Government Office for Science

Foresight

Food for 2050: how can sustainability stay on the menu?

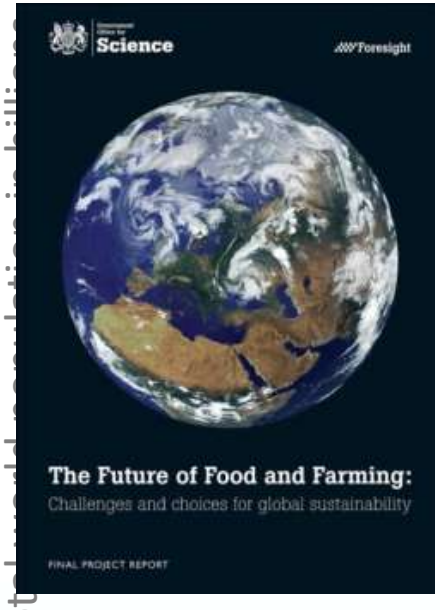
..

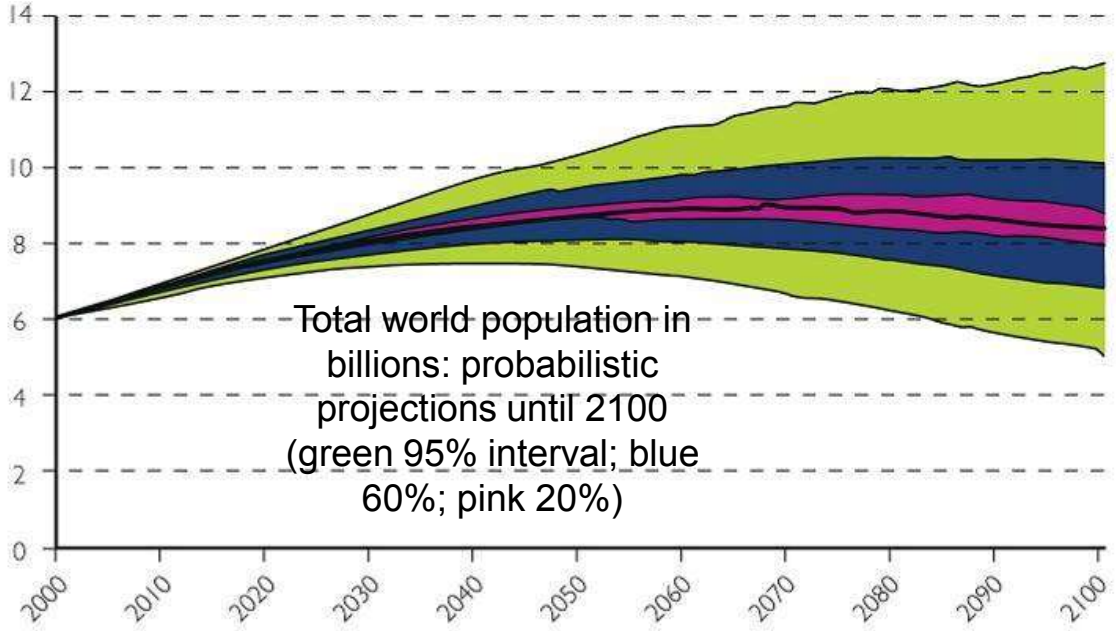
Findings from the UK Foresight Global Food and Farming Project

Prof. J F Muir UK Foresight Lead Expert Group

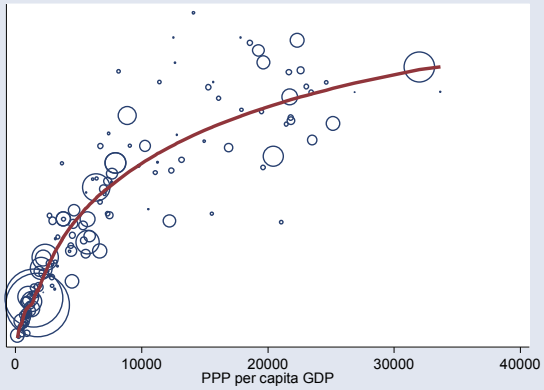
http://www.bis.gov.uk/foresight

Why this review now?



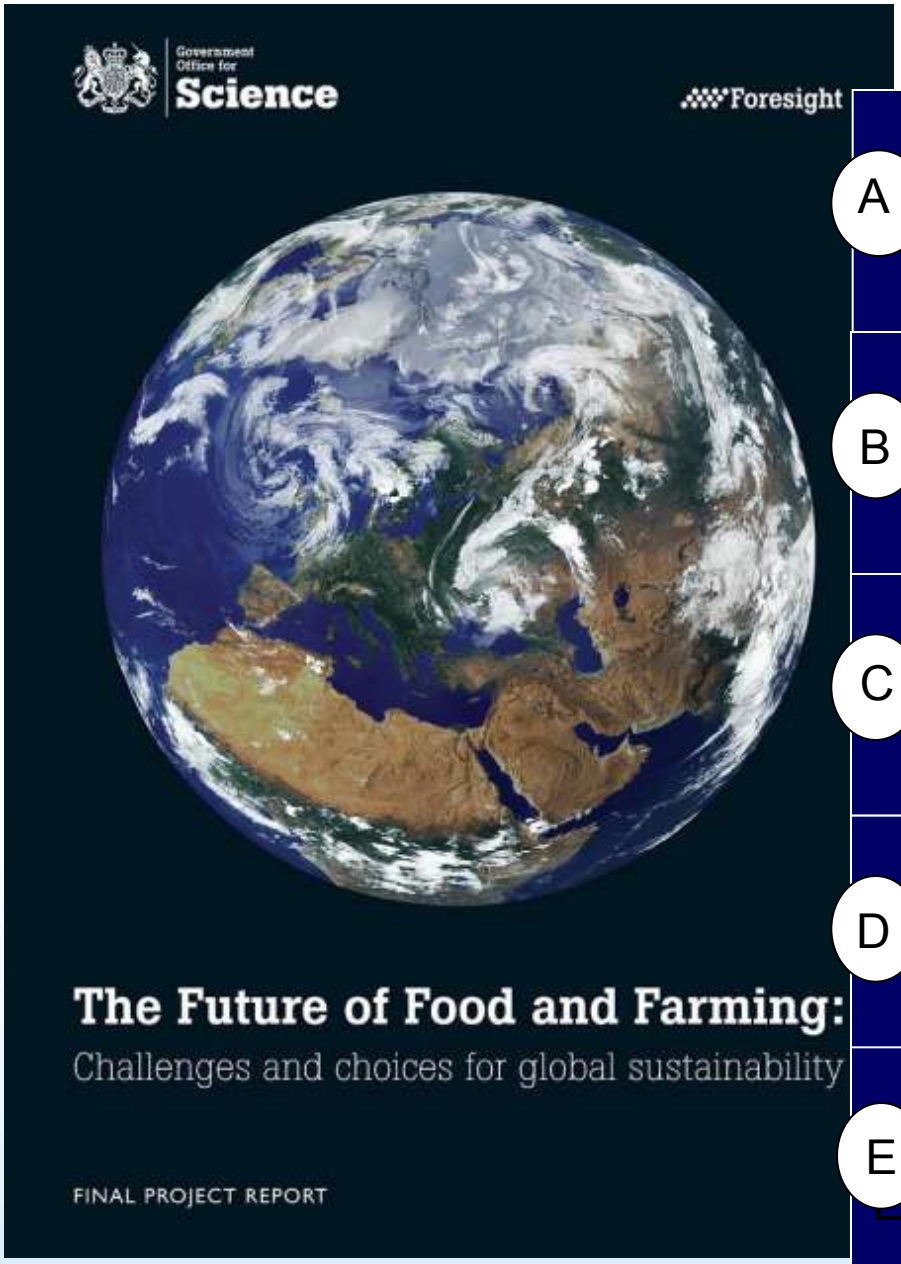


Food consumption and GDP (Engel curves)



The case for action in the food system:

