Henry Cator*

Challenges and opportunities for the next generation of farmers against the backdrop of climate change

Lettura tenuta l'11 gennaio 2012

Ladies and Gentlemen,

I wish to thank Professor Franco Scaramuzzi and Antonio Stanca for inviting me to address the Accademia dei Georgofili. It is a great honour for me as Chairman of the RASE to be here in Florence. Beside the Accademia dei Georgofili the Royal Agricultural Society of England is but a youngster having been formed only in 1837. I am a farmer and not a scientist so I offer my apologies to those scientists who may feel there are gaps in my knowledge of the science surrounding climate change!

The RASE is a charity which is set up to:

- Promote research, development and practice;
- Support innovation;
- Encourage education on rural issues;
- Champion the social welfare of rural communities;
- Provide an independent rural voice

The Royal Agricultural Society was set up to disseminate knowledge of the latest implements and science in crop production and animal breeding to increase agricultural productivity. The annual sheep shearings became events at which the members of the Society could meet and through exhibition demonstrate their knowledge and innovative technologies. The motto 'Practice with Science' was adopted. Their success came out of the need to produce

* *Chairman of the Royal Agricultural Society of England*

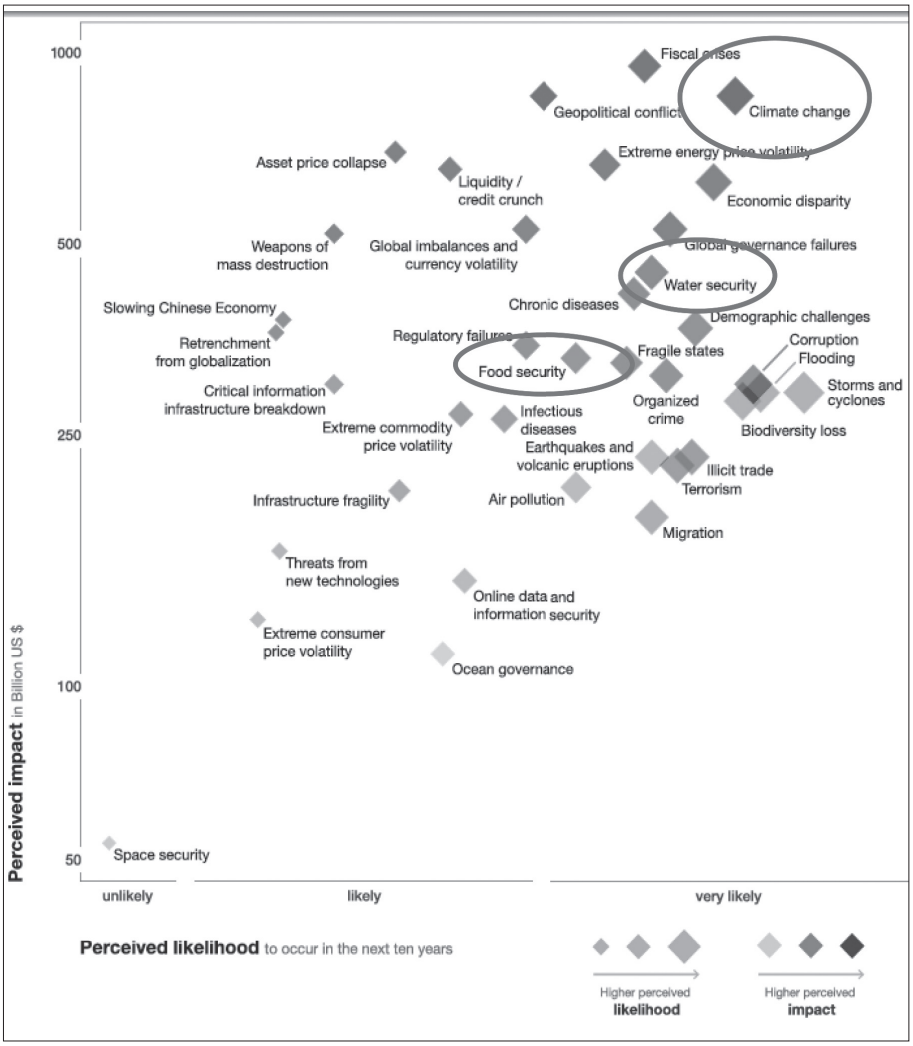


Fig. 1

more food for a growing industrialised nation. The similarity between their needs then and ours today are very close.

My talk will concentrate on three elements. Climate change, water security and food security. The graph below shows the perceived risks from the 2011 World economic risk forum survey. All three are placed as both very likely and with a large financial impact (fig. 1).

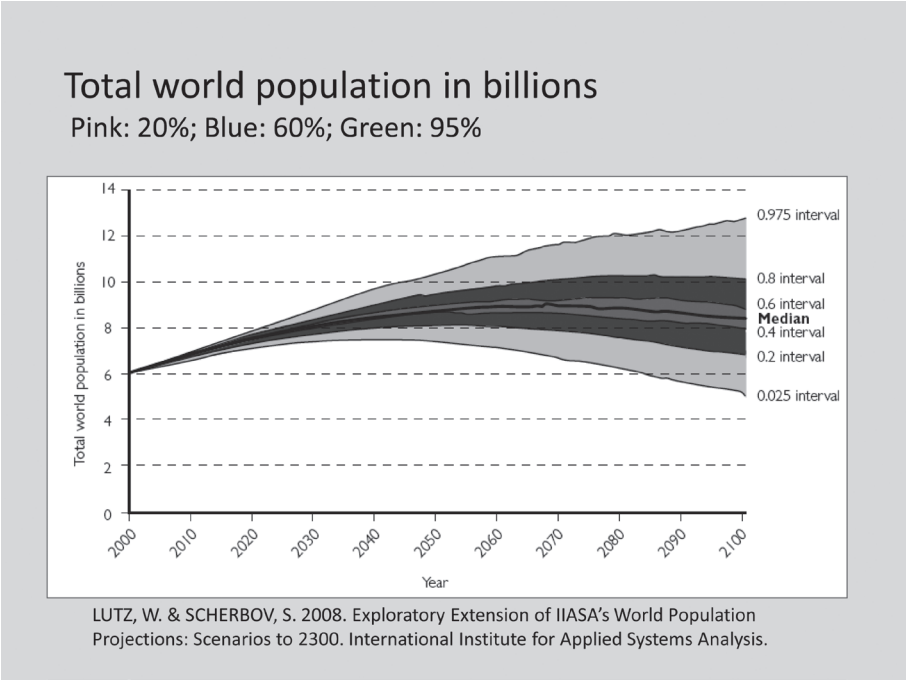


Fig. 2

The United Nations Population Division shows the current world population of around 7 billion is most likely to rise to 8 billion by 2030 and to over 9 billion by 2050. Most of these increases will occur in low income countries. Africa's population is predicted to double from 1 billion to about 2 billion by 2050. Future demand for food will thus be influenced by complex economic and social drivers acting through population growth. But if current prosperity can be maintained, the global population will decrease (fig. 2).

The first goal of the Millennium Development Commission was to reduce the number of hungry and undernourished people in the world. As a percentage of world population we are making progress but that still leaves 900 million people suffering from hunger in the world (fig. 3).

Target 1C of the Millennium Development goal sought to halve the proportion of people who suffer from hunger between 1990 and 2015. Developed countries shown in white on this diagram are not included (fig. 4).

