NH_3 and N_2O emissions from three bedded pack barns in The Netherlands

EAAP Warsaw

2-9-2015, Hendrik Jan van Dooren

J.M.G. Hol, K. Blanken, P.J. Galama

LIVESTOCK RESEARCH
WAGENINGEN UR

Introduction

- Bedded pack barns as alternative for loose housing
- Inspired by examples in USA (Minnesota) and Israel
- Change in dairy housing has different effects
    - Welfare and animal health
    - Management (of bedding)
    - Cost price of milk
    - Use of compost as fertilizer
- First few farmers around 2007
- 2015: around 50 farmers
- Research on welfare, health, milk quality, costs and environment

Why emission measurements?

- Environmental impact of ammonia and nitrous oxide
  - Acidification/Eutrophication
  - Global warming
- Nitrogen losses from housing represents economic value
- Establishing an ammonia emission factor for this housing system
  - Dutch system of ammonia emission factors of housing systems (in kg NH_3 per cow per year)
    - 4 farms, 6 times over 1 year.
- References system: Loose housing slurry system (11 kg NH_3 per cow per year, zero grazing)
- Emissions before and after housing

Objective

- To measure ammonia en nitrous oxide emissions from compost and composting (wood chips) bedded pack barn(s).

- Expectations:
  - Higher NH_3 emissions due to larger area per cow
  - Risk of N_2O emissions due to composting processes
- Flux chamber measurements

Overview of bedded pack dairy barns

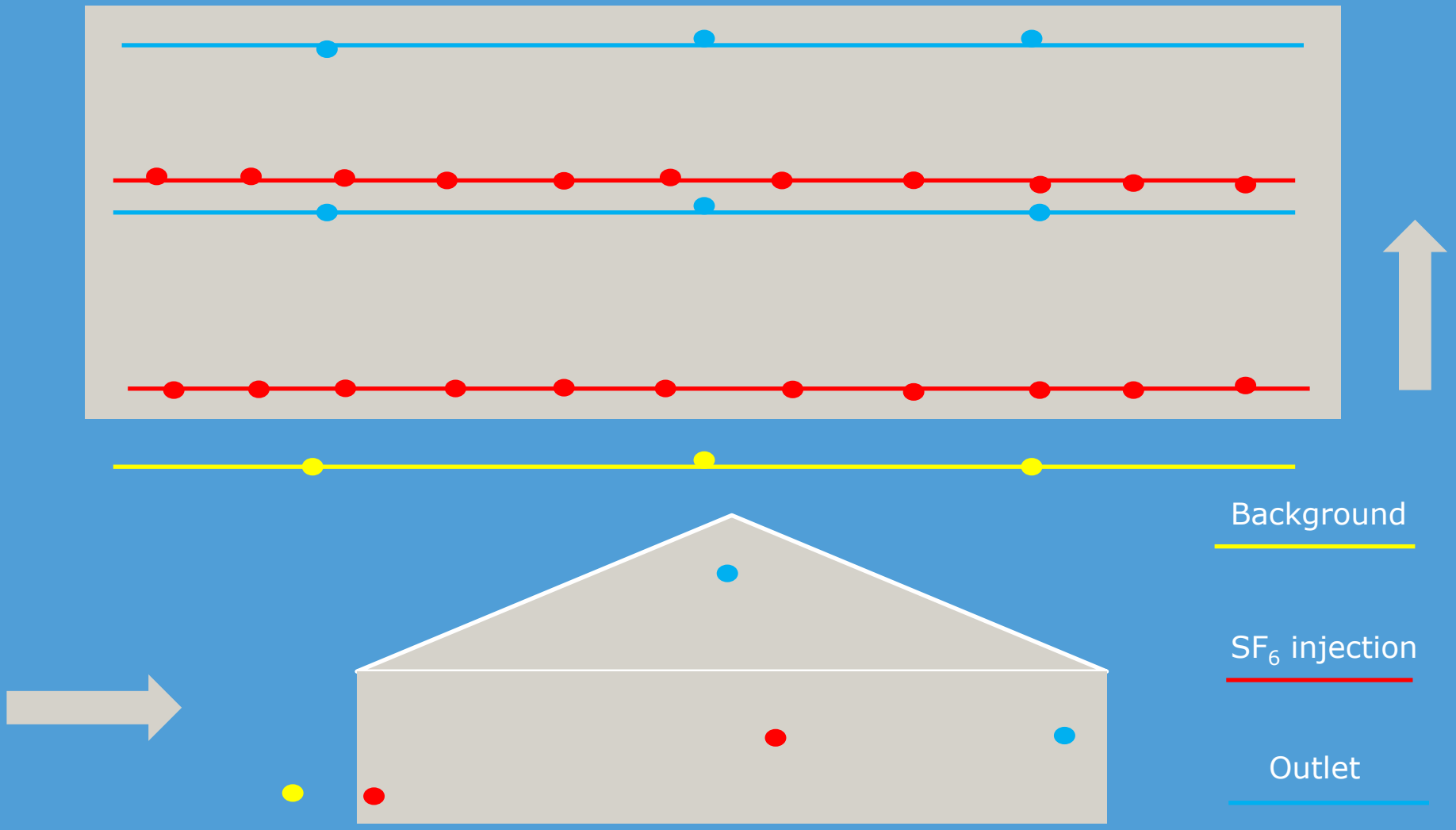
Farm number	Lying area Material	Lying area (m^2/cow)	Walking area Material	Walking area (m^2/cow)
1	Wood chips (WC)	12,5	Concrete slats	5,0
2	Wood chips (WC)	15,0	Concrete slats	4,0
3	Wood chips (WC)	15,0	Concrete slats	4,0
4	Wood chips (WC)	16,0	Solid asphalt	3,0
5	Wood chips (WC)	8,5	Concrete slats	1,5
6	Compost (C)	18,0	Concrete slats	4,0
7	Compost (C)	22,0	None	0,0
8	Compost (C)	9,5	Concrete slats	7,0
9	Compost (C)	22,0	Concrete slats	4,0
10	Straw (S)	10,0	Concrete slats	3,0