- Convergence of threats
- The food system is failing
- A unique time in history



Five Challenges

A. **Balancing future demand and supply sustainably**

B. **Addressing the threat of future volatility in the food system**

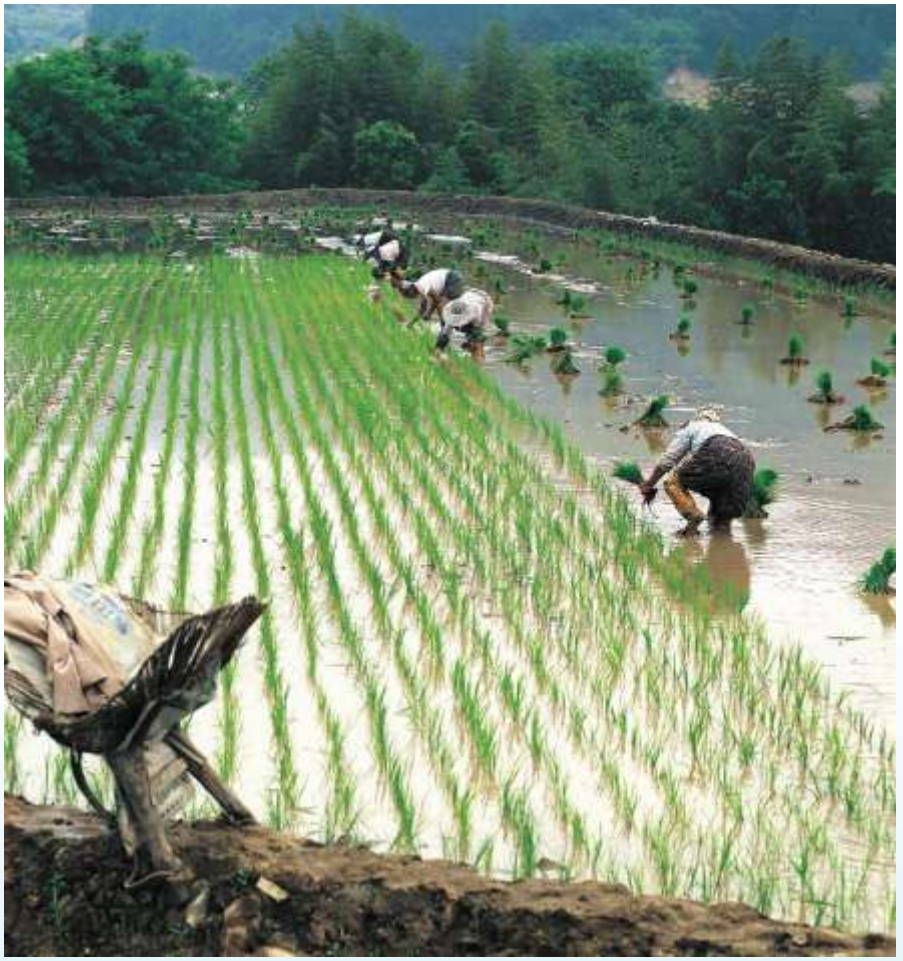
C. **Ending Hunger**

D. **Meeting the challenges of a low emissions world**

E. **Maintaining biodiversity and ecosystem services**

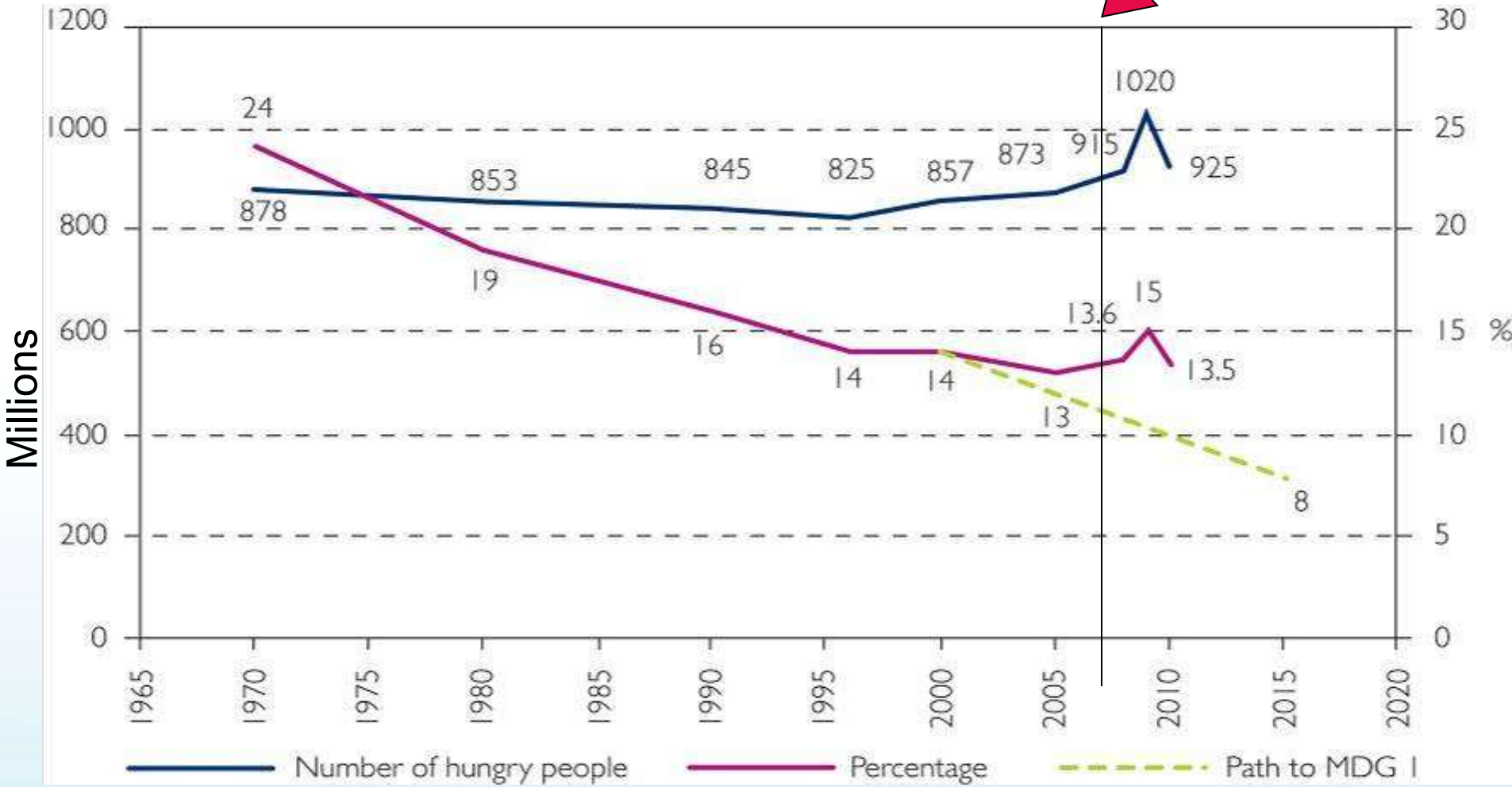
The food system is failing on sustainability...

- Over four decades food supplies have increased substantially to feed many more people.. but
- Agriculture now consumes 70% of total global water withdrawals from rivers and aquifers, many of which are overexploited
- Of 11.5 billion ha of vegetated land on earth, around 24% has undergone human induced soil degradation
- There are major concerns for fish stocks and aquatic habitats
- Agriculture directly contributes 10-12% of GHG emissions



…. and failing to end hunger

Undernourishment data versus the MDG target

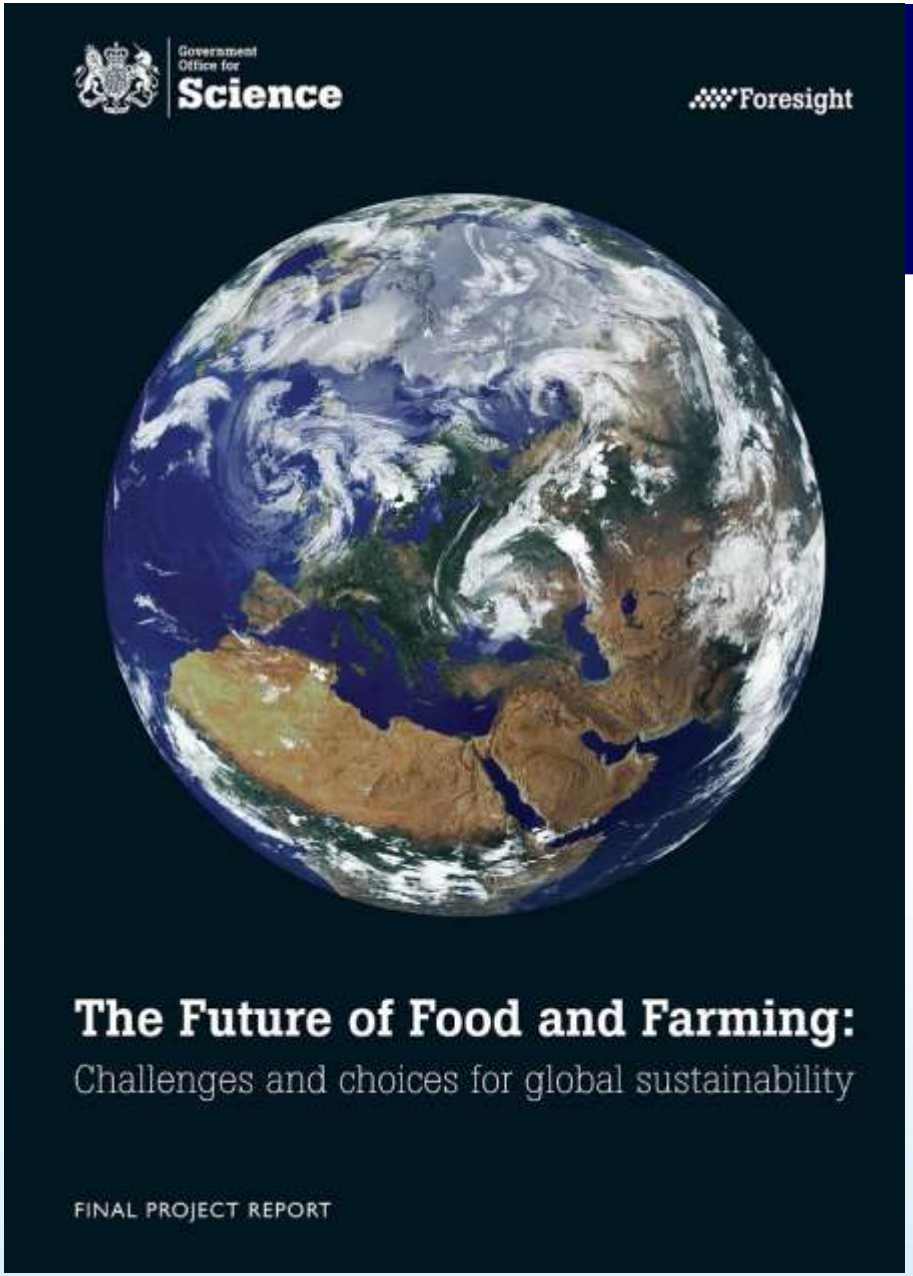


Source: Oxfam (2010) Data cited from FAO Hunger Statistics (from 1969 to 2006); UN (2009)

Looking out to the future.....