Against this need to feed the world population in 2012 of 7 billion

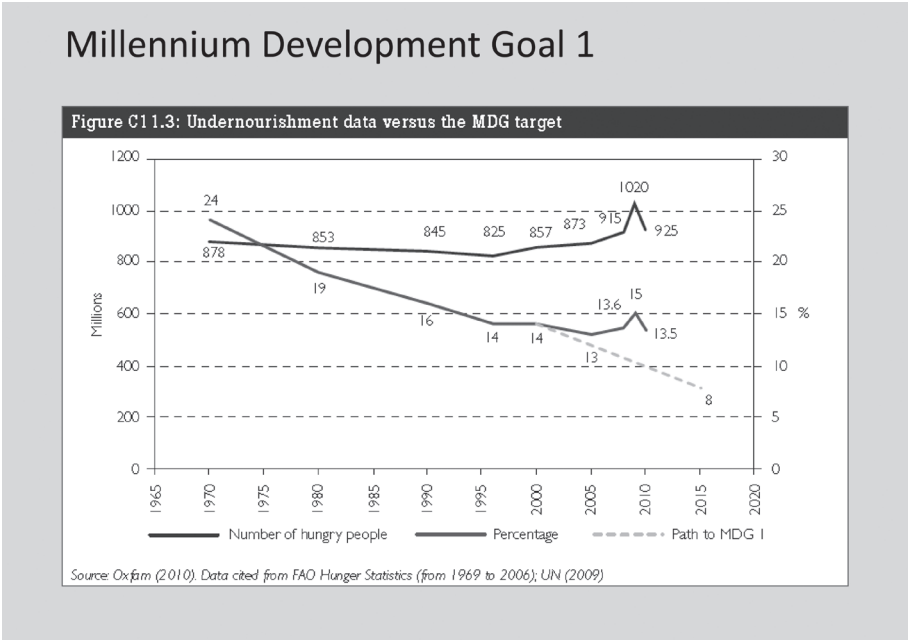

Millennium Development Goal 1
Figure C11.3: Undernourishment data versus the MDG target
Millions
%
1200
1000
800
600
400
200
0
30
25
20
15
10
5
0
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015
2020
24
878
853
19
845
16
825
14
857
14
873
13
915
13.6
1020
15
925
13.5
8
Number of hungry people
Percentage
Path to MDG 1
Source: Oxfam (2010). Data cited from FAO Hunger Statistics (from 1969 to 2006); UN (2009)

Fig. 3

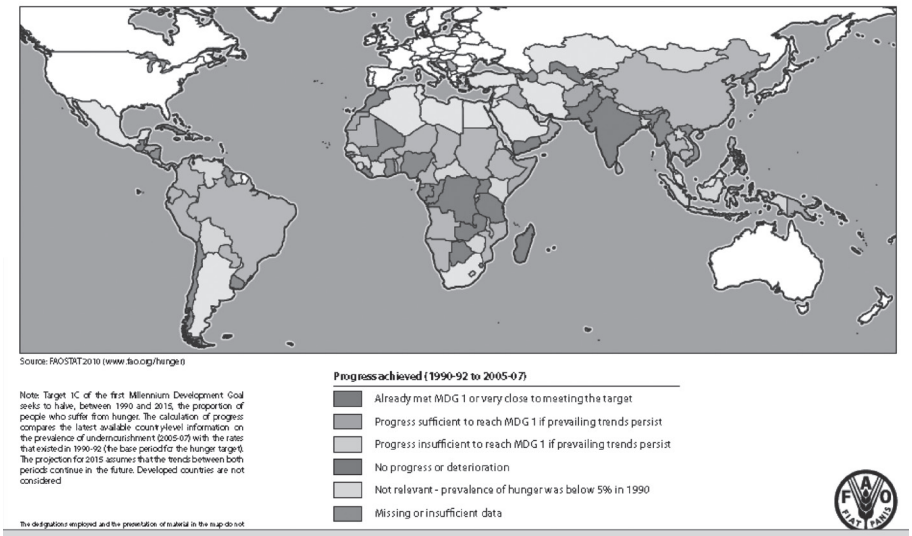
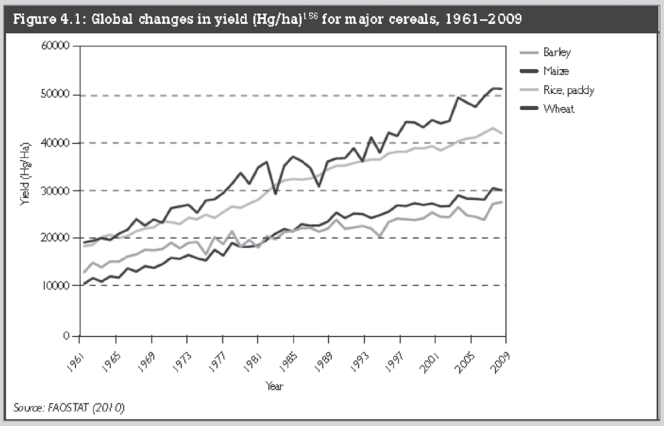

Source: FAOSTAT 2010 (www.fao.org/hunger)
Note: Target 1C of the first Millennium Development Goal seeks to halve, between 1990 and 2015, the proportion of people who suffer from hunger. The calculation of progress compares the latest available country-level information on the prevalence of undernourishment (2005-07) with the rates that existed in 1990-92 (the base period for the hunger target). The projection for 2015 assumes that the trends between both periods continue in the future. Developed countries are not considered
The designations employed and the presentation of material in the map do not
Progress achieved (1990-92 to 2005-07)
Already met MDG 1 or very close to meeting the target
Progress sufficient to reach MDG 1 if prevailing trends persist
Progress insufficient to reach MDG 1 if prevailing trends persist
No progress or deterioration
Not relevant - prevalance of hunger was below 5% in 1990
Missing or insufficient data

Fig. 4



While maize yields continue to rise, wheat yields are beginning to decline as yield ceilings are reached on an increasing proportion of agricultural land. The rates of yield gains for major rice-producing countries in South East Asia have also been variable. For example, much of the increase in China and Indonesia occurred during 1960–90, while in Bangladesh and Vietnam yields have shown greater improvement between 1990–2007.

Fig. 5

The last 50 years and the next 50 ?

	1950	2000	2050
World population	**3.0bn**	**6.5bn = 117%**	**9.5bn = 46%**
Area of cereals	**650m ha**	**725m ha = 12%**	**?**[1 bn ha?]
Yield per hectare	**1.4 tonne**	**3.1 tonne = 121%**	**?**[4.6 tonne?]
Kg grain per capita	**300kg**	**350kg = 17%**	**350kg = 0%**

Fig. 6

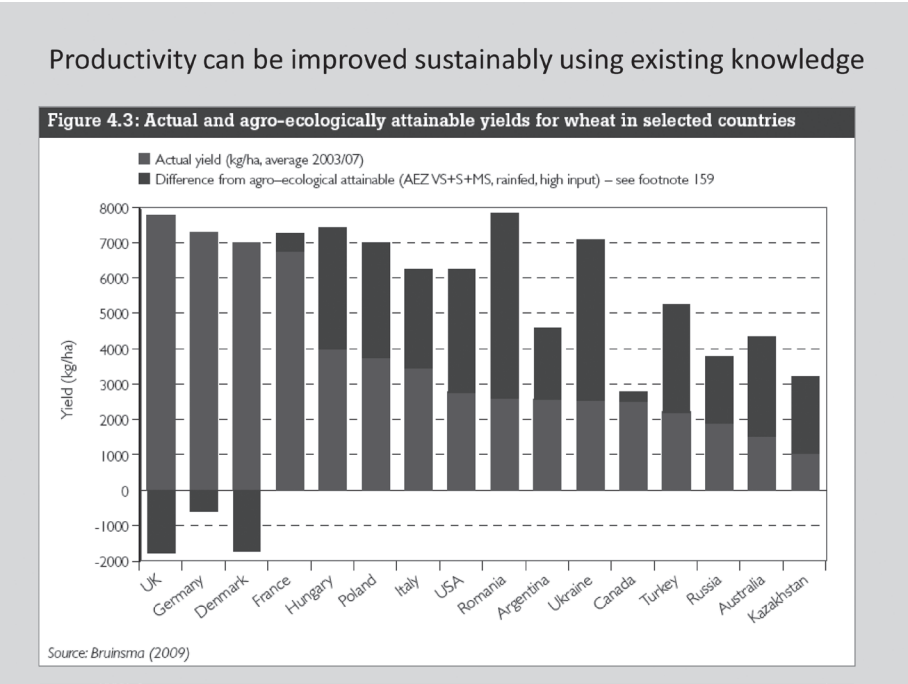


Fig. 7

people it is necessary to look at global yield changes for a variety of crops (fig. 5-6).

