Livestock and climate change – an European perspective

Peter Rowlinson

University of Newcastle,
Newcastle upon Tyne, UK

Time of many, inter-related challenges

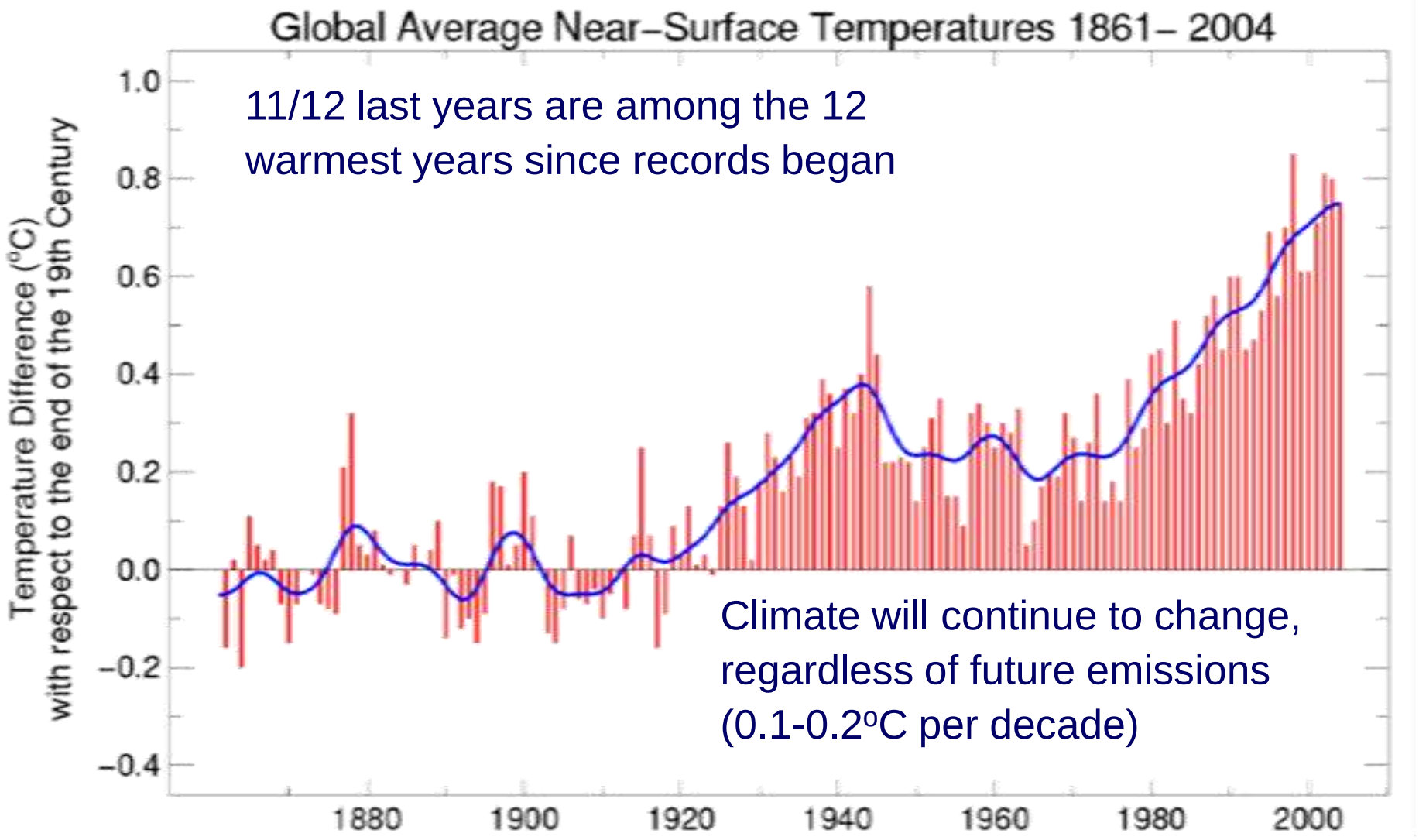
Climate change

- Increasing demand for cereal grains and other sources of biomass
- Human food
- Animal feed
- Biofuels

* “Peak Oil”

