Digestate as fertilizer – recycling of nutrients

The environmental impact and the value as a fertilizer

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- HMN Biogas ApS. , which finances and operates the upgrading plant for biogas throughout the country
- HMN gas tank ApS , which establishes and operates gas stations across the country.

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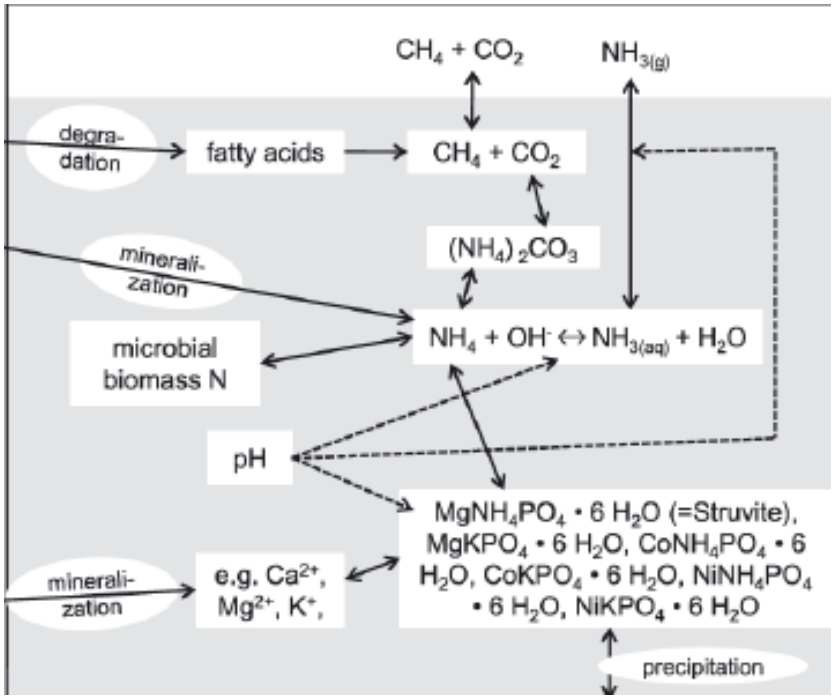
Fertilizer value

"Digestate production"

Biomass input:
Manure
Slurry
Waste
Crops



Gas output:
CH_4
CO_2

Biomass output:
Digestate
- ↓ DM%
- ↓ N-Org
- ↑ N-Inorg.
- ↓ C/N
- ↑ pH
- ↓ Bacteria
- ↓ Viscosity

(Partly from Möller & Müller, 2012)

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Mixing and digesting slurry change the characteristic of the slurry

Manure type	DM *%*	N-Total *kg/t*	NH_4-N *kg/t*	P *kg/t*	K *kg/t*	pH	NH_4 andel *%*
Cattle Slurry	6	5	3	0,8	3,5	6,5	60
Pig Slurry	5	5	3,5	0,9	2,4	7	70
Deep litter, Cattle	30	10,6	2,1	1,6	9,8	7	20
Digestate	3,5	5	3,7	1,5	5,8	7,5	75

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Inorganic N in manure and other biomasses before and after digester (estimates from Sørensen & Børgesen, 2015)

Manure type	NH4-N/total N	
	Untreated	Digestate
Pig slurry	0.79	0.90
Cattle slurry	0.58	0.68
Deep litter (cattle)	0.20	0.60
Maize-silage	0.05	0.60
Slaughterhouse waste	0.05	0.60
Fish waste	0.70	0.90

