Animal production and environmental impacts

I International Symposium on Animal Waste Management

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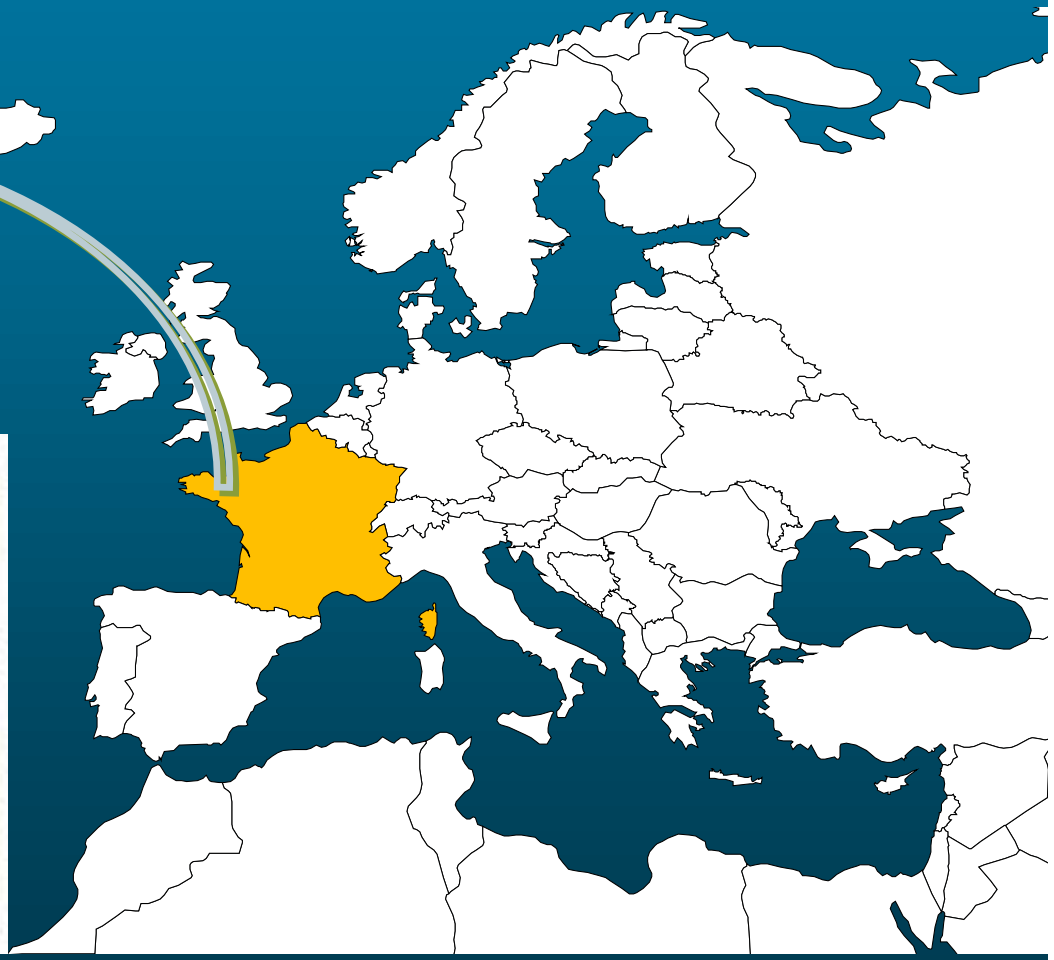
French Institute of Agricultural and Environmental Engineering Research

Environmental management and biological treatment of wastes research unit

Rennes, Brittany (France)



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Structure of presentation

- Animal production : statistics, trends, prospective
- Manure processes and mechanisms, N balance
- Environmental impacts
  - III.1. Global picture
  - III.2. Air pollution
  - III.3. Water pollution
  - III.4. Soil pollution
  - III.5. Sanitary risks
- EU Regulations

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General introduction

« Mixed farms »

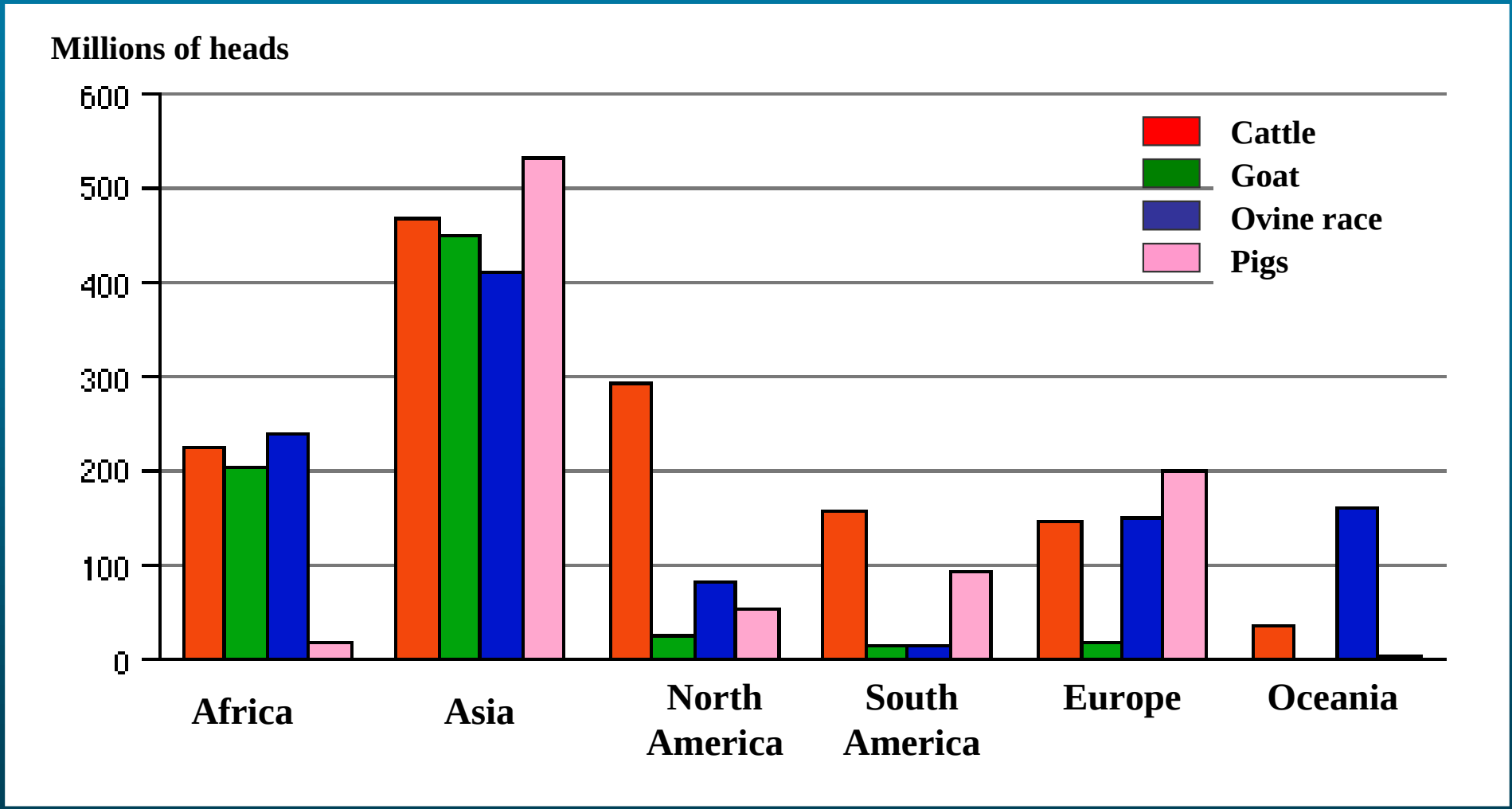
Early days

General introduction

Nowadays

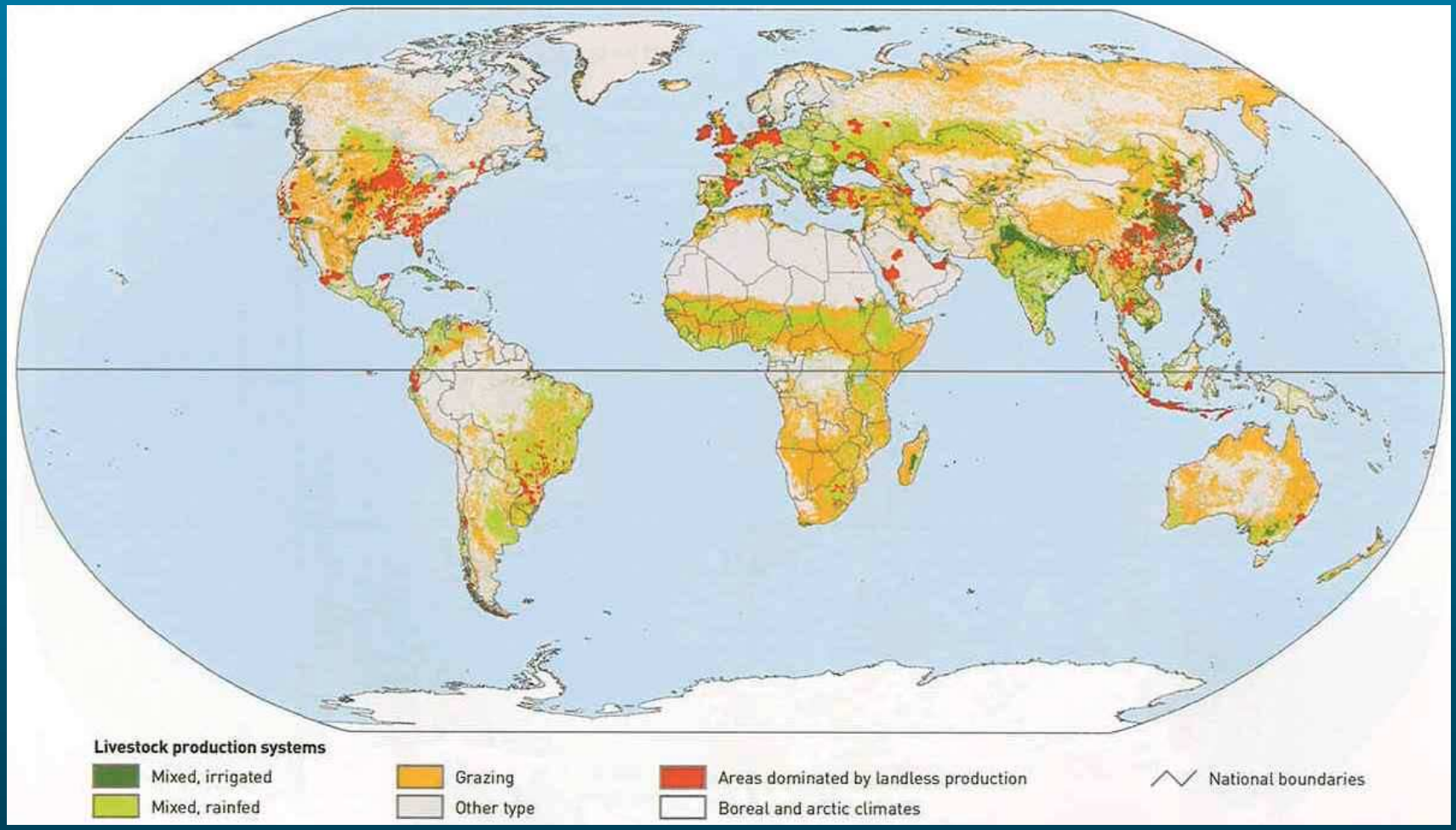
« Specialised farms »

World distribution of main domestic animal species



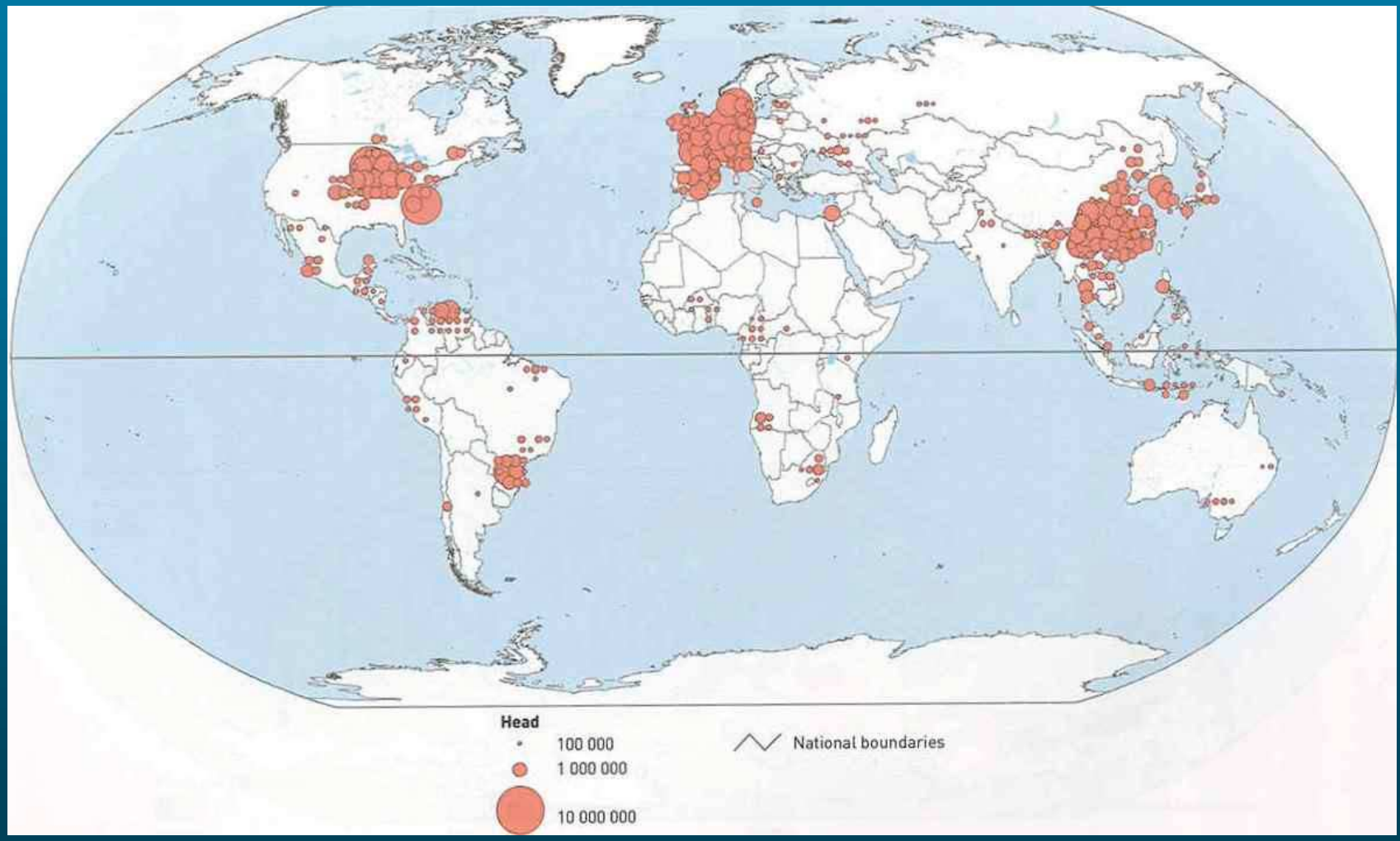
(Source : FAO, 2000. From Faye & Alary, 2001)