Increased productivity may be achieved in a sustainable way using existing knowledge (fig. 7).

However, the precise relationship between income and demand is one of the most complex in a food system and a relationship that makes projecting future demand very difficult. This is because the relationship between income and demand is non-linear, and follows an 'Engel Curve'. Increasing wealth is also associated with a decline in the proportion of starch staple foods in the diet, with a greater proportion of calories obtained from fats, protein and sugar (Bennett's Law) (fig. 8).

It is now widely understood that increases in Carbon Dioxide, Methane and Nitrous Oxide are contributing to the production of greenhouse gases in the world (fig. 9).

What is worrying is how this increase in greenhouse gases will lead to global warming and the subsequent knock on effect that has to changes in agricultural production in the future. It is worth noting the increasing importance of the northern hemisphere in this regard (fig. 10-12).

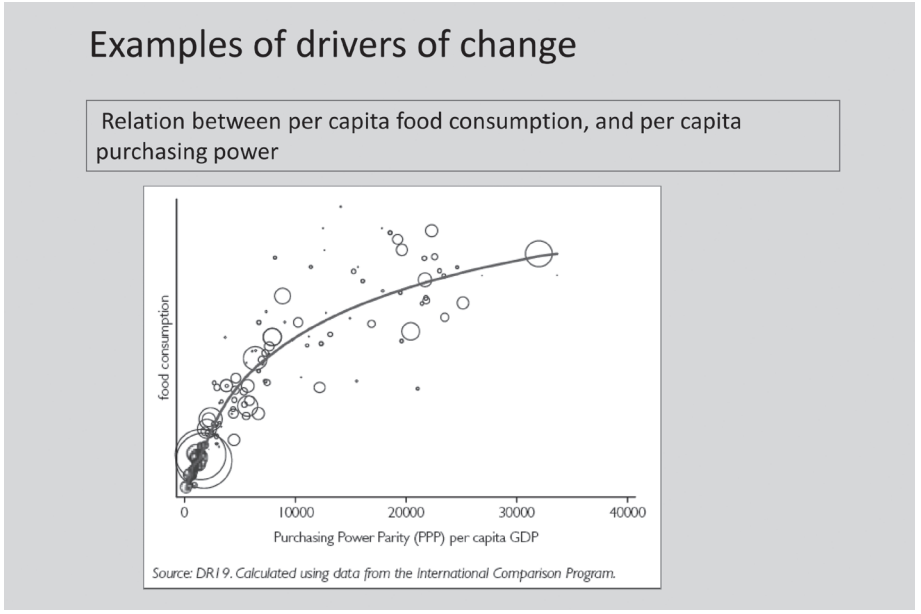

Examples of drivers of change
Relation between per capita food consumption, and per capita purchasing power
food consumption
0
10000
20000
30000
40000
Purchasing Power Parity (PPP) per capita GDP
Source: DR19. Calculated using data from the International Comparison Program.

Fig. 8

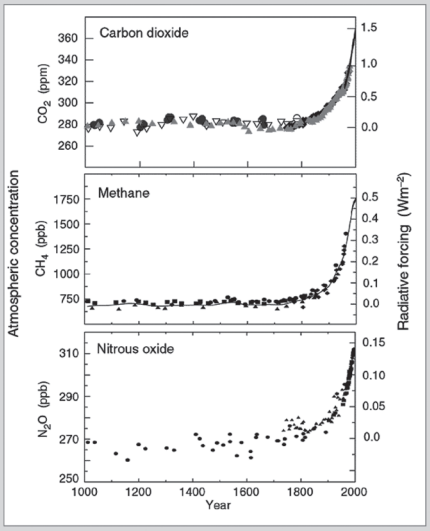

Carbon dioxide
Methane
Nitrous oxide
Atmospheric concentration
Radiative forcing (Wm-2)
CO2 (ppm)
CH4 (ppb)
N2O (ppb)
Year
1000
1200
1400
1600
1800
2000

Fig. 9

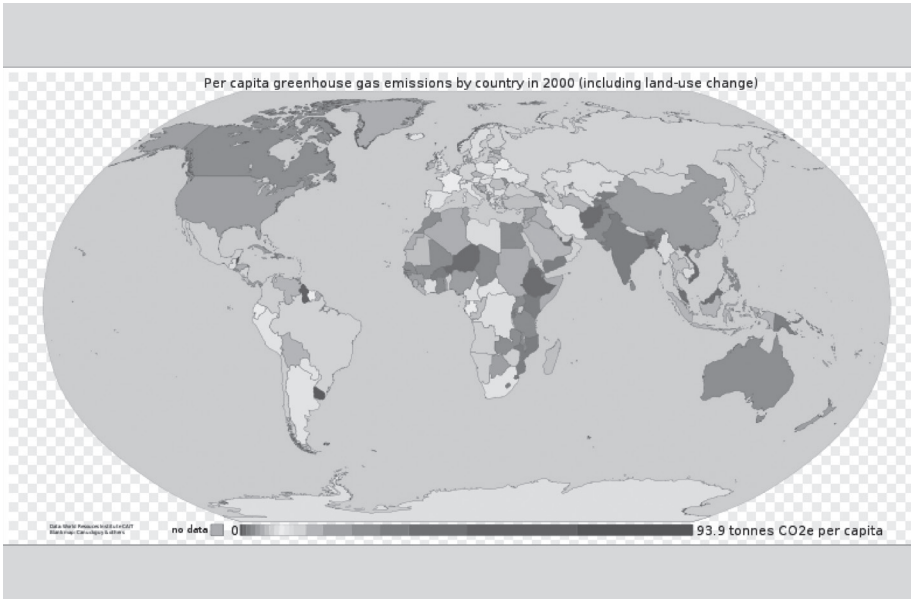

Per capita greenhouse gas emissions by country in 2000 (including land-use change)
no data
0
93.9 tonnes CO2e per capita