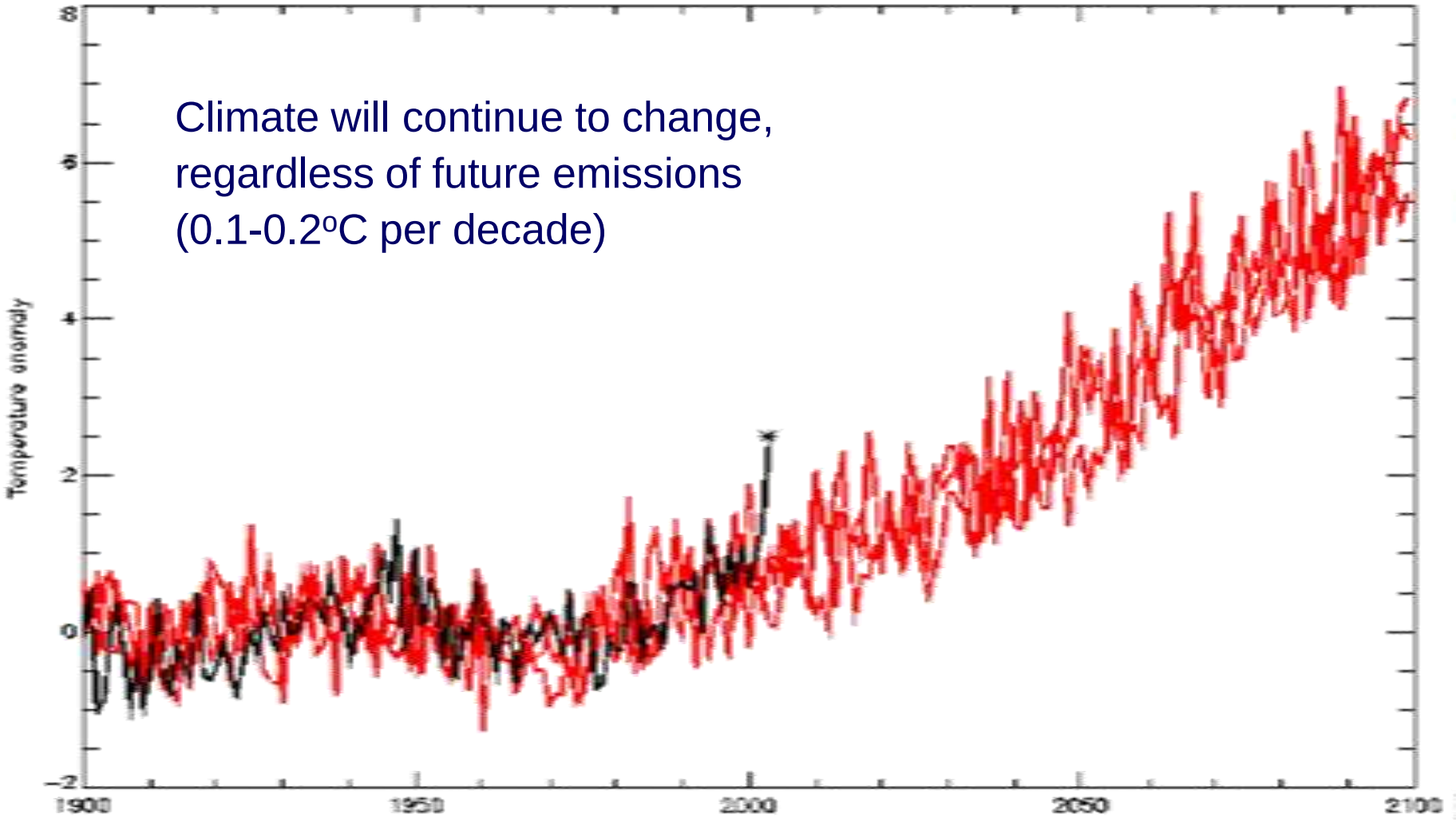
* Water resources

Temperature's rising…



UKCIP08, Hadley Centre

… and will continue to do so



Hadley Centre

Time of many, inter-related challenges

Climate change

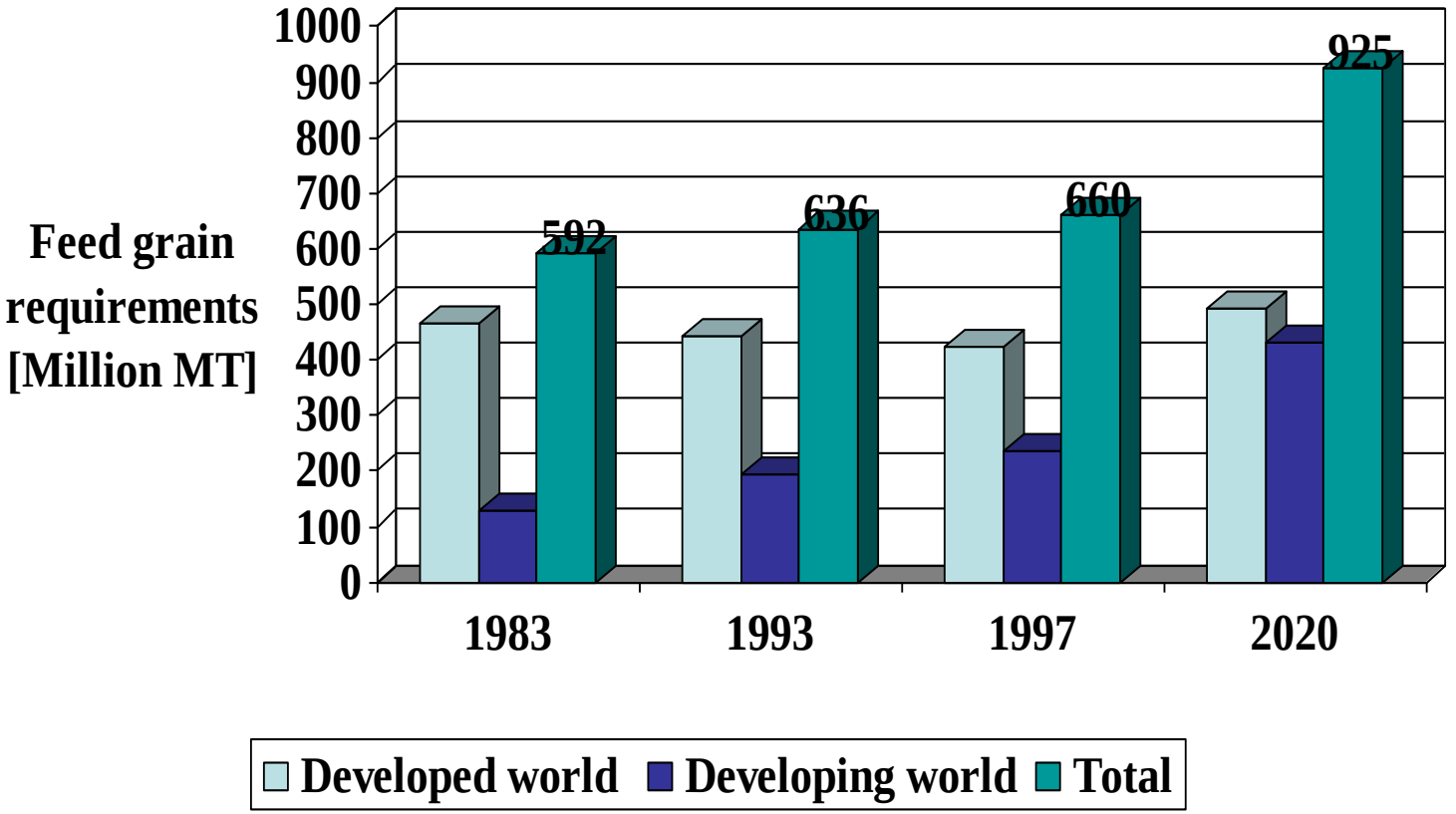
Increasing demand for cereal grains and other sources of biomass

