



# Livestock production and the feed challenge

Richard Kipling and Nigel Scollan

rpk@aber.ac.uk

# Feeding the world population

- Calorific intake<sup>1</sup>
  - Plant products: ~80%
  - Animal products: ~20%
- 12 plant and 5 animal spp. provide 75% of world's food<sup>2</sup>
- Wild foods are used by ~1 billion people<sup>3</sup>

Predicted world food requirement

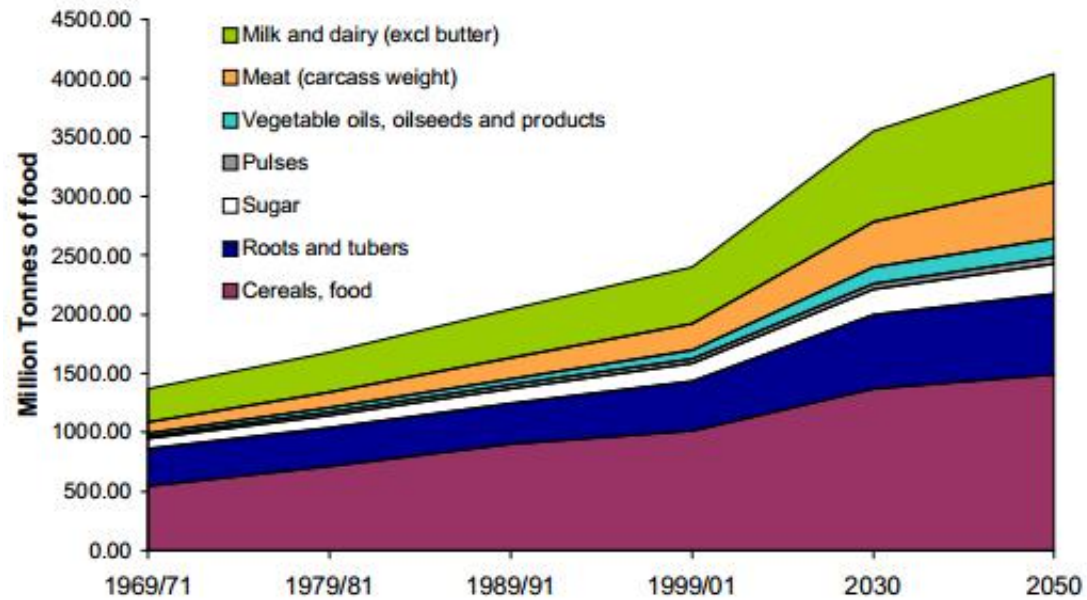


Figure source: Food, energy, water and the climate: A perfect storm of events? J. Beddington, 2009.  
<http://www.bis.gov.uk/assets/goscience/docs/p/perfect-storm-paper.pdf>

<sup>1</sup> FAO; Based upon food balance sheets for 2009, at world-wide scale; <sup>2</sup> FAO, What is happening to agrobiodiversity?; <sup>3</sup> Bharucha and Pretty (2010) *Phil. Trans. R. Soc. B.* **365**

# Food security

- “exists when all people, at all times, have access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life”
- “**Accessibility, Affordability and Availability**”

(FAO, 2009)

# Sustainable Intensification

*“The Process of Delivering more Safe Nutritious Food, per Unit of Resource, whilst allowing the Current Generation to meet its Needs, without Compromising the Ability of Future Generations to meet their own Needs”*

(Smith, 2013)

# Demand on land is increasing

- Global area of agricultural land
  - 1970 – 4.59 billion ha
  - 2010 – 4.89 billion ha
- Per capita agricultural land
  - 1970 – 1.24 ha/person/year
  - 2010 – 0.72 ha/person/year
- Major technological improvements in crop and livestock



