Task 37 Energy from Biogas

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Utilisation of digestate as fertiliser
- a common practice in Denmark

by

Teodorita Al Seadi MSc

Principal Scientist, Research Coordinator

University of Southern Denmark
Faculty of Technology
Institute of Chemical Engineering, Biotechnology and Environmental Technology
Niels Bohrs Vej 9, 6700-Esbjerg
Denmark

Content of this presentation:

- Biogas and digestate production in Denmark
- Danish practice concerning utilisation of digestate as fertiliser
- Experience gathered and conclusions

Overview of biogas production in Denmark

Type of plant	Nr. of plants	Production PJ
- Agricultural biogas plants		
1. Joint co-digestion plants	20	1,70
2. Single farm co-digestion	60	0,91
- Waste water treatment plants	64	0,87
- Industry plants	5	0,14
- Landfill gas recovery plants	25	0,44
- Household waste	-	-
Total		4,06

Digestate production in Denmark, anno 2010

20 joint biogas plants in operation
Capacity: 50-600 m3/day

60 single farm biogas plants in operation
Capacity: 5-50 m3/day

Feedstock types for agricultural biogas plants

Animal manure and slurries

- Pig manure/slurry
- Cattle manure/slurry
- Poultry manure
- Deep litter

Energy crops

- Maize and maize silage
- Green harvested crops

Agro-industrial residues

- Stomach and intestinal content from slaughterhouses
- Flotation sludge and other slaughterhouse waste
- Waste from dairies
- Waste from fish industries (fish waste and fish oil)
- Glycerine
- Residues from vine industry
- Waste from plant oil production
- Waste from sugar industries
- Meat and bone meal

Municipal waste

- Source sorted household waste?
- Municipal sludge (waste water treatment plants)

Feedstock substrates for AD
processed in joint biogas plants in 2010

Animal manures and slurries (3- 5% of total production): **1.742.156 m^3**
Organic wastes: **450.708 m^3**

Total: **2.192.864 m^3**

AD feedstock types, as % of total amounts supplied to biogas plants

Cattle slurry	33 %
Pig slurry	40 %
Other manures	2 %
Subtotal, manure	**75 %**
Slaughterhouse wastes	8 %
Fatty flotation sludges	6 %
Fish processing wastes	4 %
Dairy, Brewery, Tannery, Pharmaceutical, etc.	7 %
Subtotal, industrial wastes	**25 %**
Total	**100 %**

Source: Danish Energy Authority, 2010

Average composition of digestate in Denmark

Example of concentrations of N, ammonia and P in digestate from centralised biogas plants in Denmark

Source: Danish Environmental protection Agency, 2004

Biogas plants	Total N [kg/t]	NH_4-NH_3[kg/t]	P [kg/t]
Blaabjerg	4.75	3.25	1.1
Blåhøj	5.3	3.8	0.84
Fangel	5.83	4.38	0.92
Filskov	4.9	3.7	0.94
Hashøj	5.05	3.9	0.78
Lemvig	4.28	3.02	1.2
Lintrup	5	3.26	1.3
Nysted	4.84	3.79	0.9
Ribe	4.6	3.2	0.9
Sinding-Ørre	2.6	2.2	1.2
Snertinge	4.3	3	1.3
Studsgård	3.86	2.79	0.86
Thorsø	4.8	3.6	0.96
Vester Hjermitslev	6.3	5.1	0.56
Vegger	4.5	3.1	0.8

Declared digestate is transferred from the biogas plant to the storage tanks of the farmers, placed out in the fields.

The biogas plant pays the transport to/from the biogas plant

Regulation of digestate application as fertiliser in Denmark

Harmony rules

Danish regulation of nutrient loading from manure on farmland

Maximum nutrient load	Required storage capacity	Compulsory season for spreading
170 kg N/ha /year (cattle)	9 months	February->Harvest
140 kg N/ha/year (pig)	9 months	February->Harvest

Digestate is integrated in the fertilisation plan of the farm like any other fertiliser

- The farmer is visited by the crop consultant at the end of the season
- The farmer + consultant make a follow up on the past season
- The farmer + consultant elaborate a primary fertilisation plan for the next season (farmers receive the fertilisation plan spreadsheet + all the information necessary + assistance for calculations)

