Measurement of ammonia emission from slurry storages and environmental research units Dairy Campus

Picarro Ammonia Meeting Aarhus

20-3-2024, Hendrik Jan van Dooren and Tom Rikkers

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Outline

- Context
- Choice for Picarro
- Lab measurements
- Research
    - Dairy Campus emission units
    - Slurry storage
- Plans ahead

Two partners

Wageningen University & Wageningen Research

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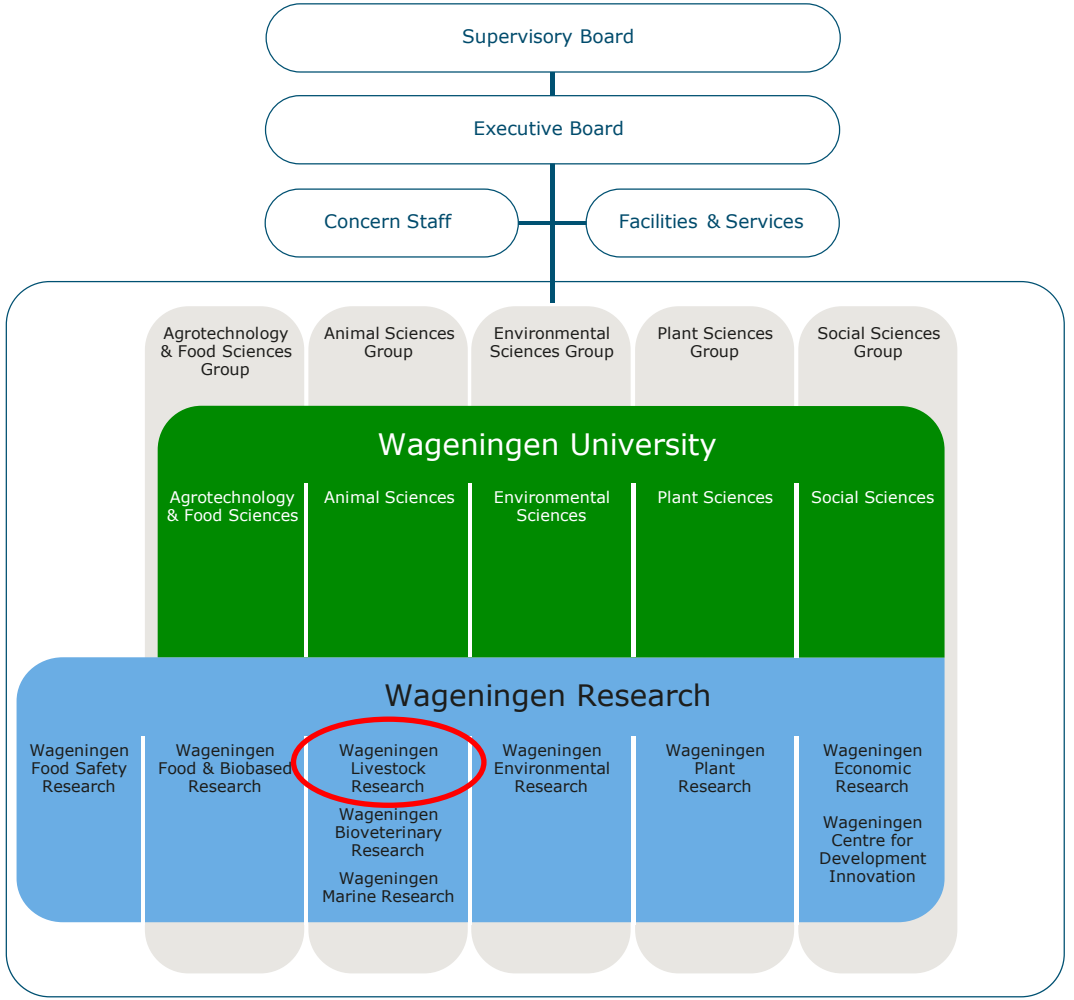
Organisation chart