# Driving productivity and efficiency

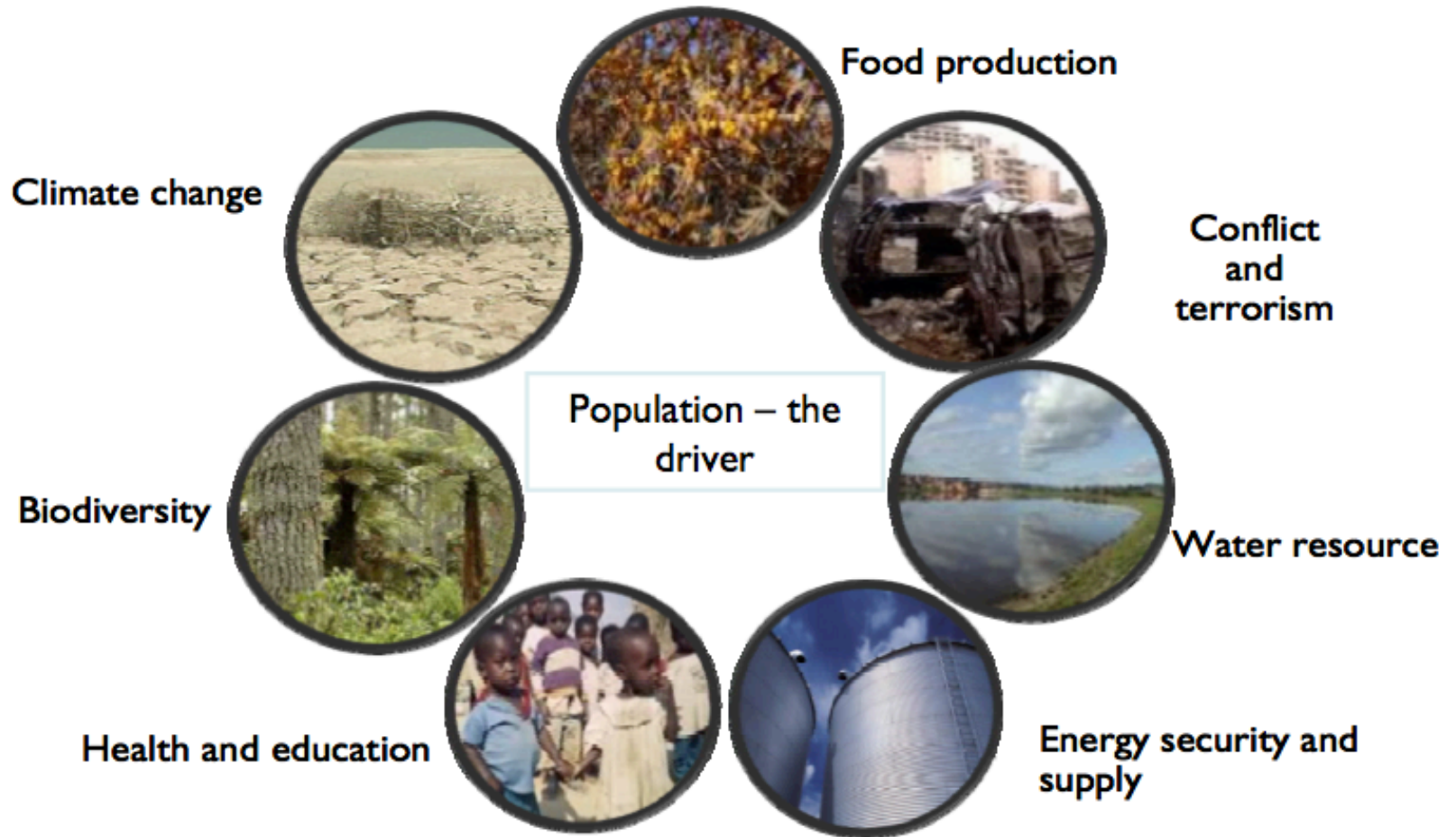
**Improved  
health**

**Improved  
fertility**

**Improved  
genetics**

**Improved  
nutrition**

## 21ST CENTURY CHALLENGES



**Agriculture is at the Center of Many of Society's Most Important Debates**



# The expectations of Science & Research has changed dramatically



- Explosion in our scientific understanding
- Opportunity to connect scientific excellence with impact by focussing on the Grand Challenges



# Challenges for food systems



- more resilient production systems
- reduce dependency of the food chain on fossil fuels
- enhance ecosystem services (i.e. soil and water)
- radically reduce GHG emissions from food system
- feed challenge