We commissioned:

- A range of international driver reviews across major production, resource and market sectors;
- Regional studies on key global systems
- African agricultural innovation review
- State of science reviews on specific innovations
- Workshops and reviews;
- Models - demand and prices – climate change links scenario



Three key messages

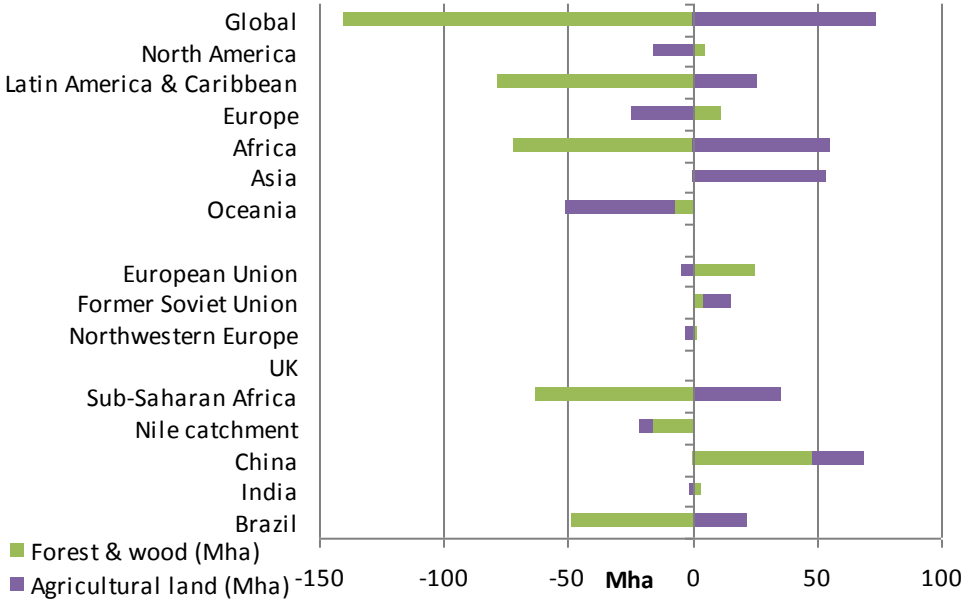
- "No action or change" is not an option
- Policies and decisions outside the food system are critical
- Radical redesign of the global food system is required

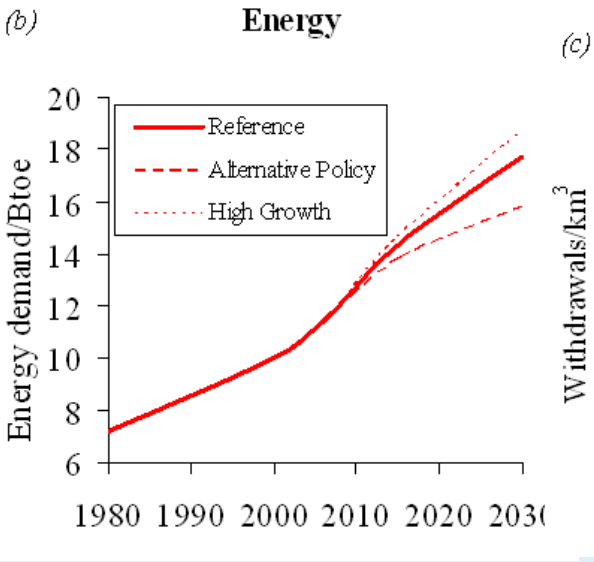
A

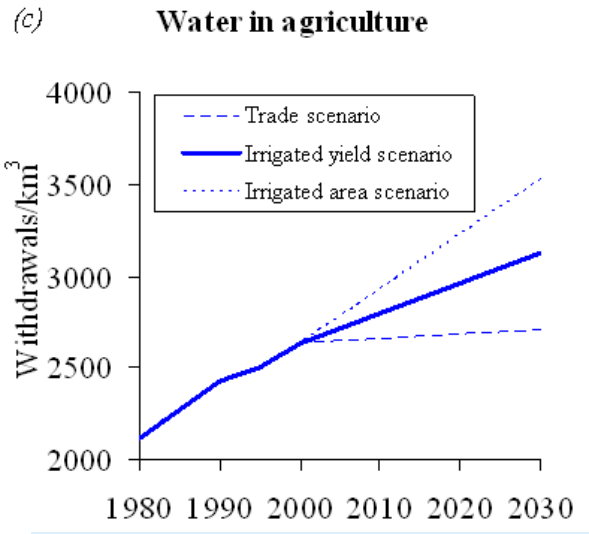
Balancing future demand and supply sustainably

Resource issues

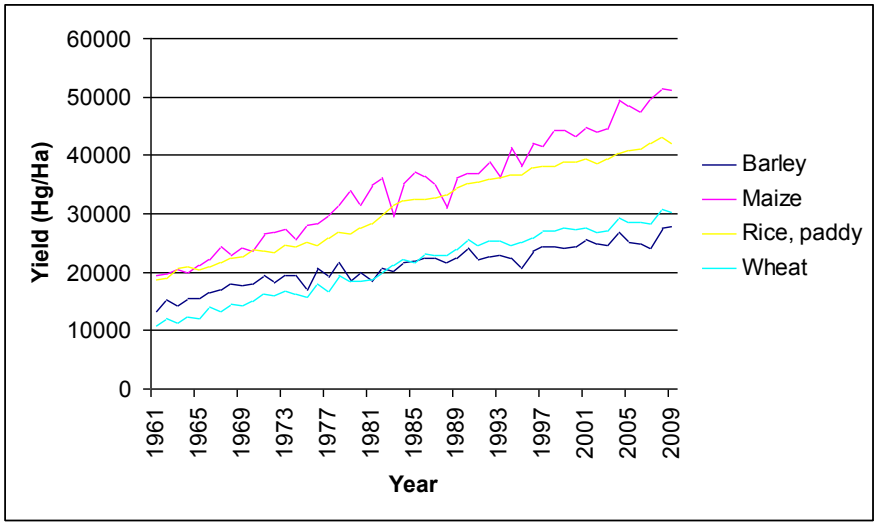
- though global yields have grown by 159% between 1968 and 2008, area of land in agriculture went up by only 9%.
- around 1600 million ha of land is cultivated for crops
- the area of arable land per person for food continues to decline (from 0.39 to 0.22 ha per person 1968 – 2008

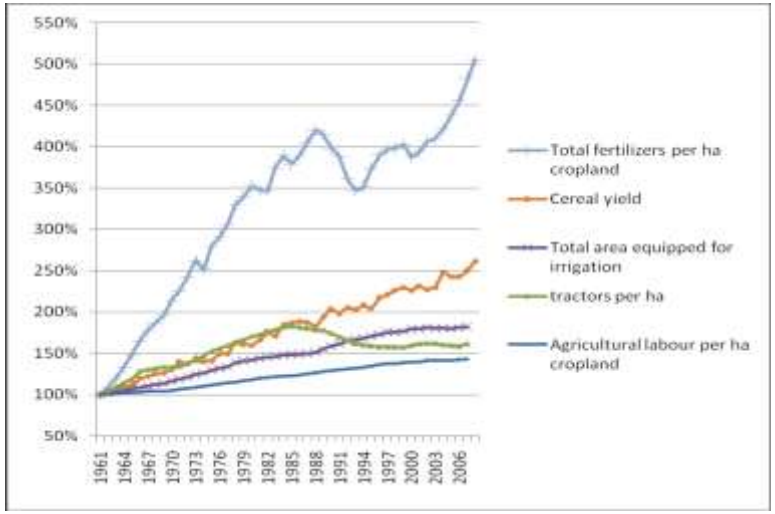


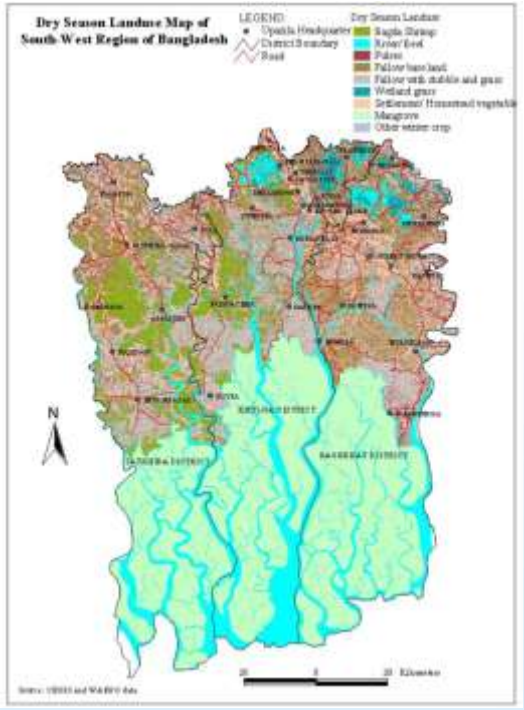




Crop production

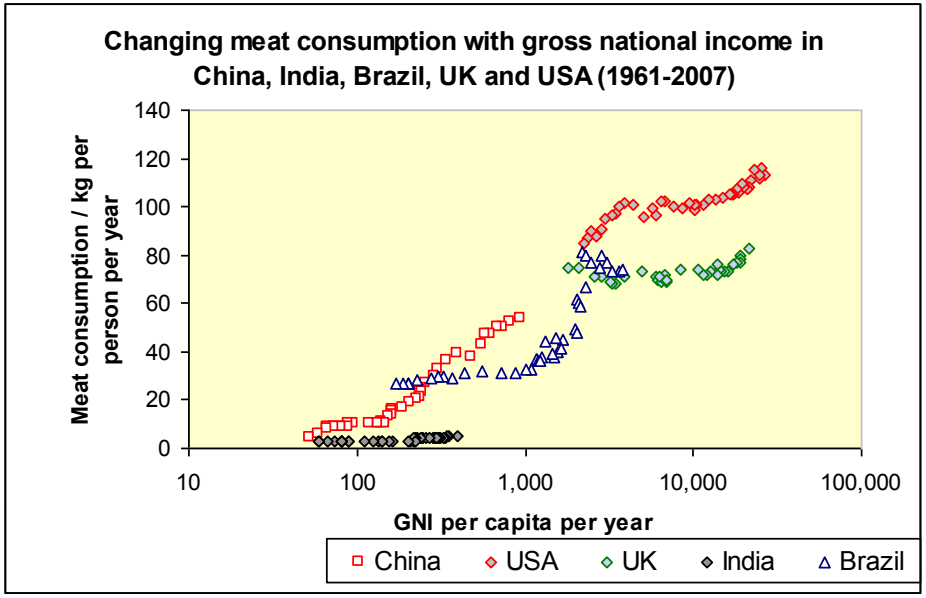






Major yield change potential – but continuity?
Ranges of crops and varieties – more diversified strategies
Need to redefine agro-ecological contexts
Better decision support options – and how to develop resilience?