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Infiltration in the field

Cattle slurry trailing hoses

Digestate trailing hoses

Biogas plant

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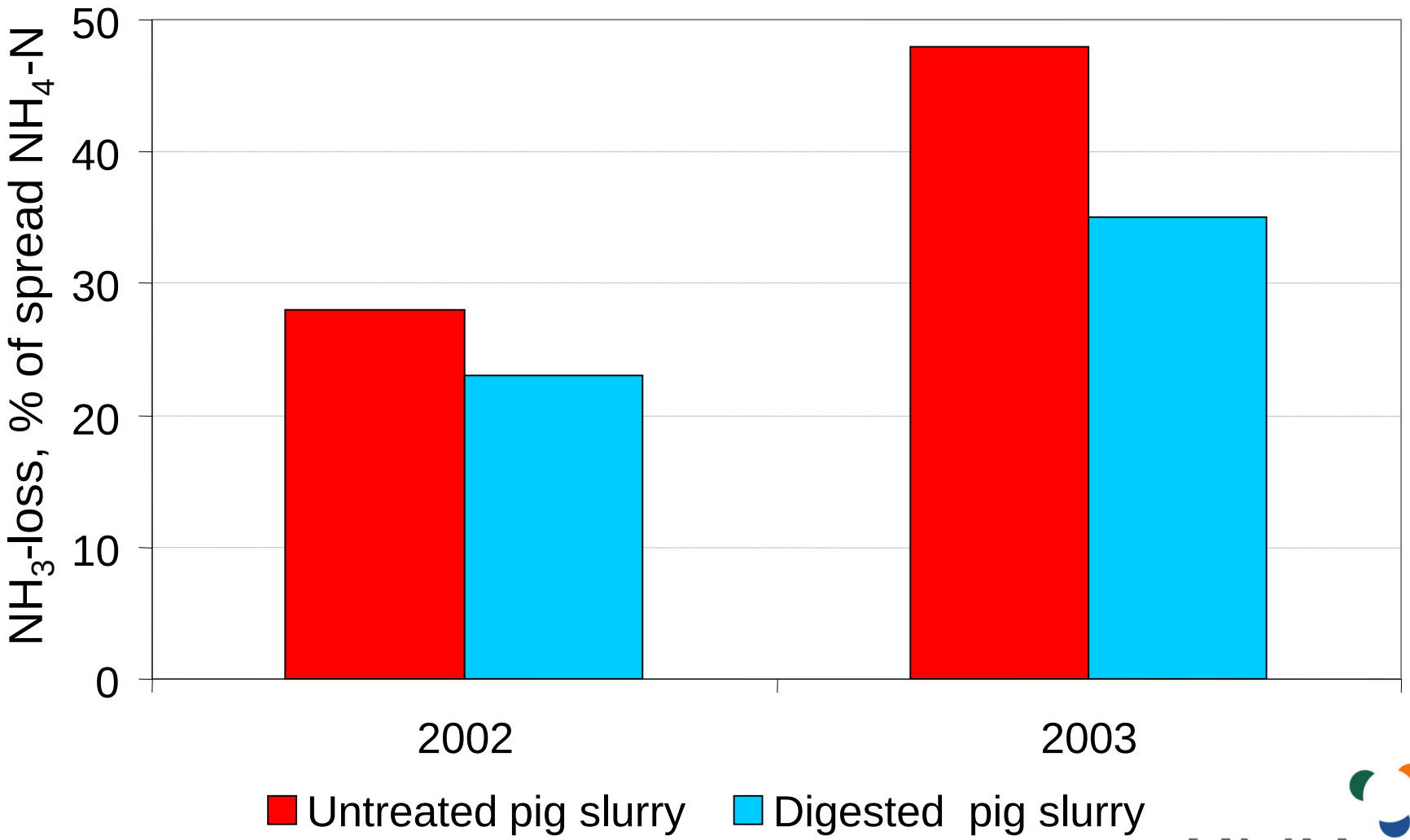
Ammonia evaporation in spring barley