# Why Focus on feed?

BREEDING

MANAGEMENT

**FEED**

ENVIRONMENT

ECONOMICS

HEALTH

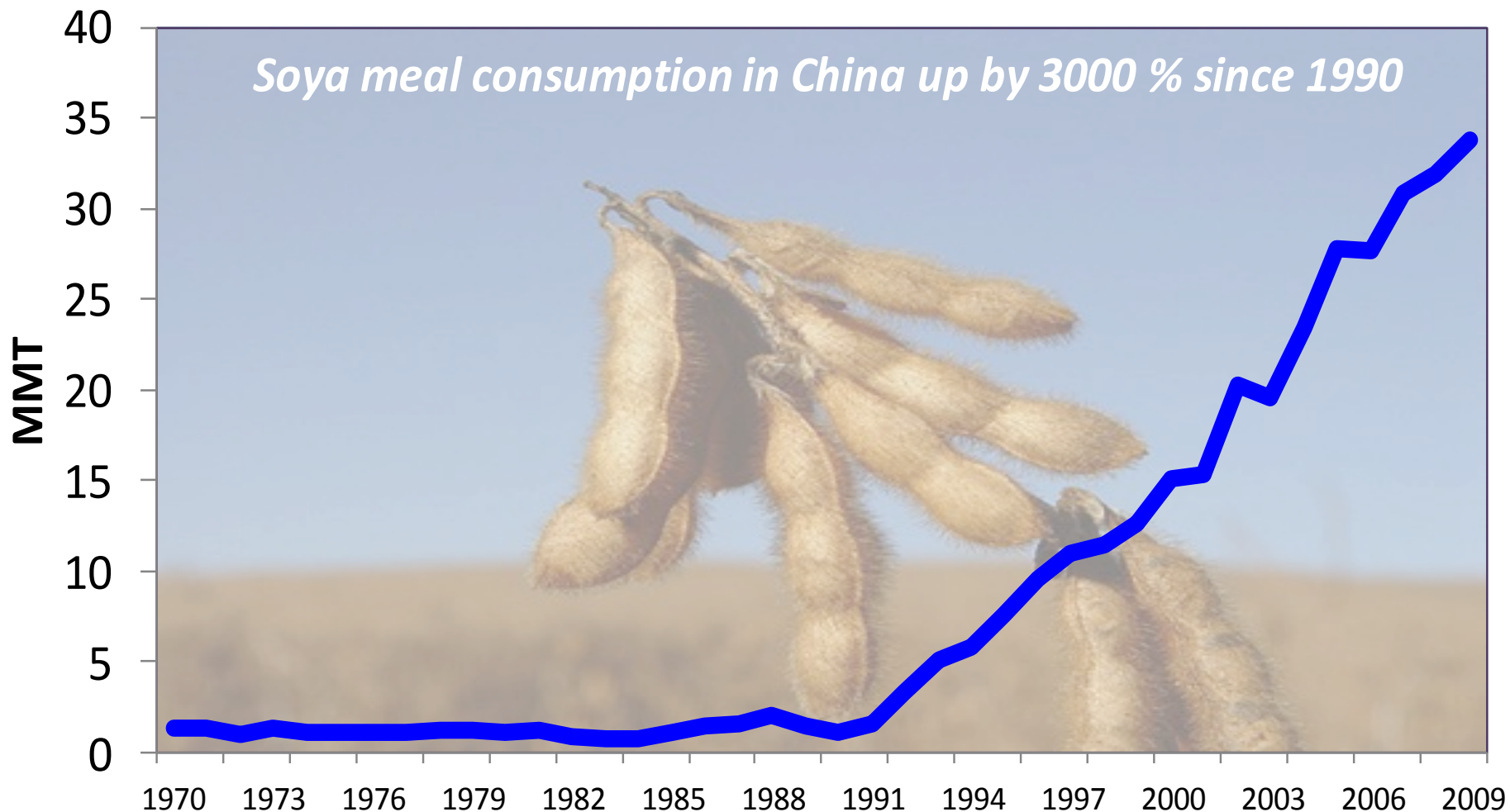


# Feed demand increasing



- World production of meat, milk and eggs – 1025 million tonnes (2007)
- 2005 - use of feed concentrate – **1250 million tonnes**
- 2050 require *additional*
  - 430 million tonnes livestock feed
  - 480 million tonnes human food

