The stabilisation of nitrogen fertilisers to ensure cost effectiveness as well as the prevention of atmospheric and ground water pollution

SAOU Webinar 27 October 2021

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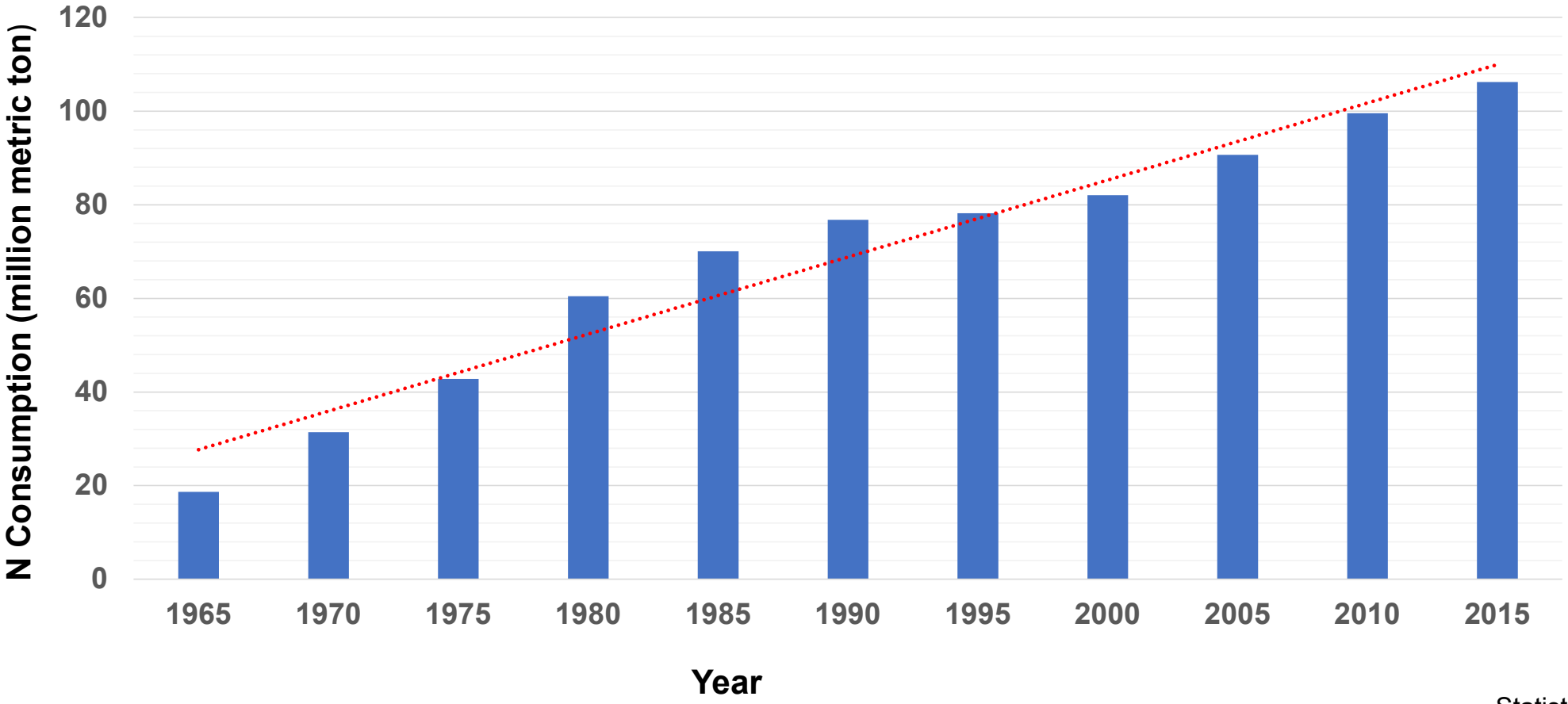
Vuma Crop PTY LTD

