr Ian Wilson	*Reader in Chemical Engineering, Jesus College*	*University of Cambridge*
Dr Jeremy Woods	*Lecturer in Bioenergy, Faculty of Natural Sciences, Centre for Environmental Policy*	*Imperial College London*
Marc Zornes	*former Engagement Manager, McKinsey; Co-founder*	*Winnow Solutions*

Rustat Conferences
Jesus College, Cambridge

The Rustat Conferences are an initiative of Jesus College, Cambridge, and chaired by Professor Ian White FREng, Master of Jesus College. The Rustat Conferences provide an opportunity for decision-makers from the frontlines of politics, the civil service, business, the professions, the media, and education to exchange views on the vital issues of the day with leading academics. Since its founding in 2009, Rustat Conferences have covered a variety of themes including: *The Economic Crisis*; *The Future of Democracy*; *Cyber Security*; *Manufacturing in the UK; The Future of Research-Intensive Universities; The Geopolitics of Oil and Energy; Drugs Policy; Organisational Change in the Economic Crisis.*

The format of the Rustat Conferences is a round-table discussion: expert speakers set the framework for each session by a brief exposition of points followed by a moderated discussion.

Previous participants include: Lord Rees, *Astronomer Royal, former Master of Trinity College, Cambridge, and former president of the Royal Society;* Sir Terry Leahy, *CEO, Tesco*; Baroness Pauline Neville Jones, *UK Government Special Representative to Industry on Cyber Security*; Adam Wethered, *Director, Lord North Street Ltd*; Sir Kevin Tebbit, *Chairman, Finmeccanica UK*; Paul Skinner, *Chairman, Infrastructure UK, and former Chair, Rio Tinto*; Professor Bernard Silverman, *Chief Scientific Adviser, Home Office*; Jon Moynihan, *Executive Chairman, PA Consulting Group*; Lord Turnbull, *former Cabinet Secretary and Head of UK Civil Service*; Dr John Jenkins, *HM Ambassador to Iraq*; Sir Samuel Brittan, *Financial Times*; Sir Richard Dearlove, *former Chief, Secret Intelligence Service MI6*; Sally Keeble MP, *Treasury Select Committee*; Baroness Onora O'Neill, *former President, British Academy*; Jonathan Neale, *Managing Director, McLaren Racing*, Dominic Casserley, *Managing Partner, McKinsey & Co. UK & EMEA*; Simon Hayes, *Chief Economist, Barclays Capital*; Chris Saul, *Senior Partner, Slaughter and May*; David Strachan, *Director, Financial Stability, FSA;* Lord Eatwell, *Professor of Financial Policy*, *University of Cambridge*; Lord Wilson, *former Cabinet Secretary and Master, Emmanuel College, Cambridge*; John Harley, *Head of Private Equity, Ernst & Young*; Will Hutton, *The Work Foundation*; Tony Wright MP; Peter Kellner, *President, YouGov*; Matthew Taylor, CEO*, RSA, former Chief Adviser on Strategy to the Prime Minister*; Robert Chote, *Director of Institute for Fiscal Studies*; Lord Gus Macdonald, *Senior Adviser Macquarie Infrastructure and former Minister Cabinet Office*; Professor Sir David Omand, *former Director GCHQ;* Dr Richard Bridge, *Head of Government Political Affairs, BP.*

In addition to acting as a forum for the exchange of views on a range of major and global concerns, the Rustat Conferences provide outreach to a wider professional, academic, student and alumni audience through the publication of reports. The conferences are held at Jesus College, Cambridge and are named after Tobias Rustat (d.1694), an important benefactor of Jesus College and the University. Tobias Rustat is best remembered for creating the first fund for the purchase of books for the Cambridge University Library. The Rustat Conferences are supported through sponsorship and the Rustat Conferences Membership scheme - we are grateful to members Lord North Street Ltd and David and Maria Willetts for their support.

Rustat Conferences

Food Security – 11 September 2014 - Jesus College, Cambridge

Executive Summary

Food Security is one of the most important challenges facing the planet today, but also one of the most complex. With an estimated 1bn people currently living under threat of starvation and 1bn people obese, it is a problem not of simply maximising production, but also of controlling demand.

The Rustat Conference on the Food Security, by bringing together leaders who would not usually meet from the worlds of business, academia, government and the media, attempted to determine what a consensus view of the issue might look like and how that might best be communicated to politicians and policy makers.

The following summarises the main outcomes of the meeting set out in response to key questions raised during the day:

1. **What do we mean by food security?** A major problem with optimising food security is that it means different things to different people. Policy-makers use the term to address adequacy of food supply – typically in developing countries; while to the trade, it means keeping shelves stocked and at the right price. The consensus view was that it should refer to how well suited a food system is at matching supply with demand, but with an increasingly complex set of direct and indirect considerations (climate change impact, globalisation, the rise of NCDs), devising best-practice advice is harder and harder to agree upon.

2. **How do we improve the stability of systems?** Developing agri-technical solutions to sustainable intensification and "closing the yield gap" is important, but the managing food loss to waste and disease is paramount in controlling stability. To be clear:

    a. Managing waste: It is estimated that agricultural wastage costs $70bn a year, divided between pre- and post-harvest waste. In the UK alone, an estimated 15m tonnes of post-harvest food is wasted every year, roughly split 50-50 between homes and the commercial sector.

    b. Minimising disease risk: The tendency among providers to choose the latest varieties of pesticide promotes crop homogeneity, which can be dangerous when new disease strains occur. Instead, an emphasis on heterogeneity needs to be put in place; and one with an increased sense of localism, choosing the right crops/livestock for the terrain and climate.

3. **What role should GM crops take?** The development of GM crops will not solve food security issues on its own, but it is an effective tool in the process. While public attitudes to GM have softened since the 1980s and '90s, it is still a contentious issue and one capable of sparking moral and ethical debate – though much of the plenary thought that there should be no moral dimension to GM discussions at all. EU regulation is currently hamstringing R&D drives in GM technology and is effectively out-pricing SMEs and making the technology the reserve of big business.

4. **How important is climate change?** At present, agriculture accounts for a relatively small part of the discussion on climate change – it is estimated at being somewhere between 10-15 per cent of the problem – though this is likely to change. Effectively, the impact of climate change on food security breaks into two constituent parts:

    a. Scientific: As changes in the climate develop little is known about the resultant impact on food systems because it is yet unclear which physical factors will have dominance over yield. There are three main scenarios:

        i. *Temperature* – if temperature turns out to be the key factor in crop production then climate-scientists are relatively well placed to predict how this might affect crop yield. Certain plants cannot live above (or below) certain temperatures

        ii. *Water availability* – the science here is much less certain. Changing rainfall patterns are harder to forecast and, therefore, any negative impact on crop yield is harder to ameliorate.

        iii. *Atmospheric CO2* – one might presume that crop yield would increase with a rise in atmospheric CO2. This is far from certain, though, as recent studies show the level of CO2 in crop production performance is (at or near) optimal.

    b. Economic: Socio-economic realities are far more pressing to agricultural communities in the developing world than issues pertaining to climate change. While developed nations have been responsible for the current level of CO2 in the atmosphere, from this point forward the issue will be entirely controlled by non-NXI nations. Consensus is split between two resultant scenarios:

        i. Food consumption patterns in developing nations mimic western nations

        ii. The ensuing food crisis in these areas will re-limit resources

What constitutes public health best-practice and how should these messages be communicated?
Consensus on public health advice was nearly unanimous. In brief, certain dietary modifications were recommended by the plenary. These included – but were not limited to – the following:

a. More diversity
b. More plants, fewer cattle for meat
c. More horticulture, less agriculture
d. More cereal (consumed direct, not fed to animals)

Little consensus was reached as to how these were communicated, however. In the past public health advisers have relied on consumer education drives. However, as policy levers, these are far weaker tools for change than tax-implementation and rationing, which are reserved for cases of 'last resort' or in times

of acute crisis. With public health in its current state, though, many thought Britain and the west were already in a state of crisis.

