THE DEMANDS FOR THE PIG INDUSTRY TO REDUCE AMMONIA LOSSES, AND SPECIFIC CHALLENGES IN ORGANIC SYSTEMS

Kristoffer Jonassen,
Innovation – Environmental Technology

Hovborg Kro
October 5th 2015

Dan Avl

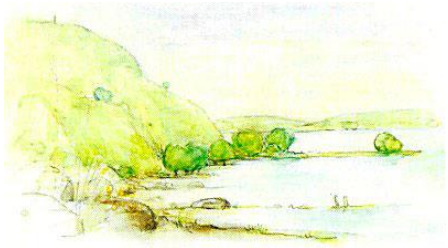
Ministeriet for Fødevarer, Landbrug og Fiskeri
NaturErhvervstyrelsen
gudp

SEGES
Pig Research Centre

OVERVIEW

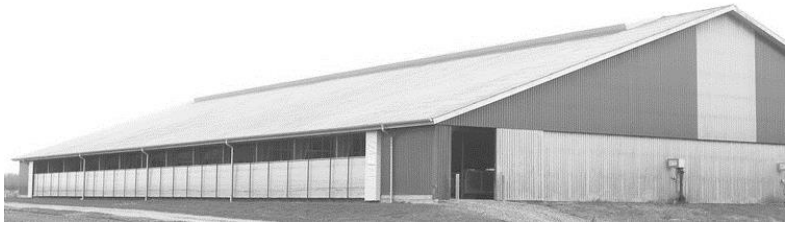
- Demands for pig industry – regulation
- Challenges in organic production systems regarding ammonia losses
- What is achieved by feed optimization
- Additional options by Environmental Technologies

ENVIRONMENTAL REGULATION



Specific ammonia deposition to sensitive nature areas

Odour requirements in relation to neighbours



General requirements for ammonia reductions - BAT

AMMONIA AND BAT

- Ammonia emission from animal houses
  - Standard numbers - updated every year
- General requirements for reduction of ammonia (not for organic production)
  - 30 % for finishing pigs and sows
  - 20 % for weaning piglets
- BAT – Best Available Techniques (not for organic production)
  - Emission limit values
  - The cost for reduction must not exceed 100 DKK (€ 13.5) per kg reduced N or 8 DKK (€ 1.1) per finisher

EMISSION LIMIT VALUES NEW FACILITIES

	BAT reference (Drained floor)	210 DE (2,200 pen-places or 8,200 finishers y^{-1})	400 DE (4,100 pen-places or 15,600 finishers y^{-1})	600 DE (6,200 pen-places or 23,400 finishers y^{-1})	750 DE (7,700 pen-places or 30,000 finishers y^{-1})
kg NH_3-N per animal (32-107 kg)	0.47	0.30	0.27	0.23	0.21
Reduction compared to BAT	-	36 %	43 %	51 %	55 %

Category Kg NH_3-N per animal	210/250 DE	210 – 750 DE	750 DE	Standard numbers (2015)	After general reduction
Weaning piglets	0.0366	0.0366 – 0.0326	0.0326	0.035	0.028
Finishing pig	0.30	0.30 – 0.21	0.21	0.44	0.28
Sows with piglets to weaning	2.53	2.53 – 2.12	2.12	3.20	2.24

AMMONIA REGULATION FOR SENSITIVE NATURE AREAS

- Maximum feasible emission depends on distance to sensitive nature areas
  - Category 1 (max. 0.2, 0.4, and 0.7 kg N/hectare in total deposition)
    - Natura 2000
  - Category 2 (max. 1 kg N/hectare in total deposition)
    - High moor, heath > 10 hectare, open grazing land > 2.5 hectare
  - Category 3 (max. 1 kg N/hectare for the new facility)
    - Additional ammonia sensitive areas

AMMONIA LOSSES - CHALLENGES IN ORGANIC PRODUCTION SYSTEMS

- Feed
- Housing systems

HOUSING SYSTEMS, FINISHER PIGS (<110 KG)