# Increasing demand for vegetable protein



# UK plant derived protein



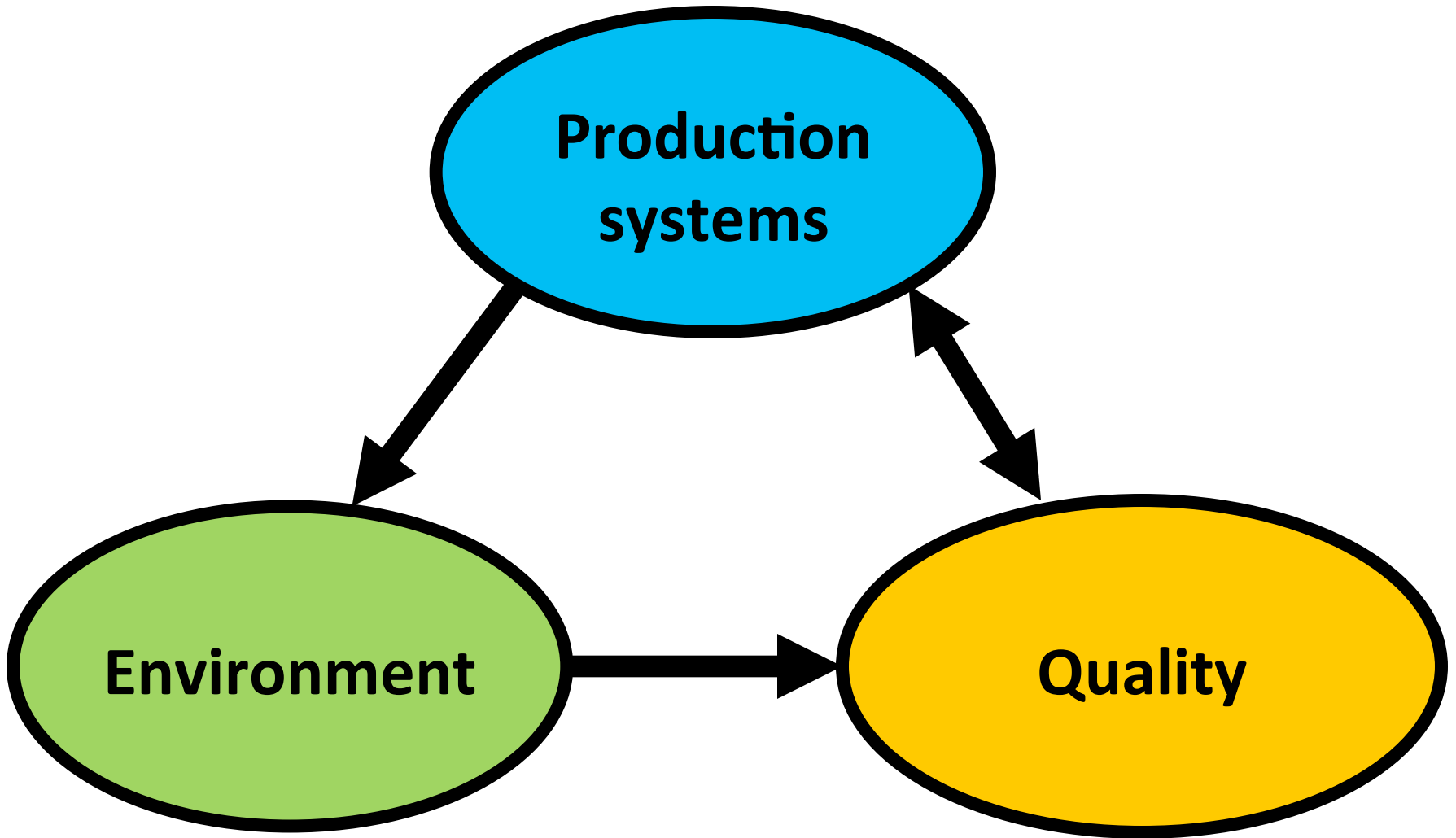
- UK uses 2.6 million tonnes/annum of plant-derived protein for animal feed
  - 37% from home-grown cereals (*ca.* 1 million T)
  - 3% from home-grown pulses (*ca.* 0.09 million T from dry peas and field beans)
  - 55% from imported soya (*ca.* 1.4 million T)
  - 5% from imported maize (*ca.* 0.13 million T)

# Crop Yields



- **Yield gaps**
  - Huge variations between potential and actual yields
  - Exacerbated by technical knowledge/access and economic limitations
- **Reducing yield gap and increasing potential yield could increase crop production on existing land by 50% by 2050<sup>1</sup>**
  - BUT that doesn't account for land competition for fibres and biofuels

<sup>1</sup> Jaggard et. al. (2010) *Phil. Trans. R. Soc. B.* 365





# Ruminant production systems



Ruminants – ability to utilise lignocellulose and convert non-protein nitrogen into meat and milk



# Ruminant production systems



- Intensive

- dairy, some beef
- reduced energy use
- constant feed supply
- cheaper products
- maximum efficiency



