Innovation for sustainable land-based production: the need for partnerships

1. *Something about Foresight*

   - the "Sustainable Intensification" agenda

2. *Something about UK funding*

   – less words more action?

3. *Something about AHDB*
4. *Something about UK opportunities*

   - land–use/management and sustainability

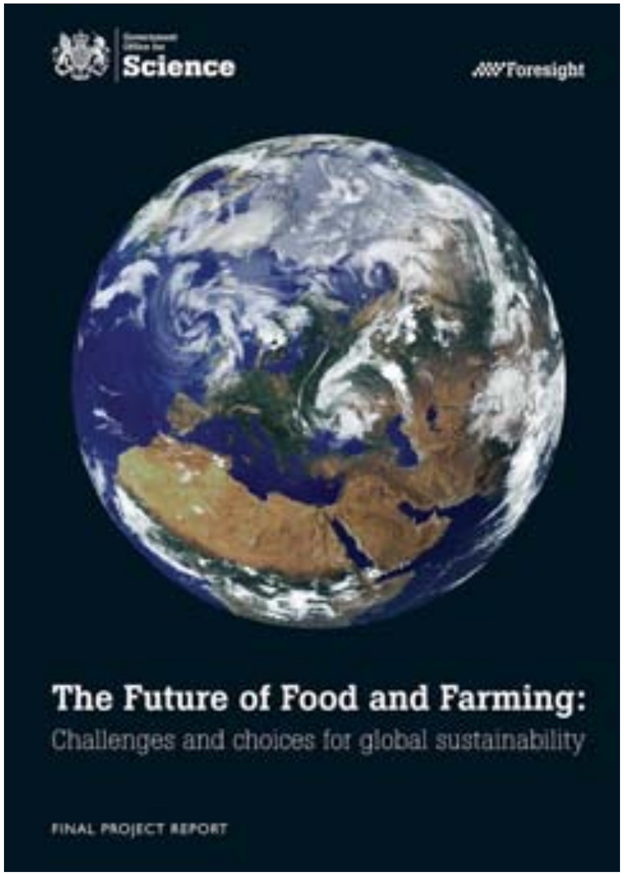
   - health of crops and livestock (reduction of waste)

   - GHG emissions and the 2008 Climate Change Act

5. *Some key messages/conclusions*

AHDB Agriculture & Horticulture Development Board

Looking ahead to 2050…………



"The Future of Food and Farming: challenges and choices for global sustainability"

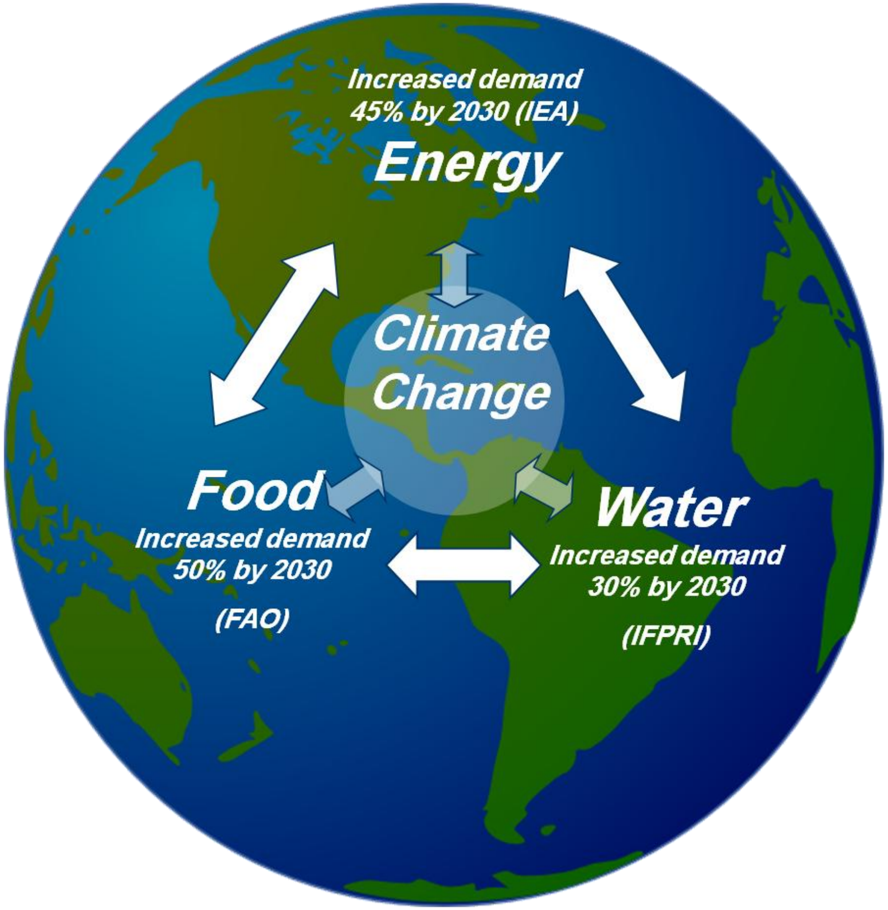
www.bis.gov.uk/foresight

Putting food security into context

In 2008 Professor Sir John Beddington raised the issue of the "Perfect Storm…"

Government Office for Science

1. Increasing population
2. Increasing levels of urbanisation
3. The rightful goal to alleviate poverty
4. Climate Change



Why this report now?