Organic DK

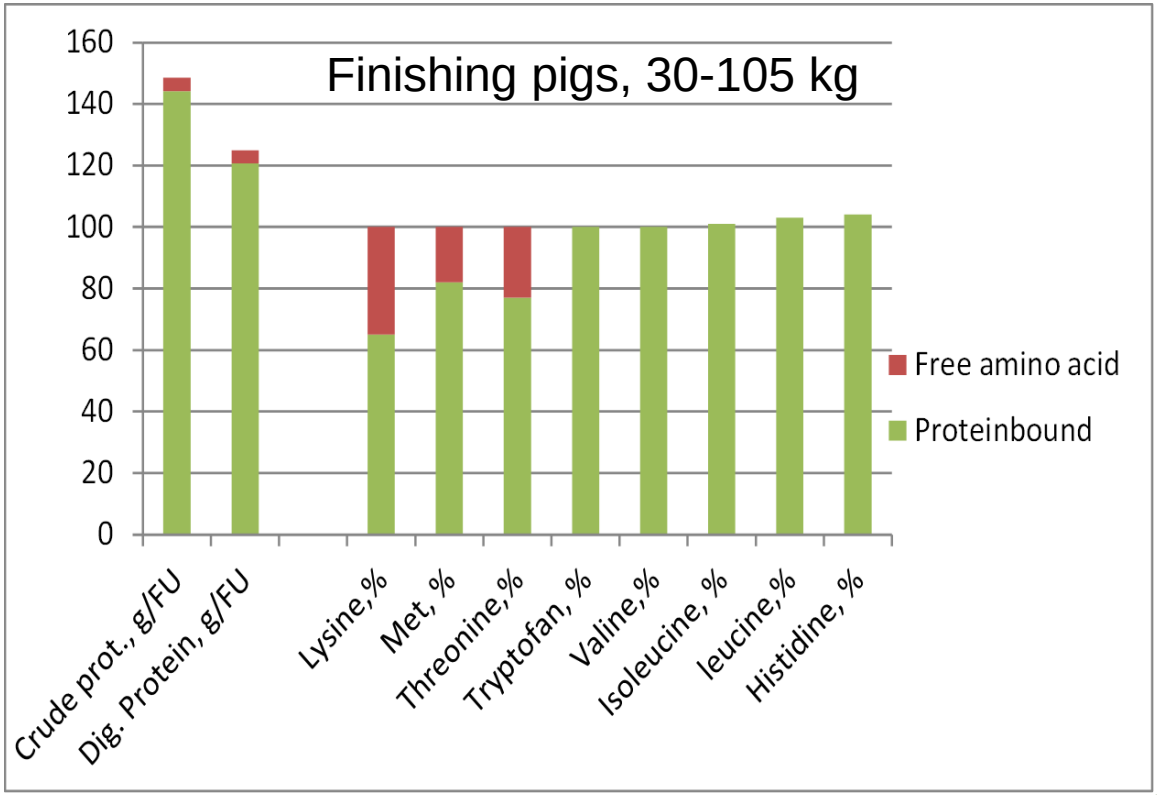
- Open housing system
- Natural ventilation
- Area per animal (m^2)
  - 2.3 in total
  - 1.0 outdoor, min. 50 % solid or drained floor
  - 0.63 lying area (solid floor) with bedding material