Fig. 10

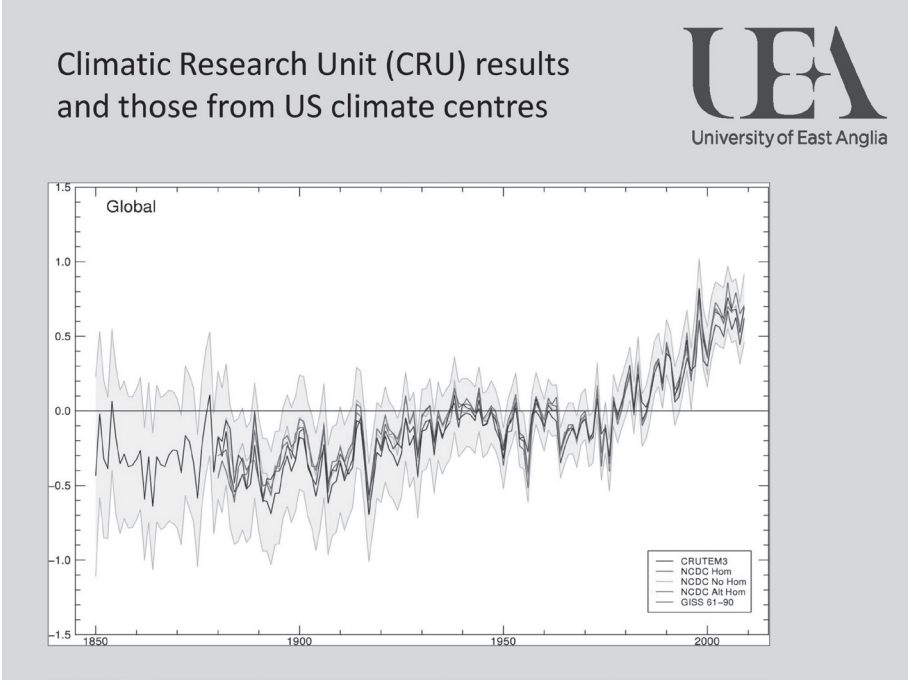

Climatic Research Unit (CRU) results
and those from US climate centres
University of East Anglia
Global
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
1850
1900
1950
2000
CRUTEM3
NCDC Hom
NCDC No Hom
NCDC Alt Hom
GISS 61-90

Fig. 11

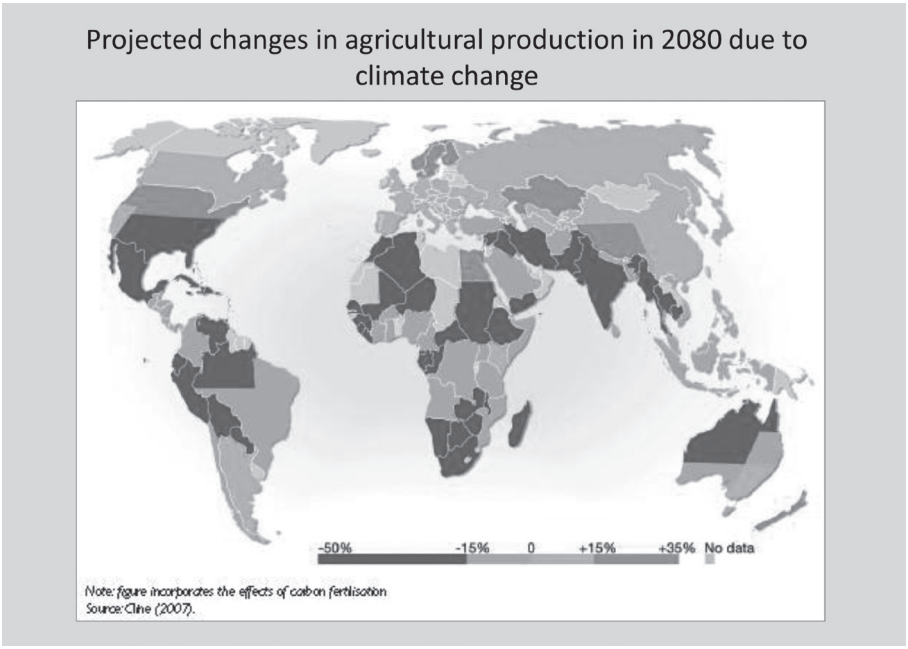

Projected changes in agricultural production in 2080 due to climate change
-50%
-15%
0
+15%
+35%
No data
Note: figure incorporates the effects of carbon fertilisation
Source: Cline (2007).

Fig. 12

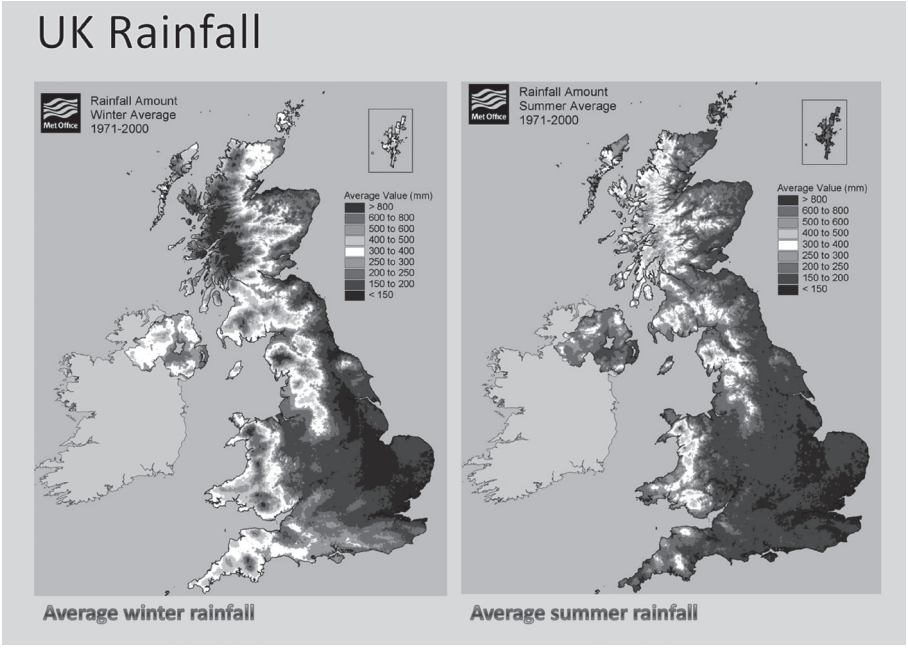

UK Rainfall
Rainfall Amount
Winter Average
1971-2000
Average Value (mm)
> 800
600 to 800
500 to 600
400 to 500
300 to 400
250 to 300
200 to 250
150 to 200
< 150
Average winter rainfall
Rainfall Amount
Summer Average
1971-2000
Average Value (mm)
> 800
600 to 800
500 to 600
400 to 500
300 to 400
250 to 300
200 to 250
150 to 200
< 150
Average summer rainfall

Fig. 13

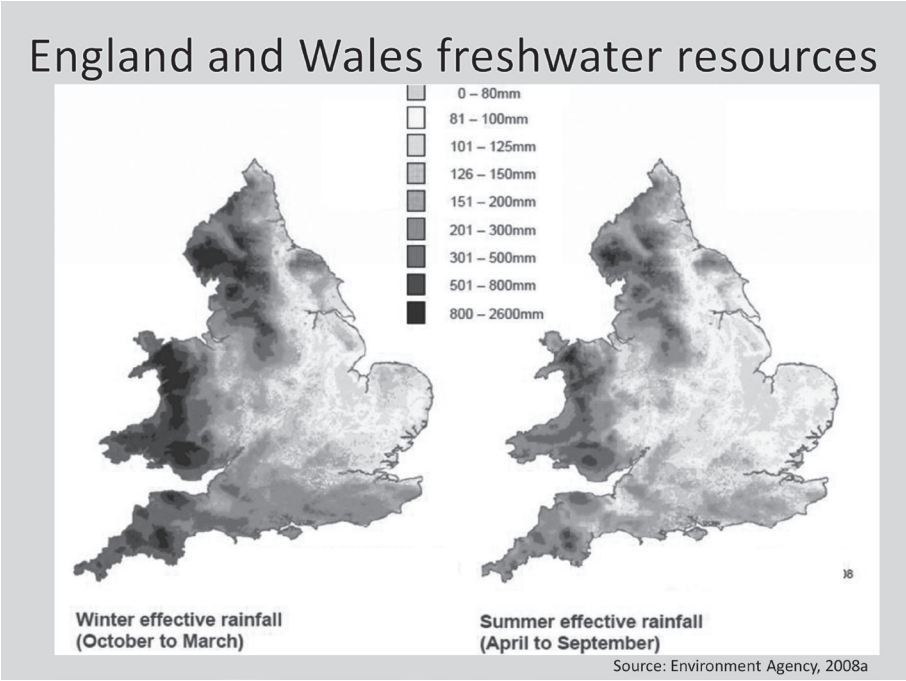


Fig. 14

I should now like to turn away from climate change for a moment and concentrate on water. Our world is known as the Blue Planet. That is because 71% of our earth is covered by water. But the majority of that water is saline. Consequently, most of the water on the planet is unable to be utilised by people to drink or by farmers. It gets worse as 69% of our freshwater is frozen and so not available. The remaining 30% is ground water leaving a very small amount in rivers and lakes for all our needs.