Are there alternatives to growing more?

Introduction and Setting the Scene

Chair: Professor Tim Benton, *UK Champion for Global Food Security and Professor of Population Ecology, Leeds University*

Professor Chris Gilligan, *Chair, the Cambridge University Strategic Initiative in Global Food Security, Professor of Mathematical Biology, Head of The Epidemiology and Modelling Group, Department of Plant Sciences*

Professor Tim Lang, *Professor of Food Policy, Centre for Food Policy, City University*

Professor Tim Benton said that our food system is in dire need of restructuring. "Recent estimates say that well over a billion people in the world are malnourished," he said. "Simultaneously, well over a billion people are obese."

Addressing the human costs, the environmental costs and thus the costs to the public purse, alongside the economic gains that the agri-food system delivers, Professor Benton said he would like to come away from the conference "with some sort of wish list: a set of actions that we can agree on that would push the system in the right direction."

He then introduced the conference's first speakers:

Professor Chris Gilligan said that, though it is difficult to get an estimate of the true losses caused by pestilence and disease, scientists are confident that it is a major concern. In light of that fact, food security innovators need to think about methods of control and heterogeneity. When new pesticides or disease-resistant crops are developed, there is a tendency among providers to choose the latest varieties, but this only promotes crop homogeneity, which can be dangerous when new disease strains occur.

The question, then, is to assess and identify what the natural scale of production and the natural heterogeneities are in any given eco-system. "There are major ethical and philosophical – as well as scientific and social – questions to decide over who gets the newest varieties," he said.

Take Nigeria as an example, a country of 160 million people, of which 100 million are dependent on cassava, a potato-like crop. There are several diseases that pose a threat to cassava, currently none are present in West Africa, but that could cause a major food shortage if they were transported there.

The professor then brought to the attention of the plenary a recent study that he was involved with entitled 'Importance of Food-Demand Management for Climate Mitigation'.

Assuming that by 2050 the world's population will have grown to 9.5bn, food production would need to increase by 60-100 per cent to meet demand. "So how might this be achieved?" he asked.

For the supply side, an increase would be needed in cultivated land[1], as well as a necessary reduction in what is called the 'yield gap'[2], brought about through sustainable intensification.

For the demand side, he suggested that reducing waste – not only the huge amount of harvest waste that is currently being felt in the developing world, but also pre- and post-harvest waste reduction measures would be needed – and altering dietary balance by relying less on meat from livestock.

The following is a diagram showing the breakdown in land use and distribution:

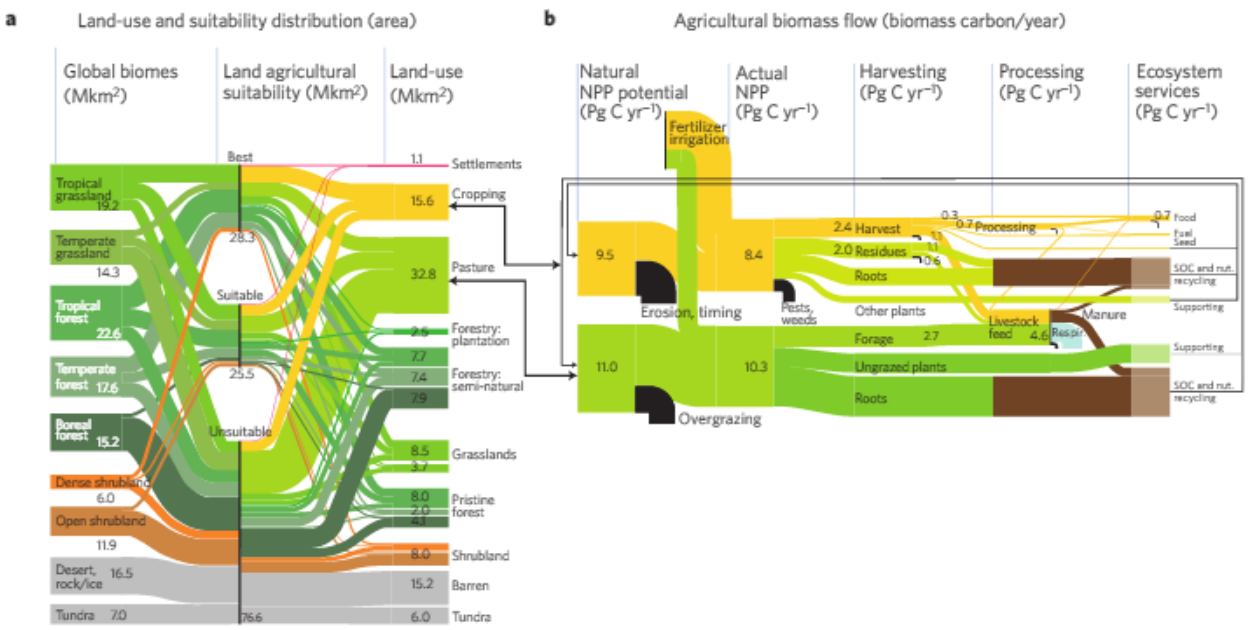


Figure 1 | Distribution of terrestrial biomes, suitability and land use and its connection to the global agricultural annual biomass flows for 2009. a, Major global biomes are traced onto three classes of land for agricultural suitability. 40% of the total ice-free land area is suitable for agriculture, of which about half is already in agricultural use for either pasture or cropping. **b**, Pasture and cropland areas support agricultural biomass growth, which we follow through harvesting and processing stages, to the delivery of final services. In both panels the width of each line is proportional to the magnitude of flow. Black lines show losses.

The study looked at the scenarios, ranging from a 'business-as-usual' trend to those where various efforts have been made to close the yield gap. The scenarios are plotted on the following table:

[1] He added that projections should not ignore the possibility of a step-change – a technological breakthrough that would boost productivity beyond its current trajectory. He cited the development and implementation of C4 photosynthesis, for example, a much more efficient type of photosynthesis with regards to crops such as rice

[2] 'Yield Gap' is defined as the difference between an observed yield and what is attainable in a given region

Table 1 | Main parameters for the six core scenarios, split into two groups.

Scenarios	Yields		Demand-side reductions	
	Current trends in yields	Yield gap closures (sustainable intensification)	50% food waste reduction	Healthy diets
CT1	×			
CT2	×		×	
CT3	×		×	×
YG1		×		
YG2		×	×	
YG3		×	×	×

The Current Trends (CT) scenarios assume yields in each region will continue to increase at current rates[4]. The Yield Gap (YG) scenarios assume that sustainable intensification will achieve yield gap closures[10] in all regions. Both yield scenarios are set against three different options on the demand-side: no changes to the system; a 50% reduction in food and agricultural waste; and waste reduction as above plus a move towards healthy diets, meaning the average consumption of sugar, oil, meat and dairy is limited according to expert health recommendations[37–40].

