

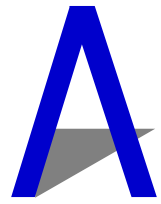
Acumentia

Acumentia Ltd – part of The VCG LLP

FOOD SCIENCE AND CHEMISTRY IN THE SUSTAINABILITY OF THE GLOBAL FOOD SUPPLY

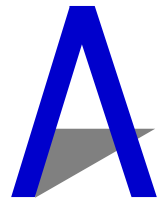
*A report for the Royal Society of
Chemistry and the Institution of
Chemical Engineers*

Presented by: Dr David Baines



THE PROJECT

- Timescales: *Mid December to March*
- The Team: *7 Consultants from the VCG/Acumentia team*
- Interviews: *A total of 58 interviews were conducted across the food chain using a carefully constructed questionnaire*
- Desk Research: *Key reports and extensive literature coverage. 203 cited references in the final report*



THE ACUMENTIA TEAM

KAARIN GOODBURN

MIKE SHAW

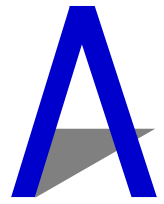
MELANIE BROWN

MARGARET ASHWELL

IAN SMITH

PAUL FRAY

DAVID BAINES



DEFINITIONS: SUSTAINABILITY AND FOOD SECURITY

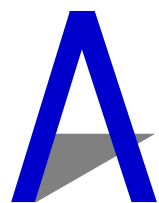
"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs".

Bruntland, G.H. et al. (1987), 'Our Common Future' : Report of the World Commission on Environment and development

Food Security: According to the FAO, 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"

Recent scenes in London – food sustainability is not affected by the loss of the pig industry in the UK but food security is.





THE SCOPE OF THE PROJECT

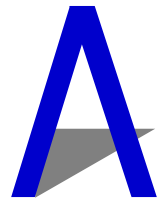
Chemical Sciences:

Chemistry, Biochemistry and Chemical Engineering

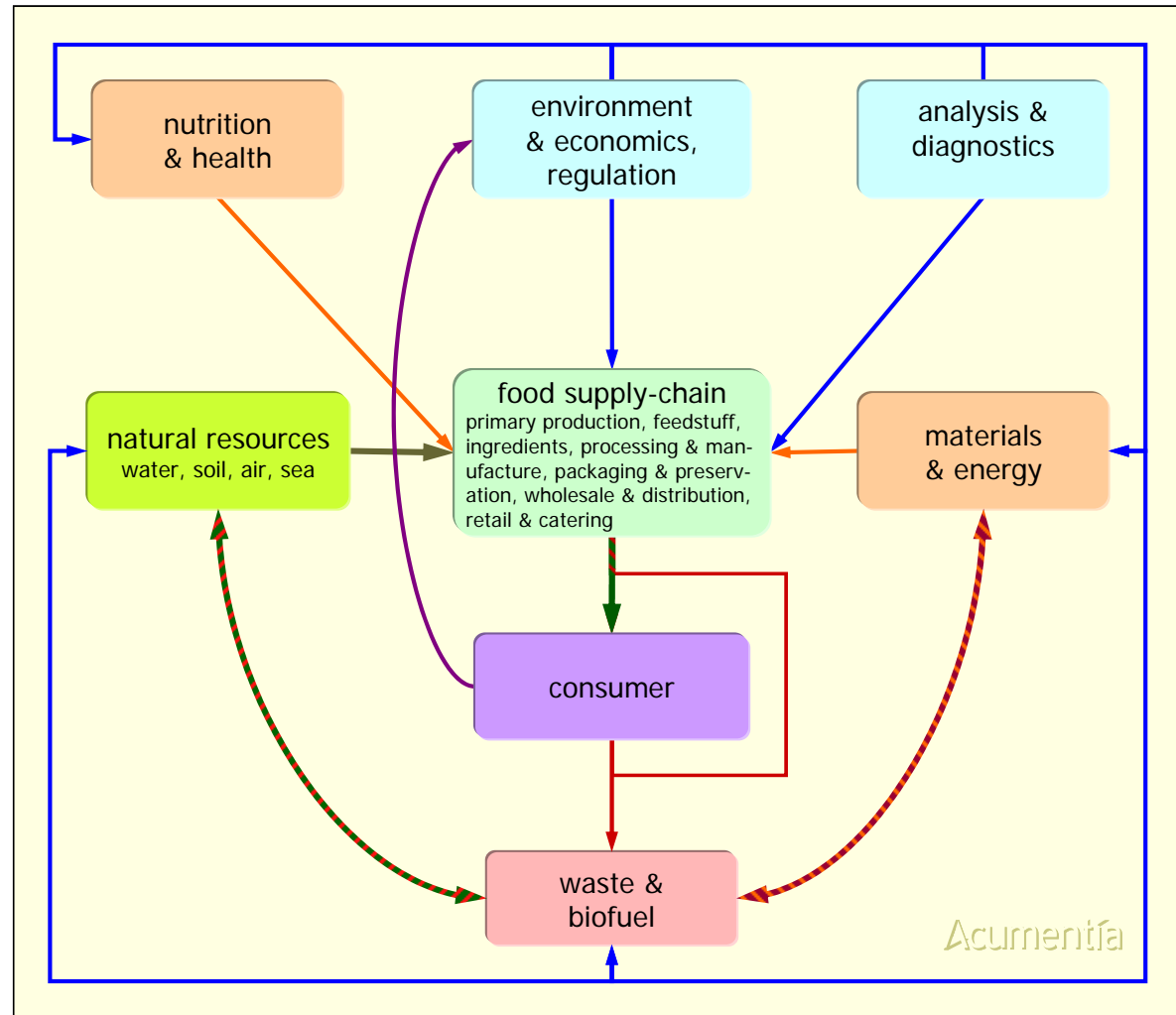
Food Science:

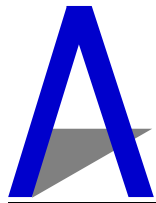
A broad range of disciplines covering chemistry, biology, physics through to agronomy, microbiology, genetics, engineering and economics

The report takes a global perspective, however, its primary aims are to influence UK and EU policy

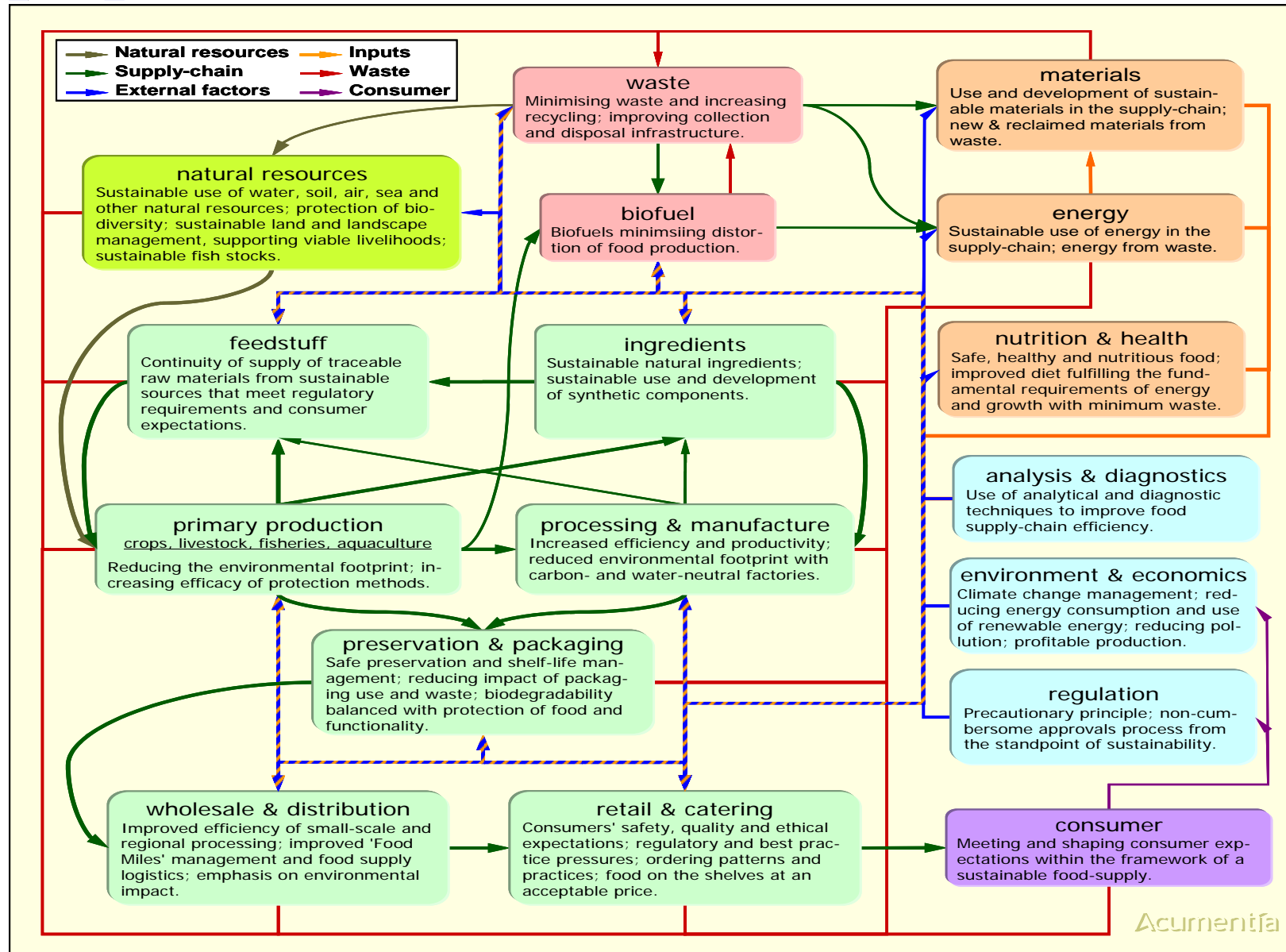


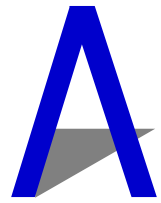