- Each selected barn had two 24 hour measurements
- Farm 9 only NH_3. - Low input level.

Measurements methods

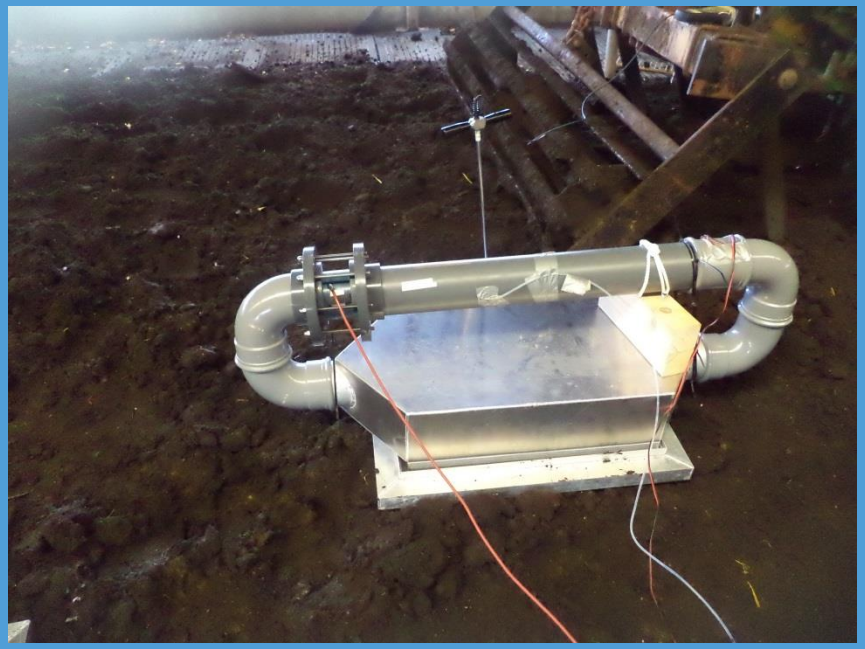
- $E = V\ (NH_{3,out} - NH_{3,in})$ (similar for N_2O)
- Ventilation (V in m^3/h) - two tracer gas methods
  - $V = CO_2\text{-prod}/(CO_{2,out} - CO_{2,in})$
  - CO_2 balance method (CIGR CO_2 production equations)
  - Estimation of CO_2 production of bedding.
  - SF_6 tracer gas method (constant injection rate)
- Concentration measurements (mg/m^3)
  - NH_3/CO_2: Outlet Open path laser (GasFinder, Boreal)
  - N_2O: Lung method and GC in lab
  - SF_6: CompactGC (Interscience)
  - CO_2: Innova 1312 photo acoustic gas monitor

Schematic setup of measurements (1 and 8)