(Grøn Viden 296, 2004
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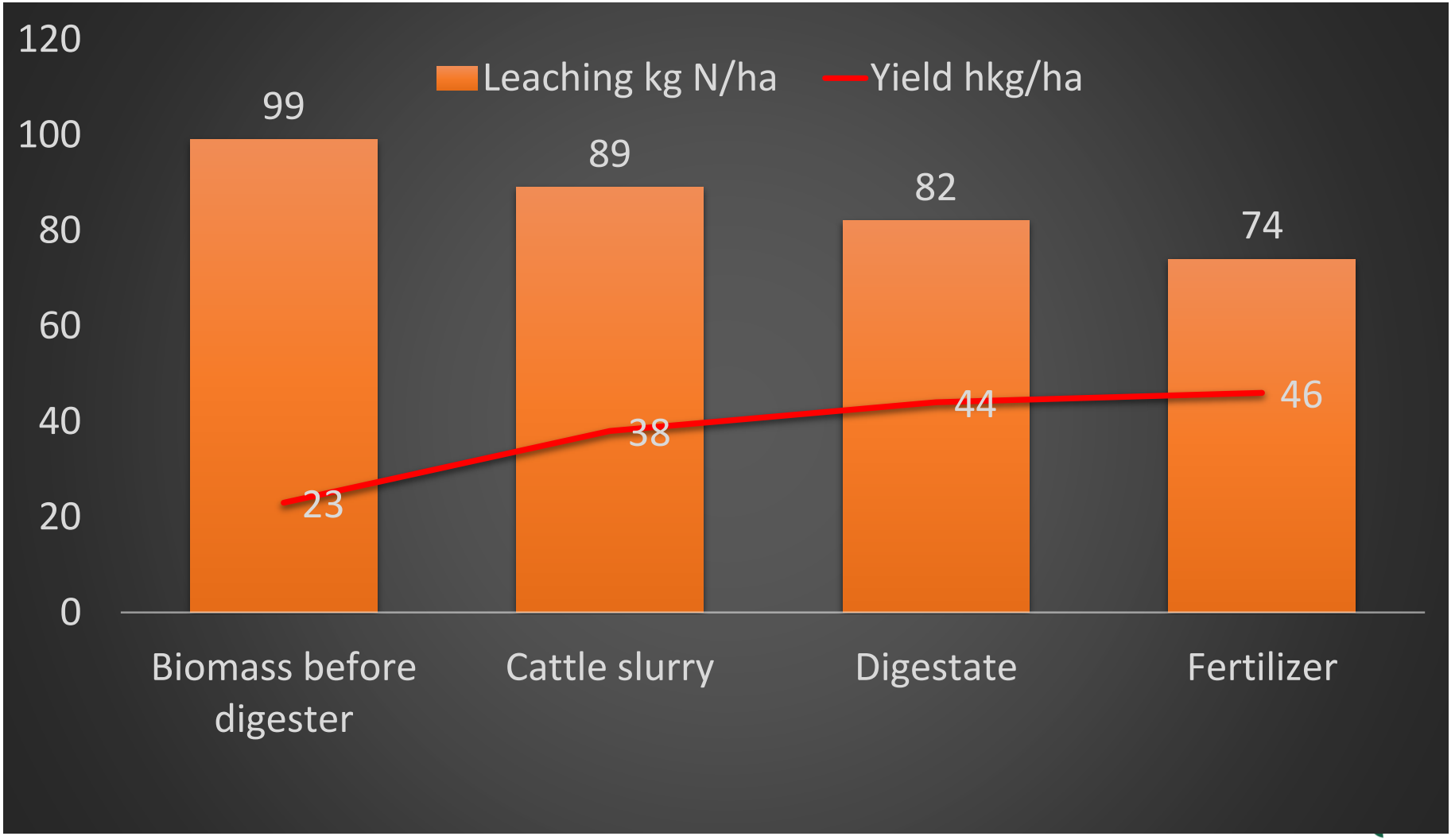
Nitrogen applied to spring barley 100 kg NH_4 N/ha



(Sørensen & Birkmose, 2002. Grøn viden Markbrug no. 266)

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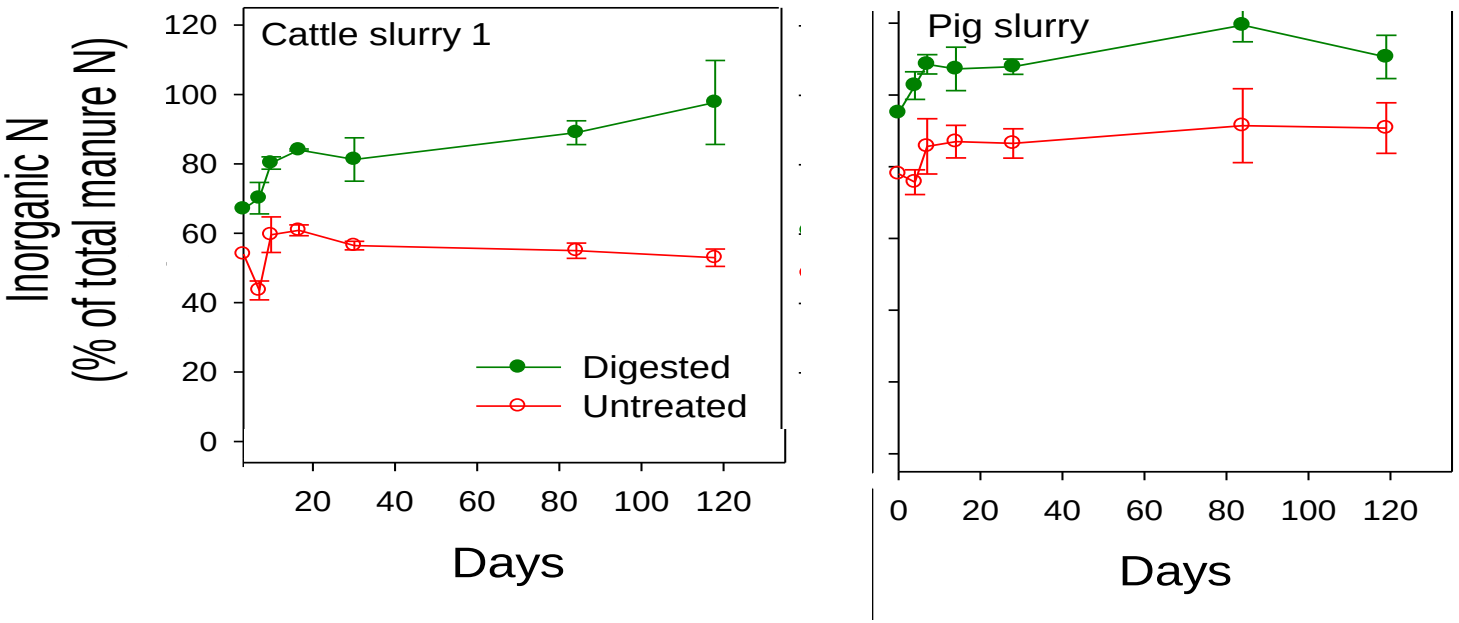
What is the effect of anaerobic digestion (AD) of manures on N leaching?
- Presentation of model and estimates