- Human food
- Animal feed
- Biofuels

“Peak Oil”

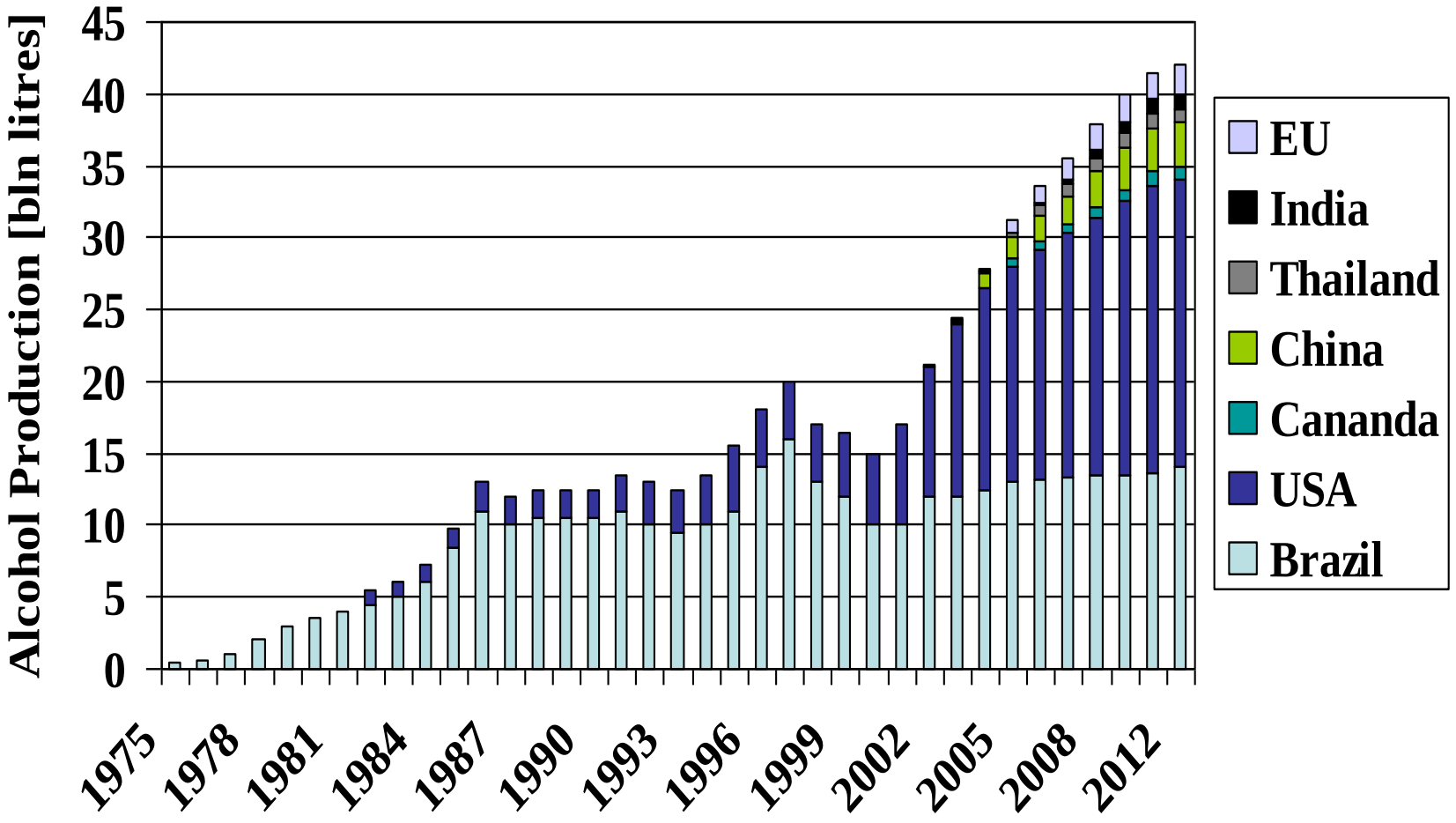
Water resources

Trends in the world use of cereal grain as feed for livestock

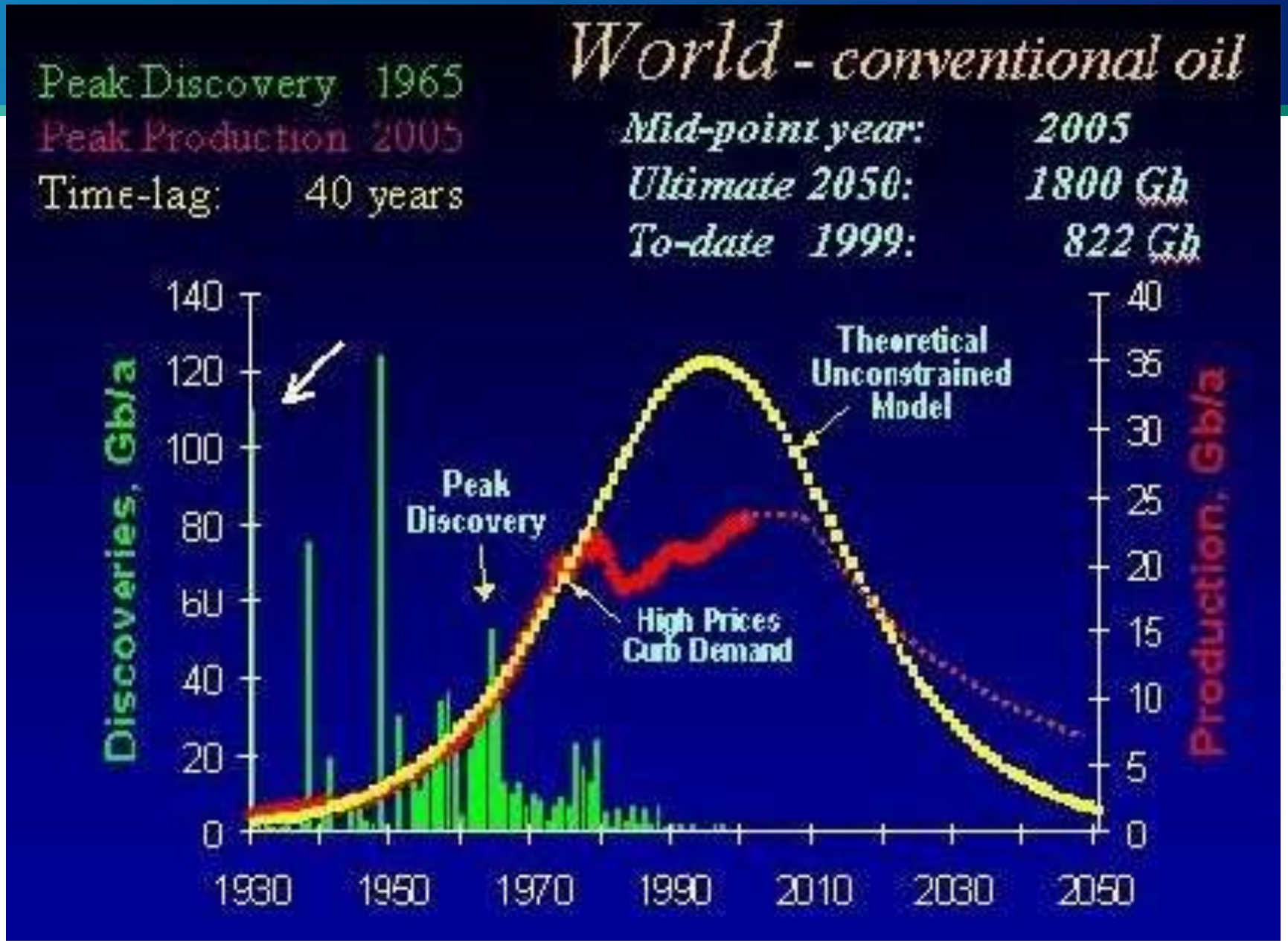


