Milan, 12th November 2008

EPMAN
Expert Panel on Mitigation of Agriculture Nitrogen

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Building air wash methods

Emerging technologies

Bounds for abatement plants in livestock houses

- Natural ventilation → High costs for channelling and fans
- High variability in air flow rate during the year (more than 10 times) → Overdimensioning, energy consumption for ventilation
- Particulate matter in the air flow → PM abatement before treatment plant (increase costs and energy request)
- Fairly complex plants, not familiars for farmers → Risk that they are switched-off

When and where are they easier applicable?

- In very critical situation as a further reduction measure
- In country with strict air quality regulations (Germany, NL, …)
- In tunnel ventilation houses (poultry farms)
- In treatment plants (composting, drying, NH_3 stripping, ….)

What techniques are available?

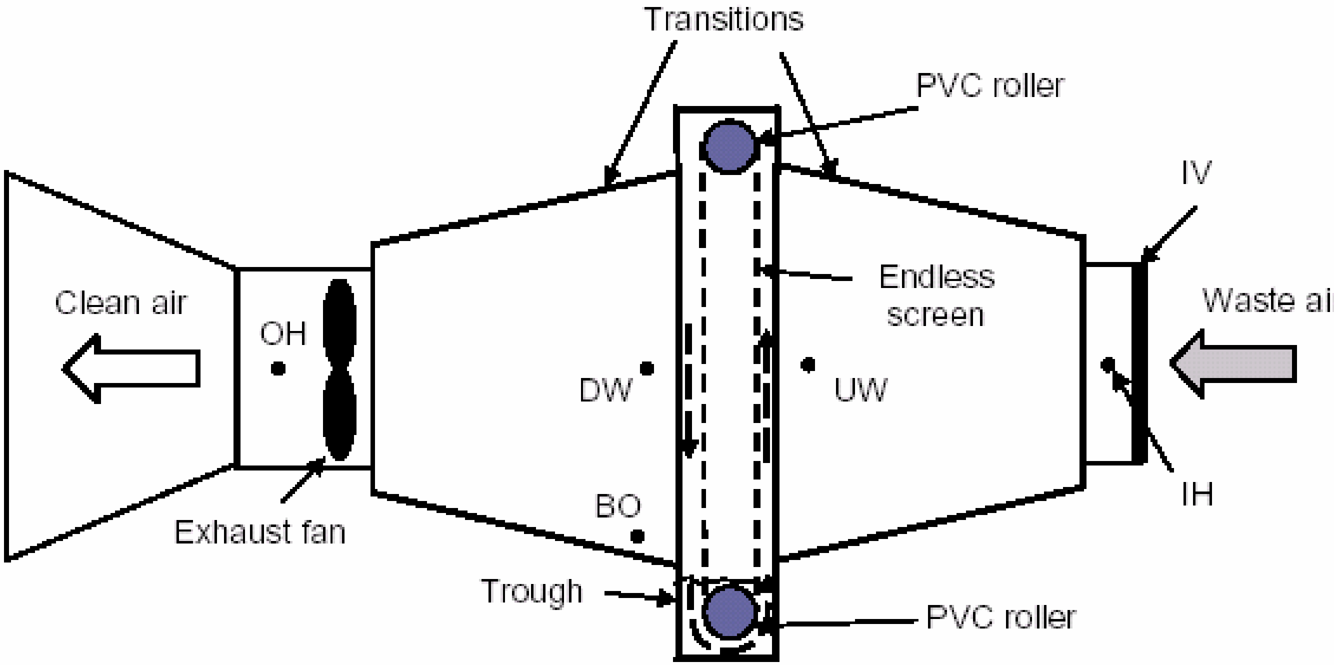
- Biofilters
- Trickle bed reactors (bioscrubbers)
- Chemical scrubber
- Muti-stage plants

The requirements in animal houses are:

- Simple and modular
- Low pressure drop

Modular chemical scrubber

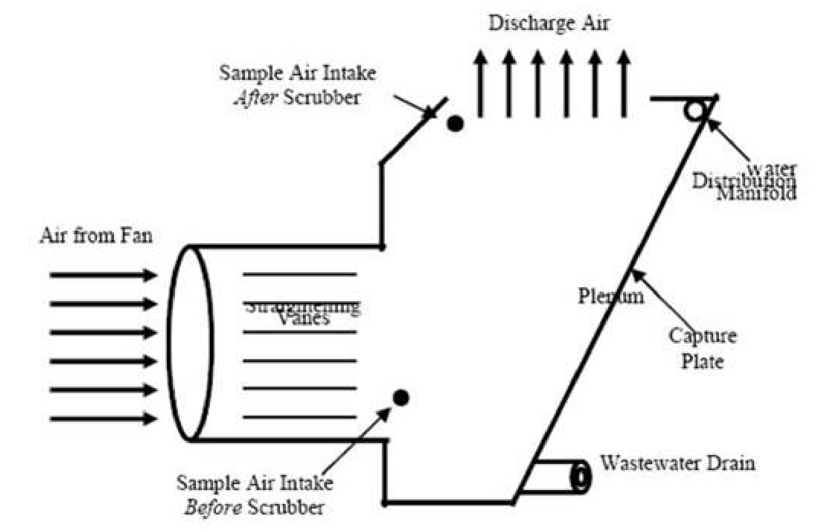
Regenerative scrubber



NH3 abatement efficiency = 58%

Low pressure drop < 100 Pa

Modular water air scrubber



Air flow rate reduction < 10%

PM abatement 40-60%

NH_3 removal = unsatisfactory

Costs = 0.5 € per pig produced

Single-stage techniques

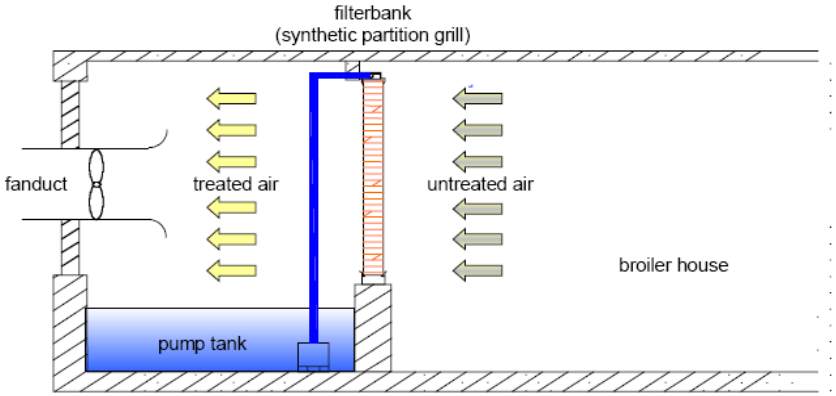
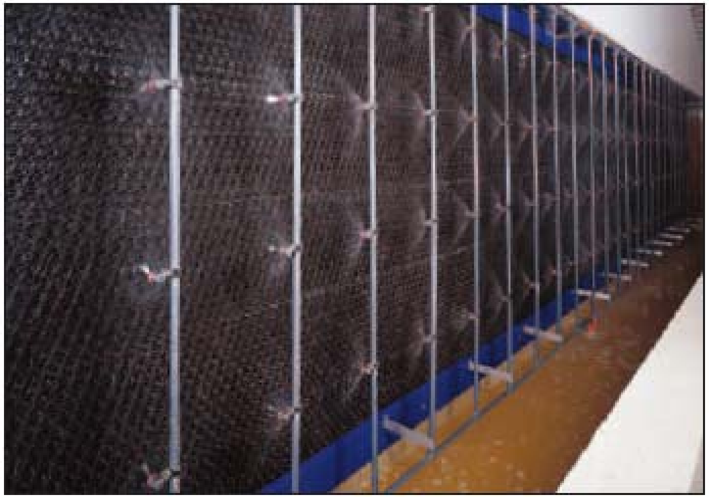


Figure 1. Schematic of the exhaust air cleaning system for a broiler house.



Nozzle groups spray water on the front of the filter bank

Backview of the filter.
The exhaust air chimney suck the air through the filter

PM abatement 45%

NH_3 removal = 78%

Multiple-stage techniques

source: KTBL publication 464

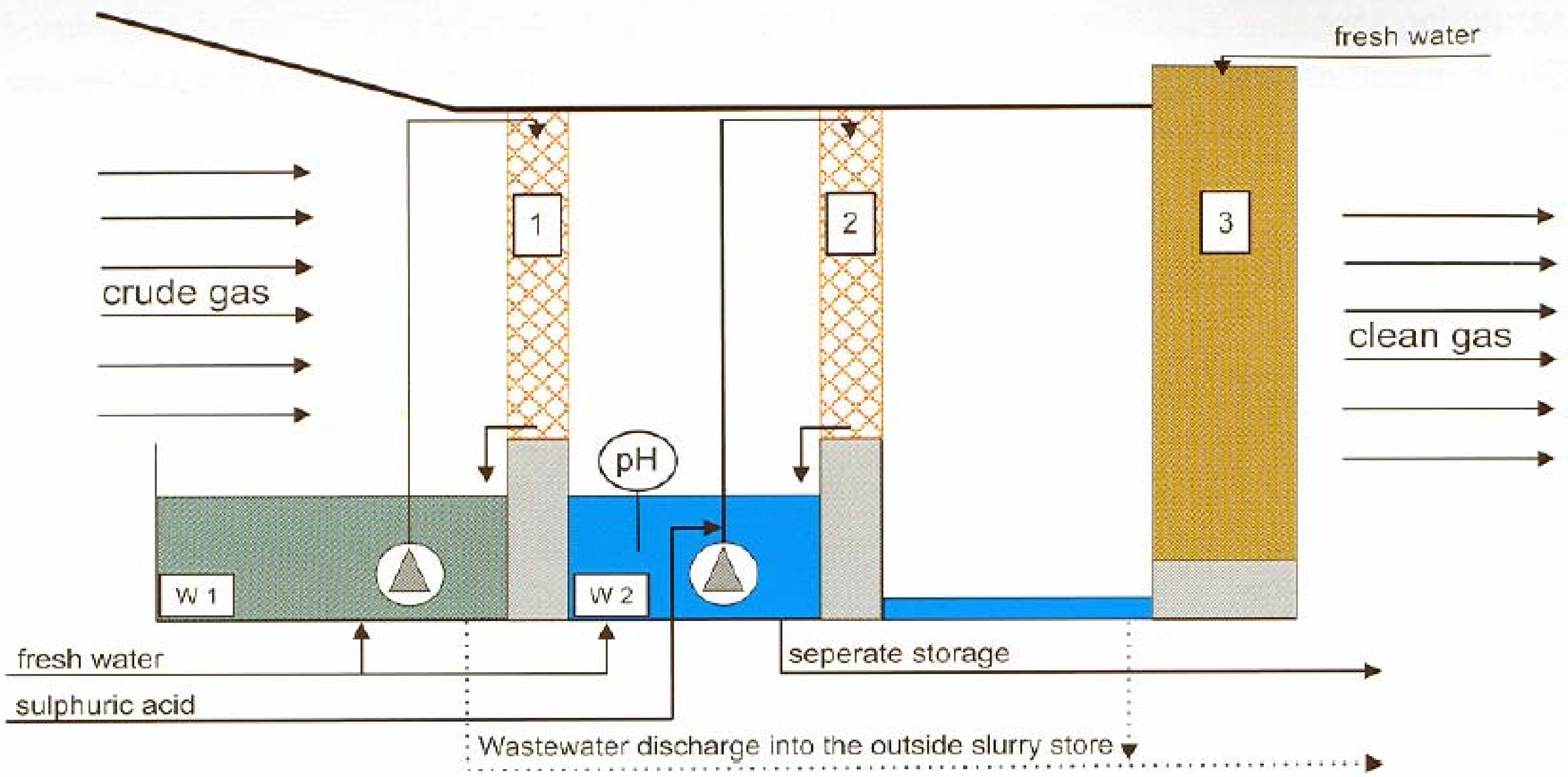
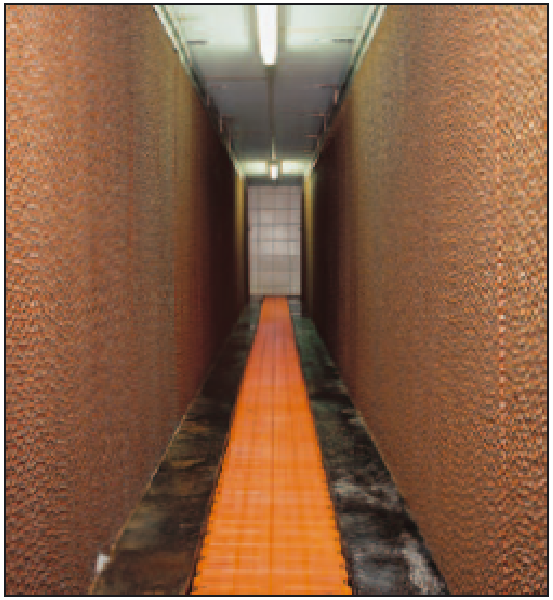


