Poultry production –
a life-cycle approach to appraisal and development

Presentation to the UK Poultry Council
Queen Elizabeth II Conference Centre, London
1 May, 2007

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and

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Murphy-Bokern Konzepte

Background

Murphy-Bokern Konzepte

This talk

Some policy background

'One Planet Living' and Life Cycle Assessment

From burdens to impacts

Further research and development

Policy drivers

The strategy for sustainable farming and food

Delivering the essentials of life – Defra's five year strategy

Climate Change: The UK Programme 2006

Developing measures to promote catchment sensitive farming

England Rural Development Programme

The air quality strategy for England, Scotland, Wales and Northern Ireland: working together for clean air

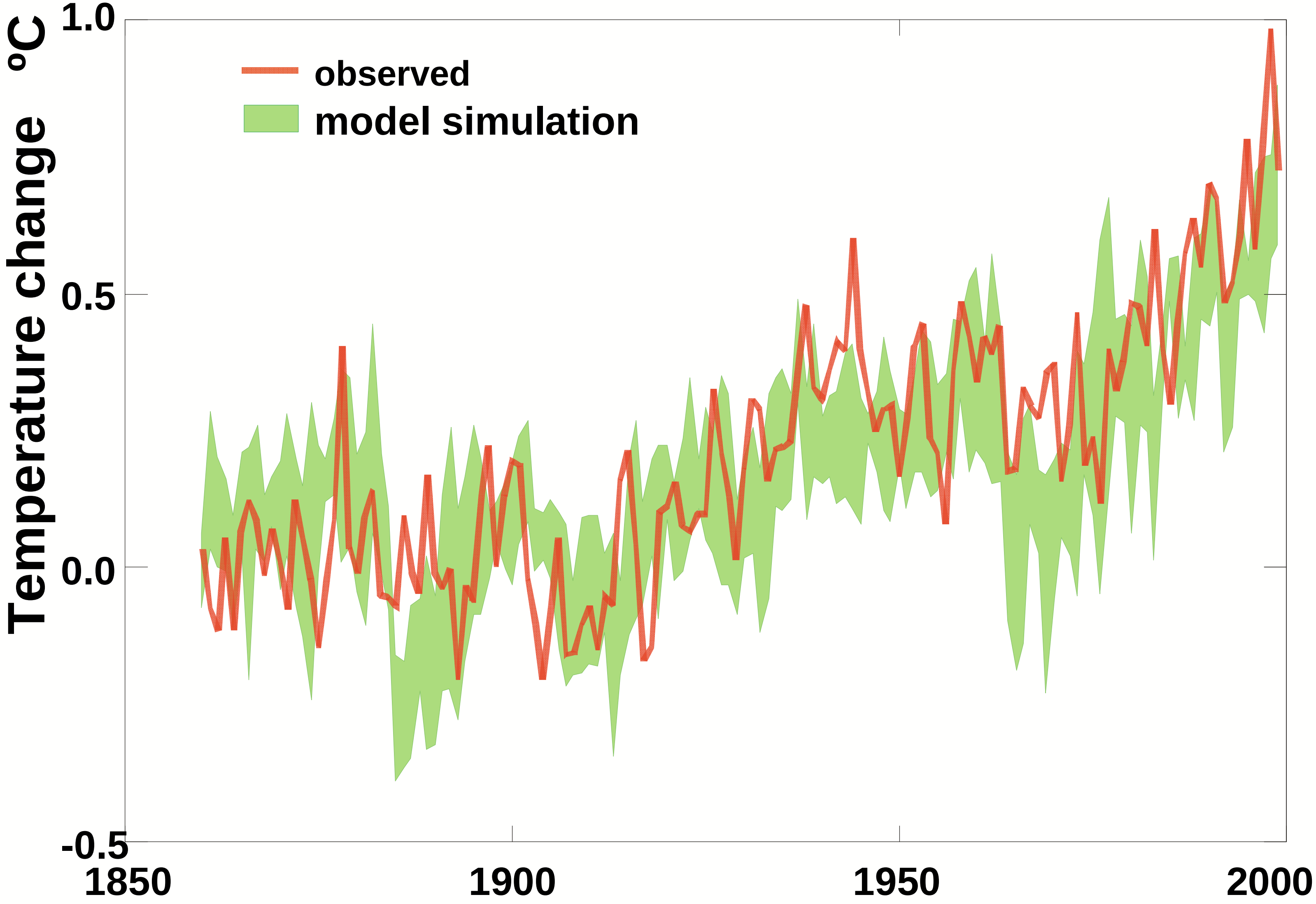
David Miliband's speeches – February 2007, January 2007, and July 2006

Climate change is a top government priority

"Climate change is probably the greatest long-term challenge facing the human race. This is why I have made it a top priority for this government, at home and internationally"

Tony Blair – Climate Change: The UK Programme 2006

Recent warming can be simulated when man-made factors are included



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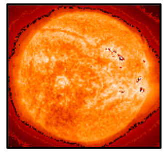

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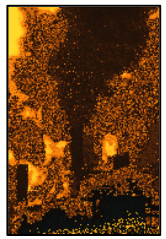
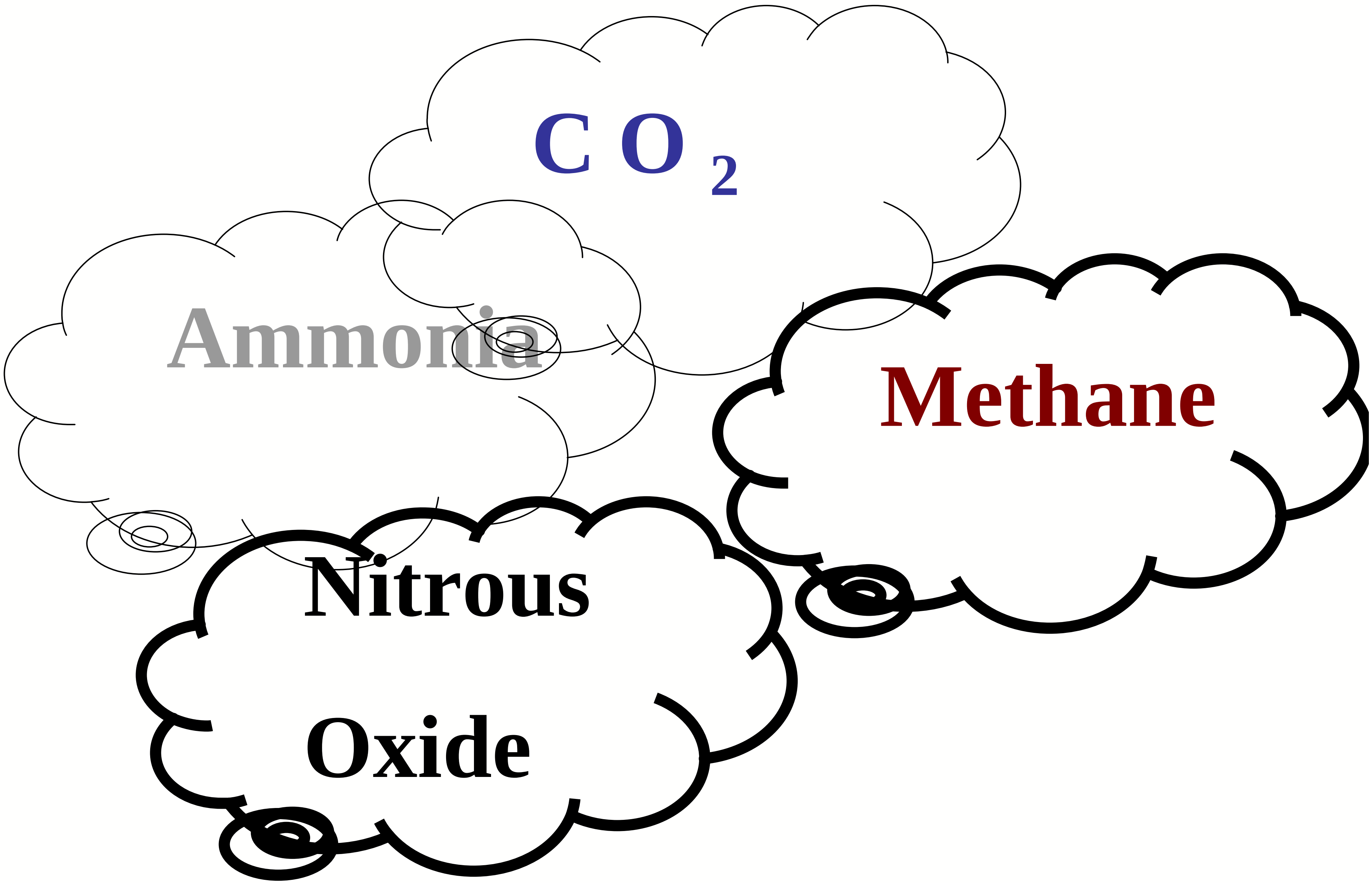
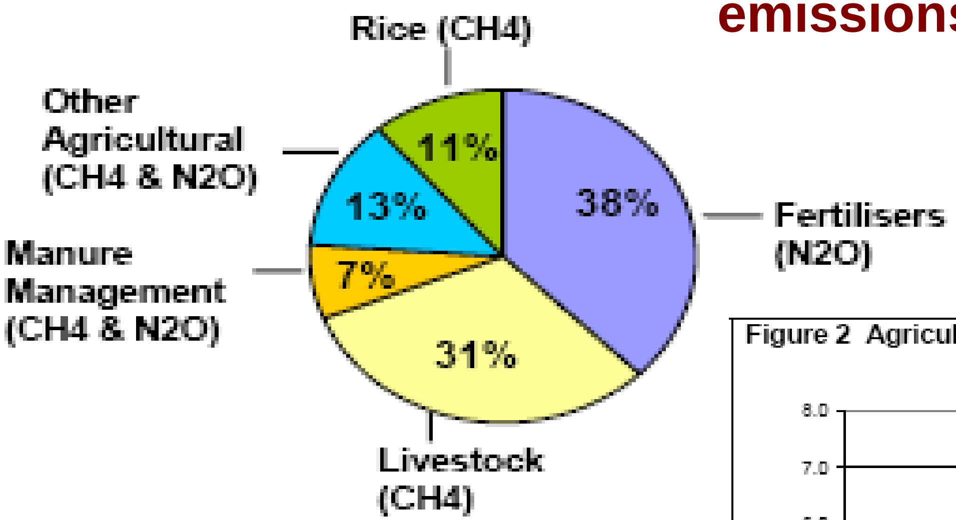




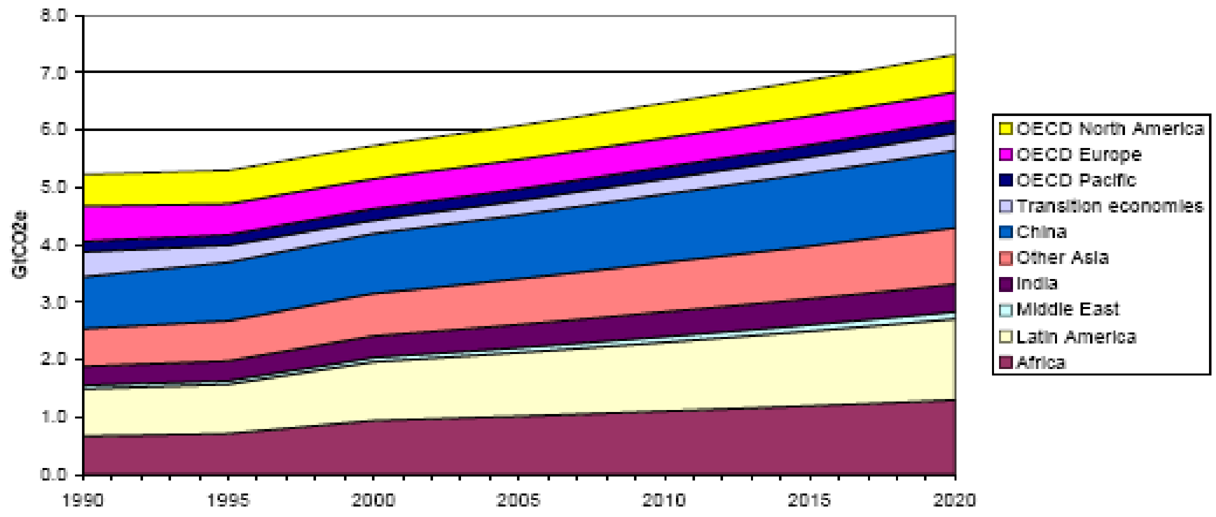
C O 2
Ammonia
Methane
Nitrous
Oxide

Stern on Agriculture



14% of global greenhouse gas (GHG) emissions in 2001

Figure 2 Agriculture non-CO_2 emissions by country (1990-2020)



One planet farming

"Put simply, we are living as if we had three planet's worth of resources to live with, rather than just one. So if we are to build a sustainable future economically as well as environmentally …we need to cut by about two thirds our ecological footprint.

For that we need 'one planet farming' as well as one planet living – one planet farming which minimises the impact on the environment of patterns of food production and consumption, and farming which maximises its contribution to renewal of the natural environment".

‘One planet farming’ symbolises globalisation of the agri-environmental agenda. It expresses the responsibility of consumption as the driver behind production.

