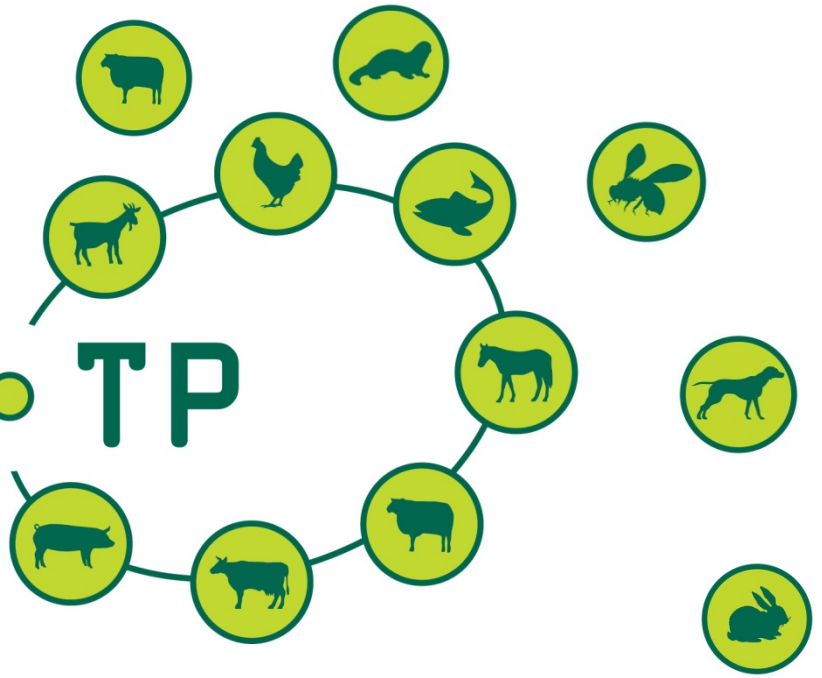
FABRE · TP



WHITE PAPER

FOOD SECURITY AND CLIMATE CHANGE

ANNE-MARIE NEETESON

This Presentation

- Animal Breeding and Reproduction
- White Paper
- Food Security and Climate Change
- How can Animal Breeding and Reproduction make a difference

Animal Breeding and Reproduction

- **Europe is on the forefront in animal breeding**
  - **Supplier** genetics
    - 30-50% European breeding populations
      ► **global trade** of breeding stock
  - **Ownership** is often in European hands, esp poultry
  - + Strong **knowledge** nodes (across species)
    - Development genetics-reproduction + support
      - In house close relationships to EU/global universities/institutes