After AD manures contain more inorganic N and release more inorganic N in soil. - How does it influence leaching?



Soil incubation study with loamy sand soil, 20°C (Sørensen et al. 2012)

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Marginal leaching factor from mineral fertilizer N estimated by NLES4 model

Crop	N-norm kg N/ha	Marginal N leaching kg N/kg N
Sandy soil, ca 400 mm water surplus/yr		
Winter oil-seed rape	175	0.25
Winter wheat	147	0.23
Winter wheat with cover crop	156	0.20
Spring barley	129	0.21
Avg.	**152**	**0.22**
Loamy soil, ca 200 mm water surplus/yr		
Winter oil-seed rape	181	0.13
Winter wheat	147	0.13
Winter wheat with cover crop	156	0.11
Spring barley	116	0.11
Avg.	**150**	**0.12**

Nearly similar avg. leaching estimates for dairy rotations

Marginal N leaching defined as:
Extra N leaching after application of 1 kg extra N (at N norm)

(NLES4 model described by Kristensen et al. 2008)

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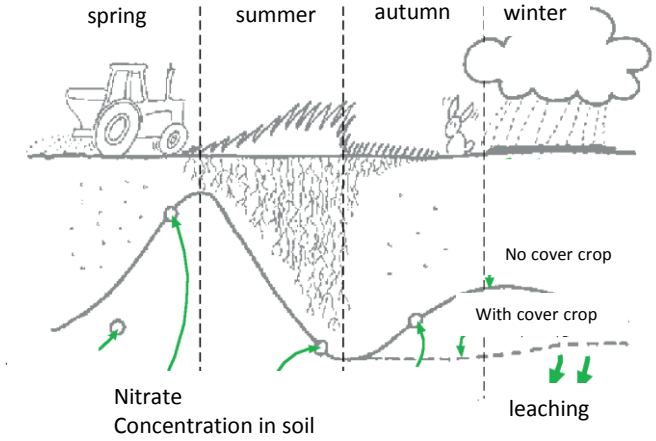
Long-term leaching factor from mineralized N: Twice as high as for spring-applied mineral N

Estimation of the proportion of mineralised N in soil that is leached by use of different proportions of cover crops using the FASSET plant-soil-system model (Petersen et al., 2006 & Vinther et al., 2013).

Soil	Land with cover crops %	Leaching of mineralized N %	Marginal N leaching inorganic N (NLES4) %
Sandy, high precip.	10	59	
	20	37	
	15	**48**	**22**
Loamy, low precip.	10	43	
	20	11	
	15	**27**	**12**



This is supported by lysimeter studies with ^{15}N-labelled fertilisers (Thomsen et al., 1997; Sebilo et al., 2013) showing nearly similar crop uptake and leaching of mineralized labelled N

