Lifestock production systems and future food security?

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Food security

“The ability to provide access to enough food of high quality for humans through sustainable methods of production, processing, storage, transport, distribution, trading and retailing”

Sustainability in this context means without
- negative impacts on the environment,
- reliance on non-renewable resources,
- an erosion of current ethical standards

while ensuring
- fair economic returns to all food chain stakeholders
- flexibility to meet the challenges of global change
How can we feed 9 million people in a sustainable way?

Amount of cereal (corn-equiv.) necessary to produce 1 kg of livestock products

- Estimated
- UN High
- UN Medium
- UN Low
- Actual

- Cereal
- Livestock
- Poultry
- Other
Total global cereal production


Total global use of nitrogen, phosphorus and area of irrigated land

Low Input Breeds - ECO AB
Symposium, Wageningen (The Netherlands)
March 15-16, 2011

Diminishing returns of fertiliser applications

Law of diminishing returns

N-efficiency of cereal production (t cereal/t fertiliser)

Tillman et al. (2002)
*Nature* 418, 671-677

Energy requirement in agricultural system (world average) in KJ/kg

<table>
<thead>
<tr>
<th></th>
<th>Nitrogen</th>
<th>Phosphate</th>
<th>Potash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td>69,530</td>
<td>7,700</td>
<td>6,400</td>
</tr>
<tr>
<td>Packaging</td>
<td>2,600</td>
<td>2,600</td>
<td>1,800</td>
</tr>
<tr>
<td>Transportation</td>
<td>4,500</td>
<td>5,700</td>
<td>4,600</td>
</tr>
<tr>
<td>Application</td>
<td>1,600</td>
<td>1,500</td>
<td>1,000</td>
</tr>
<tr>
<td>Total</td>
<td>78,230</td>
<td>17,500</td>
<td>13,800</td>
</tr>
</tbody>
</table>

(Gellings and Parmenter 2004)
Energy use – CO₂ emissions

Mineral N-Fertiliser

- 1 kg Nitrogen-fertiliser = 36,000kJ = 1 L fuel
- 1 kg nitrogen fertiliser (NH₃NO₃) results in
  = 2.38 kg CO₂ (equivalents of CO₂, CH₄ and N₂O)
- UK Farm level = 100 ha cereals x 200 kg N/ha/annum
  = 20,000 Litre fuel used
  = 47,600 kg CO₂ into the atmosphere

- European level = 11 Million t N/annum*
  = 11,000 Million Litre fuel used


Proven global reserve: 1,333Gb:
45.7 years-consumption of 2009
(BP, 2010)
When Will Phosphorus Run Out?

- Numerous scientific studies conclude that phosphorus (phosphate rock) reserves-resources will be depleted in the 21st century
  - Pessimistic: in 30-40 years
  - More optimistic: in 70-80 years

- IFDC (International Fertilizer Development Centre) prediction: 300-400 years
  - Figures disputed by the US geological survey
  - Does the fertiliser industry and its lobbying bodies just want business as usual?

Peak Phosphorus Curve

World Phosphate Rock Reserves by Country

Will these countries be reliable suppliers in the future?


Nutrients limiting wheat yield in 1900 and 2000 and predicted 2100 yields without P-fertilisation

Estimated wheat yield potential (t ha⁻¹)

Yield potential associated with different nutrients:
- N
- P
- K
- Other

3 t ha⁻¹
9 t ha⁻¹
4 t ha⁻¹

1900 2000 2100 without phosphorus
What type and how much animal production can we justify in the future from a food security point of view?

Thank you
Low Input Breeds - ECO AB
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(Source: Piesse and Thirtle, 2009)

What are the solutions?

The main approaches available are:

1. **More efficient recycling** of NPK via
   - animal and green manures,
   - crop residues, food processing waste
   - communal and domestic organic waste
   - human toilet waste/sewage

2. **Reduction of losses** of fertiliser from soils

3. **Breeding/selection** of more nutrient (especially N and P) efficient crop varieties

EU NUE-CROPS project
Open Questions?

Are there enough organic fertilisers and/or organic waste that can be processed and used as fertiliser available?

- Probably yes, if we get much more efficient in recycling organic waste
- Probably not, if we apply current EU-organic farming standards
  - which currently prohibits the use of night soil/sewage as fertiliser
Closing the nitrogen (& other nutrient) cycles

- \( N_2 \) atmosphere
- \( \text{N-fertiliser manufacture} \)
- \( \text{N-fixation by legumes} \)
- \( \text{NH}_3/\text{NO}_3 \) soil
- \( N_{\text{organic manure}} \)
- \( N_{\text{organic crop biomass}} \)
- \( N_{\text{organic livestock}} \)
- \( N_{\text{organic food processing/consumption}} \)
- \( \text{Landfill Incineration} \)
- \( \text{Sewage treatment works} \)
- \( \text{CO}_2 \)
- \( \text{CH}_4 \)