The next table shows the impact of those different scenarios on key resources:

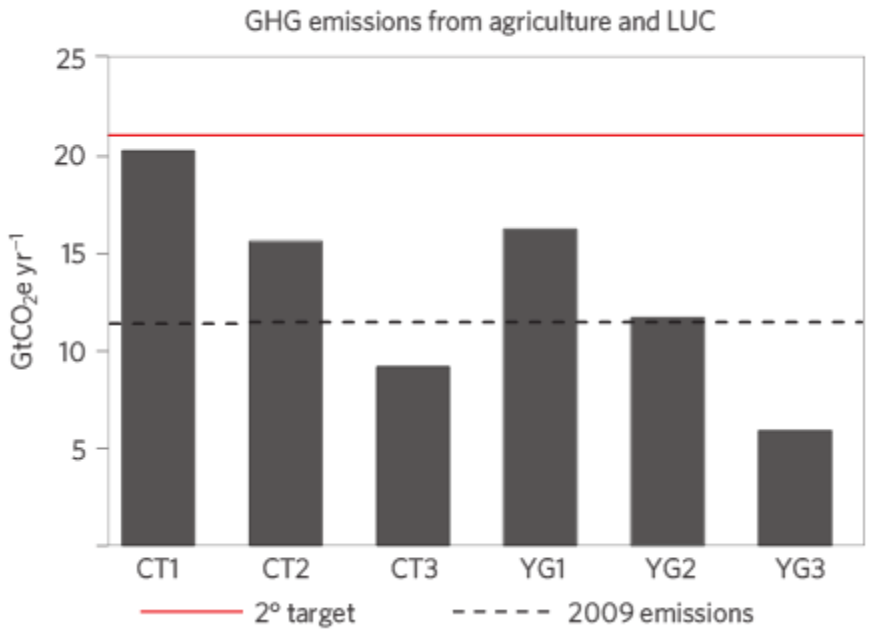
Table 2 | Main indicator outputs for six 2050 scenarios.

	Units	2009*	CT1	CT2	CT3	YG1	YG2	YG3
Cropland	Mkm^2	15.6	22.2 (+42%)	19.2 (+23%)	18.2 (+17%)	16.4 (+5%)	14.2 (−9%)	13.7 (−12%)
Pasture	Mkm^2	32.8	37.1 (+13%)	33.7 (+3%)	25.4 (−23%)	37.7 (+15%)	33.9 (+3%)	25.8 (−21%)
Net forest cover†	Mkm^2	26.1	22.6 (−14%)	23.9 (−8%)	26.0 (−0%)	24.0 (−8%)	25.9 (−1%)	27.2 (+4%)
Tropical pristine forests	Mkm^2	7.9	7.2 (−10%)	7.3 (−8%)	7.5 (−6%)	7.5 (−6%)	7.7 (−3%)	7.7 (−3%)
Total GHG emissions	$GtCO_2\ yr^{-1}$	11.4	20.2 (+77%)	15.7 (+38%)	9.3 (−19%)	16.2 (+42%)	11.7 (+2%)	5.9 (−48%)
Fertilizer use	$Mt\ yr^{-1}$	106	154 (+45%)	136 (+29%)	125 (+18%)	190 (+79%)	161 (+51%)	145 (+37%)
Irrigation water use	$km^3\ yr^{-1}$	2,890	6,370 (+120%)	5,410 (+87%)	5,270 (+82%)	4,500 (+56%)	3,830 (+33%)	3,790 (+31%)

Percentages in brackets are relative to values in 2009. In the two scenarios with no demand management, cropland area increases for 5–42%, pasture for 13–15%, there is significant deforestation and an increase in GHG emissions. YG scenarios fare better across the indicators, with the exception of fertilizer use. Demand reduction measures on the other hand improve all indicators. *Showing middle values[23,24,31,49], uncertainty ranges are up to ±70%. † Excluding boreal forests.

Professor Gilligan drew special attention to the rate of greenhouse gas emissions projected in first the current trend scenario (CT1), which indicates a 77 per cent increase on today's levels. However, by closing yield gaps, reducing waste by 50 per cent and implementing some dietary changes, not only would GHGs be cut, but so too would crop land, pasture and forest use be reduced.

Finally, focusing on GHGs, Professor Gilligan showed the following table:



"One striking message one gets from this graph is that business-as-usual could be catastrophic," he said, "but if we can close the yield gap, and utilise those supply-side changes, then we can halve our CO2 emissions."

Addressing the question Professor Benton posed at the start of the session, **Professor Tim Lang** outlined his three wishes as follows:

- A comprehensive set of sustainable dietary guidelines – "because, frankly, policy is away with the fairies at the moment in this regard."
- A reform of institutions
- A plan B – The EU does not have Food Security on its agenda, and this must change

A major problem devising a strategy to promote food security is that it means different things to different people. On the one hand, policy-makers use it to address adequacy of food supply, usually in developing countries; while on the other, it is sometimes used simplistically to indicate whether supermarket shelves are full and the food is at the right price. The term is essentially about whether the food system is matching supply and demand, but its trickiness comes from the fact that many other issues are wrapped around that match or mismatch. The modern world of food has become far more complicated than when William Beveridge argued in *British Food Control* (1928) the lesson of history is that "a benign state" is required to sort out competing demands.

"Today," said Professor Lang, "the only sensible approach to food security is through making the food system sustainable."

So how did the food system we currently have become so unsustainable? Part of the problem today is that we have inherited an approach to food and food security which was created by the Beveridge generation, which stressed increased production as the way to meet demand. "The productionist approach has been to unleash science, technology and capital to increase output, get distribution right, and bring down prices. This has been fantastically successful in the 20th century," he said, "but what people didn't expect was the consequences to public health and the environment."

The British food sector is worth £196bn. Only £9.2 bn (4.6 per cent) of that figure goes to agriculture. The money is taken by other sectors across long and lengthening supply chains. "Catering takes almost as

much of consumers' spend (£84bn) as retailers (£112bn). This is the world of a permanently eating economy."

Food culture has changed, not just in the UK since the time of Beveridge's book, but worldwide. The position of women, where the food work is, the internationalisation of complex supply chains, everything has changed. But evidence on the state of the food system now allows us to summarise the problems with the productionist paradigm:

1. It assumes that consumers are in command – but they lack good guidance[3]
2. Food systems have become increasingly complex, to the point where we can ask who is in control
3. The policy-makers of the past never imagined the proliferation of NCDs[4]

Advisers on public heath have been incredibly good at presenting evidence, but very bad at connecting it and making a case for systemic change, he said. "We have been driven into consumerist language and labels, yet consumer education as a policy lever, is among the weakest weapon in our armoury," he added. "We barely consider the strongest such as fiscal or rationing, except in crisis. But from an ecological public health perspective the mismatch of people, bodies and food is in crisis."

Personally, Professor Lang said, he would like to see the planning of food system that centred on food as the connection between public and environmental health.

Such a system would focus on encouraging demand to support:

- More diversity from field to stomach
- More plants, fewer cattle for meat
- More horticulture, less agriculture
- More cereal (consumed direct, not fed to animals)

Such a food system would need, argued Professor Lang, to:

- re-address consumer culture
- develop shorter supply chains
- give more money to primary producers
- start integrating public health with environmental health in public policy

With reference to that last measure, Professor Lang said that we need to promote sustainable dietary guidelines that operate on a national level, a bio-regional level, a European level and at a global level. "In November," the Professor said, "the International Congress on Nutrition is meeting and so far, scandalously, of the 65 draft recommendations only one is tentatively pointing in that direction."