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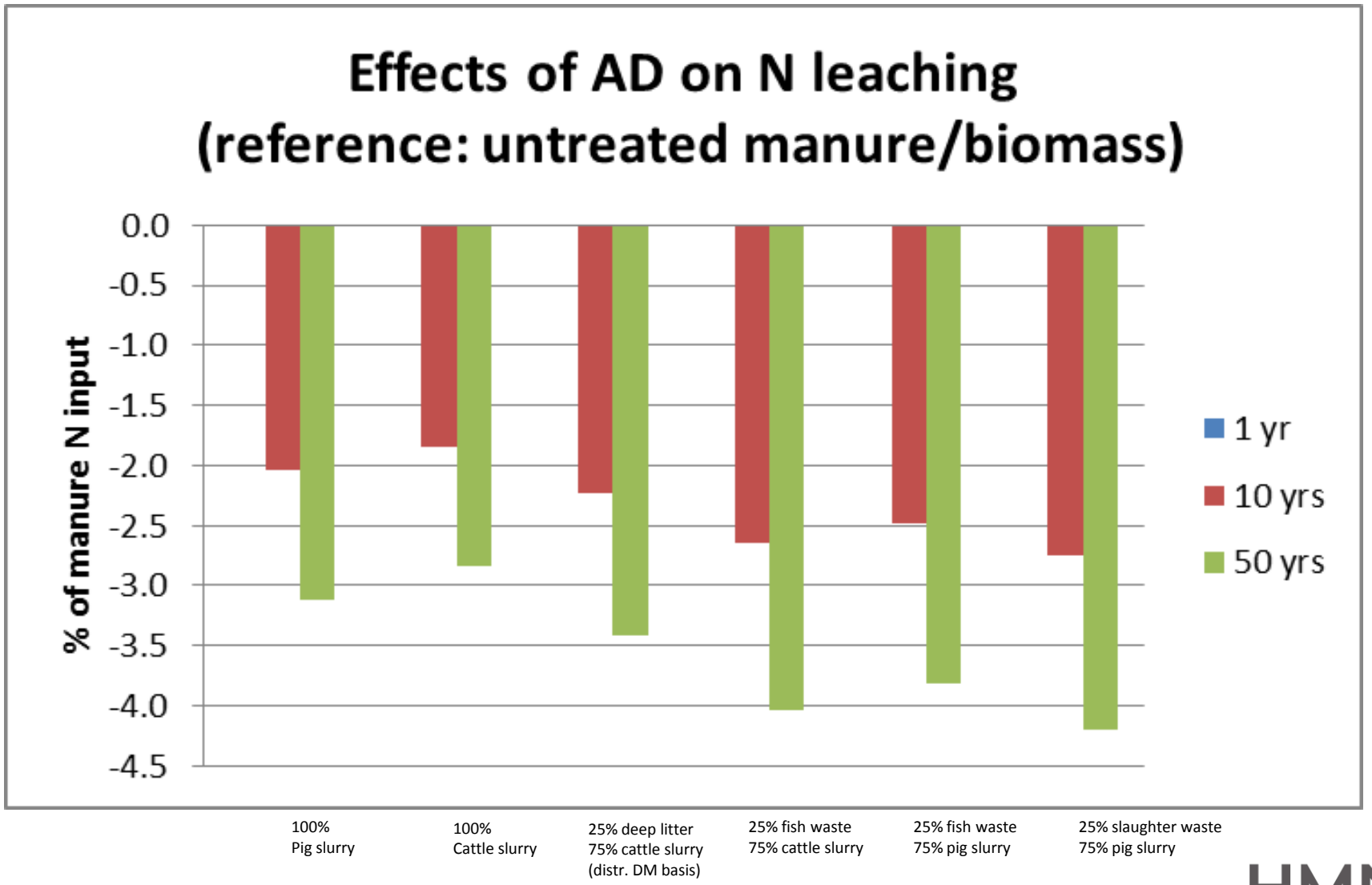
Change in N leaching due to AD estimated



(Data from Sørensen & Børgesen, 2015)