2. Example of calculation of N-utilisation requirement in digestate

	Total t a	Kg N/t b	Total Kg N a x b=c	N -utilisation requirem. d	Utilised N cx(d/100)
Kvæggylle		5,5		70	
Svinegylle		5,2		75	
Blandet gylle (50/50 pct.)		5,4		72,5	
Staldgødning, kvæg		6,2		65	
Staldgødning, svin		11,0		65	
Dybstrøelse, kvæg		9,5		45	
Dybstrøelse, svin		10,0		45	
Fast gødning, fjerkræ		15,0		65	
Dybstrøelse, fjerkræ		21,0		45	
Gylle, fjerkræ		6,9		70	
Fast gødning, pelsdyr		10,9		65	
Gylle, pelsdyr		6,3		70	
Spildevandsslam				45	
Husholdningsaffald				20	
Energiafgrøder				40	
Andre typer affald				40	
Andet:					
Sum		-	(e)	-	(f)

Minimum requirement for N-utilisation in digestate **= (f /e) x 100 =_____** **pct.**

Application of slurry in winther wheat with trailing hoses

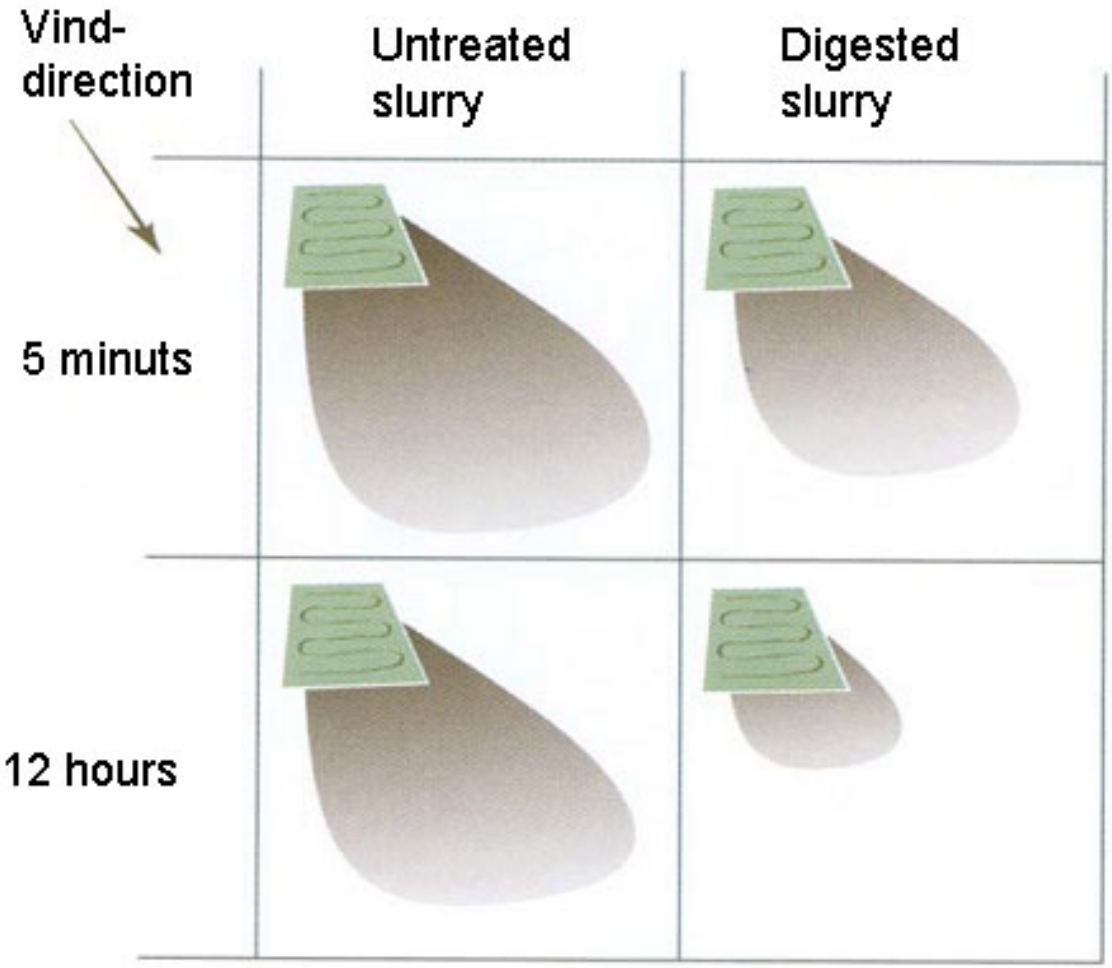
Injection of slurry in bare soil

Broad spreading of digestate and raw slurries is prohibited in Denmark, due high ammonia emissions!!