Figure 2.9: Design of a three-stage installation and its main functional elements

Multiple-stage techniques

Nozzle groups spray water on the front of the filter bank so that the dust cannot cling to the filter bank



A filter inpection isle lies between filter bank 1 ad 2

The third element is a root timber and is used for the microbial transformation of odou-carrying agents

Removal efficiency
(from KTBL)

Technique	**NH_3**	**Odour**	**PM**
Biofilter	Not suitable	80-95%	> 70%
Bioscrubber	> 70%	> 70%	> 70%
Chemical scrubber	70-95%	30-50%	> 70%
Multi-stage	70-95%	70-90%	> 70%

Costs (KTBL analysis)

- Operational costs = 60% of total costs
- Of which:
  - Electricity = 45-50% (of which 50-70% for ventilation),
  - Acid, water and wastewater = 28-34%,
  - Labour (70-80 h/y) and repairs = 21-22%

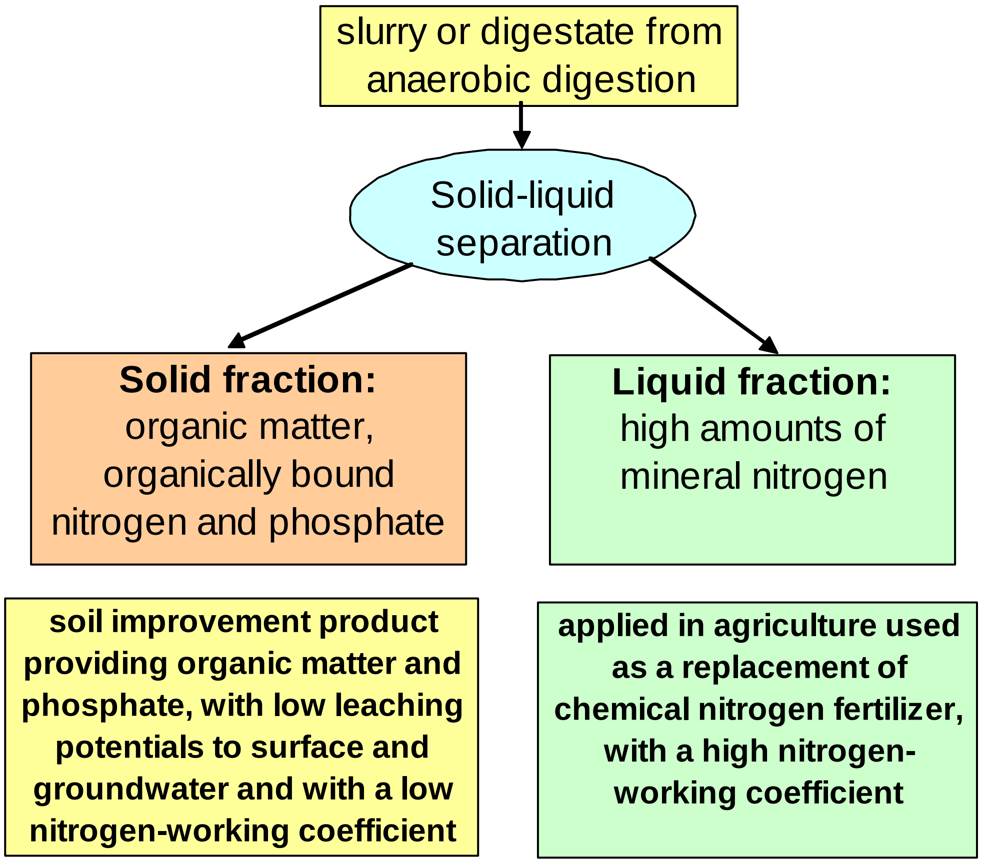
Costs (Ogink & Bosma, NL)

Fattening pigs [€/pig]	Construction	Low NH_3 pen	Chem. scrubber	Multi-phase scrubber
Investment	New	38	35	47
	Modification	30	47	59
Operational	New	4.0	11.0	12.7
	Modification	6.3	15.0	16.2

Aspects to be considered

- Disposal of discharge solutions
- Pollution swapping (NH_3 converted in N_2O in biofilter,…)
- Increase in energy consumption
- Seasonal changes in ventilation rate (bypass, cooling)
- End-of-pipe techniques don’t improve climate conditions of the housing (differentely from BATs) and don’t contribute to animal performance
- Risk that the farmer minimize ventilation rate
- Monitoring and recording by Local Authorities