Taking rainfall distribution in the UK it is easy to see the regional differences (fig. 13).

This rainfall pattern gives an annual average rainfall over England and Wales of 890mm. Nearly half of this is lost by evaporation leaving an average of 465mm for runoff to rivers or for percolation to groundwater. This amount remaining is known as effective rainfall. It should be noted that these average values hide large spatial variations in the country with the east getting only 20% of the average (fig. 14-15).

Agriculture draws 70% of the water we use in the world – in some countries this is more than 90% (WWF 2011) (The Royal Society, 2009).

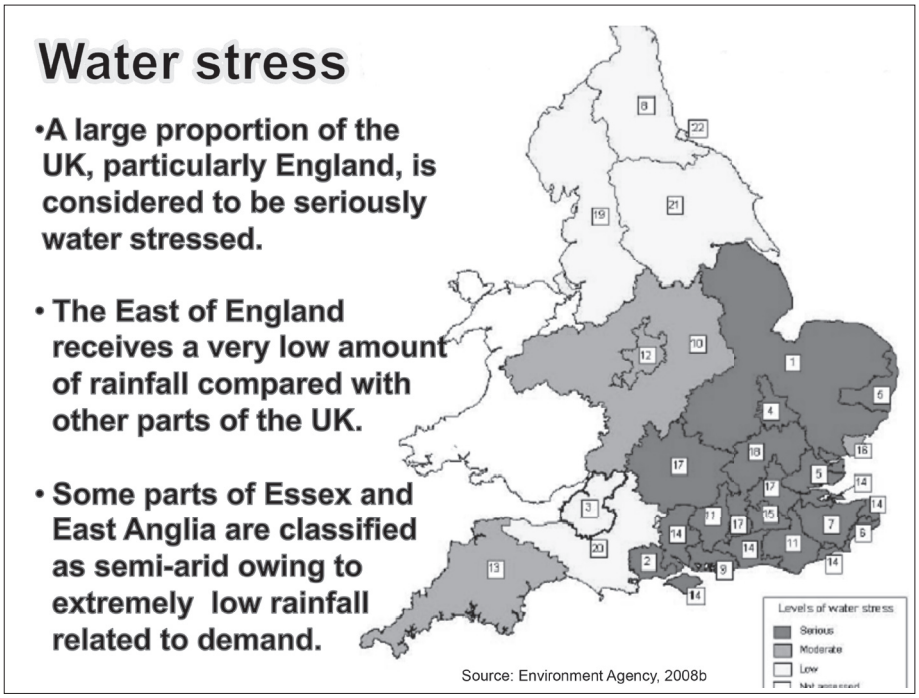


Fig. 15

Most of the water used in agriculture is for irrigation. Globally the irrigated areas are increasing, although the rate of increase appears to be slowing (Faurèsa et al., 2003). Although irrigated areas account for less than 20% of the world's cropped land, they produce nearly 50% of the global food (Doll & Siebert, 2002). Reduction in irrigated areas or the amount of irrigation could therefore have very serious impacts on global food supply. (The Royal Society, 2009).

In the UK agriculture uses a much smaller proportion of water than the global average although this is still significant. Abstractions for livestock occur in the west and are fairly evenly distributed throughout the year whereas abstractions for cropping are concentrated in the east and south and occur during the drier summer period (Chalton et al., 2010).

Another impact on agriculture will come from Sea Level rise which globally rose at a rate of 1.8mm per year between 1961-2003 (IPCC 2007a). The global mean sea level is currently increasing by approximately 3mm per year (Bindoff et al., 2007). In the UK, the relative rise in sea level depends on vertical land movement. Sinking of land in the east and south could double the impact of global rise in sea level.

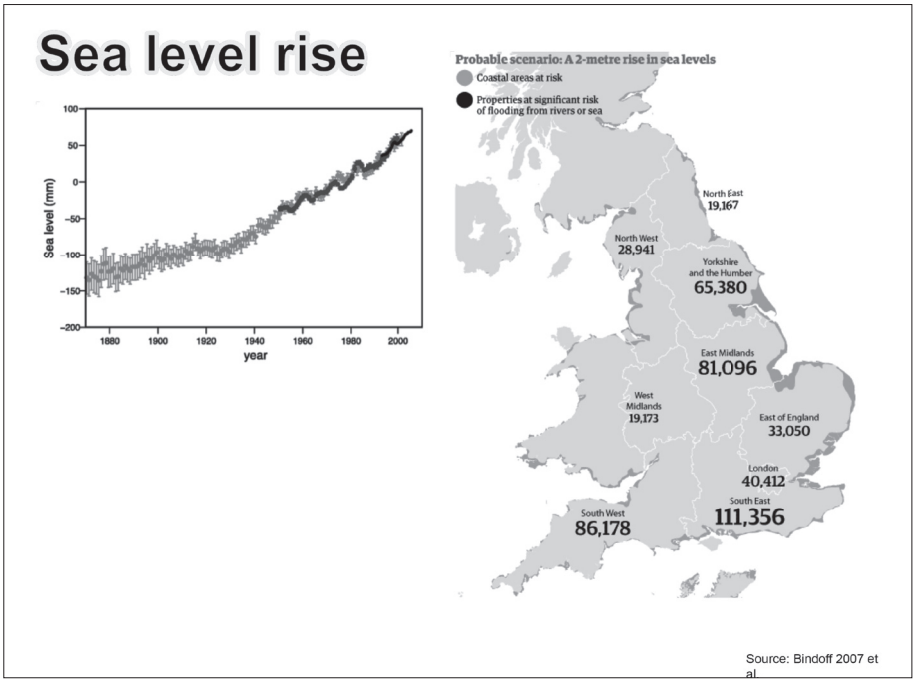
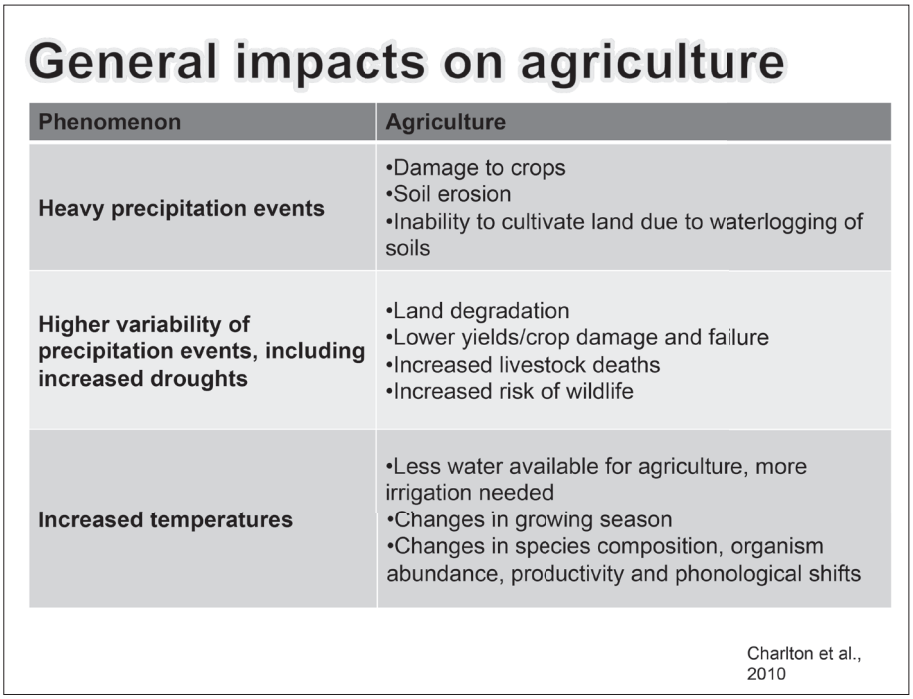