Key Messages

•*The case for urgent action in the global food system is now compelling:*

• *Convergence of threats*

• *The food system is failing*

Raise political profile of food

• *Radical redesign of global food system*

• *"No action/change" not an option*

• *Policies and decisions outside the food system critical*

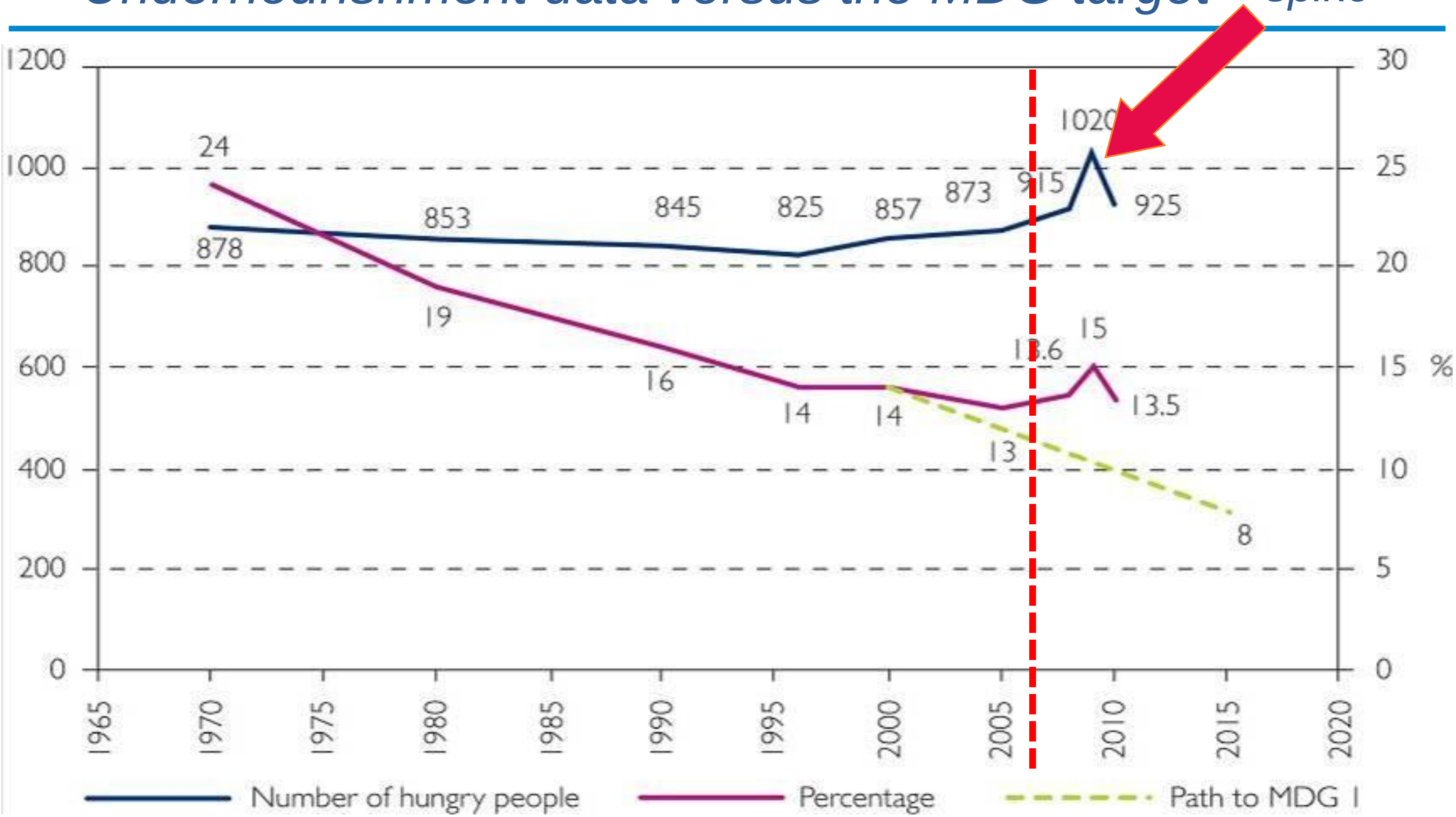
A unique time in history

AHDB Agriculture & Horticulture DEVELOPMENT BOARD

The failure to end hunger

2007-08 Food price spike

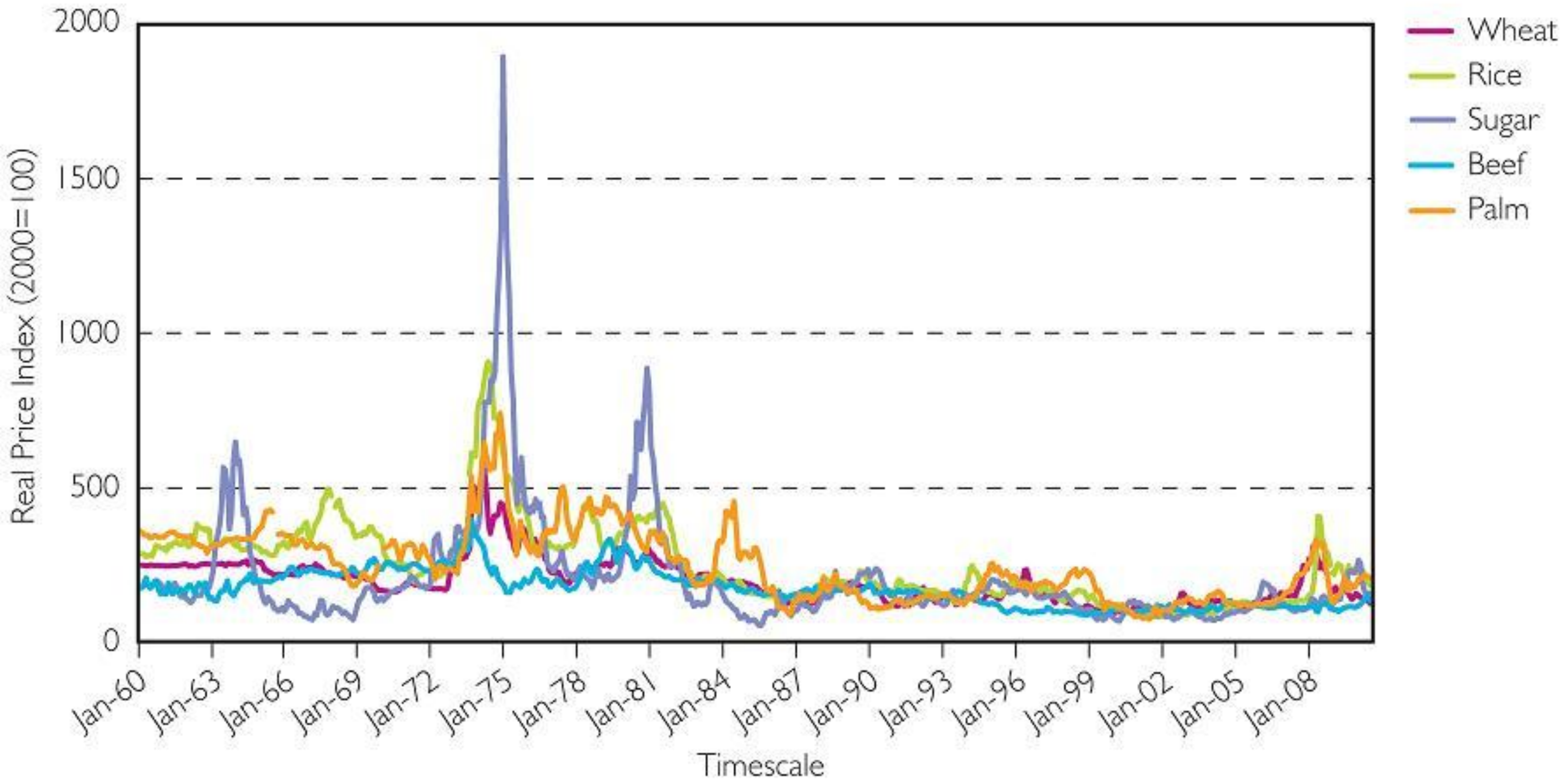
Undernourishment data versus the MDG target



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

Past volatility (complacent 80s)

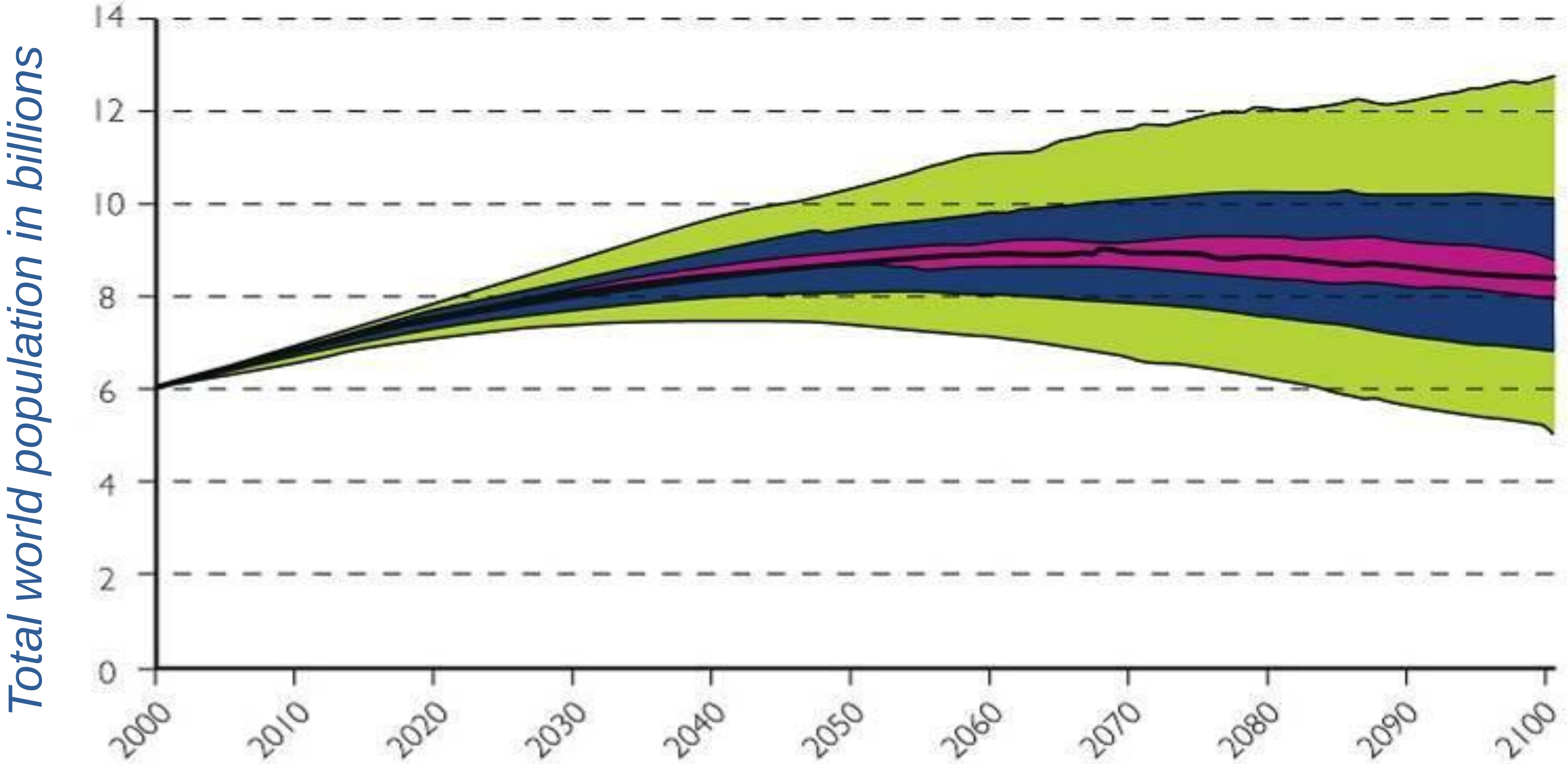
Global real price indices for major agricultural products since 1960