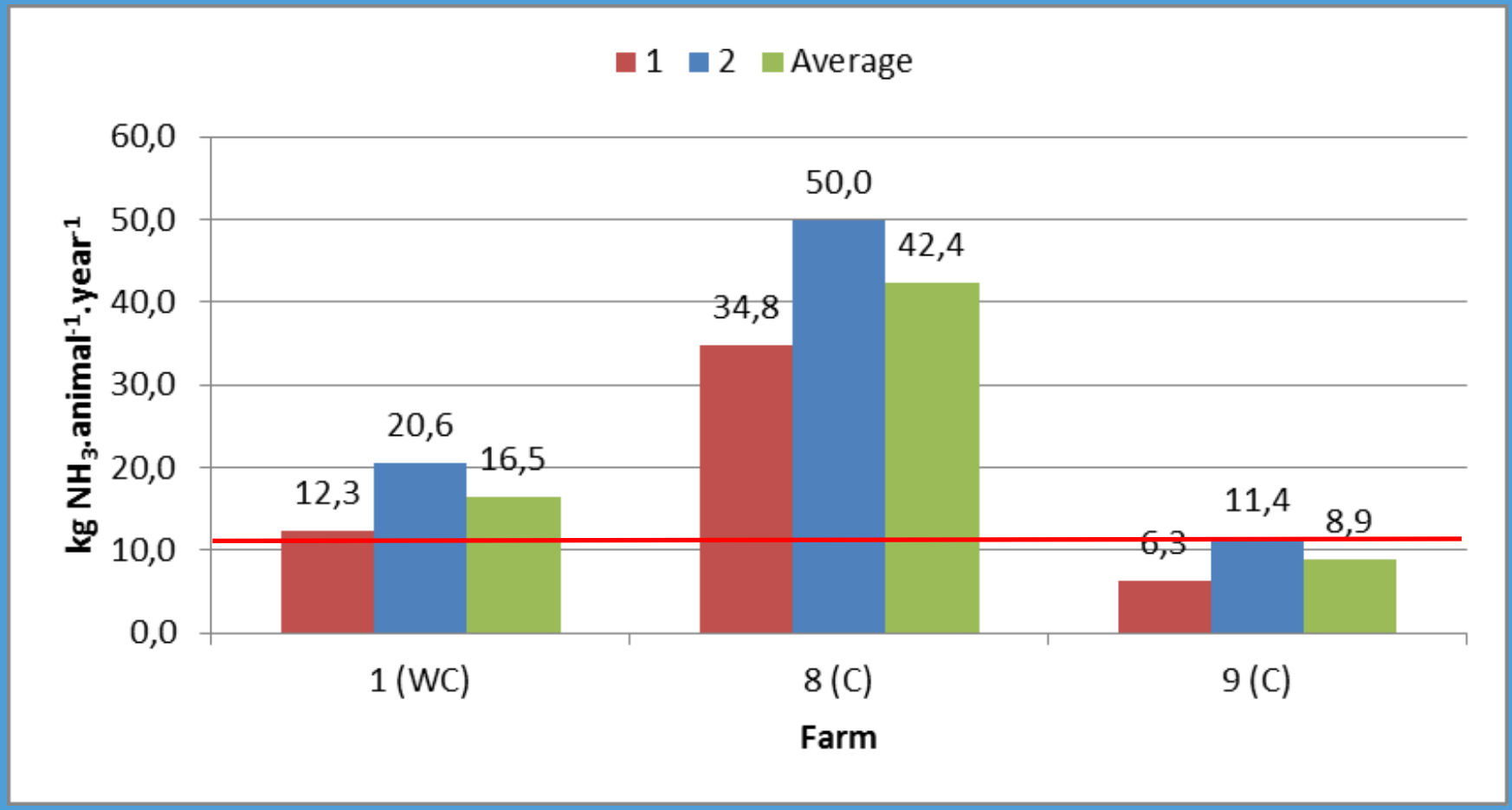


Measurement of CO_2 production from the bedding of farm 9

- Flux chamber (closed) on 20 spots per day
- Around 20 spots each day
- Result: 30-40% of cow production
- Conclusion: CO_2 release from bedding can't be ignored!!