Delgado et al 2002

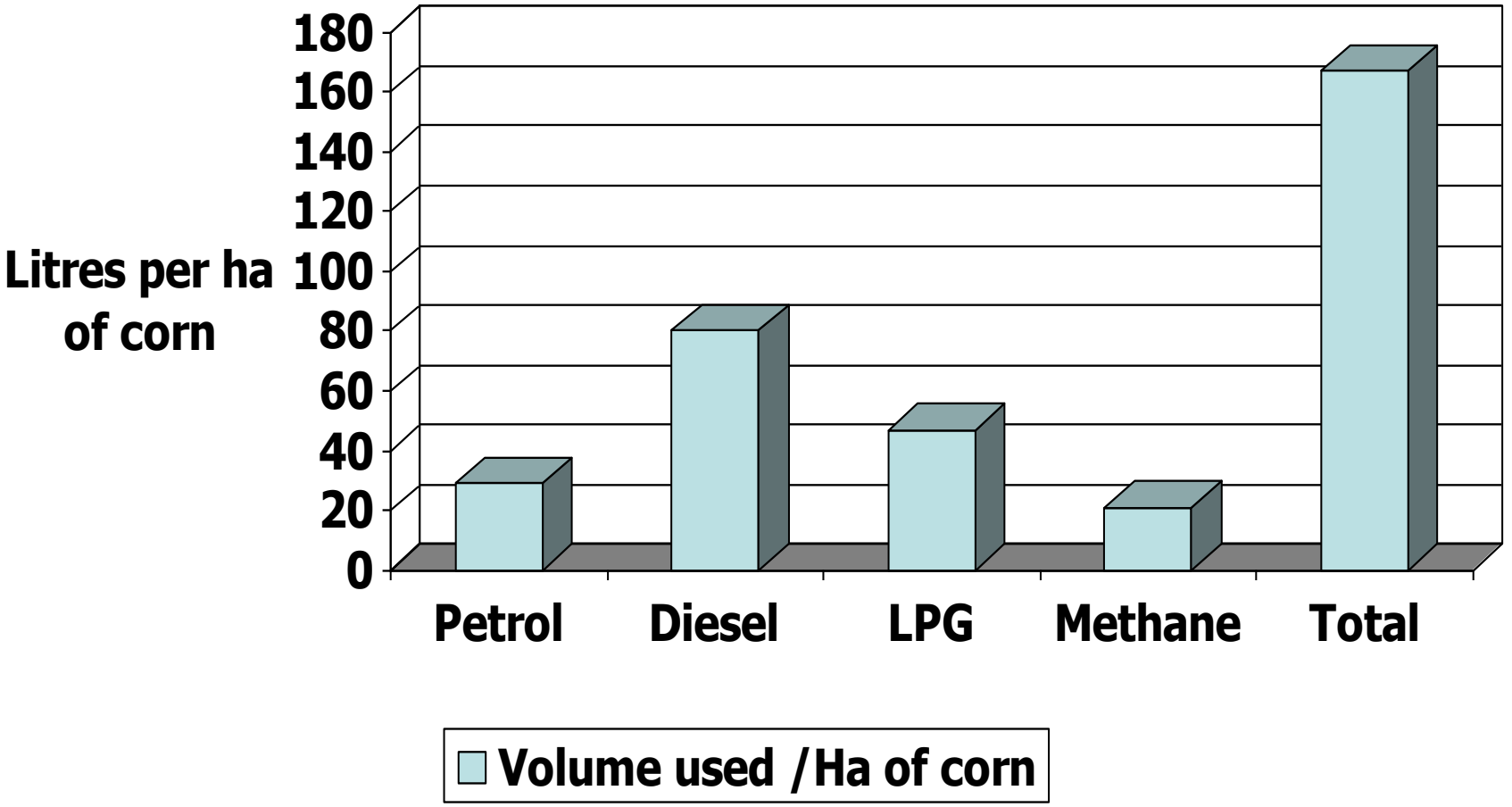
World ethanol production by country. USA is likely to become the world's largest producer using maize as the feedstock