Meat consumption and impacts



Major questions include:

- How consumption will rise in Africa.
- Will diets converge on those typical of high-income countries,
- Whether to Japanese, European or US patterns.
- Whether regional differences in diet (particularly in India) persist
- The extent to which increased GDP correlates with reduced population growth and increased per capita demand

One estimate:

Global cattle population from 1.5 billion in 2000 to about 2.6 billion by 2050, goat and sheep population from 1.7 to about 2.7 billion. Pig and poultry increases likely to exceed these.

Increased meat consumption will have major implications for resource competition and sustainability

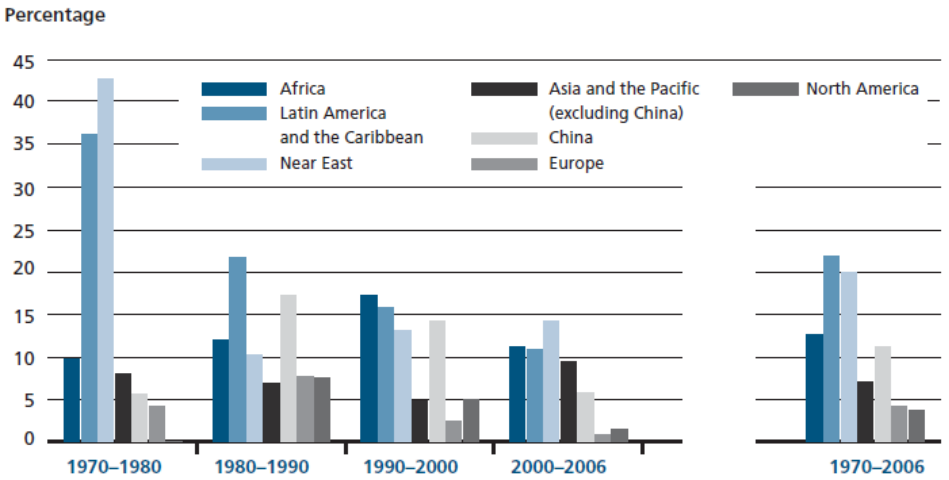
Fisheries and aquaculture

The harvesting capacity of the world's fleets greatly exceeds stocks available to be caught,

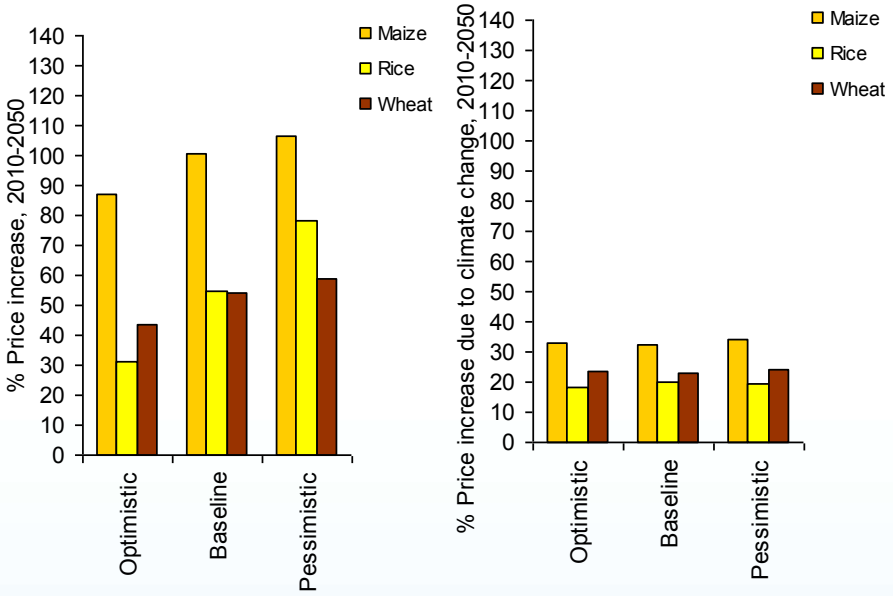
Declining catches and subsidies reduce financial returns; IUU (illegal unregulated and unrecorded) fishing is commonplace, as is discard at sea of lower value catch.

Faced also with the potentially immense challenges of ecosystem effects of climate change, governance of marine fisheries requires major overhaul.

Considerable scope for aquaculture growth , but major issues of feeds, water supply – need to expand 50-70%, better market integration and investment



Future price scenarios



CGE model found grain prices to be highly sensitive to assumptions of productivity growth.

By increasing productivity 1% /yr, price rises of 127 %, 110% and 68 % for maize, rice and wheat respectively became minimal.

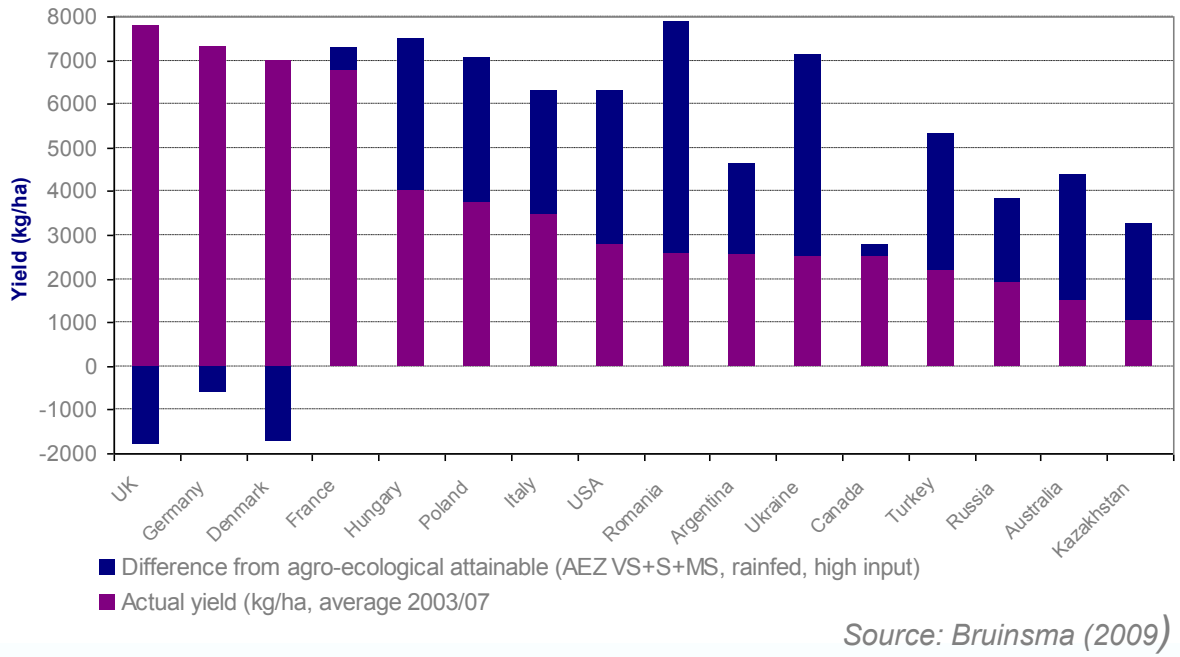
The World Bank CGE model - global productivity growth of 2.1%/yr - slight decrease in prices in 2030

Productivity growth rates in the IMPACT model for maize, wheat and rice range from 0.2-1.9%/yr

Assuming CO_2 fertilisation effects, climate change increases prices roughly by a further 7 to 20 %. Without these effects, climate change increase prices by around a further 50 to 100%.

