A model of manure nitrogen mineralisation in soil

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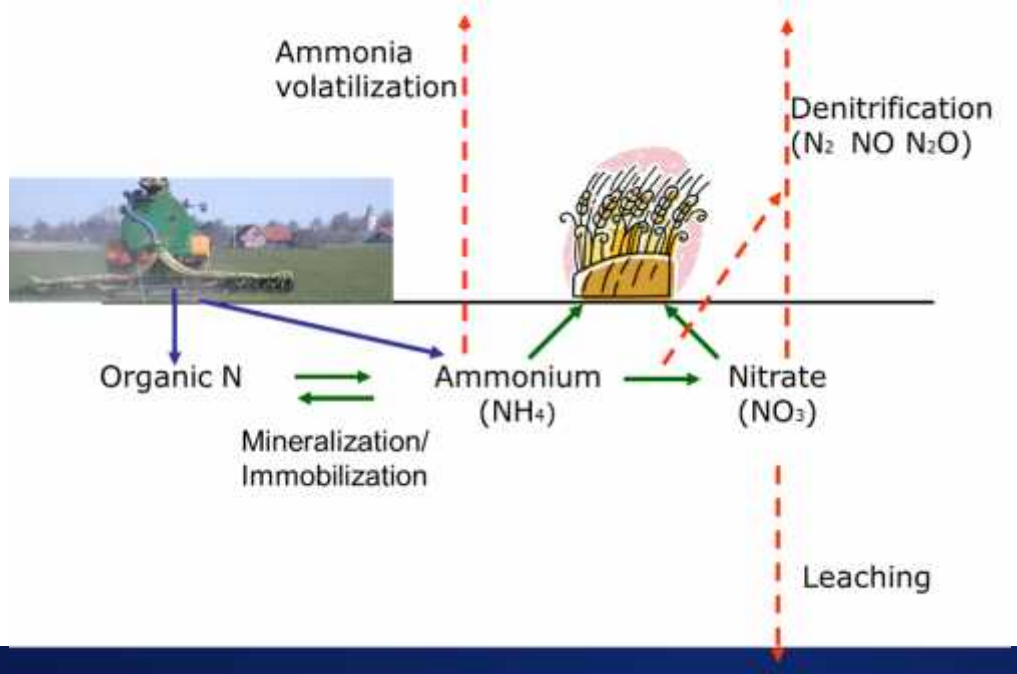
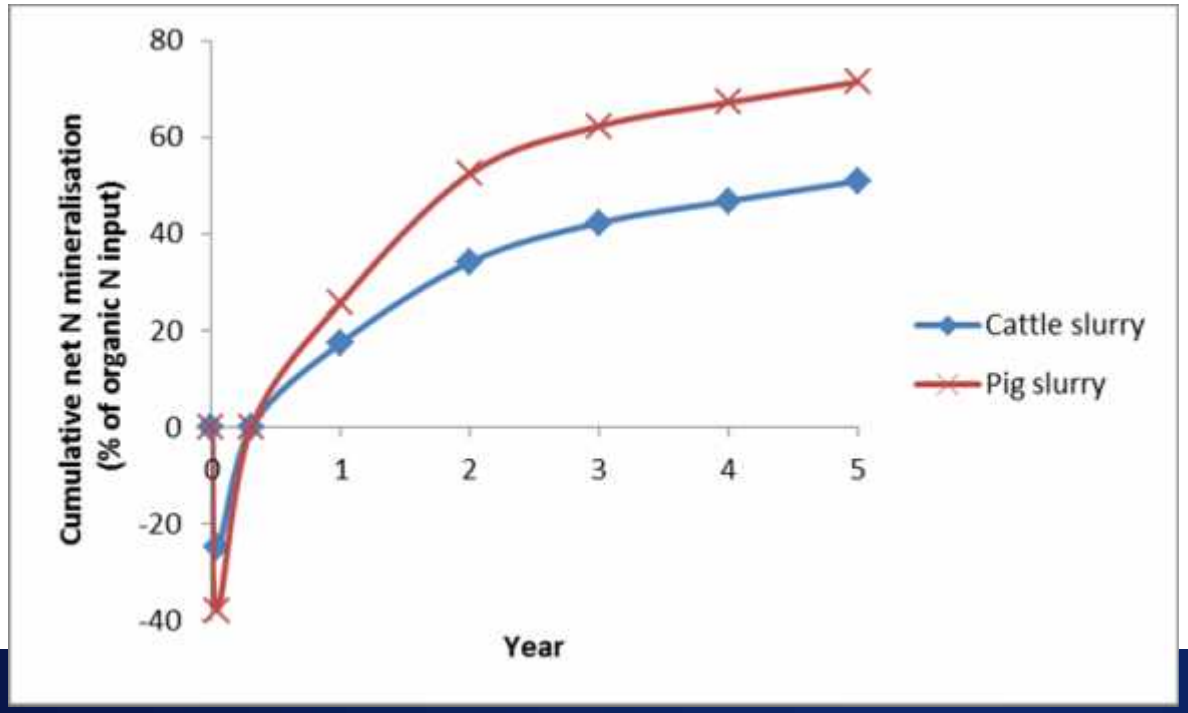
Important N transformations in soil after manure application