Discussion

The first delegate suggested that, while comprehensive dietary guidelines were a nice idea, "none of this will do any good unless one controls world population." He added that the moral and ethical turmoil that surrounds this question stems from the fact that all major world religions still have a world-view derived from the point of view of an endangered species – one where reproduction is considered a natural duty. "What is essential is that we move into an ethical paradigm where reproduction is considered a privilege and that certain sanctions should be taken on those who have too many children."

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[3] Professor Lang described this as partly a political problem. "Politicians are scared of consumers," he said.
[4] Noncommunicable Diseases

In essence then, the delegate argued population growth and food security need to be brought together. “Treating the UN projections [about the world population] as if they were inalienable and unstoppable facts is a terrible mistake,” he added.

Professor Lang said he was more positive than the delegate that spoke, saying that population growth was actually slowing dramatically – a fact he attributed to better education and income distribution.

Other delegates re-emphasised Professor Lang’s more positive spin on population growth, saying that measures were already being taken – and successfully so – to slow reproduction rates. Specifically, this was down to the education of girls which, some insisted, is far the best measure in reducing family size, without the need to resort to punitive measures.

The next delegates asked whether the attitude governments have taken over tobacco could be applied to unhealthy foods. Professor Lang said that the comparison was imperfect, but that there was some “embryonic policy lessons to be learnt” from tobacco.

The next delegate described two underlying issues not being talked about – firstly, that there is a problem with collective responsibility, with too many sectors passing the blame on to one another; and secondly, the willingness to engage in a multi-faceted solution.

Professor Chris Gilligan said that, with his team, he has repeatedly stressed the need for a multi-faceted solution. “However,” he said, “getting a collective action is much more challenging,” and suggested that the media could be used to help policy-makers achieve this.

The next delegate wanted to promote the feeding of waste food to livestock and encouraged the panel and the plenary to get behind her project The Pig Idea (http://thepigidea.org/).

Further discussion came from the idea that dietary guidelines in western Europe would be very different to those of, say, rural China, and that all notions of sustainable food systems need to be entirely rooted in their geography. In that respect, one delegate asked how such guidelines would be globalised.

Professor Lang said he agreed very strongly with the fact that sustainable dietary guidelines would need to be local, but that the principles would be universal. He then posed a question: how regional is too regional? And proposed that, at the extreme, a person living in north Wales might be offered different dietary advice to someone living in Suffolk because the land is different and different crops and livestock breeds could be cultivated and kept there more efficiently.

Health Nutrition and Hunger

Session Two: Balancing Public and Private Interests

Chair: Professor Sir Peter Lachmann, *Emeritus Professor of Immunology, University of Cambridge, former President, Academy of Medical Sciences, and former President, Royal College of Pathologists*

Dr Chris Brown, *Senior Director, Sustainable Business, Asda*

David Northcroft, *Category Varietal Development Manager, Waitrose*

Professor Sir Peter Lachmann began by asking the plenary what constitutes a healthy diet. "I ask because the answer is not quite as simple as we might pretend," he said.

"In this country there is no doubt that the rationing diet we had during the Second World War was very successful. […] But since that time, people have been able to eat what they want and we have what seems to be an epidemic of coronary heart disease and, more recently, metabolic syndrome."[5]

Bad dietary habits can be reversed, but we first need to establish what a "good diet" is. "Dietary advice has changed many times in my lifetime," said the professor, with cutting out saturated fats, trans fats and carbohydrates all being championed at one point or another. Current understanding, he said, is to blame health problems on too much salt and sugars.

Another factor to consider is how children's dietary habits affect health and weight later in life. Professor Lachmann spoke about the work of David Barker, who discovered that what is particularly important to life-long health is one's nutrition in their first year. "He found that the worst situation is [when] people are deprived of food in foetal life and in their first year, and then exposed to unlimited food later."

Dr Chris Brown said that retailers like himself were guilty of "customer worshipping", where the demands of the consumer – regardless of dietary advice – are met wherever possible. "That is what pays my wages," he said. One of the main problems with this is that, in the UK, the customer has been rather spoiled. "We have lived in this country for three or four decades without any compulsion," he said, "we can buy what we like when we like without restriction and that is how the customer thinks."

What is more, he said, what the customer knows about the impact of nutrition on health is, at best, a "patchwork of confusion."

Dr Brown then described a typical working mother's relationship with Asda:

> The kids come home at six o'clock, the question is: 'What's for dinner?' There are no ingredients in the house so it's a frozen dinner versus a take-out or a trip to the store – all this against a timeframe that says: 'We need to see Great British Bake Off, mum, hurray up'. She's got no ideas because there is a panic in terms of time, so she'll go with a good old standby which, naturally, will be met by the kids saying: 'Oh no, not that again.'

[5] A collection of diet and lifestyle--based problems including obesity and diabetes.

Dr Brown then highlighted what this typical Asda customer's five considerations were:

- The need to provide a heathy meal
- The need to get everything prepared and served on time – including shopping time
- The need to make everyone happy at dinner time
- The need to stay within a budget
- The need to get it all done in a typically limited amount of kitchen space

And lifestyles have changed, he said. "My grandmother used to like making mashed potato. After all, what could be more convenient than buying the potatoes, washing them, peeling them, boiling them and mashing them?" he joked. "Today I sell seven different types of ready-prepared mashed potato."

Remember the scale of the problem too. For a family of four, that equates to 84 meals a week, or more than 4000 meals a year. "So though guidelines are great," he concluded, "we must remember the practical constraints on encouraging healthier diets."

David Northcroft spoke about a study he was involved with last year entitled: "How can farming use science to improve the nutritional value of food?"

Mr Northcroft said that, with his background in retail, he was used to dealing with considerations on behalf of the consumer (e.g. appearance, shelf-life and taste) and for the producer (e.g. disease-resistance and yield). "But nutritional value is not something that often comes into the equation," he said.

"Can we be in a position, moving forward, where we can marry the two?" he asked, "Producing food of better quality, rather than just focusing on quantity?"

It is a worthwhile pursuit, he said, given that 64 per cent of the UK population are overweight or obese, a figure which costs the public £5bn a year.

Despite the piecemeal warnings – the five-a-day message, or warnings over diabetes – Mr Northcroft asked: "What is the tipping point that makes an individual person change their habits? What can we do to prevent health crises from occurring, rather than trying to clean up the damage?"

During his study, Mr Northcroft visited food specialists in New Zealand, where he was impressed by how joined up the thinking was between nutritionists, plant breeders and soil scientists throughout the supply chain all the way to the retailers. "Although their Vital Vegetable programme hasn't necessarily been a huge success at consumer level, the principle of improving the quality of food and its nutritional value is there and can be built upon."

There is also a problem with language. Beneforte broccoli – a more nutritionally substantive breed of broccoli – has sold very well in Scandinavia under the title 'Super Broccoli'. However, regulation within the EU prevents retailers marketing it as such and sales have not been as strong.

"There is the argument, then," said Mr Northcroft, "that if this breed of broccoli is so much more beneficial, why should it be seen as the niche and not the new norm?" He described a change in attitude of nutritionists and retailers that could result in a 'health by stealth' set of strategies.