Fig. 16

While land rising in the north would reduce the risk substantially (DEFRA, 1999). It is predicted that sea levels will continue to rise in the 21st century because of thermal expansion and loss of land ice. Sea level rise was not geographically uniform in the past and will not be in the future (Soloman et al., 2007). Across the six SRES "marker" scenarios, sea level was projected to rise by 18 to 59cm by the year 2100. Climate scientists predict that by the 2080's, sea levels could be around 70cm higher around the southern parts of the UK, making serious storm surges and floods more frequent (fig. 16-17).

UK

For grazing livestock enterprises the implications suggest little change in enterprise distribution across the country with the emphasis on changes in grazing management and forage conservation, and a change in the balance of different forages within the diet. Warmer, wetter springs will mean that grass growth starts earlier and continues for longer. Therefore, higher stocking rates may be a possibility as yields and dry matter will increase, particularly in western areas of Britain, such as the Eden catchment, where dairying is predominant. However, this increase in grass growth will occur earlier on in the growing season, with



General impacts on agriculture

Phenomenon	Agriculture
Heavy precipitation events	•Damage to crops •Soil erosion •Inability to cultivate land due to waterlogging of soils
Higher variability of precipitation events, including increased droughts	•Land degradation •Lower yields/crop damage and failure •Increased livestock deaths •Increased risk of wildlife
Increased temperatures	•Less water available for agriculture, more irrigation needed •Changes in growing season •Changes in species composition, organism abundance, productivity and phonological shifts

Charlton et al., 2010

Fig. 17

lower yields later on. Changes in growth period will have implications for seasonal and total feed availability and also quality. The type and balance of forage crops grown could change in order to find a species which can tolerate both wet winters and waterlogged conditions and dry summers.

– Impacts of climate change on crop enterprises suggests that changes will occur as a result of wetter springs, drier summers and the need for an earlier end to autumn fieldwork. Increased temperatures will impact the length of growing season giving rise to an increase in the rate of crop growth and maturation. There is therefore an increased yield potential for the majority of crops but also potential problems and increased costs associated with the over winter survival of pests and diseases e.g. fungi are favoured by humid conditions. For winter wheat there could be changes in sowing date, rate of spring growth, ripening and harvesting date. For potatoes there is the possibility of earlier sowings, earlier harvesting, and potential for higher yields. However, there will be an associated increase in nitrogen and water requirements without these yield and quality will fall. The need for water could lead to a shift of traditional potato growing areas towards the west and higher rainfall areas.

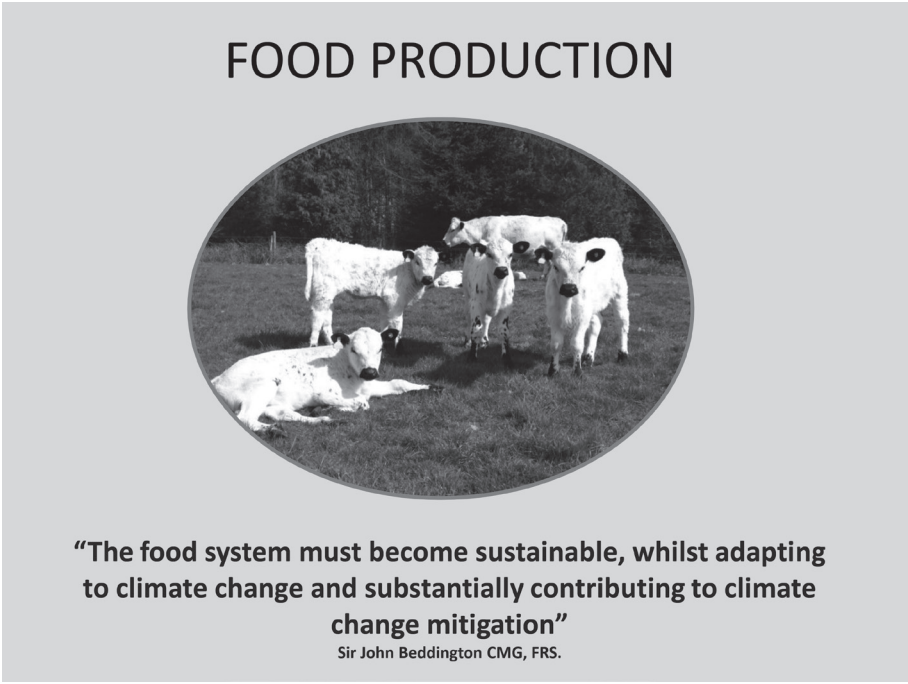


Fig. 18

– Warmer climates also present opportunities with summer vegetable cropping sequences as the warmer winters and high summer temperatures will mean earlier planting dates for summer annual crops. There could be new opportunities in the south, such as within the Medway catchment for grain maize, sunflowers, grapes for wine, winter lupins and peaches (fig. 18-19).
– Roughly one-third of the food produced worldwide for human consumption is lost or wasted, amounting to some 1.3 billion tons per year (FAO, 2011). This inevitably also means that huge amounts of the resources used in food production are used in vain, and that the greenhouse gas emissions caused by production of food that gets lost or wasted are also emissions in vain (FAO, 2011).
– Food loss/ waste in the UK occurs at every stage of the food chain from food production to household consumption (FAO, 2011)

Agricultural production
– *Vegetable commodities and products* – losses due to mechanical damage and/or spillage during harvest operation (e.g. threshing or fruit picking), crops sorted out post harvest, etc.

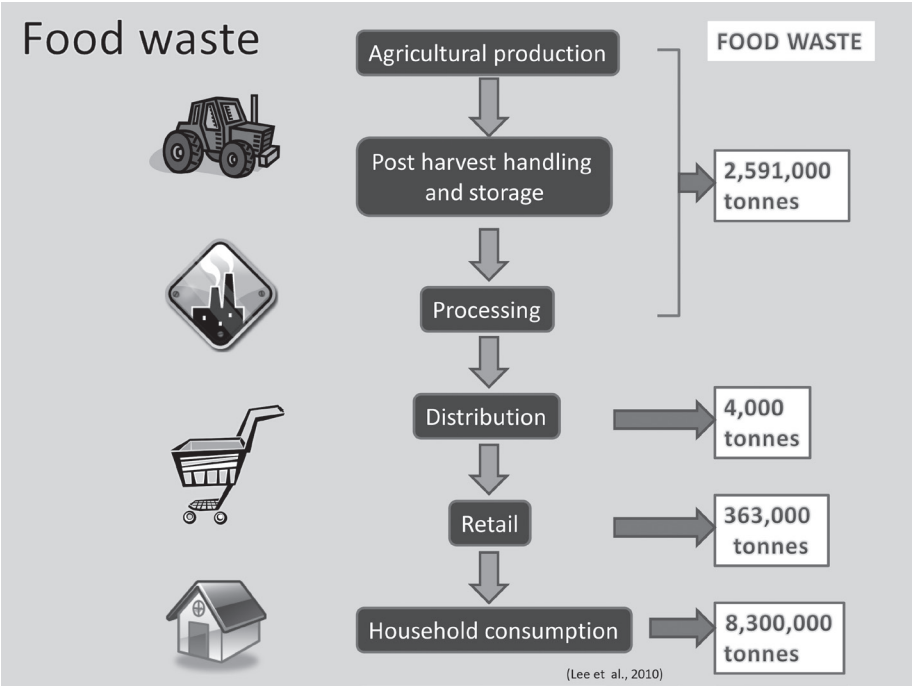


Fig. 19

– *Animal commodities and products* – for bovine, pork and poultry meat, losses refer to animal death during breeding. For milk, losses refer to decreased milk production due to dairy cow sickness (mastitis).

