From the feed mill to the GIT: A holistic approach to emission reductions

June, the 13th 2019
Cologne, Germany
Emissions in agriculture – Some terms

- **Green House Gas (GHG)** – CO₂, CH₄, N₂O
- **Others:** NH₃ – Precursor of CO₂
- **Global Warming Potential (GWP)** – Ratio of heat trapped by one unit mass of the GHG to that of one unit mass of CO₂ over a specific period of time (100 years) (IPCC, 2001)
- **GWP**
  - CO₂ = 1 (Reference)
  - CH₄ = 25
  - N₂O = 298
- **GHG quantity expressed in CO₂ equivalent (CO₂e, CO₂eq, CDE)**
- **Life cycle assessment (LCA)**
- **GGELS**: Evaluation of the livestock sector's contribution to the EU greenhouse gas emissions (European Commission Joint Research Centre)
Emissions in livestock and poultry production – Some headlines... with wide media coverage

• “Stop Eating Meat If You Want To Save The Planet, Scientists Urge” – The Huffingtonpost

• “Huge reduction in meat-eating ‘essential’ to avoid climate breakdown” – The Guardian

• 51% of global GHG emissions come from rearing and processing livestock - Worldwatch Institute, 2009

• UN/FAO 2006 – Livestock’s Long Shadow (LLS) – Livestock produce 18% of the world’s GHG emissions

  Conclusion: Livestock was doing more to harm the climate than all modes of transportation combined – WRONG CLAIM! but wide coverage from international media
Emissions in livestock and poultry production – Some headlines... not so noisy

• “If you want to save the world, veganism isn’t the answer” – The Guardian

• “Yes, eating meat affects the environment, but cows are not killing the climate” – The Conversation, by Frank M. Mitloehner - Professor of Animal Science and Air Quality Extension Specialist, University of California, Davis

• The largest sources of U.S. GHG emissions in 2016 were electricity production (28%), transportation (28%) and industry (22% percent). All of agriculture accounted for 9% and animal farming 3,9% - U.S. Environmental Protection Agency

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• An email stored in a server produces around 10g of CO$_2$ per year and 293.000 million emails are sent daily! [https://cleanfox.io/]

• A company of 100 employees will produce 13,6 tons of CO$_2$ per year due to emails = 14 go-return flights Paris-New York [https://www.ademe.fr/]

• Having one child = 58,6 tons of CO$_2$e per year!*  

* The climate mitigation gap: education and government recommendations miss the most effective individual actions  
Seth Wynes and Kimberly A Nicholas. Environmental Research Letters, Volume 12, Number 7
Reducing emissions is economically attractive!


  - Cutting emissions while improving health is economically attractive – and justifies immediate climate action.
  - Investing in climate action would save lives immediately through improved air quality and health," says UVM's Mark Budolfson.

The impact of human health co-benefits on evaluations of global climate policy - Nature Communications volume 10, Article number: 2095 (2019)
Key policies and regulation

- **Common Agricultural Policy (CAP) – Green CAP project**
Nitrate directive

Limitation of fertilizer application (mineral and organic), taking into account crop needs, all nitrogen inputs and soil nitrogen supply, maximum amount of livestock manure to be applied = 170 kg nitrogen/hectare/year.


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Author: Irinawave

https://www.eea.europa.eu/logo.jpg
EU National Emission Ceilings Directive

- Emission reduction commitment for EU member states for:
  - Nitrogen oxides (NOx)
  - Non-methane volatile organic compounds (NMVOCs)
  - Sulphur dioxide (SO₂)
  - Ammonia (NH₃)
  - Fine particle matter (PM2.5)

EU facts

• Paris Agreement requires global greenhouse gas (GHG) emissions to reach net-zero by 2055-2070

• NET-ZERO AGRICULTURE 2050

• GHG emissions from agri. Sector declined 20% between 1990 and 2015
  o 17% decline in NO₂ – Reduce use of N fertilizers
  o 22% decrease in CH₄ enteric fermentation – Reduction of livestock numbers
EU facts

- Agriculture in EU27 ~10% of economy-wide GHG emissions
  - 59% attributable to livestock production (even more)
    - Manure decomposition and enteric fermentation
    - Microbial nitrification and denitrification processes in soils – Use of fertilizers
    - Mostly non-CO₂ emissions - CH₄ from enteric fermentations of ruminants (44%), NO₂ from fertilizer application and both NO₂ and CH₄ manure management (15%)
Total GHG emissions from livestock and poultry in EU

According to CAPRI calculations total GHG fluxes of European Livestock production amount to 661 Mio tons of CO₂-eq

Source: Evaluation of the livestock sector's contribution to the EU greenhouse gas emissions (GGELS) - Final report - Administrative Arrangements AGRI-2008-0245 and AGRI-2009-0296
GHG emissions/kg of meat-milk-eggs from livestock and poultry in EU

Comparison of total GHG fluxes of different meat categories in kg of CO₂eq per kg of meat