Estimated distribution of livestock production systems



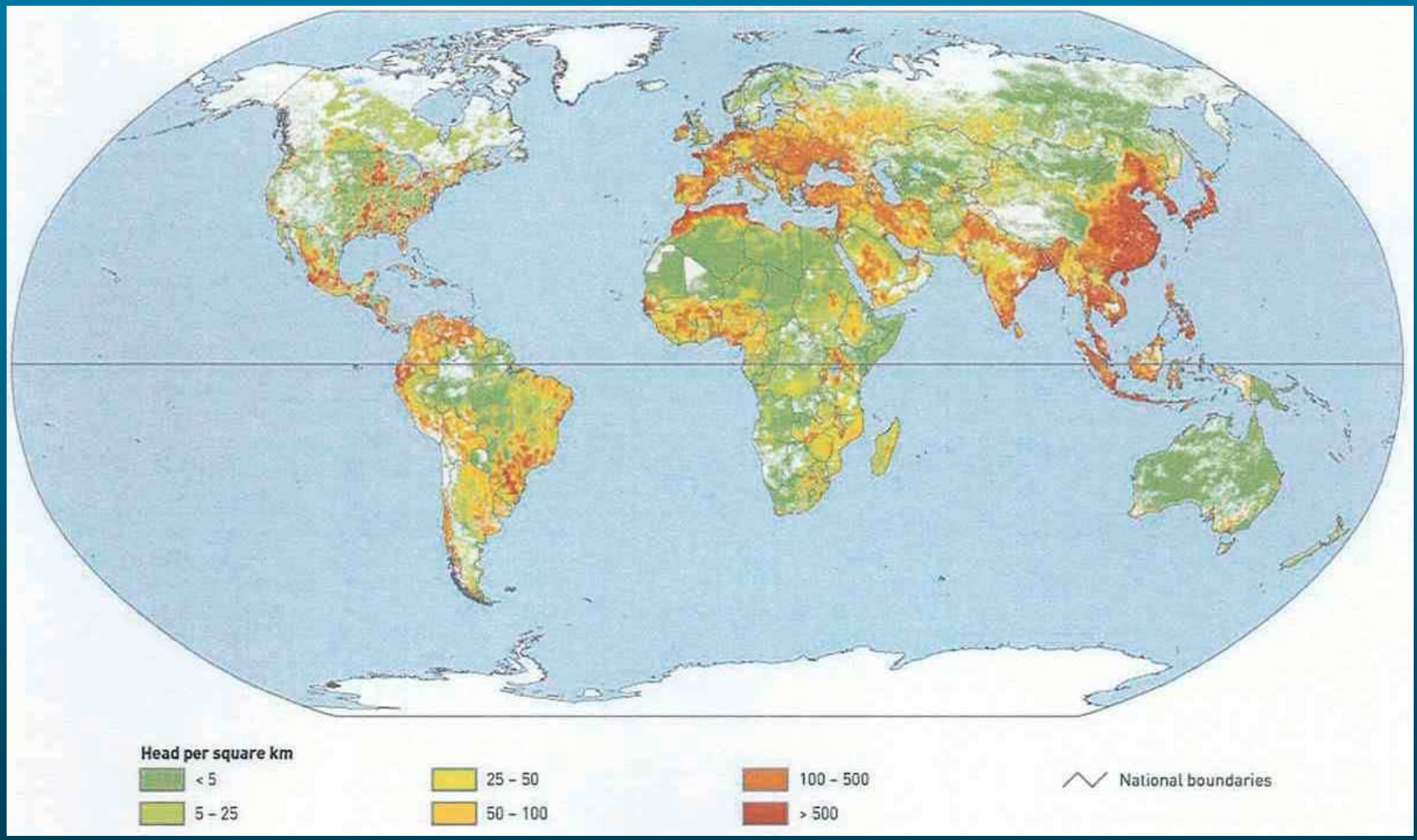
Source : LEAD.

Estimated distribution of industrially produced pig populations



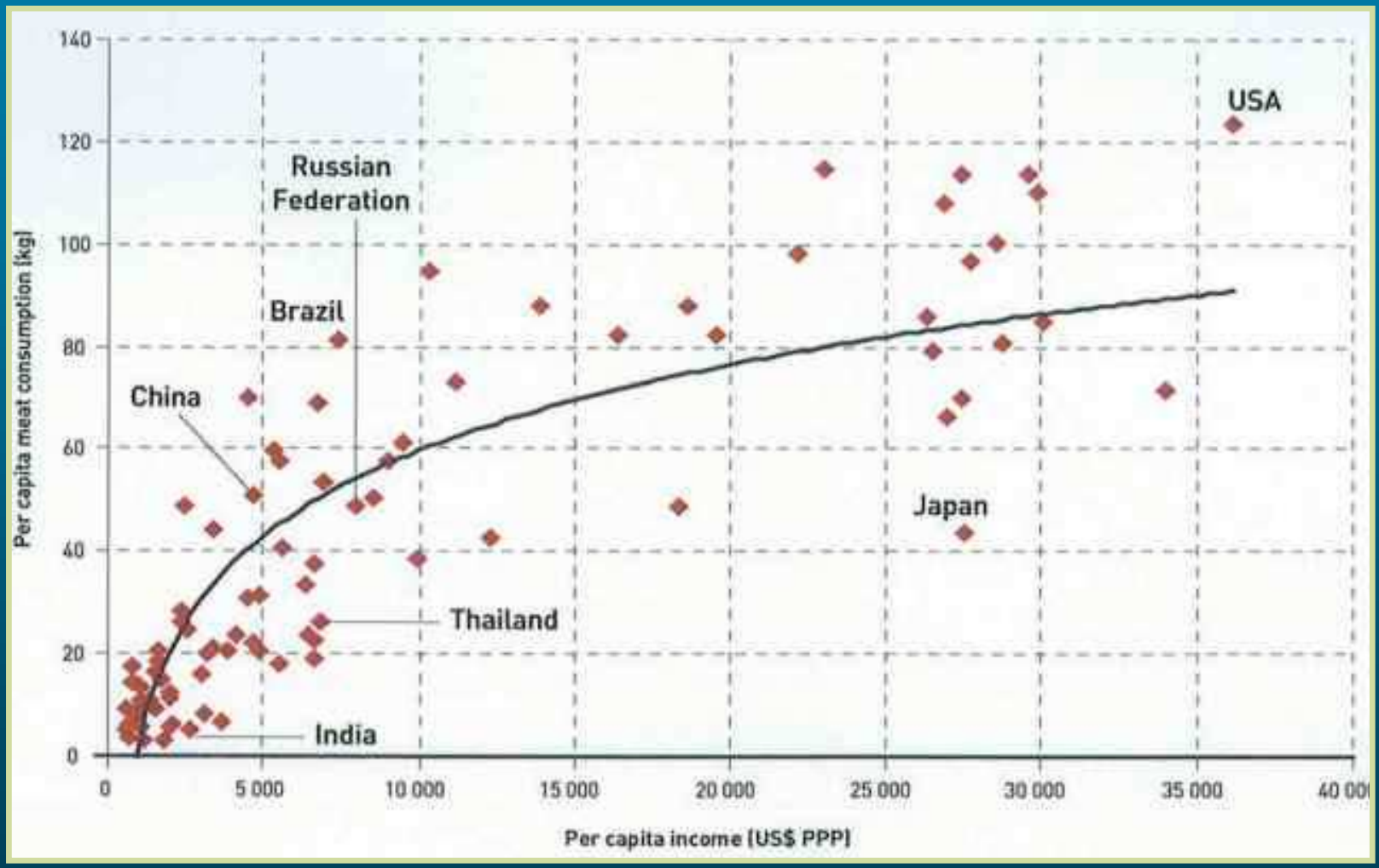
Source : LEAD.

Estimated distribution of poultry



Source : LEAD.

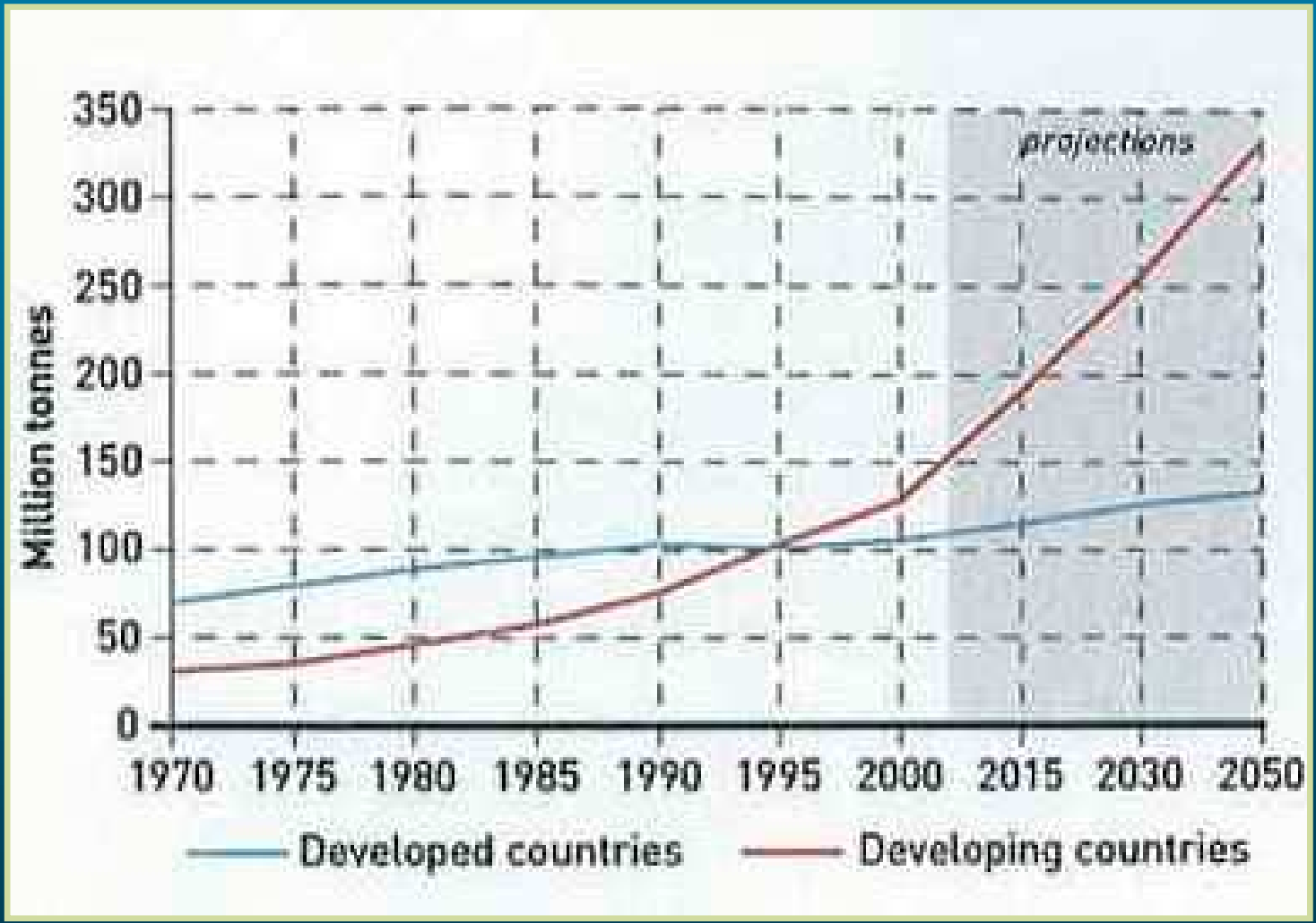
The relationship between meat consumption and per capita income in 2002



Note : National per capita based on purchasing power parity (PPP)

