Australian Agricultural Contributions to Greenhouse Gasses

Richard Eckard

Greenhouse in Agriculture
The University of Melbourne and Department of Primary Industries

Intergovernmental Panel on Climate Change
4th Assessment Report

• Consensus view of +2500 climate scientists
  – CC is occurring
    • More rapidly than previously thought
    • > 90% probability - is due to human activities
  – CO₂, CH₄ and N₂O
    • Highest in recorded and inferred history
  – Primarily due to:
    • Fossil fuels, agriculture and land-use changes
Greenhouse Gas Emissions by sector
Australia 2005

Greenhouse Gas Emissions Agriculture
Australia 2005

- Agriculture
  - 60% of all methane
  - 85% of all nitrous oxide

AGO 2007
Spatial Intensity of Methane and Nitrous Oxide from Agriculture

Nitrous Oxide from Agriculture
(kg N/ha/yr – all sources)

Enteric Methane
(t/sq km)

Methane
1. Dairy cows
2. Beef / Sheep
Nitrous oxide
3. Wheat
4. Irrigated Dairy Pasture
5. Irrigated Maize
6. Irrigated Cotton
7. Wheat
8. Mixed Farming Systems
9. Sugar cane
Methane emissions from dairy cattle

- Shorter lifetime in atmosphere and high GWP (23)
- A significant loss of energy

<table>
<thead>
<tr>
<th>Animal Class</th>
<th>Methane (kg/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mature ewe</td>
<td>10 to 13</td>
</tr>
<tr>
<td>Beef steer</td>
<td>50 to 90</td>
</tr>
<tr>
<td>Dairy cow</td>
<td>90 to 146</td>
</tr>
</tbody>
</table>

Methane Abatement

- **Improving Animal Genetics**
  - Up to 20% difference
  - Evaluate high & low FCE /NFI

- **Nutrition and Feed management**
  - Spring vs summer pasture
  - Up to -37% difference

- **Animal Management**
  - Reducing unproductive animal numbers

- **Longer-Term options**
  - Vaccination, microbial intervention

Eckard & Grainger 2006
Oil Supplements

- 6% less methane / 1% added fat

Dietary Supplements

- Oil + Summer Pasture
  - Milk Solids  +16%
  - Methane (g/day)  -12%
  - Methane /kg MS  -21%

- Tannin + Spring Pasture
  - Methane (g/day) -14 to -29%
  - Urine N -45 % to -59%
  - Faeces N +18% to +21% increase

Beauchemin, Grainger et al. 2007
Potential Source of Oils for Livestock

<table>
<thead>
<tr>
<th>Item</th>
<th>% oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooked potato chips</td>
<td>18</td>
</tr>
<tr>
<td>Soybean pollard</td>
<td>10</td>
</tr>
<tr>
<td>Ensiled grape marc (including tannin)</td>
<td>16</td>
</tr>
<tr>
<td>Brewers grains</td>
<td>8</td>
</tr>
<tr>
<td>Safflower meal</td>
<td>12</td>
</tr>
<tr>
<td>Palm kernel meal</td>
<td>10</td>
</tr>
<tr>
<td>Tomato pomace</td>
<td>15</td>
</tr>
<tr>
<td>Hominy meal</td>
<td>10</td>
</tr>
<tr>
<td>Bakery waste (dried)</td>
<td>13</td>
</tr>
<tr>
<td>Linseed meal</td>
<td>11</td>
</tr>
<tr>
<td>Citrus pulp (wet)</td>
<td>10</td>
</tr>
<tr>
<td>Naked oats</td>
<td>15</td>
</tr>
<tr>
<td>Sunflower seeds</td>
<td>58</td>
</tr>
</tbody>
</table>

Grainger et al. 2007

Nitrous Oxide

- Global warming potential
  - 297 x CO₂
  - Long residence time in atmosphere
- Inefficient use of nitrogen
  - Total N lost
    - Cropping - 20 to 50%
    - Grazing - 40 to 60%
**Nitrous Oxide - Production in Soils**

- Microbial process
- Warmer and more anaerobic (wet) soils

![Reaction diagram](image1)