Conventional

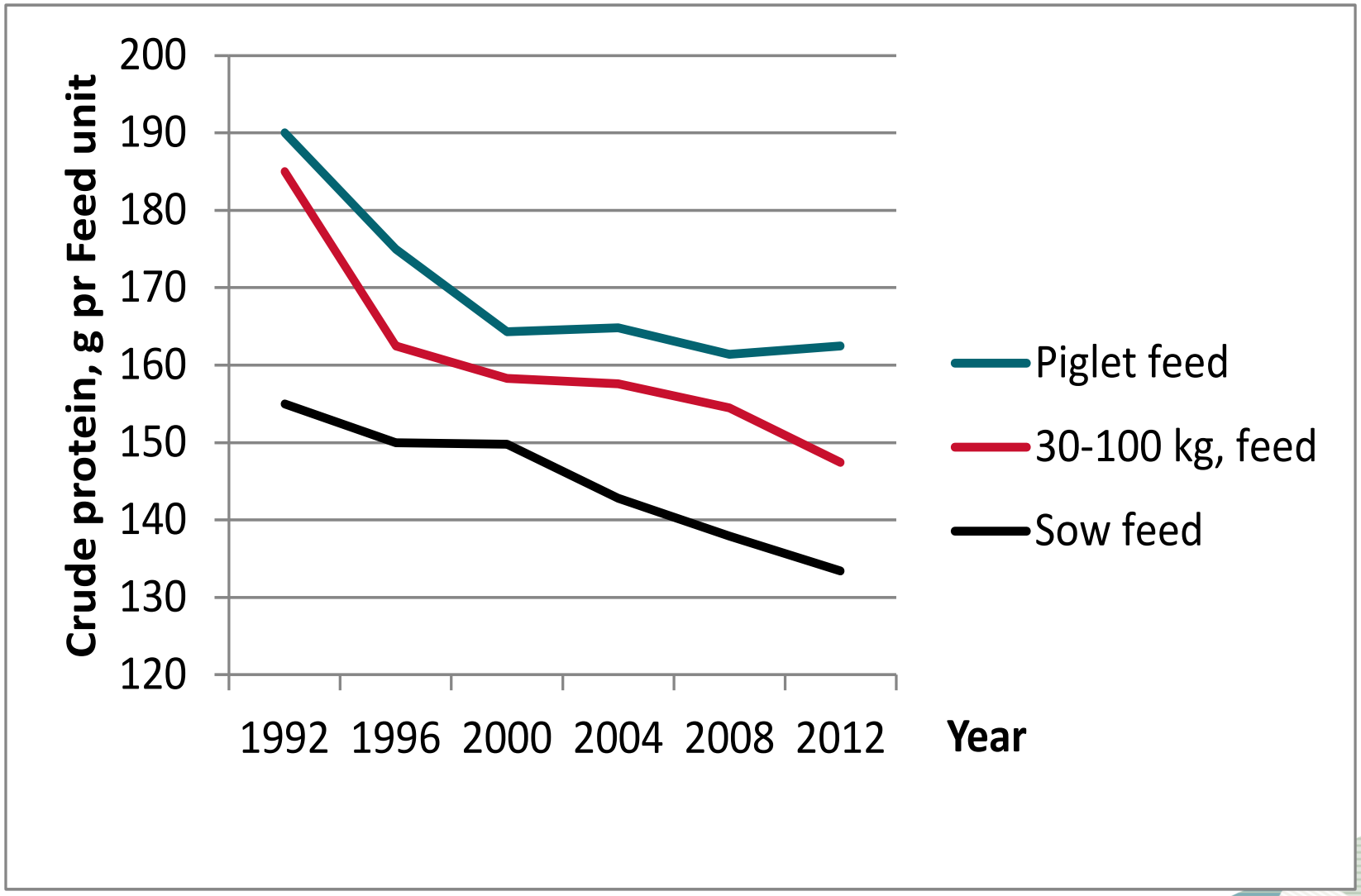
- Closed building
- Mechanical ventilation
- Area per animal (m^2)
  - 0.65 in total
  - 1/3 solid or drained floor (lying area)