Mr Northcroft then spoke about the impact a healthy eating agenda could have on internet shopping. "IPods and iPads are bought as generic items off a shelf," he said, "but as individuals, we all personalise them […] Ultimately shouldn't that be the way diets are changing?" Retailers are attempting to do this

now, producing personalised services for their customers, but the next step is to tailor dietary advice to individual consumers.

Discussion

The first talking point came from Professor Lachmann who asked if healthy drives – such as the reduction of salt levels in processed foods – is the responsibility of the retailer or the supplier.

Dr Brown said that there has been cross-industry support to reduce the levels of salt in food, but that it must be done gradually. “If you just drop the salt levels, people will put them back,” he said, adding that the consumer must take some of the responsibility too. “There is ample information printed on the front of the packs so if the consumer wants to make an informed decision whether to eat a lot of salt or not they are able to do so.”

The next delegate questioned the concept of “customer worship” that was mentioned earlier in the discussion. He recited a quotation: “Henry Ford and Steve Jobs didn’t get where they are by asking the public what they wanted; they told them what they needed.”

Dr Brown said that this was an interesting analogy, but there were differences. “You have to take the consumer with you every step of the way,” he said, “Otherwise they will leave you behind.” He gave the example of stocking endangered fish species. “If you just stop selling a type of fish that people want they will take their shopping baskets and go elsewhere. But, if you explain to them why you can no longer stock that product then they are more likely to understand and to choose something else instead.”

Mr Northcroft agreed: “If you can’t talk to the customer in a way that they can understand, then it’s very difficult to get more nutritious products to them.”

“Also, if there is a problem with the content of some of our products then come and tell me and we can try to resolve it,” said Dr Brown, “but don’t just blanket us all and paint us as pantomime villain retailers.” Standards along the supply chain are scrutinised like never before, he added, with videos of malpractice being available on the internet in a matter of minutes, transparency is something retailers have to live with these days.

With regard to healthy eating drives – such as the lowering of salt levels – the next delegate asked the panel where they thought the line was drawn between voluntarily implementing measures (that nevertheless kept shareholders happy) and where a regulatory body should step in and control the fat, salt and sugar content of foods.

“Many countries have introduced fat taxes and salt and sugar taxes,” said Dr Brown, “and in some cases these work – but where to draw the line is for the wider society to decide. That’s more a question of what sort of society do you want to live in.”

The next delegate described the discussion about the power of retailers as “uniquely British - much as the last session was a uniquely British way of talking about meat,” he said, adding that he was recently in a conference in Brazil where the suggestion that people should eat less meat was met with consternation: “Don’t you dare tell us that,” he was told.

The next delegate raised the point that the debate should include dietary supplements – especially in overseas communities when crops fail. He said, “What supply areas are you most worried about?”

“Changed climate is a big worry,” said Dr Brown, “I don’t use the phrase ‘climate change’, because it’s too wrapped up in political philosophy and belief, but we have to deal with changed climate and we have lots

of documentation on that […] also diseases," adding that diversifying modes of supply is crucial to having good food resilience.[6]

The next questions centred around small-holders – again, especially overseas – and about how major retailers like Waitrose and Asda interact with them. Dr Brown said that, as a for-profit organisation, Asda does business with them on a similar basis to large providers, but that special care needs to be taken with small holders with regard to fulfilling things like chemical-use regulation. Also using small holders was a way to benefit those local communities, largely by aiding the education of women, who make up much of the workforce.

With regard to growing populations, one delegate said that developing countries would likely undergo mass urbanisation drives, often ones which are unpopular to locals. "How will your companies help with this situation?" he asked of the panellists.

"Politicians often ask us to do things that they don't want to do because it will cost them votes," said Dr Brown. "And I'm sorry to sound like a red-clawed capitalist about this, but that's the challenge: they don't want to do things that they think will upset the populace, but they are happy for me to do it on their behalf." He stressed that changes will need to be made as populations grow – "I don't think it will result in rationing or anything like that," he said, but that that was the nature of major economic and societal change.

The next delegate asked whether supermarket shelves should be arranged colour-coded in order to help people distinguish between what they should and should not be eating a lot of.

Dr Brown said this wouldn't work. "Just about every supermarket I now is arranged with fresh produce at the front of the store," he said, "and you have to walk all the way through it to get to a cream cake."

Mr Northcroft said that most of his shoppers operate on what he called a "credit or debit" system, so that what they buy on a Friday night is likely to be more indulgent and worse for them than what they buy on a Monday. "Not every shopping trip is the same," he concluded.

[6] Dr Brown clarified a point made by Professor Tim Lang in the previous session about how "food security" means different things to different people. "To me," Dr Brown said, "food security is a policy matter; food resilience is how I keep my shelves stocked."

Climate Change and Food Security

Session Three: Is sustainability the issue?

Chair: Dr Aled Jones, *Director, Global Sustainability Institute, Anglia Ruskin University*

Professor Doug Crawford-Brown, *Director, Cambridge Centre for Climate Change Mitigation Research*

Professor Allan Buckwell, *Senior Research Fellow, Institute for European Environmental Policy*

Professor Doug Crawford-Brown said that agriculture, at present, is a relatively small part of the discussion on climate change, roughly accounting for what he estimated at being between 10-15 per cent of the problem.

"Compared to the decarbonisation of energy systems, that is very small," he said. "But although it doesn't play that large a role in negotiations at the moment, as energy systems are decarbonised, it will become more and more important."

Professor Crawford-Brown then broke down his presentation into four sections: science, global economics, cost-benefit analysis and then a section the professor entitled: "Food security is not the same as Food Profligacy."

1) Science:

"We are not remotely sure what the impact of climate change will be on agriculture," he said. If temperature turns out to be the primary factor in agricultural productivity, then people within the climate-science community would be able to make fairly sound projections. "However, where we really fall apart horribly," he said, "is on the hydrological side." If changes in rainfall patterns turn out to have the biggest impact on agricultural productivity, then projections are incredibly uncertain, especially on a 30-50-year timeframe.

If a crop's output is driven by the availability of carbon dioxide, then it is clear there will be an increase in productivity. However, this might be unlikely, as a recent study suggests cultivation efforts have meant plants are already at or near their limit when it comes to responding to carbon dioxide.

2) Global economics

When it comes to agriculture, the climate science is not the most important aspect, socio-economic realities are.

"At climate negotiation [meetings], everything is about the bottom of the economic pyramid,"[7] he said. "Therefore, it is quite clear that any climate policies are going to have to allow the non-NX1 nations to rise up."

While the developed nations have been responsible for the current level of CO2 in the atmosphere, from this point forward – and the speed at which we approach the two-degree temperature increase, which constitutes a doubling of CO2 levels in the atmosphere from pre-industrial times – the issue will be

[7] Professor Crawford-Brown described this as being made up of the 3.5-4bn of the world's poorest people.

entirely controlled by the developing nations. “If you were to stop all emissions today from developed nations you would postpone that doubling by 60 years.”

The question then, is what will happen to the consumption patterns of people in those developing nations?

Climate scientists suggest that there are two competing influences: one, that consumption patterns will begin to mimic those found in places like the US; and two, that the ensuing food crisis will increase prices dramatically, reducing spending power and therefore re-limiting consumption in these areas.[8]

3) Cost-benefit analysis

“If you look at the problem as a macro-economic problem the cost-benefit analysis is flawed,” he said. If you were to look at a macro-economic model, where each nation has 100 economic sectors, the cost-benefit analysis approach assumes that any adverse effects you have one sector – all it agriculture - will be to the detriment to the entire economy.