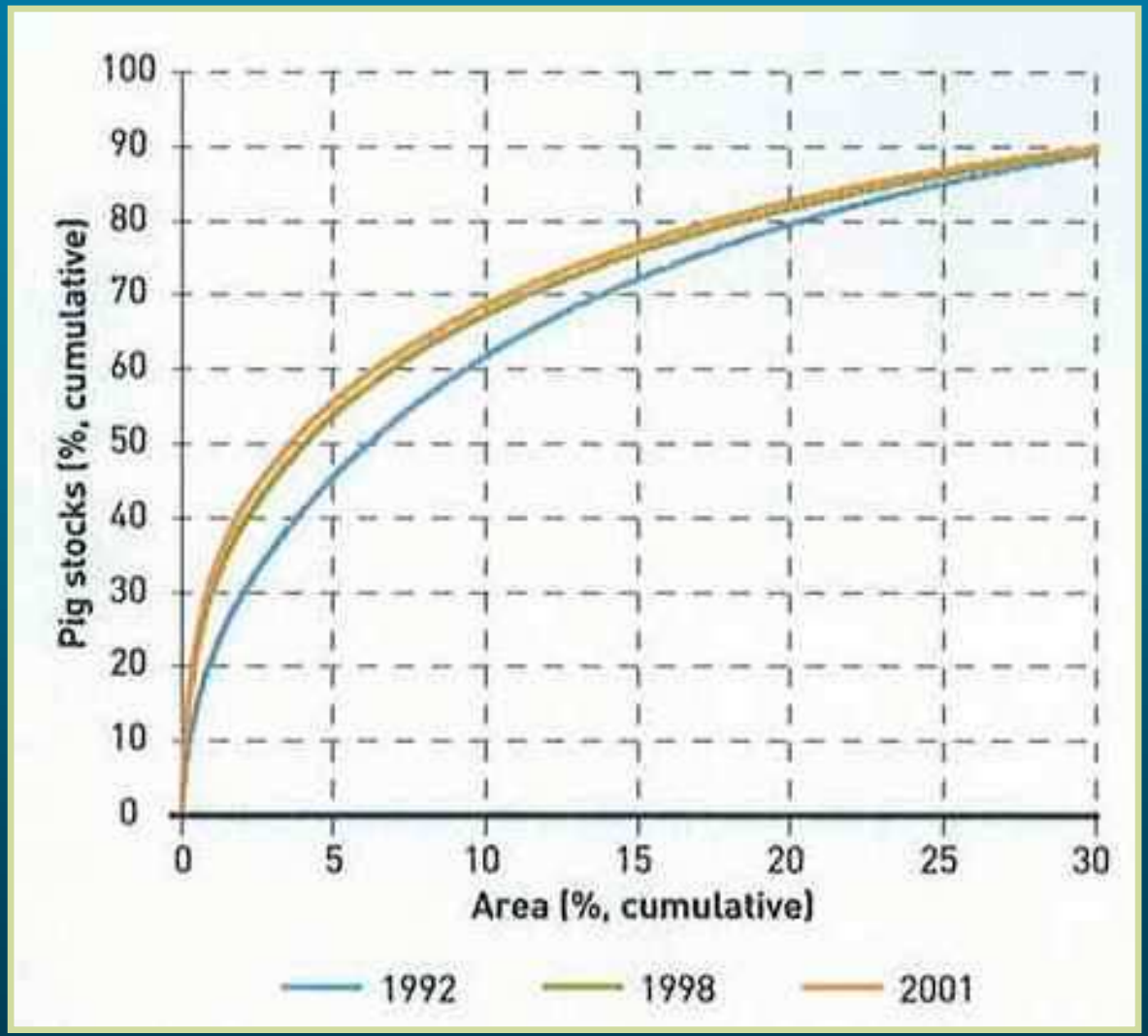
Source : Worlk Bank (2006) and FAO (2006b)

Past and projected meat production in developed and developing countries from 1970 to 2050



Source : FAO (2006a) and FAO (2006b)

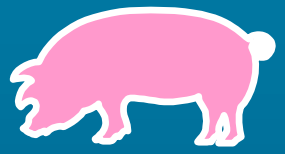
Changes in geographical concentration of pigs in Brazil from 1992 to 2001



Source : Own calculations

Intensive animal production lacated in a small area

Brittany = 6-7% of cultivated land



60% of French pig

+

30 – 40% of French poultry

+

20% of French cattle

Excess

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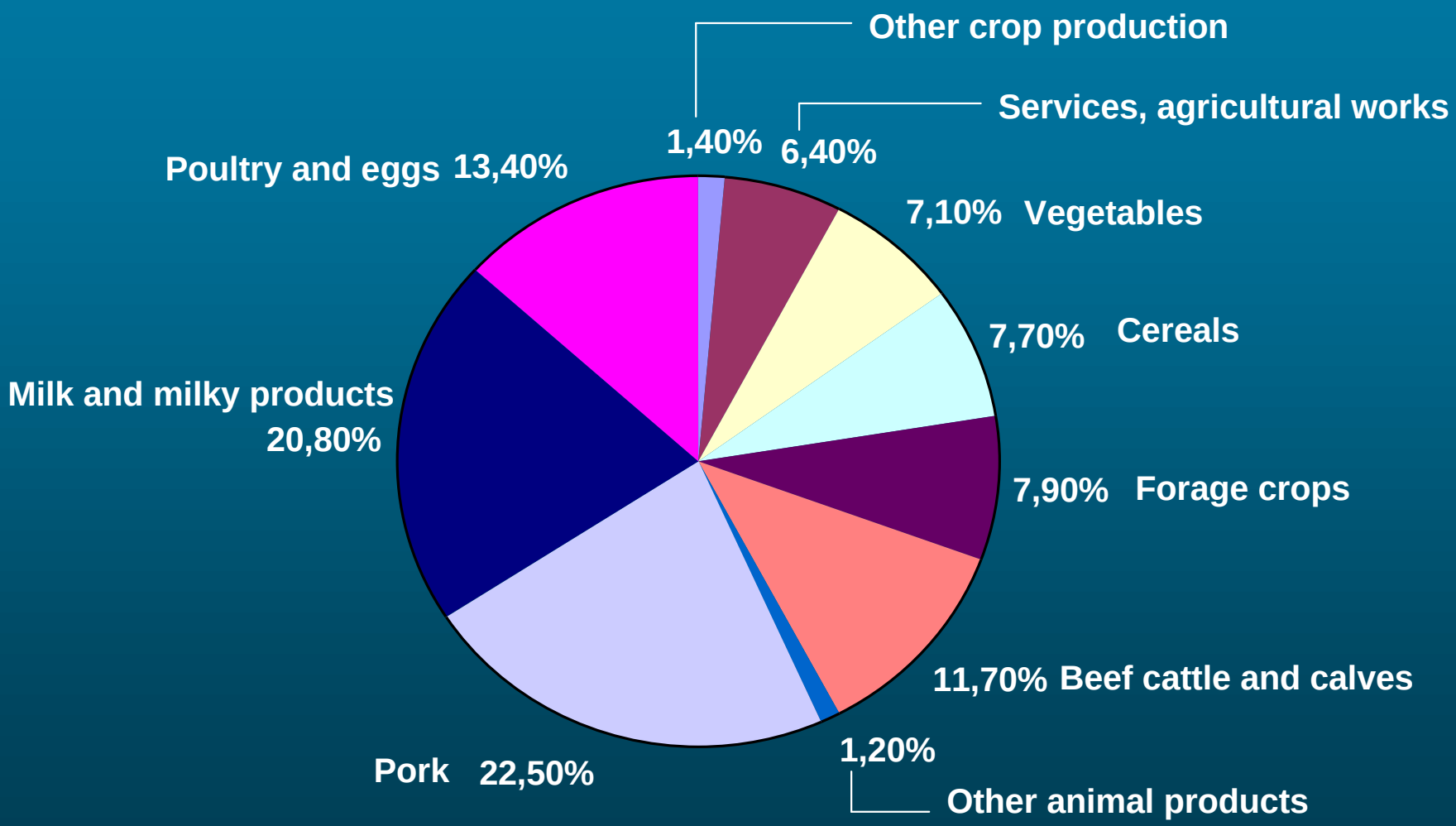
Value of agricultural production in Brittany in 2005

7 billions €, among 70% originating from animal production



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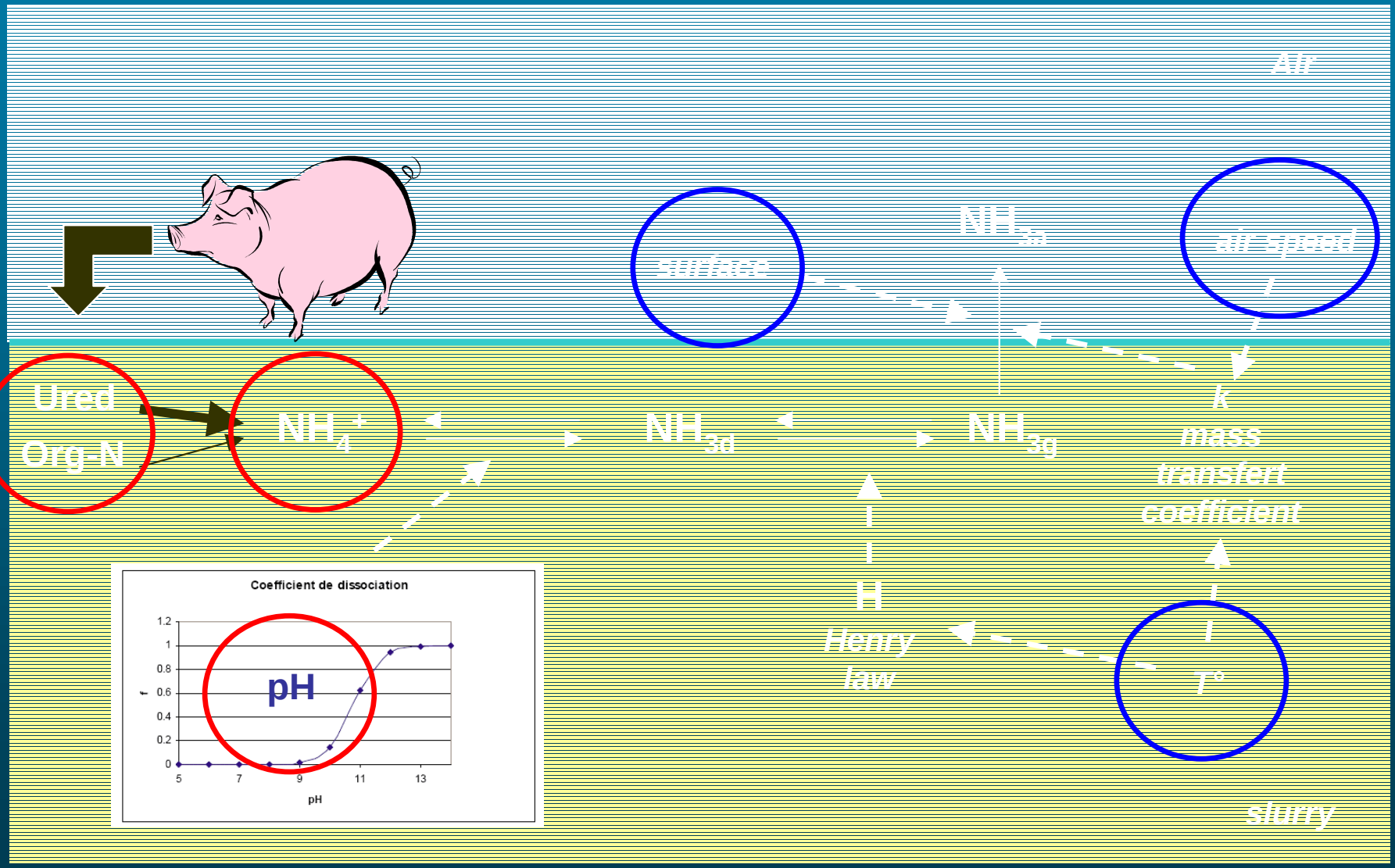
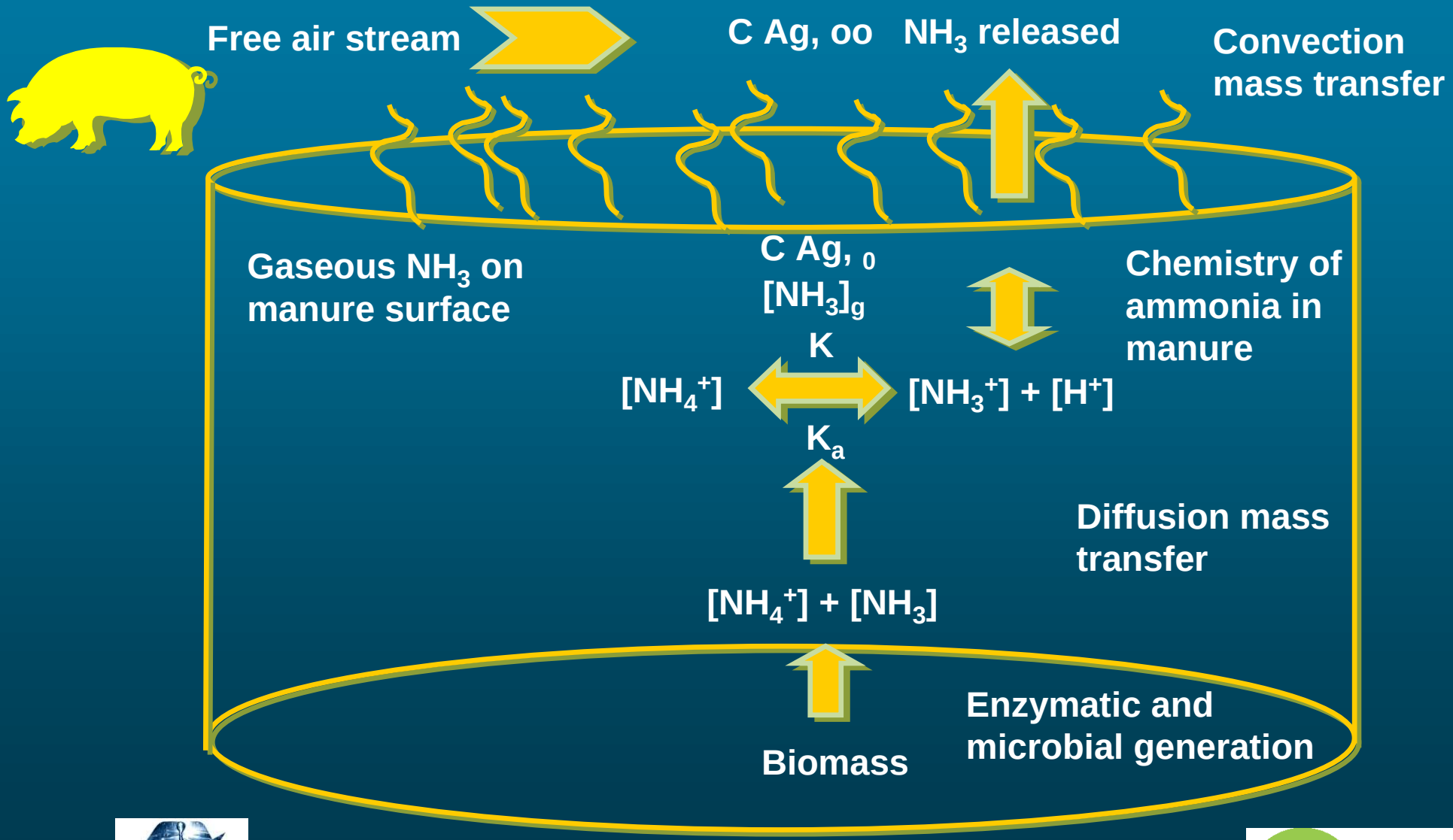
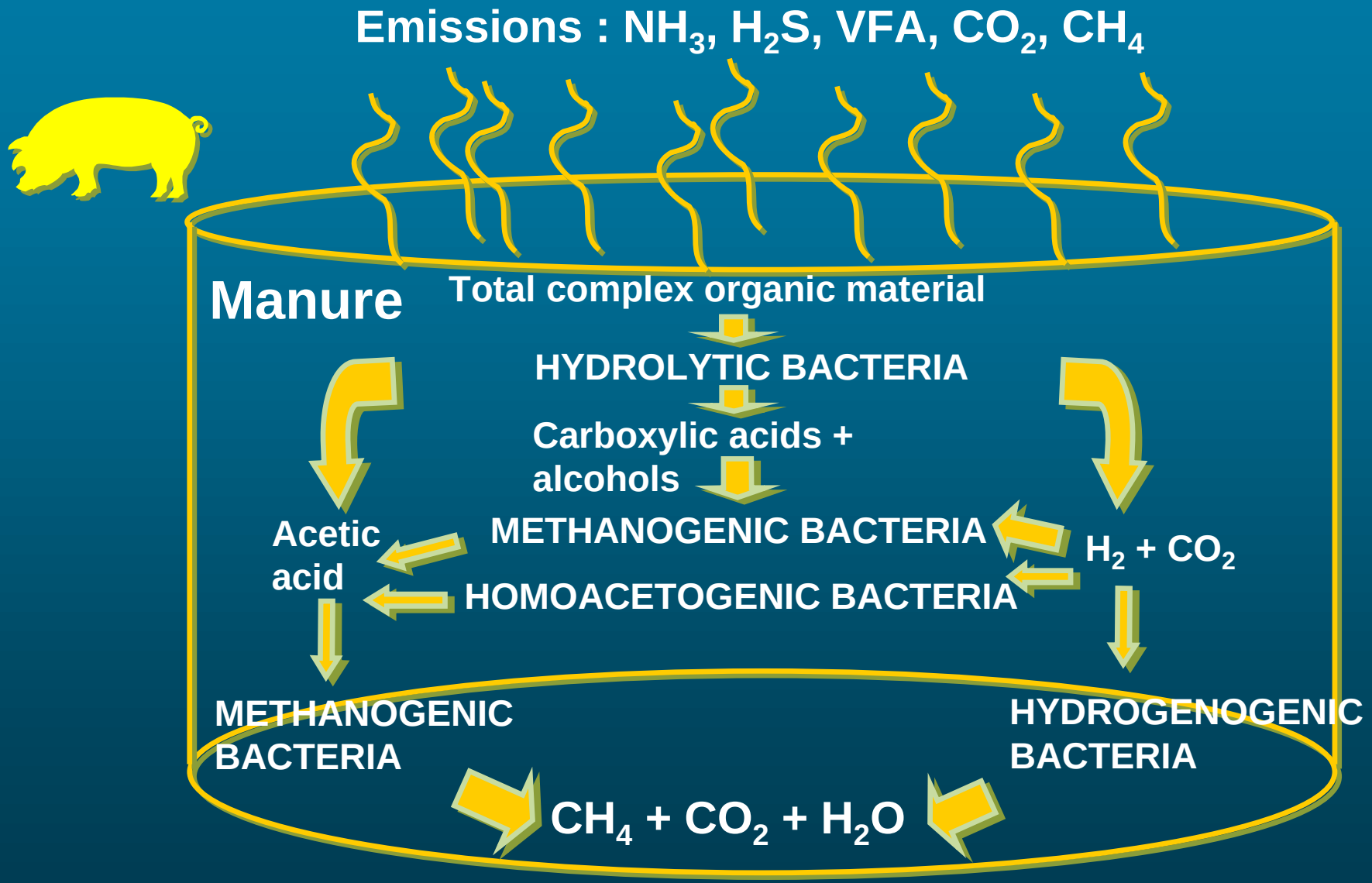
Schematic description of the ammonia volatilisation processes within the slurry