Life-cycle assessment

Life Cycle Assessment is an objective process to evaluate the environmental burdens associated with a product, process, or activity by identifying energy and materials used and wastes released to the environment, and to evaluate and implement opportunities to affect environmental improvements. (SETAC, 1990)

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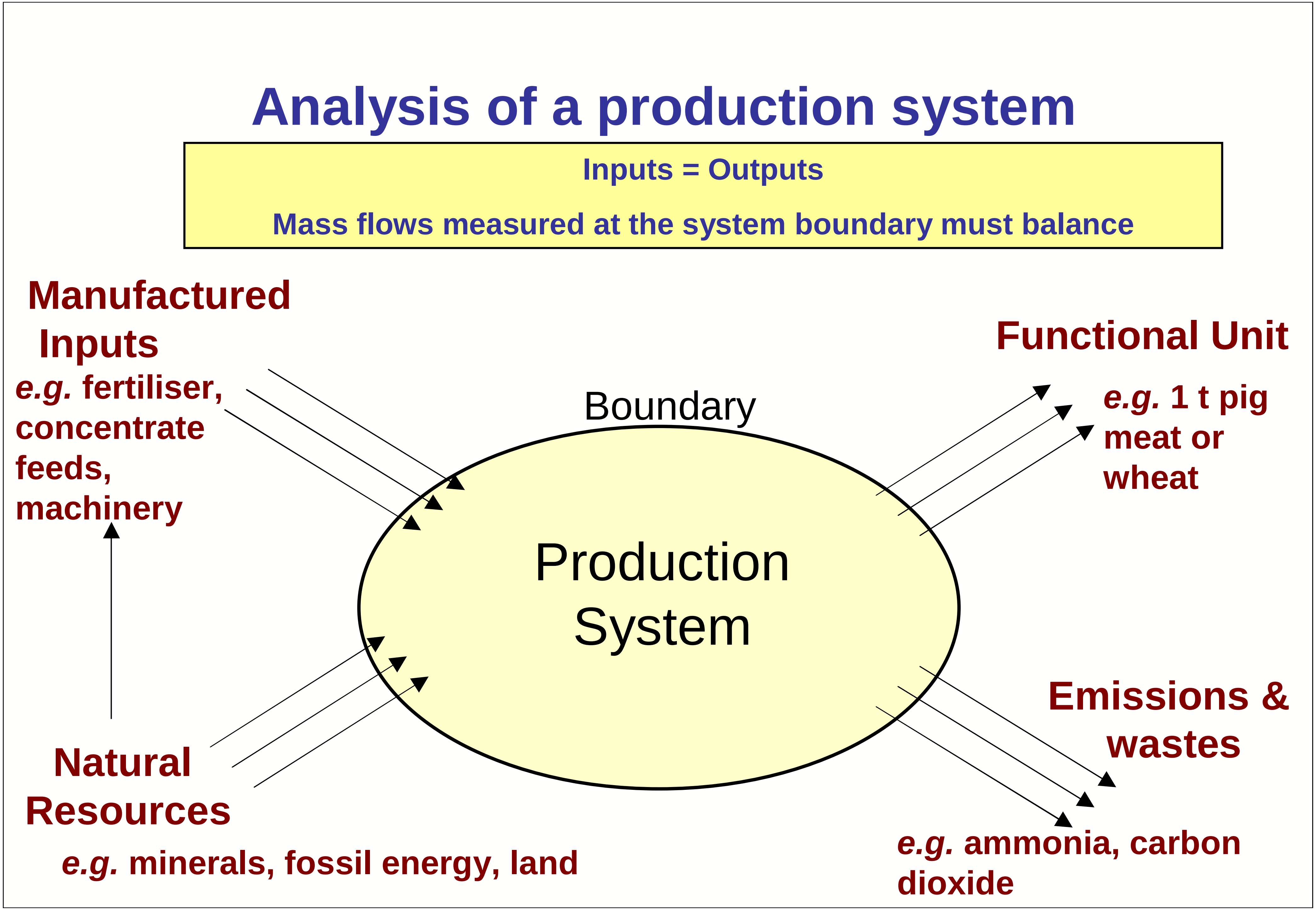
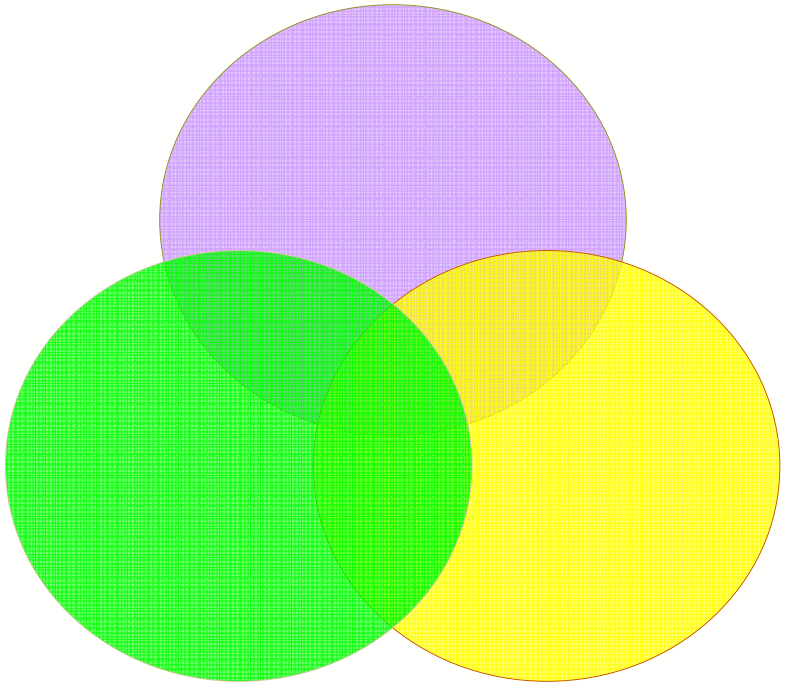
Konzepte


Analysis of a production system
Inputs = Outputs
Mass flows measured at the system boundary must balance
Manufactured Inputs
e.g. fertiliser, concentrate feeds, machinery
Functional Unit
e.g. 1 t pig meat or wheat
Boundary
Production System
Natural Resources
e.g. minerals, fossil energy, land
Emissions & wastes
e.g. ammonia, carbon dioxide

What can you do with an assessment?

Policymakers



Producers

- ‘Eco-design’ of production

Consumers

- Sustainable consumption

The ‘Cranfield’ Study

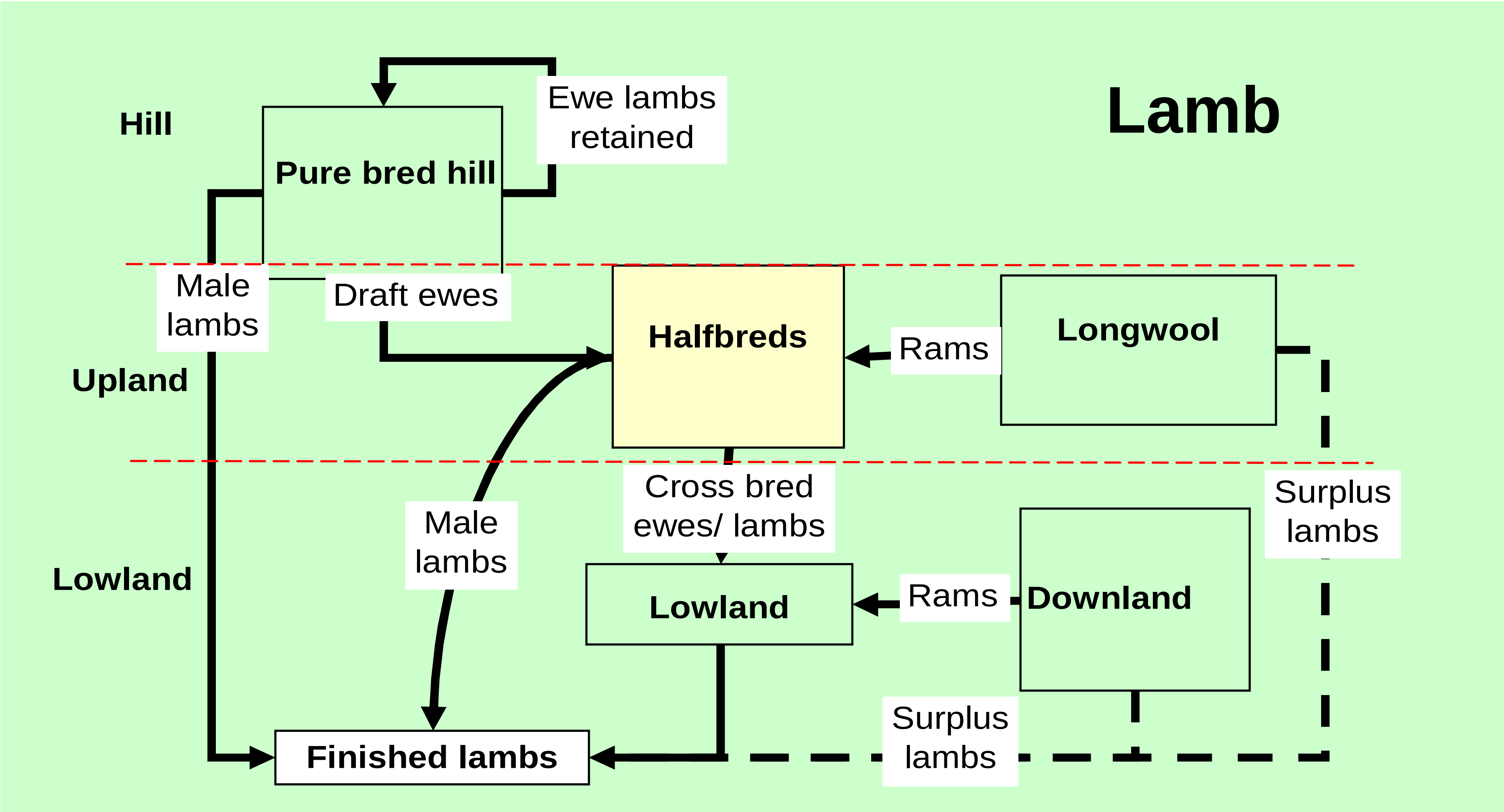
- Industry structure models
- Soil, crop & livestock process models
- Provides ability to address a wide range of questions