Vuma Crop

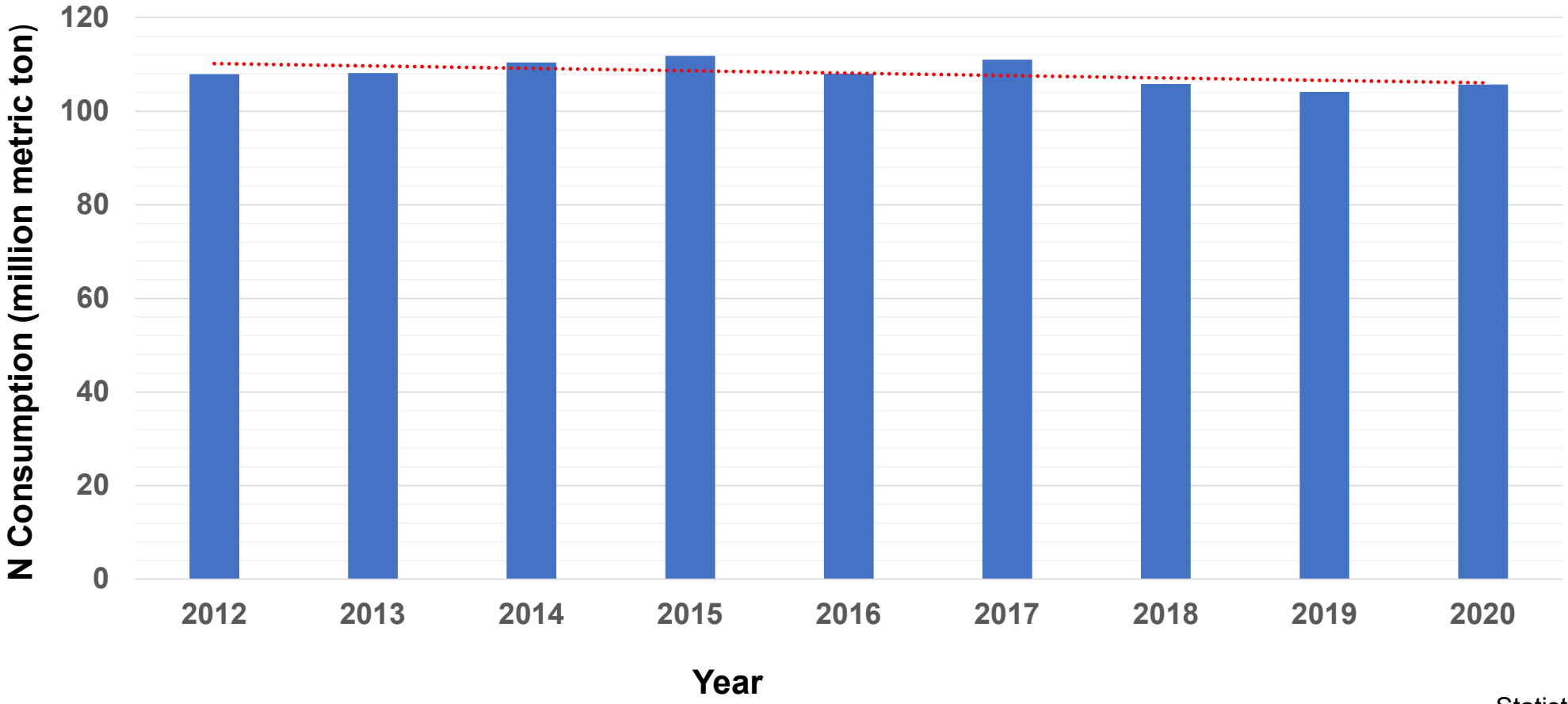
Fertilisation Expertise

Global consumption of nitrogen (N) from 1965 to 2015 for 5 year periods



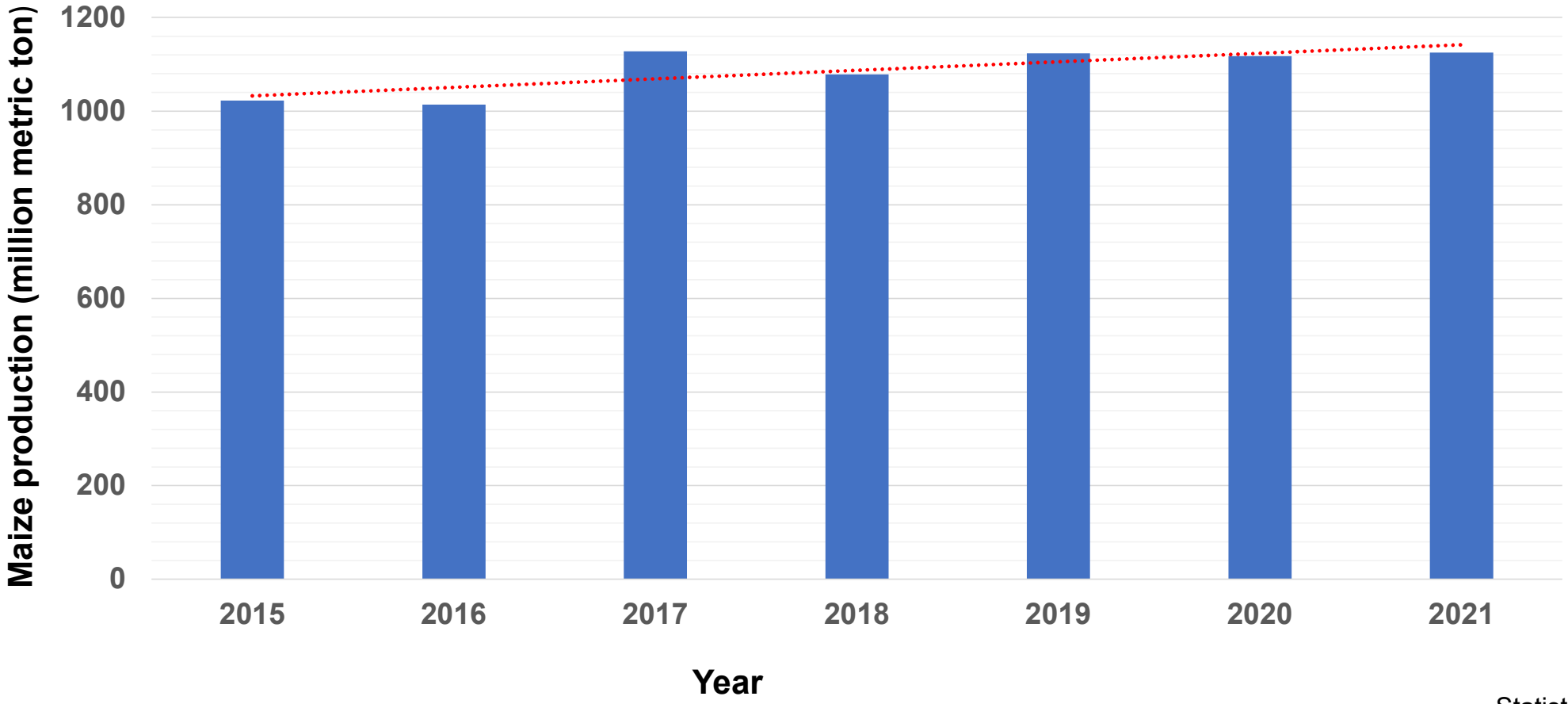
Statista 2021

Annual global consumption of nitrogen (N) from 2012 to 2020



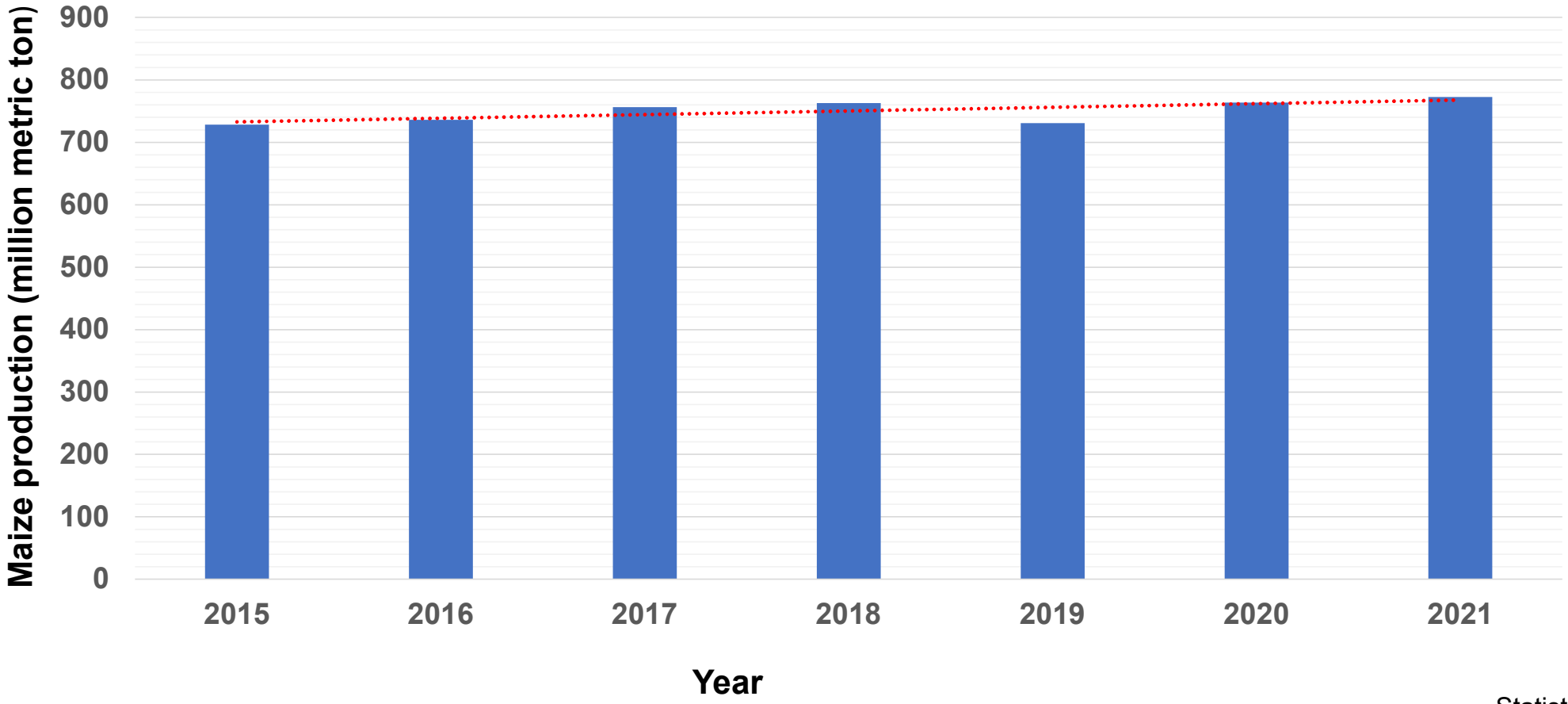
Statista 2021

Annual global maize production from 2015 to 2021



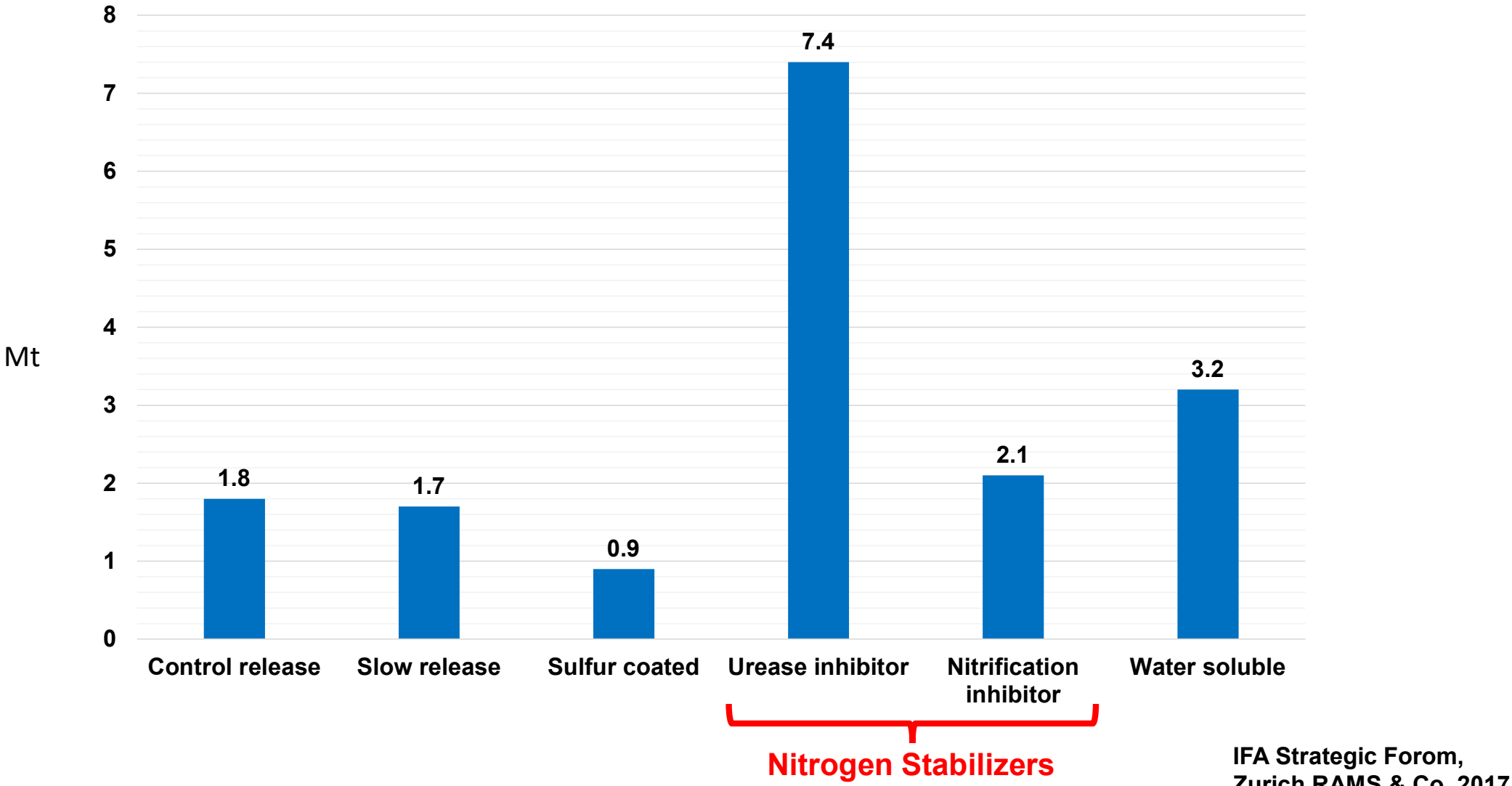
Statista 2021

Annual global wheat production from 2015 to 2021



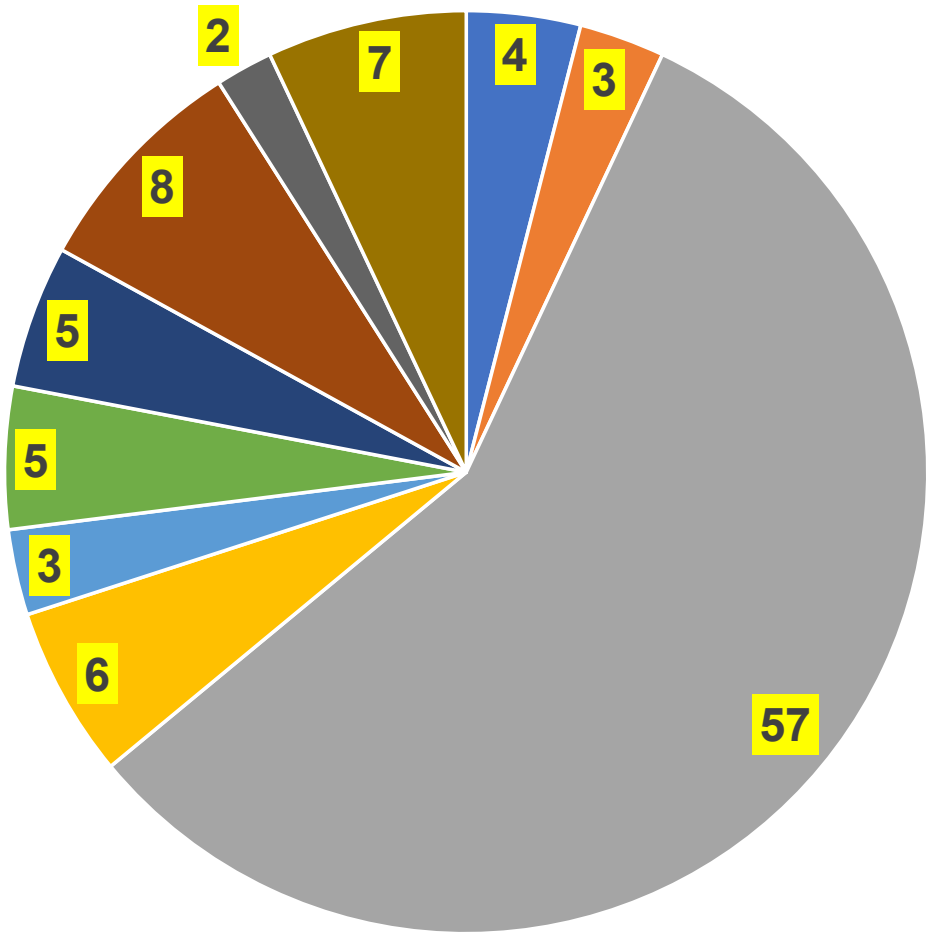
Statista 2021

Advanced efficiency fertilizers - world market



IFA Strategic Forom,
Zurich RAMS & Co, 2017

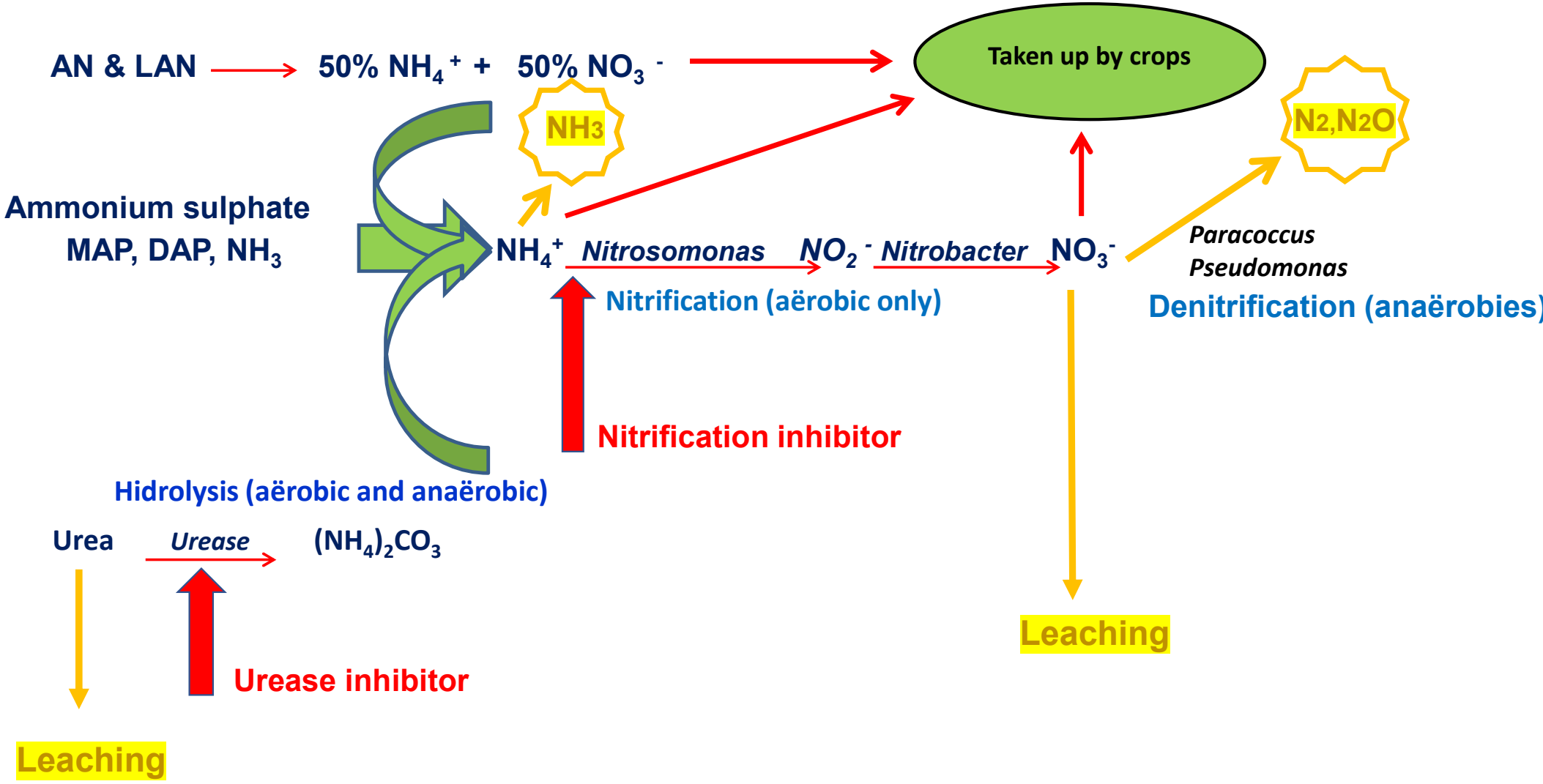
World nitrogen fertiliser consumption by product (%)



- Ammonia dir. Applic
- Ammonium Sulphate
- Urea
- Ammonium nitrate
- Calc.amm.nitrate
- Nitrogen solutions
- Other N strates
- Ammonium phosphate (N)
- Other NP (N)
- N P K compound (N)

2013/14 IFA2016a, www.ini2016.com

Conversion processes of fertilisers in and on soils



Conversion processes affected by:

1. Soil texture
2. Temperature
3. Urea/Ammonium concentration
4. Organic content of soil
5. Soil pH

Application of N-stabilizers

Urease Inhibitors:

1. Reduces NH_3 volatilisation from urea
2. Reduces NH_3 toxicity effects from band placed urea based plant mixtures
3. Reduces N_2O and N_2 emissions from waterlogged soils
4. Reduces atmospheric pollution and therefore damage to the ozone layer

Nitrification Inhibitors:

1. Reduces NO_3 leaching to groundwater.
2. Reduces N_2O and N_2 emissions from waterlogged soils
3. Reduces groundwater pollution and therefore health problems
4. Reduces atmospheric pollution and therefore damage to the ozone layer

Beneficial effects of N-stabilizers which will:
a. Improve nitrogen use efficiency
b. Combat atmospheric and groundwater pollution

- Volatilization
- Toxicity
- Leaching

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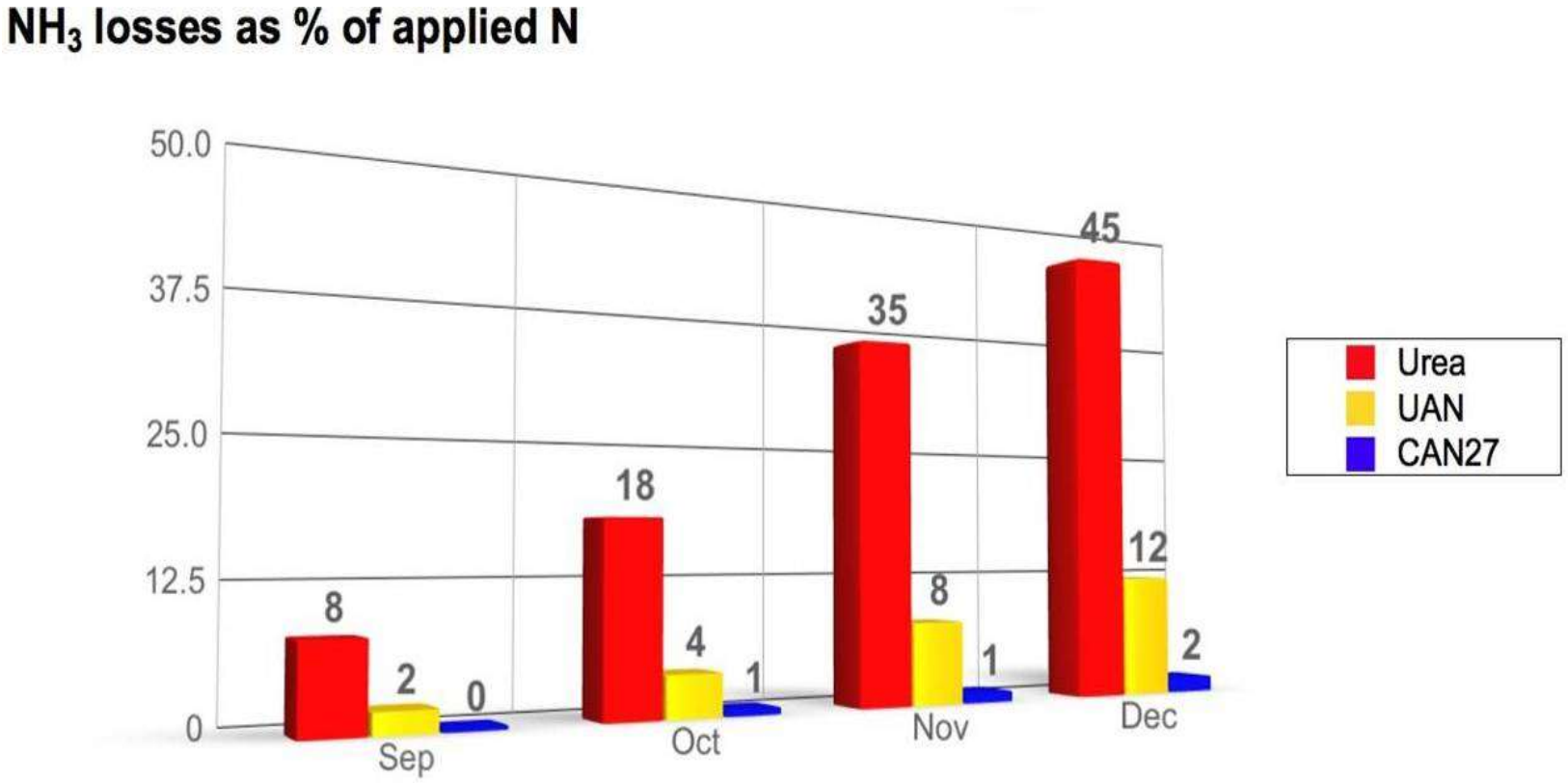
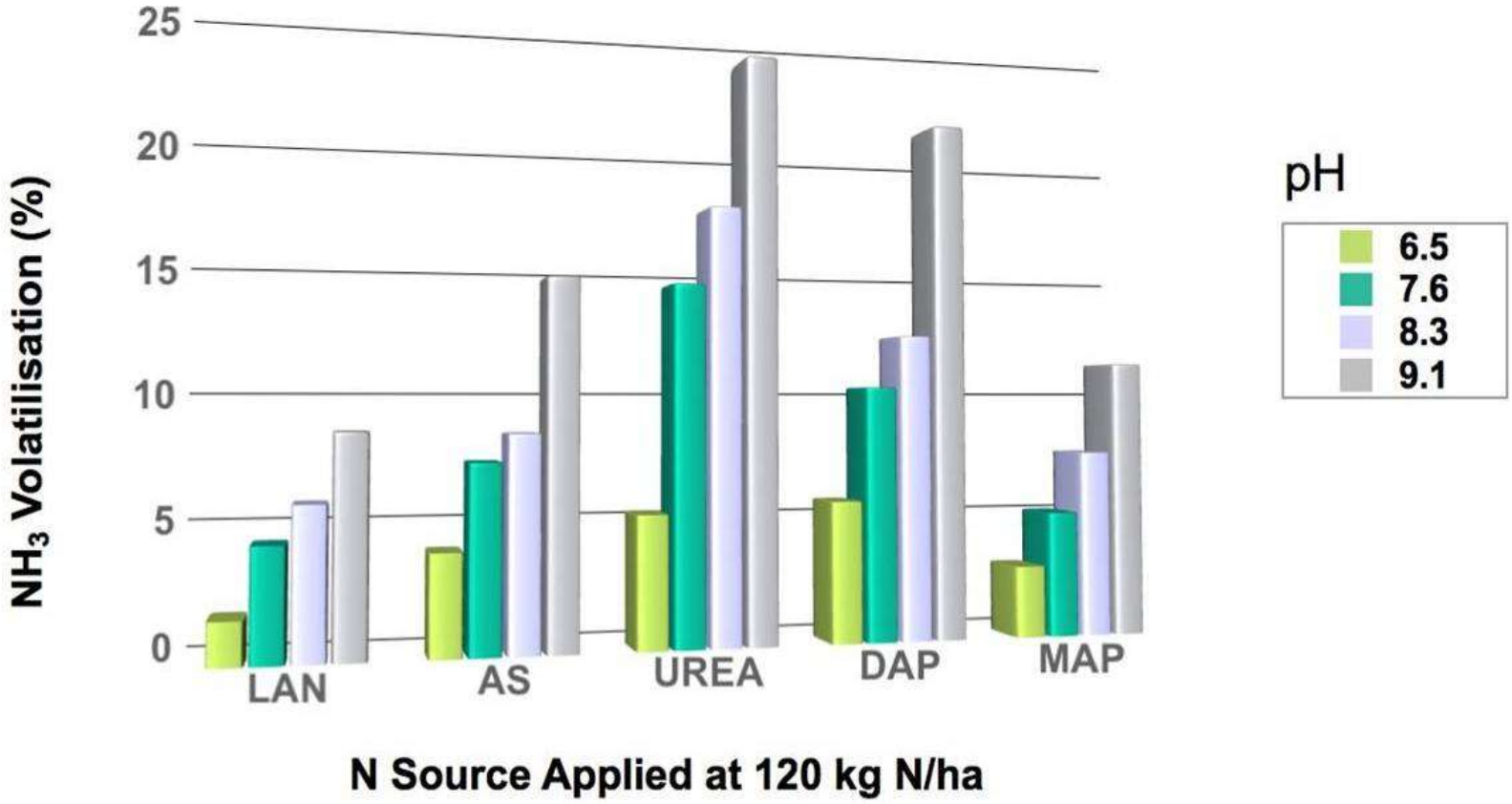
Volatilization affected by N-source and temperature