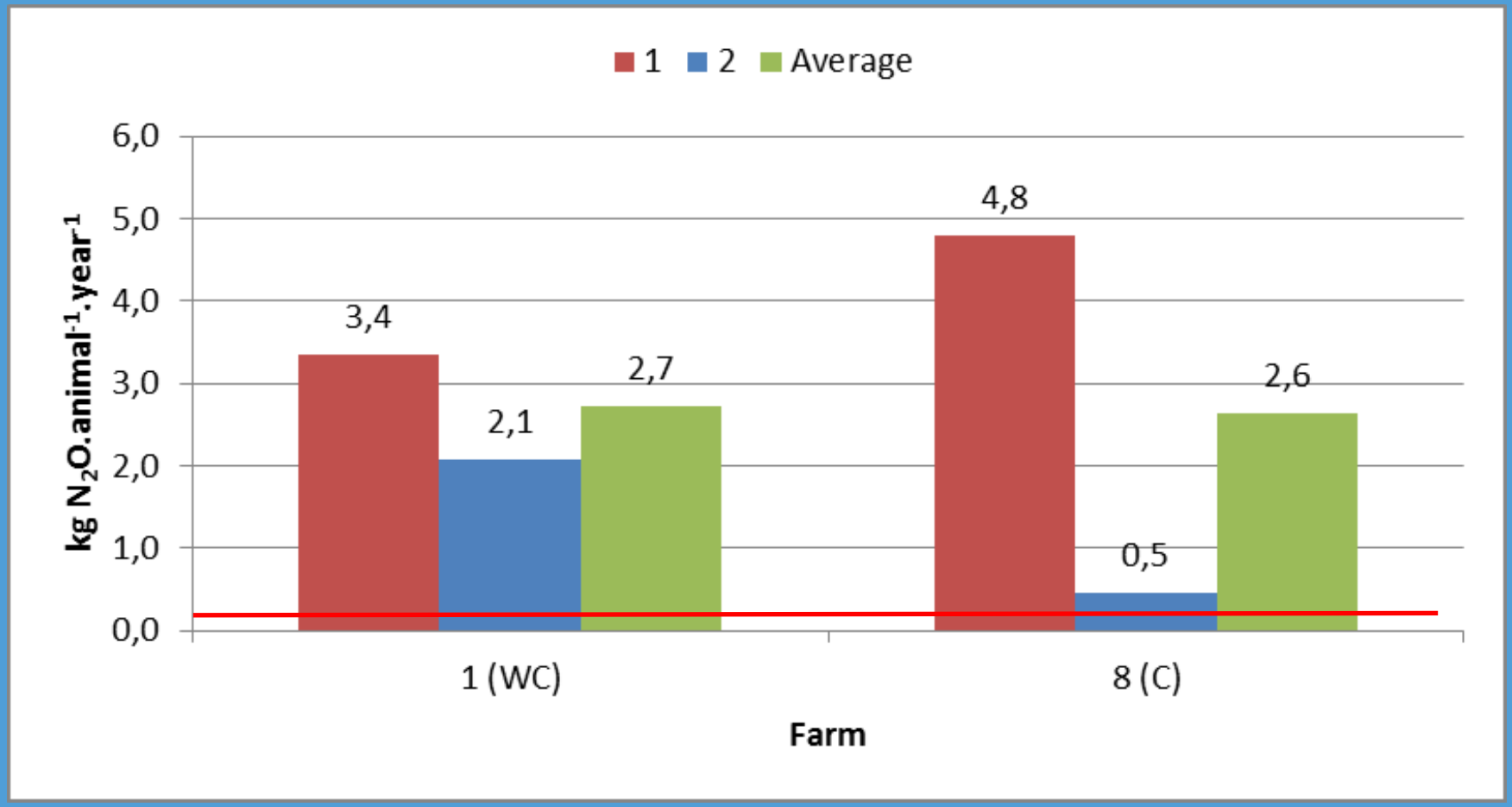


Results: ammonia emission



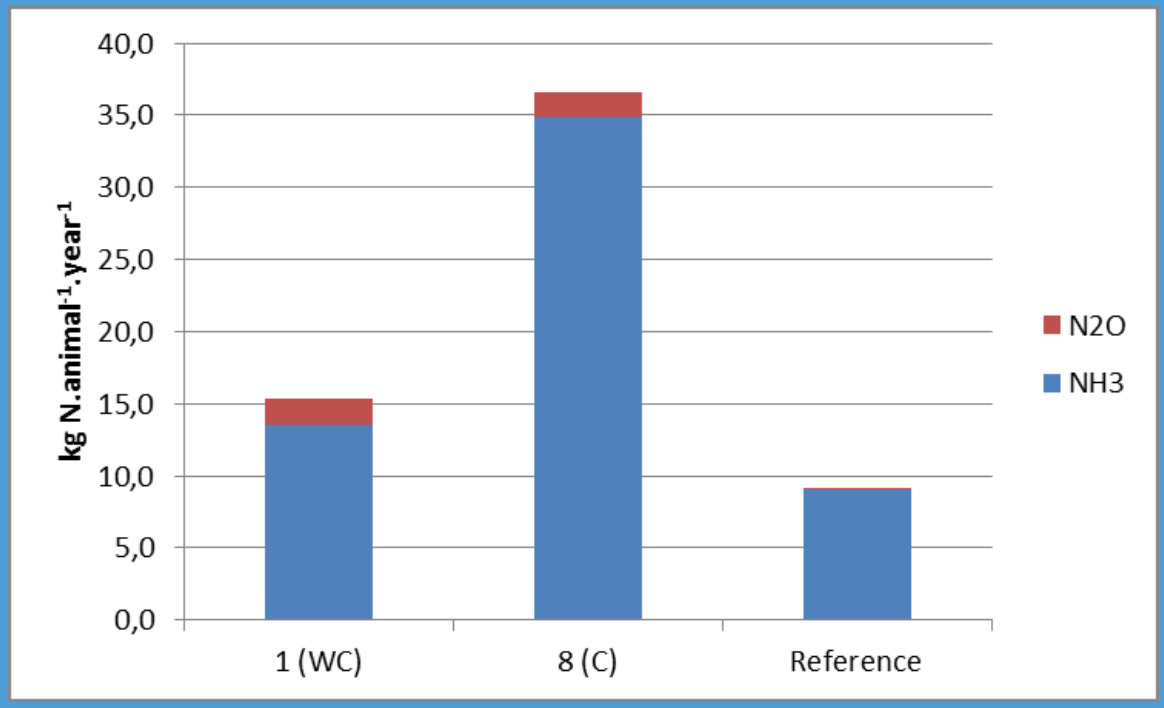
- Red line is reference level: 11 kg NH_3/animal/year

Results: nitrous oxide emission



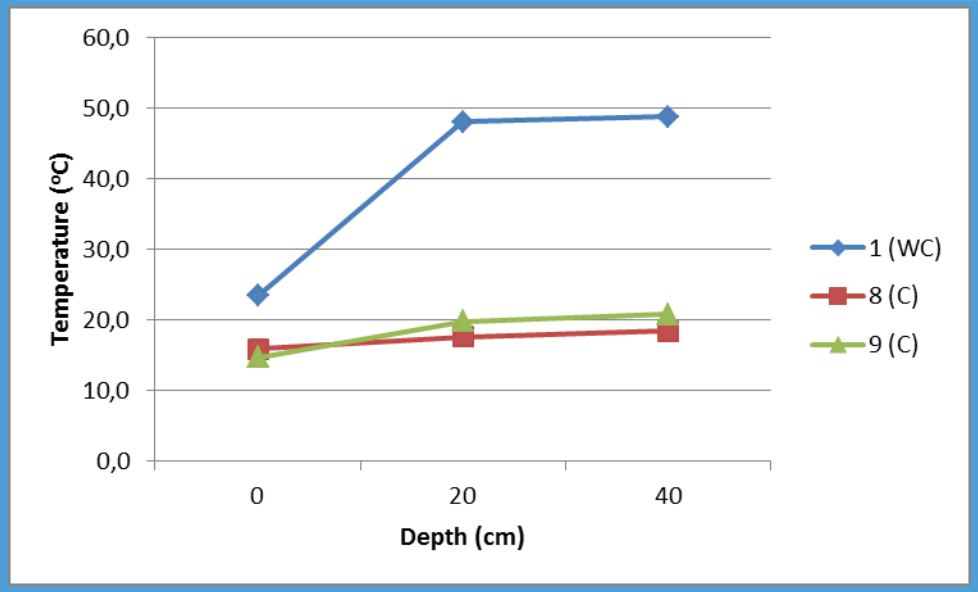
- Red line is reference level: 0,23 kg N_2O/animal/year

Results: nitrogen losses through NH_3/N_2O



- N-loss (reference=100%)
  - Wood chips: 166%
  - Compost: 397%
- N_2O share
  - Wood chips: 11%
  - Compost: 5%
  - Reference: 2%

First attempt to explain differences



- Clear temperature differences between compost and composting of wood chips
- Difference in microbial activity (composting)
- Effect of available area

Conclusions

- Ammonia emissions compost 2,5 times higher than composting wood chips
- Compost and wood chips both higher than reference system
- Considerably higher N_2O emissions:
    - Wood chips > Compost
- Further development of composting of wood chips
    - Optimization of composting process
    - Reduction of emission from feed alley
- No further development of compost barn
- Comparison of systems should include losses before and after housing.

Thank you

Report: Sustainability aspects of ten bedded pack dairy barns in The Netherlands

http://edepot.wur.nl/350932