Incentives for Danish farmers
to apply digestate as fertiliser

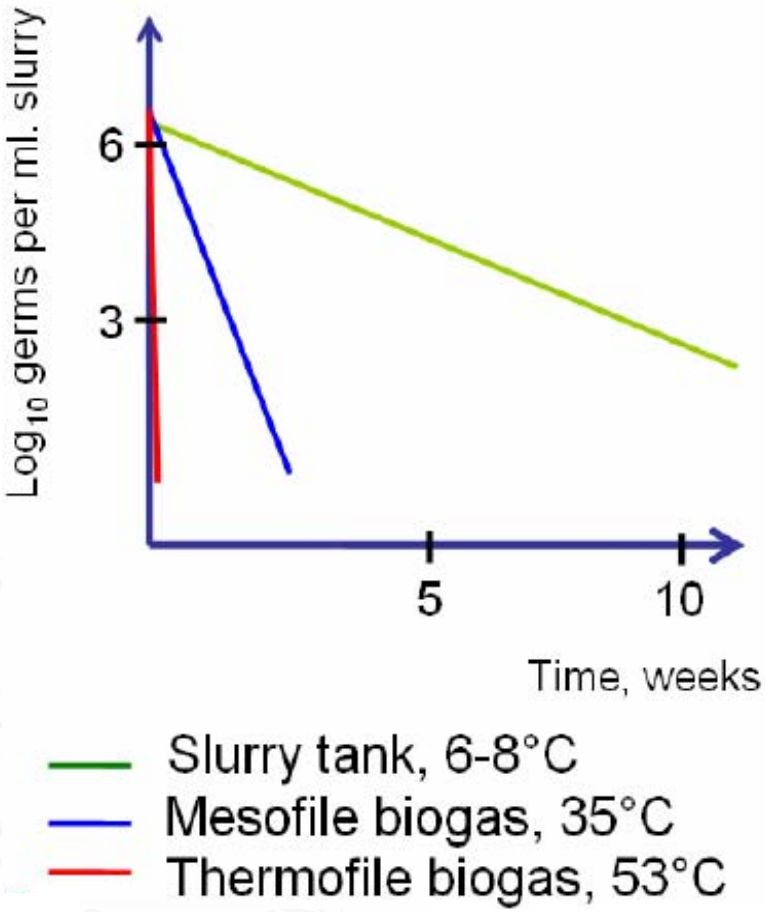
- Declaration of nutrient content
- Homogenous slurry
- Less odours
- Free of pathogens and weed seeds
- Improved N efficiency (10-15%)
- Less purchase of mineral fertiliser
- Balanced P and K application
- Reduced nitrate leaching and GHG emissions
- Reduced costs fro transport of slurry for farmers
- Alternative energy crops as feedstock
- Controlled recycling of organic wastes
- Jobs and activity in rural areas