THE SCOPE OF THE PROJECT





THE SCOPE OF THE PROJECT





SOARING FOOD PRICES

Bangladesh hit by food price riots: April 12 2008

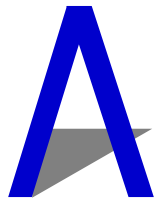


Haitian prime minister ousted over high food prices (April 21, 2008)

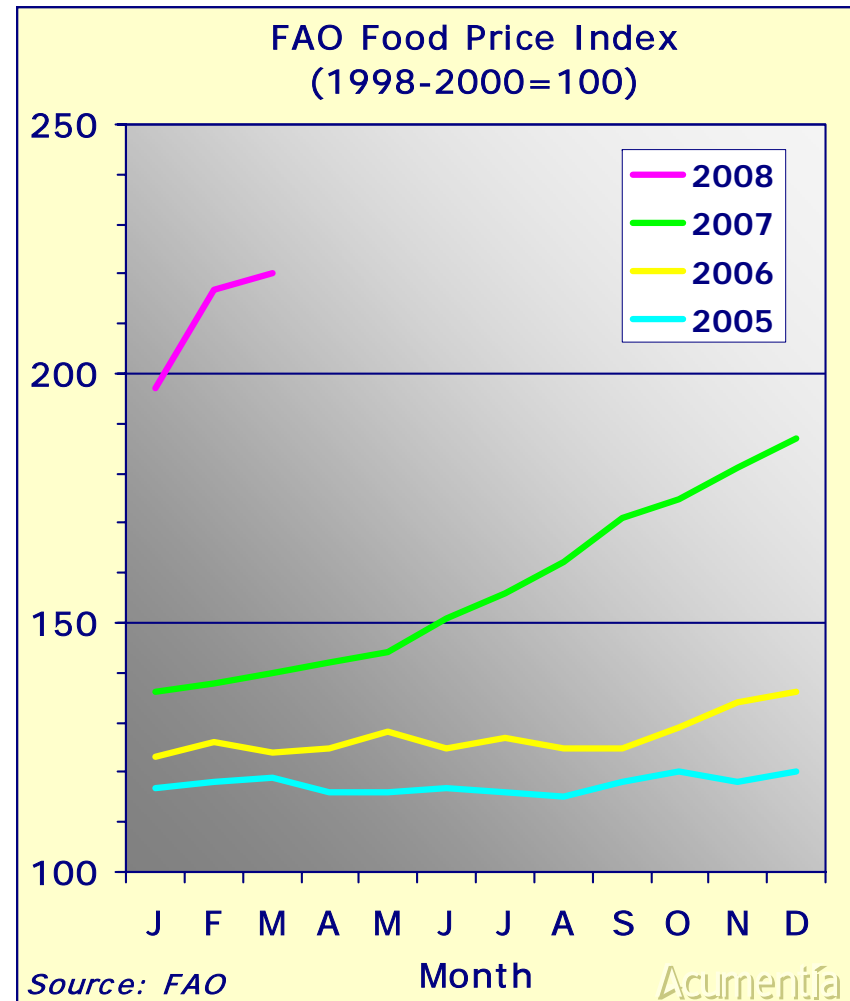
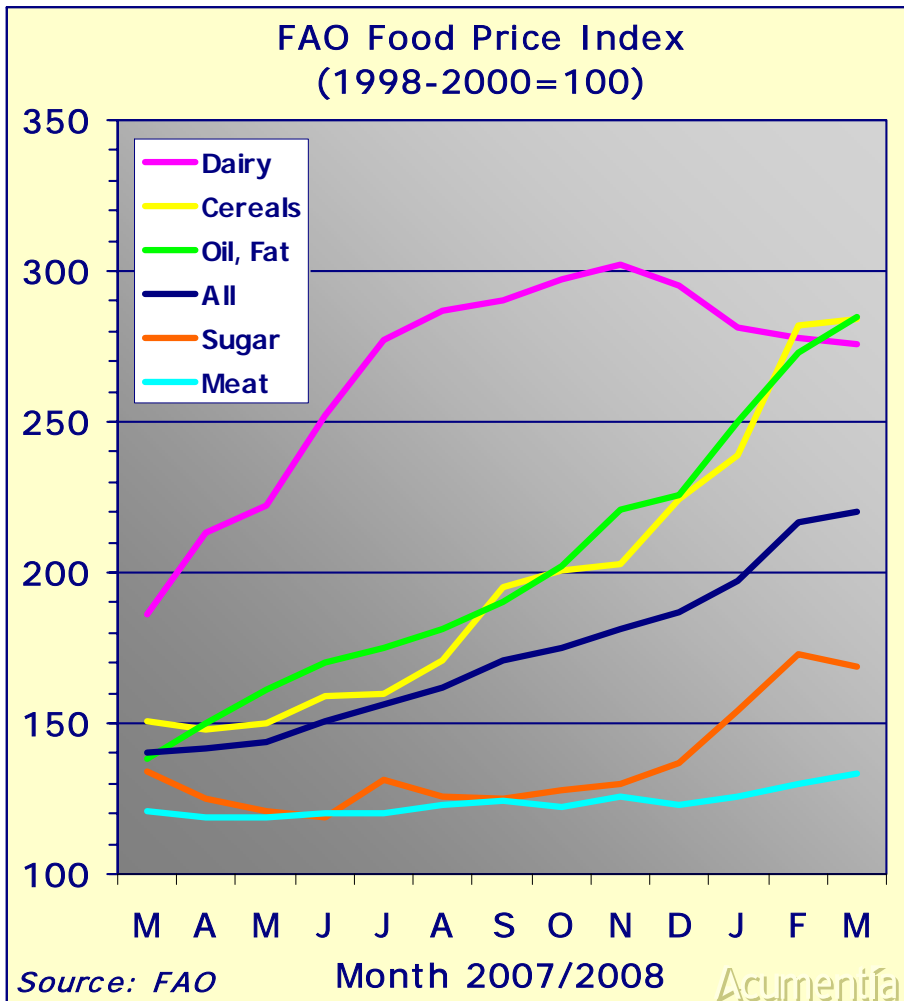
Tens of thousands riot over high food prices in Somalia

