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

Presentation to the UK Poultry Council
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and

Adrian Williams, Daniel Sandars, Eric Audsley
Cranfield University, UK
Background
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.
Ammonia

\( \text{CO}_2 \)

Nitrous Oxide

Methane
Stern on Agriculture

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

Figure 2: Agriculture non-CO₂ 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)
Analysis of a production system

Inputs = Outputs
Mass flows measured at the system boundary must balance

Manufactured Inputs
- *e.g.* fertiliser, concentrate feeds, machinery

Natural Resources
- *e.g.* minerals, fossil energy, land

Boundary

Production System

Functional Unit
- *e.g.* 1 t pig meat or wheat
- *e.g.* ammonia, carbon dioxide

Emissions & wastes

Mass flows measured at the system boundary must balance.
What can you do with an assessment?

Policymakers

Producers

Consumers

- ‘Eco-design’ of production
- 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

Non-organic: The organic industry has self-contained flocks.

Pure bred hill

Ewe lambs retained

Male lambs

Draft ewes

Halfbreds

Cross bred ewes/ lambs

Rams

Male lambs

Lowland

Rams

Finished lambs

Surplus lambs

Hill

Upland

Lowland

Longwool

Downland

Surplus lambs
• 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

- **Bread Wheat**
  - Non-O: [Diagram showing energy distribution]
  - Org: [Diagram showing energy distribution]

- **Potatoes**
  - Non-O: [Diagram showing energy distribution]
  - Org: [Diagram showing energy distribution]

60 kg crude oil
Distribution of GWP for three crops

- Bread Wheat
- Maincrop Potatoes
- 1st Early Potatoes

Non-Org, Org, N2O, CH4, CO2
Main burdens in animal production (National Scale)

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

<table>
<thead>
<tr>
<th></th>
<th>Beef</th>
<th>Sheep Meat</th>
<th>Pig Meat</th>
<th>Poultry Meat</th>
<th>Eggs</th>
<th>Milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Energy, GJ</td>
<td>28</td>
<td>23</td>
<td>17</td>
<td>12</td>
<td>14</td>
<td>25</td>
</tr>
<tr>
<td>GWP100, t CO2 equiv.</td>
<td>16</td>
<td>17</td>
<td>6</td>
<td>5</td>
<td>6</td>
<td>11</td>
</tr>
<tr>
<td>EP, kg PO4 equiv.</td>
<td>160</td>
<td>200</td>
<td>100</td>
<td>49</td>
<td>77</td>
<td>64</td>
</tr>
<tr>
<td>AP, kg SO2 equiv.</td>
<td>470</td>
<td>380</td>
<td>390</td>
<td>170</td>
<td>310</td>
<td>160</td>
</tr>
<tr>
<td>ARU, kg antimony equiv.</td>
<td>36</td>
<td>27</td>
<td>35</td>
<td>30</td>
<td>38</td>
<td>28</td>
</tr>
<tr>
<td>Land use (grade 3a), ha</td>
<td>2.3</td>
<td>1.4</td>
<td>0.7</td>
<td>0.6</td>
<td>0.7</td>
<td>1.2</td>
</tr>
<tr>
<td>Crude Oil, kg</td>
<td>650</td>
<td>540</td>
<td>390</td>
<td>280</td>
<td>330</td>
<td>590</td>
</tr>
</tbody>
</table>
Distributions of energy in meat production

- Beef as now (with milk)
- Suckler beef
- Sheep meat
- Pig meat
- Poultry meat

- Breeding
- Finishing / production
Effects of milk yield on burdens

<table>
<thead>
<tr>
<th></th>
<th>PE, GJ</th>
<th>GWP100, t CO2</th>
<th>ARU, kg ant. Equiv.</th>
<th>Land, ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>31</td>
<td>10</td>
<td>34</td>
<td>1.0</td>
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<tr>
<td>Medium</td>
<td>30</td>
<td>10</td>
<td>33</td>
<td>0.95</td>
</tr>
<tr>
<td>High</td>
<td>28</td>
<td>9.5</td>
<td>31</td>
<td>0.91</td>
</tr>
</tbody>
</table>
Poultry production input data values used in the LCA model