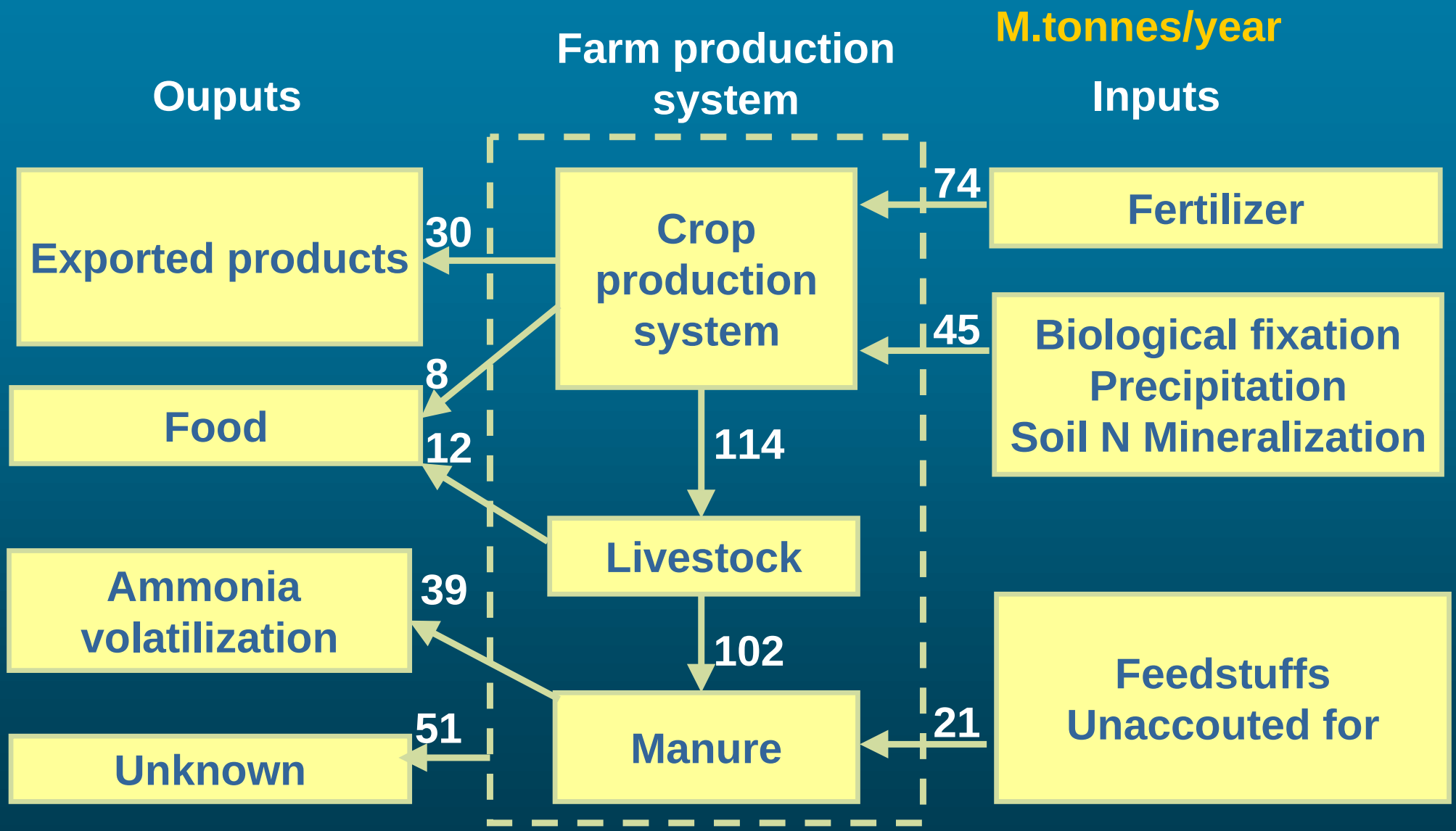
Mechanism related to ammonia release from manure



Theory and principles



Annual nitrogen budget for global agriculture



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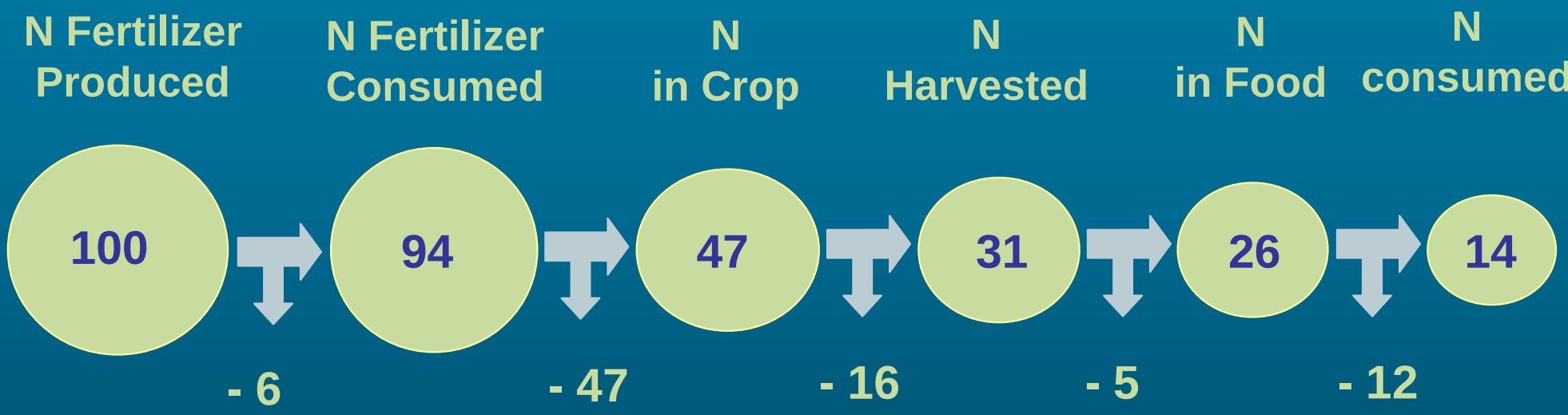
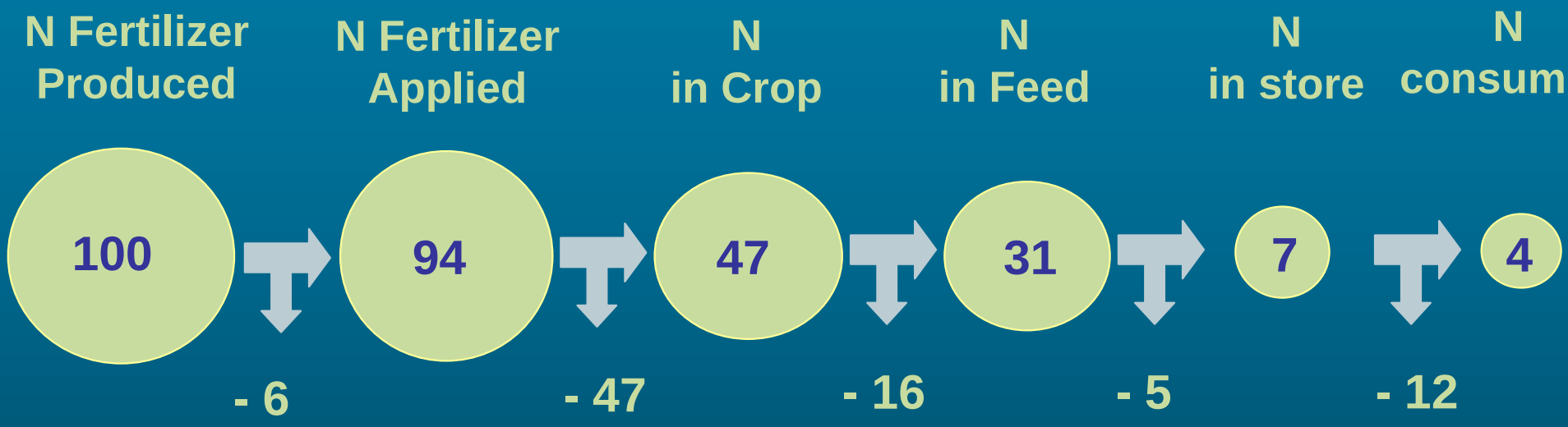
The fate of Haber-Bosch Nitrogen