Modelling the sheep production chain

Hill / mountain, 1 ewe & 0.9 lamb needs 5-10 ha

Lowland, 1 ewe & lambs needs 0.1 ha

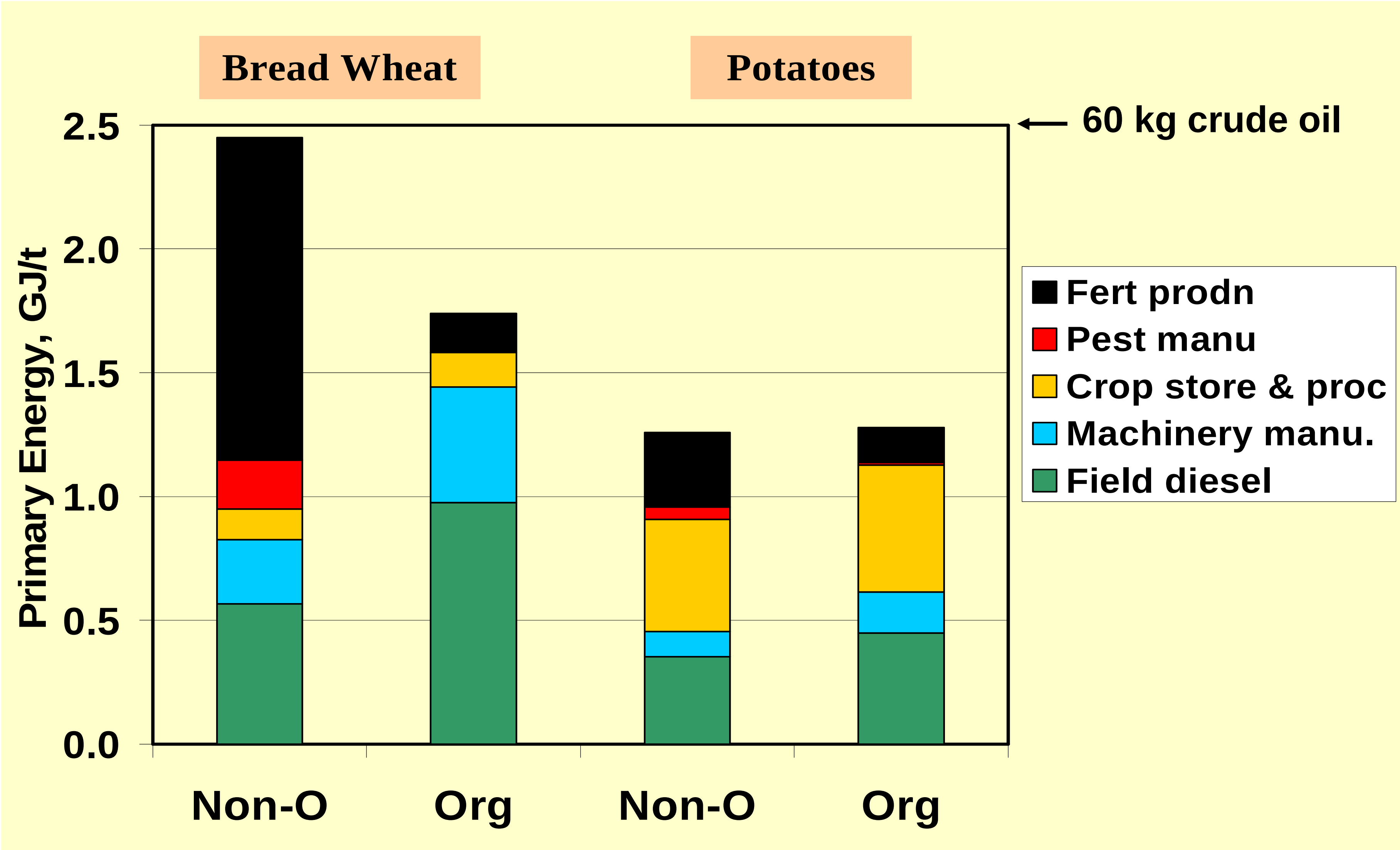
Industry Structure Model



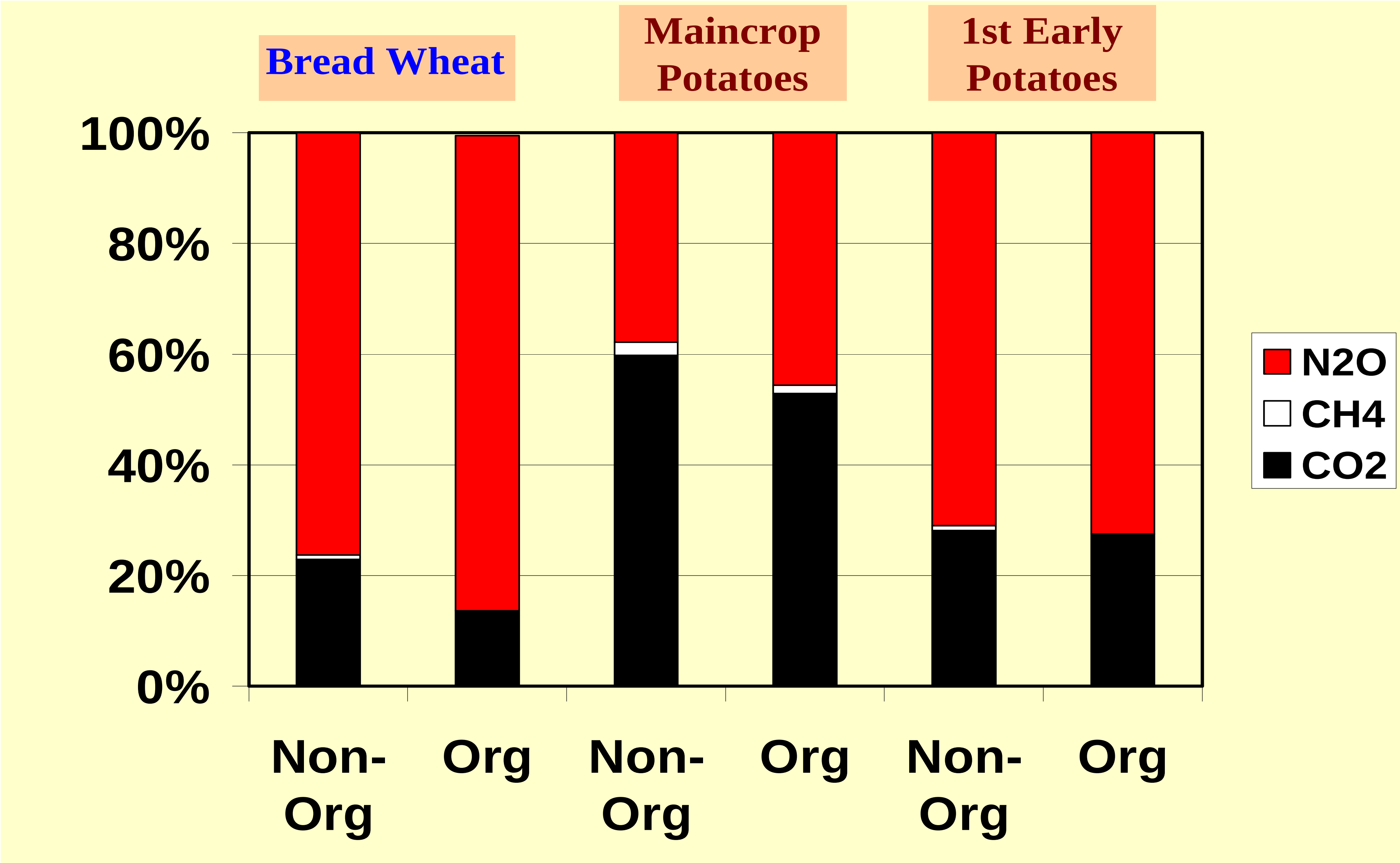
- **Long term, mass balances**
- **Functional relationships**
- **Models to inform emission estimates**
- **Animal manure credits and debits**
- **Input-output relationships as affected by**
  - **3 soil textures, 3 rainfalls**
- **Basket of outputs = commodity**

Some results

Distribution of primary energy use in bread wheat and potato production



Distribution of GWP for three crops

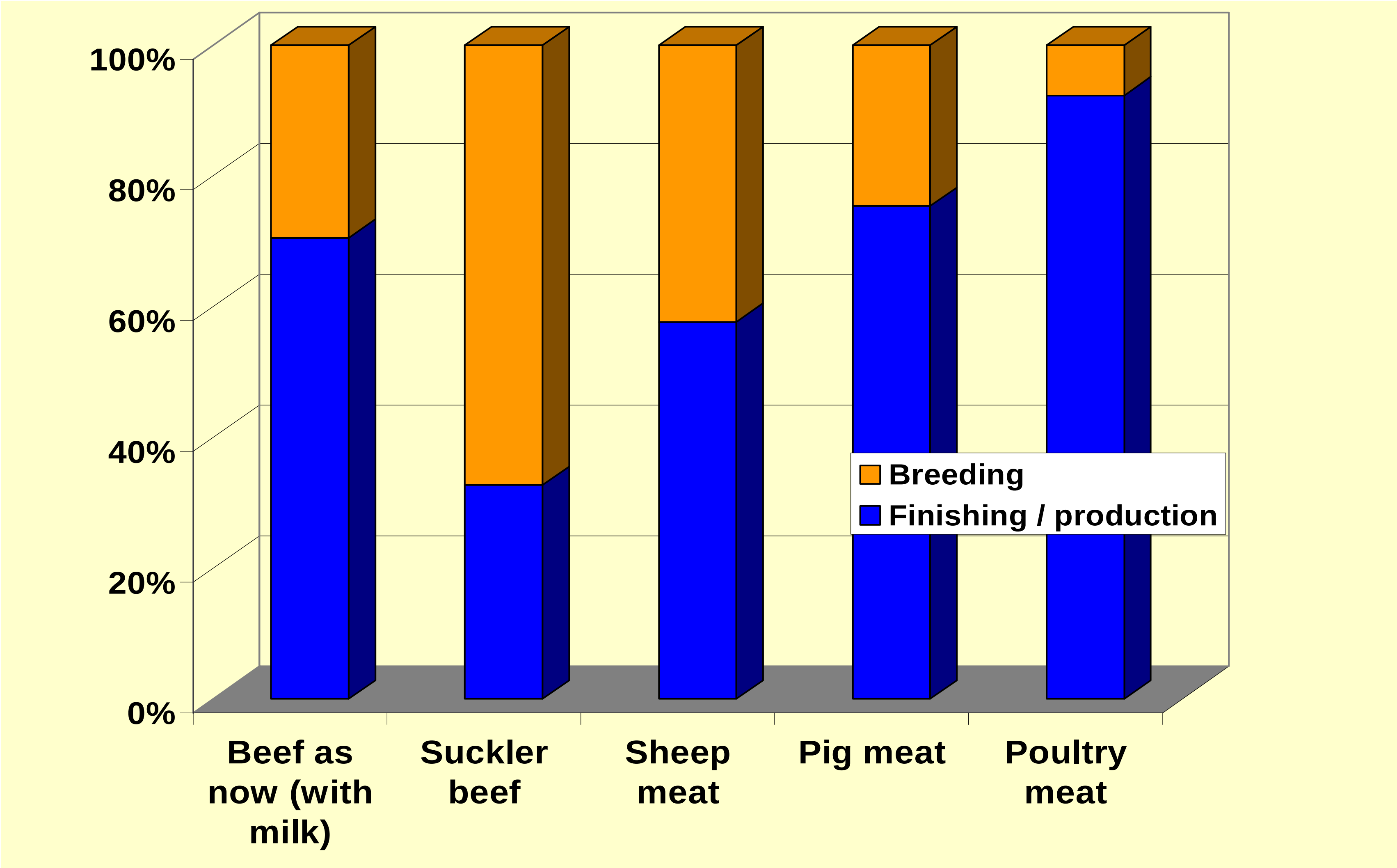


Main burdens in animal production (National Scale)

1 tonne of carcase meat, milk dry matter, 20,000 eggs

	Beef	Sheep Meat	Pig Meat	Poultry Meat	Eggs	Milk
Primary Enery, GJ	28	23	17	12	14	25
GWP100, t CO_2 equiv.	16	17	6	5	6	11
EP, kg PO_4 equiv.	160	200	100	49	77	64
AP, kg SO_2 equiv.	470	380	390	170	310	160
ARU, kg antimony equiv.	36	27	35	30	38	28
Land use (grade 3a), ha	2.3	1.4	0.7	0.6	0.7	1.2
Crude Oil, kg	650	540	390	280	330	590

Distributions of energy in meat production



Effects of milk yield on burdens

	PE, GJ	GWP100, t CO2	ARU, kg ant. Equiv.	Land, ha
Low	31	10	34	1.0
Medium	30	10	33	0.95
High	28	9.5	31	0.91

Poultry production input data values used in the LCA model

	Broiler systems				Turkey systems			
	Breeder Systems	Free-range	Free-range - Organic	Housed	Free range	Free range - Organic	Pole-barn housed	Fully housed
Time to laying, week	18							
Finishing, day		56	82	42				
Female finishing age, week					20	20	20	8
Female finishing weight, kg					7.5	7.5	7.5	5
Male finishing age, week					20	20	20	8
Male finishing weight, kg					13.5	13.5	13.5	5
Rejects, %		1.5						
Laying, time, week	54							
Eggs laid	170							
Eggs rejected	20							
Hatching rate, %	0.85							
Chicks hatched	115							
Feed, t/1000 birds	45	5.5	8	4.6	29	29	29	14
Poult feed, t/1000 birds	6.6							
Spent broiler breeder, kg	5							
Manure, t/1000 birds	42.0	3.1	4.5	2.3	16.1	16.1	16.1	6.8
Straw, t/1000 birds		1	2	1	4	4	4	2
Finished weight, kg		2.35	3	2.54				
Mortality, %		0.05	0.05	0.04	0.05	0.05	0.04	0.04
Methane, g/head	31.6	0.7	1.4	0.6	1.2	1.2	1.2	0.2
Ammonia, g/head	203.7	7.1	13.3	5.9	11.4	11.4	11.6	2.2
Nitrous oxide, g/head	10.2	2.2	4.1	1.8	5.5	5.5	5.5	1.0

Comparison burdens of production of some alternative poultry meat systems (per t)

Impacts & resources used	Non-organic	Organic	Free-range (non-organic)
Primary energy used, MJ	12,000	15,800	14,500
GWP_{100}, kg 100 year CO_2 equiv.	4,570	6,680	5,480
EP, kg PO_4^{3-} equiv.	49	86	63
AP, kg SO_2 equiv.	173	264	230
Pesticides used, dose ha	7.7	0.6	8.8
ARU, kg antimony equiv.	29	99	75
Land use, ha	0.64	1.40	0.73
N losses			
NO_3^--N, kg	30	75	37
NH_3-N, kg	40	60	53
N_2O-N, kg	6.3	9.3	7.6

Production sources – 1 tonne poultry meat

Poultry Meat (default national proportions)							
			Primary energy used, MJ	GWP100, kg CO2	Eutrophication potential, kg PO4 eqv.	Acidification potential, kg SO2 eqv.	Abiotic resource use, kg Sb eqv.
Feed			12067	2467	14	15	9
Bedding			809	-123	0	1	1
Buildings			192	25	0	0	6
Direct energy			3633	234	0	1	2
Internal transport			30	2	0	0	0
Gaseous emissions			0	466	1	7	0
Manure			-1188	95	18	70	-1
Total			15542	3166	33	94	18

Comparison burdens of production of some alternative egg production systems

(per 20,000 eggs)

Impacts & resources used	**Non-organic**	**Organic**	**100% cage, non-organic**	**100% free-range, non-organic**
Primary energy used, MJ	14,100	16,100	13,600	15,400
GWP_{100}, kg 100 year CO_2 equiv.	5,530	7,000	5,250	6,180
EP, kg PO_4^{3-} equiv.	77	102	75	80
AP, kg SO_2 equiv.	306	344	300	312
Pesticides used, dose ha	7.8	0.1	7.2	8.7
ARU, kg antimony equiv.	38	43	39	35
Land use, ha	0.66	1.48	0.63	0.78
N losses				
NO_3^--N, kg	36	78	35	39
NH_3-N, kg	79	88	77	81
N_2O-N, kg	7.0	9.0	6.6	7.9