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

<table>
<thead>
<tr>
<th>Impacts &amp; resources used</th>
<th>Non-organic</th>
<th>Organic</th>
<th>Free-range (non-organic)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary energy used, MJ</td>
<td>12,000</td>
<td>15,800</td>
<td>14,500</td>
</tr>
<tr>
<td>GWP\text{100}, kg 100 year CO$_2$ equiv.</td>
<td>4,570</td>
<td>6,680</td>
<td>5,480</td>
</tr>
<tr>
<td>EP, kg PO$_4^{3-}$ equiv.</td>
<td>49</td>
<td>86</td>
<td>63</td>
</tr>
<tr>
<td>AP, kg SO$_2$ equiv.</td>
<td>173</td>
<td>264</td>
<td>230</td>
</tr>
<tr>
<td>Pesticides used, dose ha</td>
<td>7.7</td>
<td>0.6</td>
<td>8.8</td>
</tr>
<tr>
<td>ARU, kg antimony equiv.</td>
<td>29</td>
<td>99</td>
<td>75</td>
</tr>
<tr>
<td>Land use, ha</td>
<td>0.64</td>
<td>1.40</td>
<td>0.73</td>
</tr>
<tr>
<td>N losses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO$_3^-$-N, kg</td>
<td>30</td>
<td>75</td>
<td>37</td>
</tr>
<tr>
<td>NH$_3$-N, kg</td>
<td>40</td>
<td>60</td>
<td>53</td>
</tr>
<tr>
<td>N$_2$O-N, kg</td>
<td>6.3</td>
<td>9.3</td>
<td>7.6</td>
</tr>
</tbody>
</table>
## Production sources – 1 tonne poultry meat

<table>
<thead>
<tr>
<th>Poultry Meat (default national proportions)</th>
<th>Primary energy used, MJ</th>
<th>GWP100, kg CO2</th>
<th>Eutrophication potential, kg PO4 eqv.</th>
<th>Acidification potential, kg SO2 eqv.</th>
<th>Abiotic resource use, kg Sb eqv.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed</td>
<td>12067</td>
<td>2467</td>
<td>14</td>
<td>15</td>
<td>9</td>
</tr>
<tr>
<td>Bedding</td>
<td>809</td>
<td>-123</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Buildings</td>
<td>192</td>
<td>25</td>
<td>0</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Direct energy</td>
<td>3633</td>
<td>234</td>
<td>0</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Internal transport</td>
<td>30</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Gaseous emissions</td>
<td>0</td>
<td>466</td>
<td>1</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Manure</td>
<td>-1188</td>
<td>95</td>
<td>18</td>
<td>70</td>
<td>-1</td>
</tr>
<tr>
<td>Total</td>
<td>15542</td>
<td>3166</td>
<td>33</td>
<td>94</td>
<td>18</td>
</tr>
</tbody>
</table>
Comparison burdens of production of some alternative egg production systems
(per 20,000 eggs)

<table>
<thead>
<tr>
<th>Impacts &amp; resources used</th>
<th>Non-organic</th>
<th>Organic</th>
<th>100% cage, non-organic</th>
<th>100% free-range, non-organic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary energy used, MJ</td>
<td>14,100</td>
<td>16,100</td>
<td>13,600</td>
<td>15,400</td>
</tr>
<tr>
<td>GWP\textsubscript{100}, kg 100 year CO\textsubscript{2} equiv.</td>
<td>5,530</td>
<td>7,000</td>
<td>5,250</td>
<td>6,180</td>
</tr>
<tr>
<td>EP, kg PO\textsubscript{4}\textsuperscript{3-} equiv.</td>
<td>77</td>
<td>102</td>
<td>75</td>
<td>80</td>
</tr>
<tr>
<td>AP, kg SO\textsubscript{2} equiv.</td>
<td>306</td>
<td>344</td>
<td>300</td>
<td>312</td>
</tr>
<tr>
<td>Pesticides used, dose ha</td>
<td>7.8</td>
<td>0.1</td>
<td>7.2</td>
<td>8.7</td>
</tr>
<tr>
<td>ARU, kg antimony equiv.</td>
<td>38</td>
<td>43</td>
<td>39</td>
<td>35</td>
</tr>
<tr>
<td>Land use, ha</td>
<td>0.66</td>
<td>1.48</td>
<td>0.63</td>
<td>0.78</td>
</tr>
<tr>
<td>N losses</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO\textsubscript{3}-N, kg</td>
<td>36</td>
<td>78</td>
<td>35</td>
<td>39</td>
</tr>
<tr>
<td>NH\textsubscript{3}-N, kg</td>
<td>79</td>
<td>88</td>
<td>77</td>
<td>81</td>
</tr>
<tr>
<td>N\textsubscript{2}O-N, kg</td>
<td>7.0</td>
<td>9.0</td>
<td>6.6</td>
<td>7.9</td>
</tr>
</tbody>
</table>
Production sources – 20,000 eggs