- Extensive

- beef, sheep, goat
- lower output
- reduced labour
- low input, high management
- consumer friendly



# Sources of feed



## Human - inedible materials:

- Forages from land not able to grow crops
- Crop residues
- Food and fiber processing by-products

# Common by-products used for feed



Nutrient supplied	By-product
Protein	brewer's grains, distiller's grains, cull beans, feather meal
Protein and energy	brewer's grains, distiller's grains, corn gluten feed, peanut screenings, wheat midds
Energy	bakery meal, fat, hominy feed, snack food waste, soft drink syrup, soyhulls, vegetable, fruit-processing waste
Roughage sources	apple pomace, corn cobs, cottonseed hulls, peanut hulls, rice by-products

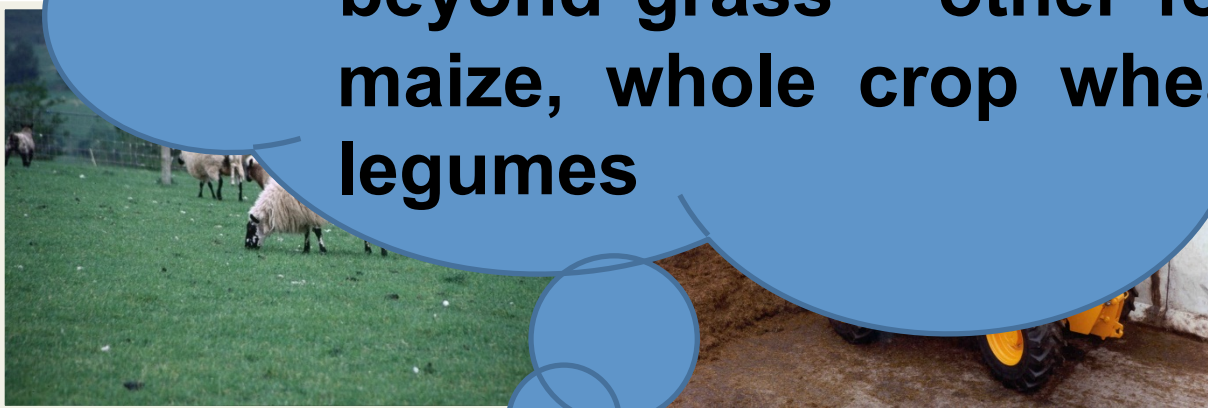
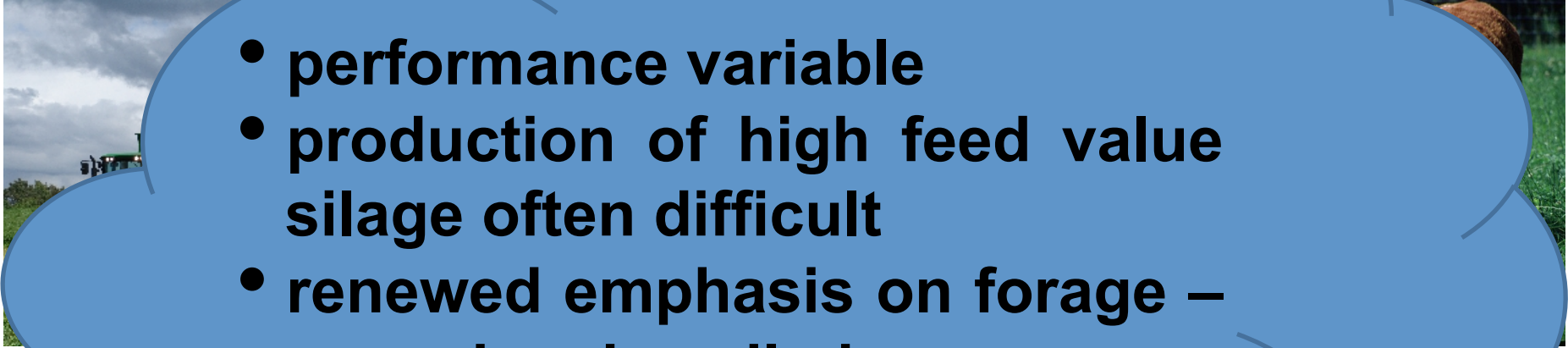
*There are wide range of by-products. Increased and efficient use of by-products is important for animal agriculture in future!!!*