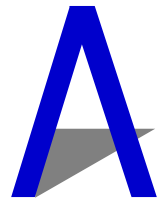
The Associated Press. Published: May 5, 2008





SOARING FOOD PRICES

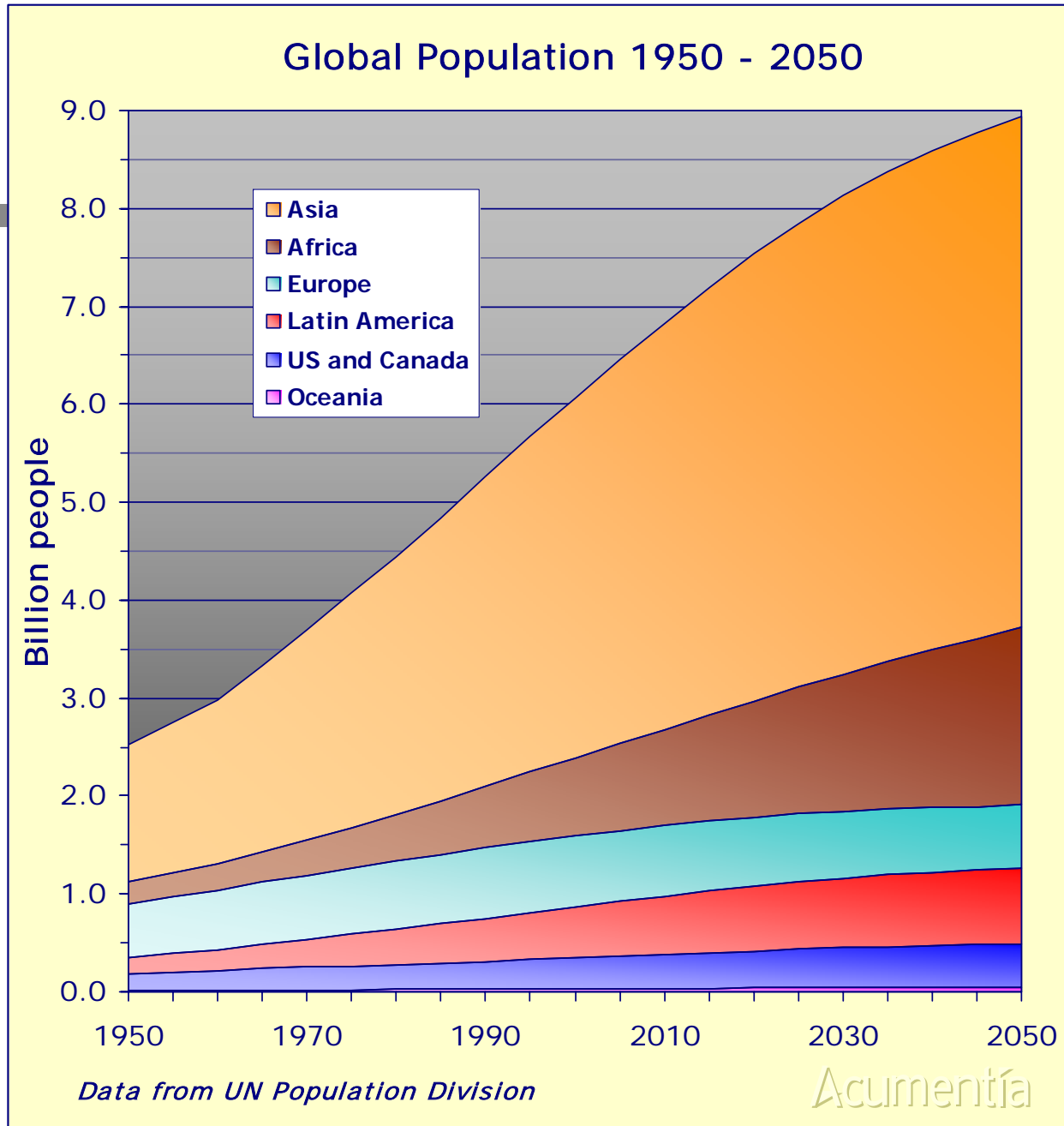
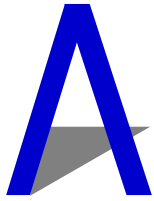