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

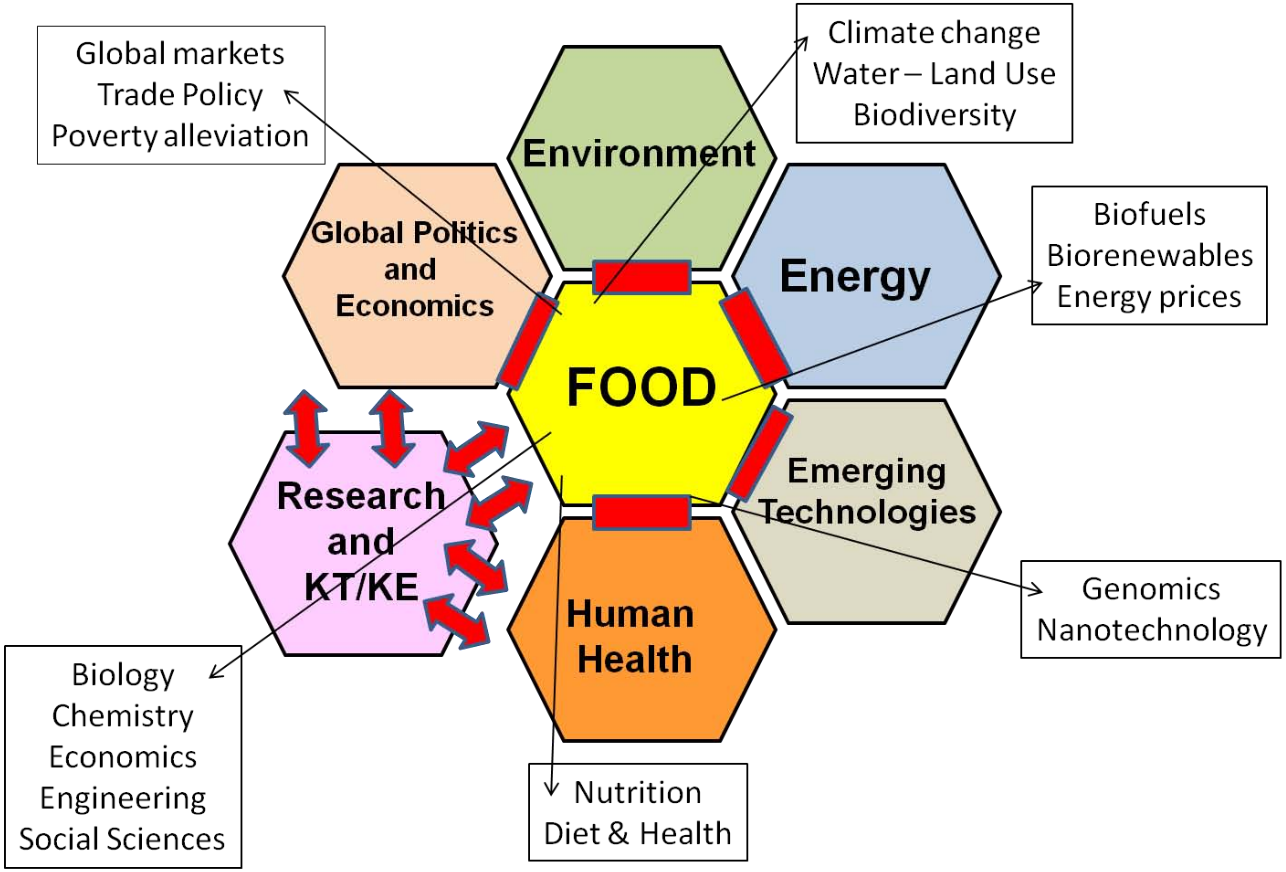
A unique time in history

Total world population in billions: probabilistic projections until 2100 (green 95% interval; blue 60%; pink 20%).



Modified from Figure 1 of Lutz and Scherbov (2008)

Food (and agriculture) has rapidly become centre-stage



Looking ahead to 2050…………

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

"Sustainable Intensification" – a unifying concept

Royal Society: Reaping the Benefits (2009); Foresight – Future of Food and Farming (2011)

- *Primary objective of land use for agriculture is efficient conversion of solar energy into varied forms of chemical energy for utilisation by mankind*
- *Some land is best used to produce animal forage/feed as intermediates*
- *Energy conversion involves manipulation and management of the interaction between genotype and the environment to improve efficiency*
- *There are physical and biological constraints*
- *Maximising efficiency provides options to achieve "other" objectives (carbon sinks, maintenance of biodiversity etc).*
- *"Other" objectives should not be confounded with the requirement to produce food and other agricultural products as efficiently as possible (while sustaining ecosystem functions)*

Producing as efficiently as possible on the smallest footprint of land capable of delivering market requirements is the "greenest" and usually the most profitable way to farm

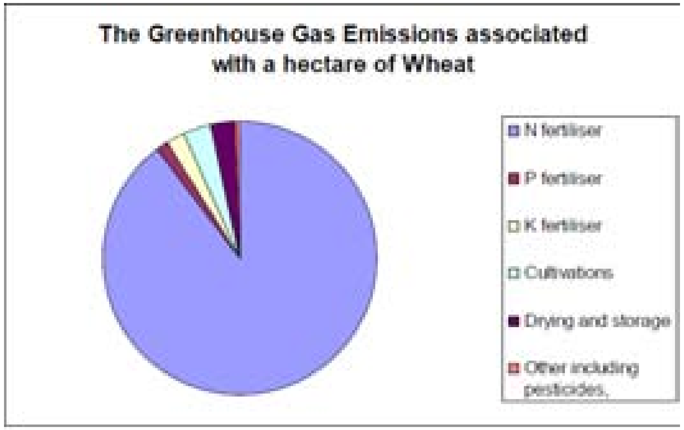
Crop (and livestock) health is fundamental to GHG emissions reduction

ca. 4000 - 5000 KgC0$_2$eq./ha to grow a crop of wheat
(N, other ag-chem, machinery, cultivations, spraying, harvesting)

Lost yield = wasted inputs (economic loss) and > GHG emissions/tonne

Nitrogen inputs, cultivated areas, yield and N use efficiency are key determinants of GHG emissions from cropped land