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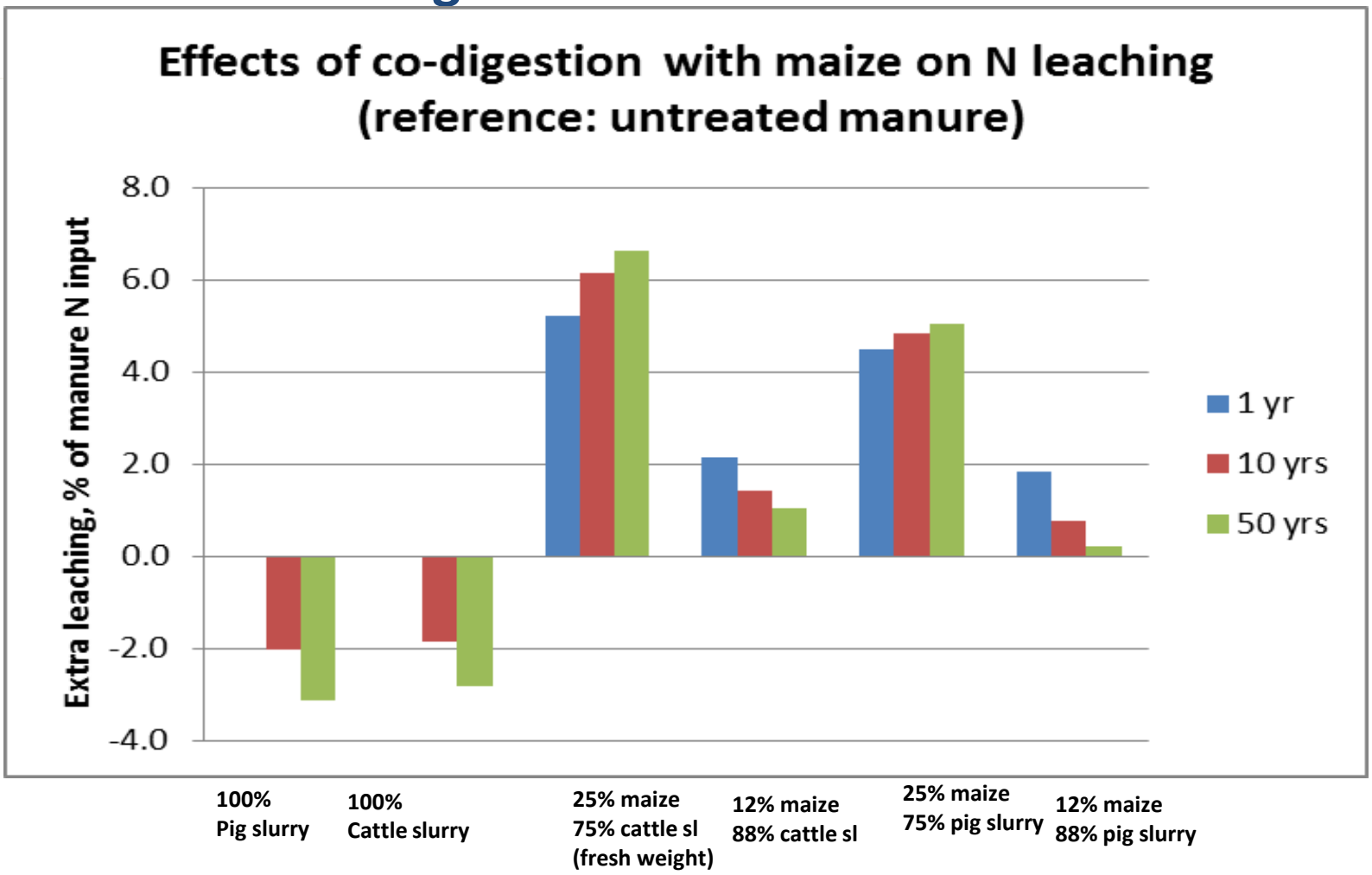
Co-digestion of manure with maize silage (energy crop) can increase N leaching



(Data from Sørensen & Børgesen, 2015)

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Additional leaching reduction if mineral fertiliser application is reduced after manure digestion

- Increased fertilizer value of digestate: 5-8% of total N (after accounting for lower residual affect)
- Additional reduction in N leaching if accounting for 8% higher fertilizer value by mineral N application:

  Sandy soil: 1.8 % of manure N

  Loamy soil: 1 % of manure N

Conclusions

- In the first year there is no effect of AD on N leaching,
- In the long-term (50 yr) the reduction in N leaching is equivalent to 1.5-4 % to of the manure N application (compared to untreated manure).
- By co-digestion of manure with energy crops (e.g. maize) N leaching increases in the first years but is similar to untreated manure in the long-term if only 10% of the input N is derived from the energy crop.
- Application of ”new” wastes gives similar effect as for energy crops.
- If the use of mineral fertiliser is reduced according to an expected increase in fertiliser value of 8% points, an additional reduction in N leaching of 1.0-1.8% of the manure N input is estimated.

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Thank you for your attention!

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