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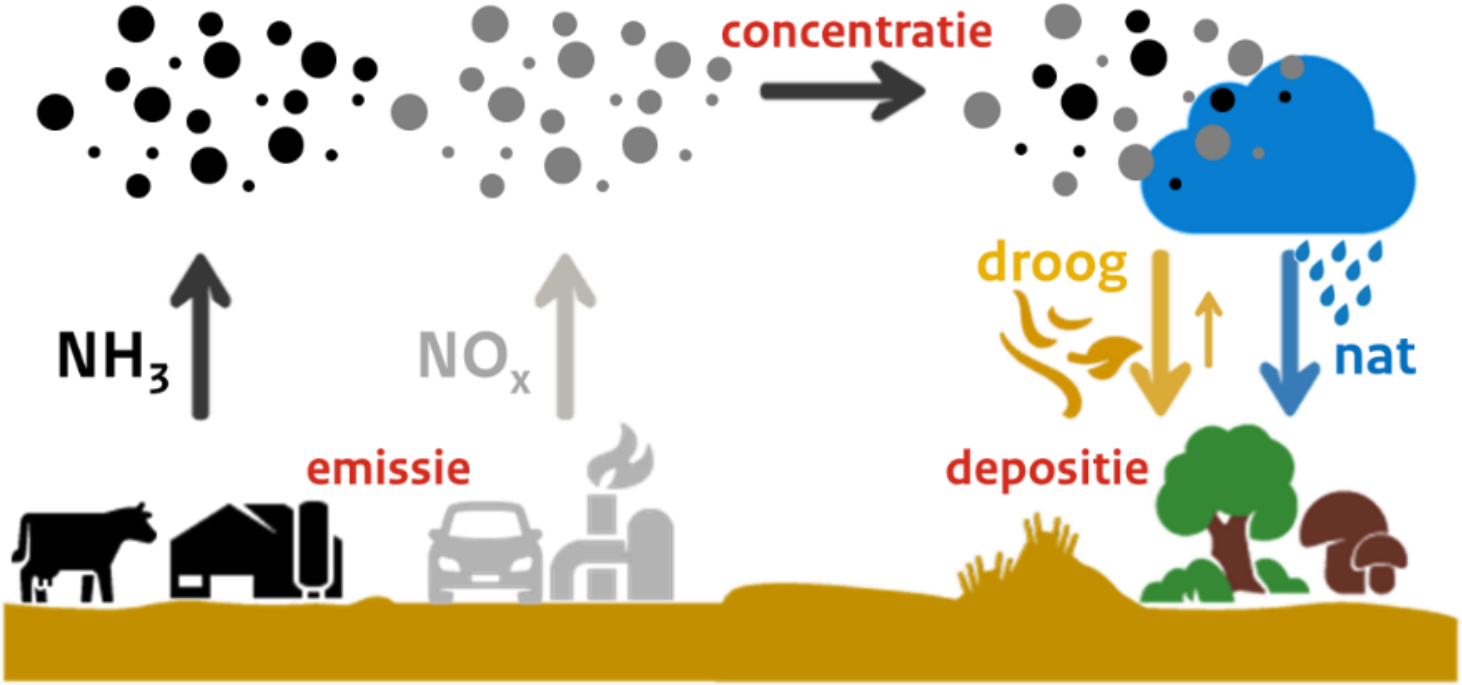
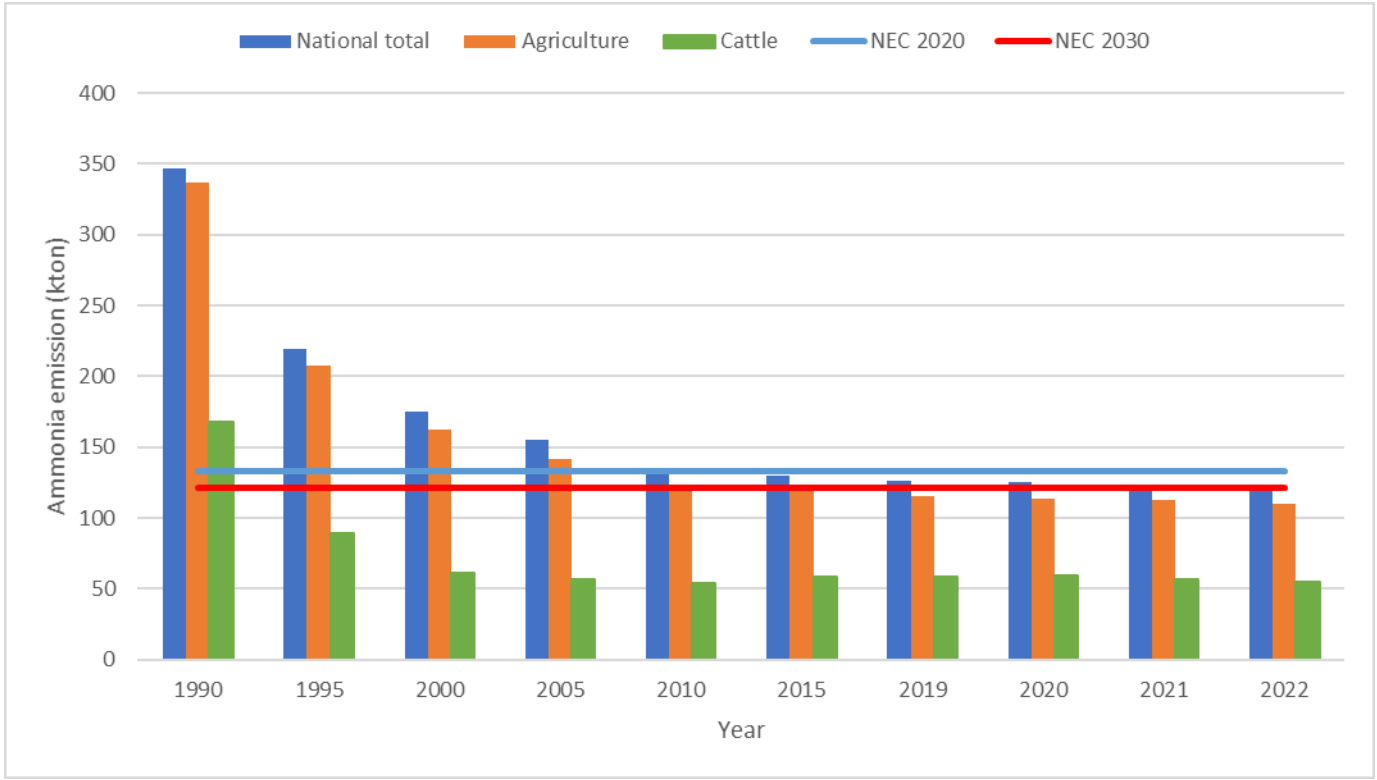
Nitrogen routes from emission to deposition