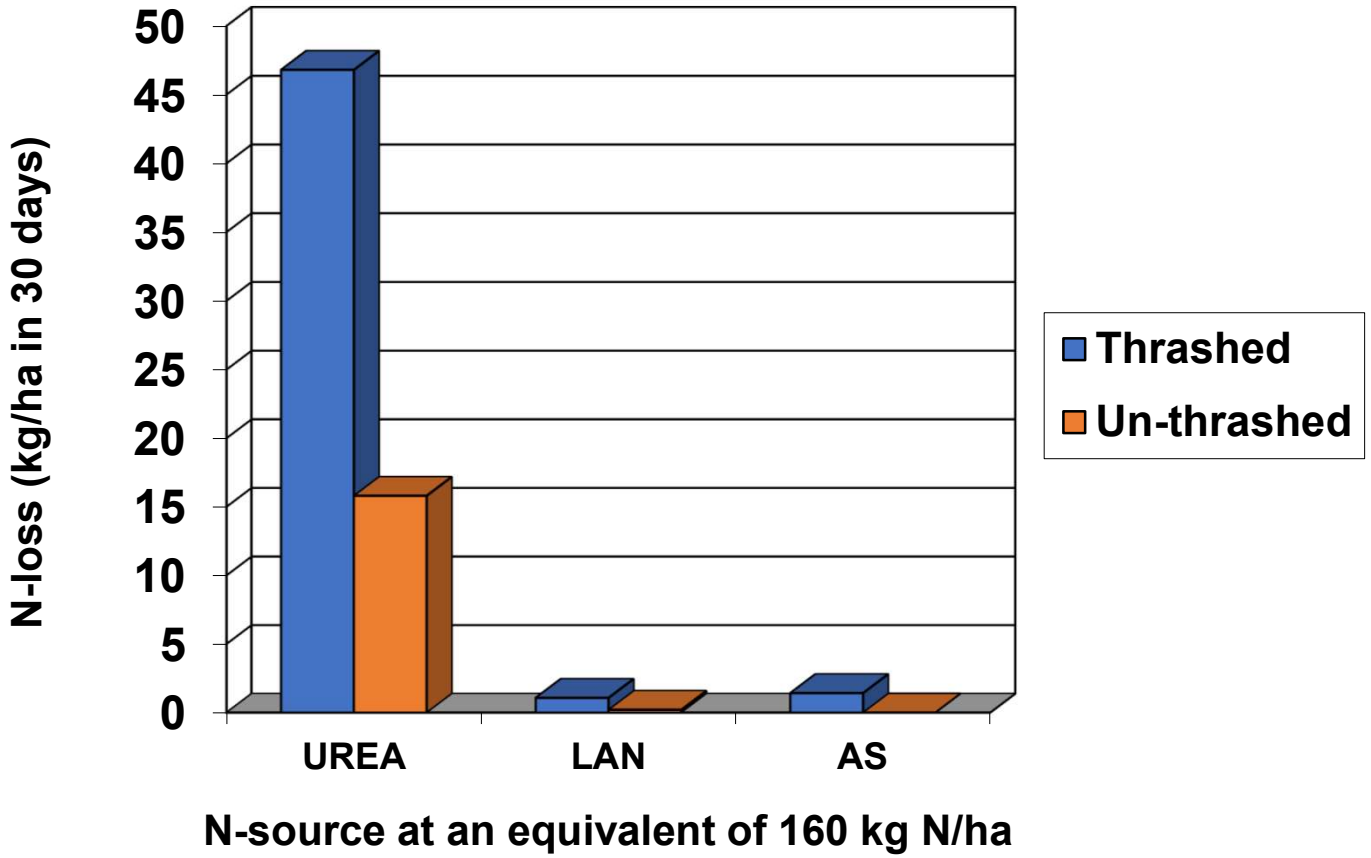
Fantanetto, 1995

Volatilisation affected by N-source and pH



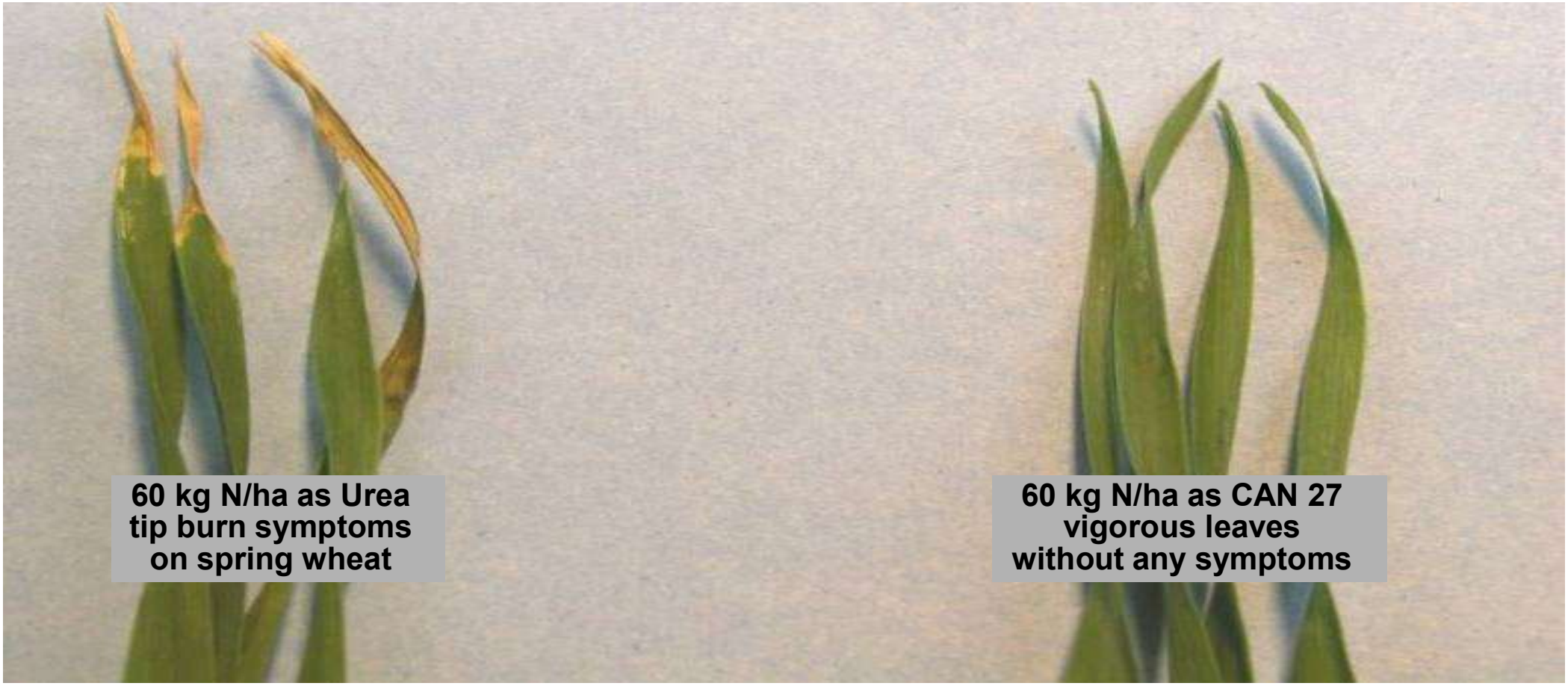
Du Preez and Burger 1986

Volatilization affected by N-source and sugar cane residues



Nixon D J et. al.

Urea toxicity effects compared to CAN 27 on wheat



Yara Research Centre Hanninghof Germany (2007)