The impact of future biofuel production will depend on uncertainties such as energy prices, policies and technological change.
Current modelling finds increased biofuel production results in food price rises but impact is reduced if second generation technology (i.e. using cellulose stocks, not carbohydrate crops) is available or if international trade encourages production in more suitable regions

Sustainable intensification - producing more from similar resources; existing and new knowledge



Source: Bruinsma (2009)

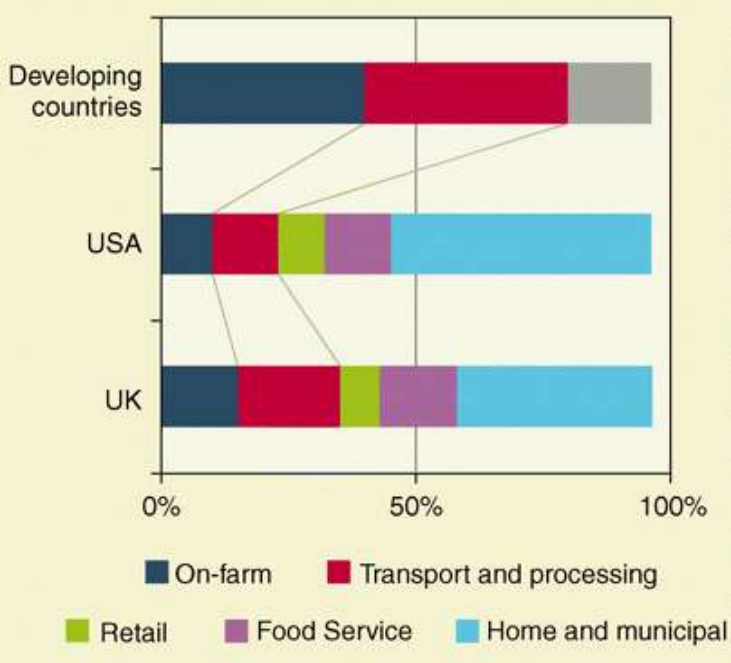
Yield gaps for wheat

Innovation to produce more

- New knowledge needed to maintain and increase yields
- Refocused research, better interactions across systems and supply chains
- Use all tools available – no single solutions

Reducing waste

Waste in different countries



A clear priority to reduce the estimated 30% of food produced but never consumed

Reduce losses

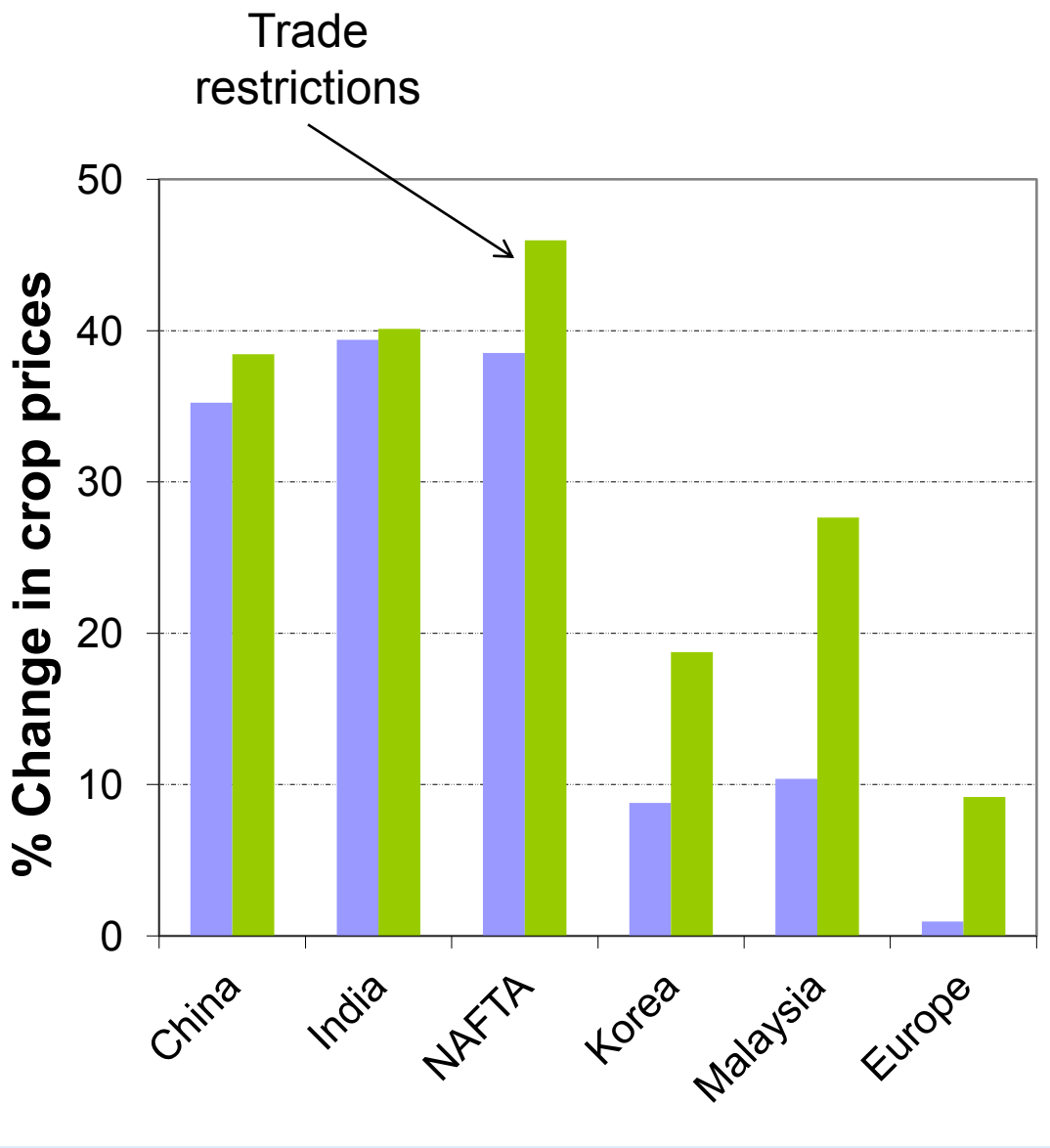
- Better storage, management, transport
- More efficient processes, yield recovery
- Reduce system waste, grade-outs

Manage demand

- Clarify choice, context and consequences
- Develop a strong evidence base
- Simple and consistent information
- Inform and empower consumers
- Build societal consensus
- Use feedback

Better governance

- Make globalisation work for sustainability and food security
- Improve resource manage-ment and producer security
- Accelerate the reduction of production subsidies
- Promote pro-poor and pro-sustainability international trade policy



Raise the political profile of food

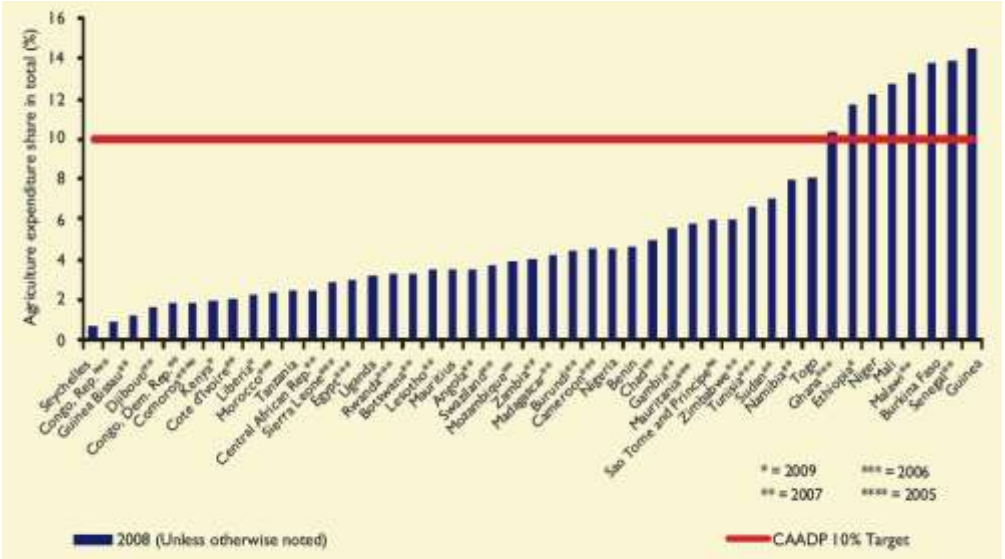
Research and development

Poor record of recent investment – but up to 40% RR has been shown on agricultural R&D

Without Consultative Group on International Agricultural Research (CGIAR) inputs:

- poor countries would have produced 7-8% less food,
- world food prices would be 18-21% higher,
- leading to a 5% average drop in per capita food consumption in developing countries.