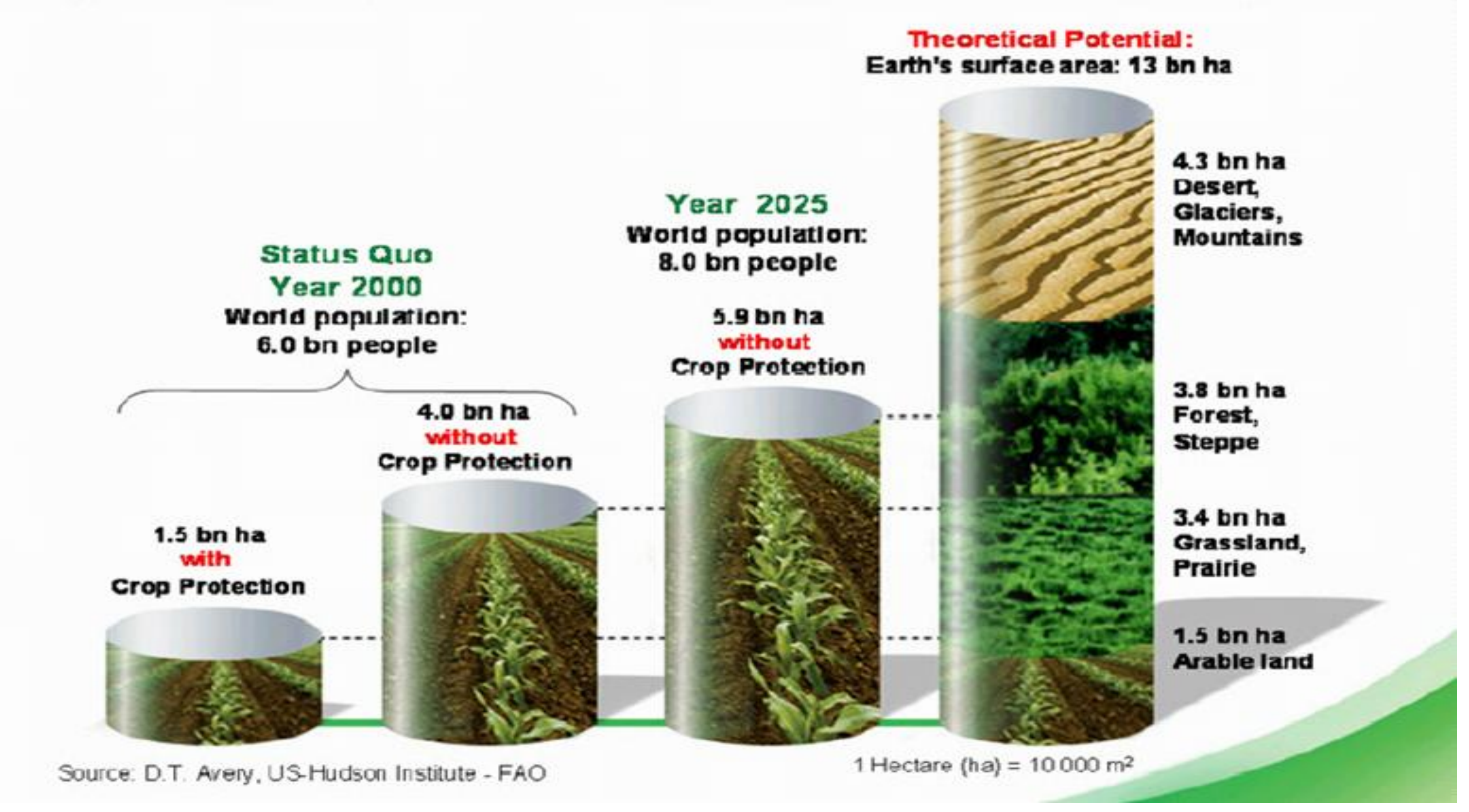
Nine UK & Danish wheat crops			
	Fungicide	No fungicide	SEM
Opt. N (kg/ha)	158	106	11.5 **
Yield (t/ha)	8.9	6.7	0.55 **
GHG emissions – Kg CO_2 eq. per tonne			
Fungicide/treated optimum	417		
No fungicide/untreated optimum	430		12 (NS)
No fungicide/treated optimum	546		31**
No fungicide/untreated opt. + LUC	740		70**



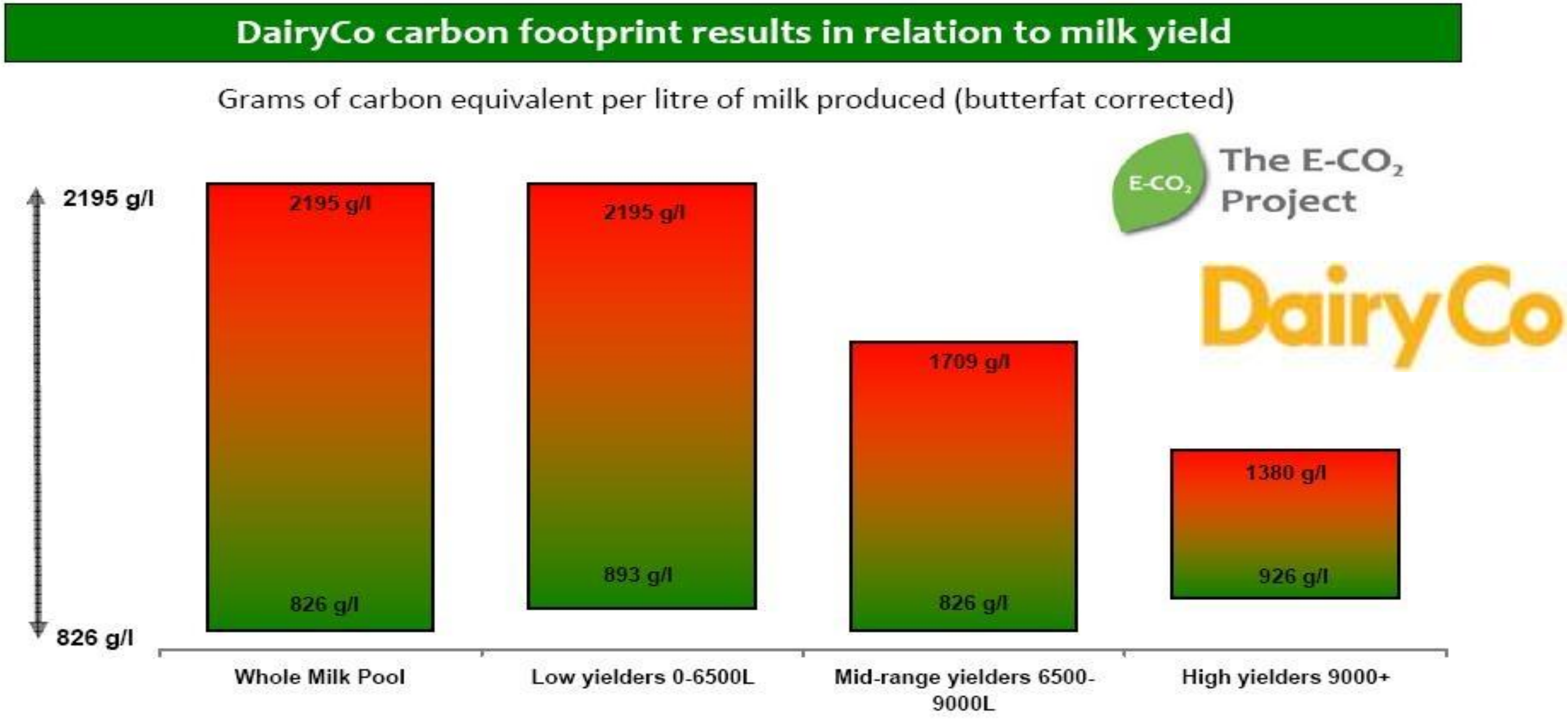
Mortimer (2003)

Berry et al (2010)

The global significance of crop loss due to diseases, pests and weeds.