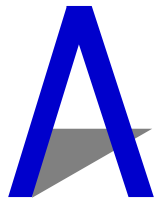


SOARING FOOD PRICES

The roots of the crisis:

- *Population growth*
- *Climate change*
- *The competition for agricultural land from biofuels*
- *Growing affluence in emerging economies*





THE CRITICAL ROLE OF THE CHEMICAL SCIENCES IN THE FOOD SUPPLY CHAIN

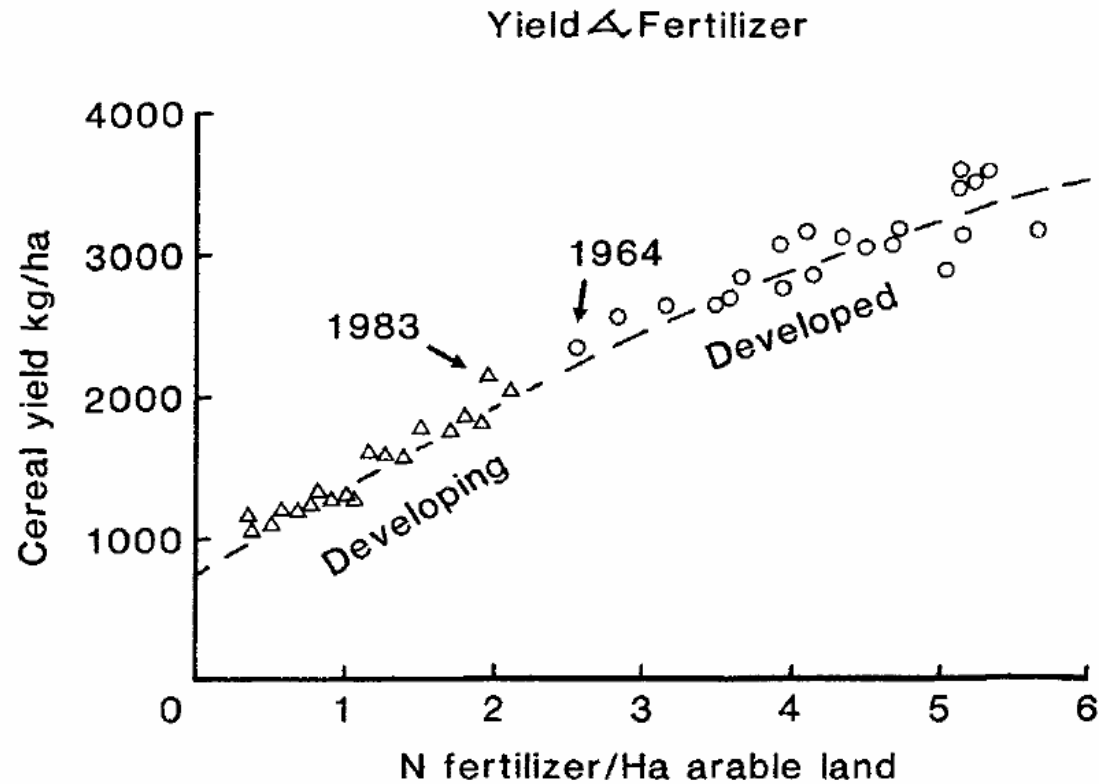
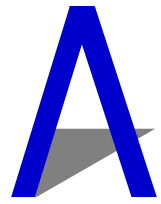


Fig 4—Cereal yield in relation to nitrogen fertiliser input, 1964–83.