Berg C[2003]World biofuel production Int. Sugar J, 1 [1] 5-15


World - conventional oil
Peak Discovery 1965
Peak Production 2005
Time-lag: 40 years
Mid-point year: 2005
Ultimate 2050: 1800 Gb
To-date 1999: 822 Gb
Theoretical Unconstrained Model
Peak Discovery
High Prices Curb Demand
Discoveries, Gb/a
Production, Gb/a
140
120
100
80
60
40
20
0
40
35
30
25
20
15
10
5
0
1930
1950
1970
1990
2010
2030
2050

The fossil fuel used in producing a hectare of corn [approx 7200kg/ha]



Patzec 2004

Adapting to climate change

- Why ?
- Two separate but inter-related issues:
- **1. Our livestock systems contribute to global warming (and therefore to climate change) – how can we alter these to reduce emissions?**
- **MITIGATION**

Adapting to climate change

- Why ?

- Two separate but inter-related issues:
- 1. Our livestock systems contribute to global warming (and therefore to climate change). – how can we alter these to reduce emissions?
- 2. **The climate changes – what impact does that have on our livestock systems (in the UK and other temperate areas)?**

- **ADAPTATION**

Tropical regions

- “Developing countries in tropical latitudes, that still have a high proportion of the population in rural areas, are better placed for a future when **localization will replace globalization** as the basis of sustainable life-styles involving food, feed and fuel production.”
- (Preston and Leng 2008)

Temperate regions

- “Farmers in developed countries will have the most difficulties in adapting to this strategy because of the impacts of urbanization and their almost complete dependence on products derived from fossil fuels” (Preston and Leng 2008)

Temperate regions

- "Farmers in developed countries will have the most difficulties in adapting to this strategy because of the impacts of urbanization and their almost complete dependence on products derived from fossil fuels" (Preston and Leng 2008)
- Agreed !
- - not so much because of climate change *per se*, but due to the other inter-related changes

Livestock's contribution to climate change

- Our livestock systems contribute to global warming (and therefore to climate change). – how can we alter these to reduce emissions?

- Much of the contribution is associated with feed:
- - production costs
- - transport costs
- - enteric losses: inefficiencies in feed digestion in the animal (eg methane production)
- Some with housing

Livestock's contribution to climate change

- Globally, one of the main issues relates to **numbers of livestock**
- - in particular numbers of livestock for a given level of offtake (animal product)
- "Efficiency"
- Large differences between developed and developing countries
- - but remember, in developing countries livestock at often about more than just production ! – their multi- purpose role.

Developed v. Developing Countries Beef Production per animal

	Developed	Developing
Cattle numbers (m)	410	858
Meat production (m t)	34.6	15.2
Meat production / animal (kg)	84.3	17.7

Livestock's contribution to climate change

- Much of the contribution is related to livestock numbers
- Larger numbers mean more feed is grown, often more is transported and more losses occur (particularly from ruminants)
- **Probably the greatest contribution we could make would be to reduce livestock numbers**
- …….but with the Livestock Revolution, with increasing demand for livestock products, leading us in the opposite direction !

Reduce Livestock numbers ?

- Reduce ? Or reduce to zero ?

- Cease to consume livestock products ?
- No meat ?
- No eggs ? , no dairy products ?

- It is not going to happen !
- - Increasing demand
- - Areas of grassland where biomass can only be harvested for conversion to human food by livestock
- - central role of livestock in sustainable mixed farming systems

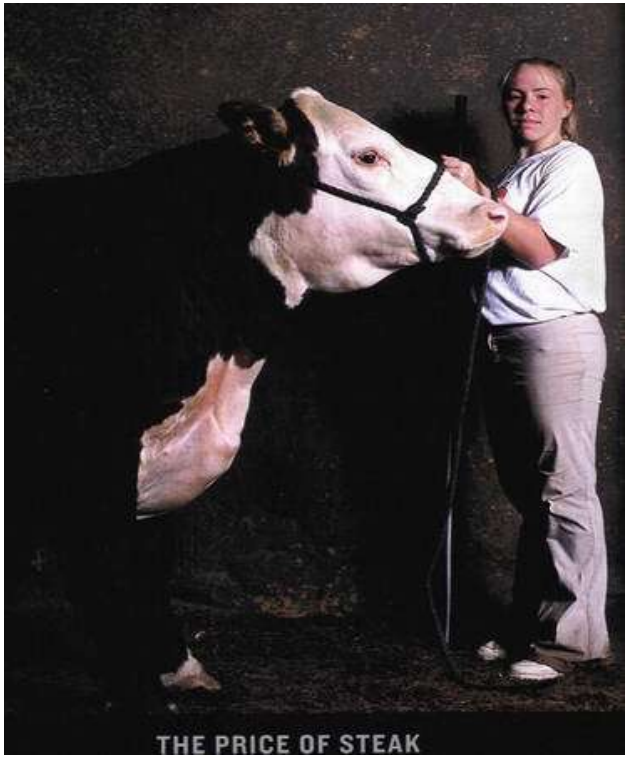
Livestock's contribution to climate change – developing countries