14% of the N produced in the Haber-Bosch process enters the human mouth …. if you are a vegetarian. The remainder is lost to the environment

Galloway and Cowling, 2002

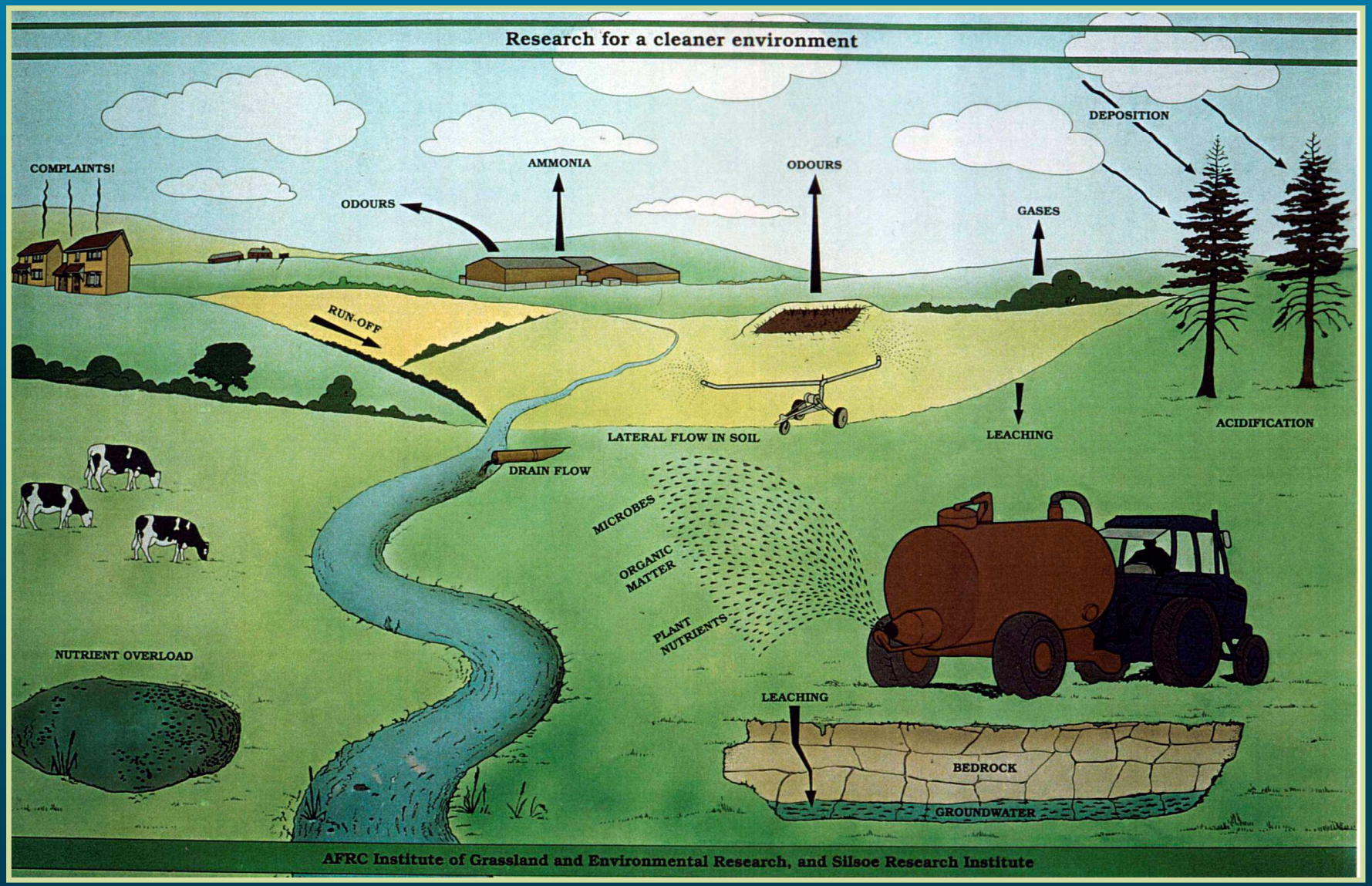
The fate of Haber-Bosch Nitrogen



About 4% of the N produced in the Haber-Bosch process and used for animal production enters the human mouth.
Again, the remainder is released to the environment

Galloway and Cowling, 2002

Environmental impact from livestock farming



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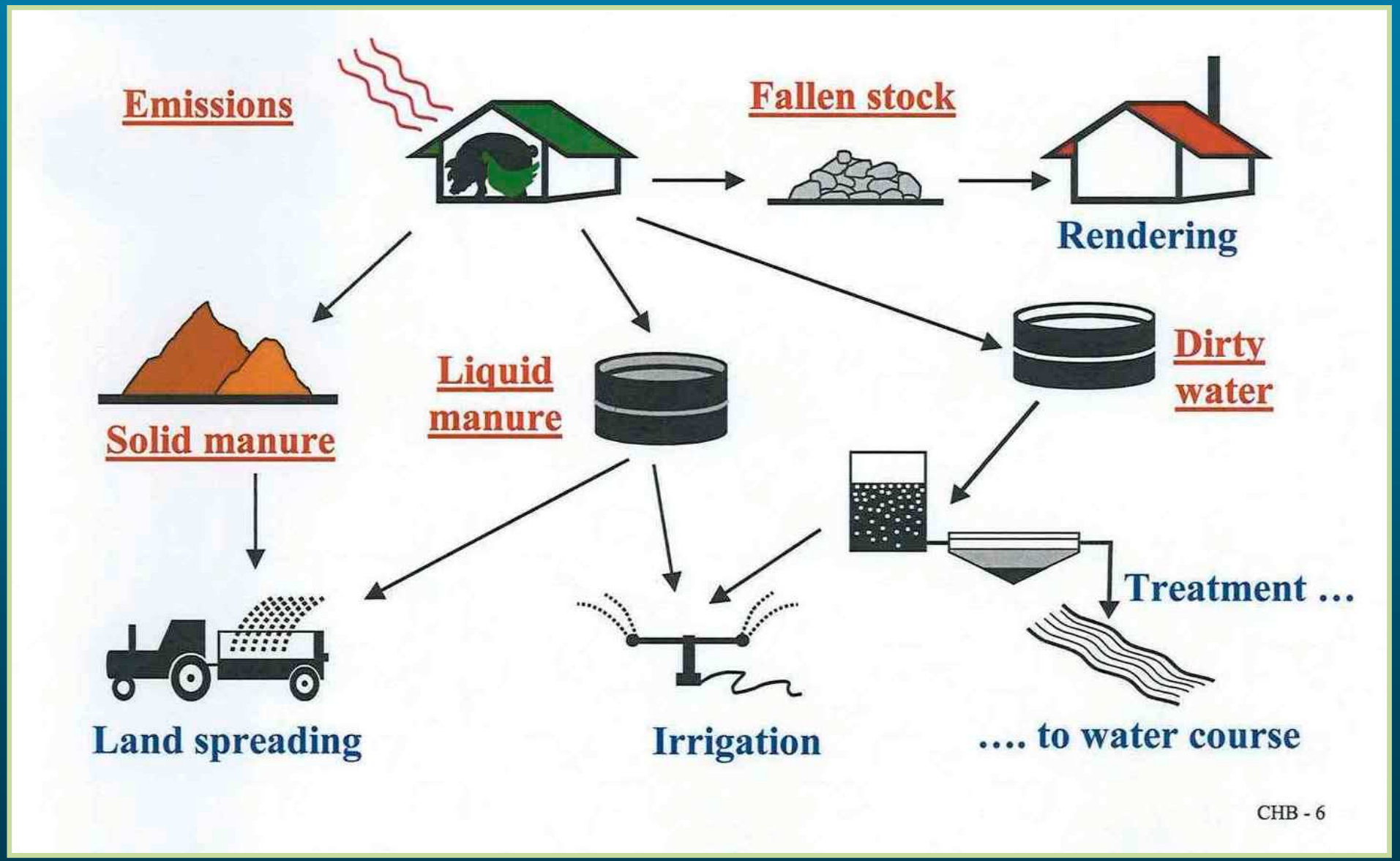
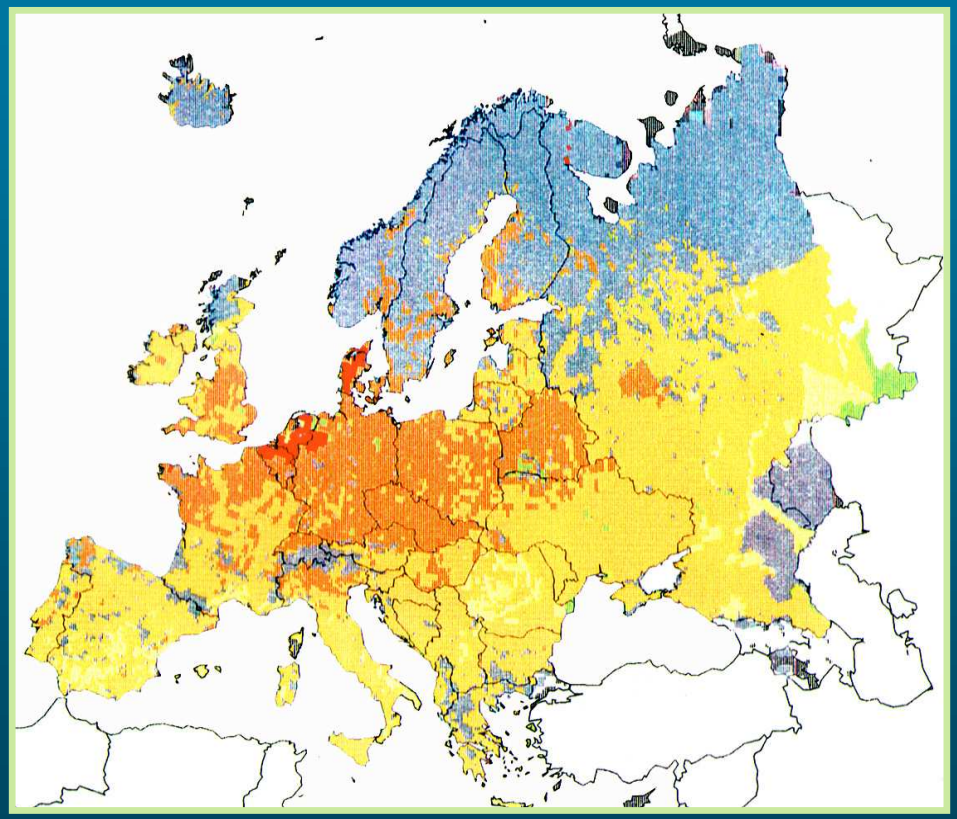
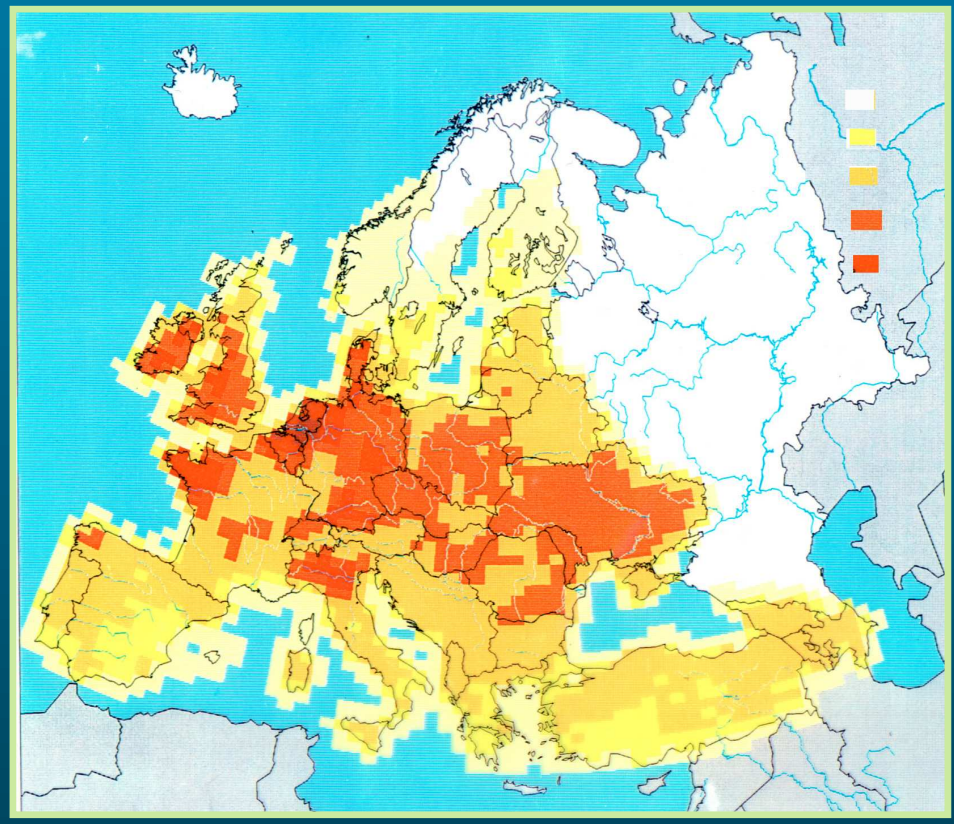
The main waste streams