FABRE TP

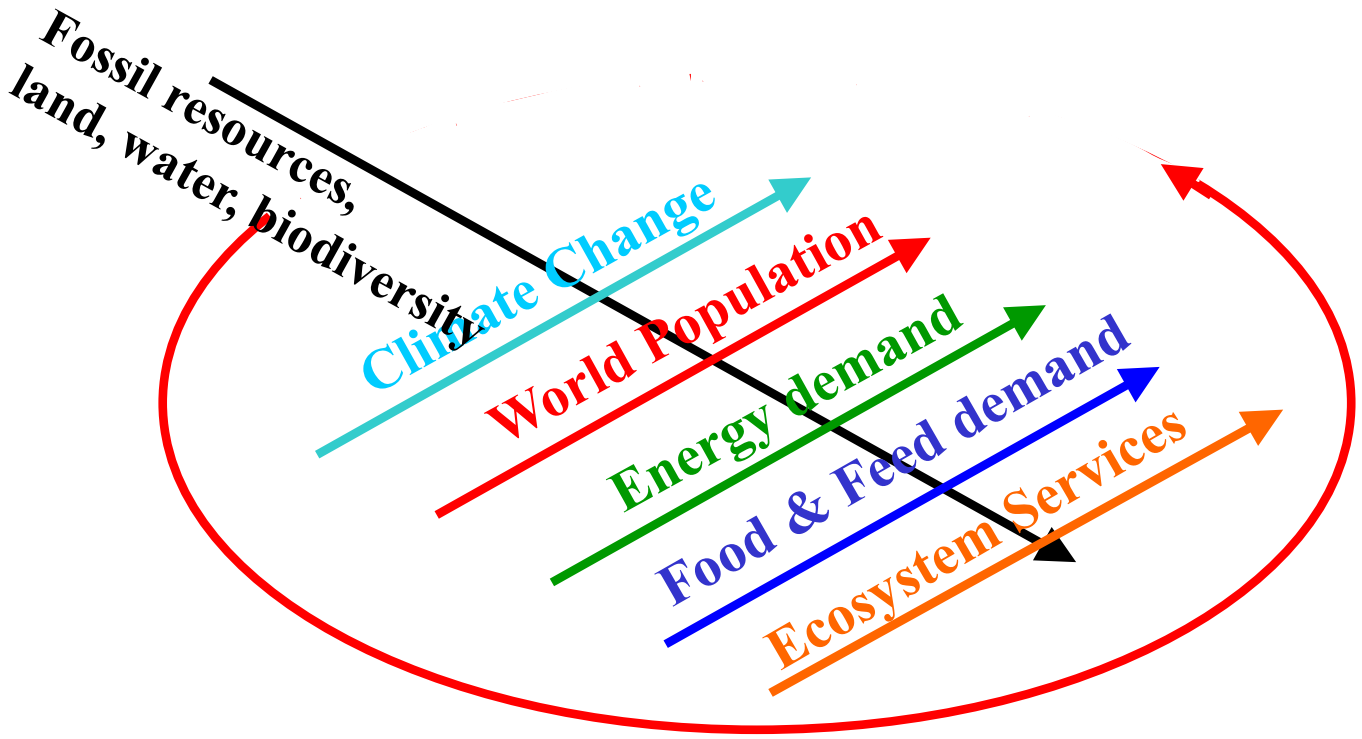
White Paper
Food Security and Climate Change

- Further to the SRA work
  - 13 FABRE TP expert groups
- Detailing the challenges and opportunities coming from Food Security + Climate Change

- **Focused** basis for future research planning and funding
  - To offer informally to the **Joint Programming Initiative Agriculture, Food Security and Climate Change**
    - National funding driven programme of 20 countries
    - www.faccejpi.com

FABRE TP

A PERFECT STORM*



A "perfect storm" of food shortages, scarce water and insufficient energy resources threaten to unleash public unrest, cross-border conflicts and mass migration as people flee from the worst-affected regions.

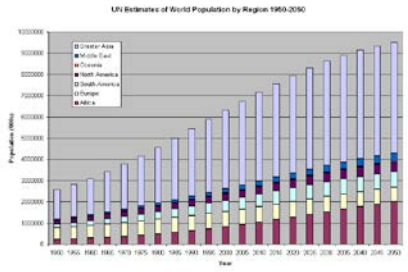
Prof. John Beddington, UK Chief Scientific Adviser

* JPI Food Security and Climate Change ppt July 2011

FABRE TP

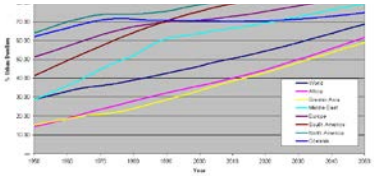
Food Security:
Outlook Global Food Demand

Population Change 1950/2050



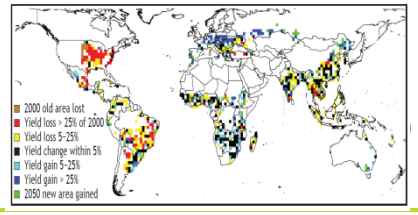
- **Population** Change **+ 35-50%**
  - 1 billion hungry
  - ↑ 70% food production by 2050
- Demand driven **livestock** revolution (Delgado et al)
  - Upcoming economies eating meat starting with chicken
  - 2010-2019 renewed expansion of the meat sector is expected for non-OECD countries

Urbanisation Rate 1950/2050



- Available agricultural land
  - Europe-Asia scarce vs Americas-Africa-Ocean
  - Competition with other functions:
    - urbanisation, nature, energy production
- Availability water, fertilisers, energy

Estimated Yield Effect of Climate Change – Un-irrigated Maize



Food Security
Outlook Global Food Demand

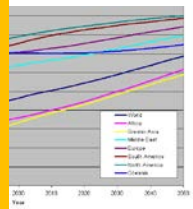
Population Change 1950/2050

- Po
  -
  -
- De
  -
- Ava
  -
  -
- Ava
- Effect climate change on **feed**
  - Availability and price feed