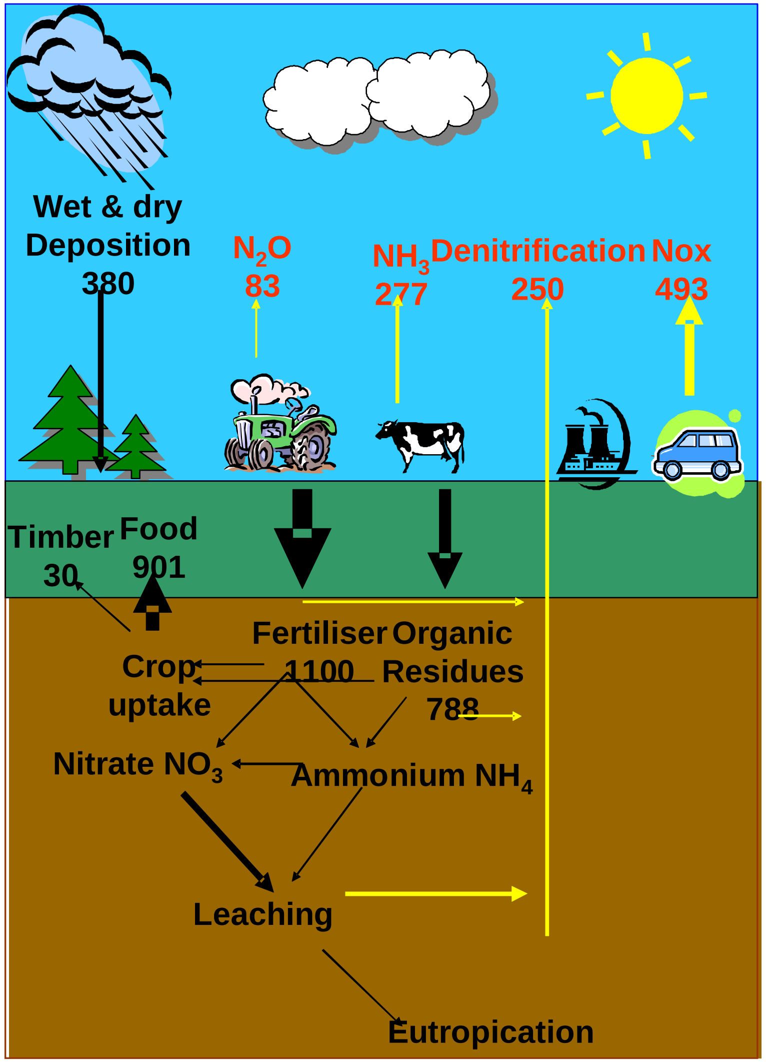
Production sources – 20,000 eggs

			Primary energy used, MJ	GWP100, kg CO2	Eutrophication potential, kg PO4 eqv.	Acidification potential, kg SO2 eqv.	Abiotic resource use, kg Sb eqv.
Feed			12040	2177	11	13	10
Bedding			0	0	0	0	0
Buildings			773	93	0	1	13
Direct energy			2408	128	0	0	1
Internal transport			77	5	0	0	0
Gaseous emissions			0	534	6	34	0
Manure			-1390	130	22	87	-1
Total			13908	3067	40	135	23

Qualifications

- Steady states - not transition
- Soil C not included
- N_2O could be calculated by other methods
- Activity data are limited
- Not about environmental performance of individual farms or biodiversity
- Burdens, not impacts

Nitrogen and the LCA of agricultural commodities



"… a carbon footprint inadequately describes agriculture; it has a *carbon-nitrogen footprint*…..The majority of environmental burdens arising from the production of agricultural food commodities arise either directly or indirectly from the nitrogen cycle and its modification….."

(Adrian Williams, Eric Audsley and Daniel Sandars of Cranfield University – Executive summary of the Defra Project Report IS0205)

Improving the nitrogen economy of UK agriculture lies at the centre of improving environmental performance re the major LCA parameters

From burdens to impacts – location, location, location

- Nitrates
- Ammonia
- Phosphorus

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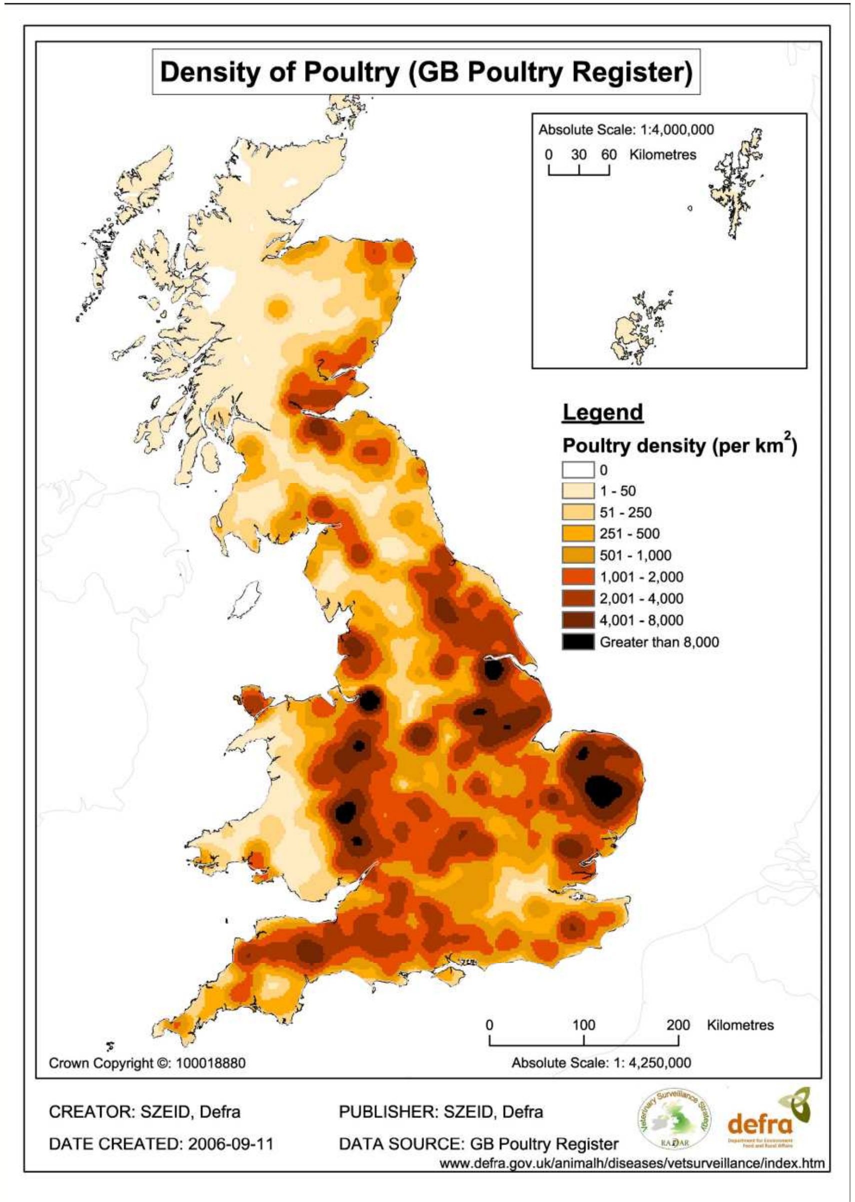

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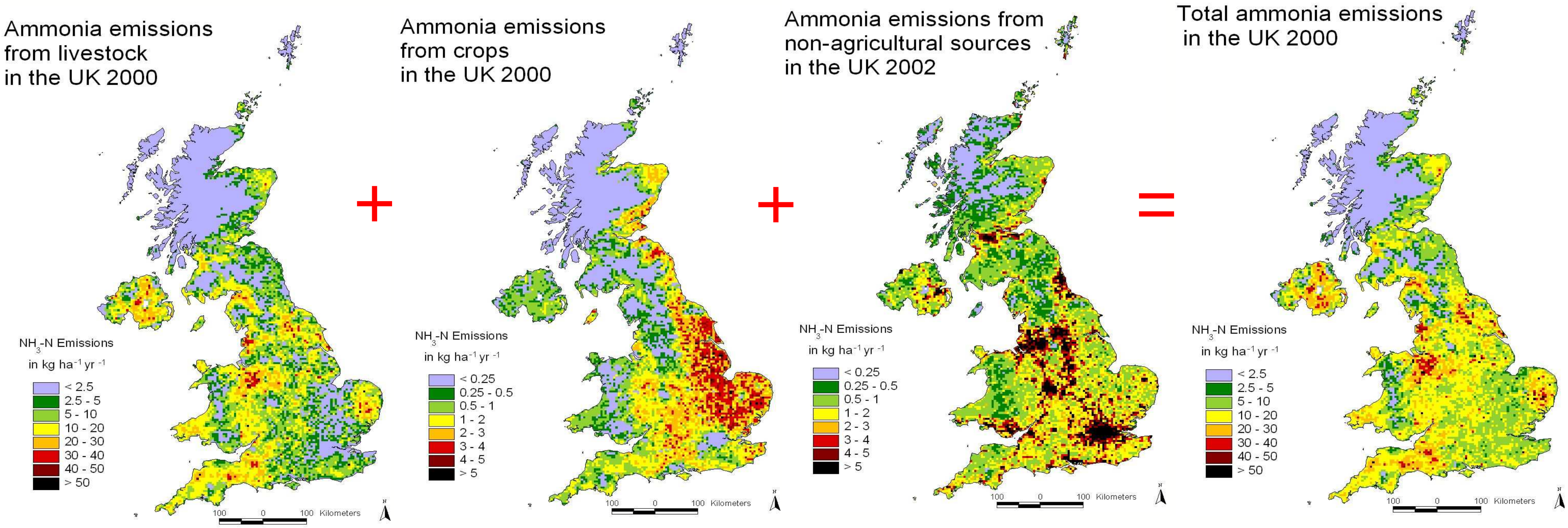
Ammonia (NH_3)

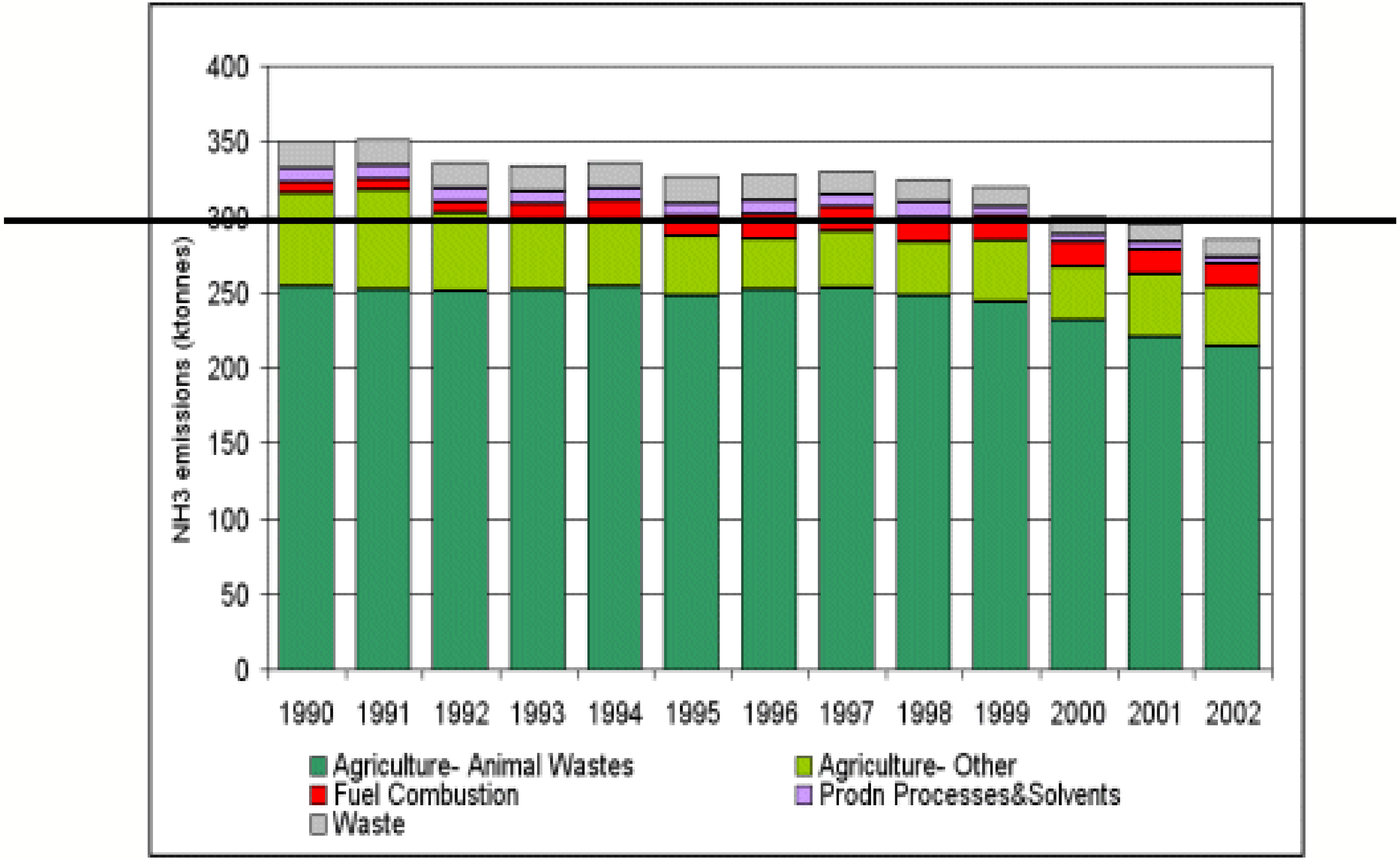
- Highly reactive gas
- Short and long range