Emission of ammonia from agriculture



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National emission ceiling

- NEC 2020: 133 kton NH_3 emission
- NEC 2030: 121 kton NH_3 emission
- National emission 2020: 125 kton
- Dairy farming:~ 50% of Agriculture
    - Housing and slurry storage: ~50%
    - Slurry application and grazing: ~50%
- Targets for deposition reduction are not met by far
- -> Innovation and developement of low emission farming systems

Emission measurements at dairy farms

- Focus research and evaluation
- Research farm Dairy Campus
  - NOx with NH_3->NO converter (Phillips et al.,1998)
  - Multiplexer
  - Need for faster responce
  - Including GHG

- Focus emission monitoring
- Practical dairy farms
  - Reference methods
  - Open path TDL
  - Sensors

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Purchase history

- Stationary setup
- Multi-gas monitor
- Fast response (for ammonia)
- Low concentration levels
- Experiences from AU en ILVO

- Dairy Campus Emission research units (2018)
  - 2 Picarro G2508 Extended range CH4
  - 2 A0311-S manifolds
- Slurry storage – mini-silo's (2020)
  - 1 Picarro G2508
  - 1 A0311-S manifold
- Air Quality Lab (2022)
  - 1 Picarro G2509

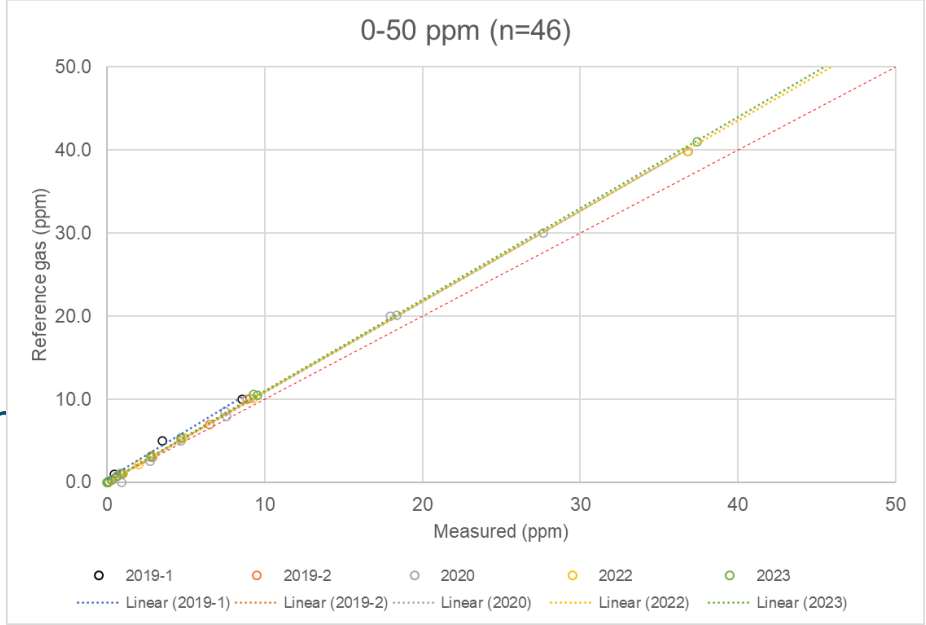
‘Standard’ dilution (right) vs Dynamic dilution

Lab measurements

- Calibration on single (diluted) gasses
  - NH_3: 0-50 ppm
  - CH_4: 0-500 ppm
  - CO_2: 0-4500 ppm
  - N_2O: 0-3 ppm
- Example of Picarro 1
  - Five replication: 2019-2020-2022-2023

Results over time

- Linearity is good
- Time shift over the years is minim



	2019	2019	2020	2022	2023
Slope	1.15	1.12	1.09	1.09	1.10
Intercept	0.41	-0.07	-0.03	0.01	0.04
R^2	0.99	1.00	1.00	1.00	1.00