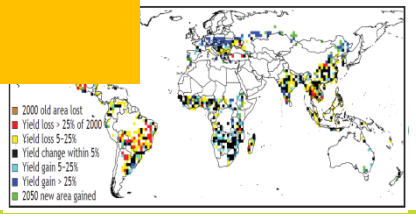
Demand ▲ **Scarcity** ▲

et al)

1950/2050



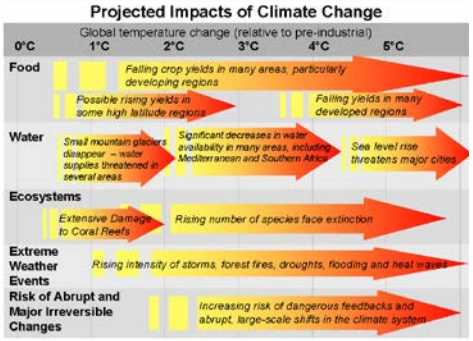
ffect of Climate
gated Maize



Climate Change

- *Agriculture + land use = 30% of emissions*
  - *need to be part of solutions*
    - *new and strong emphasis on agricultural research vital for sustainable global development*
- Adapation to **extremer/different climate/conditions**
  - Temperature – wet/dry
  - Fluctuations
  - Disease – Pathogens

  } Robustness
  - Feed, management, population adaptation, reproduction, physiology
- **Input-output balance**
  - ↓ use resources
  - ↓ emissions
  - ↓ waste
  - ↑ efficiency



FABRE TP

First Results

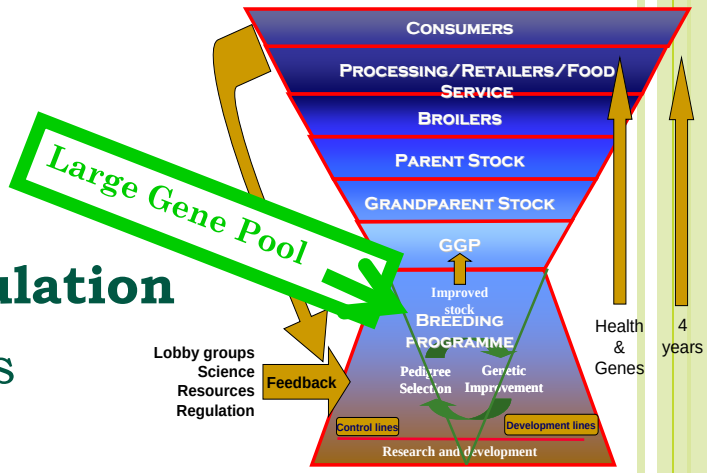
Adaptation to Extreme – Different Climate (1)

- More **Robust** Animals
  - Adaptation to high **temperatures** (reduction heat constraint)
    - Air (livestock) and water (aquaculture)
  - Adaptation to **crops** with less impact on environment (less water dependent) and to reduced nutritional quality
  - Increased **metabolic** functions
  - Impact of environmental **epigenetic** effects (use of various genetic and gm models)
  - Coping with **disease challenge, new pathogens, zoonotic organisms, host-pathogen interactions**
    - Animal itself
    - Carriers pathogen human food (gene network knowledge, phenotypic and genotypic predictors)
  - Understand biology behind this

FABRE TP

Adaptation to Extreme - Different Climate (2)

- **Food safety** in relation to changing environment
- **Reproduction** techniques for more varied and extreme climate conditions
- **Gene bank** maintenance + use
  - Knowledge + skills



- **Diversity** and **´resilience´ of the population**

  to adapt in time to changing conditions
  - Diversities of industry populations
  - Diversity of breeds and specialties
- **Disease free breeding stock and robust animals**
- Development adapted finetuned management knowledge
  - Constant adaptation of **management guides** to changing circumstances