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

• Steady states - not transition
• Soil C not included
• N$_2$O 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
Ammonia (NH$_3$)

- Highly reactive gas
- Short and long range

**Sources:**
- Urban sources
- Agriculture
Sample output data from AENEID

Ammonia emissions from livestock in the UK 2000

Ammonia emissions from crops in the UK 2000

Ammonia emissions from non-agricultural sources in the UK 2002

Total ammonia emissions in the UK 2000
Ammonia emission trend – 15% reduction since 1990
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
Ammonia Emissions from poultry year 2000

AENEID
Level-I data
5 km resolution

NH3-N Emissions (kg/ha)

< 1
1 - 2.5
2.5 - 5
5 - 7.5
7.5 - 10
10 - 20
20 - 30
> 30

100 0 100 Kilometers

Ammonia Emissions from cattle year 2000

AENEID
Level-I data
5 km resolution

NH3-N Emissions (kg/ha)

< 1
1 - 2.5
2.5 - 5
5 - 7.5
7.5 - 10
10 - 20
20 - 30
> 30

100 0 100 Kilometers
Dealing with spatial scale

European exceedances of the critical load for nitrogen

Ecosystem protection

National targets and policy
Agroforestry systems for ammonia abatement

National benefits of ammonia recapture by trees

Mark Theobald
Locally - Four-way benefit of trees

1. Sheltering reduces emissions -20%

2. Recapture of NH$_3$ by trees -10%

3. Increased mixing of the air -30%

4. Recapture of NH$_3$ from livestock under trees -80% (?)
Phosphorus

Phosphate from fertilizers

Phosphate in fossils, rocks, guano

Weathering

Up-lifting over time

Inorganic phosphate stored in soils and dissolved in rivers

Run-off to oceans

Plant phosphate

Decomposers

Animal phosphate

Organic wastes and remains

Phosphate in oceanic sediments
CONTRIBUTION OF MANURE TO PHOSPHATE SUPPLY ON AGRICULTURAL LAND

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

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Policy Forum

Agriculture

Losing the Links Between Livestock and Land

Rosamond Naylor,1,2 Henning Steinfeld,3 Walter Falcon,2 James Galloway,5 Vaclav Smil,6 Eric Bradford,7 Jackie Alder,9 Harold Mooney3

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 with in 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
## Production sources – 1 tonne poultry meat

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

<table>
<thead>
<tr>
<th></th>
<th>UK NH$_3$ Emission (kt NH$_3$) 2000</th>
<th>% animals in IPPC (England, 2004)</th>
<th>UK NH$_3$ regulated under in IPPC (kt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pig</td>
<td>29.8</td>
<td>42%</td>
<td>12.5</td>
</tr>
<tr>
<td>Poultry</td>
<td>45.5</td>
<td>83%</td>
<td>37.8</td>
</tr>
<tr>
<td>Cattle</td>
<td>139.6</td>
<td>a) 37% b) 20% c) 11%</td>
<td>a) 51.7 b) 27.9 c) 15.4</td>
</tr>
</tbody>
</table>
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
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
• 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
Reconnecting plant and animal production to close nutrient cycles

- Wet & dry Deposition 380
- $N_2O$ 83
- $NH_3$ Denitrification Nox 277
- $NH_4^+$ 250
- Food 901
- Fertiliser Organic 1100
- Residues 788
- Crop uptake 30
- Nitrate $NO_3^-$
- Ammonium $NH_4^+$
- Leaching
- Eutropication
Mr Bernard Barlage: closing nutrient cycles growing maize for pig production
And using advanced production technology to reduce nitrogen emissions to air.
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