CRUDE PROTEIN AND FREE AMINO ACIDS

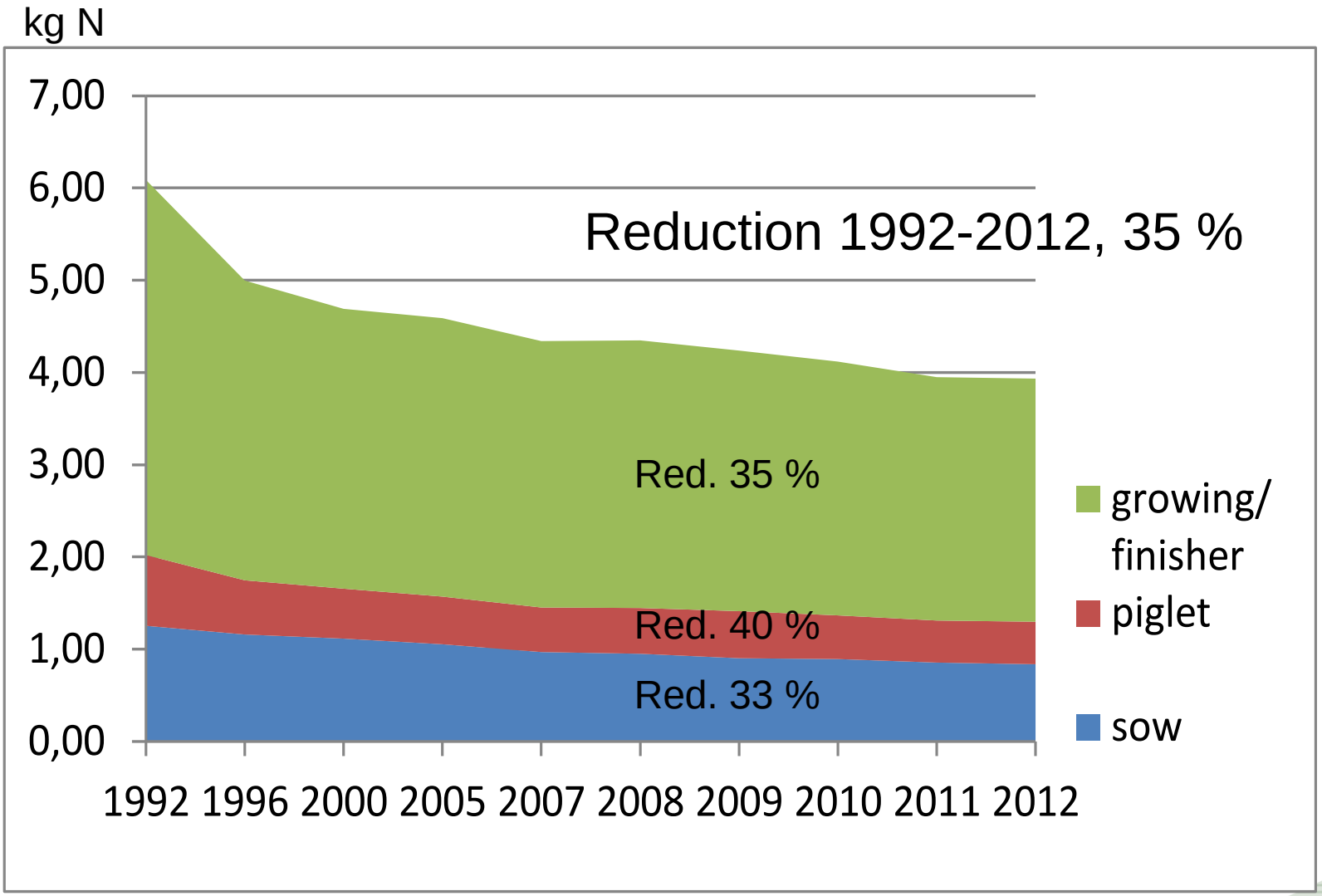
- SEGES Pig Research Centre makes recommendations
- Feed industry and home mixers follow recommendations
- Danish pigs all get the ”same” feed
  - Different raw materials but same nutrional standards



CRUDE PROTEIN IN FEED



N EX ANIMAL PER 100 KG LIVEWEIGHT



EFFECT OF REDUCED PROTEIN

- A reduction of 10 % in N ex animal
  - 11 % reduction, TAN-N sows
  - 13 % reduction, TAN-N, 30-100 kg pigs
  - 15 % reduction, TAN-N, weaners
  - 0.1 lower pH
  - 15 % reduction of ammonia emission, average
- 1992-2012 : 35 % reduction in N ex animal
  - Expected around 50 % reduction in ammonia emission from housing
  - Coming from less protein and better feed utilization

