Livestock production and manure management in EU-27

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ReUseWaste Kick off meeting
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Outline

- Agriculture in European Union (EU-27)
- Livestock production in EU-27
- Manure management
- Summary
European Union (EU-27)

- 27 countries
- 4.2 million km$^2$
- 500 million people
- 23 official languages
- UAA: 1.6 million km$^2$
- 7 million farms
- Average size 22 ha
Potential crop yields in EU-27

WINTER WHEAT
WATER LIMITED ABOVE GROUND BIOMASS

to : 31 December

Long term average (LTA)

Units: kg.ha⁻¹ (x10⁴)
- 0.4741 - 1.0788
- 1.0788 - 1.2926
- 1.2926 - 1.4449
- 1.4449 - 1.5570
- 1.5570 - 1.7038
- 1.7038 - 1.8459
- 1.8459 - 2.3705

Source: JRC - AGRICAST Action - MARS Unit
Processed by: ALTERRA Consortium
On behalf of: AGRICAST Action - MARS Unit
Agriculture in European Union (EU-27)

- Diverse farming systems
  - Type (crop/animal/mixed)
  - Size
  - Management
- Diverse environment
  - Climate
  - Soils

Figure 1.1.5: Average UAA per holding*, 2003, 2005 and 2007

(1) Figures do not sum to 100% due to rounding.
Source: Eurostat (ef_lu_ovcroepsu)
Livestock uses ~ 70% of agricultural land in EU

- Grassland
- Arable land for feed
- Arable land for food
Self sufficiency of main food products in EU-27, in %

- Cereals
- Protein rich products
- Fish
- Cheese
- Eggs
- Poultry meat
- Pig meat
- Beef and veal
- Sheep and goat meat

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Number of animals; EU-27, 1960-2005

- Cattle: -10%
- Sheep & goat: +10%
- Pigs: +70%
- Poultry: +60%

FAO, 2007
Number of animals; World, 1960-2005

- **Cattle**: +30%
- **Pigs**: +150%
- **Sheep & goats**: +30%
- **Poultry**: +400%

FAO, 2007

<table>
<thead>
<tr>
<th>Year</th>
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Animal production and its effects are changing

Driving Forces
- Demography & prosperity
- Technology & Business development
- Governmental Policies
- Public Pressure Groups

Changes in animal production
- Animal species & number
- Location & size of animal systems
- Type & organization of animal systems

Effects
- Animal performance
- Emissions & resource use
- Animal health & welfare
- Livelihoods

After Steinfeld et al., 2006; 2010; FAO, 2010
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Trends in livestock development

- Specialization
- Intensification
- Up-scaling
- Agglomeration

Increase competitiveness
Agriculture in EU and Governmental Policy

- UNECE-CLRTAP Gothenburg Protocol
- UNFCCC Kyoto Protocol
- EU National Emissions Ceilings Directive
- EU Strategy for Sustainable Development
- EU IPPC
- EU Birds & Habitat Directives
- EU CAP + cross compliance
- EU Food Quality Regulation
- EU Rural Development Program
- EU Animal Welfare
- EU Directive on Pesticides
- EU Water Framework Directive
- EU Biofuel Directive
- EU Nitrates Directive
- EU Soils Strategy
- EU Groundwater Directive
- EU Food Quality Regulation
- EU Directive on Pesticides
- EU Biofuel Directive
- EU Nitrates Directive
- EU Soils Strategy
- EU Groundwater Directive

Emissions to air

Emissions to water

Resources

Agriculture

Food, Income, Services, fiber
Livestock production systems

• Grassland-based dairy production
• Grassland-based beef production
• Mixed crop-pig and crop-poultry production
• Specialized, land-less pig and poultry production
• Grassland-based sheep and goat production
Nitrogen balance in Ag. in EU-27 in 2000

Velthof et al. (2008)
What is manure management?

...... process of collecting, handling, storing and allocating of manure....

...... to achieve agronomic and environmental objectives....
Management: cyclic process of activities

1. Analysis
2. Decision making
3. Planning
4. Execution
5. Monitoring
6. Evaluation

Achieving objectives
Achieving objectives of manure management

- **Agronomic objectives**
  - Achieve high nutrient use efficiency
  - Effective use of organic matter

- **Environmental objectives**
  - Low emissions

- **Social/societal objectives**
  - Safety (NH3, H2S toxicity)
  - Human health (pathogens, zoonosis), no odour
Manure management requires a chain approach.
Comparison of pig production costs

Euro per kg slaughter weight (at sector level)

NL: 1.40 + 0.05
FR: 1.48
DE: 1.57
DK: 1.40
ES: 1.62
PL: 1.61
US: 1.04
BR: 0.91

Legend:
- Feed
- Capital
- Labour
- Other
- Housing
- Producton rights

Hoste and Puister, 2009
Additional costs in pig production due to measures

Euro cent per kg slaughter weight (at sector level)