Many other national equivalents



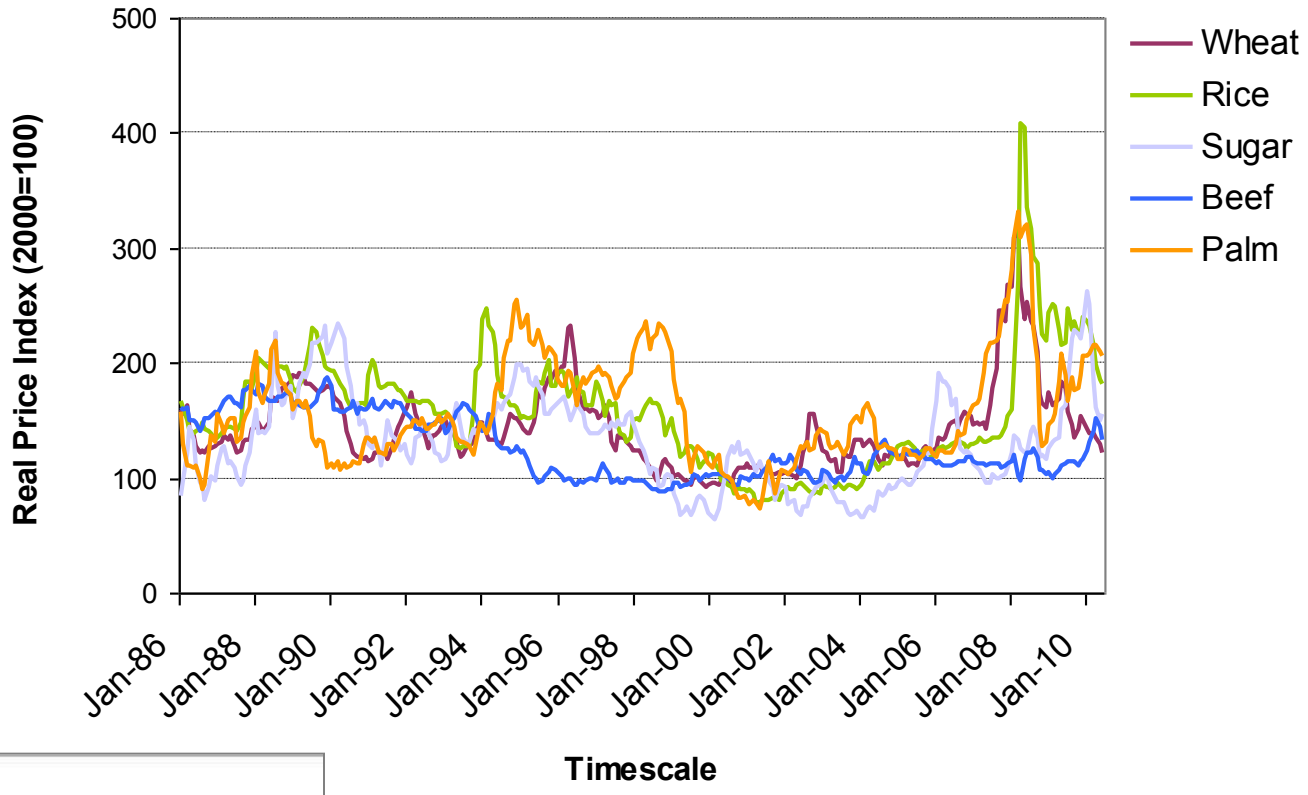
- No approach alone is capable of delivering sustainable high productivity, output and value.
- A complete food system perspective is needed; a blend of approaches for resilience.
- Key role of public-private partnerships; public funding essential for fundamental science and technology base but value is delivered through agribusiness, small producer and NGO sector interests and investments.

B

Addressing the threat of future volatility in the food system

Past volatility

Source: HMG (2010) Data sourced from UNCTAD, BEA




guardian.co.uk

News | Sport | Comment | Culture | Business | Money | Life & styl

Environment › Food

Food crisis threatens security, says UN chief

· Warning of instability and backlash for economies
· Progress on development goals could be wiped out


TIMESONLINE

NEWS | COMMENT | BUSINESS | MONEY | SPORT | LIFE & STYLE | TRAVEL | DRIVING | ART

UK NEWS | WORLD NEWS | POLITICS | ENVIRONMENT | WEATHER | TECH & WEB | VIDEO | PHOTO

Where am I? › Home › News › Environment

From The Times

March 7, 2008

Already we have riots, hoarding, panic: the sign of things to come?

Modelling shocks and impacts

Drought in the North American Free Trade Agreement area, China and India and a protectionist response: This modelled a 20% yield drop in US, Canada, Mexico, China and India followed by a 25% export tax in exporting regions.

- High crop price rises (around 35-40%) in domestic markets of the regions directly affected by the drought.
- Net importers in East Asia face price rises because drought-affected regions export less and compete more for imports (Malaysia 10%, Korea and Taiwan 8%).
- Increased incentives to produce in regions not affected by drought, together with international trade, limit the fall in global crop production to less than 2 %.

However, if food exporting regions impose a protectionist response,

- crop prices are significantly higher in all regions and trade is harshly impeded (e.g. price rises are Malaysia 27%, Korea and Taiwan 18%).
- Global crop production does not fall, since high crop prices provide an incentive to produce more, but often in areas with a comparative disadvantage.
- Restrictions on exports thus lead to inefficient high-cost production.

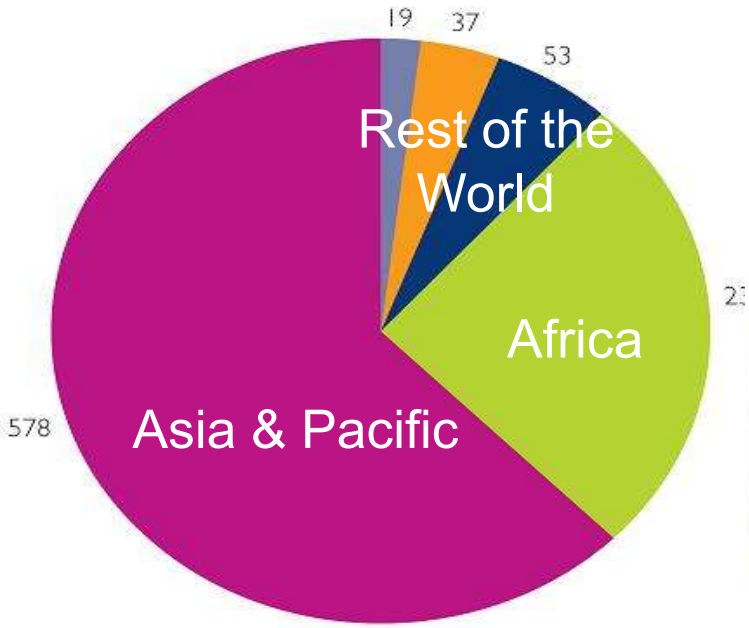
Actions on volatility

- Better understanding of shocks and production/market/trade responses
- Reliable liberalised international trade
- Review interactions with other sectors such as biofuels, water, energy, address potential conflicts
- Caution on calls for a global system of virtual/actual food reserves
- Appropriate insurance/risk management tools for poor farmers
- Targeted food reserves and safety nets for vulnerable

C

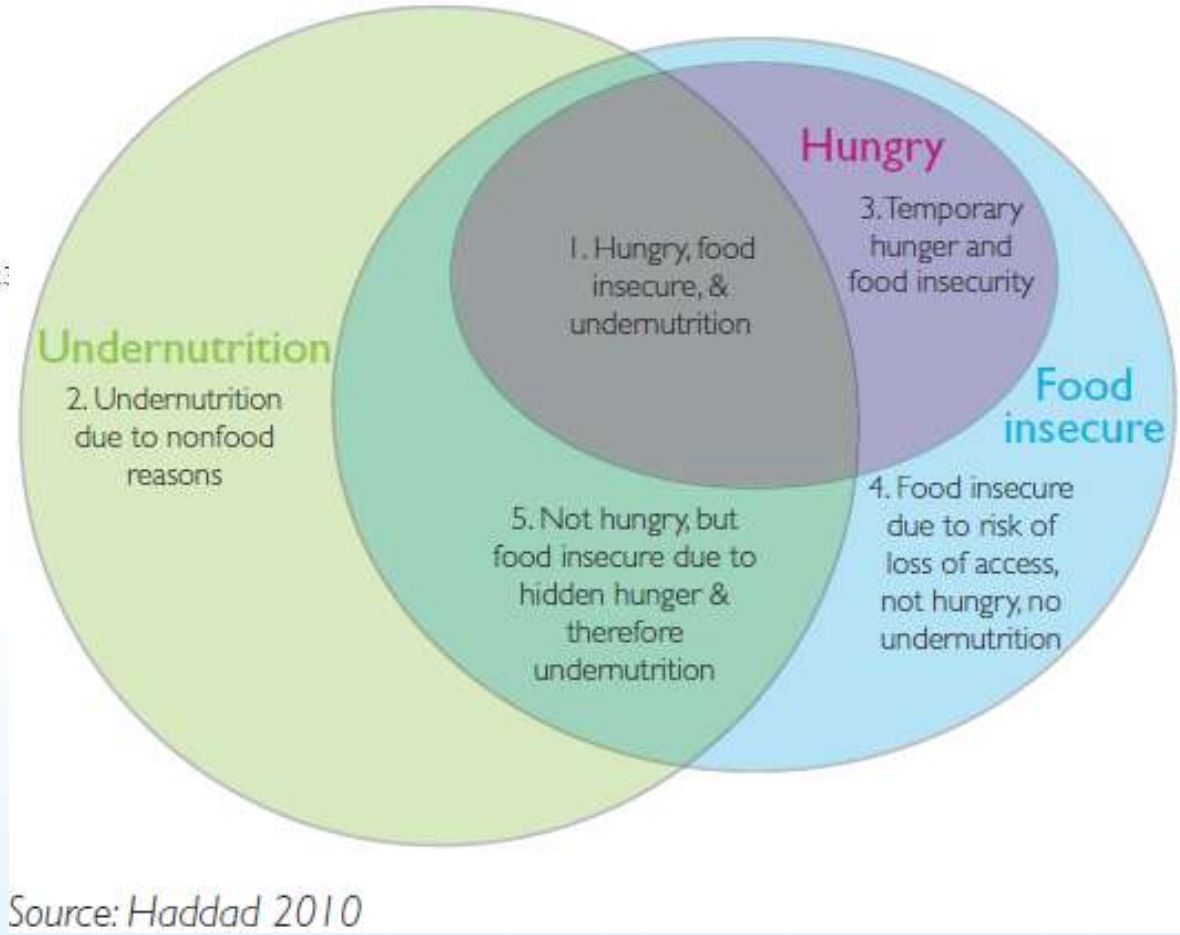
Ending Hunger

Ending hunger



The world's hungry (millions)
Source: FAO (2010)

... and vulnerability to hunger



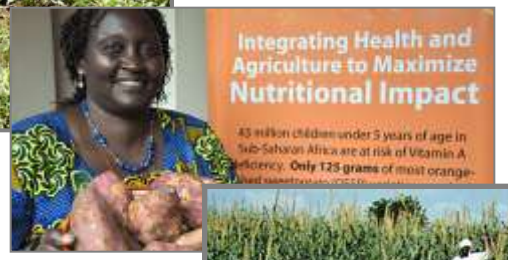
Source: Haddad 2010

One billion hungry, another billion in "hidden hunger"