FEED OPTIMIZATION

- Finishing pigs
  - Reduced crude protein content in feed
    - 13 – 22 % reduction of ammonia emission
  - Benzoic acid
    - < 10 % reduction of ammonia emission
    - Addition of max. 1 % Benzoic acid
- Weaning piglets
  - No possibilities for reduction in raw protein content
  - Addition of max. 0.5 % Benzoic acid
- Sows
  - Reduced raw protein content in feed
    - 8 – 16 % reduction in ammonia emission

PRODUCTION RESULTS

Finishing pigs (30-110 kg)	Daily gain (g)	Lean meat percentage (%)	Feed conversion (Feed unit (kg gain)$^{-1}$)	Crude protein (g Feed unit^{-1})	N ex animal (kg)
Conventional production	922	60.2	2.84	145.7	2.93
Organic production	790	58.6	3.07	170.8	4.34

O. Jessen (2015): Notat 1523, SEGES Pig Research Centre
M.G. Christiansen (2014): Notat 1442, SEGES Pig Research Centre
H. Damgaard Poulsen (ed.) 2015: Normtal for husdyrgødning
H. Maribo (2007): Meddelelse 782, SEGES Pig Research Centre

ENVIRONMENTAL TECHNOLOGIES

- Danish EPA - List of Environmental Technologies
  - Housing systems
    - Floor design
    - Cooling of the manure
    - Acidification of the manure
  - Air cleaning
  - Manure storages
    - Rigid cover of the manure storages
  - Field application
    - Injection of manure
    - Acidification

PARTLY SOLID FLOOR

Kg NH_3-N per animal	Drained floor (33 %)	Solid floor (25 – 49 %)	Solid floor (50 – 75 %)
Emission (kg NH_3-N per animal)	0.40 (+0.04)	0.33 (+0.04)	0.25 (+0.04)
Reduction (%)	-	17	34

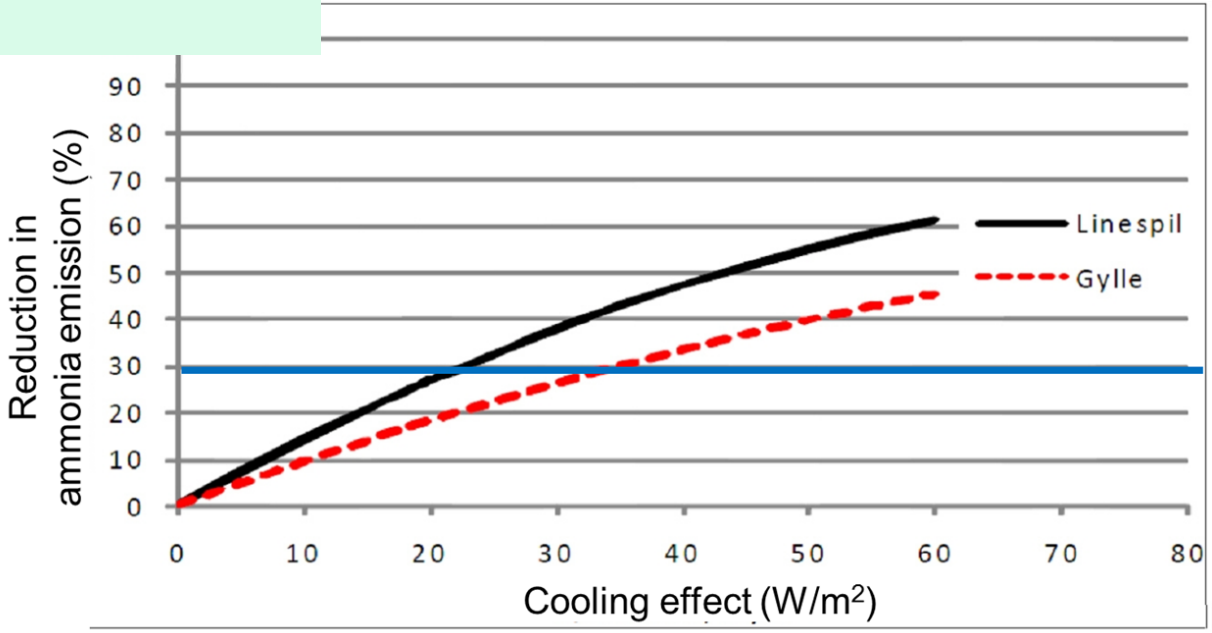
Can cause trouble with fouling in the laying area