Post harvest handling and storage

– *Vegetable commodities and products* – Losses due to spillage and degradation during handling, storage and transportation between farm and distribution.
– *Animal commodities and products* – For bovine, pork and poultry meat, losses refer to death during transport to slaughter and condemnation at slaughterhouse. For milk, losses refer to spillage and degradation during transportation between farm and distribution.

Processing

– *Vegetable commodities and products* – Losses due to spillage and degradation during industrial or domestic processing, e.g. juice production, canning and bread baking. Losses may occur when crops are sorted out if not suitable to process or during washing, peeling, slicing and boiling or during process interruptions and accidental spillage.

– *Animal commodities and products* – for bovine, pork and poultry meat, losses refer to trimming spillage during slaughtering and additional industrial processing, e.g. sausage production. For milk, losses refer to spillage during industrial milk treatment (e.g. pasteurization) and milk processing to, e.g., cheese and yoghurt.
– 'Disposing is cheaper than using or re-using' attitude in industrialized countries leads to food waste.

Industrialized food processing lines often carry out trimming to ensure the end product is in the right shape and size. Trimmings, in some cases, could be used for human consumption but are usually disposed of. Food is also lost during processing because of spoilage down the production line. Errors during processing lead to final products with the wrong weight, shape or appearance, or damaged packaging, without affecting the safety, taste or nutritional value of the food. In a standardized production line these products often end up being discarded (Stuart, 2009; SEPA, 2008).

In the developing world, over 40 percent of food losses occur after harvest-while being stored or transported, and during processing and packing. In industrialized countries, more than 40 percent of losses occur as a result of retailers and consumers discarding unwanted but often perfectly edible food (FAO, 2011).

Distribution/ Retail – Losses and waste in the market system, at e.g. wholesale markets, supermarkets, retailers and wet markets.
– *In industrialized countries food gets lost when production exceeds demand.* In order to ensure delivery of agreed quantities while anticipating unpredictable bad weather or pest attacks, farmers sometimes make production plans on the safe side, and end-up producing larger quantities than needed, even if conditions are "average". In the case of having produced more than required, some surplus crops are sold to processors or as animal feed. However, this is often not financially profitable considering lower prices in these sectors compared to those from retailers.
– *High 'appearance quality standards' from supermarkets for fresh products lead to food waste.* Some produce is rejected by supermarkets at the farm gate due to rigorous quality standards concerning weight, size, shape and appearance of crops. Therefore, large portions of crops never leave the farms. Even though some rejected crops are used as animal feed, the quality standards might divert food originally aimed for human consumption to other uses (Stuart, 2009).
– *Large quantities on display and a wide range of products/ brands in supply lead to food waste in industrialized countries. Retail stores need to order a*

variety of food types and brands from the same manufacturer to get beneficial prices. Consumers also expect a wide range of products to be available in stores. A wide range of products does, however, increase the likelihood of some of them reaching their "sell-by" date before being sold, and thereby wasted. When shopping, consumers expect store shelves to be well filled. Although certainly beneficial for sales statistics, continually replenished supplies mean that food products close to expiry are often ignored by consumers. This is particularly difficult for small retail stores (SEPA, 2008).

*Household consumption*_– Losses and waste during consumption at the household level.

– In the UK we throw away a third of the food we buy this equates to 8.3 million tonnes a year. 61% of this wastage could have been eaten. 40% of this was food that was not even opened. For example, everyday seven million slices of bread and 4.4 million whole apples are thrown away. This means that the average UK family household with children pay for £680 each year for food that is simply thrown away. The emission of 20 million tonnes of carbon dioxide could be avoided if this perfectly good food didn't go to waste (the equivalent of taking one in four cars off the road) (Quested & Johnson, 2009)
– *Abundance and consumer attitudes lead to high food waste in industrialized countries.* Perhaps one of the most important reasons for food waste at the consumption level in rich countries is that people simply can afford to waste food. The amount of available food per person in retail stores and restaurants has increased during the last decades in both the USA and the EU. Retail stores offer large packages and "getting one for free" bargains (Stuart, 2009).
– Making the food chain more efficient through waste reduction measures will reduce pressure on resources required for food production, lower greenhouse gas emissions and contribute to other policy agendas, such as cutting the need for further space set aside for landfill, which in turn would reduce GHG emissions (Government Office for Science, 2011)
– While the developed world is wasting huge quantities of food many are starving in other countries. There is a Millennium Development Goal which aims to address this concerning issue. This aims to halve the number of undernourished people from the 1990 level of 16% to 8% in 2015. China has already met this target but other countries in Africa and south Asia are unlikely to succeed by 2015 (the Government office of Science, 2011)

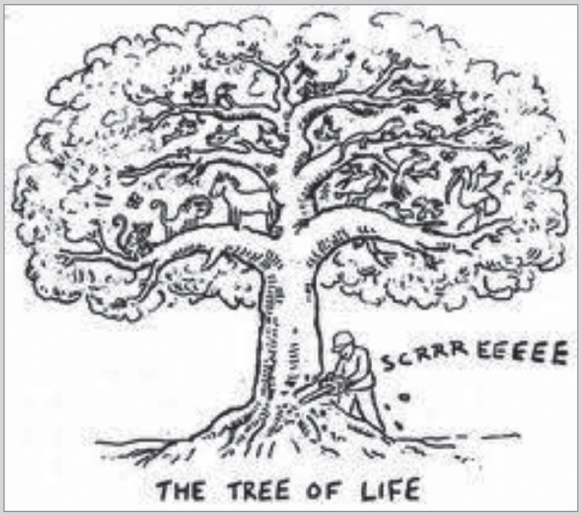


Fig. 20

What was a good image for farming in the 1970's?
- Farm properly and keep your head down
- Don't leave mud on the road
- Don't boast about your subsidy
- Be a patron of rural society

What is a good image today?

Positive contribution to:
- The economy
- The environment
- The social structure
- Feeding the world
- Water management and climate change
- Human health and welfare
- Animal health and welfare

