Agriculture and climate change – Strategic planning and R&D in a global fertilizer company

Frank Brentrup, PhD
Yara International ASA
Why fertilizer?
Fertilizer replace nutrients that are removed from the field and add nutrients for higher yield

Supply of crop residues and organic fertilizer

NPK

Crop residues are decomposed to minerals

- Export of nutrients with the harvest
- Unavoidable losses from the field
- Growing demand for food & feed
Who is Yara?
1905: From a Norwegian pioneer in mineral Nitrogen ...

World’s first production of nitrogen fertilizer (calcium nitrate) at a plant in Notodden, Norway

Visit of Notodden plant by King Rama V/ Chualalongkorn of Siam

Calcium Nitrate being shipped in wooden barrels
to a global presence
We sell about 35 Million Tons of Products & Solutions On Six Continents

Revenue 2016: ~ 12 billion €
EBITDA = 2,2 billion €
Employees = 13,000

Sales figures mill. tons
- Fertilizers
- Industrial products & solutions

%= total sales
Yara Crop Nutrition - our approach

Consolidated and deep knowledge on crops

Tools and services, application competence

Large portfolio of fertilizer product for better efficiency
Our Mission

Responsibly feed the world and protect the planet.

Our Vision

A collaborative society; a world without hunger; a planet respected.
The global challenge to agriculture
Global food production needs to increase to satisfy growing demand of increasing population

We recommend *sustainable intensification* of agricultural production

= produce more food, on the same land, with less environmental impact
Contribution of the agricultural sector and land use change to global GHG emission

Total: 49.4 Billion t CO$_2$-equivalents

Agriculture (10.2%):
- Livestock & manure (6.8%)
- Mineral fertilizer (1.2%)
- Rice (1.0%)
- Residues & org. soils (1.2%)

Land use change** (11.2%)

11.2% of global GHG emission are ~ 5.5 Billion t CO$_2$-equivalents.

Total EU28 GHG emission in 2010 were ~ 5.0 Billion t CO$_2$-equivalents


* Based on IFA (2009)
Land use change and agriculture dominate GHG emission of regions with strong agricultural growth

Emissions from land use change are mainly related to deforestation

* Net emissions (sources – sinks)

FAOSTAT data
GHG emission of regions with strong agricultural growth in comparison to Europe and N-America

Large emission caused by land use change to agriculture suggest not to increase arable land but to increase productivity on existing agricultural land by closing yield gaps.

For comparison:

In Europe and N-America forests are a net-sink for CO2
Climate change and food security are related. Innovation, knowledge transfer & cooperation will contribute to solutions.
Initiative and Innovation to reduce GHG emission in European N fertilizer production
N fertilizer induced GHG emission dominate the carbon footprint of crop production

Based on a long-term field trial data with winter wheat (UK), N source = Ammonium Nitrate
We developed a catalyst to reduce N$_2$O emission in fertilizer production.
The catalyst cut carbon footprint of crop production by about 40%.

Based on a long-term field trial data with winter wheat (UK), N source = Ammonium Nitrate.
Yara was the first company to deliver Carbon footprint certification for nitrogen fertilizers

Yara guarantees a carbon footprint of <3.6 kg CO2eq/kg N at production

The data and calculations are verified by Det Norske Veritas (DNV)
Implementation of catalyst reduced GHG emissions from European fertilizer production
(example Ammonium Nitrate, AN)

kg CO$_2$eq / kg AN-N

1990s: 8.7
2006: 6.2
2014: 3.6

Ecoinvent (2002)  Fertilizers Europe reference values*

* 2006 value from Brentrup & Palliere (2008); 2014 value derived from Fertilizers Europe Carbon Footprint Calculator v2.1 (2016)
Today the European fertilizer industry has the lowest GHG emission in N fertilizer production (Ammonium Nitrate, AN, 2014)

* Assumption for ammonia production in China: 75% coal-based, 25% gas-based

All data derived from Fertilizers Europe Carbon Footprint Calculator v2.1 (2016)
How to reduce N$_2$O emission from soils?

- Higher crop Nitrogen Use Efficiency (NUE)
  
  \( \text{NUE} = \text{share (\%)} \text{ of fertilizer absorbed by crop} \)

- What can be measured can be improved
The catalyst cut carbon footprint of crop production by about 40%.

Based on a long-term field trial data with winter wheat (UK), N source = Ammonium Nitrate.
Yara N-Sensor® - variable rate N fertilization to apply N fertilizer precisely according to crop N demand

Plant nutrition know-how embedded in advanced technology
Detection of crop nitrogen demand on-the-go
Crop analysis and fertilizer application as 1 job
Fast and easy to use
Trial results confirm, variable rate N fertilizer application with the N-Sensor improve crop yield

Average yield and N application of 23 trials with winter wheat
N fertilizer use efficiency (NUE) in EU15 is increasing since the late 1980s.

Today Europe has the highest Nitrogen Use Efficiency (NUE) of any region in the world.
In Europe (EU 15) NUE has increased while N$_2$O emissions from agricultural soils have decreased.

Source: United Nations Framework Convention on Climate Change (UNFCCC, 2011)
Data of best practice nitrogen management trials confirm even higher N use efficiency is possible.

NUE (%)

- average EU 27: 62%
- Yara field trials (n=139): 83%
We do research to reduce N$_2$O emissions from soil after N fertilizer use
$\textit{N}_2\textit{O}$ emissions from fields are influenced by N fertilizer product

- 110 kg N/ha, broadcast, wet conditions

Cumulative $\textit{N}_2\textit{O}$ Emission after 42 days (in g $\textit{N}_2\textit{O}$-N / ha)
Yara was founding member of the Cool Farm Alliance

- The Cool Farm Alliance is a group of **multinational companies, NGOs and academics** working together to measure how improved agricultural practices mitigate greenhouse gas emissions.

- **The aim?** To enable millions of farmers globally to make more informed on farm decisions towards sustainable agriculture.
The Cool Farm Tool

What can be measured can be improved!

An easy to use and standardised online tool for calculating the on-farm environmental impacts, currently greenhouse gas emissions.

The cool farm tool
✓ is scientifically robust
✓ is farmer-friendly
✓ is Industry-backed
✓ shall create incentives for low GHG emission
Summary

• Sustainable intensification of food production is required to meet food security and to protect the environment.

• Best practice crop nutrition is an essential component of sustainable intensification.

• Sustainable intensification needs innovation and knowledge transfer
  • Innovation in manufacturing to reduce emission and raw material consumption
  • Innovation in tools and services to facilitate knowledge transfer and improve nutrient use efficiency.

• Internationally agreed metrics are required to measure environmental impact and to document improvements.