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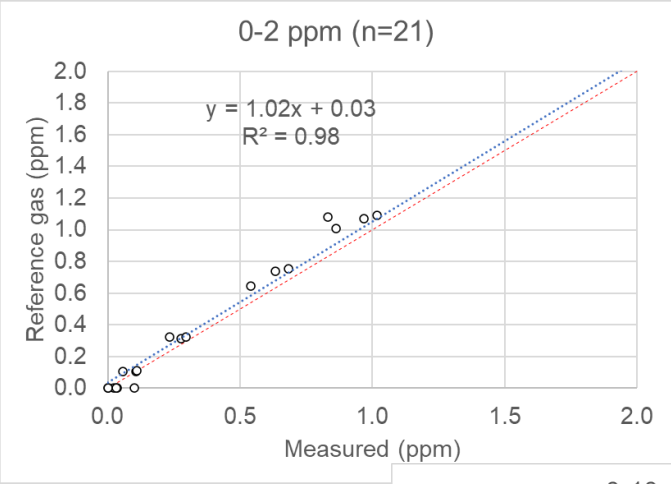
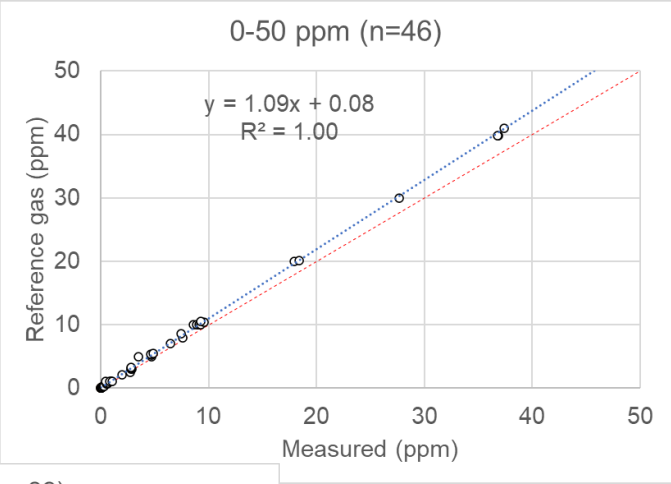
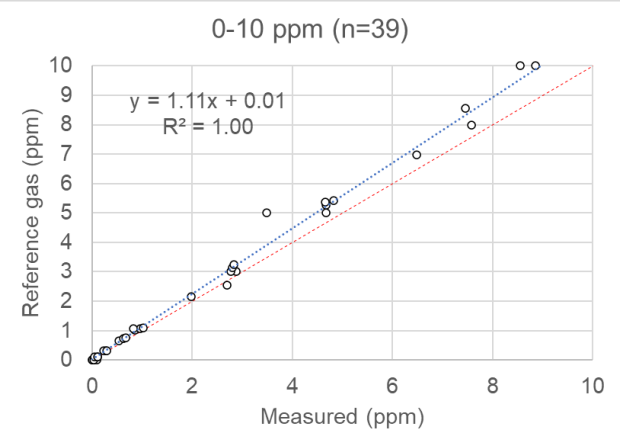
Calibration lines







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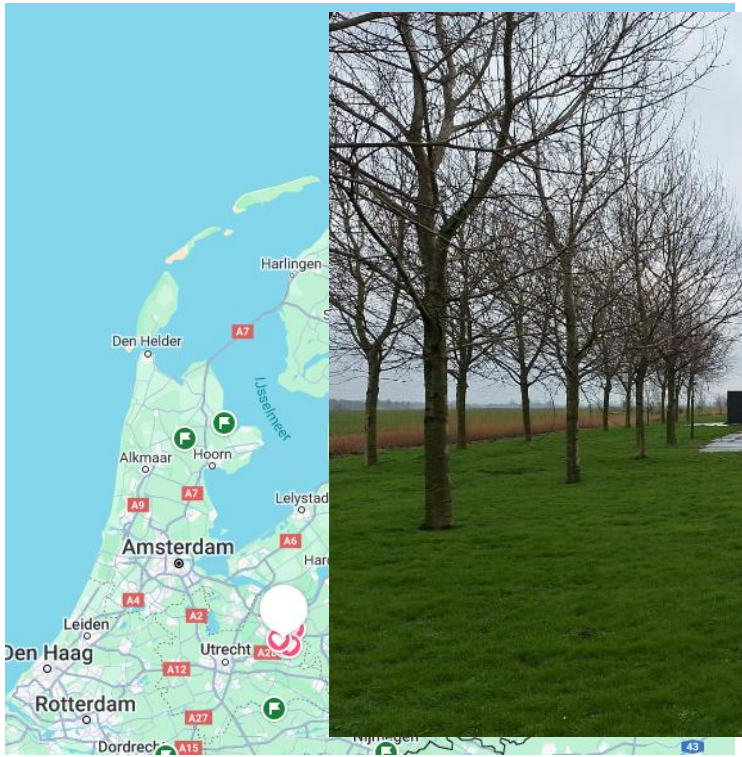
Dairy Campus, Leeuwarden.