- *Sources*:
  - Urban sources
  - Agriculture

Sample output data from AENEID



Ammonia emission trend –15% reduction since 1990



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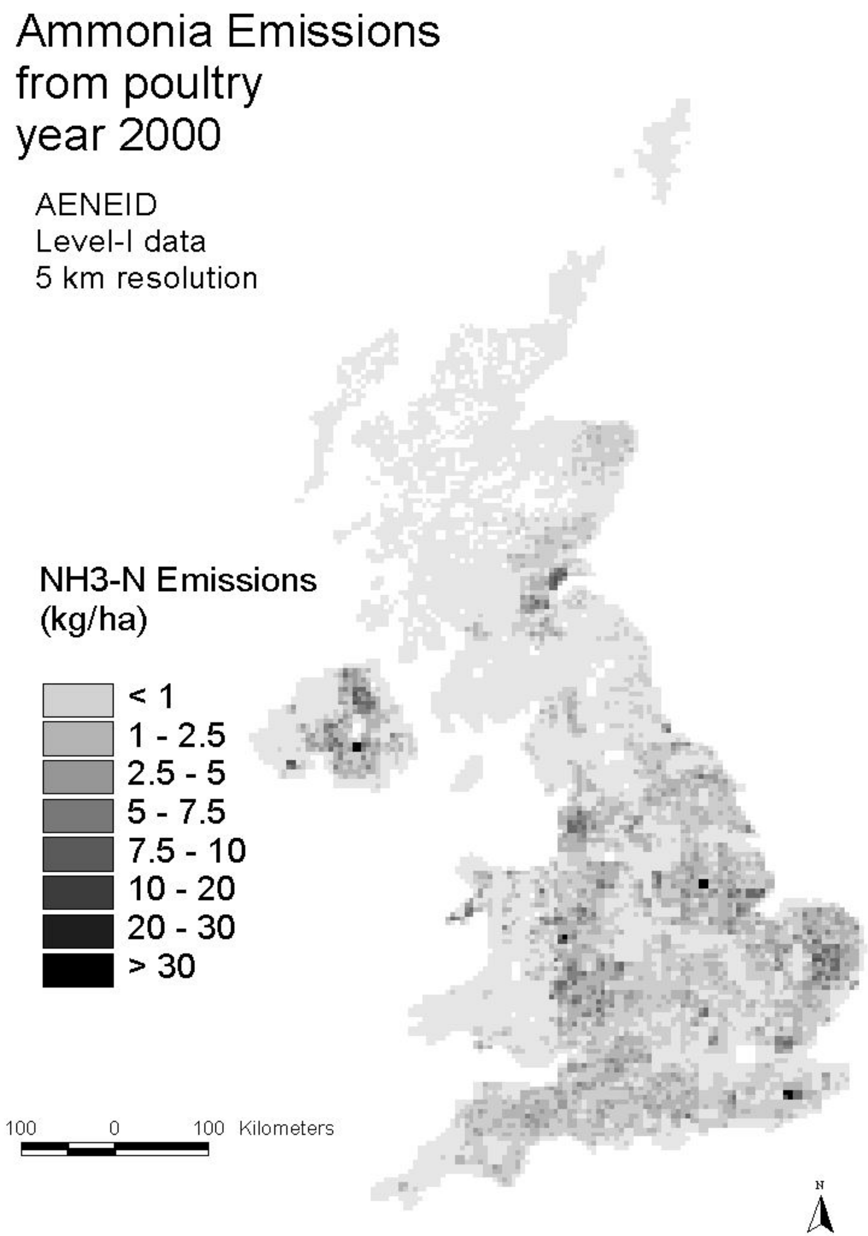
Where are we now?
Eutrophication – habitats at risk

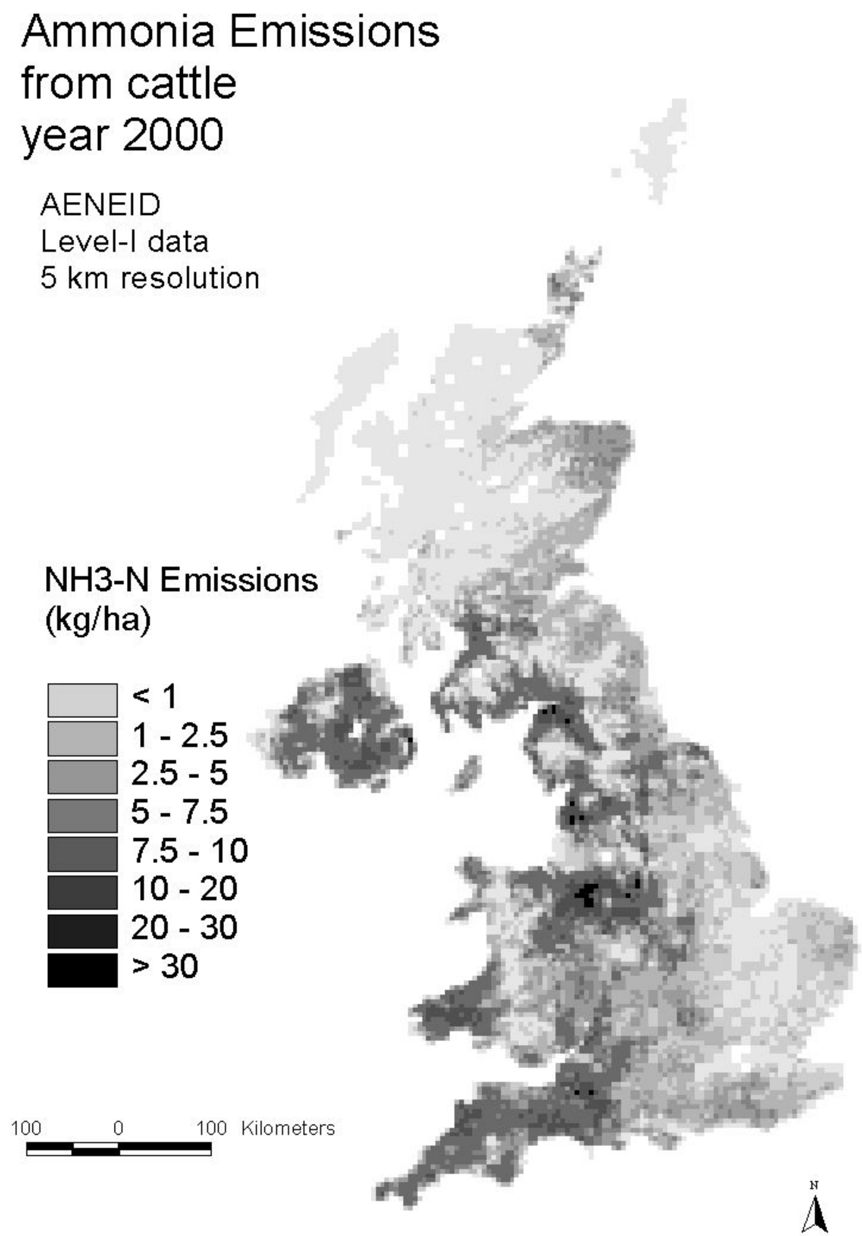
Percentage area of sensitive habitats at risk:

65% in 1995-97

60% in 2001-03

52% in 2010





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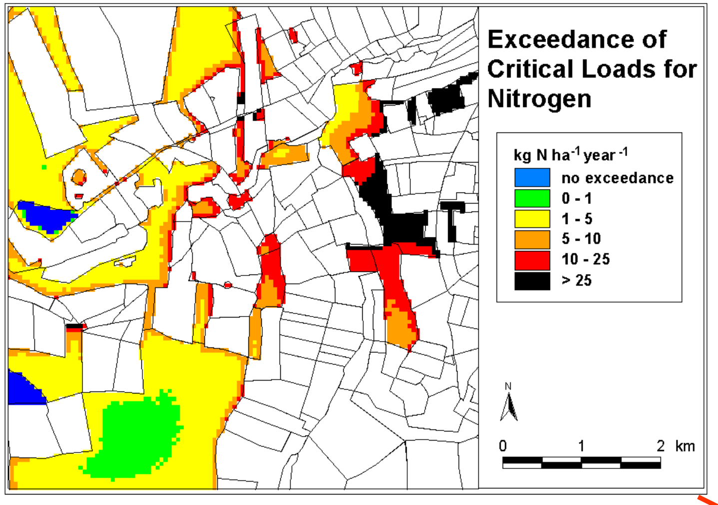
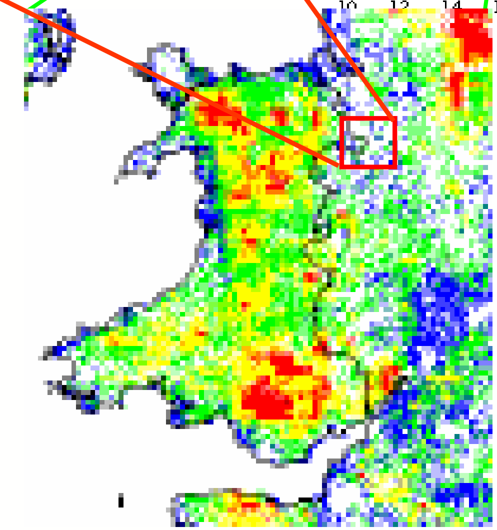
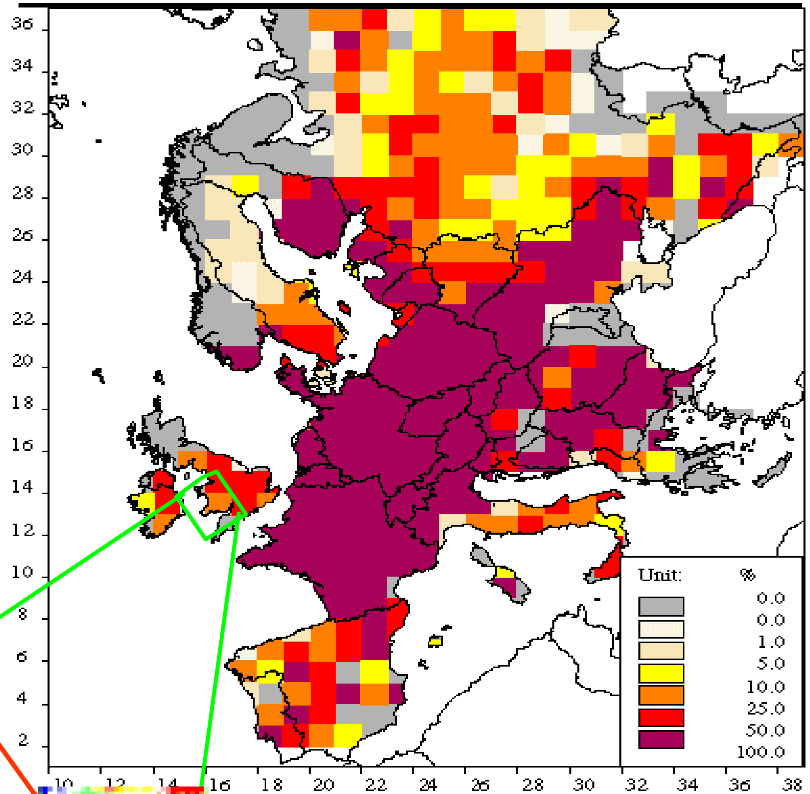
Dealing with spatial scale