# Feed in ruminant systems



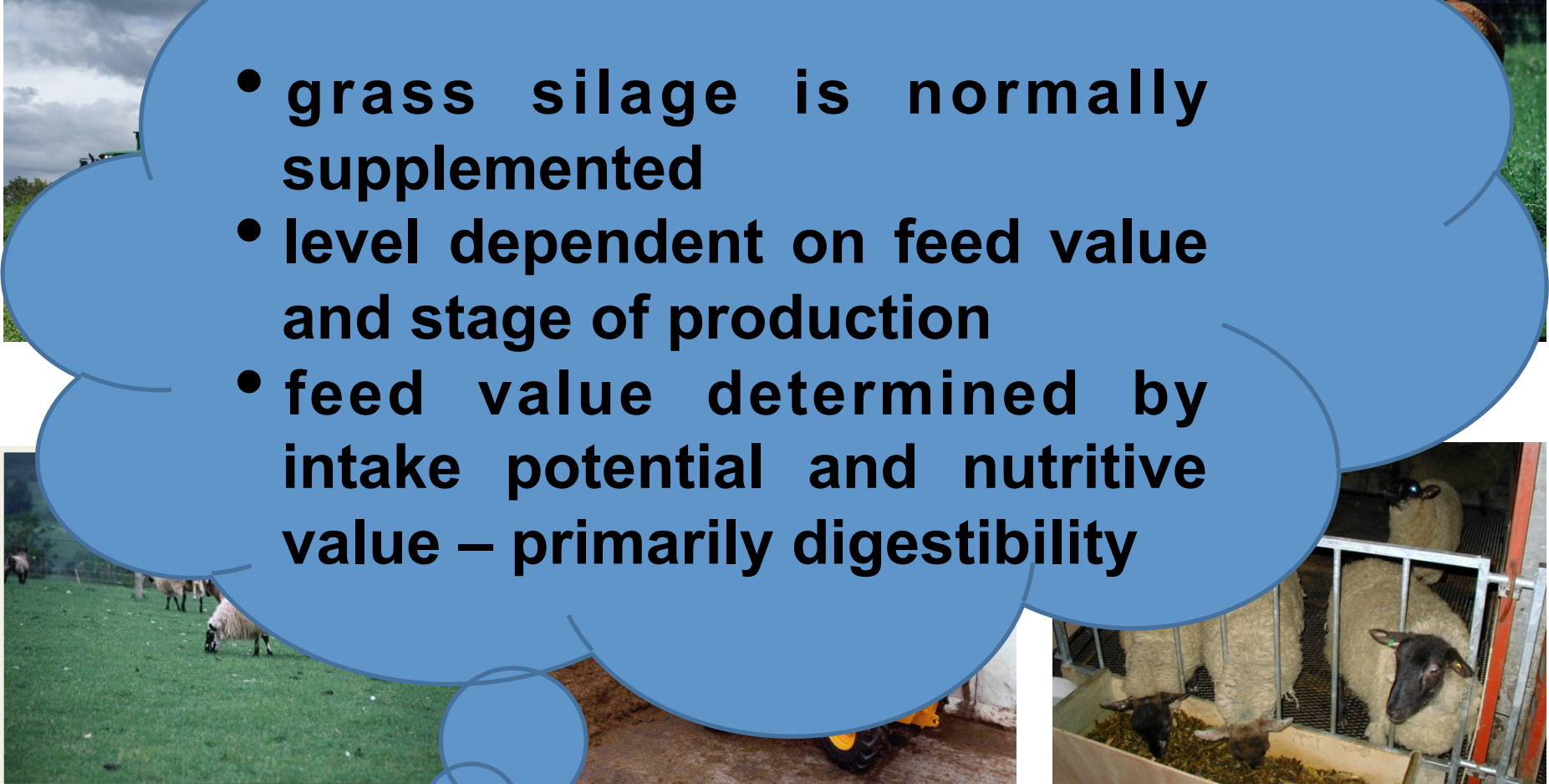
- performance variable
- production of high feed value silage often difficult
- renewed emphasis on forage – grazed and ensiled
- beyond grass – other forages, maize, whole crop wheat and legumes



# Feed value of grass silage



- grass silage is normally supplemented
- level dependent on feed value and stage of production
- feed value determined by intake potential and nutritive value – primarily digestibility



# Silage digestibility – major driver



Each 10 g/kg increase in DOMD resulted in daily increase in carcass gain of 29, 30 and 13 g/d when concentrates contributed 20, 40 and 60% of DM intake, respectively