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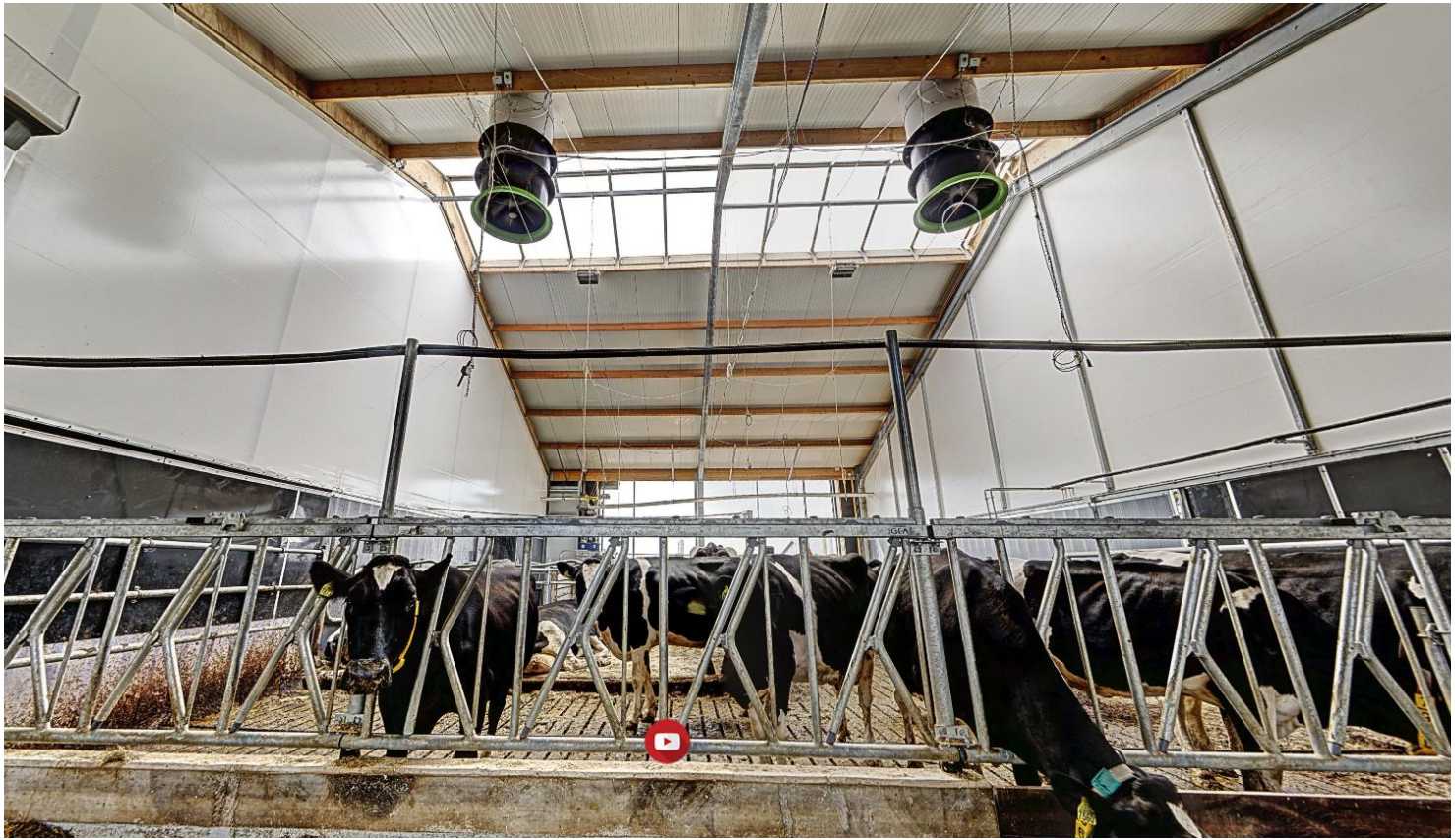
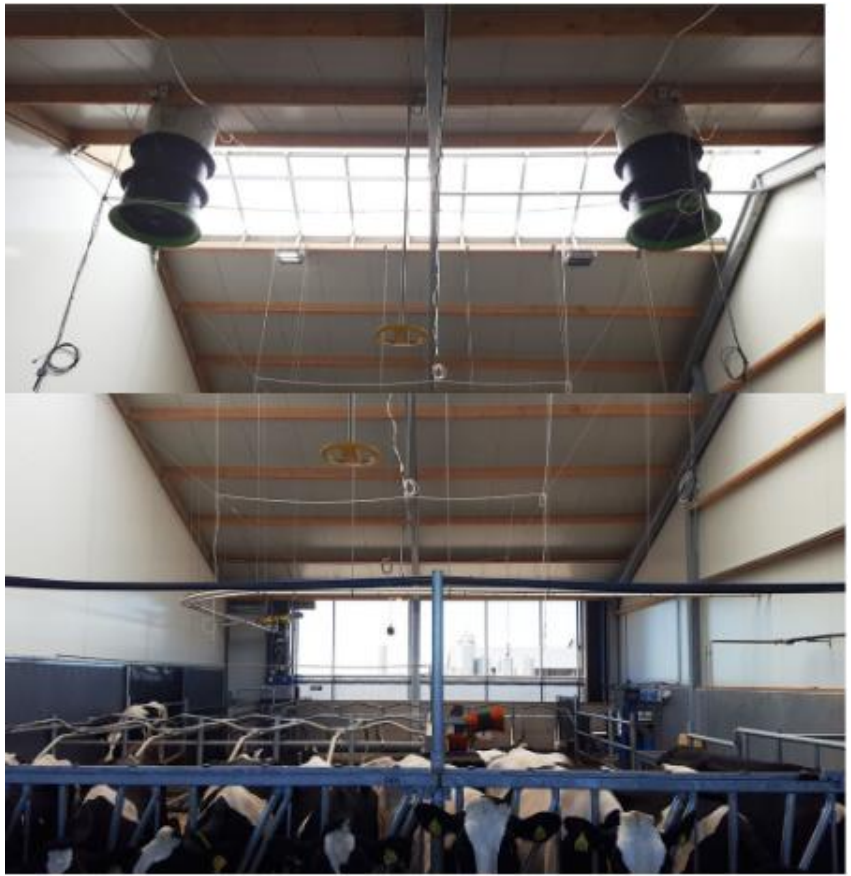
Dairy Campus emission units.