Ecosystem protection





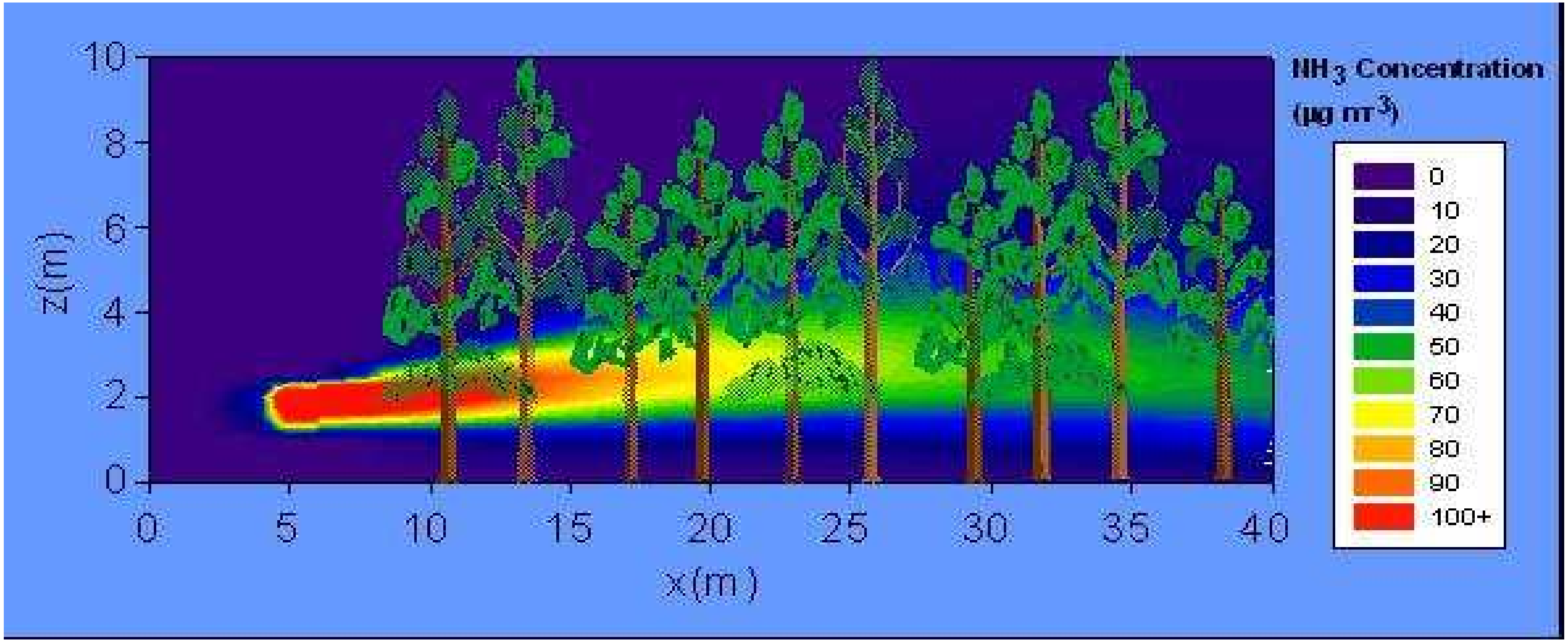
European exceedances of the critical load for nitrogen

National targets and policy

Agroforestry systems for ammonia abatement

National benefits of ammonia recapture by trees

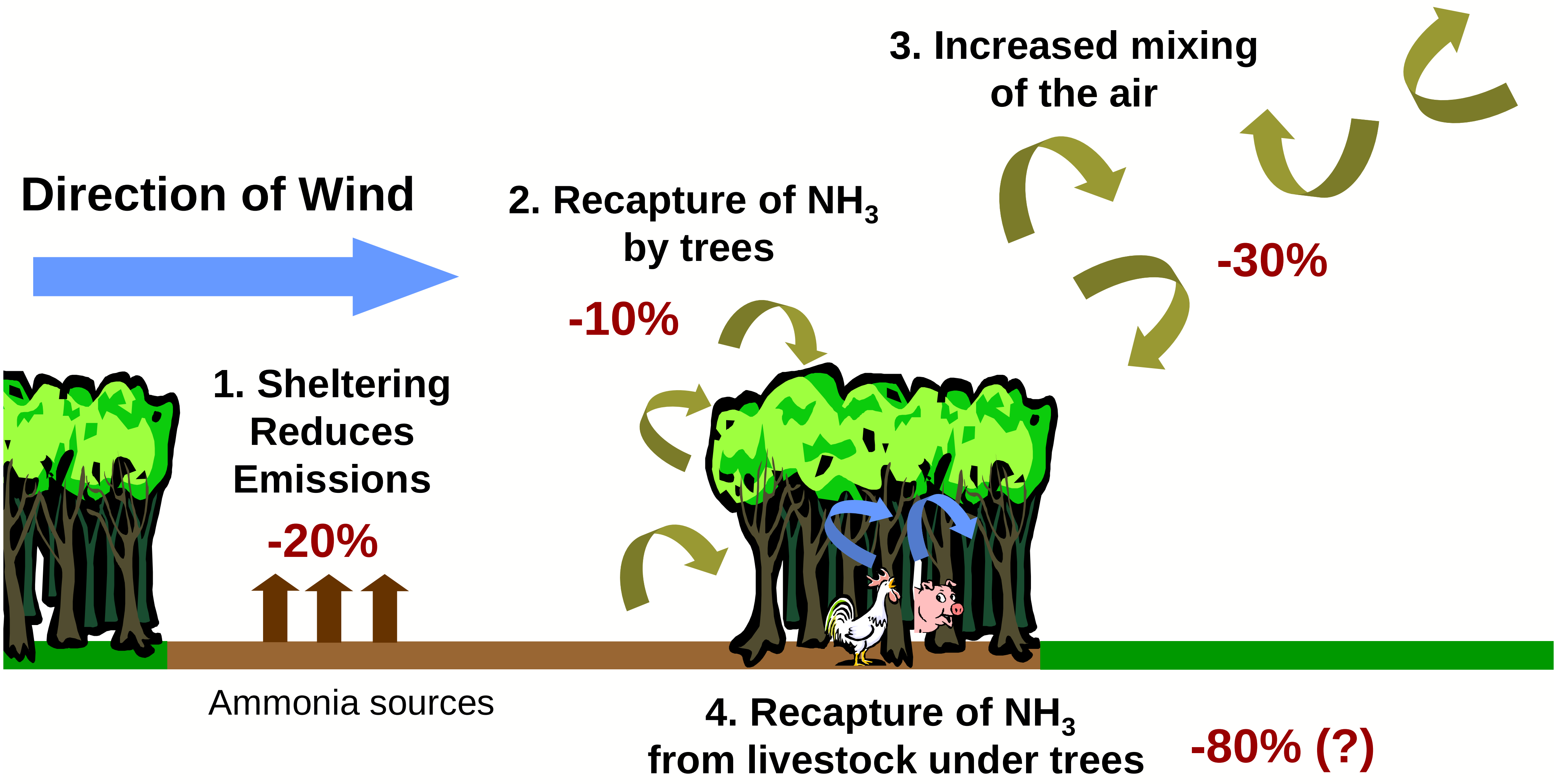
Mark Theobald



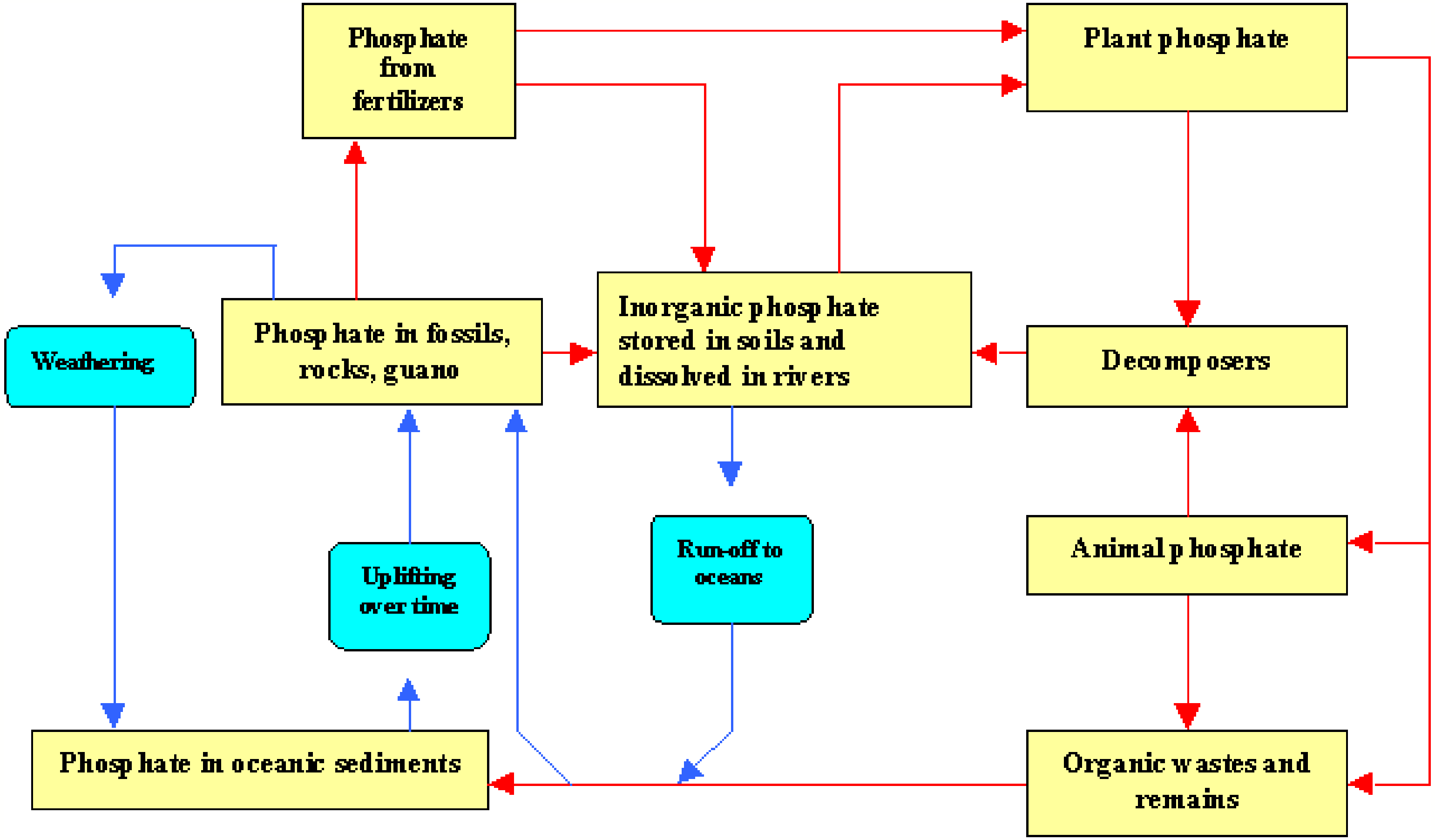
Centre for Ecology & Hydrology
NATURAL ENVIRONMENT RESEARCH COUNCIL

defra
Department for Environment Food and Rural Affairs

Locally - Four-way benefit of trees



Phosphorus



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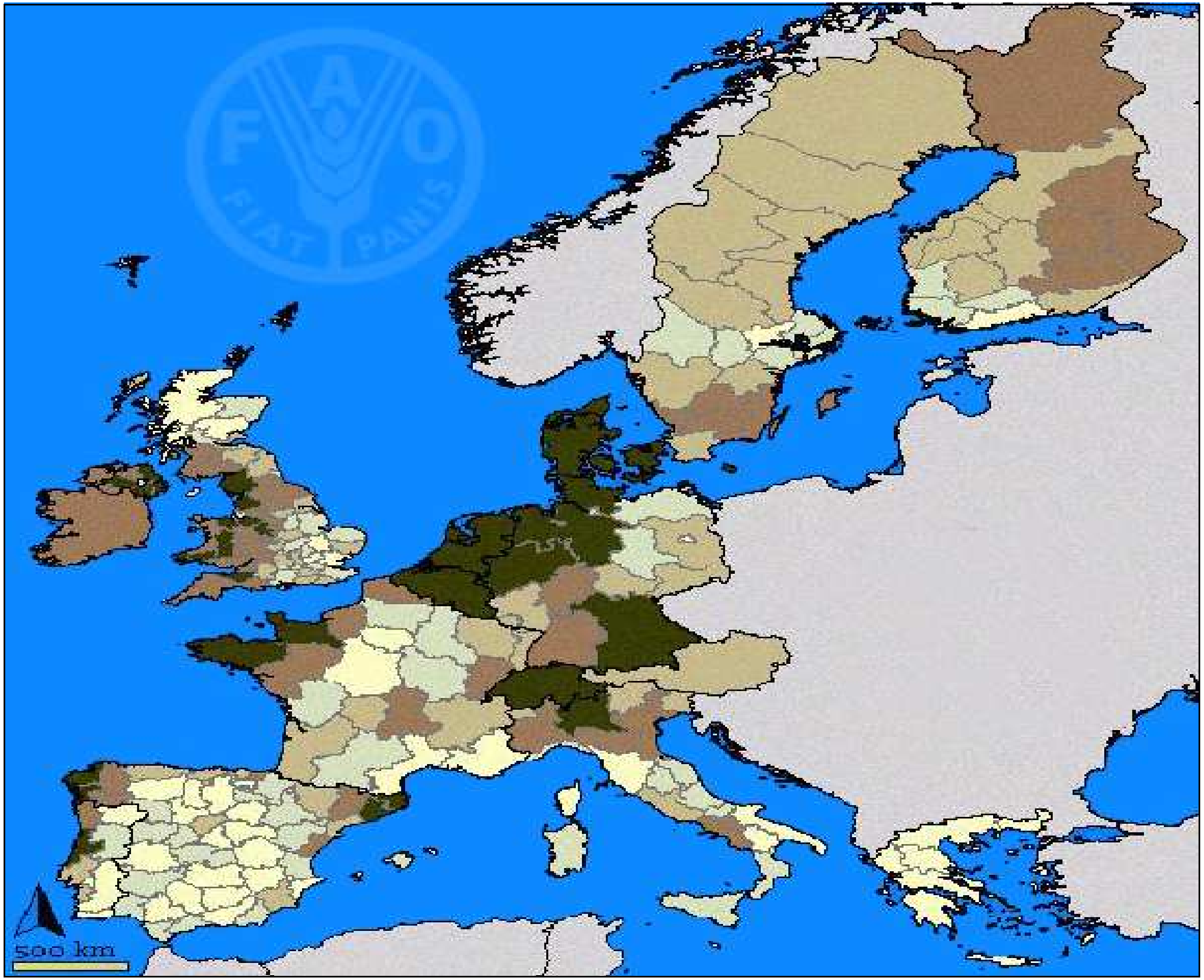
TOTAL LIVESTOCK BIO-MASS ON AGRICULTURAL LAND