Emerging techniques
Solid-liquid separation



Distribution by irrigators of clarified slurry mixed to irrigation water

- Digestate from anaerobic digestion mixed with irrigation water applied on maize with drip pipelines

Filtering group

Pipelines setting

Distribution by drip pipelines of digested slurry mixed to irrigation water

- High N uptake (20% higher than in the case of raw slurry applied at one time)

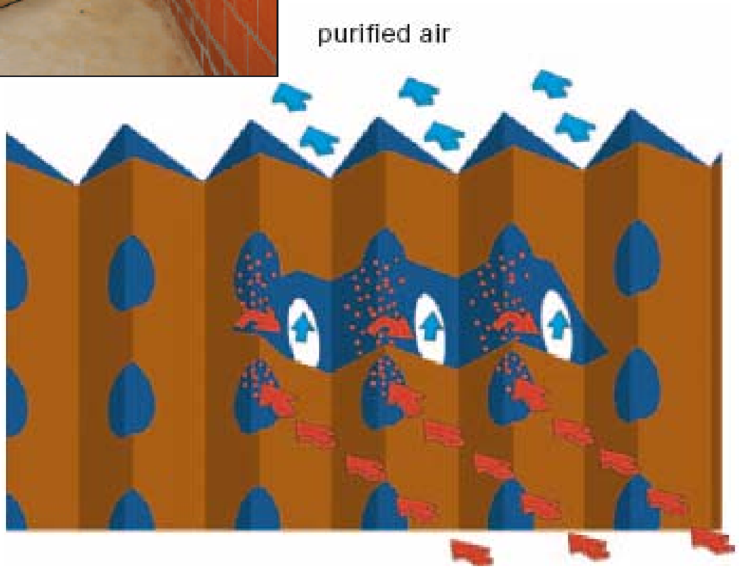
N input-output	Drip pipelines with slurry	Drip pipelines with water
Chemical fertilizer	78	78
Slurry	194	245
Total N input	272	323
N uptake	290	247

Distribution of digested slurry mixed to irrigation water

Very low NH_3 emissions (< 5% Ntot)

Ammonia emissions are strongly reduced (up to 80%) with reference to an application of raw slurry by the same system