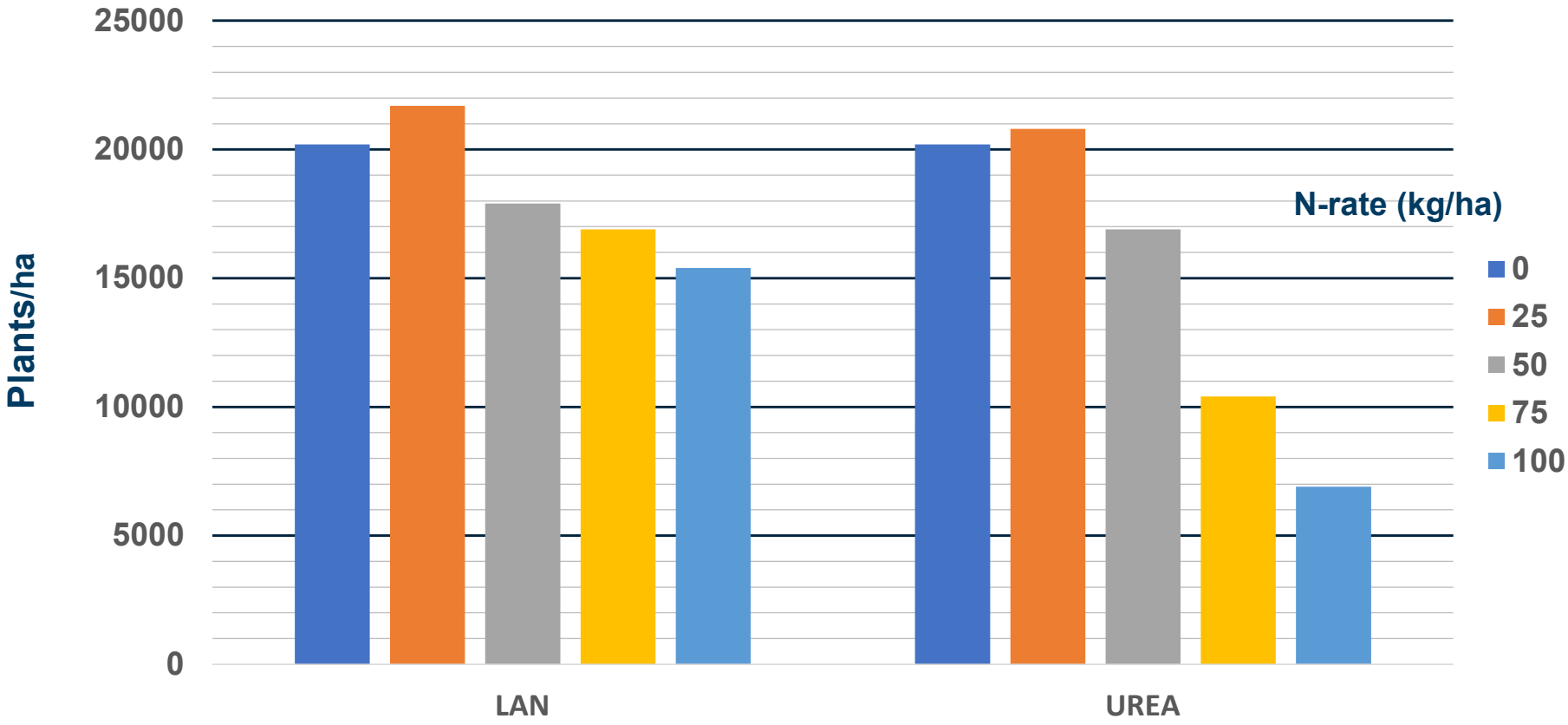
NH_3 toxicity on maize

Hoeft et al. 2000

Urea toxicity effects compared to CAN 27 on maize

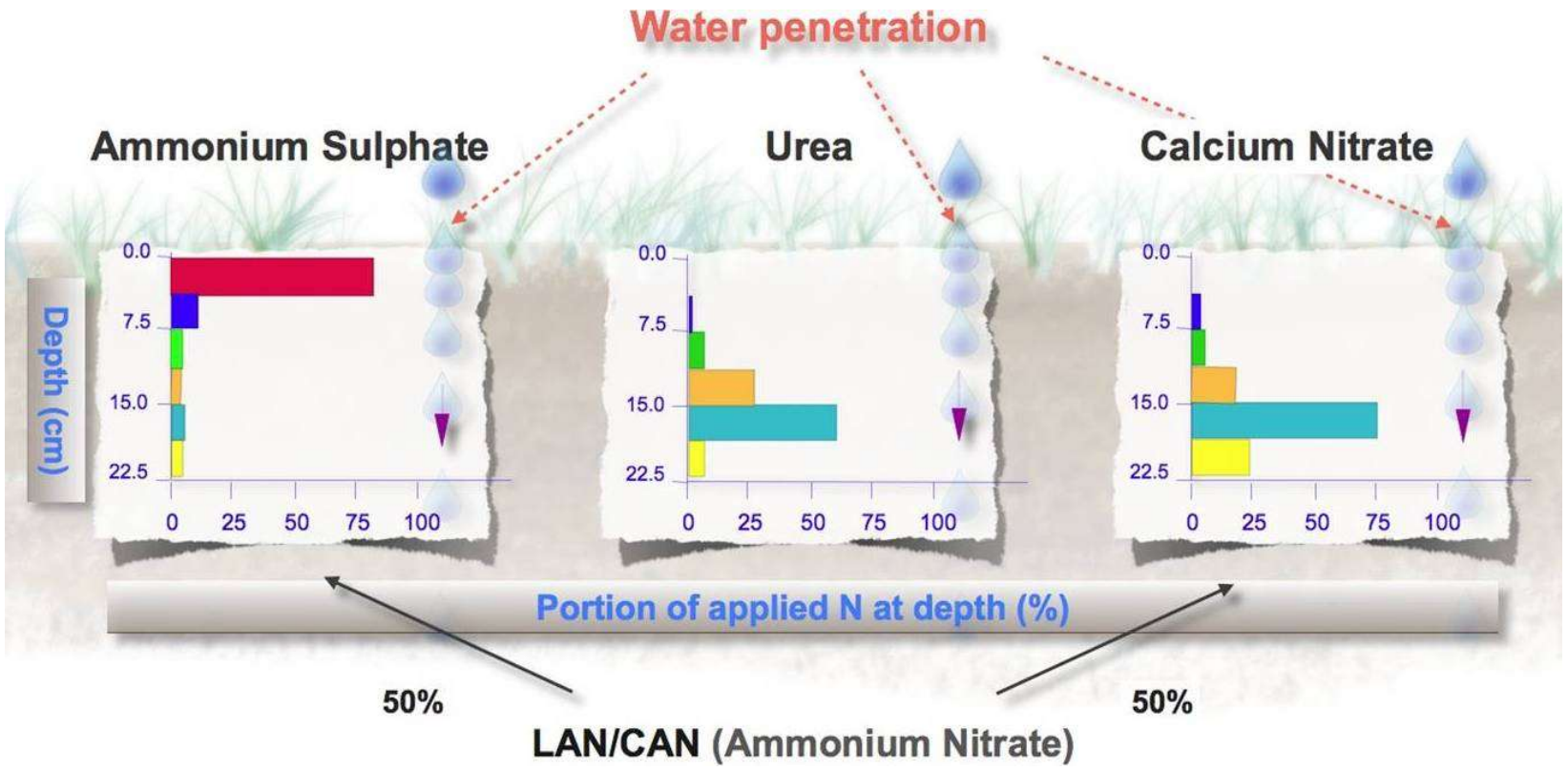
Yara Research Centre Hanninghof Germany (2007)

Urea mortality effects compared to LAN 28 on maize



Adriaanse, 1991

Leaching of N-sources in sandy loam soil



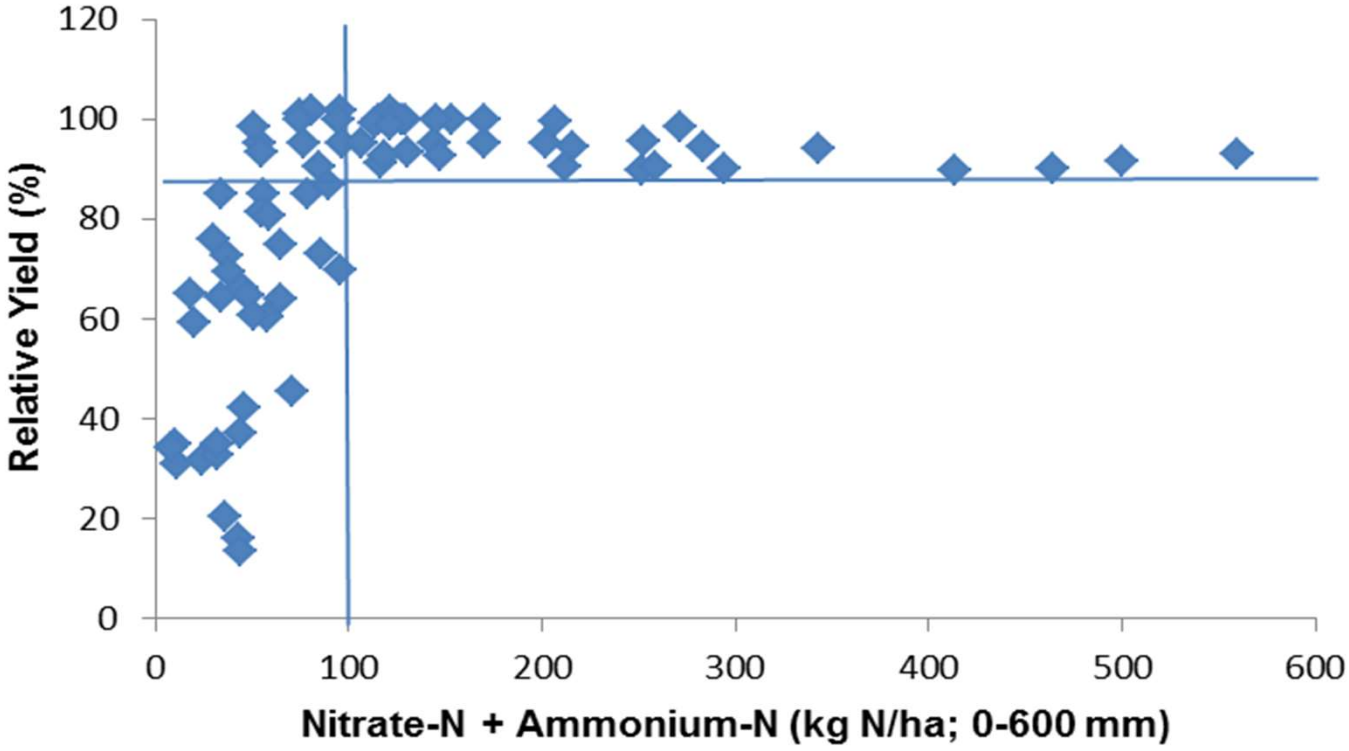
Broadbent et. al. 1958

N leaching

- 63kg N/ha 2 weeks before planting
- 40kg N/ha at planting
- More than 100mm rain shortly after planting
- Well drained sandy soil


N leaching

Relationship between inorganic soil nitrogen and relative yield for maize production