- Widely use in the organic production

H. Damgaard Poulsen (ed.) 2015: Normtal for husdyrgødning

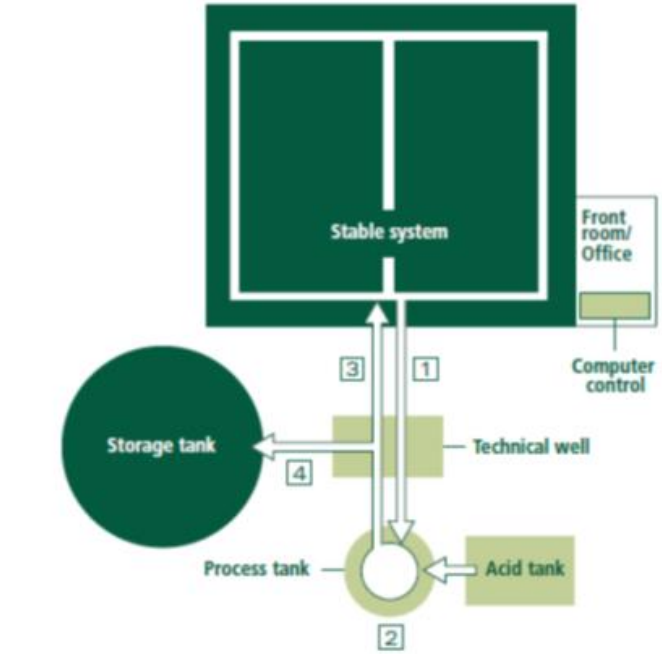
COOLING AF SLURRY

- < 30 % reduction of NH_3
- Reuse of heat
- Less slurry surface to cool
- Limited effect in organic production



ACIDIFICATION OF SLURRY

- Acidification with H_2SO_4, pH 5.5
- 64 % reduction of NH_3 from the housing system
- 50 % reduction from storage

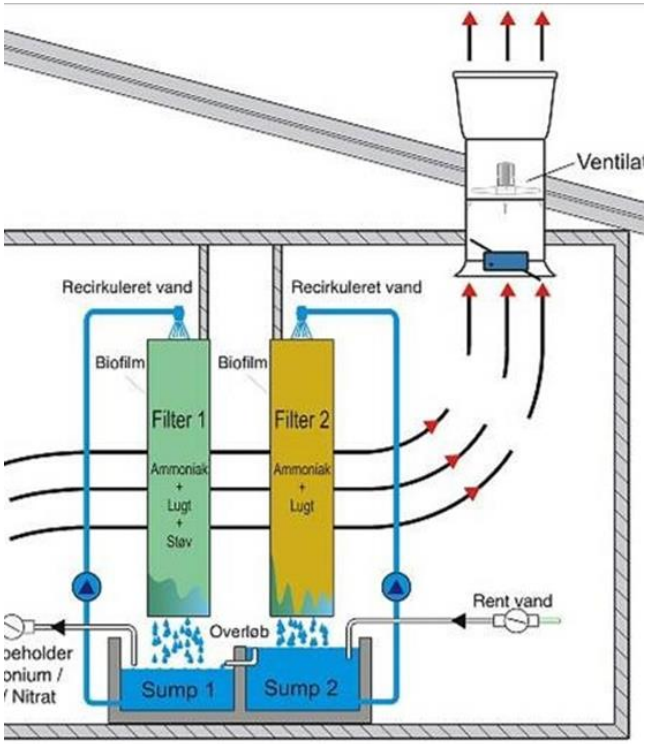


Possible alternatives for the organic production

- Lactic acid (generated by bacteria)
- Sugar, straw or starch
- Other organic acids

AIR CLEANING

- Biological or chemical air cleaning
- ~90 % NH_3 reduction
- Mechanical ventilation
- Use of H_2SO_4