Variation in emission from 230 dairy Farms in relation to productivity

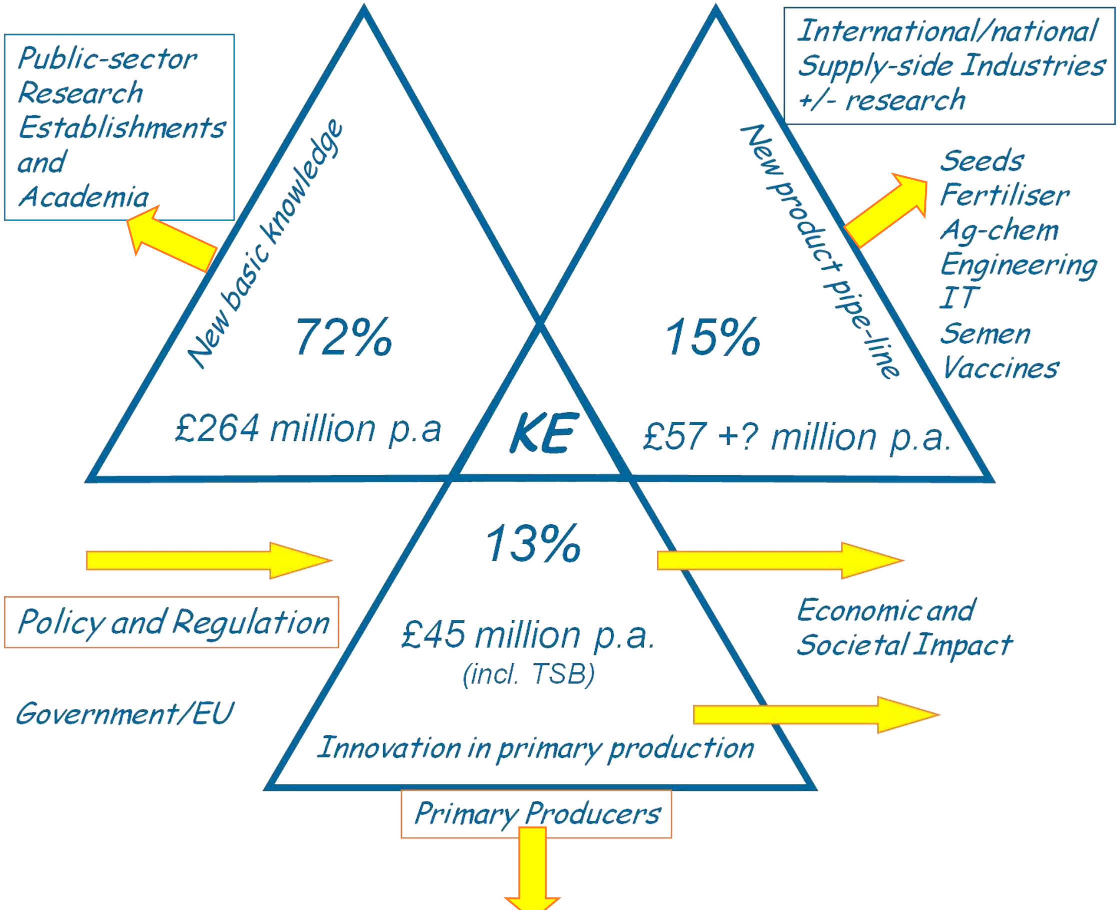


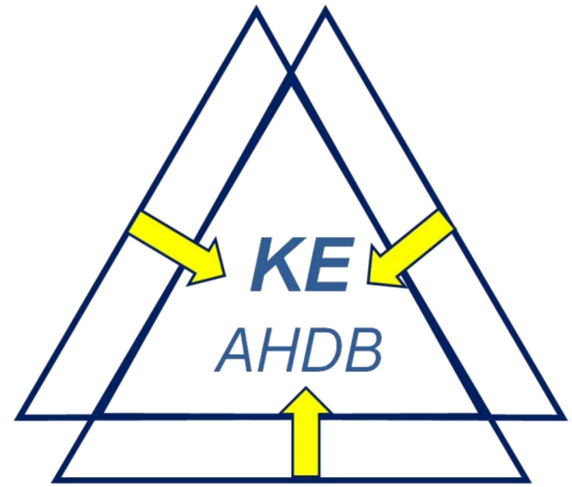
Sustainable Intensification

Producing as efficiently as possible on the smallest footprint of land capable of delivering market requirements is the "greenest" and usually the most profitable way to farm

The Knowledge Exchange "space" has got smaller – reversal is required

Central importance of public–private partnerships, and redistribution of resources





"Reaping the Benefits"
Taylor Report
Food Research Partnership
Foresight Report

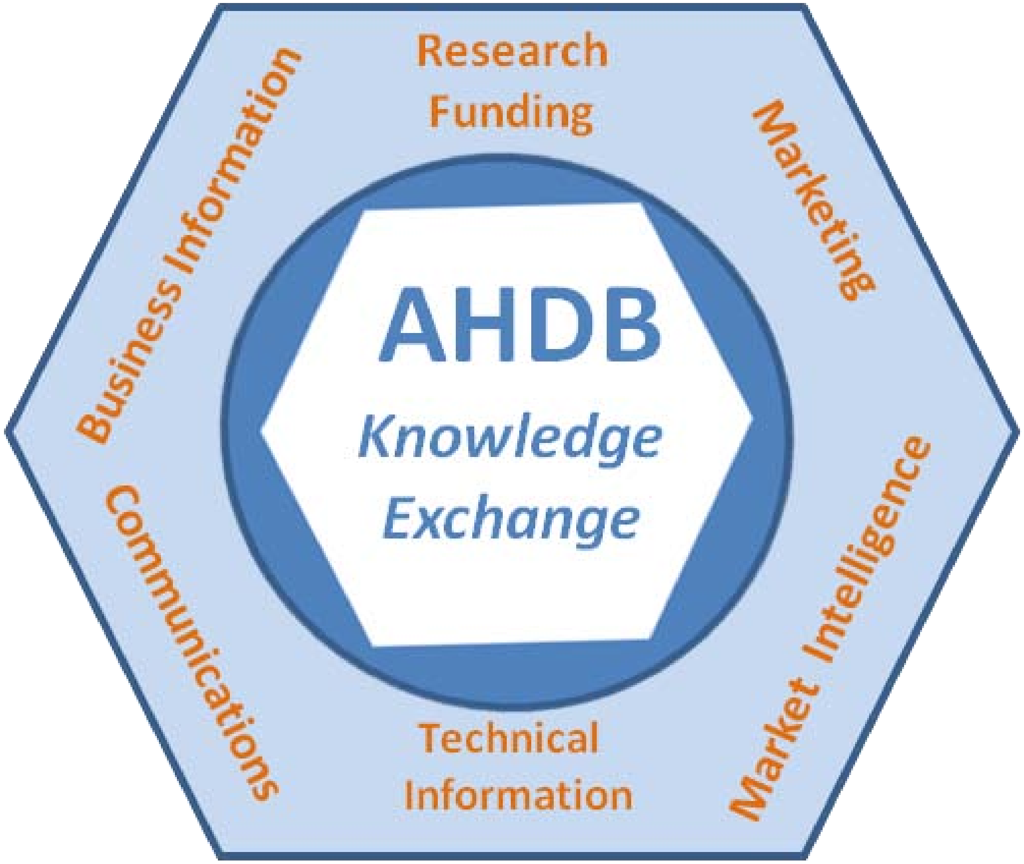
All in agreement

Knowledge Transfer or Exchange?

AHDB
Knowledge
Exchange

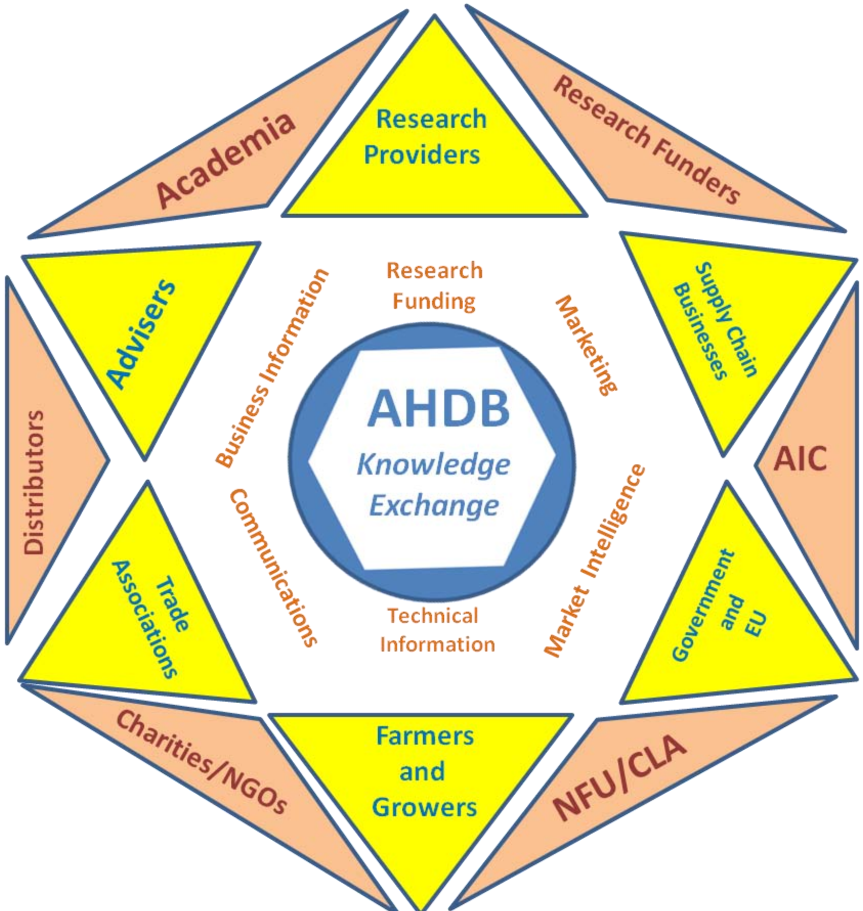
AHDB is a "hub" to broker and orchestrate industry-led integration and coordination of Research & Knowledge Exchange

Six "deliverables"



Funded by and serving the needs of 300,000 science-based SMEs (i.e. farming businesses)

Partnerships are essential to effective delivery



EBLEX – beef & lamb:	£14.5 m (England)
HGCA – cereals & oilseeds:	£10.6 m (UK)
BPEX – pigs:	£7.9 m (England)
DairyCo – milk:	£6.9 m (GB)
PCL – potatoes:	£5.9 m (GB)
HDC – horticulture:	£5.3 m (GB)

£51.1 m

- ***Integration***
- ***Co-ordination***
- ***Added-value***

Sector-specific priorities and objectives all adopt the following high-level drivers

- ***Satisfy the increasing UK and, where appropriate, global demand for food by improving <u>production efficiency and sustainability</u>. This will require well informed consideration of the efficient use of land, <u>energy, water, fertilisers, pesticides and biotechnology</u> as well as an awareness of impacts on biodiversity.***

- ***Reduce <u>emissions of greenhouse gases</u> and take actions to adapt to future <u>climate change</u>.***