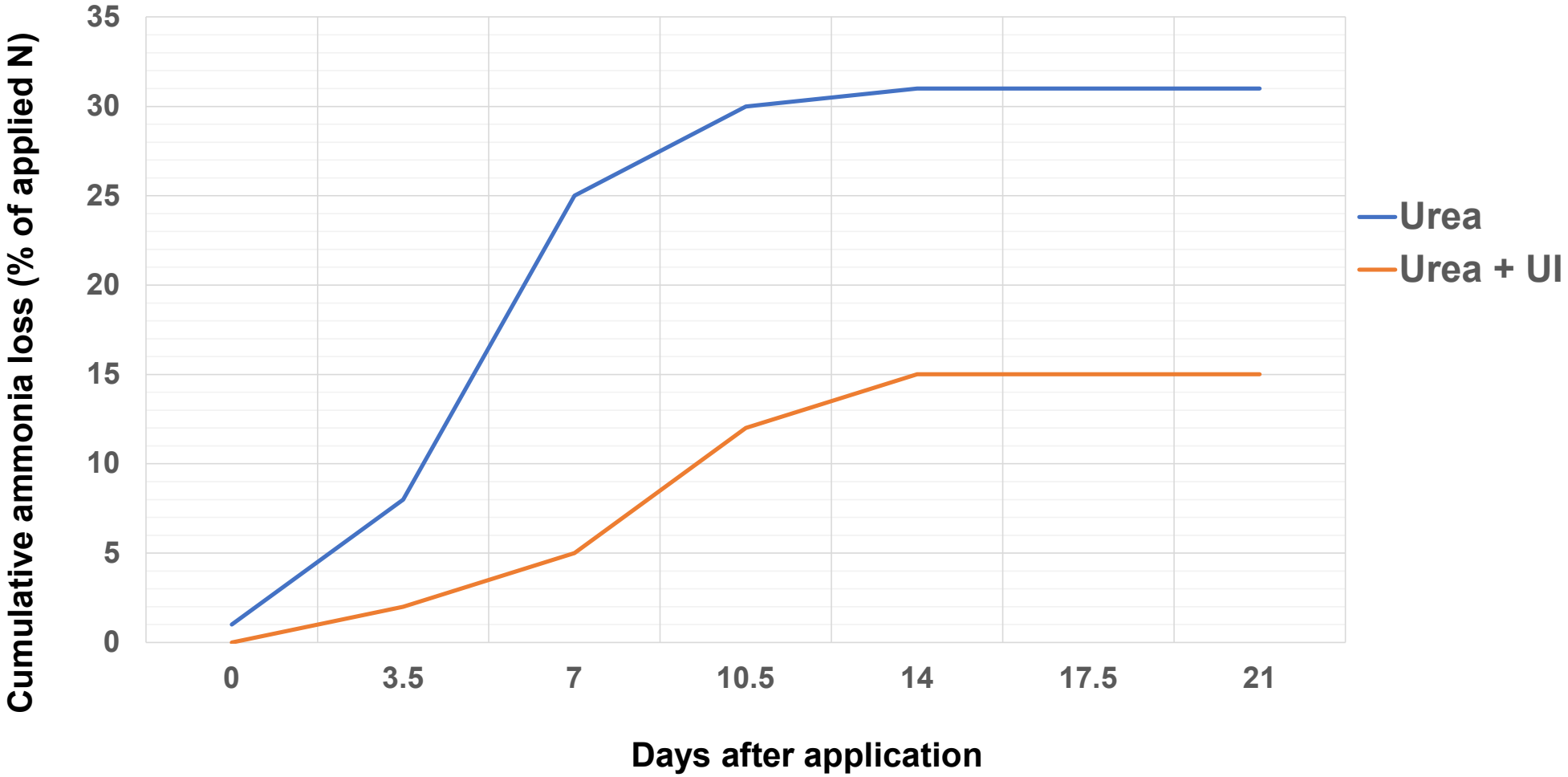


F G Adriaanse, 2013

Active ingrediencies of urease Inhibitors and producers

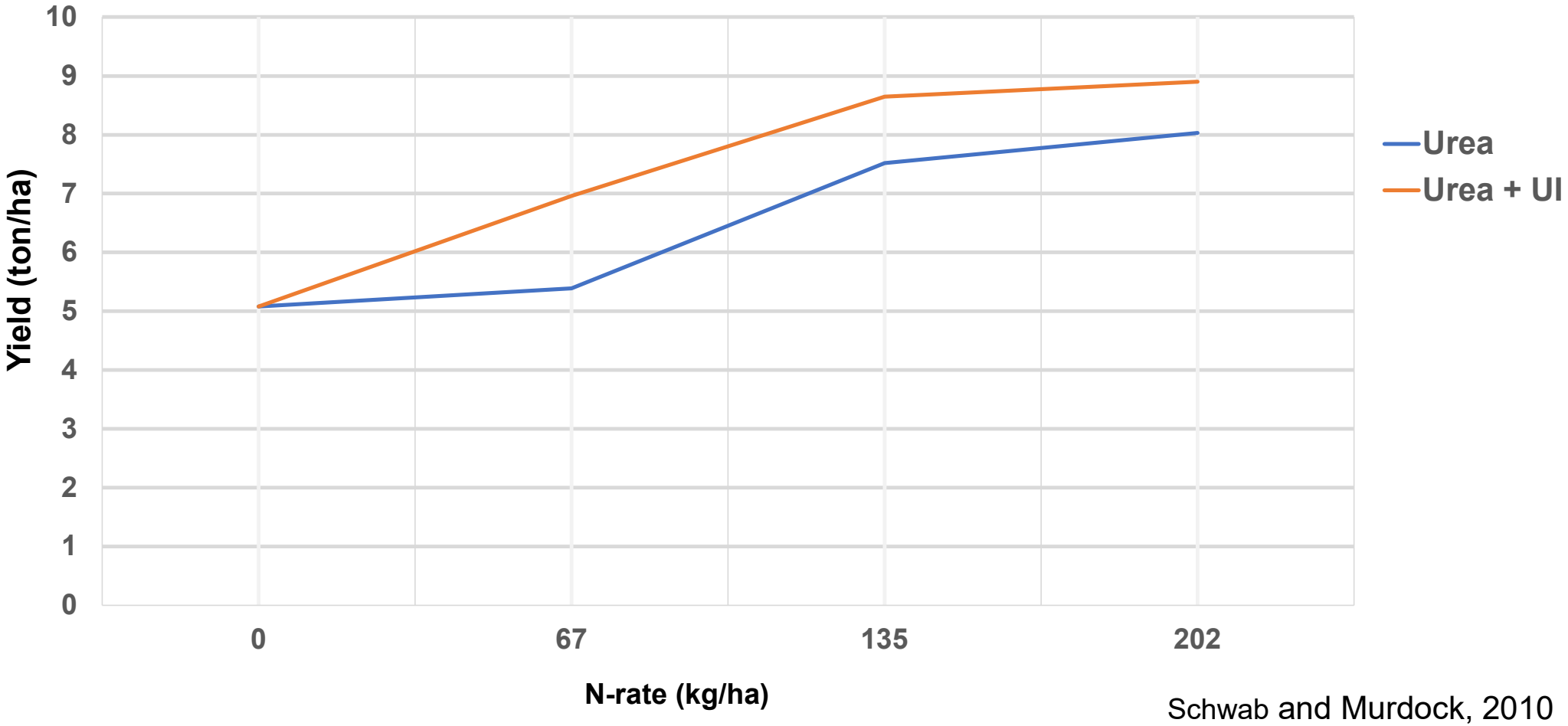
Active ingredient	Producer	Country
NBPT	Koch Agronomical Services Jiujiang Woxin Chemical Co., Ltd	USA China
1,2,4-triazole (2-NPT)	SKW Piesteritz	Germany
Pronitridine	Koch	USA
Schiff bases	Kimleigh Chemicals SA	SA

Effect of urease inhibitors to reduce ammonia losses from surface applied urea



Illustration

Effect of surface-applied urea fertilizer with and without the addition of urease inhibitor (NBPT), on maize yield