FABRE TP

Climate Change – Input Output Balance
↓ **Emissions**

- **GHG and mineral emissions**
  - easy **measurable** indicator **traits** that can be included in selection
- Understanding **biology**
  - underpinning differences in animal environmental impact
- **Data** on emissions and **options for reduction**
  - in different environments – diets - per physiological stage (pregnancy, lactation etc) – age - G x E
- **Combination** targeted genetic improvement of environmental footprint with
  - ▲production (food security demand)
  - Basic principles and technology in principle available and implemented – needed:
    - Data to support estimation of relative weightings,
    - Covariances with production and functional traits

FABRE TP

Climate Change - InputOutputBalance

↓ WASTE

- **Re-use** animal products
- Utilisation of **by-products** food production

- Traits, methods to measure, genotypes

Climate Change – Input Output Balance Food security

- Considerable improvements achieved
- Further improvements needed

- *Efficiency and other improvements should be obtained **simultaneously** in broad breeding programmes balancing antagonistic effects*

  e.g. growth and welfare

Inputs

Impacts & resources used / t of carcass, / 20,000 eggs (~ 1 t) or / 10m³ milk (about 1 t)	Beef	Pig meat	Poult meat	Sheep meat	Eggs	Milk
Primary energy used, GJ	28	17	12	23	14	25
GWP_{100}, t CO_2	16	6.4	4.6	17	5.5	10.6
Eutrophication potential,kg PO_4^{3-}	158	100	49	200	77	64
Acidification potential, kg SO_2	471	394	173	380	306	163
Pesticides used, dose ha	7.1	8.8	7.7	3.0	7.7	3.5

GWP=Global Warming Potential

Inputs

Impacts & resources used / t of carcass, / 20,000 eggs (~ 1 t) or / 10m³	Beef	Pig meat	Poult meat	Sheep meat	Eggs	Milk
Primary					14	25
GWP_{100},					5.5	10.6
Eutrophi potential					77	64
Acidifica SO_2					306	163
Pesticide					7.7	3.5

40 years selection

FCR*

3,4 →2,4 kg feed

/ kg meat

***Food Conversion Rate**

GWP=Global Warming Potential

Life Cycle Analysis Modelling - Outputs

% change in emissions per tonne product through genetic improvement (1988-2007)

	Methane	Ammonia	Nitrous Oxide	GWP_{100}
Layers	-30	-36	-29	-25
Broilers	-20	10	-23	-23
Pigs	-17	-18	-14	-15
Dairy	-25	-17	-30	-16
Beef	0	0	0	0
Sheep	-1	0	0	-1

Project for Defra by Genesis Faraday and Cranfield University (AC0204), 2008
These figures exclude any post-farm-gate efficiencies such as reduced waste.
GWP=Global Warming Potential

Efficiency and Environment Improvements Over Time at Production Level

Species	Trait	Indicative performance		
		1960s	2005	% Change
Pigs	Pigs weaned /sow/year	14	21	**50**
	Lean %	40	55	**37**
	Kg lean meat/tonne feed	85	170	**100**
Broiler chickens	Days to 2 Kg	100	40	**60**
	Feed conversion ratio	3.0	1.7	**43**
Layer hens	Eggs per year	230	300	**30**
	Eggs/tonne feed	5000	9000	**80**
Dairy cows	Milk/cow/lactation (Kg)	6000	10,000	**67**