- ***Reduce <u>waste</u> in the food chain including the efficient use of co-products and management of the losses associated with <u>diseases of crops and livestock</u>***

- ***Contribute to the continuing high levels of <u>food safety</u> and to efforts to ensure consumers are well-informed about the relationship between personal <u>diet and health</u>***

- ***Increase the level of <u>technical awareness and skills</u> in the industry and encourage early, widespread uptake of beneficial advances in science and technology.***

Objectives and Mechanisms

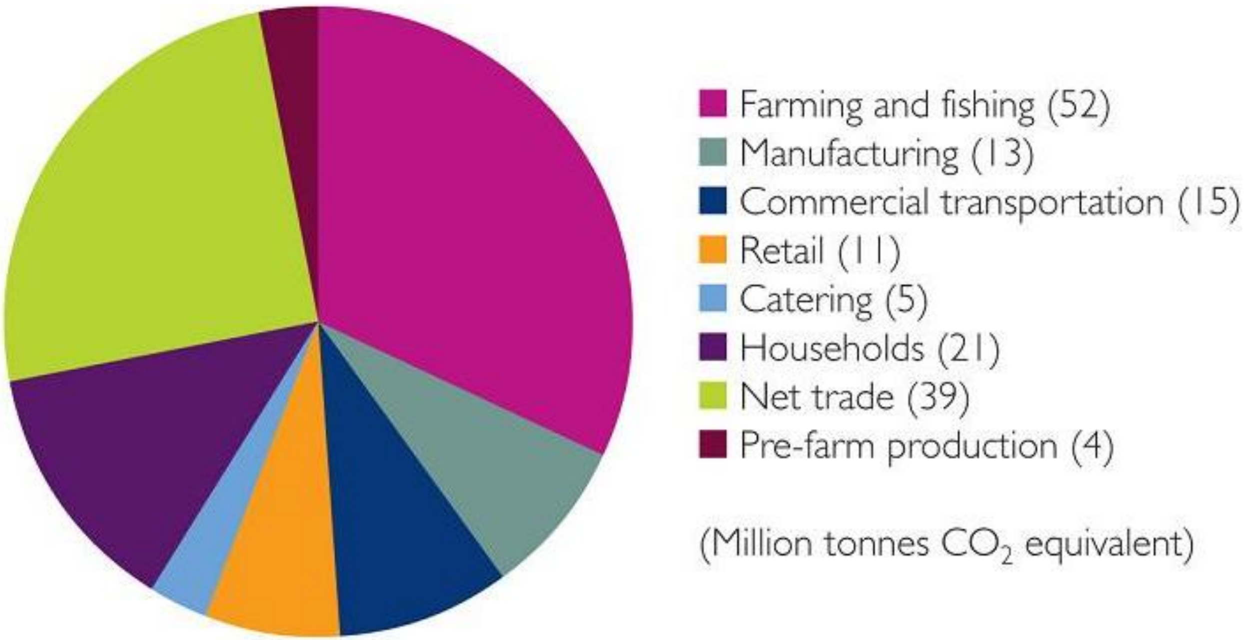
AHDB sets out to provide effective mechanisms for *Knowledge Exchange* between scientists, research funders and levy payers.

The objective is to access the collective experience and expertise of practitioners and scientists to ensure that:

- ❑ relevant, high-quality research of value to end-users is conducted;
- ❑ users are provided with ready access to well-founded, science-based technical information using a range of appropriate tools, techniques and formats;
- ❑ users are enabled to achieve business objectives through improved understanding and early adoption of beneficial new products and practices.

GHG emissions from UK food chain

- ***Agriculture: ca. 9% GHG emissions***
- ***Food system: 30% including land conversion***
- ***CH_4 from ruminants and manure***
- ***N_2O from soil nitrogen (fertilisers, legumes, manures)***



Total = ca. 160 mt CO_2 eq. pa

(Defra data)

The UK Climate Change Act 2008
- GHG Emissions and the Agri-Food Sector

- *80% reduction by 2050 (on 1990 baseline of 748 Mt CO_2eq.– excl LUC)*
- *UK primary production (2009) (DECC, 2011)*
  49.5 of 566.3 Mt CO_2eq. p.a. = 8.7%
  N_20 (55%) @ 289xCO_2; CH_4 (36%) @ 72xCO_2 and CO_2(8%).
- *Actions captured in UK Low Carbon Transition Plan 2009 (Ch7)*
  ⇒18% reductions on 2008 levels by 2020 (= 34% on 1990 levels) = 3Mt CO_2eq. for England by the third Carbon Budget period (2018-2022)
- *Agriculture industry consortium presented Voluntary Action Plan to Defra (2010)*
- *Committee on Climate Change sceptical about voluntary approach*
- *Committee delivered advice for the 4th UK carbon budget period (2023-27) in June 2010 - **indicates annual reduction of 5Mt CO_2eq.***

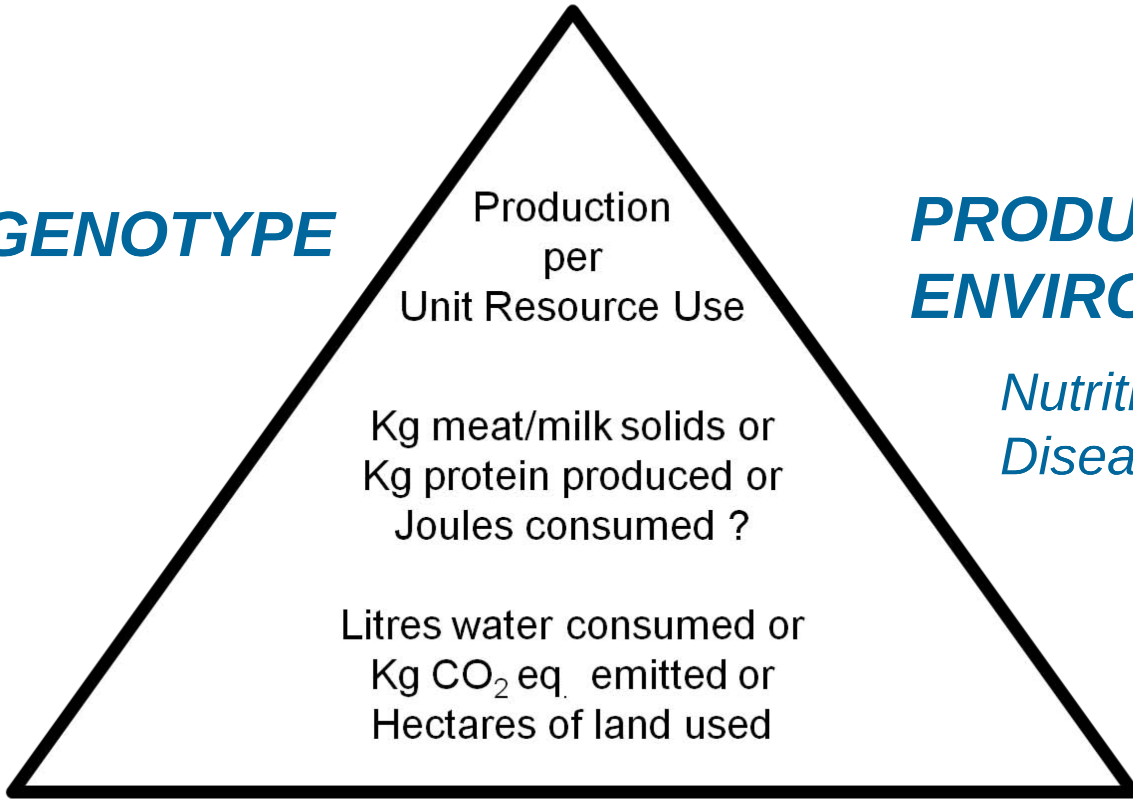
Land use and management has a major impact on net GHG emissions per unit area