Means of ending hunger

- Greater priority must be given to the food system
  - Well supported and functioning
  - Agriculture as a profession
- Agriculture can help end hunger
  - Essential for physical access to food
  - Increased farm productivity raises incomes & generates employment
  - Can empower women
  - Social protection policies
  - Monitoring and evaluation
- Political courage and leadership
- Accountability – measuring commitment

A charity project for small farmers in Southern Africa



Project that provides nutrition education & sweet potato vines to women in Kenya

A project to demonstrate the benefits of micro-fertilisation in Africa

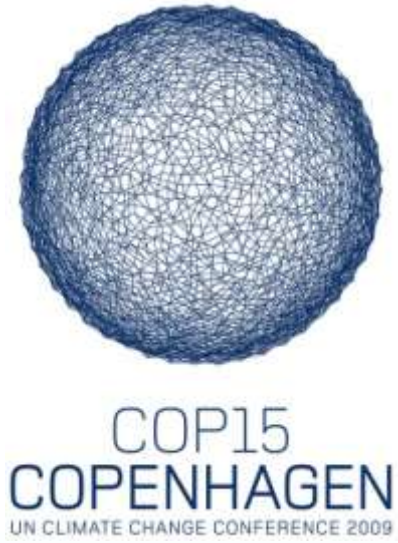
The international community must challenge itself over the apparent ease with which hunger is ignored

D

Meeting the challenges of a low emissions world

Agriculture and the food system must be taken into account in climate change negotiations

Climate change negotiations: Agriculture has not been included

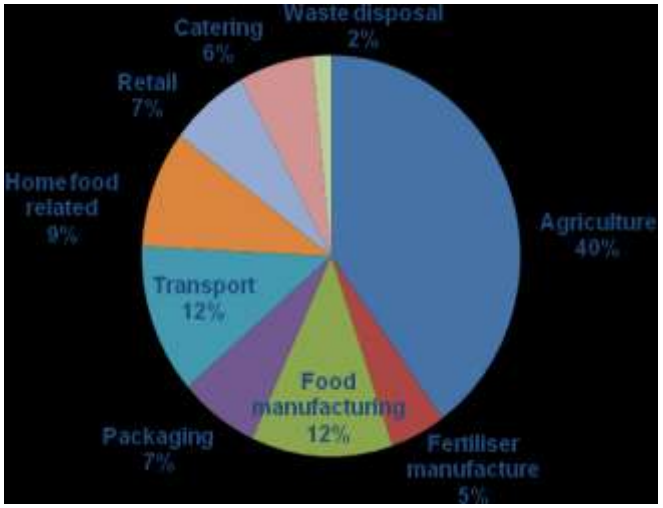


- The Copenhagen Accord provided a commitment to **hold the increase** in global temperatures below 2°C
- **More than 70 countries** submitted emissions reduction targets
- More formal UN agreement on the 2°C limit at Cancun in December 2010
- A work programme on agriculture was **not** included in the wider climate agreements
- Profile raising in Durban COP17 – the realities of a 4°C increase?

The food system and GHGs

Where's it coming from?

Source	GHG	Gt CO_2e	%age
Primary processes			
Enteric fermentation	CH_4	1.792	27.0
Manure	N_2O	0.413	6.2
Fertilised soils	N_2O	2.128	32.1
Biomass burning	CH_4,N_2O	0.672	10.1
Rice production	CH_4	0.616	9.3
Industrial factors			
Fertiliser production	CO_2, N_2O	0.410	6.2
Farm machinery	CO_2	0.158	2.4
Irrigation	CO_2	0.369	5.6
Pesticide production	CO_2	0.072	1.1
Total		6.558	100
Strategic factors			
Land use changes*	CO2	5.880	
Total		12.438	



How to reduce GHGs?

- Reduce waste
- More efficient use of nitrogen fertiliser
- Management changes to wetland rice production
- Increase carbon sequestration through integrated soil, vegetation and aquatic system management
- Agroforestry – possibly biochar
- Reduce methane and nitrous oxide emissions from livestock production
- Second generation biofuels and the integration of biomass production for both food and energy

Actions

- Better metrics and standards
- Integration into CC policy
- Actions are needed on:
  - Carbon sequestration
  - Reduce emissions
- Innovate for sustainability
- Bolster adaptation
- CGIAR CCFAS program – Commission on Sustainable Agriculture and Climate Change

We need climate smart agriculture

CLIMATE CHANGE
AGRICULTURE AND FOOD SECURITY

Climate Smart Agriculture

Aim for multiple win approaches:
- reduce GHG related impacts
- improve efficiency and resilience
- improve yields and returns to producers

Options/elements include:
- better nitrogen use and management
- better soil management practice
- lower energy inputs
- more efficient use of water
- diversified production, strains

Can apply in a wide range of systems, also including aquatic production

Farmers reducing Nitrogen application

- Mexican farmers use infra-red technology to determine correct time and amount of nitrogen fertilizer to apply to wheat crops.
- Yields are maintained using far less fertiliser and less excess nitrogen washes into the nearby sea.

E

Maintaining biodiversity and ecosystem services while feeding the world

Maintaining biodiversity and ecosystem services while feeding the world

- Major knowledge gaps
  - National Ecosystem Assessment to assess services and their value
  - Low-income countries
- A range of trade-offs
  - Yield versus ecosystem services
  - Land sparing versus wildlife-friendly agriculture (and aquatic equivalents)
  - Biodiversity and the needs of the poor
- All land and water provides ecosystem services
  - align environmental and market incentives
- Policy needs to be connected at global, national and landscape scales

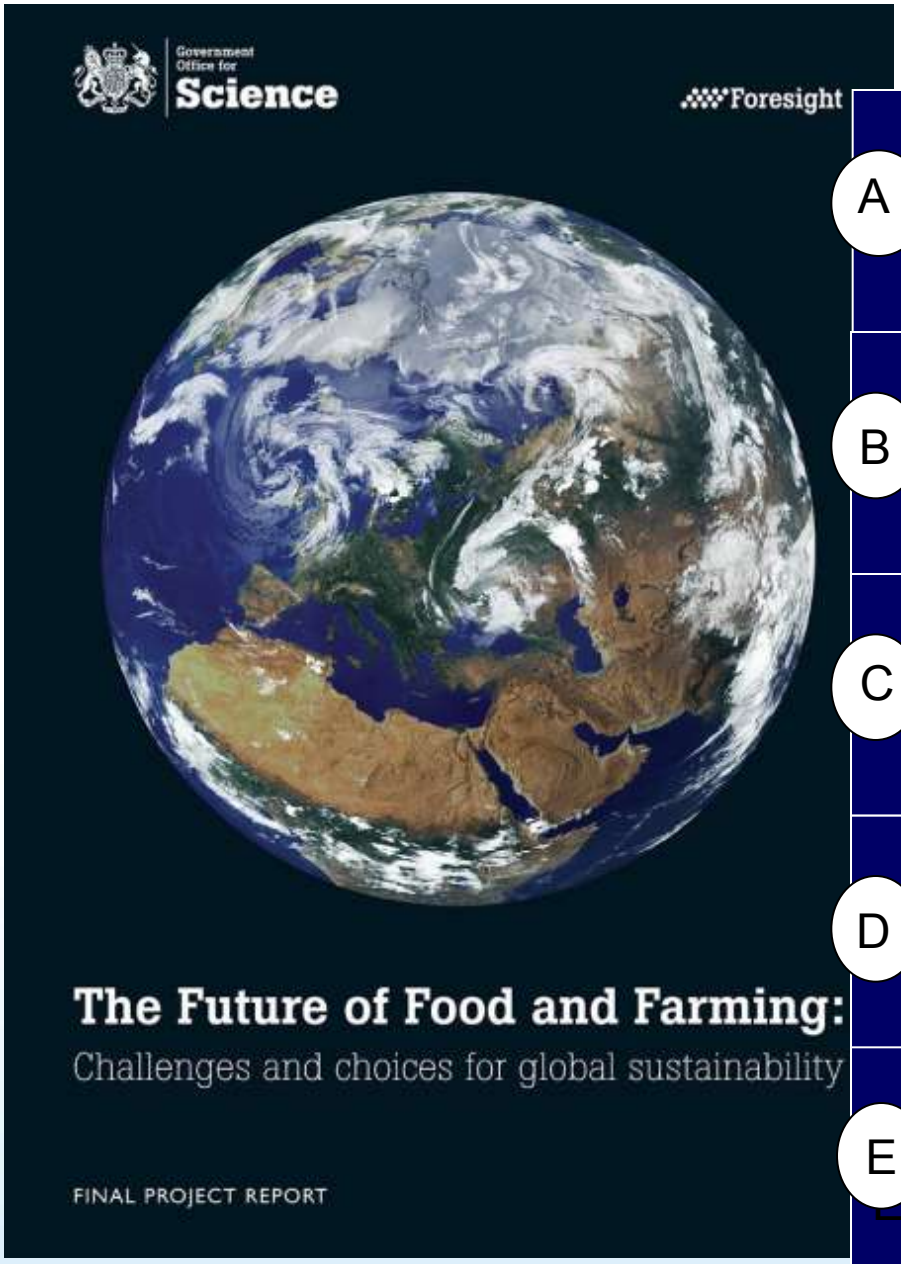
Conservation needs food security

Nagoya 2010: New global biodiversity framework

- Agreement on a new Strategic Plan for global biodiversity conservation to 2020 and beyond. Underpinned by 20 sub-targets on:
  - Halting species loss and habit degradation
  - Reducing pollution and over-exploitation
  - Increasing financial support to developing countries
- Agreement on a resource mobilisation package to fulfil the plan
- Agreement on a new 'Nagoya Protocol' on Access and Benefit Sharing