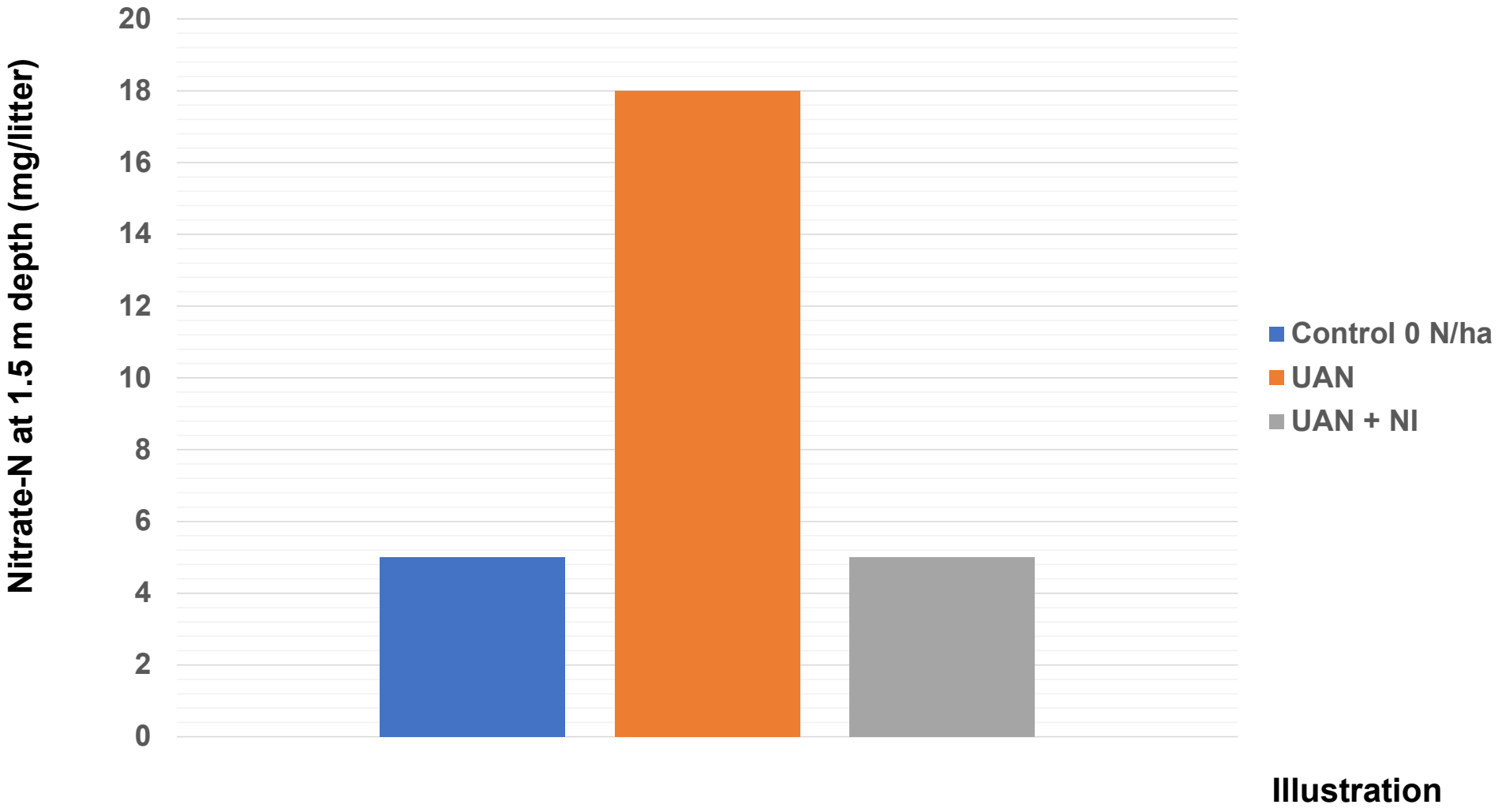


Schwab and Murdock, 2010

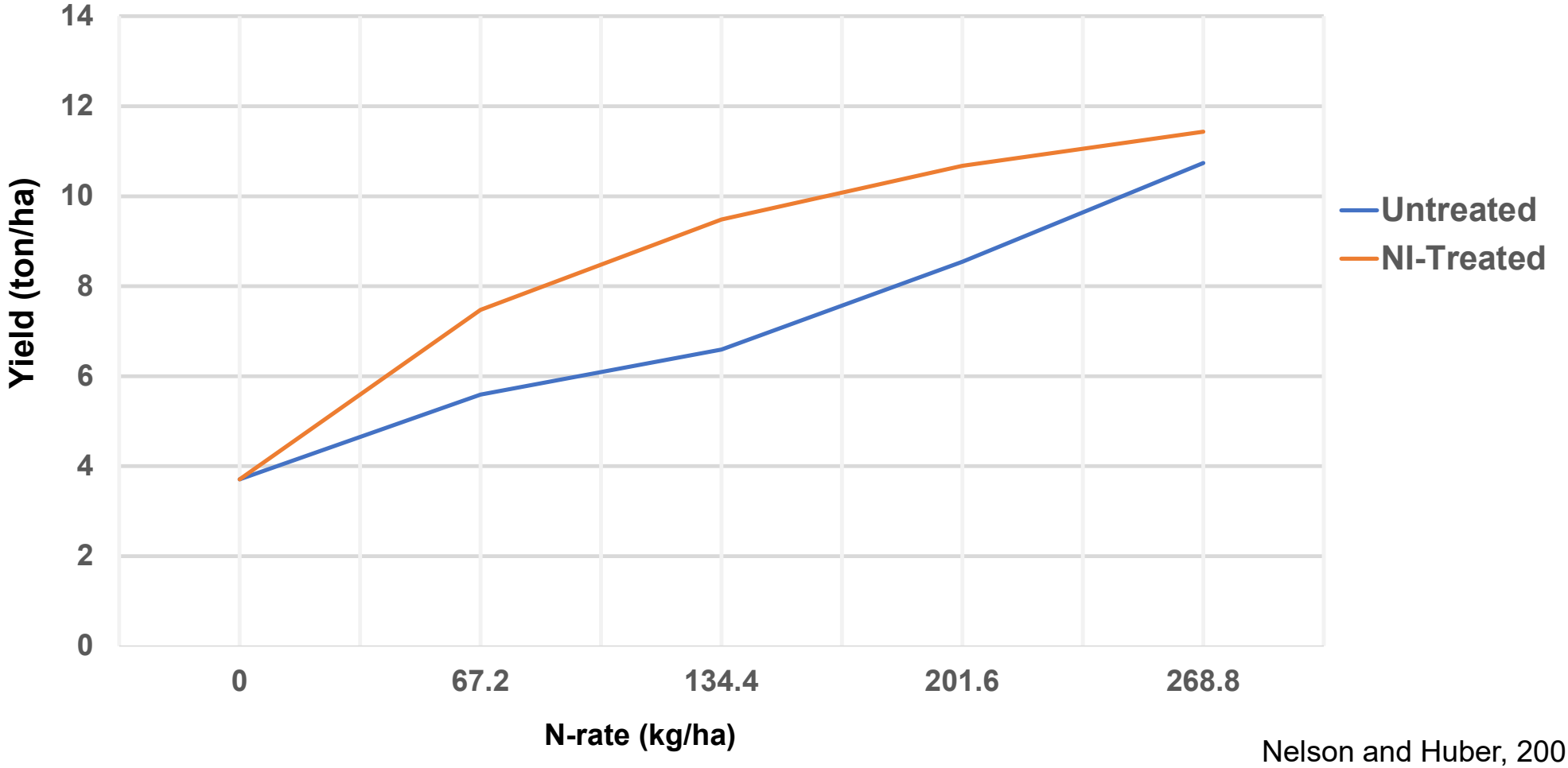
Active ingrediencies of nitrification inhibitors and producers

Active ingredient	Producer	Country
Nytrapyrin (N-Serve)	Dow AgroSci.	USA
DCD (Dicyandiamide)	SKW Piesteritz BASF	Germany Germany
DMPP (3,4 –Dimethylpyrazole)	BASF	Germany
Heterocyclic Nitrogen compounds	Kimleigh Chemicals	SA

Effect of nitrification inhibitors to reduce nitrate leaching

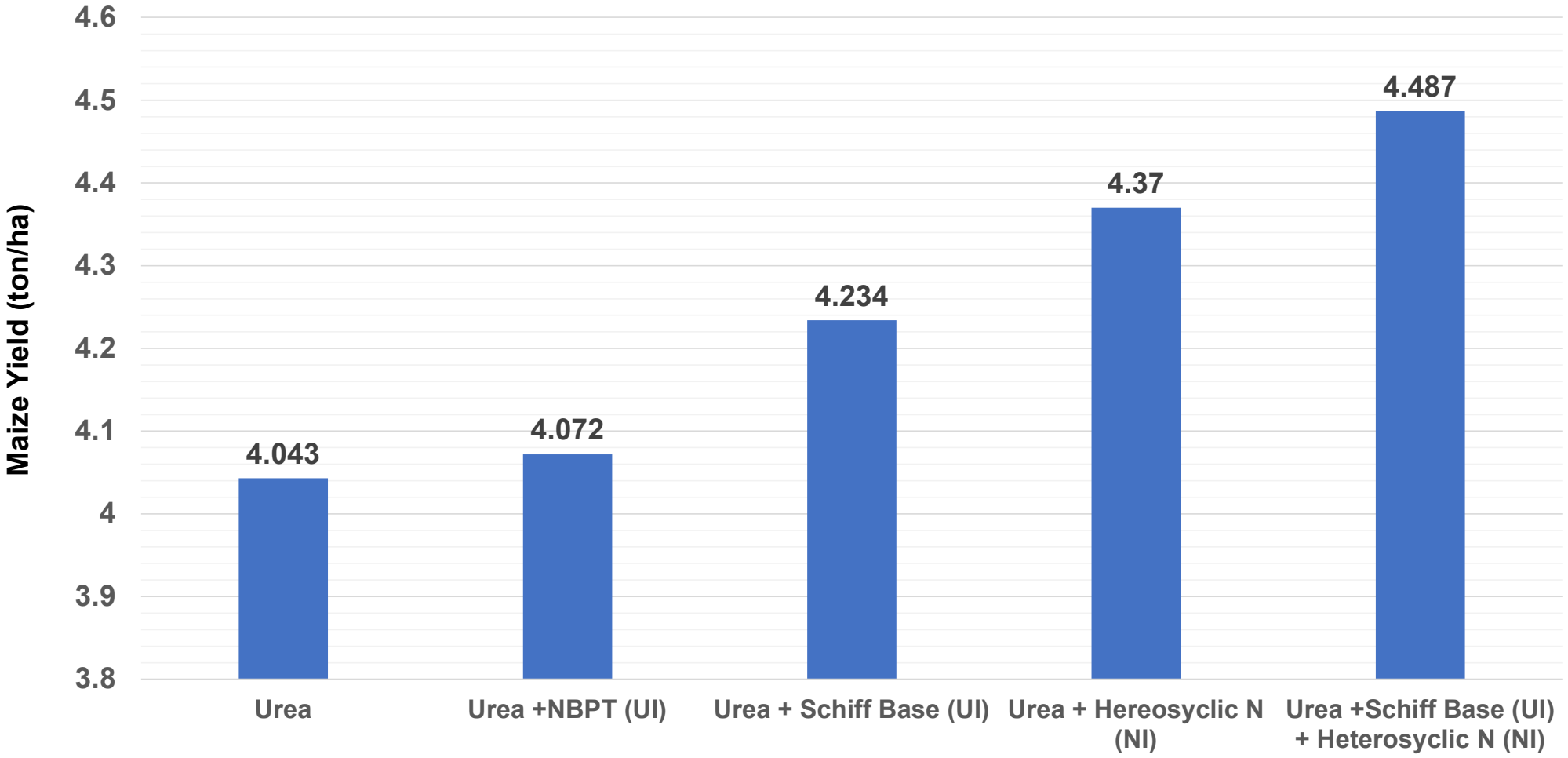


Effect of nitrification inhibitor(nitrapyrin) added to urea on the yield of irrigated maize on a sandy loam soil



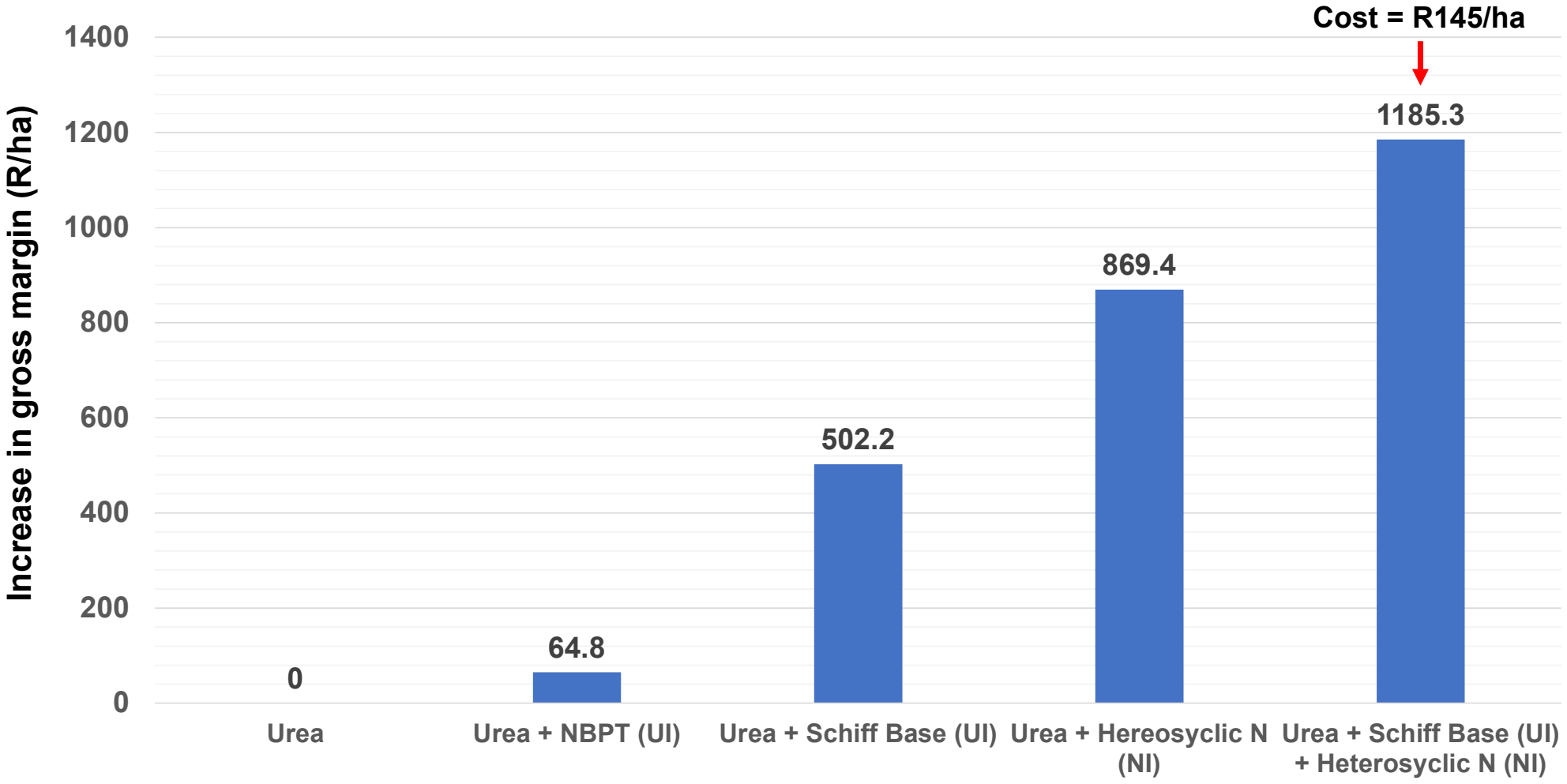
Nelson and Huber, 2001

Effect of new generations urease inhibitors (UI) + nitrification inhibitors (NI) on maize yield at 75 kg N/ha (Deelkraal, South Africa)



FG Adriaanse 2021; Kimleigh Chemicals SA

Effect of urea-stabilizers on the increase in gross margin at 75 kg N/ha and a maize price of R2 700/ton (Deelkraal, South Africa)



FG Adriaanse 2021; Kimleigh Chemicals SA

EU ammonia emission reduction commitment

- Member states to reduce emissions by 21% by 2030
- Compulsory to use urease inhibitor on urea in Germany since 2020 if not incorporated in the soil within 4 hours