Odour reduction by application of digestate



Digestate has a low pathogen content

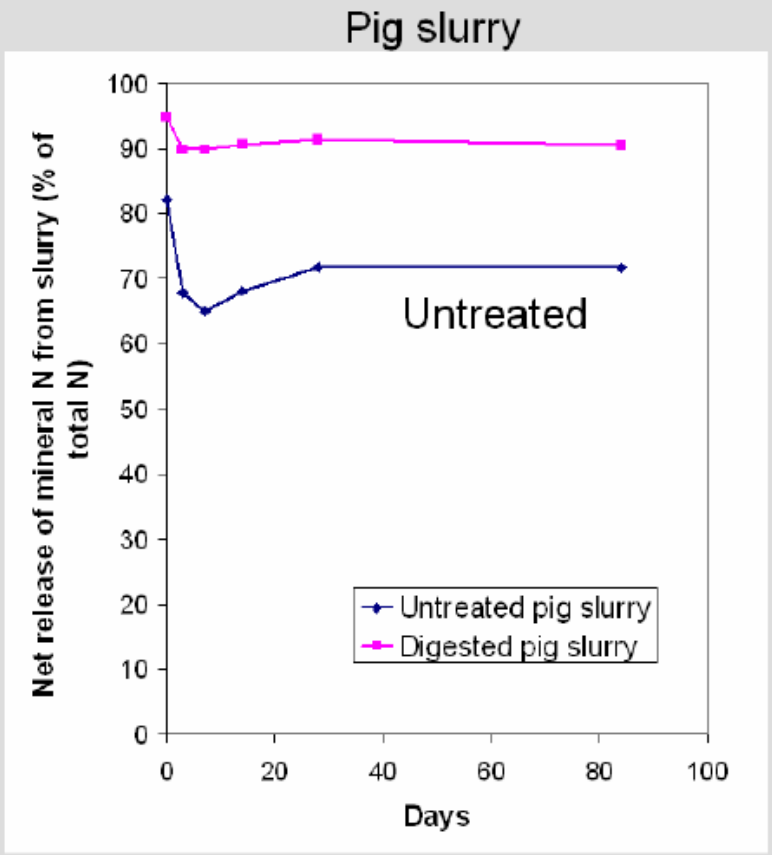
Source: Dansk Landbrugsrådguivning

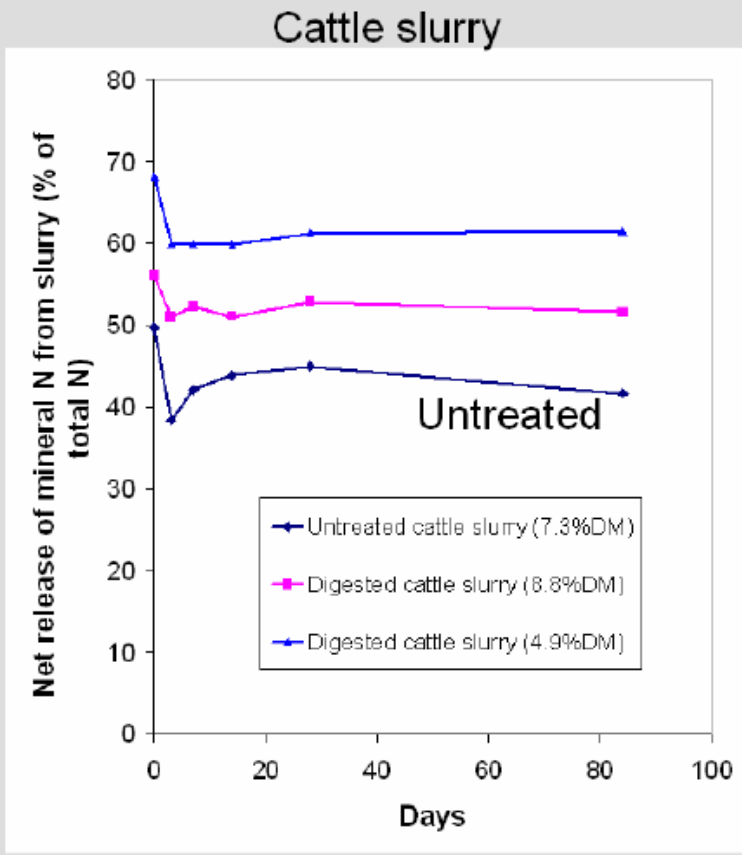


Test results from Ribe Biogas
bacteria per ml. slurry (1998)

Date	Before	After
Mar. 18	1,300,000	<5
May 13	140,000	<5
July 15	690,000	<5
Sept. 9	9,000,000	<5
Nov. 11	62,000	<5