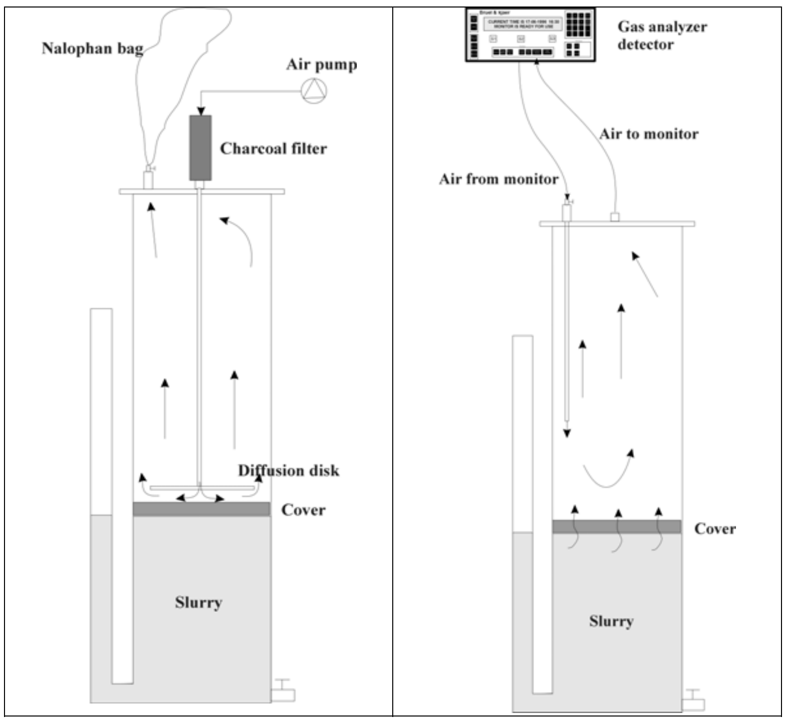
Emerging techniques: PM abatement

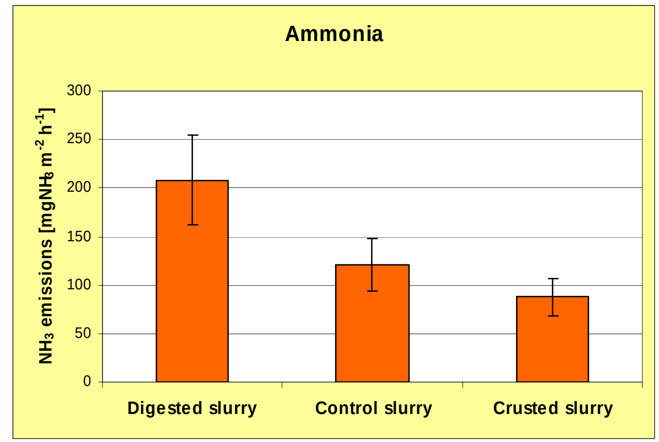


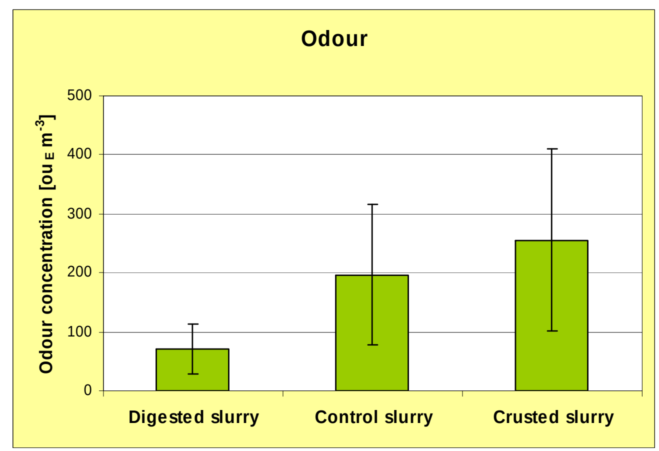
Big Dutchman system

Emerging techniques: anaerobic digestion

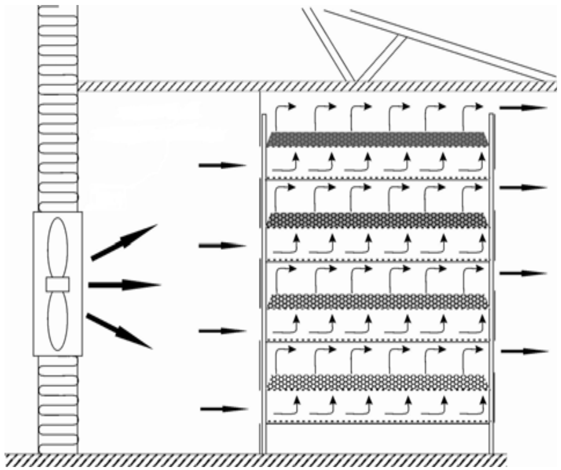
Emissions from anaerobic digested cattle slurry

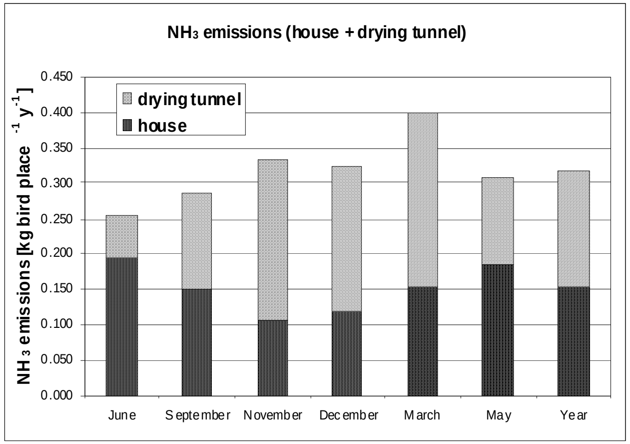




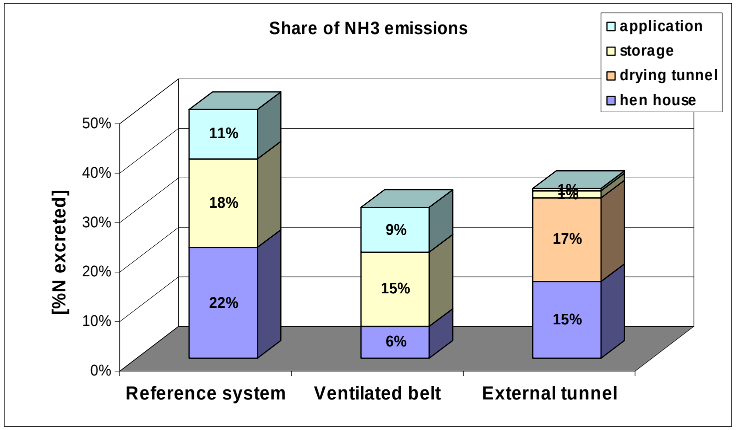


Poultry manure drying tunnel





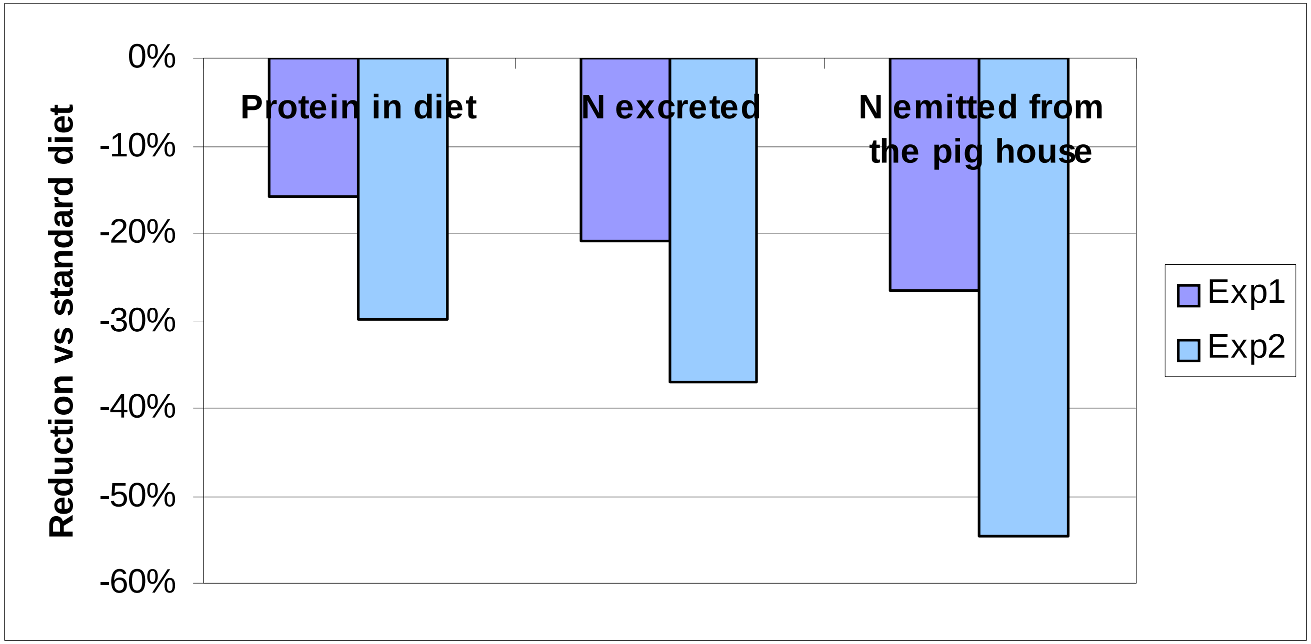
	NH_3 [kg head^{-1} y^{-1}]	N_2O [kg head^{-1} y^{-1}]	CH_4 [kg head^{-1} y^{-1}]	CO_2 [kg head^{-1} y^{-1}]
		Layer House		
Mean (year)	0.152	0.002	0.094	65.3
St. Dev.	0.035	0.004	0.056	3.7
Min-Max	0.044-0.290	0.000-0.017	0.000-0.354	58.8-69.6
		Drying tunnel		
Mean (year)	0.167	0.001	0.010	3.39
St. Dev.	0.026	0.001	0.005	1.75
Min-Max	0.126-0.210	0.000-0.003	0.003-0.028	1.26-7.59