Examples of research

Virtual tour



Dairy Campus emission units.



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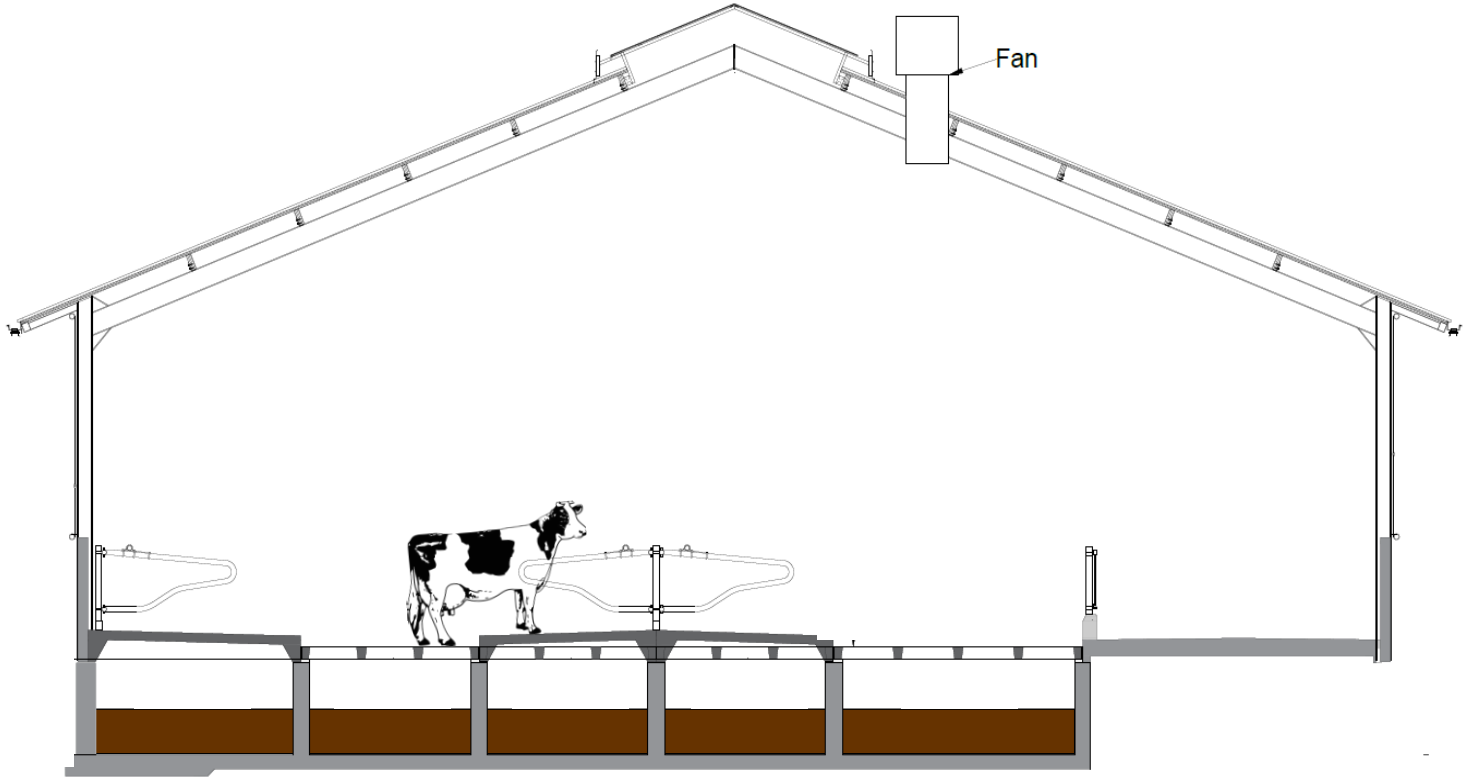
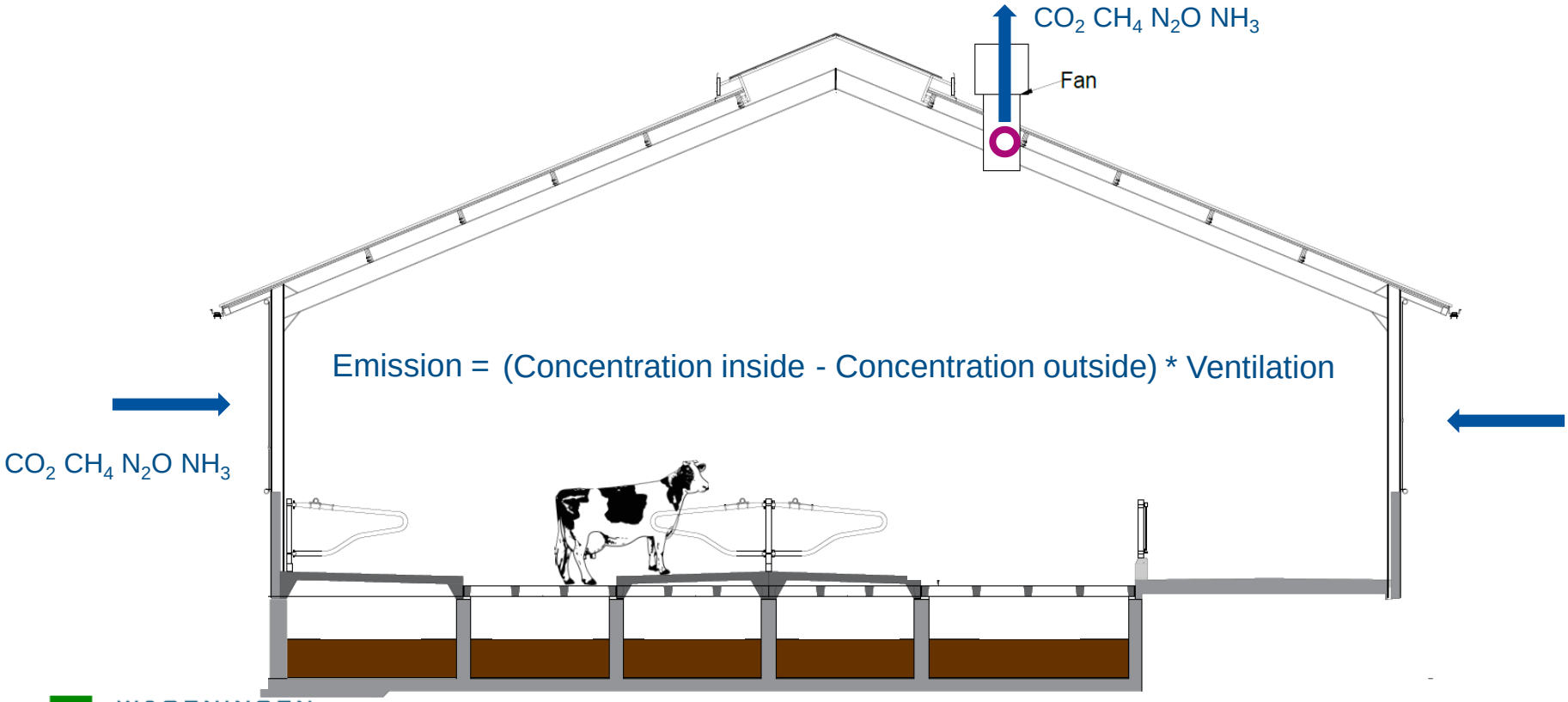
Measuring housing emissions at Dairy Campus