Kenneth Blaxter (1987), 'Future Hunger' The Lancet, pp 309-313



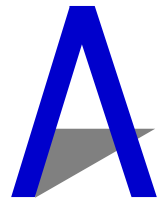
THE CRITICAL ROLE OF THE CHEMICAL SCIENCES IN THE FOOD SUPPLY CHAIN

FERTILISERS

'In northern Europe, fertiliser use has increased from about 45kg/ha to 250kg/ha since 1950. In the same period, wheat yields in France increased every year from about 1.8tonnes/ha to more than 7tonnes/ha.'

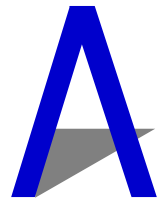
FAO(2003), 'Fertiliser and the Future'. UN Food and Agriculture Organisation, Rome.

Pesticides, herbicides, veterinary medicines, disinfectants, packaging, vitamins, food additives, refrigerants.



THE OUTCOMES

- CROPS
- LIVESTOCK
- FISHERIES AND AQUACULTURE
- OTHER SOURCES OF FOOD
- FOOD PRODUCTION, DISTRIBUTION AND RETAIL
- RESEARCH, EDUCATION, REGULATION, POLICY AND THE CONSUMER

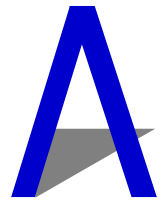


CROPS, WATER, SOIL

27% of global land mass is suitable for rain-fed crop production.
10% is currently in use.

ISSUES:

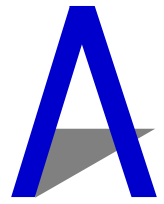
- Climate change
- Destruction of rainforest
- Land degradation
- Soil quality
- Use of marginal land
- Water quality and availability
- Pollution
- Biodiversity
- Competition between food crops and biofuel production



CROPS, WATER, SOIL - SOLUTIONS

KEY TECHNOLOGIES AFFECTING SUSTAINABILITY

- ***Modern biotechnology/genetic engineering/genomics.***
Plants capable of withstanding drought and salinity, improved nitrogen fixing capability, nutritional enhancement (for humans and animals), disease resistance, crop defence factors, reduced anti-nutritive factors.
- ***Soil Chemistry***
Understanding the biogeochemistry of soil ecosystems and carbon, nitrogen and sulphur cycling to improve plant uptake of nutrients, increase carbon sequestration, water retention, reduce nitrous oxide emissions. Development of bioremediation technologies to degrade and detoxify environmental contaminants; sequestrants to complex toxic metals. Improved understanding and use of methanotrophs in the development of methane fixing technologies.



CROPS, WATER, SOIL - SOLUTIONS

KEY TECHNOLOGIES AFFECTING SUSTAINABILITY

- ***Chemical Engineering***

Development of new methods for the efficient use, purification and cost effective recovery of water. Improved irrigation technologies, reuse of greywater and treated effluents, water neutral factories. Improved hydroponics. Desalination technologies.

- ***Global Positioning Technology***

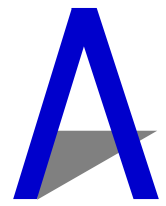
Combination of the use of climate forecasting, global positioning technology and remote sensing by satellite with soil analysis, moisture content, and other analytical information to help optimise fertiliser application, pesticide use, disease control, irrigation and other crop management strategies.

A LIVESTOCK

Livestock grazing and feed crop production account for 30% of the ice free terrestrial surface of the planet. Over 1.3 billion people or 20% of the world population depend on livestock for their living.

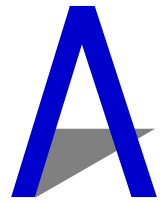
ISSUES:

- Greenhouse gasses - 37% of total methane, 67% of total nitrous oxide. Also 68% of total ammonia.
- Land degradation
- Loss of biodiversity
- Water pollution – nitrogen and phosphorous.