A new simple empirical model of yearly net N mineralisation of org. N in pig and cattle slurry



Crop N uptake data from 3 yr field experiment with pig and cattle slurry used

Treatments (year 1):

Slurry (103 kg NH4-N/ha)

Mineral N (100 kg N/ha)

Small framed plots with spring barley and cover crops (CC) each year

2 Slurry types:

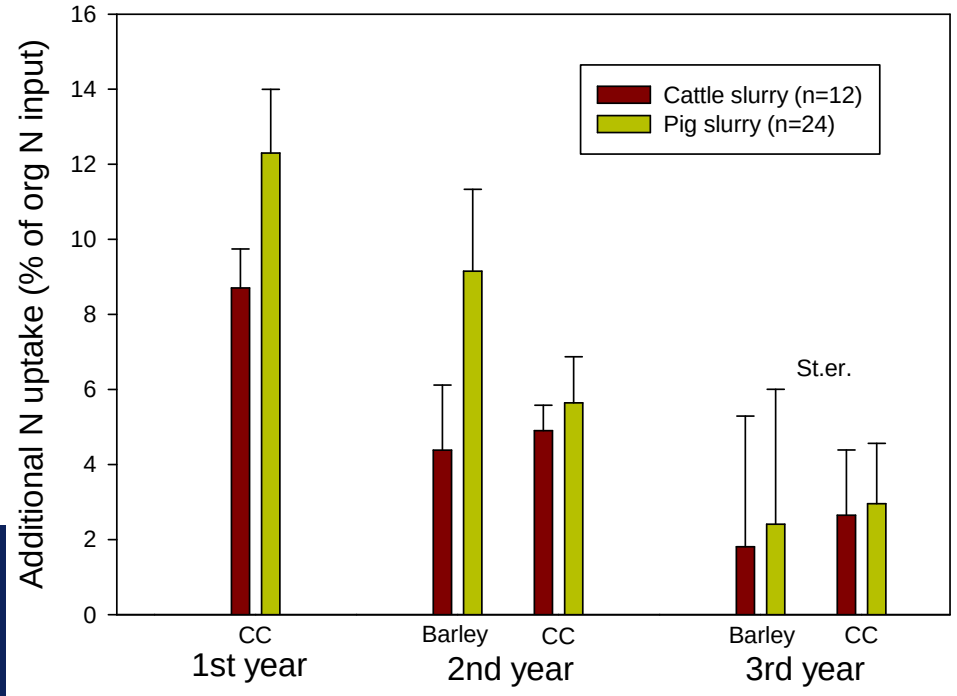
Pig (51 kg org. N/ha)

Cattle (81 kg org. N/ha)

(Sørensen & Amato, 2002; Sørensen, 2004)

Measured additional N uptake in crops due to mineralisation from manures (% of org N input)

Additional N uptake compared to mineral N reference measured in barley crops and ryegrass catch crops (CC)



Avg. of 3 slurry application methods:
Incorporated/mixed
Simulated injection
Surface-banding (4 weeks later)

Crop N uptake related to N mineralisation in soil

Net mineralisation based on the observed apparent N recovery (ANR) in crops and assuming ANR of mineralised N in crops is similar to ANR measured in mineral N treatments on the same location.

	1st year	2nd year		3rd year	
	Ryegrass CC	Spring barley	Ryegrass CC	Spring barley	Ryegrass CC
Estimated ANR of mineralised N (%)	49	60	49	60	49
Cattle slurry net mineralisation (% of organic N input)	17	7	10	3	5
Pig slurry net mineralisation (% of organic N input)	26	16	11	4	5

Extrapolation of yearly organic manure N mineralisation to 5th yr in model

Estimated yearly mineralisation of organic N applied with pig and cattle slurry

Manure	1st year	2nd year	3rd year	4th year	5th year
Cattle slurry (% of residual organic N)	17	20	12	8	8
Pig slurry (% of residual organic N)	26	36	21	13	13
Cattle slurry (% of organic N input)	17	17	8.1	4.5	4.1
Pig slurry (% of organic N input)	26	27	9.8	4.9	4.3