Sustainable land use/management and the G x E x E interaction

GENOTYPE

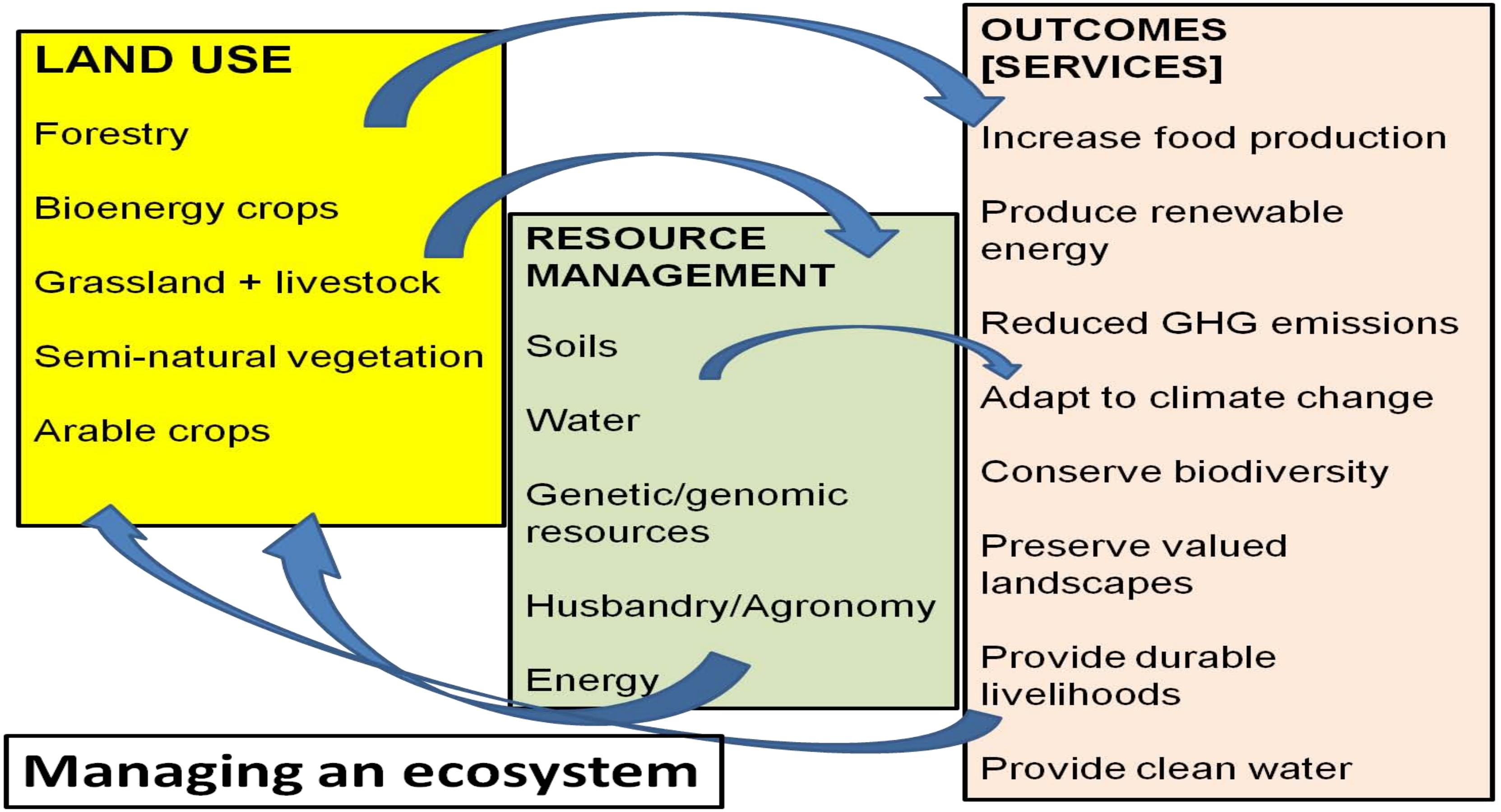
PRODUCTION ENVIRONMENT

Nutrition
Disease etc.



ENVIRONMENTAL IMPACT

Balancing requirements from land: the need for a systems approach



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UK Plant-derived protein (supply and demand)

UK uses ca. 2.6 million tonnes of plant-derived protein for animal feed per annum:

- *37% from home-grown cereals (ca. 1 million tonnes)*
- *3% from home-grown pulses (ca. 0.09 million tonnes)*
- *55% from imported soya (ca. 1.4 million tonnes)*
- *5% from imported maize (ca. 0.13 million tonnes)*

Global soya bean supply and demand (mt)

	Supply	Consumptn	Difference
USA	91	61	+30
Brazil	57	33	+24
Argentina	31	19	+12
China	15	42	-27
India	10	10	0
Other	18	57	-39

Source: FAOStat 2010

UK (and EU) vulnerability to inadequate plant protein supply

Average productivity increases of UK crops necessary to match US soya bean per hectare protein yields (1.33 t/ha)

Tonne/ha	Current yield	Required yield	% increase
Wheat	7.9	11.0	39%
Barley	5.8	13.2	128%
Field bean	3.6	4.6	26%
Dry pea	3.1	5.5	77%
Dry bean	-	5.5	-

The UK is vulnerable to global competition for soya bean and needs a 5 tonne/ha protein crop as an alternative "break" from cereals:
- a target for legume improvement

Wheat yields in RL Trials (2009)
(highest yielding variety)

HGCA

	Tonnes per hectare	
	Fungicide Treated	Fungicide Untreated
Group 1 (milling & baking)	10.6	8.3
Group 2 (milling/feed)	10.8	8.4
Group 3 (soft milling/feed)	10.9	9.0
Group 4 (soft)	11.1	8.5
Group 4 (hard)	11.2	8.5

[World record yield: "Einstein" (Group 2) –
15.64 Tonne/Ha - Southland, New Zealand - Mike Solari]

Protein production and the need for nitrogen

ROTHAMSTED RESEARCH

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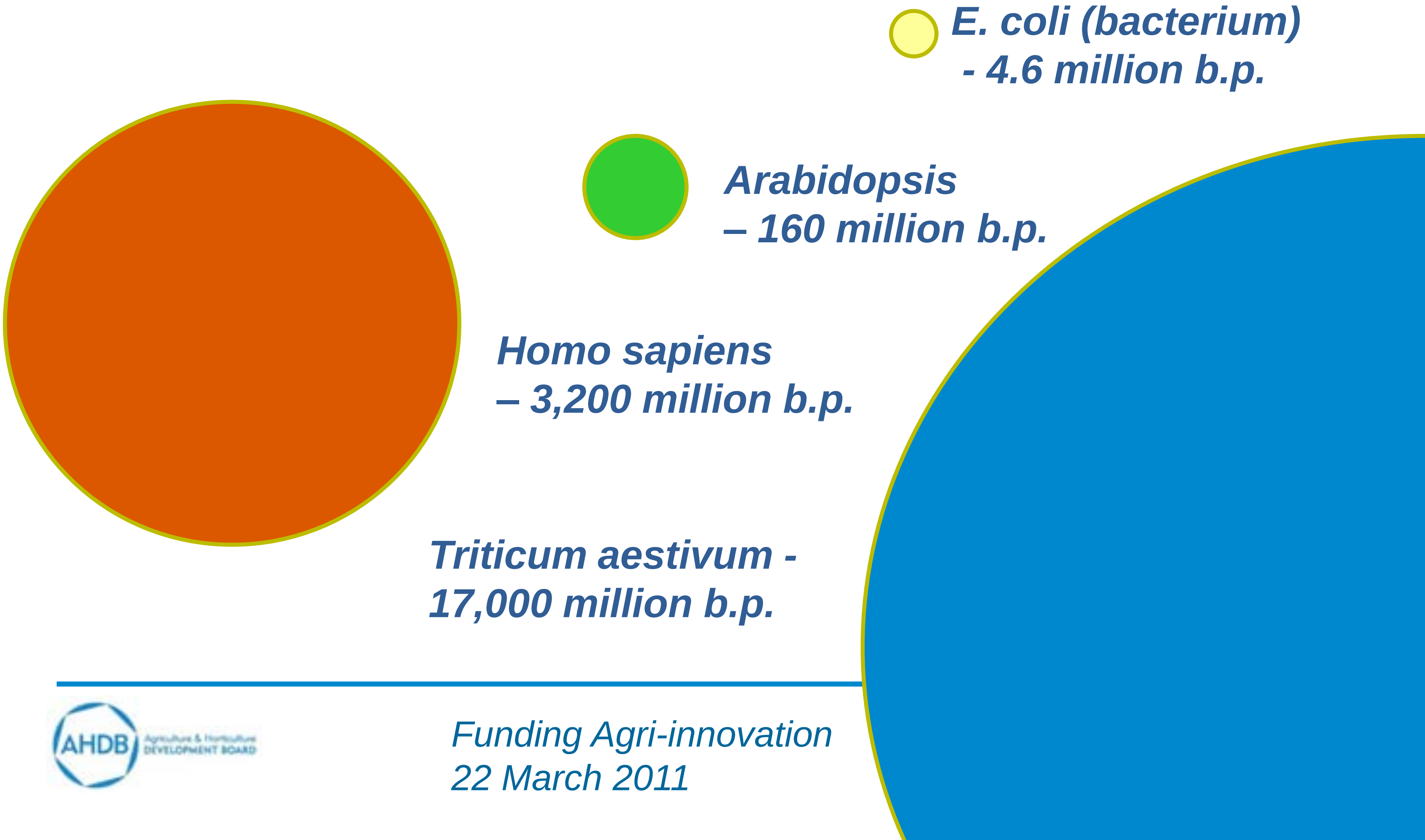
Relative genome sizes