- **Increase offtake**
- Encourage consideration of livestock systems which involve fewer livestock but with higher Animal Production Levels (APLs)
- ie – Production is a higher proportion of M+P
- - less energy (and other nutrients) going solely towards M
- But, be aware of cultural issues – where number of animals is often more important than productivity
- ……and issues to to with sustainable use of local feed resources by appropriate local breeds

Livestock's contribution to climate change – developed countries

- "Efficiency" in European livestock farming, as we typically measure it, is already regarded as high
- - but is it really if we consider all the energy costs (and their contributions to global warming and climate change) associated with the production and transport of our livestock feeds?

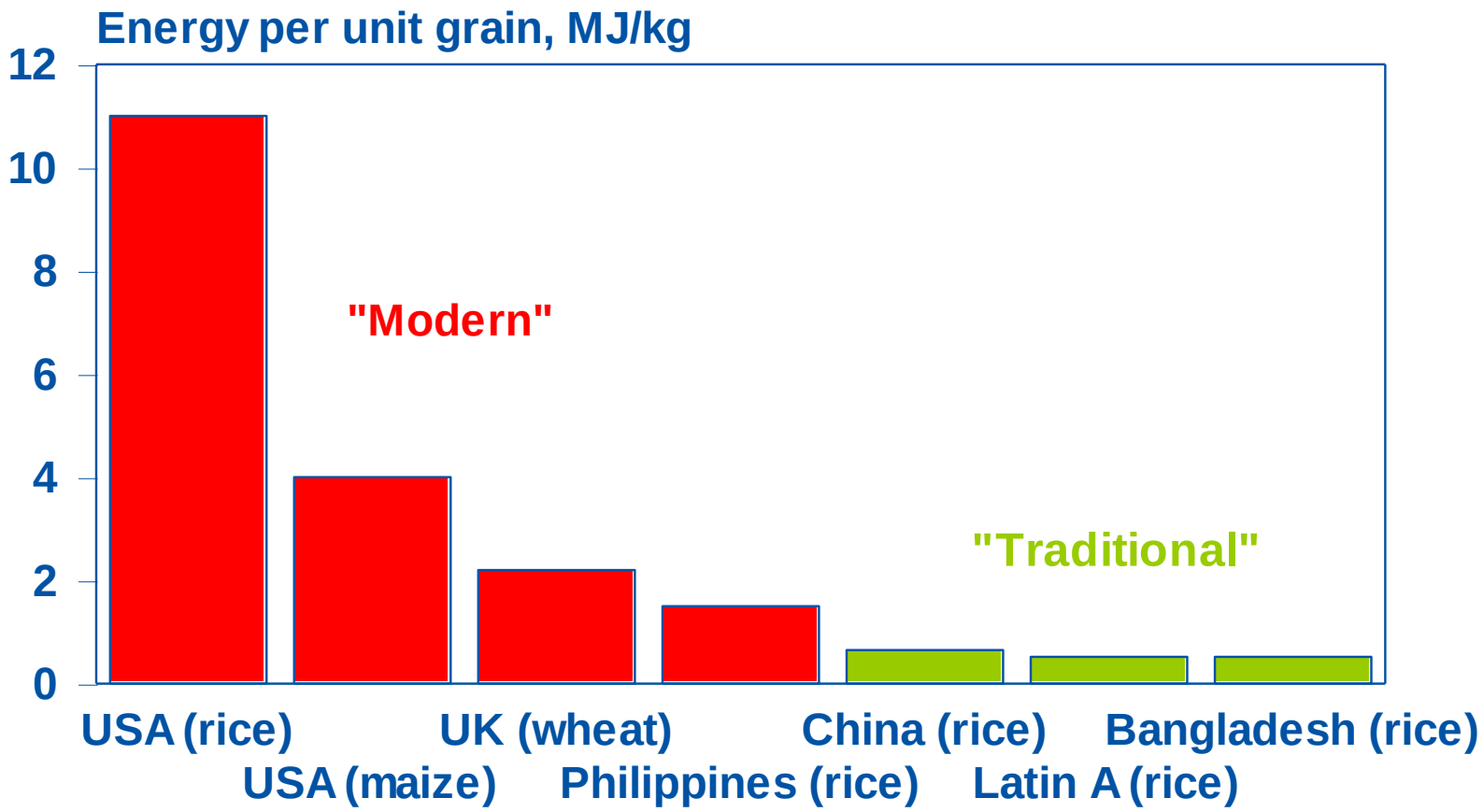
The price of steak from grain fed ruminants must be measured in terms of oil costs involved in growing the feed, managing and marketing the meat



I kg of beef requires approximately 5.7 litres of oil. Or to produce this little beauty at 600kg live weight 1075 litres of oil

National Geographic June 2004

Use of energy for grain production "modern" vs "traditional" systems



Source: Pretty 1995

Livestock's contribution to climate change – developed countries

- Our "efficiency", as we typically measure it, is already high
- - but is it really if we consider all the energy costs (and their contributions to global warming and climate change) associated with the production and transport of our livestock feeds?
- **Need to consider if our systems need to be more sustainable** (this may or may not mean organic / ecological)

Livestock's contribution to climate change – developed countries

- Even our "efficient" developed systems are carrying the luxury of too many passengers – non producing animals
- Often because our mind-set is too concerned with production in the short term (eg milk yield kg/d) rather than in the longer term (eg kg/day of life)
- - the later of course takes in to account inefficiencies associated with protracted rearing periods, reproductive inefficiencies and high culling rates

Livestock's contribution to climate change

- A number of these inefficiencies can be tackled by managemental approaches including feeding
- However, many of these non genetic farm technologies require ongoing investment of some sort to maintain the commercial benefit
- Genetic improvement on the other hand is effectively a permanent change and does not require additional or continuing resources.