Nitrate leaching and ammonia emissions from the European Union Livestock sector



Nitrate leaching in European Union

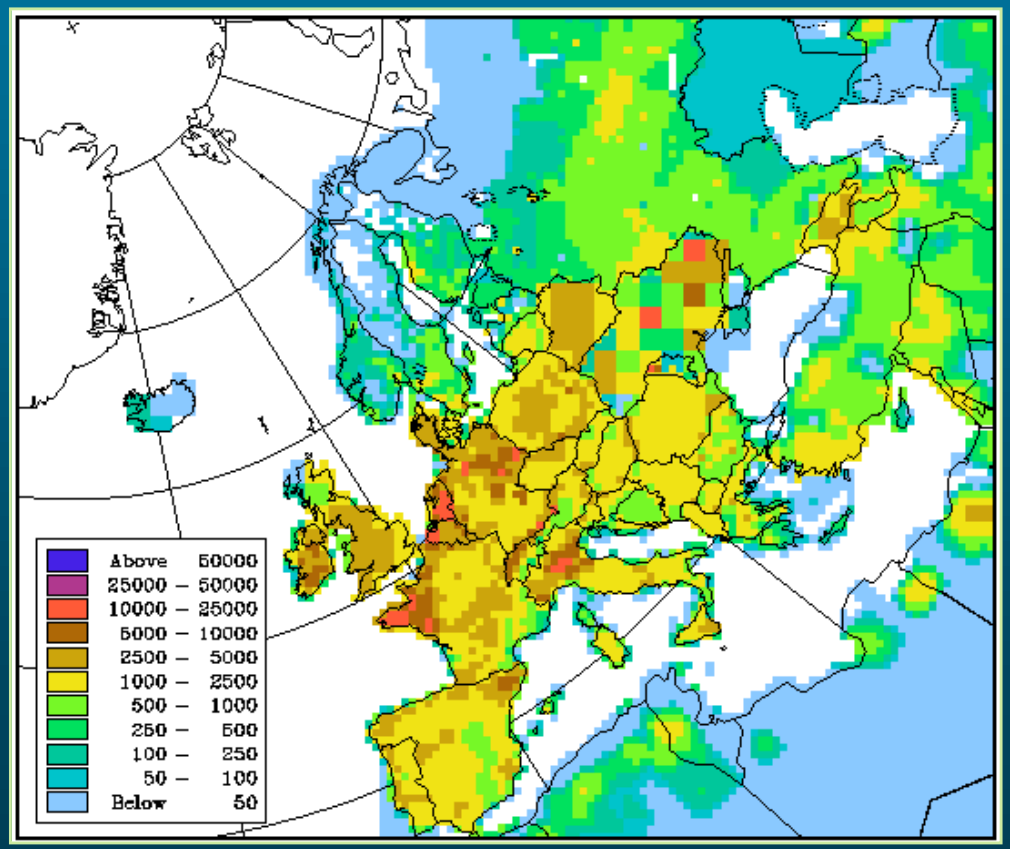


Ammonia emissions

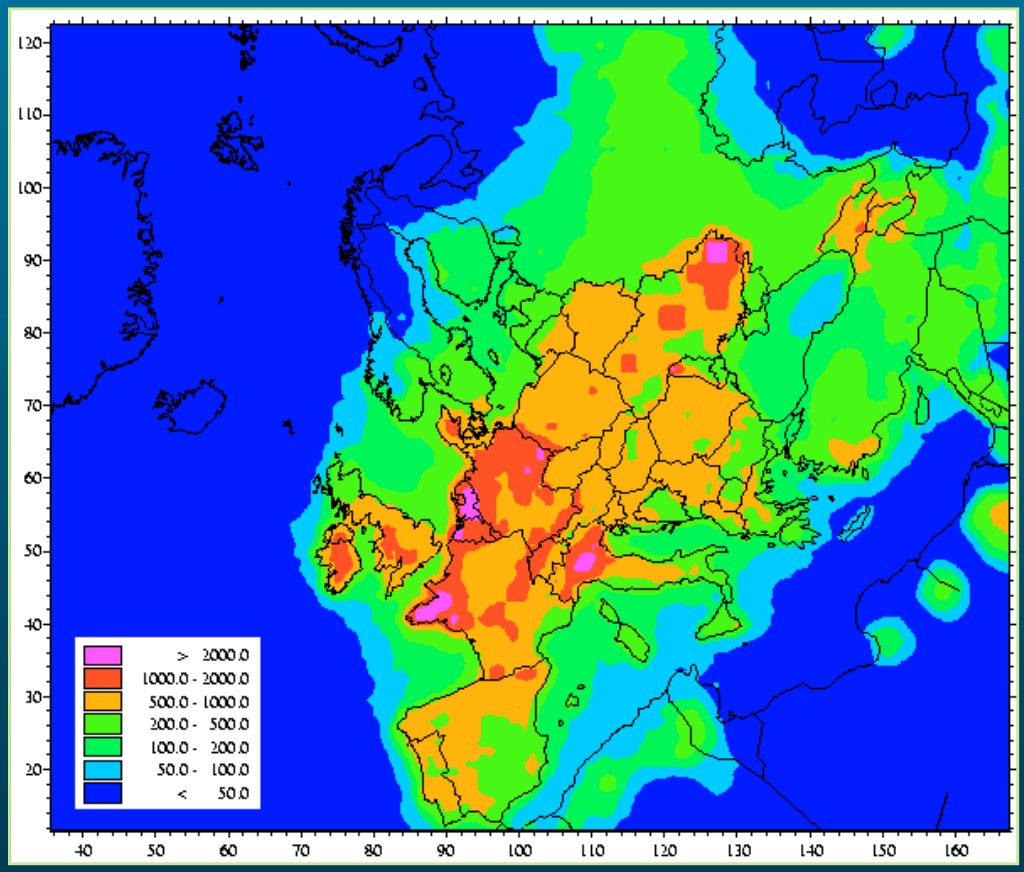
Acidification / Eutrophication Issue

Reduced Nitrogen (NH_3, NH_4^+) in 1999

Emissions (t NH_3/50x50 km)



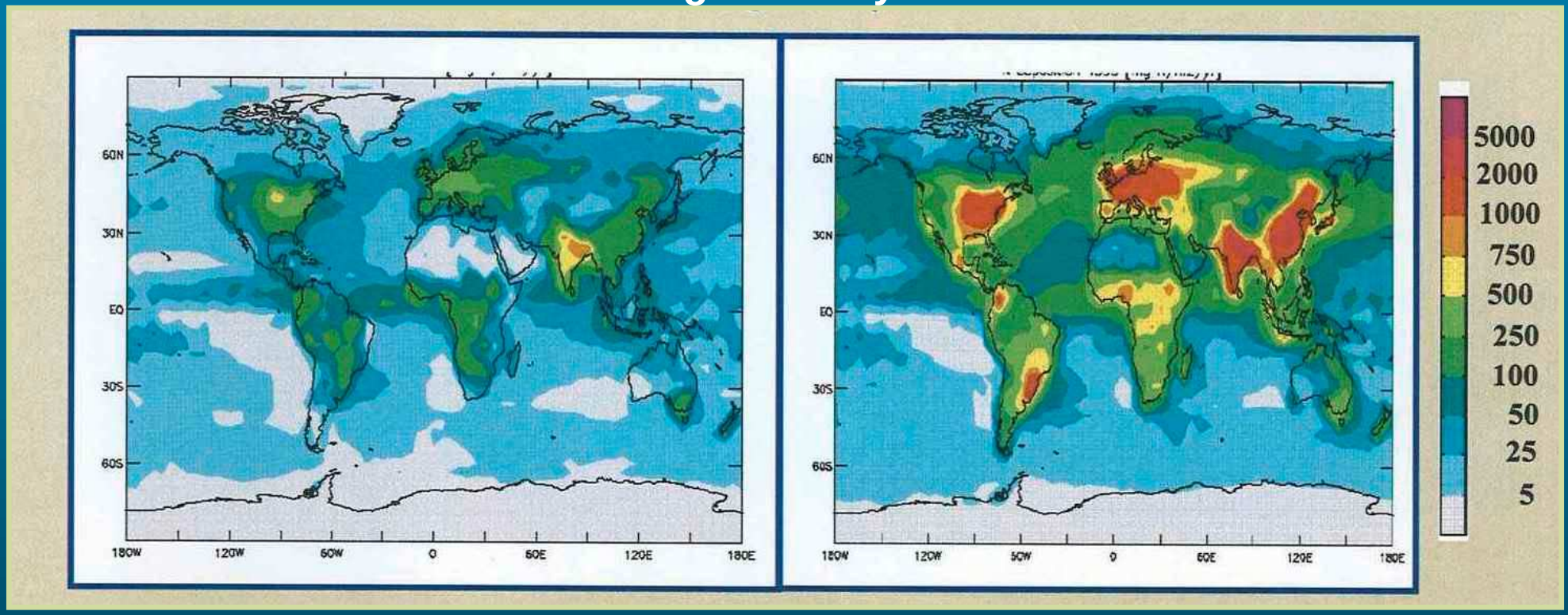
Deposition (mg/m^2/year)



Source : EMEP MSC-W

Nitrogen deposition

Mg N / m² / yr

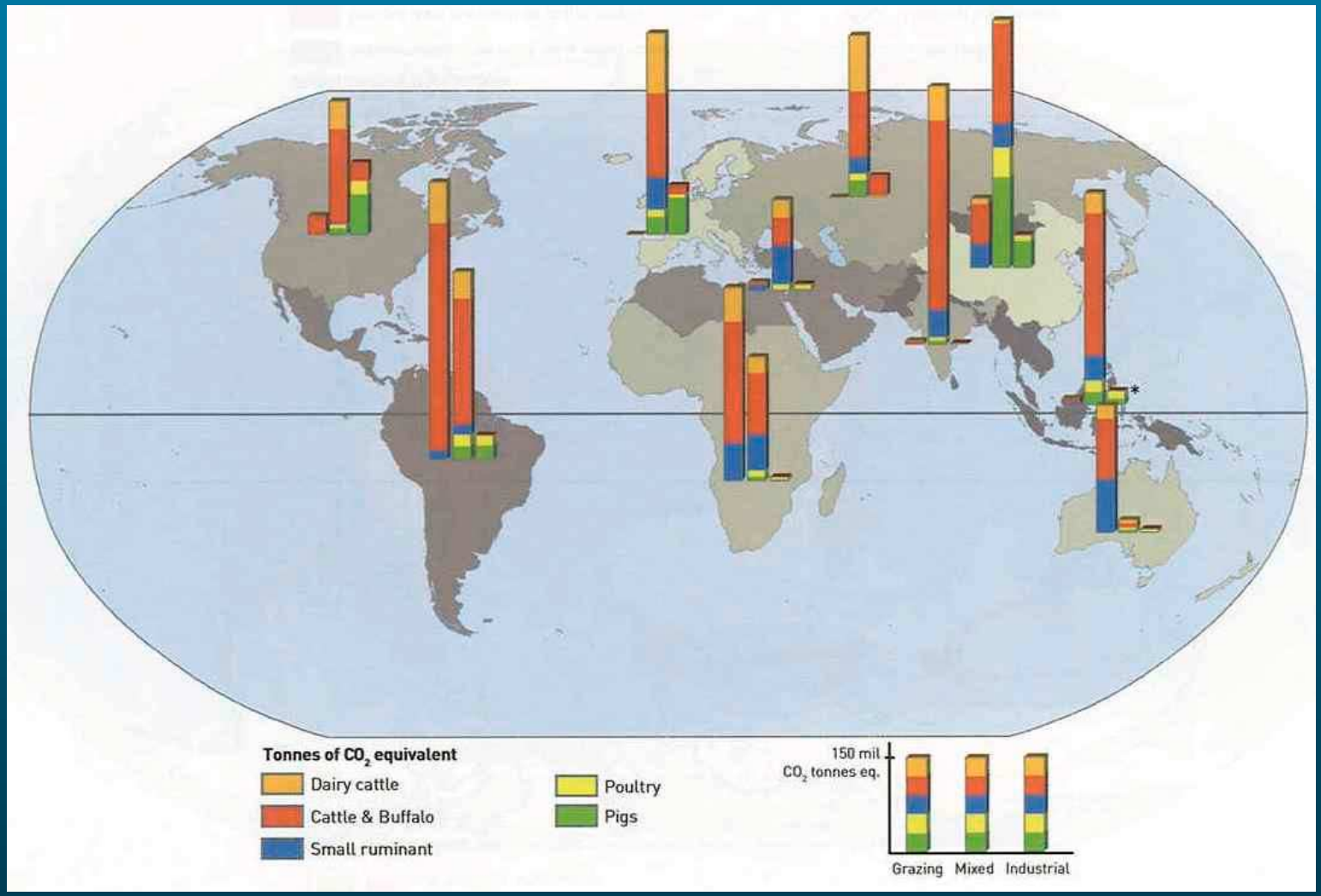


1860 **1993**

- **Nitrogen is emitted as NOx to the atmosphere by fossil fuel combustion**
- **Nitrogen is emitted as NH3 and NOx from food production**
- **Once emitted, it is transported and deposited to ecosystems**
- **In 1860, human activities had limited influence on N deposition**
- **By 1993, the picture had changed**