Source: Evaluation of the livestock sector’s contribution to the EU greenhouse gas emissions (GGELS) - Final report - Administrative Arrangements AGRI-2008-0245 and AGRI-2009-0296
Mitigation strategies

- **Reducing activities** – Reducing heads of livestock
- **Reducing emission intensity** – Emitting less per unit of production – EFFICIENCY!
  - Optimization of fertilizer application rates
  - Reduce energy consumption of feed production
  - Improved feed conversion efficiency
    - Reduce the amount of undigested nutrients (N)
    - Improving intestinal health
  - Improved rumen efficiency
  - Manure management – Reduce anaerobic decomposition (↓ N₂O)
  - Reduce CO₂ emissions from soil

Feed additives from the feedmill to the GIT
Reduce energy consumption of feed production

• Pelleting process = 60-80% of energy consumption in feed mills*
• 1 ton of pelleted feed = 35 kg of CO₂ emissions*
• The use of **technological feed additives - tensioactive dispersing solution:**
  o Reduce variability – Process standardization
  o Increase productivity:
    • Increase pellet throughput
    • Reduce energy consumption
    • Improve feed yield output

*Enviros. CCA data for the period October 2006 to September 2007
**Effect of MillSMART™ on Feed Processing Key Performance Indicators MetaData 2017 involving 14 trials. Kemin Internal Reference 18-00013
- Due to lower contact angle droplets spread on the surface and penetrate
- Improving efficacy More feed surface area and thereby

- Reduces drop size during spraying phase due to lower surface tension.
- Smaller droplets improve dispersion

The multifactorial concept

1. Volumes
   - 1 litre of liquid
   - 6 m²

2. Nozzle Technology
   - In the applicator reduces droplet size before spraying
   - Smaller drops cover a larger surface area

3. Surface tension
   - Reduces drop size during spraying phase due to lower surface tension.
   - Smaller droplets improve dispersion

4. Contact angle
   - Due to lower contact angle droplets spread on the surface and penetrate

Technological feed additive

Actvated Carrier

Tension-active dispersing solution
Pelleted feed throughput can be improved by 20%* with the use of **tensioactive dispersing solutions** (more feed is produced with the same energy consumption) = 7 kg of CO₂ emissions less per ton of feed

What does this mean?

- 220 million tons of processed feed (compound and RM) produced in EU*
- Total reduction of CO₂ = 1,5 million tons of CO₂ reduction per year ~ 1,5 million go-return flights Paris-New York**

*Effect of MillSMART™ on Feed Processing Key Performance Indicators MetaData 2017 involving 14 trials. Kemin Internal Reference 18-00013

**https://www.ademe.fr/
## Improving nutrient digestibility - Enzymes

Use of multienzyme complex containing **protease**, amylase, xylanase, betaglucanase and cellulase in nutrient digestibility of piglet diets

<table>
<thead>
<tr>
<th>Nutrient*</th>
<th>C</th>
<th>KZ 250</th>
<th>KZ 1000</th>
<th>SEM</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>OM (%)</td>
<td>82,9a</td>
<td>83,7a</td>
<td>84,8b</td>
<td>0,3</td>
<td>&lt;0,01</td>
</tr>
<tr>
<td>Ash (%)</td>
<td>51,3</td>
<td>49,7</td>
<td>50,2</td>
<td>0,7</td>
<td>0,258</td>
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<tr>
<td>DM (%)</td>
<td>81,11a</td>
<td>81,8a</td>
<td>82,9b</td>
<td>0,3</td>
<td>&lt;0,01</td>
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<tr>
<td>CP (%)</td>
<td>75,2a</td>
<td>76,6ab</td>
<td>78,2b</td>
<td>0,7</td>
<td>0,021</td>
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<tr>
<td>Cfat (%)</td>
<td>68</td>
<td>70,6</td>
<td>68,8</td>
<td>1,1</td>
<td>0,239</td>
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<tr>
<td>Starch (%)</td>
<td>99,4</td>
<td>99,5</td>
<td>99,6</td>
<td>0,1</td>
<td>0,481</td>
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<tr>
<td>NSP (%)</td>
<td>32,9a</td>
<td>35,4a</td>
<td>40,5b</td>
<td>1,3</td>
<td>&lt;0,01</td>
</tr>
<tr>
<td>CF (%)</td>
<td>26,5a</td>
<td>29,1a</td>
<td>38,6b</td>
<td>2</td>
<td>&lt;0,01</td>
</tr>
<tr>
<td>GE (%)</td>
<td>80,4a</td>
<td>81,4a</td>
<td>82,5b</td>
<td>0,4</td>
<td>&lt;0,01</td>
</tr>
<tr>
<td>NE – kcal/kg (MJ/kg)</td>
<td>2085a (8,73)</td>
<td>2114ab (8,85)</td>
<td>2140b (8,96)</td>
<td>0,05</td>
<td>&lt;0,01</td>
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<tr>
<td>ME – kcal/kg (MJ/kg)</td>
<td>2916a (12,21)</td>
<td>2957ab (12,38)</td>
<td>3007b (12,59)</td>
<td>0,07</td>
<td>&lt;0,01</td>
</tr>
<tr>
<td>DE – kcal/kg (MJ/kg)</td>
<td>3129a (13,1)</td>
<td>3167a (13,26)</td>
<td>3212b (13,45)</td>
<td>0,06</td>
<td>&lt;0,01</td>
</tr>
</tbody>
</table>

* OM = organic matter; DM = dry matter; CP = crude protein; Cfat = crude fat; NSP = non-starch polysaccharides; CF = crude fiber; GE = gross energy; NE = net energy; ME = metabolizable energy; DE = digestible energy.