**Nitrous Oxide - Drivers**

- Substrate availability
  - C and N (NO₃)
- Soil Temperature
- Anaerobicity
  - WFPS

[Diagram image](image2) - Granli & Bäckman 1994
Nitrogen Fertiliser trends in Australia

Daily N\textsubscript{2}O fluxes
Irrigated dairy pastures in Victoria

- N\textsubscript{2}O flux 2-3 days after irrigation, for 1-2 days
- Annual N\textsubscript{2}O Emission Rate
  - Zero 1.4 kg N/ha
  - 150 kg N 2.0 kg N/ha
  - 200 kg N 4.0 kg N/ha

Phillips et al. 2006
**N Source in winter rainfall Dairy Pastures**

- Low in dry summer
- Higher in Wet Winter
- Nitrate vs Urea in wet soils

![Graph showing Nitrous Oxide loss (kg N/ha) across seasons](image)

*Eckard et al. 2002*

---

**N Rates on Irrigated Cotton**

- Rate exceeds plant requirement
  - High N$_2$O losses

![Graph showing Nitrous oxide-N (kg/ha) across N rates](image)

*Grace et al. 2007*
Annual N$_2$O Emissions from Winter Wheat

- Cunderdin Rutherglen
  - 0.09 – 0.11 %
  - 0.05 – 0.1 %

- Low N$_2$O emissions
  - N matched to plant demand
  - Applied in Cool Season

Stubble Management in Irrigated Maize

- Stubble burning + 300N
  - 2.8% of N

- Stubble retention + 300N
  - 1.6% of N
  - >40% lower
Improving National Estimates

- Revised National Inventory for 2004
  - From 1.25% of all N fertiliser to...

<table>
<thead>
<tr>
<th>Production System</th>
<th>Emission Factor (% applied N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigated pasture</td>
<td>0.4</td>
</tr>
<tr>
<td>Irrigated crop</td>
<td>2.1</td>
</tr>
<tr>
<td>Non-irrigated pasture</td>
<td>0.4</td>
</tr>
<tr>
<td>Non-irrigated crop</td>
<td>0.3</td>
</tr>
<tr>
<td>Sugar cane</td>
<td>1.25</td>
</tr>
<tr>
<td>Cotton</td>
<td>0.5</td>
</tr>
<tr>
<td>Horticulture/vegetables</td>
<td>2.1</td>
</tr>
</tbody>
</table>

Galbally et al. 2005

Managing Nitrous Oxide from N fertiliser

- Fertiliser management:
  - Rate, Timing, Source and Placement
  - Water use / Irrigation management

- Soil management:
  - Conserving soil structure
  - Stubble retention

- Fertiliser formulation
  - Nitrate vs Ammonium in wet soils
  - New Market for
    - Controlled release
    - Nitrification inhibitors
Nitrous Oxide
Best Management Practices

• BMPs incorporated into:
  – FERTCARE®
  – EMS
  – Existing BMP manuals
• New AGO ‘guidelines’

Urine - The “wild-card” problem

• Cows excrete 75 - 80% of N ingested
• N rates in a urine patch 1000 -1300 kg N/ha eq
  – 3 to 4 years to fully cover pasture
  – 40 to 60% of N excreted is lost!
Annual N$_2$O Emissions from urine on dairy pastures in Victoria

![Graph showing annual N$_2$O emissions from urine on dairy pastures in Victoria. The graph shows a comparison between Nil, + Urea, and + Urine treatments. The data is from Kelly et al., 2007.]

Urine N Management

- **Nitrification inhibitors**
  - 60 - 80% reduction in N$_2$O
  - Increased pasture production 15%?
  - Emissions Trading Incentive?
    - New Zealand Inventory

- **Dietary Supplements**
  - Tannin, salts, inhibitors
  - Balancing CP:ME

- **Grazing Management**
  - Wet season, Stand off pads
  - Irrigation and drainage

![Image of a sheep with text: De Klein and Eckard 2007]
In Summary

• A carbon-constrained future
• New incentive for
  – Nitrification Inhibitors
  – Controlled release products
• Improving efficiency in Agriculture