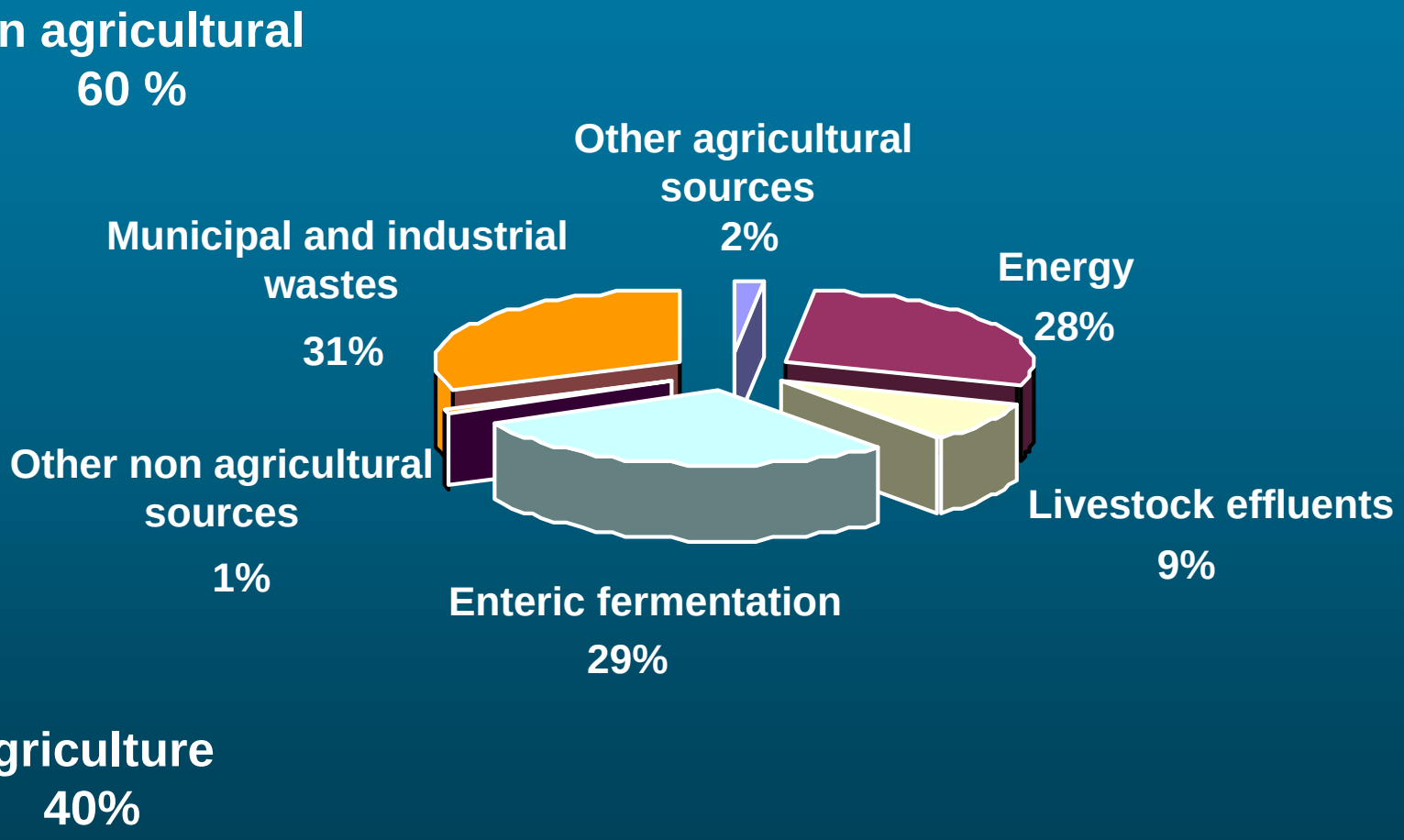
From Galloway et al, 2002

Total greenhouse gas emissions from enteric fermentation and manure per species and main production system



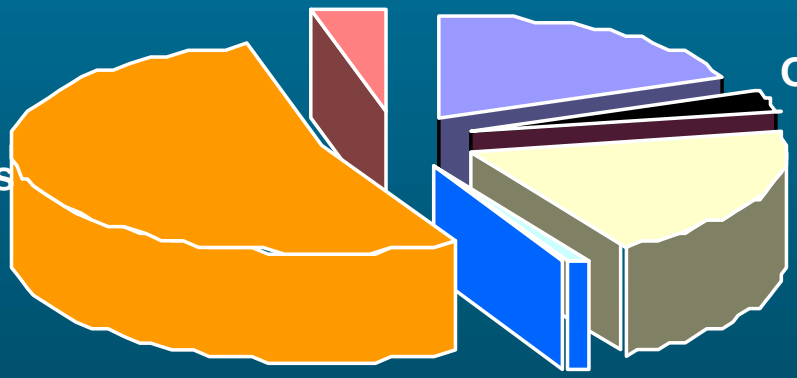
Source : LEAD.

Main methane emissions sources



From OCDE, 2001

Main nitrous oxide sources



Non agricultural

42%

Livestock effluents

4%

Energy

18%

Other non agricultural sources

4%

Agricultural soils

53%

Industrial processes

20%

Agriculture

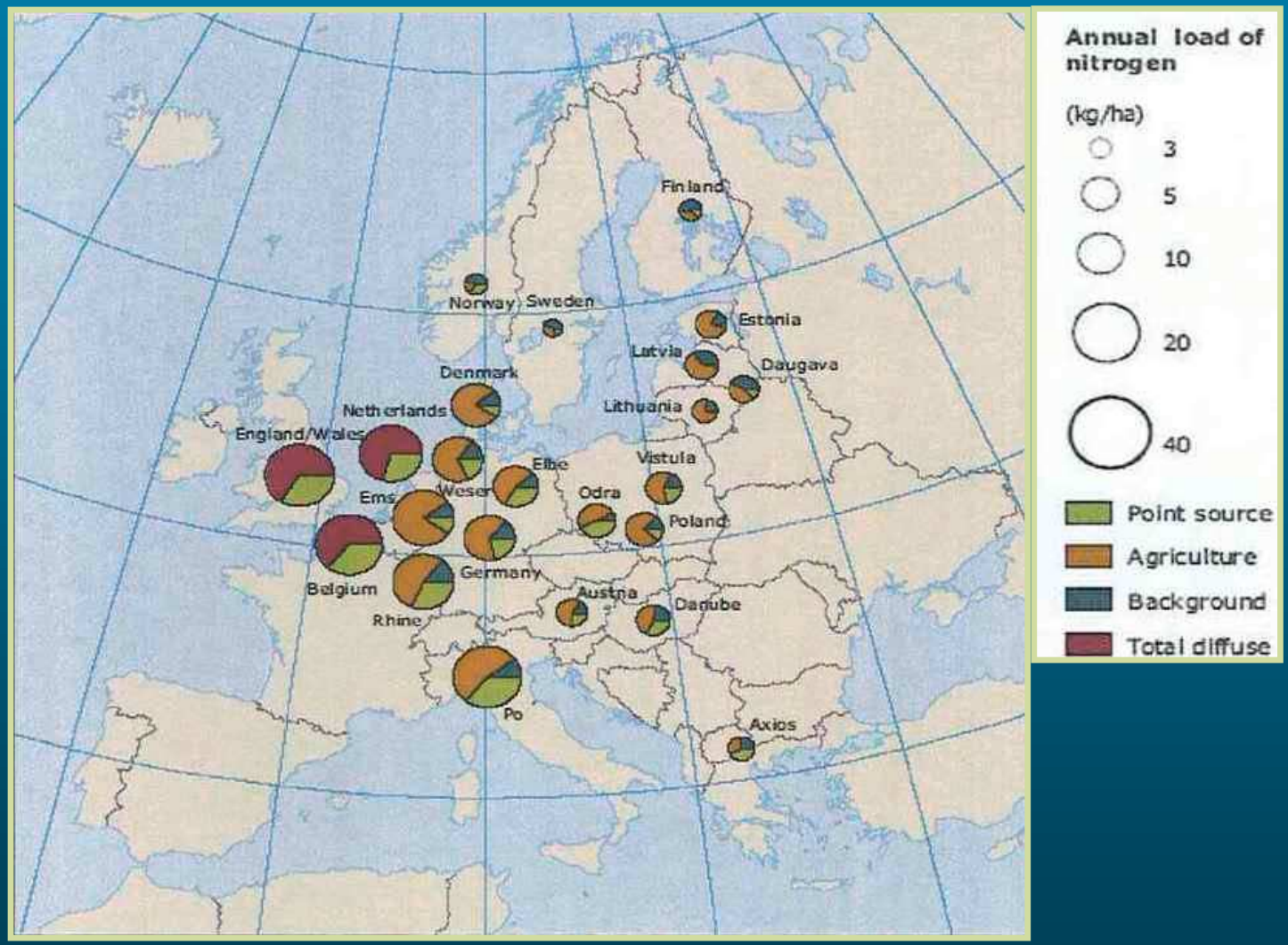
58%

Other agricultural sources

1%

From OCDE, 2001

Nitrogen losses to surface water



Source : EEA, 2005

- **Agriculture is the single dominating source of nitrogen pollutionn**
- **50-80% of the total load**
- **It is crucial for water protection to fully implement the nitrates directive**

Estimated N losses to freshwater ecosystems from manured agricultural lands

Region	N from animal manure		N losses to freshwater courses
	Crops	Pasture	
North America	1 790	1 790	896
Central & South America	1 403	1 402	702
North & West Africa	216	171	97
Rest of Africa	367	3 311	920
OECD Europe	3 408	737	1 036
Eastern Europe	3 149	2 556	1 427
Asia	9 907	2 306	3 054
Oceania & Japan	424	111	134
World	**20 664**	**12 384**	**8 266**

Source : FAO and IFA, 2001 ; Carpenter et al, 1998 ; Hooda et al, 1998 ; Galloway et al, 2004

Estimated relative contribution of pig waste, domestic wastewater and non-point sources to nitrogen emissions in water systems

Country/Province	Nutrient	Potential load (tons)	Percentage contribution to nutrient emissions in water systems		
			Pig waste	Domestic wastewater	Non-point source
China/Guangdong	N	530 434	72	9	19
Thaïland	N	491 262	14	9	77
Viet Nam	N	442 022	38	12	50

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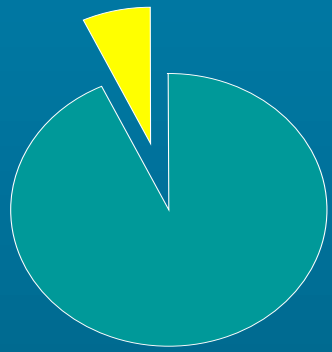
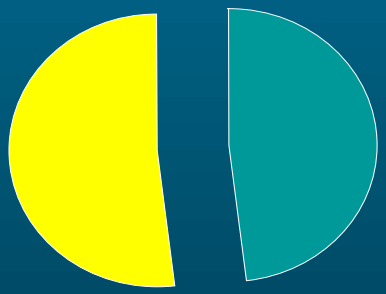
Impact of agriculture

Ammonia

Methane



Dust (PM10)



Nitrous oxide

Water pollution incidents

Agriculture Other sources

Example figures from UK. 1996-1999

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Liver copper concentrations (mg/kg fresh weight) in Galician cattle in relation to soil copper content

	Cu soil (mg/kg)					
	< 5	5 – 10	10 – 25	25 – 100	100 – 150	> 150
Geometric mean	24.6	39.3	64.0	82.1	110	112

From Lopez Alonso et al. 2000. The Veterinary Journal « Effect of pig farming on copper and zinc accumulation in cattle … »

Liver zinc concentrations (mg/kg fresh weight) in Galician cattle in relation to the soil zinc content

	Zn soil (mg/kg)			
	25 – 50	50 – 200	200 – 400	> 400
Geometric mean	42.1	44.4	47.0	51.6

From Lopez Alonso et al. 2000. The Veterinary Journal « Effect of pig farming on copper and zinc accumulation in cattle … »

Concentrations of copper and zinc in the livers (mg/kg fresh weight) of Galician cattle in relation to the number of young pigs (piglets and growing-finishing pigs/100 ha)

	Number of young pigs / 100 ha					
	< 1	1 – 26	26 – 51	51 – 85	85 – 145	> 145
Cu	44.0	52.6	46.5	75.1	61.3	70.7
Zn	46.1	46.4	45.6	46.0	50.5	47.7

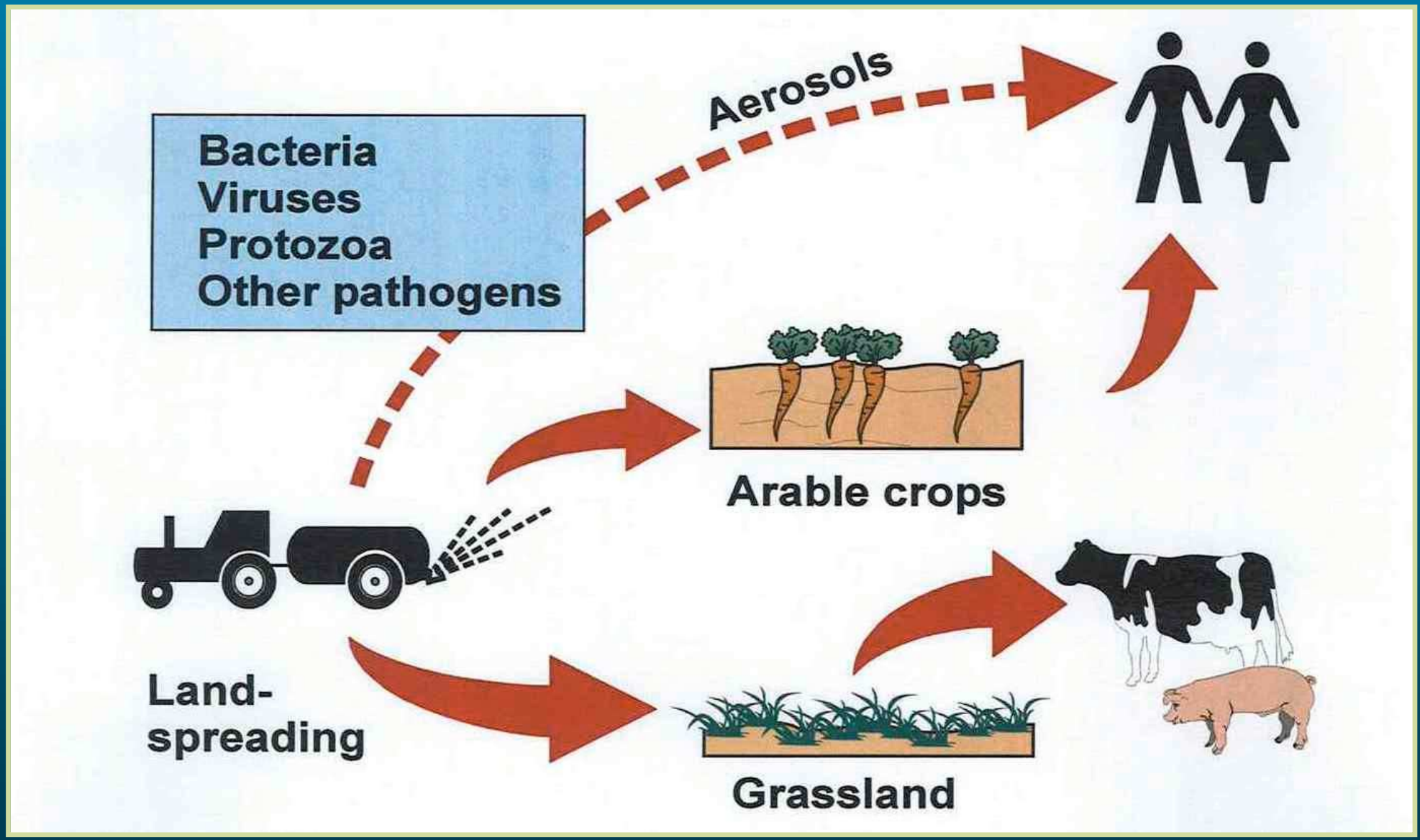
From Lopez Alonso et al. 2000. The Veterinary Journal « Effect of pig farming on copper and zinc accumulation in cattle … »