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Hoste and Puister, 2009
Summary and conclusions

- Livestock production in EU-27 is diverse;
- Strong agglomeration in specific areas;
  - Regional surpluses of manures;
  - Need for manure processing
- Amounts of N and P in manures are as large as in fertilizers
- Storage and use of manures regulated by EU policies
- No major changes expected in livestock production volumes
Difference between ‘excretion’ and ‘production’

- Excretion = amounts of carbon and nutrients excreted (‘under the tail’)

- Production = amounts applied to land (excreted amounts corrected for ‘un-avoidable’ gaseous losses during storage)
Calculation of nutrient excretion

Basic formula:

- \( \text{Nutrient excretion} = \text{nutrient intake} - \text{nutrients in marketable animal products}, \)

where,

‘marketable’ products = milk, meat, egg, wool
Management measures & manure excretion

Many measures affect manure excretion and production:

- **Herd management:**
  - Genetic potential
  - Animal health management
  - Reproduction management

- **Animal feed management**
  - Precision feeding, depending on production phase of the animal
  - Grazing management
  - Low-protein feeding
  - Low-P diets
  - Water supply
  - Supplementation of metals, antibiotics, hormones

- **Housing management**
  - Indoor climate (temperature, ventilation, NH3 and PM2.5 concentrations, etc.)
  - Space per animal
  - Bedding material
Manure management

- Coherent chain approach:
  1. Targeted animal feeding (N & P contents in feed)
  2. Calculation of manure production: amounts of N and P
  3. Collection of all urine and faeces in animal housing systems
  4. Leak-tight & covered storages; capacity minimal 6 months
  5. Prohibition period for manure application (~5 months)
  6. Low-emission manure application techniques; injection in soil
  7. Soil- and crop-specific application limits
  8. Manure transport to other farms if production > application
Simple formula for feed requirements dairy cattle

- DM intake = \( q \times [MW \times a + LWG \times b + MY \times c] \)

where

- DM intake = total dry matter intake, in kg/cow/year
- MW = metabolic weight = (weigth)^{0.75}, in kg
- LWG = liveweighting gain, in kg/year
- MY = milk yield per ruminant, kg/year
- \( a, b, c \) and \( q \) are empirical constants
N excretion dairy cattle as function of milk yield.

\[ y = 0.0101x + 57 \]
\[ y = 0.0081x + 66 \]
\[ y = 0.0074x + 42 \]
\[ y = 0.0067x + 55 \]

Milk yield, kg per cow

N excretion, kg per cow
### N excretion other cattle, kg/animal/year

<table>
<thead>
<tr>
<th>Cattle category</th>
<th>Average estimate</th>
<th>Lower estimate</th>
<th>Upper estimate</th>
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<tbody>
<tr>
<td>Replacement cattle, &lt; 1 yr;</td>
<td>30</td>
<td>25</td>
<td>45</td>
</tr>
<tr>
<td>Replacement cattle, &gt; 1 yr;</td>
<td>60</td>
<td>40</td>
<td>80</td>
</tr>
<tr>
<td>Fattening calves &lt;0.5 year;</td>
<td>15</td>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>Fattening bulls 0.5-1.5 year</td>
<td>35</td>
<td>30</td>
<td>50</td>
</tr>
<tr>
<td>Suckling cows &gt; 2 years</td>
<td>70</td>
<td>50</td>
<td>90</td>
</tr>
<tr>
<td>Other fattening cattle &lt;1 year</td>
<td>35</td>
<td>30</td>
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In the Gothenburg Protocol, N management is seen as a measure to reduce NH$_3$ emissions

- An integral measure to decrease N losses and to improve the performance of the farm;
- Helps to prevent pollution swapping, esp. mixed farms

Indicators:
- $N_{\text{surplus}} = N_{\text{input}} - N_{\text{output}}$
- $NUE = \frac{N_{\text{output}}}{N_{\text{input}}}$

But benchmarking needed
Conclusions (i)

- Little empirical information about cost of N management;
- Cost of N management tend to go down over time;
- Cost-effectiveness largest on large farms;
- Indirect effects appear significant.

- More studies needed!!
Conclusions (ii)

- Relatively cheap measures include:
  - Proper timing of activities;
  - Increasing N fertilizer value of manure;
  - Selecting high-yielding varieties and breeds;
  - Precision fertilization and precision feeding;
  - Optimization of crop and animal husbandry
Conclusions (iii)

- Relatively expensive measures include:
  - Fertilizer application far below economic optimum;
  - Leak-tight and covered manure storages;
  - Low-emissions animal housing;
  - Long-distance manure transport
  - Manure treatment

Cost of manure disposal
Thank you!

Questions?
Thank you!

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