Low protein diet in fattening pigs

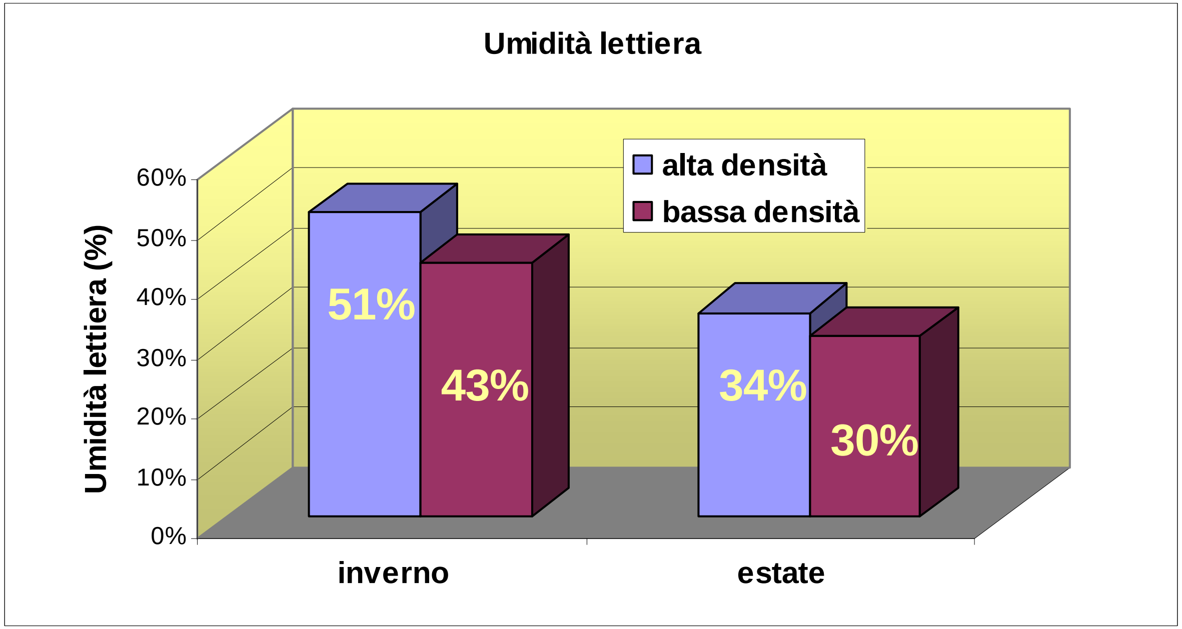
Finishing pigs from 100 to 160 kg (6 pen with 12 pig per pen, 2 fattening cyles)

Parameter	**Unit**	**Standard diet**	**Low protein diet**	**Standard diet**	**Low protein diet**
Protein in diet	[% wb]	14	12	13	9
ICA	[kg_{feed}/kg_{meat}]	3.9	4.0	3.9	4.0
N excreted	[kg/pig place/y]	17.8	14.1	17.1	10.8
N emitted from pig house	[kg/pig place/y]	3.2	2.3	3.1	1.4



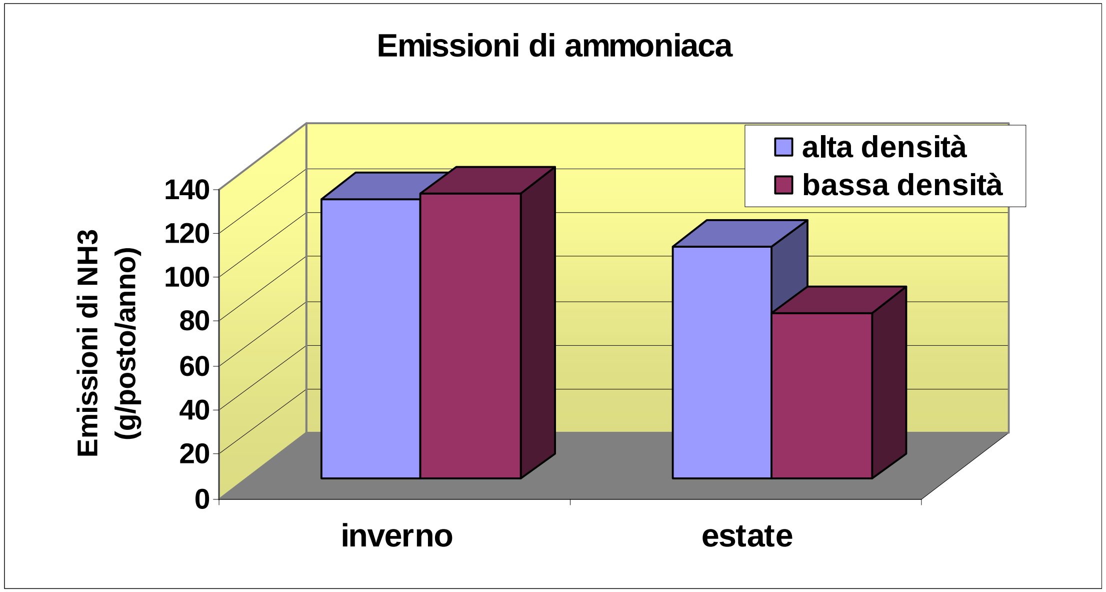
Animal welfare (broiler and turkey)

- Higher bird density cause wetter litter and crust formation, worsening animal health (foot dermatitis) and welfare, but lower density..