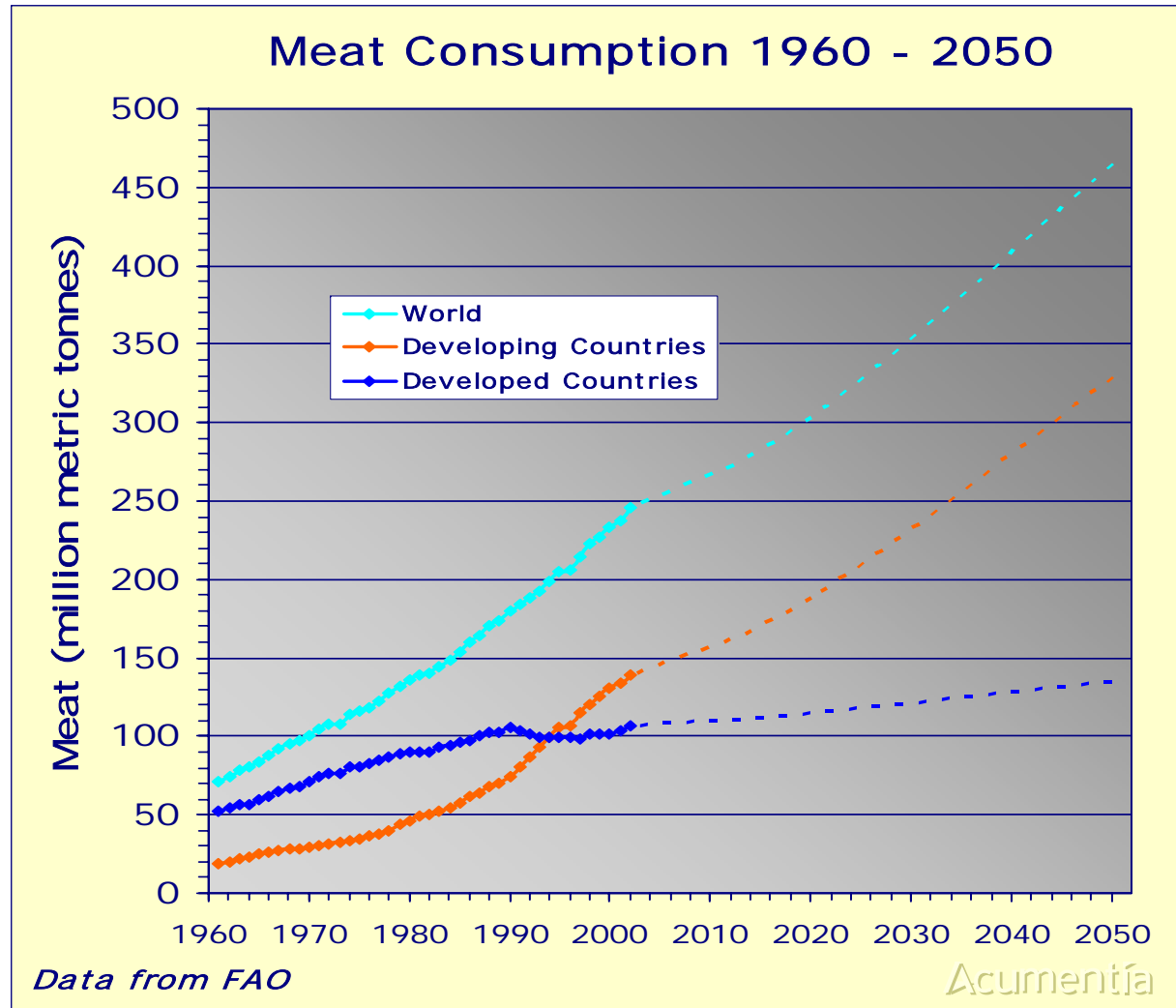


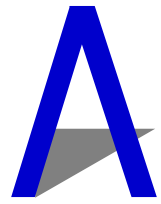
LIVESTOCK Algal blooms in the Gulf of Mexico





LIVESTOCK – MEAT CONSUMPTION





LIVESTOCK - SOLUTIONS

KEY TECHNOLOGIES AFFECTING SUSTAINABILITY

- ***Disease Control Technologies***

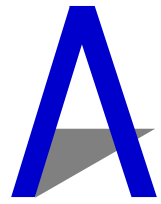
Development of new vaccines and veterinary medicines are crucial to the sustainability of livestock farming – foot and mouth, bluetongue, PMWS. Zoonoses – development of vaccines target disinfectants and new feed ingredients to control *salmonella*, *E.coli O157*, *avian influenza*, *MRSA*, *etc.*

- ***Animal Feed Technology***

Modification of ruminant livestock diet to reduce methane emissions (Rowett). Animal nutrition, feed conversion, efficiency of meat production.

- ***Genetic Engineering***

Improved disease resistance, reduced greenhouse gas emissions, improved feed conversion, improved phosphate utilisation



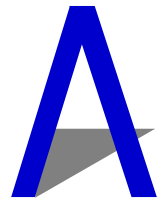
FISHERIES AND AQUACULTURE

Only 3% of wild marine fish species are ranked by FAO as under exploited. Of 600 species 25% are over exploited, 52% fully exploited, 20% moderately exploited.

Farmed fish production is growing at 8%/annum. It has grown globally from 9Mt in 1980 to 46Mt in 2006. In the EU it has quadrupled since 1970 to 1.8Mt. Over 43% of all fish consumed in 2006 was farmed. Fish farming is seen by FAO as crucial in the fight against hunger.