Livestock's contribution to climate change

- Many breeding goals for livestock species include production traits and production efficiency and this helps to reduce emissions.
- In many cases this can be achieved simply through selection on production traits.
- Reducing the number of animals required to produce a fixed level of output can also have a favourable effect on methane emissions

Livestock's contribution to climate change

- Two key areas :
- 1. The overall effect of animal numbers and efficiency
- - including all the benefits following from reducing emissions associated with production and transport of the feed
- 2. Specific issue of the production of greenhouse gases (GHG) by livestock – particularly methane by ruminants

Adapting to climate change

- Changes in our livestock practices to aid **mitigation**

- - but also, as a result of climate change, our production systems may need to **adapt**

- The climate changes. – what impact does that have on our livestock systems (in Europe and globally)?

Climate change (in temperate areas eg Europe)

- Exact nature of any change in climate remains unclear
- Likeliest scenario:
- - increased variability, particularly at the extremes
- - overall increases in mean temperature?
- - overall decreases in mean rainfall?

Climate change (in the UK)

- Exact nature of any change in climate remains unclear
- Likeliest scenario:
- - increased variability, particularly at the extremes
- - overall increases in mean temperature ?
- - overall decreases in mean rainfall ?
- **What do these changes mean for our livestock and how may our livestock management, feeding and breeding adapt ?**

Climate change effects

- **Direct**
- - direct effects of the altered environment on the animal
- and
- **Indirect**
- - indirect effects, resulting from the alterations in the climatic environment, due to feed supply or disease susceptibility

Direct effects of climate change on the animal

- Follow the “normal rules” of
- - environmental temperature
- - relative humidity
- - wind speed
- on the animal’s climatic physiology

- With respect to environmental temperature, large differences between our non-ruminant and ruminant species in their comfort zones

Direct effects of climate change on the animal - ruminants

- Wide comfort zones
- High degree of thermal tolerance
- Thus it is likely that climate change resulting in an increase of a few degrees is not going to have any major effect on animal performance
- Exceptions would be at the extremes

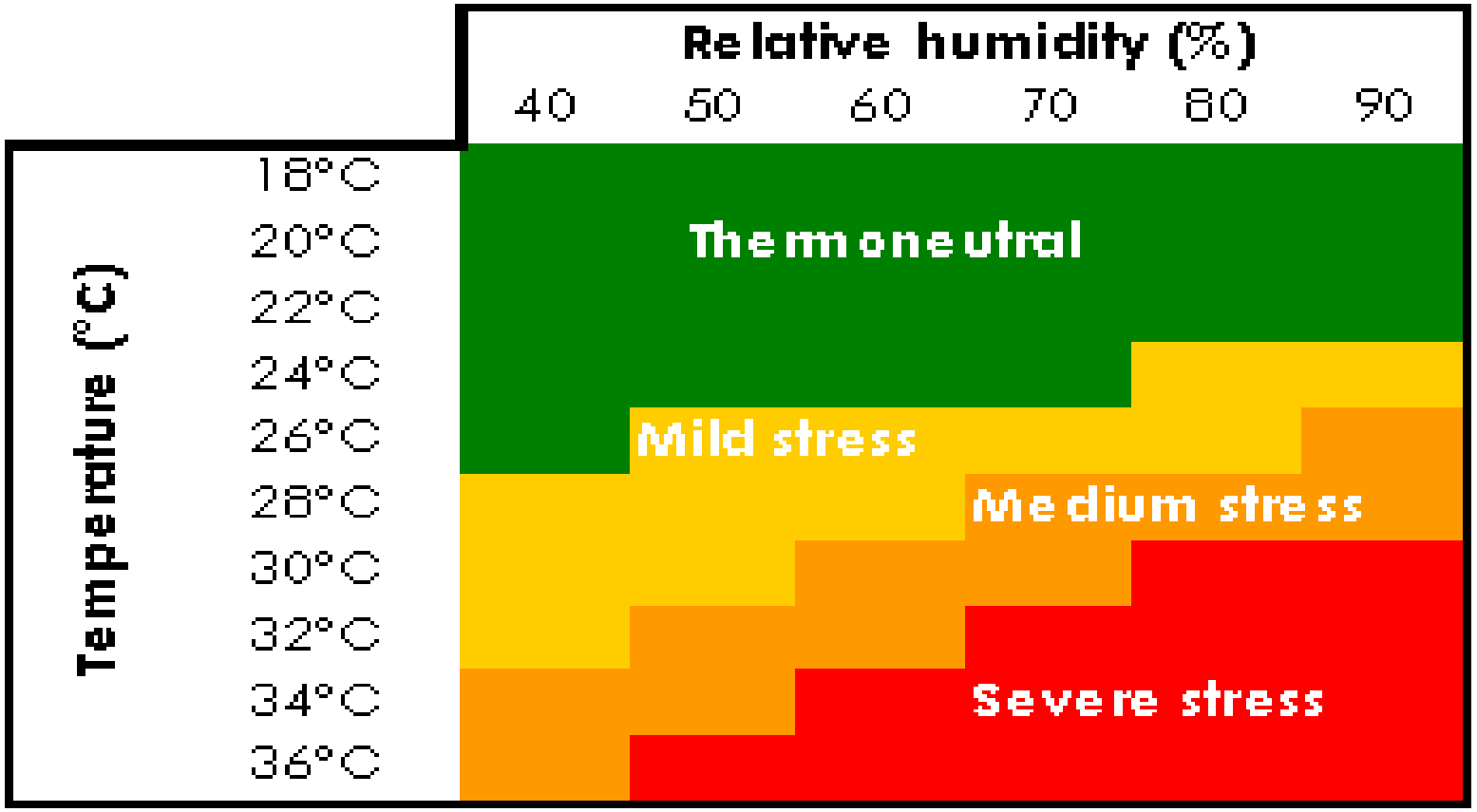
Direct effects of climate change on the animal - ruminants