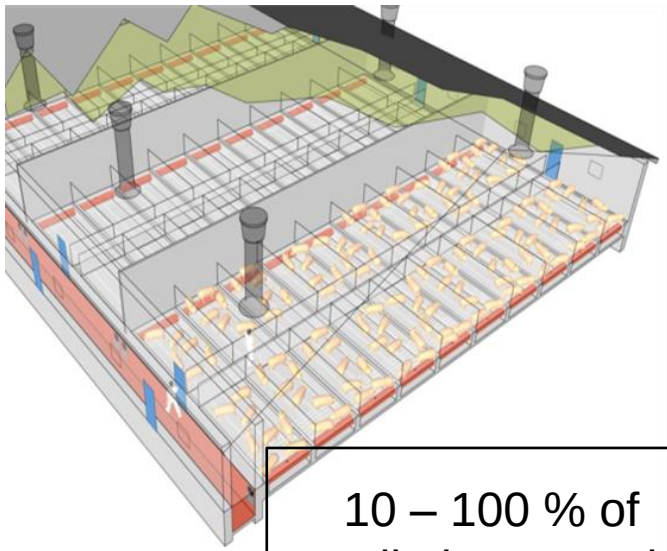
Adapted to be used in the organic production

- Point extraction
- Oxalic or other organic acids

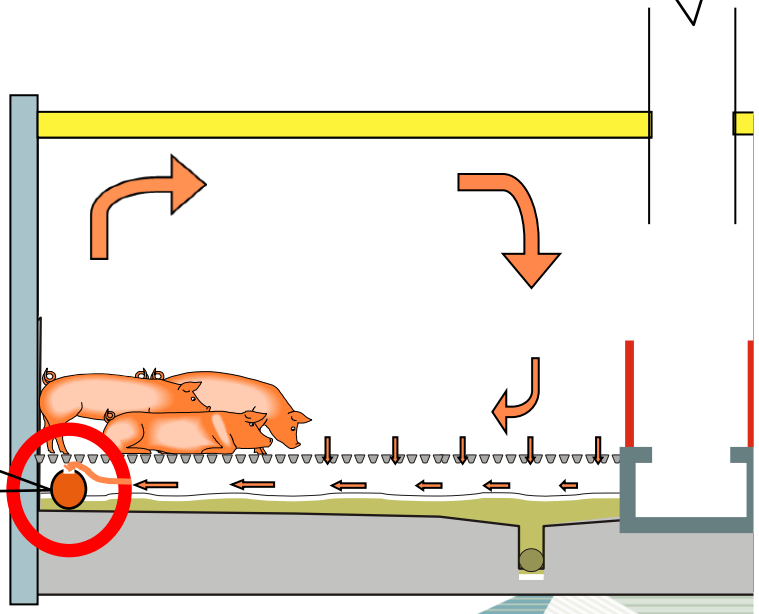
POINT EXTRACTION

- Optimized partial air cleaning
- Cleaning the “dirtiest” part of the ventilated air volume

- Point extraction with 10 m^3 h^{-1} pig^{-1} contains
  - 25 % of total ventilated air volume (m^3 $year^{-1}$)
  - 65 % of NH_3 emission (kg $year^{-1}$)
  - 50 % of odour emission (OU_E $year^{-1}$)



10 – 100 % of ventilation capacity



10 % of ventilation of capacity – connected to an air cleaner

POINT EXTRACTION AND AIR CLEANING

- NH_3 reduction (%) = 0,7 x E -12
  E = efficiency of the air cleaner (%)
- ~50 % reduction from the housing facility

- Hybrid ventilation
  - Natural ventilation combined with point extraction

SUMMARIZING

- Demands for pig industry - regulation
- Challenges in organic systems
  - Feed
  - Housing systems
- Feed optimization by reduced crude protein and use of free amino acids
  - 35-50 % reduction of ammonia emission since 1992
- Additional options by Environmental Technologies
  - Floor design – already widely used
  - Cooling of the slurry – could have an effect (reduced slurry surface), but the heat has to be re-used
  - Acidification of the slurry – rethinking the acid
  - Air cleaning – biological air cleaning, modified chemical air cleaning, acceptance of (partly) use of mechanical ventilation, e.g. as point extraction