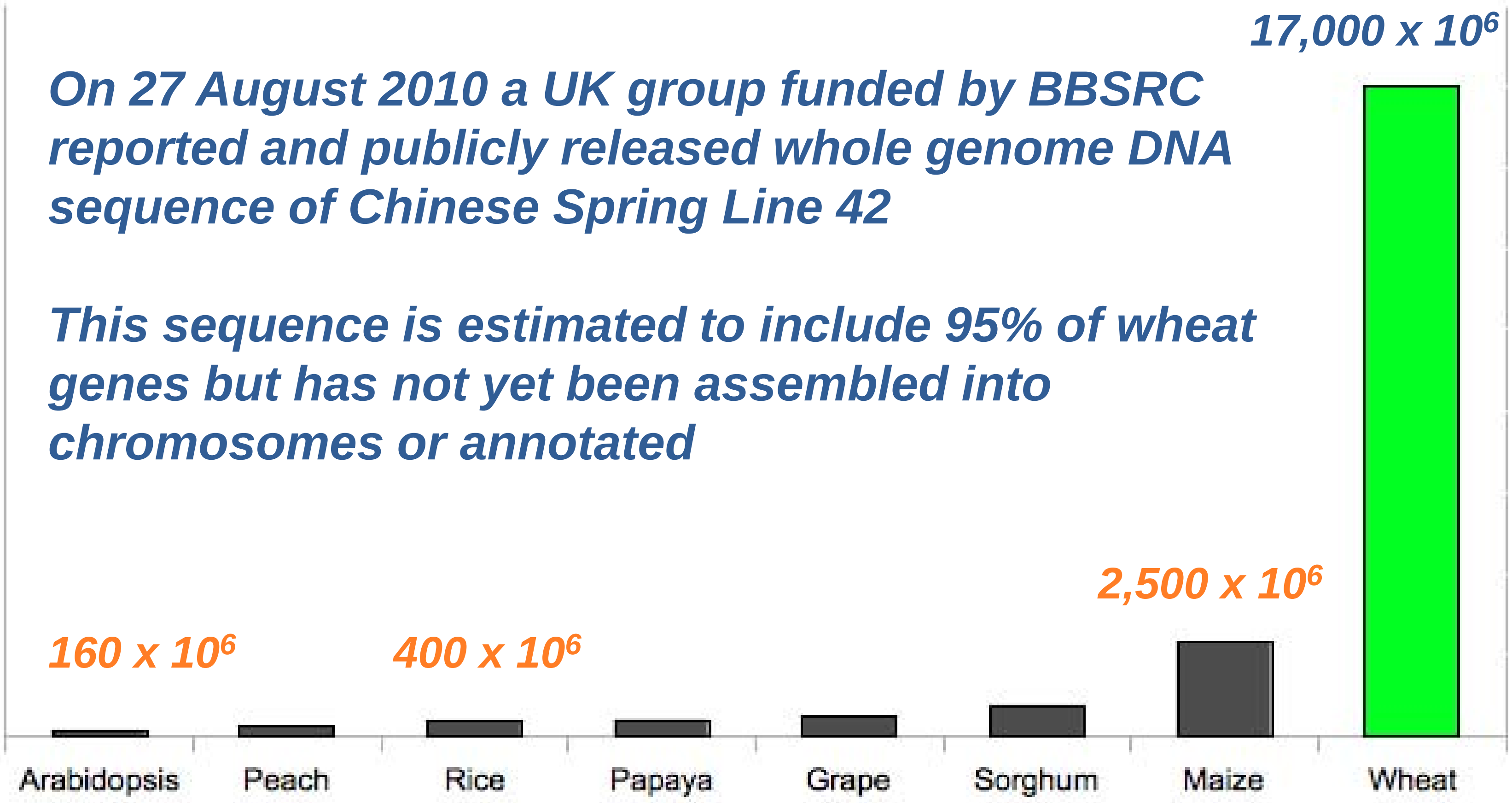
The wheat genome is huge!



Relative crop/plant genome sizes

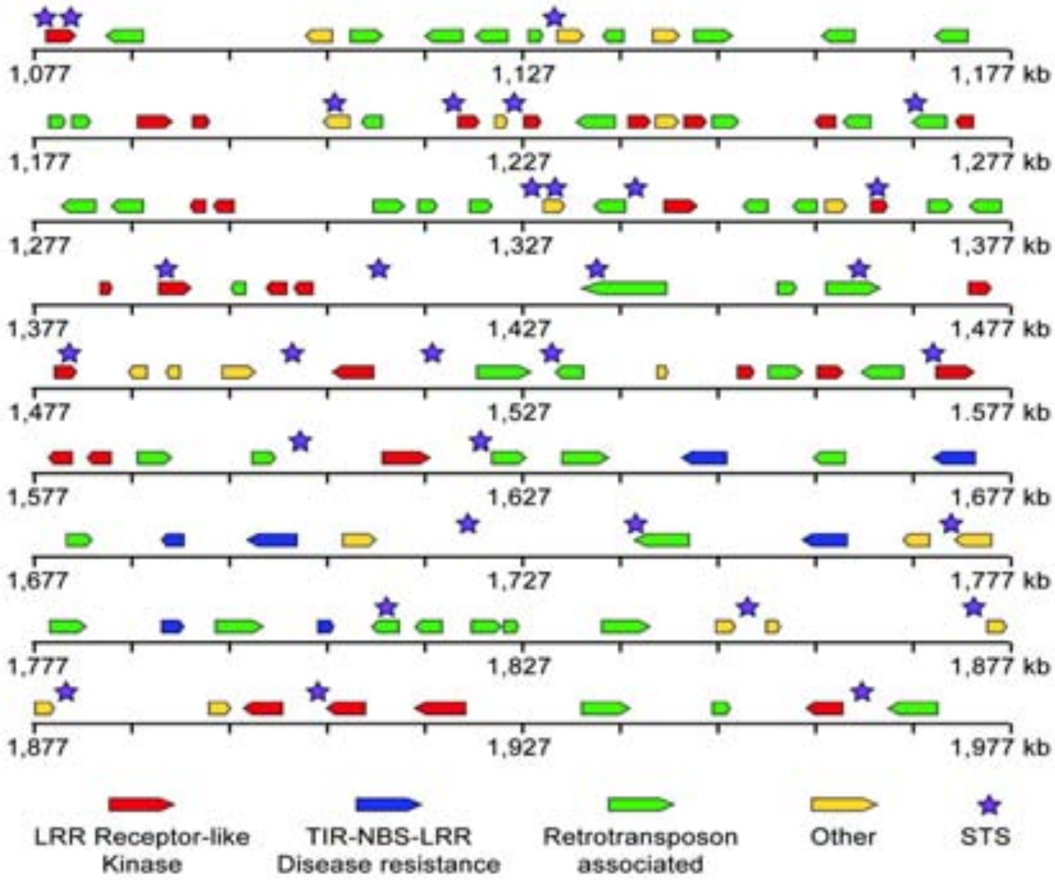
On 27 August 2010 a UK group funded by BBSRC reported and publicly released whole genome DNA sequence of Chinese Spring Line 42

This sequence is estimated to include 95% of wheat genes but has not yet been assembled into chromosomes or annotated



Gene identification will get easier

Bioinformatic tools allow stretches of DNA sequence to be examined for the presence of genes characterised by particular sequence "motifs".



Two examples of disease resistance in action:

- *often due to single genes*
- *genomics should enable efficient identification and selection of gene combinations*

Some conclusions

1. Britain is well-suited and intellectually equipped to explore and utilise innovative approaches to identify and quantify trade-offs in the way land and other resources will best be used for the future benefit of the region's inhabitants [and maybe the planet at large].

2. We need more analytical approaches to land-use based on crop models, future weather scenarios linked to biotic and abiotic constraints. Protection of carbon sinks will be vital; we need to understand better the impacts of expanded forestry and/or bioenergy crops

3. A national (and international) strategy for targeted crop and livestock genetic improvement needs to be implemented (mitigation and adaptation)

4. Cost-benefit analyses need to have CO_2 eq. as well as £ as the currency