Ammonia atmospheric pollution:
Long-term exposures to particulate matter, 2.5 micron (ammonia + sulphates + nitrates)

- Reduced lung function,
- Chronic bronchitis
- Premature death

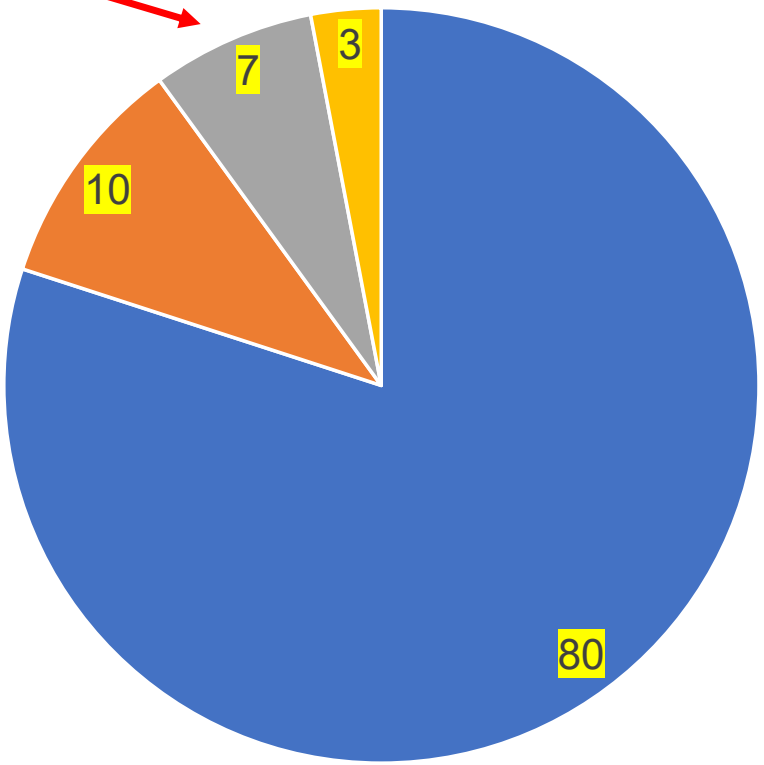
The Fertilizer Institude, 20002 www.tfi.org

Direct contact with ammonia: Concentration/duration/ health effects

- 10,000 ppm: Promptly lethal
- 5,000 – 10,000 ppm: Rapidly fatal
- 700 – 1700 ppm: Incapacitation from tearing of the eyes and coughing
- 500 ppm for 30 minutes: Upper respiratory tract irritation, tearing of the eyes
- 134 ppm for 5 minutes: Tearing of the eyes, eye irritation, nasal irritation, throat irritation, chest irritation
- 140 ppm for 2 hours: Severe irritation, need to leave exposure area
- 100 ppm for 2 hours: Nuisance eye and throat irritation
- 50 – 80 ppm for 2 hours: Perceptible eye and throat irritation
- 20 – 50 ppm: Mild discomfort

US greenhouse gas emissions in 2019 (%)

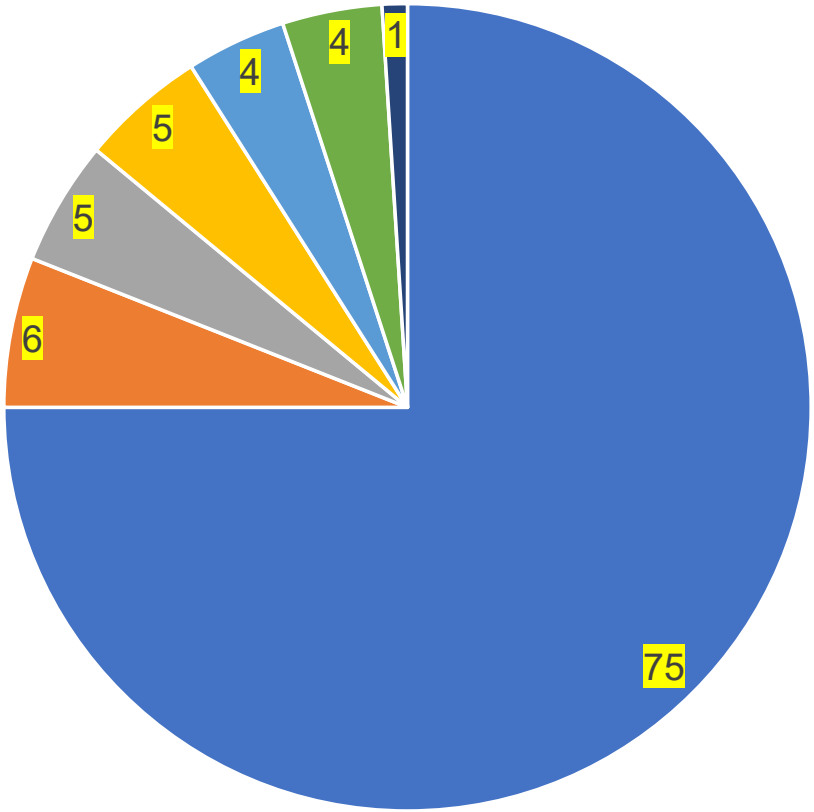
The impact of N_2O/unit on warming the atmosphere is almost 300 times that of carbon dioxide



- Carbon Dioxide
- Methane
- Nitrous Oxide
- Fluorinated Gasses

EPA.gov/ghgemissions, 2019

US nitrous oxide emissions by source in 2019 (%)



- Agricultural Soil Management
- Wastewater Treatment
- Stationary combustion
- Industry or Chemical Production
- Manure Management
- Transportation
- Other

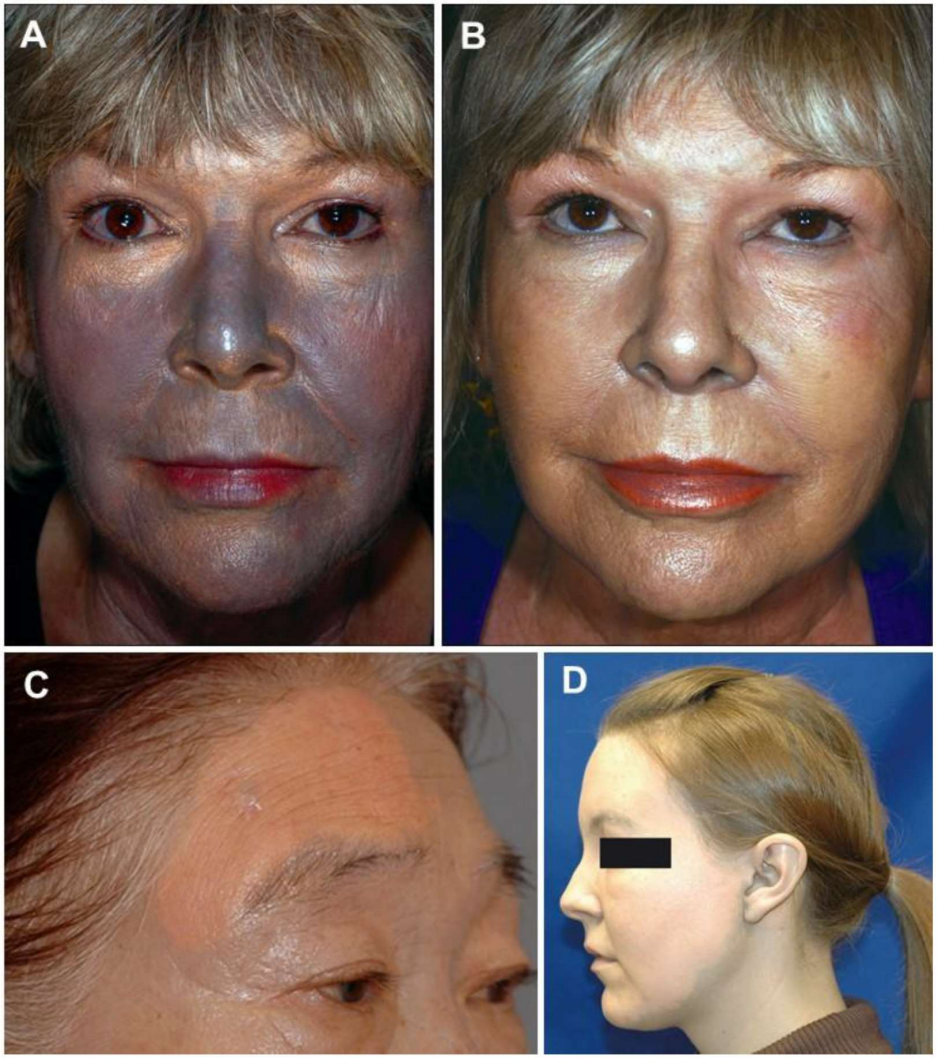
EPA.gov/ghgemissions, 2019

Nitrate-N limits in drinking water for humans and poisoning symptoms

- United States - 10 mg/L as nitrate-nitrogen (NO_3-N).
- World Health Organization (WHO) - 50 mg/L as NO_3 or 11.3 mg/L NO_3-N (multiply NO_3 mg/L by 0.2258).
- Bluish skin from a lack of oxygen (methemoglobinemia)
- Limits were set to protect against infant methemoglobinemia; more sensitive to toxicity near the 30th week of pregnancy.
- Exposure to N-nitroso compounds from drinking water and dietary sources may result in cancer, birth defects, or other adverse health effects.
- Difficulty breathing,
- Nausea, diarrhoea, vomiting,
- Dehydration (from loss of bodily fluids)
- Fast pulse, dizziness, weakness, coma and/or convulsions

M H Ward et al, 2018; Patient Education Care Instruction Sheet

Methemoglobinemia as a result of nitrate-N toxicity



Wikipedia

Nitrate-N limits in drinking water for animals and poisoning symptoms

- 0-100 mg nitrate-N /litre - safe
- 100- 300 mg nitrate-N /litre – possible problems, also consider feed additives
- >300 mg nitrate-N /litre – toxic
- bluish/chocolate brown mucous membranes
- rapid/difficult breathing
- noisy breathing
- rapid pulse (150+/minute)
- salivation, bloat, tremors, staggering
- weakness, coma, death
- dark “chocolate-coloured” blood
- Pregnant females may abort due to a lack of oxygen to the fetes. Abortions generally occur approximately 10 to 14 days following exposure to nitrates.

North Dakota State University

Nitrogen stabilizers - conclusions

- **Decrease in global nitrogen consumption** despite an increase in crop production - partly ascribed to the use of nitrogen stabilizers
- **Higher nitrogen use efficiency and profitability** - due to reduction in volatilization and leaching losses as well as reduction of toxicity effects
- **Reduction in detrimental atmospheric effects** - due to reduction in ammonia and nitrous oxide losses to the atmosphere
- **Elimination of toxic nitrate-N effects in drinking water** - due to the reduction of nitrate leaching to groundwater
- **Preservation of drinking water** as a scares resource
- **Legislation** to enforce the use of urease inhibitors and nitrification inhibitors under specific conditions required
- **Monitor to manage** nitrate-N and ammonium-N in soils, nitrate-N in drinking water, nitrous oxide and ammonia + sulphates + nitrates in the atmosphere.

Thanks for the opportunity!

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