“But money doesn’t disappear,” he said. “It goes elsewhere in the economy”.

Therefore, he asked if rising prices are simply a negative thing, or will they help produce more economically efficient economies around the world – and, as a result, drive economic development in those parts of the world that need it most.

4) Food Security is not Food Profligacy

“We will not be able to have a situation where everybody moves to an American-style diet but that is not necessarily a bad thing,” he said, referencing the ill effects on health and weight that it accords.

The question is: what kind of agricultural system can we afford in the climate policy world?

The professor pointed at the Netherlands as a good example: “Agriculture’s real influence lies in land use and land use change,” he said. “And if instead what you’re doing is producing your food in hydroponic chambers and you’re not making changes in land use, then you don’t have many of the problems that arise in the climate model.”

In conclusion, he said, the climate negotiation world is leaning toward a sense of consumption-based accounting. Up until this point it has all been production-based accounting – so if food producers in Ghana give off excessive CO2 emissions while producing food for the UK, then they are the ones who receive the penalties. “The dirty little secret in the UK and the EU is that, despite the fact we say we have reduced CO2 emissions, we haven’t […] we have just sent them off to other countries.”

But consumption-based accounting is still a very new field, so exactly how we move forward with the formation of policy is still unclear.

Professor Allan Buckwell said we are being too pessimistic about the future of food security and climate change. Referencing the study that Professor Gilligan presented earlier, he said: “When you model five-or-six global aggregates – like crop areas, forest areas, pasture areas and so on – you’re almost by definition aggregating over such variation that, to be frank, I do not believe the numbers.”

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[8] The professor said that this second scenario is problematic since the developing nations will simultaneously undergo a massive economic upheaval, meaning any projections based on their current purchasing power are ‘missing the point’.

And though he was supportive of the intention to carry out such research, he said: "If you think macro-economic modelling is difficult, then modelling the global food supply with as few variables as [those expressed in the study] is quite a brave thing to do."

Broadly, there is a systematic underestimation of research and development and its effect on productivity, which the professor said was one of the best-established economic relationships of the past 60 years.

"You may say that I am a naïve techno-optimist," he said, "but it seems to me that 20th-century challenges in food production were a lot greater than the 21st century's."

Not least in his reasoning, he said, was the fact that in the 20th century the population growth was considerably larger than the one being projected today.

The only important counter-factor in those two cases is the presence of climate change, he said, but even that is unclear as to its aims. To prove this, Professor Buckwell then read out some of the conclusions from section seven of the IPCC's Fifth Assessment Report. One example, cited by the report as being made with 'high confidence', is as follows:

> All aspects of food security will be potentially affected by climate change, including food access, utilisation and price stability.

But the professor pointed out: "potentially affected" is not particularly assertive; "so we have high confidence in a not very strong statement," he said. Furthermore, with regard to climate change-driven price increases, the report projected an increase by 2050 of between 3 and 84 per cent. "To be honest, is that statement worth anything at all?" the professor asked.

It is often said that modern or intensive agricultural practices are unsustainable, meaning that they are currently undermining their own capacity for indefinite continuation. "Now, I question this statement," he said. "Firstly I can't find a universal definition of sustainability," he said, "and I am suggesting that we have no evidence as to what and where the limits are."

Plants will not survive above certain temperatures, said Professor Buckwell, that is certain, but beyond that, projections regarding the loss of biodiversity, fuels, fertilisers, landscapes and water, there is no clear evidence as to what those limits are.

He said his intention was not to discourage those scientists researching in the field, but to encourage more scientific research as to where the limitations are and how close we are to them.

Many agricultural practices in the developed world do have negative environmental impacts – soil erosion and compaction, water and resource depletion, biodiversity destruction and cultural landscape degradation – but whether the trends in those variables are rendering the system unsustainable, is not clear. "Especially since agricultural productivity is growing," he said.

That is not to say that nothing should be done. The professor said that agriculture practices should be intensified, with an improved level of what he called "environmental performance"[9] by "applying more knowledge to every square hectare of land that is managed".

There is huge scope to improve the productivity of agricultural practices, especially in the developed world. "If only we put as much time in helping the farmers understand the environmental impacts of their

[9] He preferred this term to "sustainable Intensification"

activity [as we do constructing climate-change models] then we would enable them to maintain productivity and significantly reduce their negative environmental impacts."

The policy conclusions that Professor Buckwell then suggested, boiled down to two recommendations:

- We have to use agricultural policy to steer towards so-called 'sustainable intensification'
- R&D policy needs to be geared towards providing information and advisor services to farmers

Though consumer-side changes like eating less meat and cutting down fats, sugars and salts, are vital, while it is still unclear as to whether regulatory bodies or better information initiatives are more effective tools to incite change, time and resources must be devoted to improving agricultural production.

Discussion

Before opening up the debate to the plenary, **Professor Jones** said that he regarded himself as what he called a "techno-socio optimist", in that he believed the problem, though difficult, was a solvable one. "The only problem is," he said, "we are not currently investing enough in the problem."

Many delegates that spoke agreed with the plenary's championing of R&D funding as a vital tool to protect food security.

Professor Gilligan said that he welcomed Professor Buckwell's challenge and his optimism. "Though, I don't think it is a question of optimism," he said. "I think to a degree everyone in this room is optimistic, otherwise we wouldn't get up in the morning."

He said he rejected the idea that his study was too simplistic. Instead it attempted to provide a transparent framework for assessing different scenarios. "It is not enough," he said, "to say simply, 'we must improve agricultural practices.'" He said the study provides a 'heathy scepticism' and that it could be used as a tool to identify where gaps in our knowledge are currently located.

Professor Buckwell said he agreed with Professor Gilligan's point.

Other delegates spoke out about the dangers of optimism. "Lack of evidence does not mean lack of a problem," one delegate reminded the plenary.

Much of the discussion that followed centred around notions of 'sustainable intensification' – "which sounds like an oxymoron," noted one participant. Much would need to be done overseas, said one delegate, who added that some new technology, like renewable energy sources, should be made available to producers that are made up from or in the same community as the so-called "bottom billion".

"Drives have been made to reduce the yield gap in the UK and the west, and rightly so," he said, "but the yield gap in Africa is vast." He added that over the last 50-60 years there has hardly been any increase in cereal yield per capita in the region. "The potential must exist," he said.

Another delegate question why sustainable intensification is only usually applied to farming – "why not conservation?" he asked, suggesting that we could invest in creating those habitats that promote biodiversity.

The next delegate questioned the emphasis the session seemed to take on producing more and better data. "It's not always data that is going to help intersect the problems here with popular culture […] We also need to think about making an emotional case too," he said.

The role of GM in Food Security

Session Four: Are societal views on GM wrong?

Chair: Professor Janet Bainbridge *Head of Agricultural Technologies, UKTI*

Professor Dale Sanders *Director and CEO, John Innes Centre*

Mark Driscoll *Head of Food, Forum for the Future*

Professor Janet Bainbridge stressed the importance of an open mind when discussing the role of GM crops in food security, which has been historically a contentious issue. "In this discussion, it is absolutely vital to express [one's] views freely," she said.

The biggest issue overhanging the food security debate is population growth, she said, which requires an uplift in food production of an estimated 70 per cent. She said she would like the discussion to take that into account from the beginning.