Higher N availability

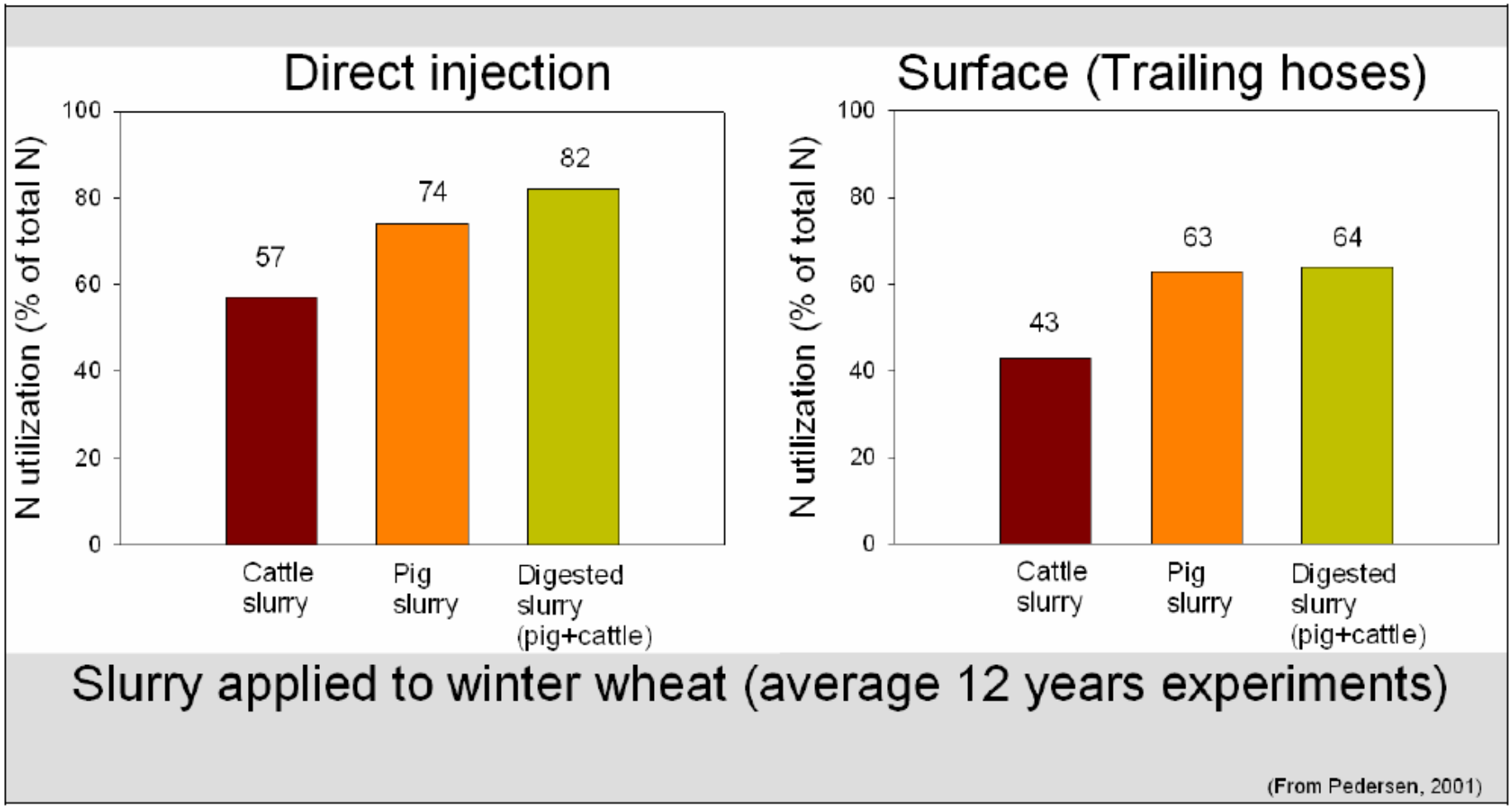




Incubation study with loamy sand soil

Better nitrogen utilisation

Surface application and direct injection



Less consumption of mineral fertilisers

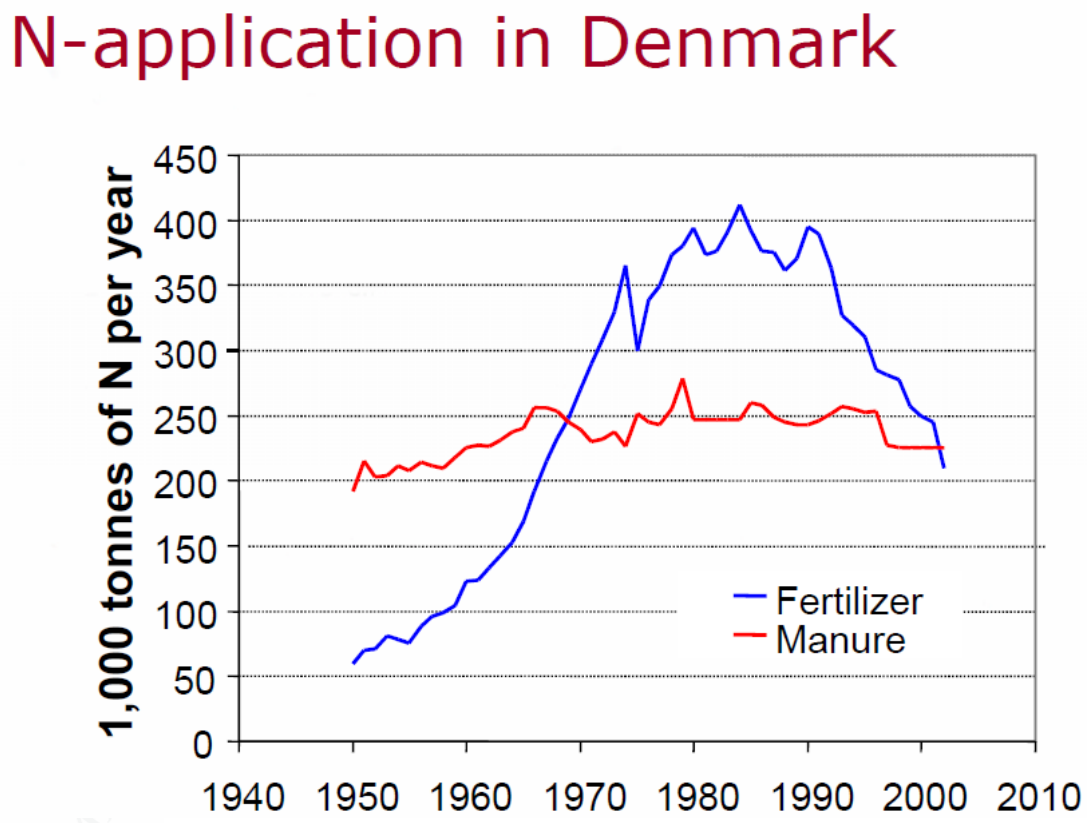
(Source: Dansk Landbrugsrådgivning)

Per hectare	Cattle slurry	Digested slurry
N-requirement, kg	250	250
N in slurry, kg total	170	170
N-utilization, %	40	60
N- in slurry, utilized, kg	68	102
Mineral fertilizer	182	148
Saved, kg	-	34
Saved, Euro	-	27

dansk landbrugsrådgivning

Reduction of nitrogen application in Denmark, as a result of higher nitrogen utilisation efficiency in raw and digested animal manure

Source: Danish Energy Authority, 2009



Digestate has higher risk of ammonia volatilisation

Benefits of digestate utilisation are achieved only through good practices

- As a principal rule, digestate should only be applied at the start of the growing season, in March and April, and later on only in vegetative growing crops.
- The digestate must be incorporated into the soil immediately after it has been applied, to minimise ammonia volatilisation. The best thing to do is to simultaneously spread and incorporate the digestate. The use of dragging hoses or shallow injection equipment is recommended.
- The optimum weather conditions for application of digestate are when it is raining or there is a very high humidity and no wind. Dry, sunny, and windy weather reduces the N-efficiency considerably.
- When digestate is applied to grass crops, direct injection should be used to maximise N-efficiency. Application with traditional equipment or dragging hoses can only be recommended if it can be done in rain or weather with high humidity.

Good practices minimise ammonia volatilisation during storage

- always have a well established crusting surface in the storage tank
- pump the digestate in at the bottom of the storage tank to avoid stirring of the digestate
- stir the digestate just before it is to be applied
- place the storage tank in the shadow and sheltered from the wind

Thank you for your attention!