- Areas currently characterised by **low temperatures** and high rainfall may become more favourable
- - reduced neonatal mortality of lambs and calves

Direct effects of climate change on the animal - ruminants

- At the other extreme, **high summer temperatures** may be expected to present the dairy cow with thermal stress and result in reduced intakes and performance
- - adaptations to management such as increased provision of shade and water should be adequate to counter this
- - at extremes, dairy cattle may be housed and provided with forced ventilation

Dairy cow and heat stress



Direct effects of climate change on the animal – non-ruminants

- Narrow comfort zones
- - one of the reasons our pig and poultry systems have often been based on intensive, housed systems
- Dealing with housed livestock we might expect the direct effects of climate to be small – which is true with two important riders:

Direct effects of climate change on the animal – non-ruminants

- *Higher environmental temperatures in winter may lead to a saving in heating costs for pig and poultry buildings.

Direct effects of climate change on the animal – non-ruminants

- *Higher environmental temperatures in winter may lead to a saving in heating costs for pig and poultry buildings.
- ***However in the summer months our existing housing systems may not be able to cope with the increased thermal load. This may lead to an increased requirement for costly air conditioning systems.**

Direct effects of climate change on the animal – transportation

- Additionally, there may be issues associated with the transport of live animals in elevated environmental temperatures

Direct effects of climate change on the animal - genetics and breeding

- Although the likely direct effects of climate change on the animal are likely to be small
- - consideration could be given to inclusion of traits associated with temperature tolerance in breeding indices for species/breeds under threat
- - This is in addition to mitigation (Wall 2008) - for adaptation
- eg genetics of heat stress and G*E interactions

Indirect effects of climate change on the animal – feed supply, non-ruminants

- Central to this consideration is an appreciation of what is currently fed to our farm livestock.
- Non-ruminant livestock will continue to receive diets consisting largely of cereals and oilseed residues and with least cost ration formulation fairly major changes in ingredient inclusion can be made without altering the nutrient specification.
- Many diets already include a lot of high quality by-products and imported ingredients and it is unlikely that climate change would alter the range of ingredients available for ration formulation.

Indirect effects of climate change on the animal – feed supply, non-ruminants

- A much greater threat is likely to be posed by the food:feed:fuel conflict providing reduced feed supplies.
- Together with issues to do with “feed miles” – the miles travelled by so much of our animal feed raw materials and the associated transport costs and GHG emissions

Indirect effects of climate change on the animal – feed supply, ruminants

- Ruminant diets differ in that there is a major forage component.
- In the case of extensive systems this may make up the entire diet whereas in more intensive dairy cattle systems the forage is balanced by a more concentrated supplement.
- It is the source, quality and quantity of the forage component of ruminants' diet which is likely to be affected by climate change.
- The result may be either effects (advantageous or deleterious) on the existing forage species or a change to forage species not currently grown.

Indirect effects of climate change on the animal – feed supply, ruminants

- Existing forage species
- Low environmental temperature, particularly in spring, is one of the major limitations to higher Dry Matter production.
- Thus any increase in temperature might be expected to have benefits on early season growth.
- It is important to note the effect which this might have on the component species of a mixed sward.
- If mean rainfall were to decline this would lead to soil moisture deficits which would require expenditure on irrigation unless reductions in DM yield were to be accepted.

Indirect effects of climate change on the animal – feed supply, ruminants

- For existing species the stage of maturity at which the crop is cut is a major determinant of quality and in any altered climatic scenario the interplay between increasing quantity and declining quality would continue to be of major importance
- Alterations in climate may be favourable to conservation and reduce losses during either ensilage or hay-making.
- In many hill and upland areas, which are currently characterised by low temperatures and water logged soils, climate changes may be expected to lead to more favourable conditions and result in a shift towards more productive plant species with accompanying implications to both animal production and the appearance of the countryside.

Indirect effects of climate change on the animal – feed supply, ruminants

- The other major possibility is that climate change will lead to a shift in the forage species grown.
- For example, elevated temperatures may lead to an increase in the hectarage of maize grown for silage and of alfalfa for hay in cool temperate regions
- This might be expected to result in improvements in both the quantity and quality of forage for ruminant livestock and could lead us towards higher inclusions of the forage components of rations typically fed to dairy cattle elsewhere in warm temperate and sub-tropical areas

Indirect effects of climate change on the animal – disease incidence

- A new range of pests and diseases will affect our crop and forage species with effects on the quantity and quality of livestock feeds.
- Similarly, we will face new challenges in the field of livestock diseases.
- Diseases currently thought of as “exotic” may become of importance (eg Bluetongue)
- - whilst existing diseases eg parasitic gastroenteritis may become more widespread with increased costs of control and risks of immunity developing.
- ……and increased incidence of vertebrate pests - rabbit

Indirect effects of climate change on the animal – housing systems

- Altered climate may result in altered soil conditions which may encourage outdoor systems of poultry and pigs….
- and encourage out wintering of livestock which have previously been housed
- – not because of the climate having direct effects on the livestock but due to indirect effects via treading / poaching
- This has possible implications on the type and sophistication of housing systems required.

Conclusions

- **Climate change will bring changes to our livestock systems**
- nb Interacting, influencing factors
- - population growth, food*feed*fuel, peak oil, water
- - to aid **mitigation**
- - and **adaptation** due to the changes
- Changes being due to both indirect and direct effects of the elevated temperatures