Legend

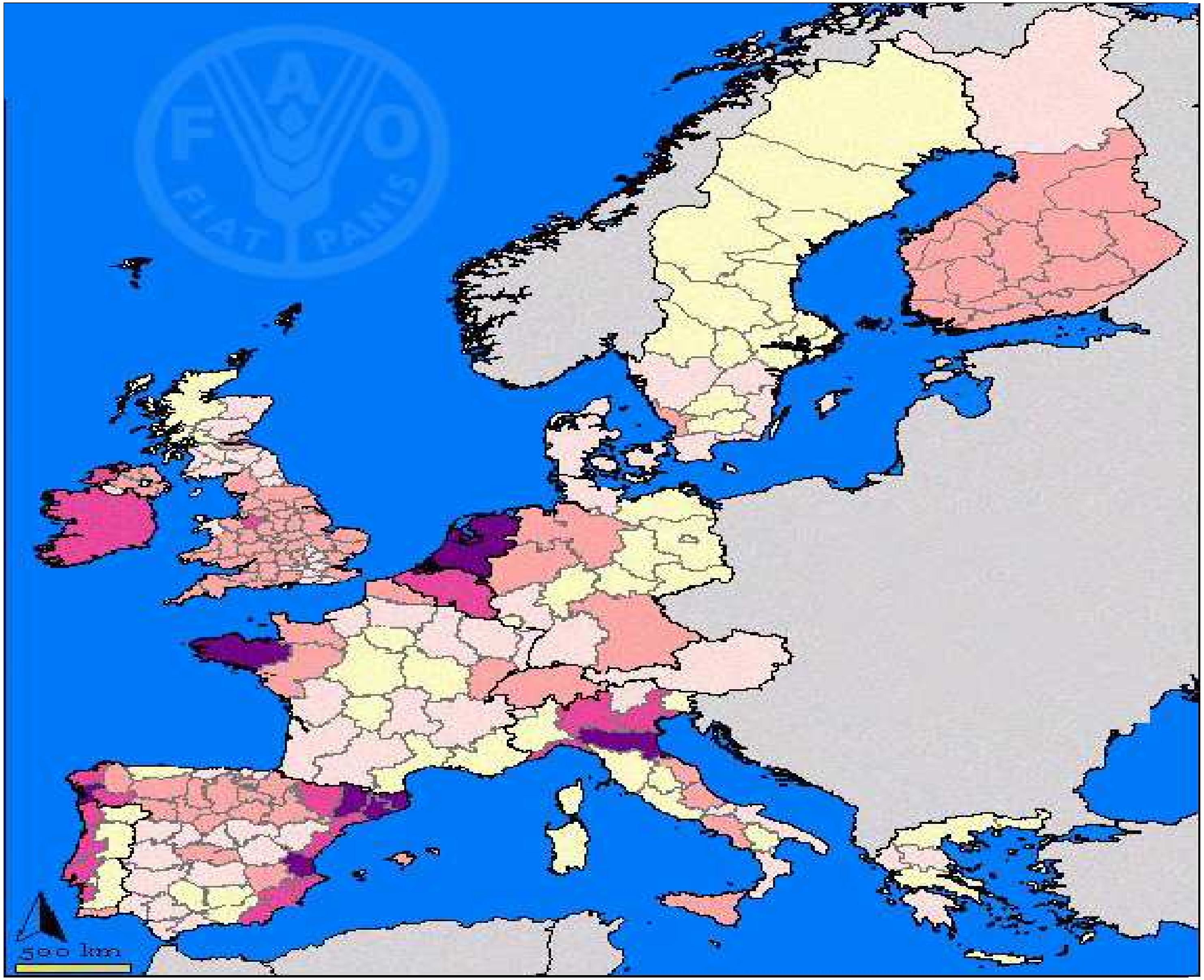
Kg/ ha

- 0 - 100
- 100 - 200
- 200 - 400
- 400 - 500
- > 500

Source : LEAD FAO
Year :2002
Map prepared by LEAD - FAO

Contact us:
lead@fao.org

PHOSPHATE BALANCE ON AGRICULTURAL LAND



Legend

Kg/ ha

- no overload
- 10 - 20
- 20 - 40
- 40 - 70
- > 70

Source : LEAD FAO
Year :2002
Map prepared by LEAD - FAO

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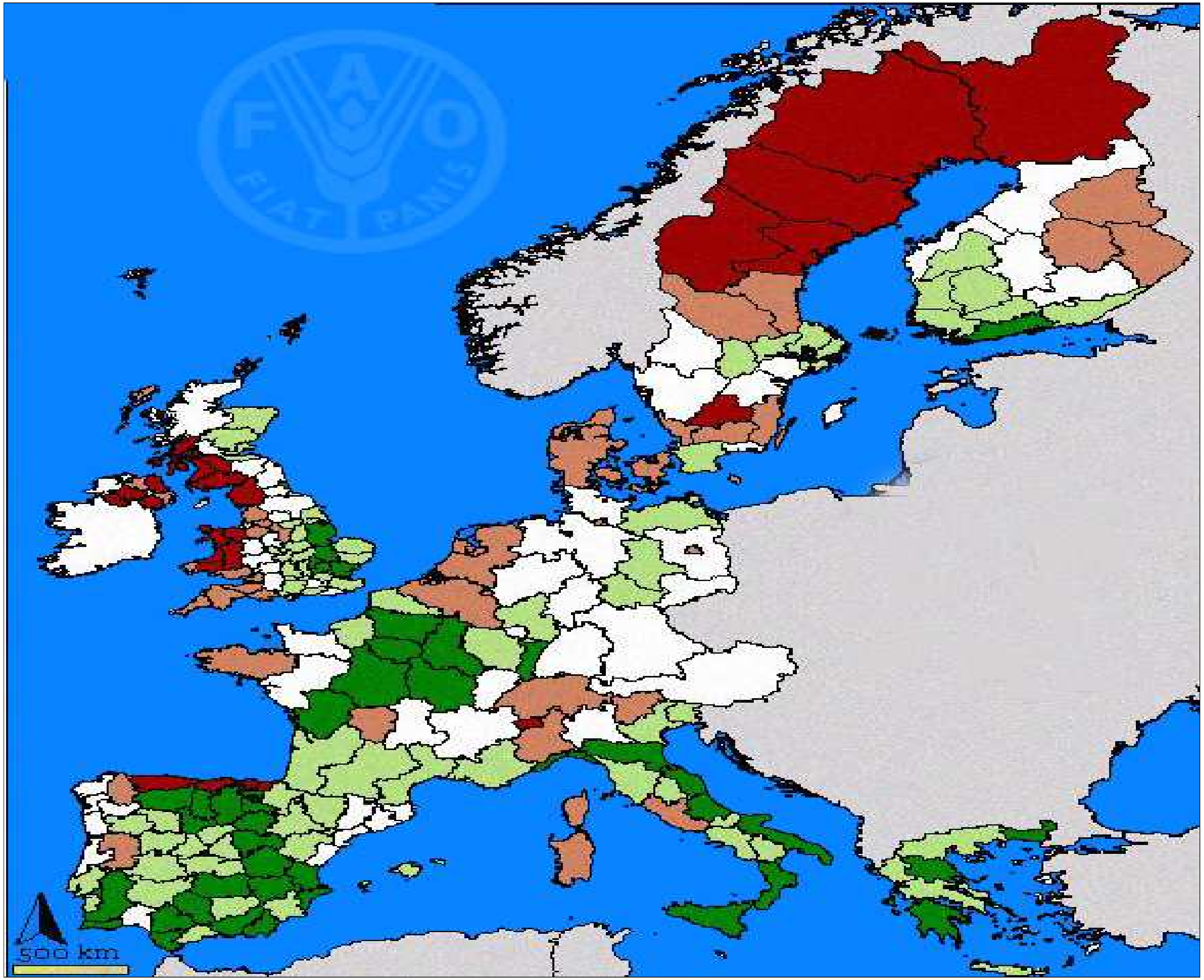
CONTRIBUTION OF MANURE TO PHOSPHATE SUPPLY ON AGRICULTURAL LAND



Legend

Percentage

- 0 - 20
- 20 - 40
- 40 - 60
- 60 - 80
- 80 - 100

Source : LEAD FAO
Year :2002
Map prepared by LEAD - FAO

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AGRICULTURE

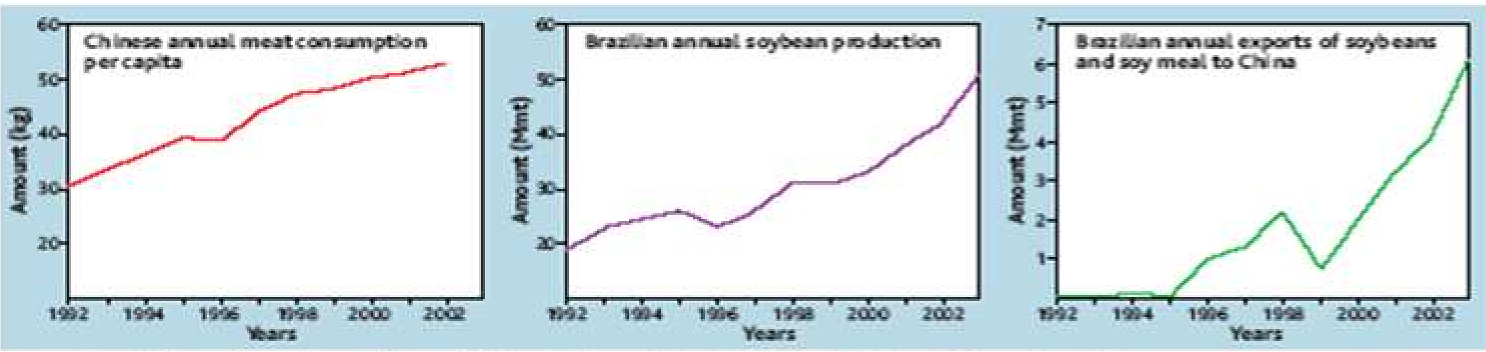
Losing the Links Between Livestock and Land

Rosamond Naylor,[1,2*] Henning Steinfeld,[4] Walter Falcon,[2] James Galloway,[5] Vaclav Smil,[6] Eric Bradford,[7] Jackie Alder,[8] Harold Mooney[3]

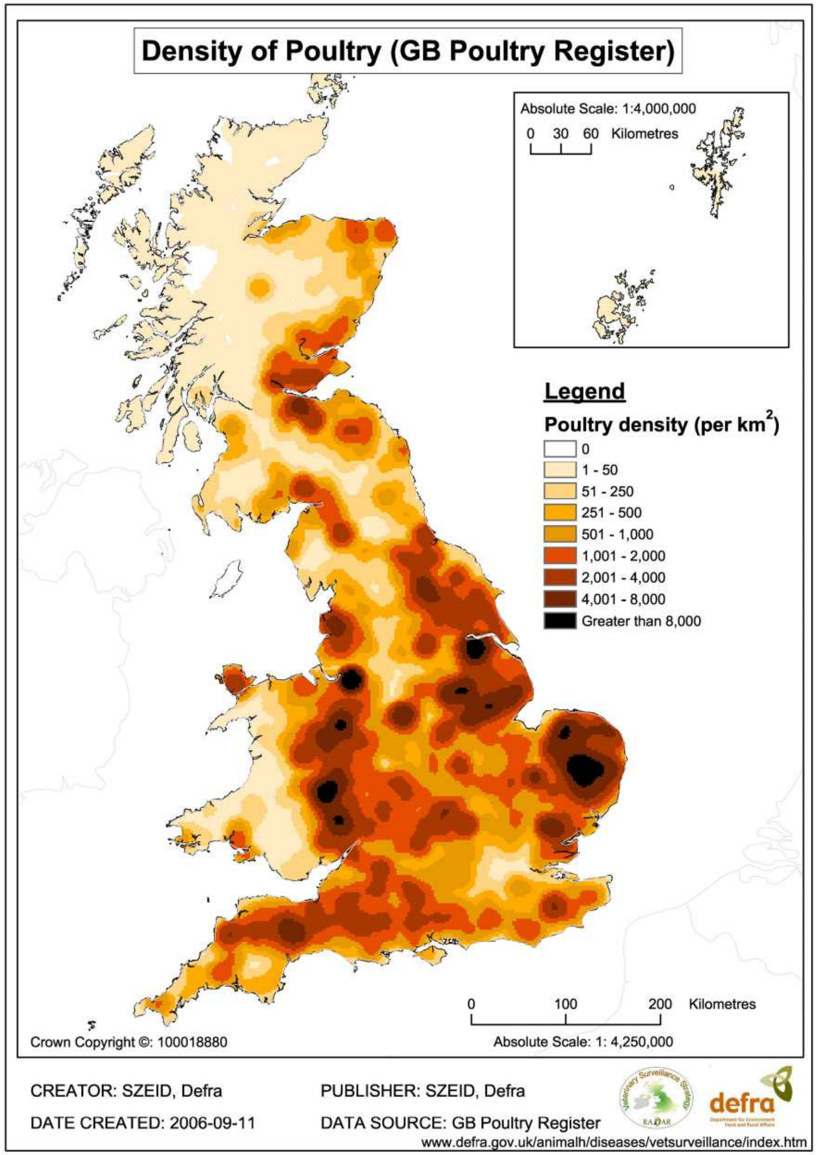
The industrial livestock sector has become footloose—no longer tied to a local land base for feed inputs or to supply animal power or manure for crop production. Spatially clustered within and among countries, this sector is expected to meet most of the income-driven doubling in meat demand forecast for developing countries by 2030 (*1*). Large-scale, intensive operations, in which animals are raised in confinement, already account for three- systems—often separated in space from each other and from the consumer base—remain largely unaccounted for in the growth process.