She said that, on balance, she was optimistic about the future of food security and the role of GM crops. "But I also want to look at the advances in non-GM," she said. "Between 2008-12, there was an 8 per cent increase in the number of pigs born per litter to sows that had a 17 per cent decrease in food intake over the same period. That's completely non-GM," she said, "That's good animal husbandry."

Professor Bainbridge spoke about the antagonistic relationship that GM had with the public in the 1980s. At the time the context for the debate was one of miss-communication and lack of understanding; but today, faced with possible food shortages, the landscape is very different. "It doesn't help that there is still so much misinformation produced," she said, "but the public attitude to GM has softened."

"Will GM solve the problems facing food security?" she asked. "Absolutely not. Will it help? Absolutely yes."

Professor Dale Sanders said moving genes around has been with us since the beginning of agriculture, and that genetic modification is an extension of that. "That said," he added, "GM cannot be taken in isolation [and separated] from great agronomy."

Genetic improvement enables the full genetic potential to be attained, he said. The four areas the GM can assist are:

- Yield
- Food quality
- Cost
- Reduce environmental impact

With reference to the last point, the professor said that new EU regulation will affect the amount of agrochemical use – a measure that could seriously reduce the UK's production of oil seed rape. If we can find genetic alternatives to extensive chemical use, he said, then that could be an area where GM technology lessens environmental damage.

There are further advantages to GM, he said, one of them being speed of breeding. "We spoke earlier about the development of super broccoli," he said, "that was a conventional breeding project started at

the John Innes Centre in the late 1980s and only reached supermarket shelves three years ago. If GM practices had been used in that project it would have taken far less time."

A second improvement is precision. In conventional breeding there is a phenomenon called 'linkage drag', where deleterious traits are introduced into the process unintentionally.

Thirdly, it allows you to introduce into organisms completely new traits not associated with their species.

Professor Sanders then gave examples of different projects currently underway that were aiming to benefit from the use of GM, describing firstly efforts to reduce fungal blight susceptibility in potatoes. "Typically, a farmer each year will make 12 sprayings of antifungicide on their potato crop," he said. In trials about 1 in 3 crops were negatively affected by blight, but research carried out at the John Innes Centre produced inoculated varieties that were insusceptible to the infection and so required no spraying whatever.

Another study looked at cereal yields in Africa and how GM tech could help close the yield gap. "Typically, they are currently producing between 10 and 20 per cent of their genetic potential because the soils there are poor in nitrogen, and the cash – and infrastructure - isn't there to pay for fertilisers to counteract this." At present, those fertilisers, which are common in the west, account for around half of agriculture's carbon footprint, so increasing them would not be beneficial in any case. The project currently underway at the John Innes Centre – a project funded by The Gates Foundation, with no associated IP rights whatsoever – could potentially enable a nitrogen-fixing cereal to make better use of its surroundings.

"Whenever you discuss GM you need to look at the benefits, not just for the consumers, but for the producers and the environment," he said. Then, moving on to discuss the objections to GM, he cited the four main categories into which they tend to fall: health, environment[10], economics and what the professor called a "quasi-religious" blind mistrust of the artificial.

With regard to any negative impact on health, the professor paraphrased former chief scientific advisor to the government Professor Sir John Beddington, who calculated that since the introduction of GM crops 15 years ago, two trillion meals have been eaten in the US (the most litigious nation on earth) and there has not been a single case of someone suing for the deleterious effects of eating GM produce.

With regards to the environmental negatives, the professor said that he was not aware of a single trial cited for harming the local surroundings which has not been the fault of bad agronomy, rather than the GM itself.

Moving on, the professor said that he thought the regulation of GM within the EU is outdated and cumbersome. "It rests on the precautionary principle," he said, "which says we should be cautious with the advent of new technology. But I would argue that this is not new technology, it's pretty much tried and tested."

Furthermore, the regulatory hurdles, including the costs, prohibit GM as an avenue for SMEs. This is ironic, he added, because as he mentioned before, much of the objection to the GM economics is due to a dislike of big business. "The regulator action anti GM groups have pushed for, therefore, has actually played into the hands of big business."

The professor concluded his talk by saying that recent technological advancements in GM have moved the debate forward. So-called genome-editing technology is blurring the lines between GM and non-GM and

[10] Including horizontal gene transfer and herbicide-resistant wheat

the regulation needs to change accordingly. His final recommendation was that new regulation be drawn up according to the trait – i.e. what you are putting into the organism – rather than method.

Mark Driscoll said that he was a believer in the idea of scientific limits, and that needed to be taken into account when discussing GM food security.

“My perspective is very much the perspective of the consumer,” he said, “and why they have been reluctant to accept GM technology.”

Mr Driscoll said that much of the antagonism between the public and GM is not down to the science, but rather how the research development academic community engages with consumers.

“I am quite neutral when it comes to the use of GM,” he said, “I believe it has a potential role to play, but there are bigger issues that need addressing first.”[11]

We should be reframing the sustainable food debate so that it does not simply refer to increased production or tonnage-per-acre, but to increased nutritional value.

“GM is upon us,” he said. “We use it whether we like it or not, whether we are pro or against.” Estimates show that 80-90 per cent of the soya for livestock feed is effectively GM. Not only is GM not the “’knight in shining armour” come to save food security, said Mr Driscoll, but it may actually be a red herring to R&D drives, since so many resources are devoted to it.

“To my mind working on roads, or better grain storage infrastructure facilities in the developing world actually achieve much more than billions of pounds invested in GM R&D.”

Consumers have been not been engaged in the GM debate, he said, and it has remained incredibly insular. Many supporters have been hoping that, over the years, growing public understanding of GM would result in a greater acceptance, but the evidence doesn’t show this. “Improving knowledge has seemed to strengthen opinions, rather than shift them.”

Mr Driscoll said that we were then left with a difficult question to answer: “How can we develop a multi-stakeholder approach to GM technology that will prevent some of these hugely opposed and frictional views?”

He then suggested two areas for improvement:

- Concentration – wider engagement is a must
- Transparency – we need better explanation of science (and benefits)

Discussion

The first delegate wanted to clear up some misconceptions about GM. “Firstly,” he said, GM as a general technique is entirely neutral. All plant breeding involves genetic modification. To discuss the morality of GM technology in general is giving credence to people who just don’t understand the subject”

There is also a misconception with the morality of the precautionary principle, he said, adding that it is predicated on an assumption that doing harm by omission is better than doing harm by commission.

[11] The bigger issues he itemised as food-wastage and sustainable diets

Professor Saunders said that, though he agreed with everything the delegate said, he wanted to stress that he thought moving forward in the debate was not to attack anti-GM groups, but rather to work with them on their objections.

Mr Driscoll disagreed with the delegate's interpretation of the precautionary principle, saying that he thought it was there to protect society from what he called "fundamental risks and errors".

Other delegates wanted to stress that GM has become such a high-profile political issue that it has had a deleterious effect on other food security issues.

Another participant asked, with reference to Professor Saunders' assertion that the time taken to develop "Super Broccoli" would have been cut down by GM technology, were there other projects that could have their time-to-market – and crucially their cost – reduced. "Is it then a question for economists to explain the financial benefits of GM tech?"

Another delegate suggested that the treatment of food security in the UK is presented at two extremes – either concerning itself with hi-tech GM science or with a "knit-your-own-ciabatta" style ethos. What the delegate thought the debate was missing was enough information on the enormous swathe in the middle which constituted standard food production.