Modified from van der Steen, Prall and Plastow, 2005 J. Anim Sci 83: E1-E8

Opportunities Efficiency

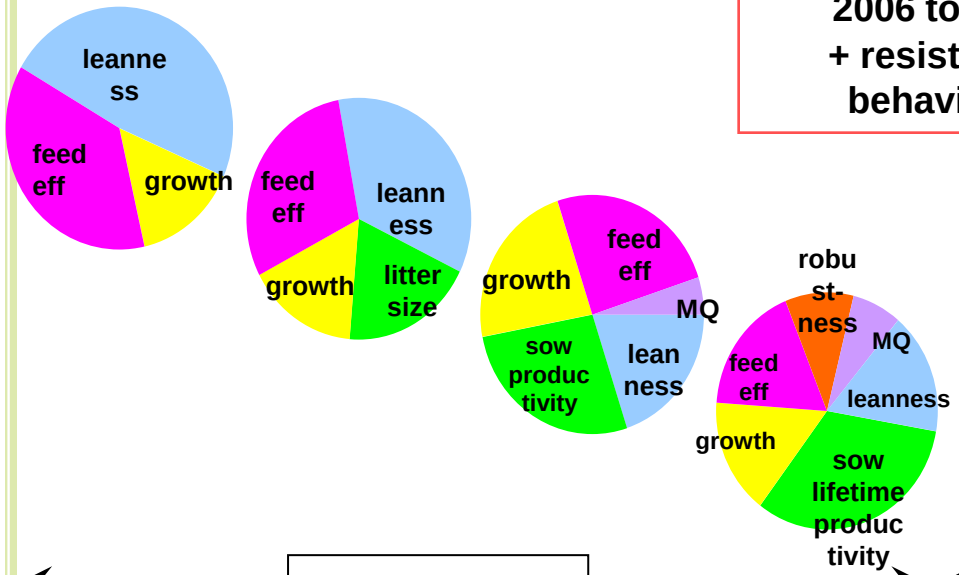
- **Trait improvement** on
  - Feed efficiency
  - Digestibility
  - Water efficiency……

- Adaptation livestock to
  - intensive production systems
    - Especially in highly dense areas, fast growing developing countries
    - For more effective control of GHG and mineral emissions
  - reduced chemotherapeutics use

FABRE TP

Broadening Breeding Goals

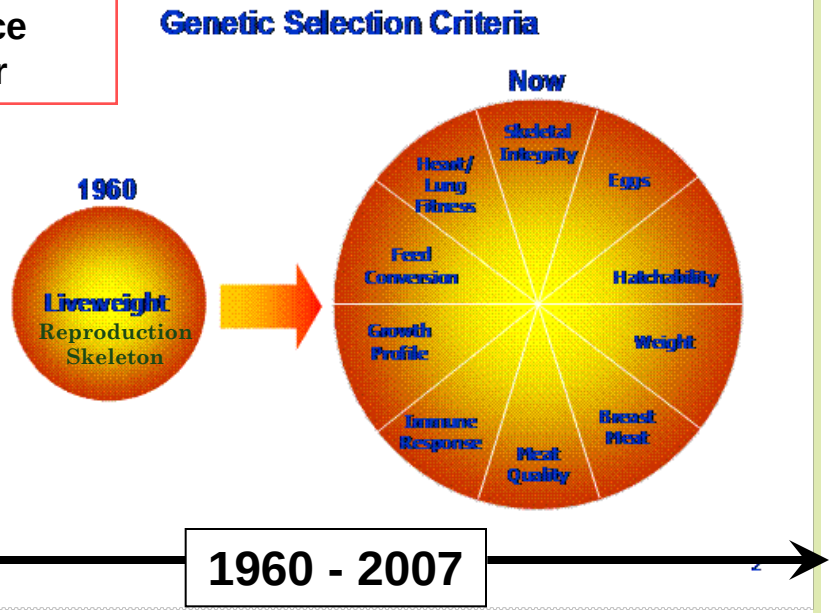
PIGS



1980 - 2005

2006 to 2010
+ resistance
behaviour

BROILERS



1960 - 2007

Acknowledgement: Pieter Knap

Acknowledgement: Ken Laughlin

Prerequisites Broad Balanced Breeding

- Good **Traits**
  - Reliable
  - Repeatable,
  - Easily measurable in large amounts
- Powerful **Computers**
- **Data**
  - A steady flow **cost-effectively, reliably, repeatably** recorded traits on thousands of individually identified pedigreed animals, managed in a sophisticated data base
- Good Breeding **Programming**
  - Inclusion of new traits
  - Implementation genomics
  - Constant development + further finetuning

Use of the abundance of company data

FABRE TP

Science, among others…

Genetic relationships change over tim
Phenotypes always needed

- Genomes and way they function
- Genomics tools developments
- Tools for genetics and physiology
- Evaluate consequences of using new methods

- Effective and practical reproduction
- Data comparability
- Ontology

Standardisation public data
For science, transparency, visibility
improvements

FABRE TP

- Moving from
  - Farming systems to production systems
  - Law only to Corporate responsibility
  - Descriptive to Solving research
    - E.g. welfare: from behaviour science to the right fit:

      the optimal animal for a defined production system with fine-tuned management support
  -

Thank you for your attention

Success to the Expert Groups

Questions ?