Industrializing and globalizing livestock systems have hinged on declining real prices for feed grains; advances that have improved feed-to-meat conversion efficiencies, animal health, and reproduction rates; relatively cheap transportation costs; and trade liberalization. The most dramatic shift United States for several decades. Industrial poultry and pork operations are largely uniform worldwide, which facilitates a rapid transfer of breeding and feeding innovations. Larger firms typically control production from animal reproduction to the final product, mainly to minimize economic and pathogen risks. As these firms increasingly supply major retail chains, corporate attention is directed toward food safety and the production of homogeneous (yet diverse), high-quality products. In addition to scale, industrial livestock operations have become concentrated geographically in areas where input costs are relatively low; infrastructure and access to markets are well developed; and in many cases, environmental regulations are lenient (*6*).

The most striking feature of this geographic concentration is the delinking of livestock from the supporting natural



International linkages in supply and demand of livestock products, 1992–2003 (*3*). Mmt, millions of metric tons.



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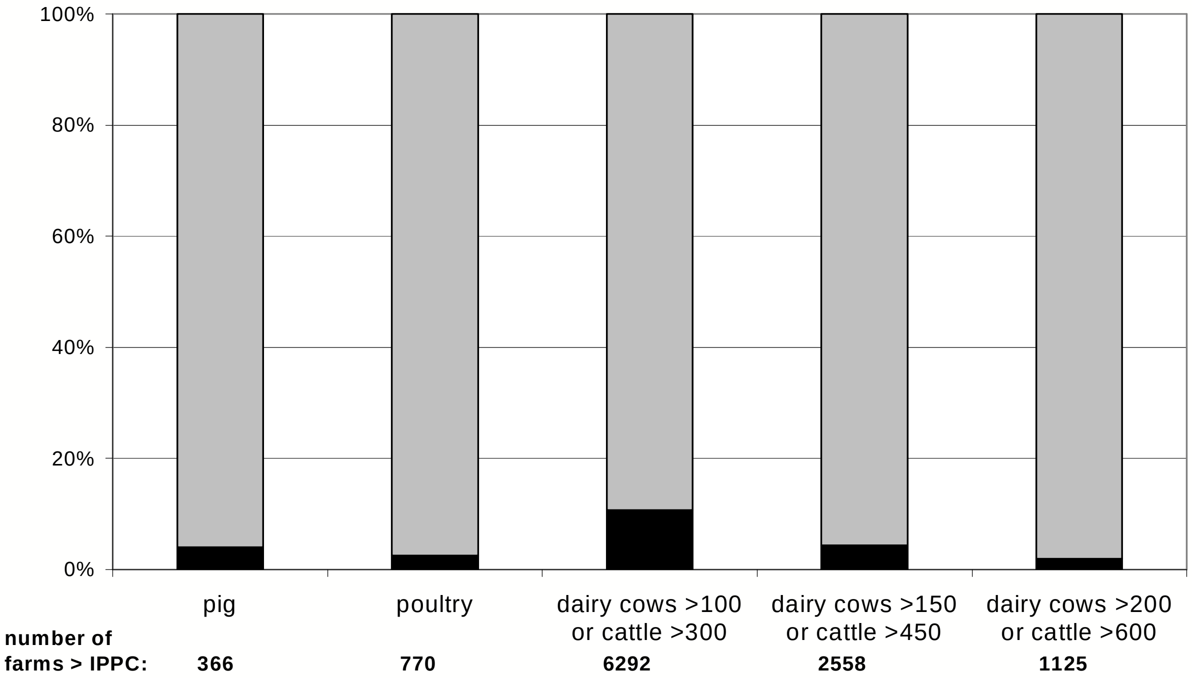
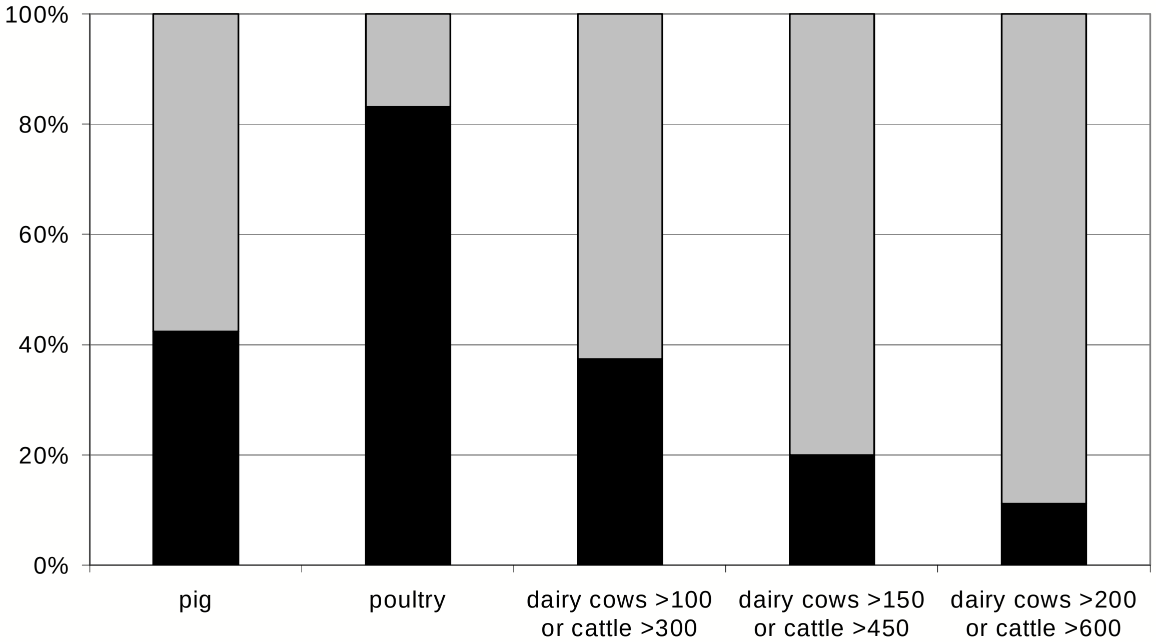
Production sources – 1 tonne poultry meat

Poultry Meat (default national proportions)							
			Primary energy used, MJ	GWP100, kg CO2	Eutrophication potential, kg PO4 eqv.	Acidification potential, kg SO2 eqv.	Abiotic resource use, kg Sb eqv.
Feed			12067	2467	14	15	9
Bedding			809	-123	0	1	1
Buildings			192	25	0	0	6
Direct energy			3633	234	0	1	2
Internal transport			30	2	0	0	0
Gaseous emissions			0	466	1	7	0
Manure			-1188	95	18	70	-1
Total			15542	3166	33	94	18

Analysis of IPPC size distribution

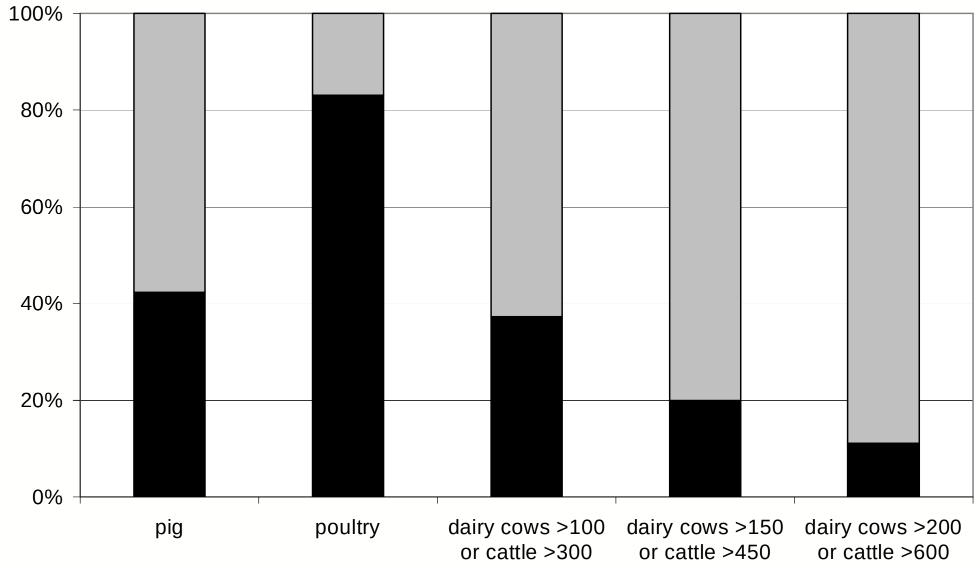


% of farms in England (2004) below
and above IPPC thresholds
and experimental cattle thresholds



% of animals in England (2004) below
and above IPPC thresholds
and experimental cattle thresholds

Contribution of NH_3 from (potential) IPPC farming to UK emissions



	UK NH_3 Emission (kt NH3) 2000	% animals in IPPC (England, 2004)	UK NH_3 regulated under in IPPC (kt)
Pig	29.8	42%	**12.5**
Poultry	45.5	83%	**37.8**
Cattle	139.6	a) 37% b) 20% c) 11%	**a) 51.7** **b) 27.9** **c) 15.4**

Conclusions

The environmental burdens from the UK poultry industry are relatively low.

Well located to reduce impacts from burdens

Well placed to reconnect plant and livestock production

Further research and development

Source: Scottish Agricultural College

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Emissions trading

... “We need to look closely at how **incentives** within the **food, energy and land markets** can reflect environmental impact more closely”.

David Miliband, Oxford Farming Conference Speech 2007

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- **Comparative life-cycle assessment of food procured through a diversity of food chains**

- **The size and configuration of a sustainable livestock sector**

- **Global warming impacts on livestock**

- **Reducing the N load – ‘GREEN grain’**

- **Biogas**

- **Reconnection – protein quality.**

Kroge-Ehrendorf, Lower Saxony

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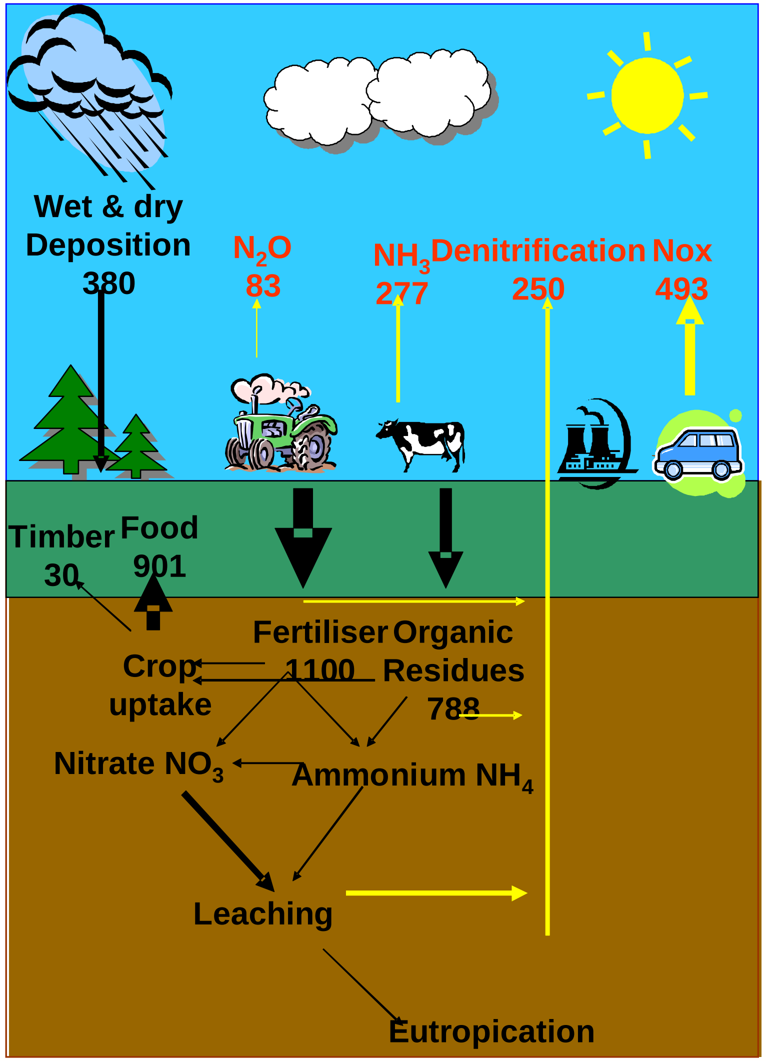
Reconnecting plant and animal production to close nutrient cycles



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Mr Bernard Barlage: closing nutrient cycles growing maize for pig production

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And using advanced production technology to reduce nitrogen emissions to air

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Acknowledgements

Mark Sutton, Stefan Reis and Mark Theobald of the Centre for Ecology and Hydrology

Rosemond Naylor, Stanford

Katherine Bass and Soheila Amin-Hanjani, Defra

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Thank you for your attention

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