Another delegate said that he thought the umbrella term GM was damaging, and we ought to start talking about specific crops or other products. His work with malaria-carrying mosquitos, he said, has been very well received by consumers in Brazil. "Remember an issue is only political if it will win or lose votes, so it's voters you need to convince […] when you explain the specifics of a new technology and what it can do for them, they tend to react much better than when you talk about something in general."

Policy-Focused Discussion Panel

Session Five: What are the policy messages for industry, not just government?

Chair: Professor Tim Benton, *UK Champion for Food Security*

Professor Chris Gilligan, *Chair, the Cambridge University Strategic Initiative in Global Food Security*

Professor Ottoline Leyser, *Director and Professor of Plant Development, Sainsbury Laboratory, University of Cambridge*

Eugene Philhower, *Councillor for Agricultural Affairs, US Embassy*

Rowan Douglas, *Chairman, Willis Research Network*

Professor Tim Benton said that too often discussions over policy "wish away" current circumstances. He stressed that he would like the following session to focus instead on practicalities: "The question is: where can we get to from where we are now?"

Rowan Douglas spoke about the way insurance companies assess food systems. He said he would like to offer one observation and one suggestion. The observation was that the food security issue required a "unifying lens," that takes into account its impact on consumers, business people, policy-makers, scientists and lawyers -"There is a strong basic human rights agenda in access to food," he said. "Otherwise, we'll all be shouting at once and policy will be made up of a bit of this and a bit of that and we won't get anything done. And people will suffer."

Mr Douglas then outlined his suggestion. "About 20 years ago my industry [insurance] suffered what can only be described as an existential crisis," he said, describing the aftermath of Hurricane Andrew in 1992, which resulted in a massive depletion in capital for insurance companies due to a high-level of claims.

"This crisis brought about a philosophical change in the industry," he said, which saw the realisation that an analysis of the resilience and sustainability of a system should deal directly with extremes, rather than the mean. The crisis posed the question: "What should be the tolerance of an insurance contract?" he said, "and no one had ever asked that before." Eventually, a figure of maximum possible loss was reached which was 1 in 200-250 years.

It was an action that paid off, he said. "In 2011, the worst year in history – Tohhoku, tsunami, terrible tornados in the States - [It cost] $121bn in insurance claims. The market didn't even move."

"What we must do, then," Mr Douglas said, "is apply these sorts of stress tests to the wider economy [and to] food security."

The result would be an intensification of interest and resources in the sector, he said. "As soon as capital is held against these risks on an enduring basis, your business understanding food security becomes a very exciting combat sport because the models you use and the decisions you take will affect capital in an incredibly way."

The involvement of investment analysts and other representatives from the financial sector would sure up the debate.

"There is only one country in the world that has the various elements of finance, regulation, science and progressive public policy that could bring the parties together […]. Fortunately, that is this country"

Professor Chris Gilligan said that a focus on low-probability high-impact events was important, "but let us not forget," he said, "a billion people are going to bed each night hungry, which we must address."
He then said that he would make six quick points that he thought would advance the debate:

1) We need to stratify the globe so we can think clearly about the different needs of developing and developed countries.
2) We need to give more thought as to who the opinion-formers are.
3) We need to identify what we want to achieve – not just from the supply side but from demand.
4) Improve the integration of knowledge – "we need to get more bang for our buck"
5) What are the quick wins? This will spur on the issue and the remedy.
6) Should government bodies such as Defra have food security as one of its priorities?

Professor Ottoline Leyser stressed the need for recognising the complexity of the food security issue. "We often have an anxiety, either to look for the magic bullet – which doesn't exist – or else to runaway screaming at the horrible complexity of the thing. Policy makers have got to understand that."

Important levers in the debate, she said, was to decide what actions could be taken at national and international levels.[12]

Eugene Philhower said that, from his experience working in Haiti, the most important thing in improving food security was agricultural production. On this front, Mr Philhower said that there needs to be greater private and public sector investment in R&D. However, this needs to be strategically spent. "There is an enormous gap," he said, "between the research institutions and the farm."

However, the way the gap is filled – and the way supply and demand shortcomings are made up for – needs to be tailored to the location. In the UK, public health drives are positively responded to, but in the US, such initiatives are often viewed with suspicion and as evidence of a "nanny state".

Discussion

The first delegates to talk spoke about the need to get behind innovation. "The area that would really provide a win-win, though," he said, "would be in waste reduction." He described it as a $750bn-problem, which represents the second largest research-productivity opportunity in the world after energy efficiency.

The next delegate stressed the need for food security to be included in the national curriculum. "Between 0 and 7 is the age to capture people with this," she said, "that way we can take advantage of the natural and social engagement with issues over what is in food and where it is coming from and the like."

[12] Waste reduction would be a national issue, water preservation an international one.

This point was taken up by the next delegate who spoke, saying that he thought food security was a great way to train students in inter-disciplinary thinking.

The next participant asked about the impact of increasingly severe weather patterns, when once-in-500-year events were seemingly happening every few years.

Mr Douglas said that that phenomenon was just the sort of thing that they needed to think about when they were devising their insurance programme.

“The usual channels of pubic persuasion – through nudges and incentives – won’t work in this case,” said he next delegate. “We’ve spoken about identifying the ‘opinion formers’,” he added, “but I think there needs to be more discussion as to who these people are.”

The final delegate to speak described what she thought was a failing in people’s human rights. “The right to food is a well-established human right,” she said, querying why there is not more legal involvement in the preservation of food security supply chains.

Conclusions:

Professor Tim Benton:

I challenged the plenary to suggest three things that would move things in the direction of sustainable food security – and this was the consensus:

1. Develop guidelines for what makes a "sustainable and nutritious diet" (e.g. along the lines of the assumptions made in the attached paper). These guidelines could then help nudge people and the agri-food industry into providing better advice.

2. Invest in more research as a priority to understand local and planetary guidelines. As per our discussion on soils, we know that we are degrading soils rapidly, but it is difficult to predict at which point "unsustainable use" will undermine ability to produce food, and without having better estimates, we're still in "woolly territory". The agri-tech strategy is fine in pushing investment in raising yields, but we need better to understand where the ecological limits are.

3. Encourage a shift in the mental frame of reference. Rowan Douglas (from Willis Re) pointed out that 2 decades ago, the insurance industry was not regulated around an assessment of their total risk, and in the late 80s a string of disasters came close to bankrupting the industry. Since then, they are now regulated to ensure that they can cover a 1 in 200 year risk across the board. Clearly, they now have to better understand the risks of disruptive events, assess the evidence and ensure they carry sufficient capital to underwrite. Rowan's idea was to use the rules of capital management more constructively. If, for example, the food industry had to assess the risks of future supply disruptions and report their exposure to the risks, and perhaps more importantly, how they were managing the risks by increasing resilience (and sustainability), in addition to other necessary reporting functions (financial risk and accounts etc) this would then, again, provide a lever for engagement with the issues. So, a food company with little action on risk-management would find it harder to get insurance and finance etc. The key concept here is that resilience to shocks (e.g. climate impacts) is related to sustainability (good soil management helps both).

4. Natural Capital Accounting is a good idea about maintaining natural capital to provide ecosystem services for the people. However, "sustainability" inherently requires maintaining services at a "landscape" scale. Encouraging NCA at a smaller administrative scale (e.g. local authority scale) would perhaps provide a more natural link (i.e. at an appropriate scale) between environment and local needs, and serve as a valuable planning tool.