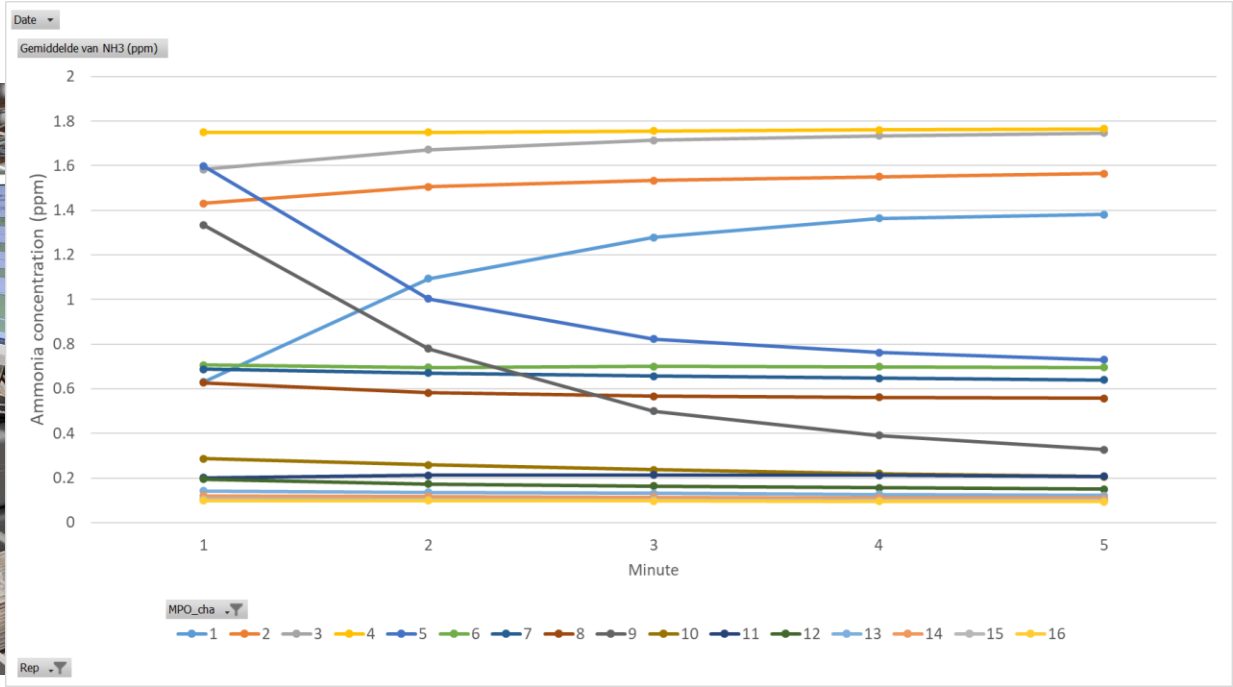


Measuring housing emissions at Dairy Campus



Response after concentration change

- Ammonia concentration per minute
- Response of Picarro and Manifold



Slurry Storage

- Mini silos – emission reducing techniques for external manure storage
  - 6 mini silo's of ± 6 m^3 each
  - 2 with cooling facilities, 4 with mixing facilities
  - Emissions of CH_4, N_2O, CO_2 and NH_3

Filling of mini silo’s

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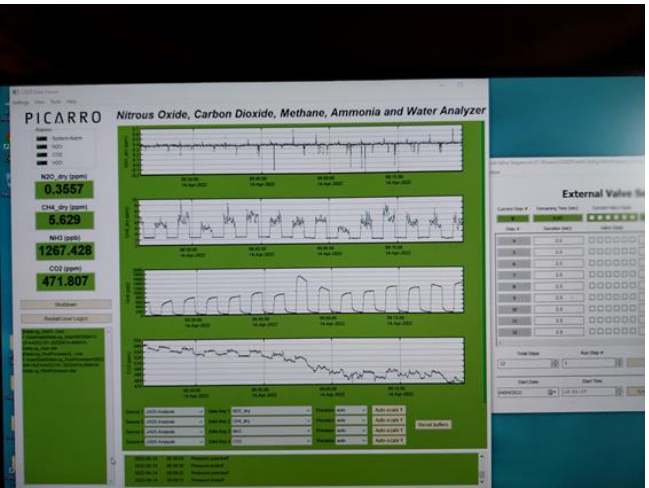
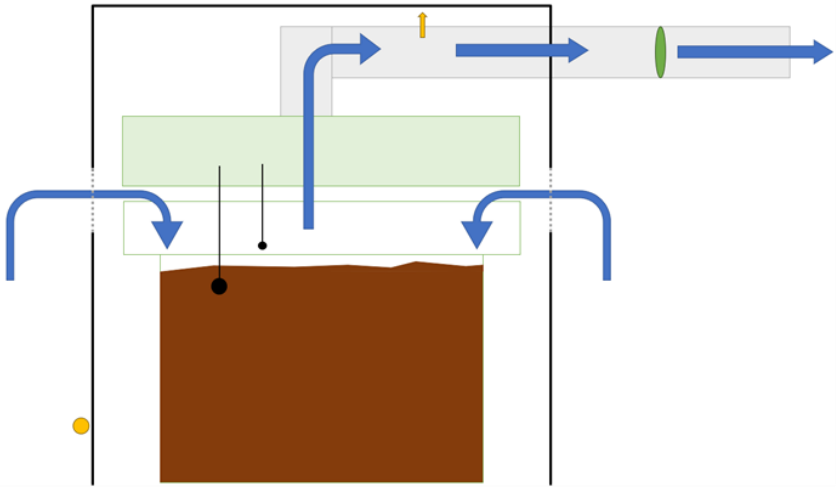
Mini silos for emission from slurry storage

- Case control set up
- Open flux chamber
- Frequent sampling of concentration in airflows and incoming air
- Measuring fans for air flow rate
- G2508 combined with A0311-S manifold





Future

- Use of G2509 for linking NH_3 calibration gasses to national standards (VSL)
- Role of moisture interference to calibration results in different gasses with use of new dilution system
- Better understanding of use of Picarro outside ‘standard’ measurement ranges (NH_3)
- Comparing with reference methods in field tests for acceptance as device for emission measurements in practice

Thank you!

Questions?