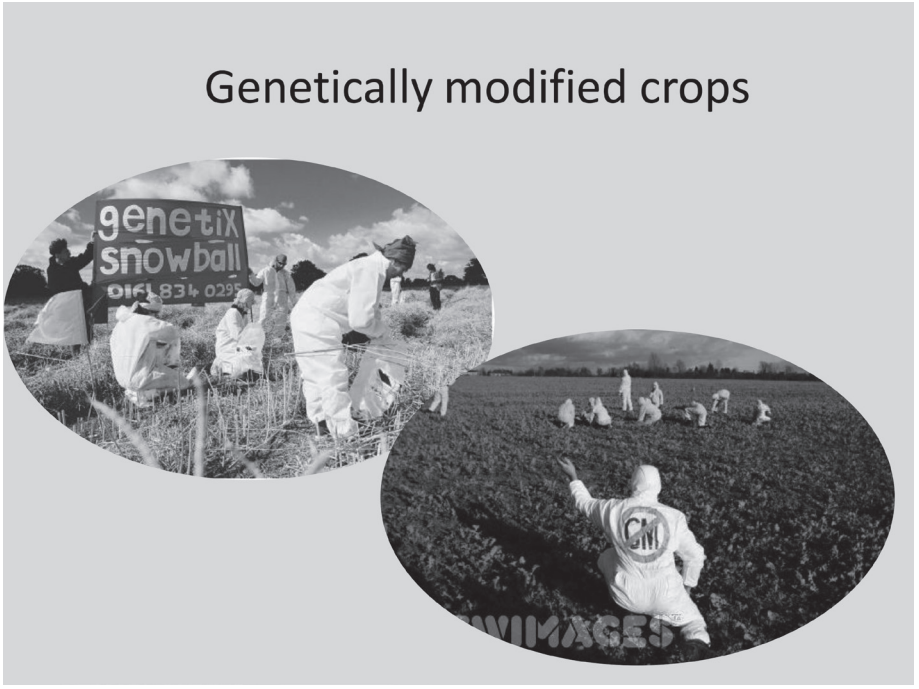


Fig. 21

And still...!
– Farm properly and keep your head down
– Don't leave mud on the road
– Don't boast about your subsidy
– Be a patron of rural society

Why does it matter:
– Public opinion
– Political opinion
– Customer opinion
– Financial opinion
– How is the argument going? (fig. 20-21)

Genetically modified crops give us the potential to react to climate change. Produce cultivars that are resistant to salt, drought, and heat. Provide crops for energy and bio-mass, the ability to use fields to provide essential product ingredients – a route to sustainability. Over the last five years we have

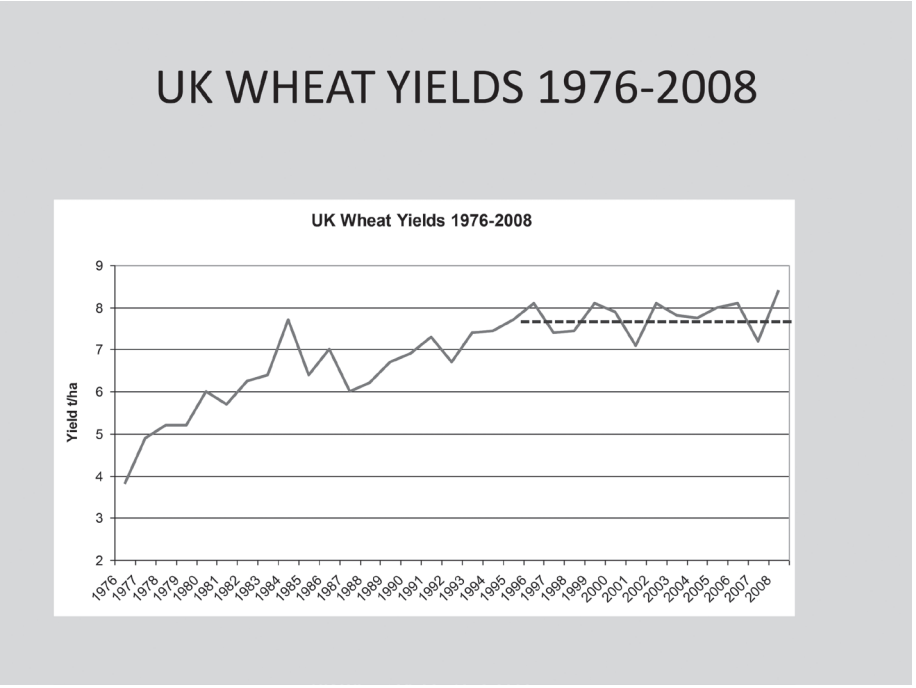


Fig. 22

lost the argument through clumsy and half-hearted campaigning. Whilst our competitors have used this same time to take commercial advantage over UK farmers. GM has been in the diet for years in fact it is the longest running trial in history and no one has died. The tide of opinion is slowly starting to turn but we must align this with the right partners and promote scientifically sound messages. E.g. If we can produce a genetically modified broccoli which gives the consumer a defence against cancer this is a real benefit and the customer would seek out the new broccoli because of its beneficial effects on their health (fig. 22).

The worrying thing about wheat production in the UK is that yields have flat lined over the last 10 years. This despite a trend where farms have become bigger, the workforce smaller, new variety progress has been maintained but where are we going wrong?

What are the influences on wheat crop:
– Soil
– Climate

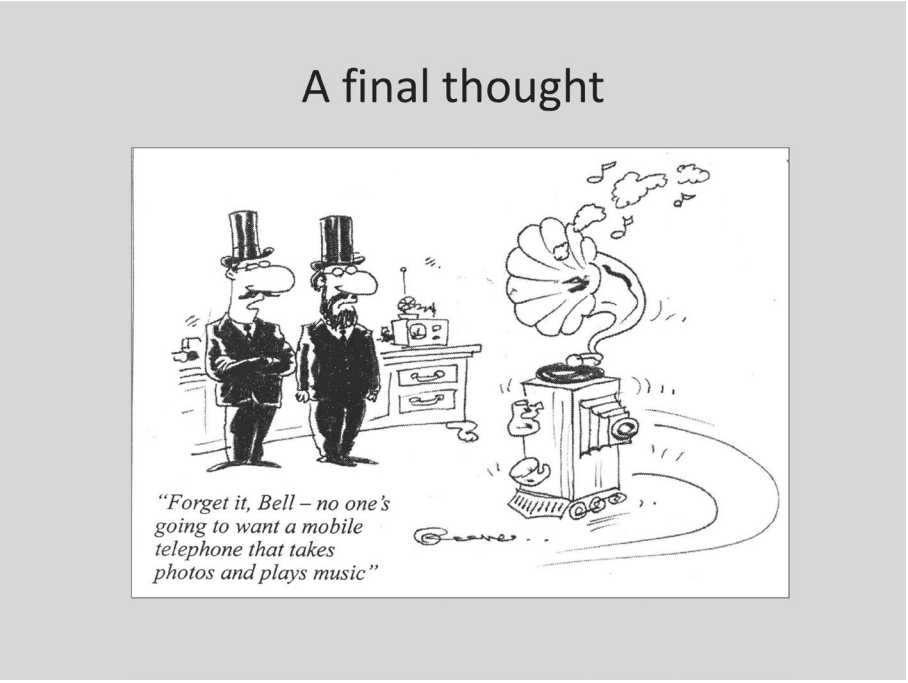


Fig. 23

- Varietal choice
- Management
- Advisers/consultants
- Grain markets
- Workforce

British agriculture is a great place to work. Farming now needs 60,000 new entrants in the next 10 years. If we are to achieve that we need to demonstrate a professional career path. We need to look modern, challenging and rewarding as a career destination. We need to work AS AN INDUSTRY at the interface with schools, new entrants, teachers and parents to put farming's case. With the whole agricultural sector struggling for entrants how can we stop agriculture being viewed as a low skill, low reward industry into one which is high tech, high reward, with high satisfaction?

The answer must be that we need to work together to put the case in favour of agriculture and its related sectors in the food industry. We not only need to completely understand the challenges that we face but meet them

head on and change to meet that challenge. By extending the net we can ensure that the correct message is taken to potential entrants in urban and suburban areas. We need to encourage late and senior entrants and some to change careers. We need to constantly survey young people to ascertain their attitude to farming and the countryside as a career destination.

In conclusion, success comes through conviction and a feeling of self worth. Farming is a great industry and we must be able to compete for the best entrants. Failure to do so jeopardises technical progress and safety. We need to be more professional from owner to manager through to advisor to worker.

«People make history and not the other way around. In periods where there is no leadership, society stands still. Progress occurs when courageous, skilful leaders seize the opportunity to change things for the better» (Harry S Truman, Past President of the USA).

A final thought... (fig. 23)

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