Animal welfare (broiler and turkey)

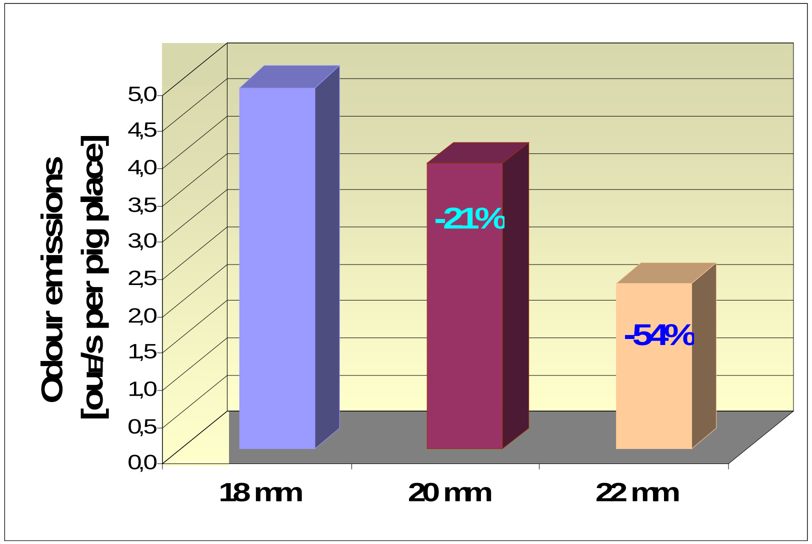
- …. may have negative effects on NH_3 emissions, especially in winter, when the air flow rate is reduced and the litter crust make a cap for the emissions

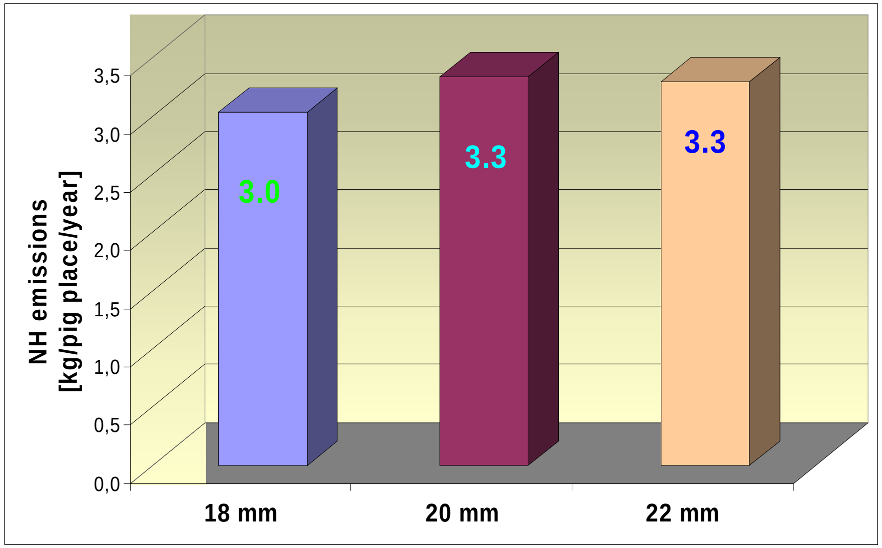


Animal welfare (pigs)

Directive 2001/88/EC on pig welfare establishes a maximum width of 18 mm for openings in slatted flooring used for groups of rearing pigs.

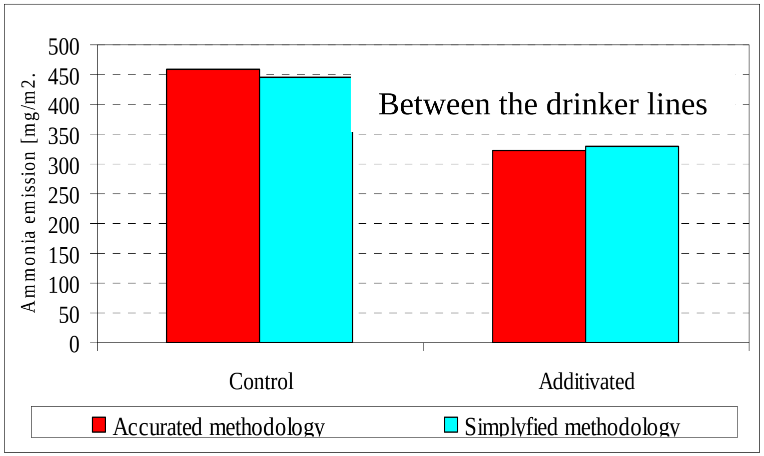
In the case of finishing pigs over 110 kg, a maximum opening width of 20-22 mm is usually adopted to speed up manure discharge and reduce fouling of both the floor and the animal skin