(Steen et al 2002; Keady and Kilpatrick, 2006)



# Factors affecting digestibility



## **Date of harvest**

- each week delay, DMD falls by 3% (primary and regrowth)

## **Crop lodging**

- lodging accelerates digestibility decline
- severe lodging: DMD declined up to 9% units/week

## **Silage fermentation**

- poor fermentation reduces DMD

## **Nitrogen fertiliser application**

- excess nitrogen reduces DMD due to heavy crops lodging

## **Wilting**

- DMD declines by up to 2% per 24 hrs and increases intake with no effect on animal performance

# Alternative forages – maize



# Alternative forages – whole crop wheat



- Ensiled and fermented at 250 – 450 g/kg dry matter
- Ensiled at 550-800 g/kg dry matter with urea or urea-based additive (alkanine)

Increased intake in dairy cows and beef cattle  
but not performance



# Alternative forage legumes



*Ryegrass*



*Red clover*



*Lucerne*



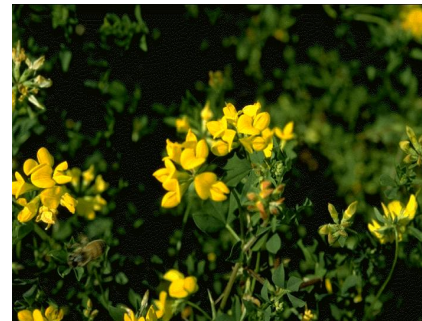
*Brassicas*

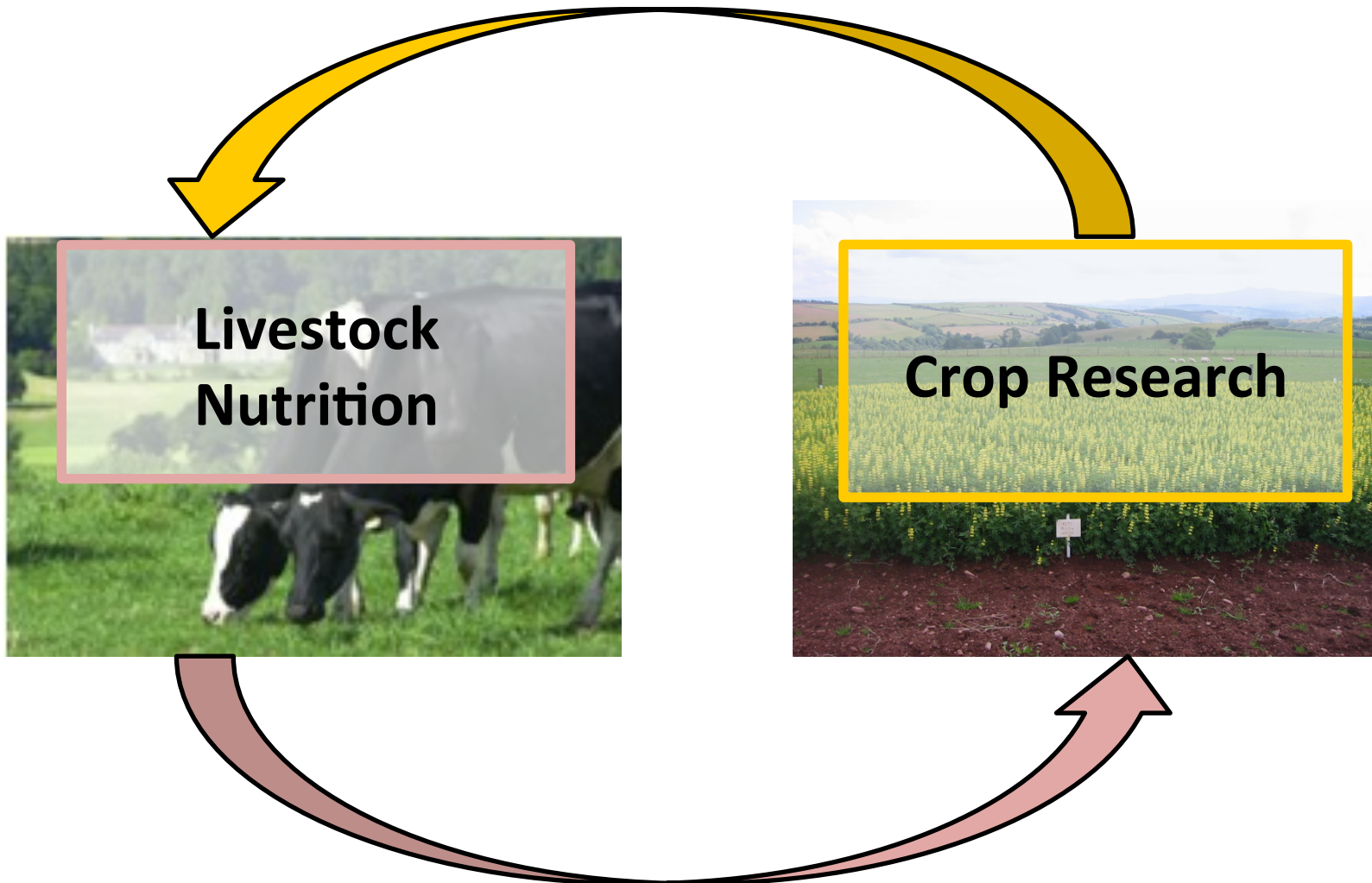


*Peas*



*Bird's foot  
trefoil*

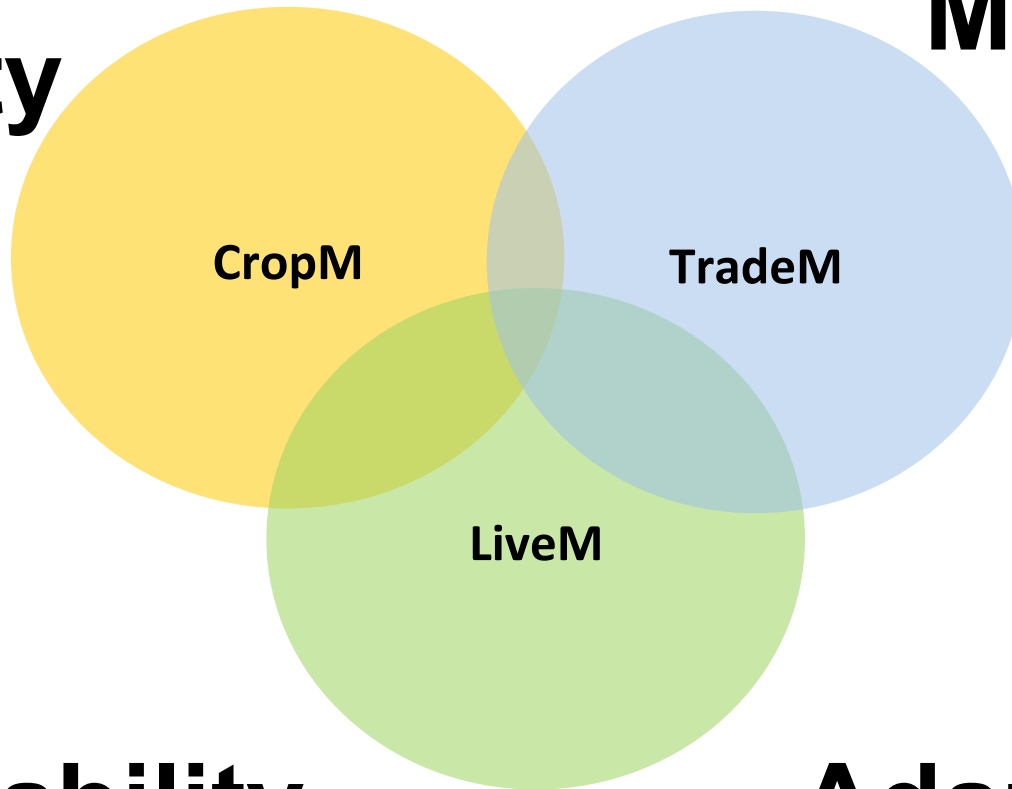




# The Feed Challenge

**Food  
Security**

**Mitigation**



CropM

TradeM

LiveM

**Sustainability**

**Adapatation**

# Future Farming Systems

To identify viable future farming systems that will prove sustainable adopting new practices and technologies which address:

- Productivity
- Profitability
- Resilience
- Environmentally beneficial
- Nutritious foods
- Resource cost
- Environmental requirements
- Increasing climate instability

**“This requires a fundamental shift in thinking to our production systems”**



# Acknowledgements

Modelling European Agriculture with Climate Change for Food Security  
— a FACCE JPI Knowledge Hub —