ISSUES:

- Conservation of wild fish stocks- collapse of fisheries
- By-catch – estimated at 20Mt/annum
- Climate change
- Industrial fishing
- Disease control – aquaculture



FISHERIES AND AQUACULTURE - SOLUTIONS

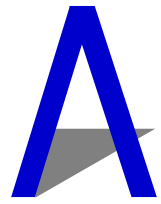
KEY TECHNOLOGIES AFFECTING SUSTAINABILITY

- ***Disease Control Technologies***

FAO consider that disease is the biggest impediment to aquaculture development. Water recirculation, aeration and oxygenation technologies. Development of drugs for use with fish diseases, rapid diagnostic assays and vaccines.

- ***Selective Breeding***

Significant productivity increases for salmon, trout, tilapia using standard breeding technology. Considerable scope for further increases including selection for disease resistance, reproductive success, better feed conversion, improving shelf life, flavour and texture.



FISHERIES AND AQUACULTURE - SOLUTIONS

KEY TECHNOLOGIES AFFECTING SUSTAINABILITY

- ***Feed Technologies***

Reducing the dependence of aquaculture on industrial fish feed. Development of technologies to provide sources of plant or algae based omega-3 unsaturated fatty acids to reduce the need for industrial fishing. By-products from ethanol production from maize as a source of protein for aquaculture.

- ***Genetic Modification***

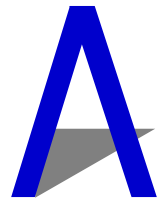
Major improvements are still possible through selective breeding programmes but disease resistance is of paramount importance to the success of aquaculture.

A

OTHER SOURCES OF FOOD







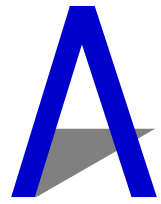
OTHER SOURCES OF FOOD



Roberto Candia/AP

PETA Launches Contest to Create Lab-Grown Meat
April 25, 2008 10:45 AM

PETA has offered \$1 million to the first person who can create chicken meat from animal stem cells, and have it ready to sell by 2012.
(People for the Ethical Treatment of Animals)

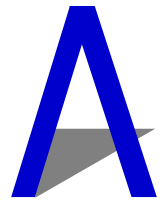


FOOD PRODUCTION, DISTRIBUTION AND RETAIL

Food and drink is the UK's largest manufacturing sector, with a turnover of almost £74,000m employing 470,000 people. UK food retailers and caterers employ a further 2.5 million people. Supermarkets dominate the UK retail market in food, representing 56% of all retail food sales in 2007, estimated to be worth £72,800m, an increase of 18.5% since 2002.

ISSUES:

- Continuity and security of supply of key raw materials
- Nutrition and health requirements
- Carbon footprint
- Waste



FOOD PRODUCTION, DISTRIBUTION AND RETAIL - SOLUTIONS

- ***Anaerobic Digestion***

Development of anaerobic treatment plants to process farm, abattoir and retail waste into biogas for energy.

- ***Irradiation***

A developed technology that could make enormous savings in the food supply chain with consumer acceptance. An estimated 25-30% of harvested food is lost as a result of microbial and pest contamination.

- ***Refrigerant Chemicals***

Refrigeration processes consume 50% of the electrical energy consumed by the UK food and drink industry. Development of new, more efficient refrigerant chemicals, e.g. the trans-critical carbon dioxide heat pump.

A FOOD PRODUCTION, DISTRIBUTION AND RETAIL - SOLUTIONS

- *Nanotechnology*

Controlled delivery and release of nutrients via nanotechnology microstructures that, for example, combat obesity and over-consumption, nanofiltration - removal of pathogens from food, nanoencapsulation - to protect against environmental factors, nanoemulsions - to reduce fat content, nanoscale biosensors and packaging.....

- *Packaging*

Intelligent packaging for the improved control of spoilage (possibly via nanotechnology), development of biopolymers and bioplastics from plant polymers (biodegradable or edible). Edible nanolaminates. Antimicrobial packaging. Nanoscale films. Differentially permeable films. Technologies that reduce packaging.

A FOOD PRODUCTION, DISTRIBUTION AND RETAIL - SOLUTIONS

- *Diagnostics*

Rapid screening methods for food contaminants and natural toxins; allergens, mycotoxins, pathogens, heavy metals, pesticides, carcinogens and mutagens, etc.

- *Nutrigenomics*

Personalised nutrition based on genotype to optimise nutrition and health, protect against disease and combat allergenicity.

- *Life Cycle Analysis (LCA)*

DEFRA: Life cycle analysis (LCA) is a process used both to evaluate the environmental burdens associated with a product, process or activity and to consider opportunities to effect environmental improvements.