*abc Values within rows with different superscript differ significantly (P ≤ 0,05)

**CP of the diets = 180 g/kg**  
Δ CP dig = 3%
Implications - enzymes

- 5.4 g less of CP per kg of feed is excreted by piglets supplemented with enzymes
- 0.864 g of N per kg of feed less is excreted by piglets supplemented with enzymes
- Total piglet feed production in EU-27 ~ 9 million tons/year
- Potential less N excreted per year ~ 7776 tons (9442 tons of NH₃)
- Maximum amount of N in livestock manure to be applied in NVZ* = 170 kg nitrogen/hectare/year) – 45.741 ha of land saved

* Nitrogen Vulnerable Zones
Improving nutrient digestibility – Nutrient absorption enhancers

• Digestibility trial at UAB University (Spain)
• 24 days of age Ross 308 chickens – 8 cages per treatment with 5 chickens per cage

CP of the diets = 203 g/kg

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>Absorption enhancer</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dig DM, %</td>
<td>66,9</td>
<td>70,1</td>
<td>***</td>
</tr>
<tr>
<td>Dig OM, %</td>
<td>71,7</td>
<td>74,6</td>
<td>**</td>
</tr>
<tr>
<td>Dig GE, %</td>
<td>74,1</td>
<td>76,8</td>
<td>**</td>
</tr>
<tr>
<td>Dig CP, %</td>
<td>60,5</td>
<td>64,2</td>
<td>*</td>
</tr>
<tr>
<td>Dig. Total FA, %</td>
<td>86,4</td>
<td>88,5</td>
<td>***</td>
</tr>
<tr>
<td>AMEn, kcal/kg</td>
<td>2903</td>
<td>3013</td>
<td>***</td>
</tr>
</tbody>
</table>

*P<0,05; **P<0,01; ***P<0,001
Implications – Absorption enhancers

• 1.2 g of N per kg of feed less is excreted by broilers supplemented with the nutrient absorption enhancer

• Total broiler feed production in EU-27 ~ 25 million tons/year

• Potential less N excreted per year = 30 000 tons (36 430 tons of NH₃)

• Maximum amount of N in livestock manure to be applied in NVZ* = 170 kg nitrogen /hectare/year) – 176.470 ha of land saved

* Nitrogen Vulnerable Zones
Improving intestinal health – Active microbials

• Unmarketable eggs
  o Eggs shell-less, soft shell, cracked, micro-cracked, in general presenting shell deformities, dirty eggs
  o The magnitude of unmarketable eggs in EU goes from 1.5 to more than 8%
  o Ca absorption decreases with age, and the larger is the egg, the thinner is the shell
  o Aggravated by the longer laying cycles (even more than 100 weeks)
  o Very much related to deficient intestinal health
Effects of dietary probiotic inclusion on performance, eggshell quality, cecal microflora composition, and tibia traits of laying hens in the late phase of production


Data with different letters are statistical significant with a P-value < 0.05
Improving intestinal health – Active microbials

Egg shell density (mg/cm²)

Unmarketable eggs (%)

Data with different letters are statistical significant with a P-value < 0.05

Implications – Active microbials

- EU production of eggs ~ 8 million tons
- GHG flux of eggs ~ 3 kg CO$_2$eq per kg of egg mass*
  - Total GHG flux = 24 million tons of CO$_2$eq
- Improvement of 2% in marketable eggs could lead to additional 160,000 tons of eggs
- New GHG flux of eggs = 2.94 kg CO$_2$eq per kg of egg mass
- Reducing emission intensity – Emitting less per unit of production – EFFICIENCY!

*Greenhouse gas emissions from the EU livestock sector: A life cycle assessment carried out with the CAPRI model
Agriculture, Ecosystems and Environment 149 (2012) 124–134
Franz Weiss, Adrian Leip (Joint Research Centre, Institute for Environment and Sustainability (IES), Climate Change and Air Quality Unit, Via E. Fermi 2749, 21027 Ispra, VA, Italy)
Conclusions

• Emissions from livestock and poultry production are under the spotlight of public opinion

• WE are determined by EU commitments - The sooner we take action, the better

• Feed additives offer is wide and diverse and future (present?) decision making process should involve GHG mitigation potential

• The approach to mitigation potential needs to be holistic – CO₂ emissions throughout all the process - from the feed mill to the GIT
THANK YOU