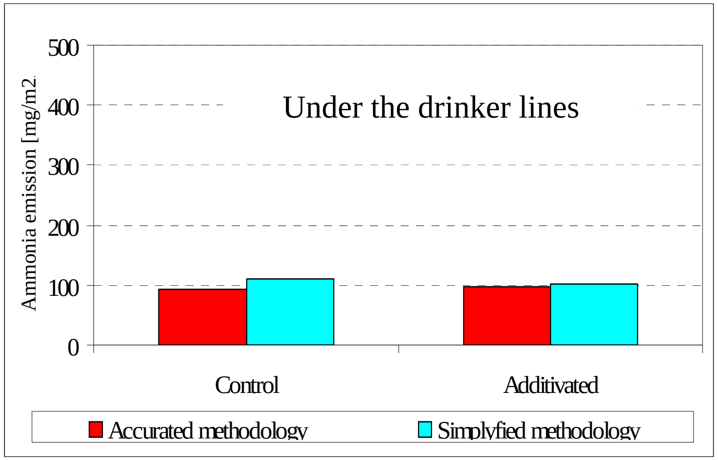


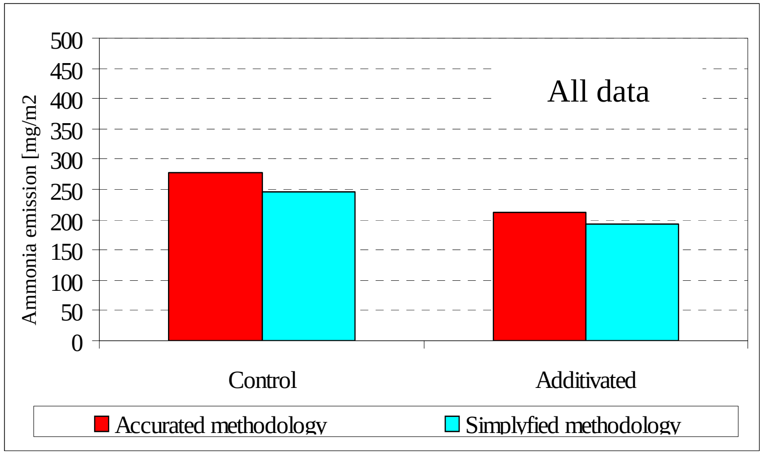


Additives (poultry litter)

Ammonia emissions [mg/m2.h]







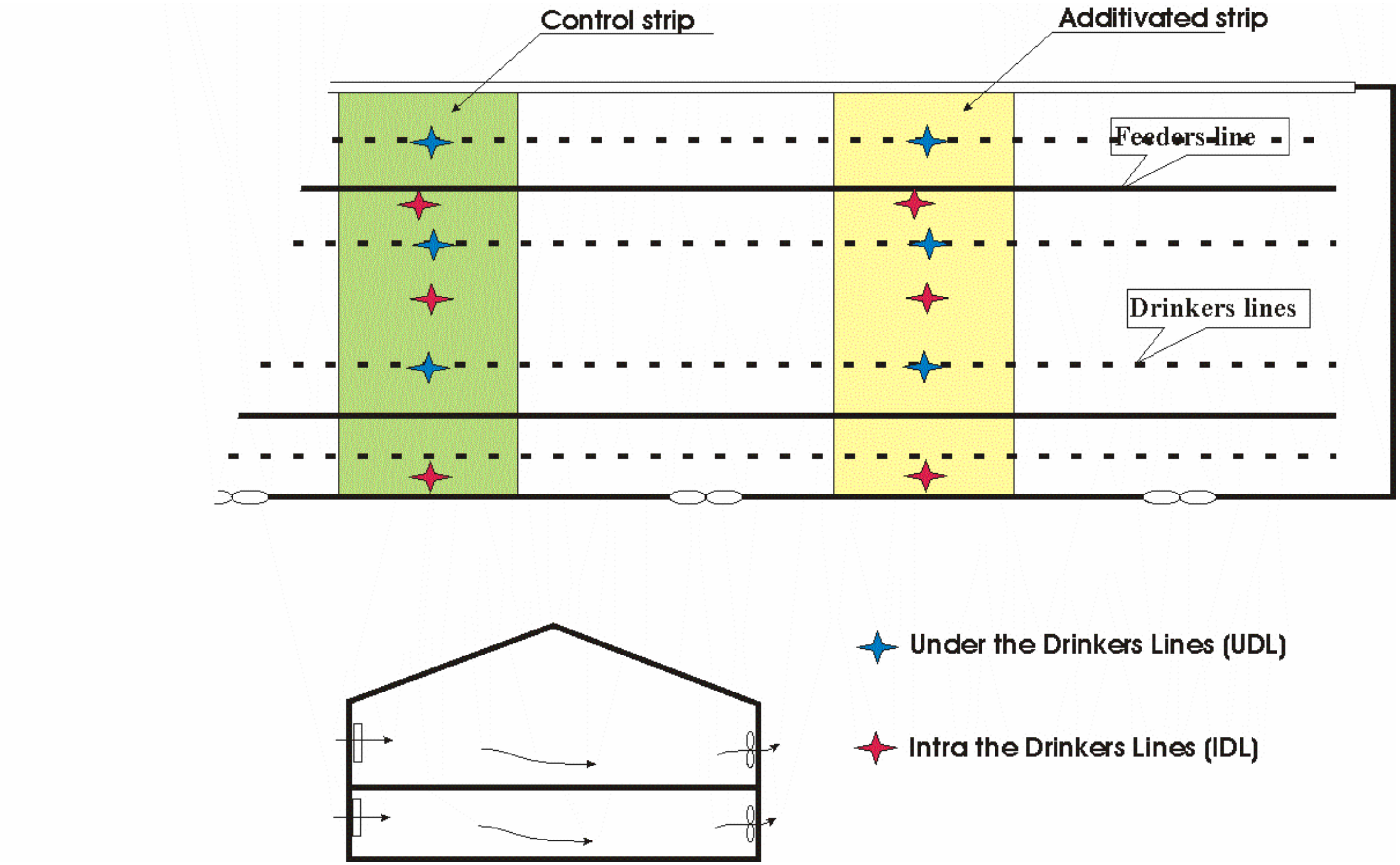
Results:

in the BDL portions the emissions from the treated litter were 27-30% lower than the control, while in the UDL portions the additive efficiency is not evident.

With a weighted average the additive efficiency was circa 25%

Materials and methods

two strips of litter were identified in a house for broilers close to the end of their fattening cycle



Device used for ammonia emission measurements

The measurement technique is based on the “static air chamber method” for flux

measurements