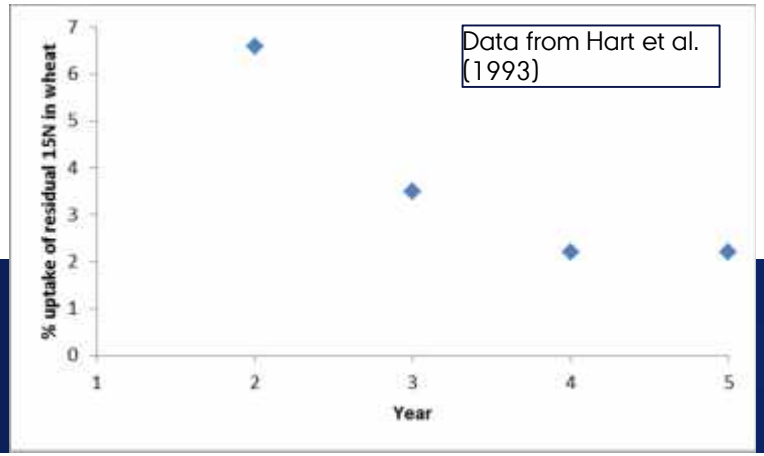


Fig: Crop uptake of residual labelled N in soil measured during 5 yrs after using ^{15}N-labelled fertiliser in the first year (uptake of mineralised N from labelled crop residues in wheat crops)

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Relative yearly release rate from residual N in yr 4 and 5 was assumed to be similar to Hart et al. (1993) in our model.

Manure N mineralisation measured in other studies – Chadwick et al (2000)

N mineralisation from manures after 199 days estimated from apparent N recovery in grass and expressed as % of applied organic N taken up in grass in pots. All ammonium-N was stripped before manure application (data from Chadwick et al. 2000).

Manure type	% org. N mineralised (range)	% org. N mineralised (average)	% org. N mineralised (year 1 in our model)
Cattle slurry	2-19	12	17
Cattle FYM	11-24	14	-
Pig slurry	21-37	27	26
Pig FYM	18-30	21	-
Poultry manure	16-56	29	-

Manure N mineralisation measured in other studies – Schröder et al. (2007)

Nitrogen fertiliser replacement values (NFRV) measured after 1-4 years repeated applications of cattle slurry by injection to grassland in the Netherlands and estimated yearly mineralisation rate of organic manure N.

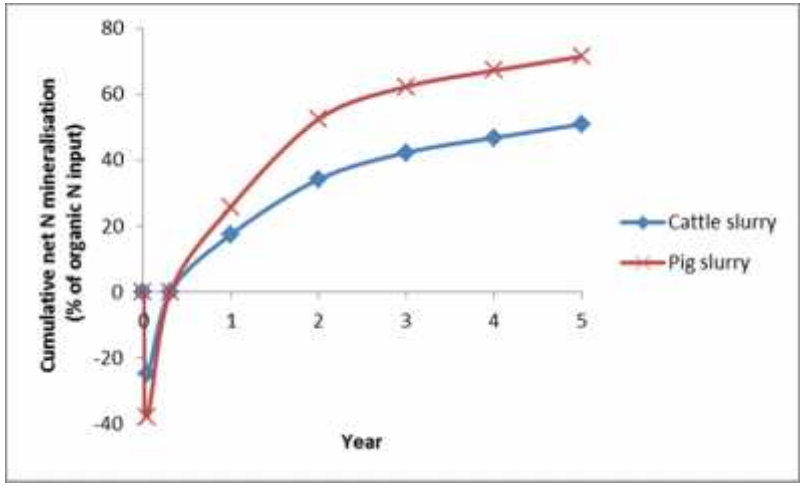
Year	NFRV slurry 1 % of tot-N	NFRV slurry 2 % of tot-N	NFRV slurry avg % of tot-N	NFRV Yearly effect % of tot-N	NFRV Yearly effect % of Org N input	Estimated N mineralisation % of org N input*	New model N mineralisation % of org N input
1	54	66	60	9.5**	19	21	17
2	66	73	69.5	9.5	19	21	17
3	70	76	73	3.5	7	8	8
4	74	77	75.5	2.5	5	6	5

*Assuming that 90% of the yearly mineralisation was available for crop uptake in grass

** NFRV in the first year minus mineral N in the slurry (NH4-N/total N was 0.505)

Conclusions

- A new simple empirical model of manure net N mineralisation over a 5 yrs period was developed.
- The model was based on data from cool moist conditions like in Northern Europe.
- The model is based on data from slurries - but we suggest it could also be applied to organic N in solid manures.
- The estimated N mineralisation pattern can be used for calculation of longer-term residual effects on N leaching and crop N uptake.



Thank you

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