Heavy metal inputs to agricultural land in England and Wales

Source	Inputs per year (tonnes)	
	Zn	Cu
Atmospheric deposition	2 457	631
Livestock manure	1 858	643
Sewage sludge	385	271
Industrial waste	45	13
Miscellaneous sources	293	63
Total	5 038	1 621

From Nicholson et al, 2003

Disease transmission risks



Sanitary risks related to livestock effluents

Pathogens content

- **bacteria**

Salmonella, Campylobacter

Yersinia enterocolitica…

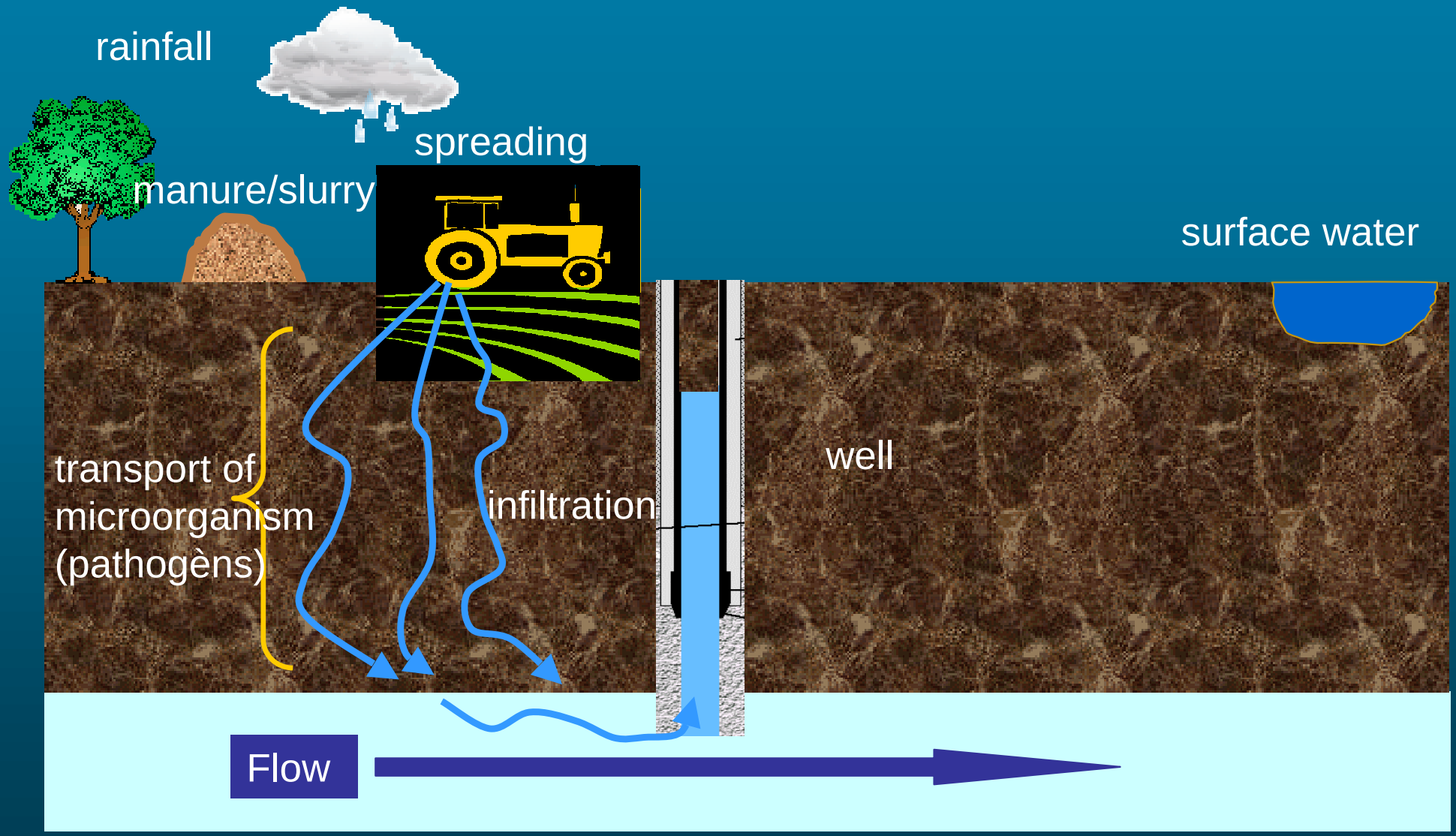
- **parasites**

Cryptosporidium, Giardia, *Ascaris…*

- **virus**

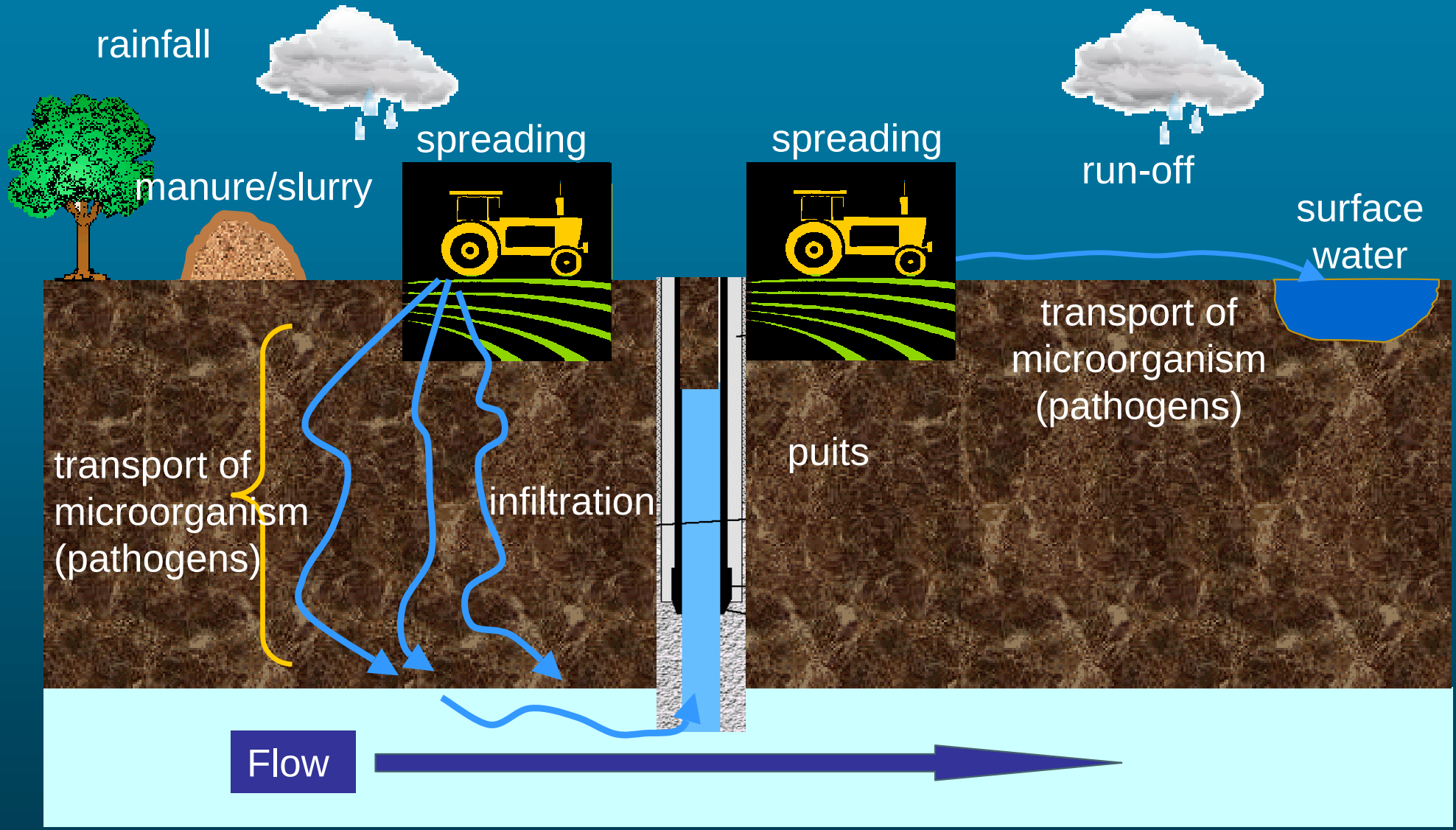
hepatite E…

Sanitary risks related to livestock effluents



From Pourcher A.M, personal communication

Sanitary risks related to livestock effluents



From Pourcher A.M, personal communication

Threshold values for microbial and parasite indicators within the raw product

germ	French Norm NFU 44-051	Homologation of fertilizers products		European regulation N°1744/2002
		All crops	Vegetables and strawberries	
E.coli	10^2 / g[a]	10^3 / g	10^2 / g	5 10^3 / g
Enterocoques	10^4 / g	10^4 / g	10^2 / g	5 10^3 / g
C. perfringens		abs. / 1g[b]	abs. / 1g[b]	
Salmonella	abs. / 1g or abs./ 25g[c]	abs. / 1g	abs. / 25g	abs. / 25g
L. monocytogenes		Abs. 25g (grassland)	abs. / 25g	
Eggs of viable helminthes	abs. / 1,5g	abs. / 1g	abs. / 25g	
S. aureus or coagulase +		< 10 / g	< 10 / g	

a Indicative value provided to help the producer to evaluate the sanitation effect of composting
b spores and vegetables forms
c for horticultural crops

Legislative responses (Environment and health)

NEC Directive

Air Quality Directive

Nitrates Directive

Water Framework Directive

AIR

WATER

IMPACT OF MANURE

STS and SFD

SOIL

IPPC Directive

OVERALL

WASTE

EIA Directive

Waste Framework Directive

Animal byproduct regulation

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Water pollution legislative responses

- **Nitrates Directive (91/676/EEC)**
  Relevant for nitrates, general good practice

- **Water Framework Directive (2000/60/EC)**
  Relevant for all agriculture through river basin management planning

The Nitrates Directive
Action programmes

Specific measures on manure

- Minimum storage capacity
- Construction of manure vessels
- Maximum nitrogen amount applied with livestock manure : 170 kg / hectare

The Nitrates Directive
Action programmes

Examples of measures on fertilisers Applying also to manure

- Prohibition periods of fertiliser application
- Fertilization according to a nitrogen balance
- Fertilisation procedures near water courses, on slopes, on frozen, water logged, snow covered soils
- Vegetation cover in winter periods

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Air pollution legislative responses

- **NEC Directive (2001/81/EC)**
  Target to reduce ammonia emissions from agriclture (93% EU total)

- **Air Quality Directive (1999/30/EC)**
  Ammonia contributing to particulate matter in the atmosphère

UNECE Gothenburg Protocol 1999

Addresses 4 atmospheric pollutants :

S	63% ↓
NO_x	41% ↓
VOC	40% ↓
NH_3	17% ↓

Target reductions at European level for 2010 cf. 1990 baseline.

Individual country targets based on a scientific assessment of the pollution effect and abatement options.

Integrated pollution prevention and control

Directive 96/61/EC

- Covers 13 pollutants including NO_x, NH_3 and VOC
- Includes intensive pig and poultry farms :
  - 40 000 poultry places
  - 2 000 production pigs (>30 kg)
  - 750 sows
- All qualifying installations to comply by Oct. 2007
- Use of best available techniques (BAT)
- BAT reference document for pig and poultry sector (EC July 2003)

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The book

- Second edition
- Review of livestock waste management across Europe
- Research and applied level
- 600+ cited sources
- 2½ years in preparation

http://www.quae.com/

Review of impacts

Climate change

- **18% of anthropogenic GHG emissions are related to livestock (equivalent CO_2)**
  - Deforestation: 35% of sector's emissions
  - Manure: 31% of sector's emissions
  - Enteric fermentation : 25% of sector's emissions
  - Feed production: 7% of sector's emissions
- **Ammonia emissions (30 million tonnes/year = 68 % total emissions**)

Gerber P. 2008. Livestock's long shadow

Thank you for the invitation

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