Convention on Biological Diversity

2010 International Year of Biodiversity



Five Challenges

A. **Balancing future demand and supply sustainably**

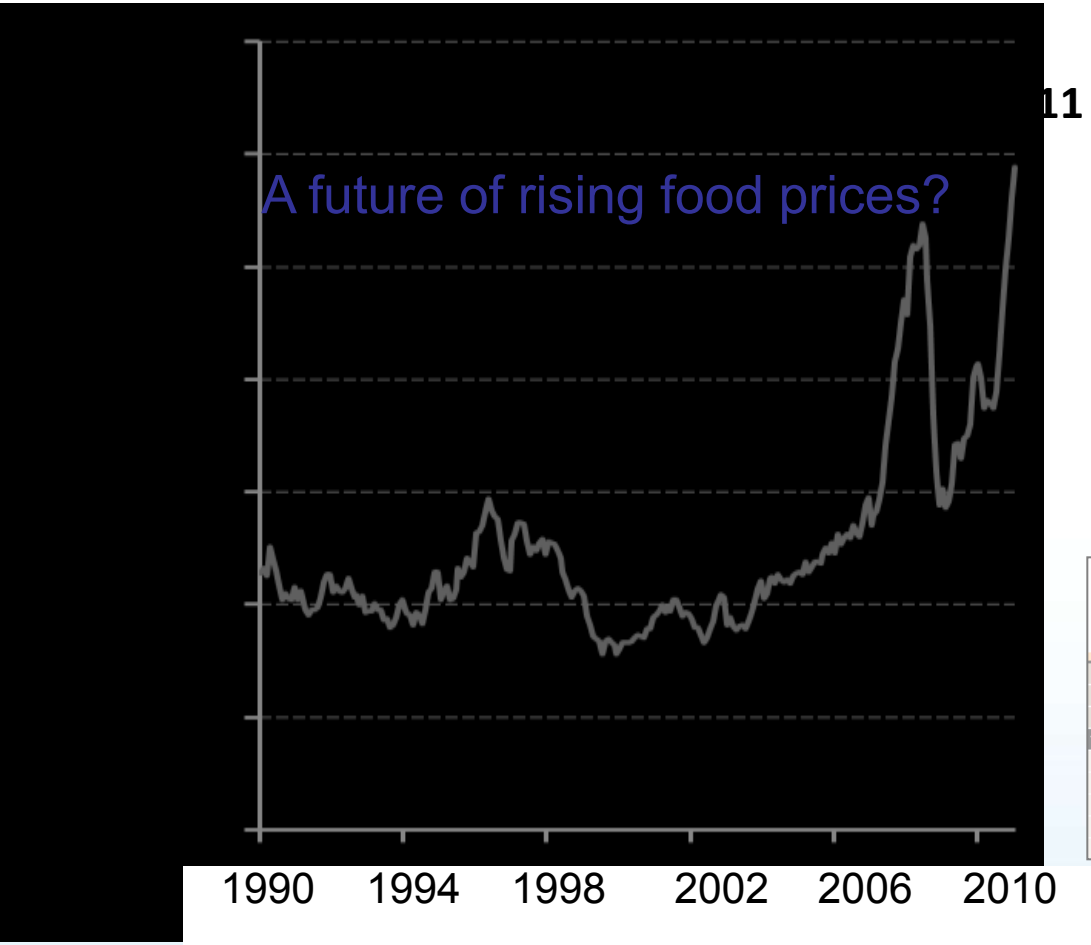
B. **Addressing the threat of future volatility in the food system**

C. **Ending Hunger**

D. **Meeting the challenges of a low emissions world**

E. **Maintaining biodiversity and ecosystem services**

And where to go from here?



11

guardian.co.uk

News | Sport | Comment | Culture | Business | Money | Life & style

Business > Commodities

Food prices hit new record high

A United Nations food price index reached a new record in February, as unrest in Libya pushed up the price of oil, a major part of agricultural production

Phillip Inman
guardian.co.uk, Thursday 3 March 2011 12.51 GMT
Article history

FT.com FINANCIAL TIMES — Commodities

FT Home > Markets > Commodities

- Front page
- World
- Companies
- Markets
  - FT Alphaville
  - FTfm
  - Markets Data
  - FT Trading Room
  - Equities

Rise in wheat prices fastest since 1973

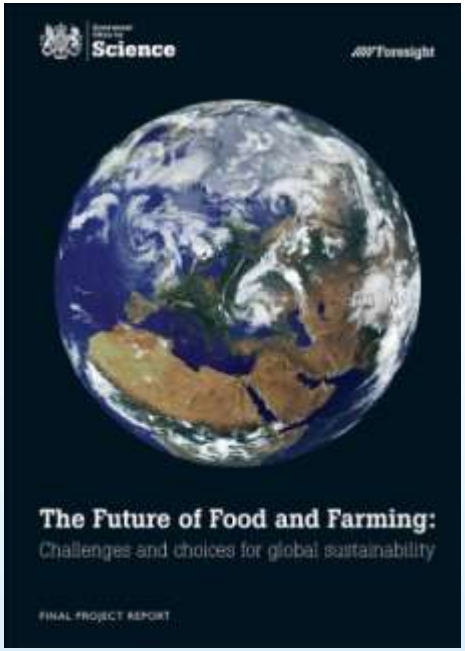
By Javier Blas in London and Isabel Gorst in Moscow
Published: August 2 2010 19:19 | Last updated: August 2 2010 19:19

Wheat prices have seen the biggest one-month jump in more than three decades on the back of a severe drought in Russia, prompting warnings by the food industry of rising prices for flour-related products such as bread and biscuits.

Recent food price volatility has thrown an additional **44 million people** into extreme poverty

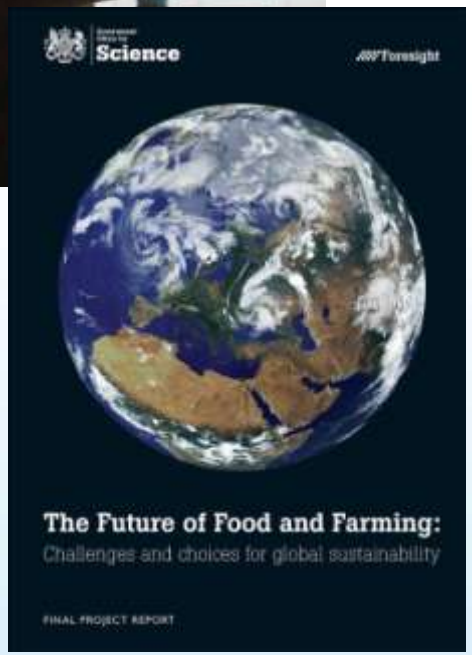
Priorities for action: National governments

- Food must move further up the policy agenda
- Global food supply must be increased through sustainable intensification
- Climate resilient land use and water resource policies are essential
- Ensure long-term sustainability of fish stocks
- Increase food literacy among consumers
- Increase proportion of international aid focussed on sustainable food production
- Improve science, knowledge, practice



Priorities for action: Research community and funders

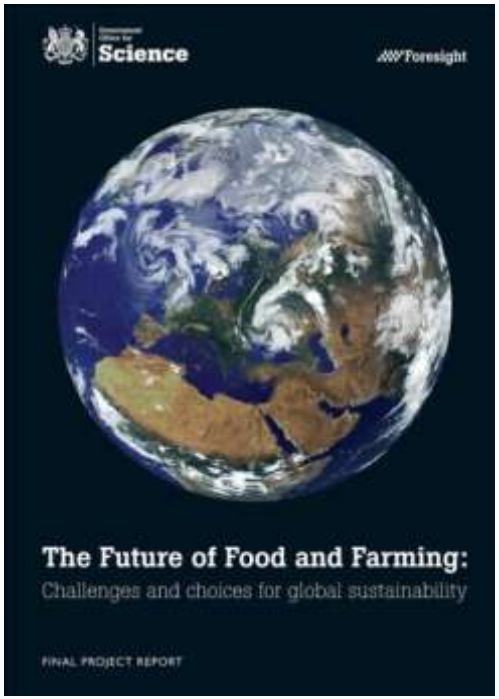
- Portfolios need to address entire supply and value chain, include all areas of science and technology
- Research in currently neglected areas such as agronomy, agro-ecology and soil science, and in wider valuation contexts
- Multiple approaches using existing knowledge and emerging technologies – open debate on trade-off areas, indicators of acceptability
- New partnerships between public, private and third sector funders and users
- Develop hunger indicators that are reliable, accurate and not prohibitively expensive
- Preserve multiple varieties, rare breeds and wild relatives of domesticated species



Where next:

- Raising food issues on global and national agendas
- Increasing and strengthening interactions with public, private and NGO sector agents
- UK and EU government agencies – feeding into longer term strategies
- Building effectiveness in multilateral agencies – FAO, IFAD, WFP, WB also CGIAR
- Private sector/commercial entities– strategy, horizon-scanning, opportunity areas
- Linkages with climate change knowledge and policy – IPCC, UNFCCC CoP 17 Durban
- Defining pathways, developing strong indicators, promoting investment
- Invoking political will and courage

Thank you!



http://www.bis.gov.uk/foresight/our-work/projects/published-projects/global-food-and-farming-futures