DIFFERENT FERTILISER VALUES IN ORGANIC AND CONVENTIONAL FIELD TRIALS

Marie Reimer og Peter Sørensen
AU Department of Agroecology
Henrik B. Møller – AU Department of Biological and Chemical Engineering

ClimOptic

ICROFS Organic RDD

POSSIBILITIES TO INCREASE NUTRIENT SUPPLY TO (ORGANIC) FARMS

Increasing the nutrient efficiency of available sources:

Anaerobic digestion of animal manures &

Treatments of digestates can increase fertilizer value

Increasing the quantity of nutrients with available sources:

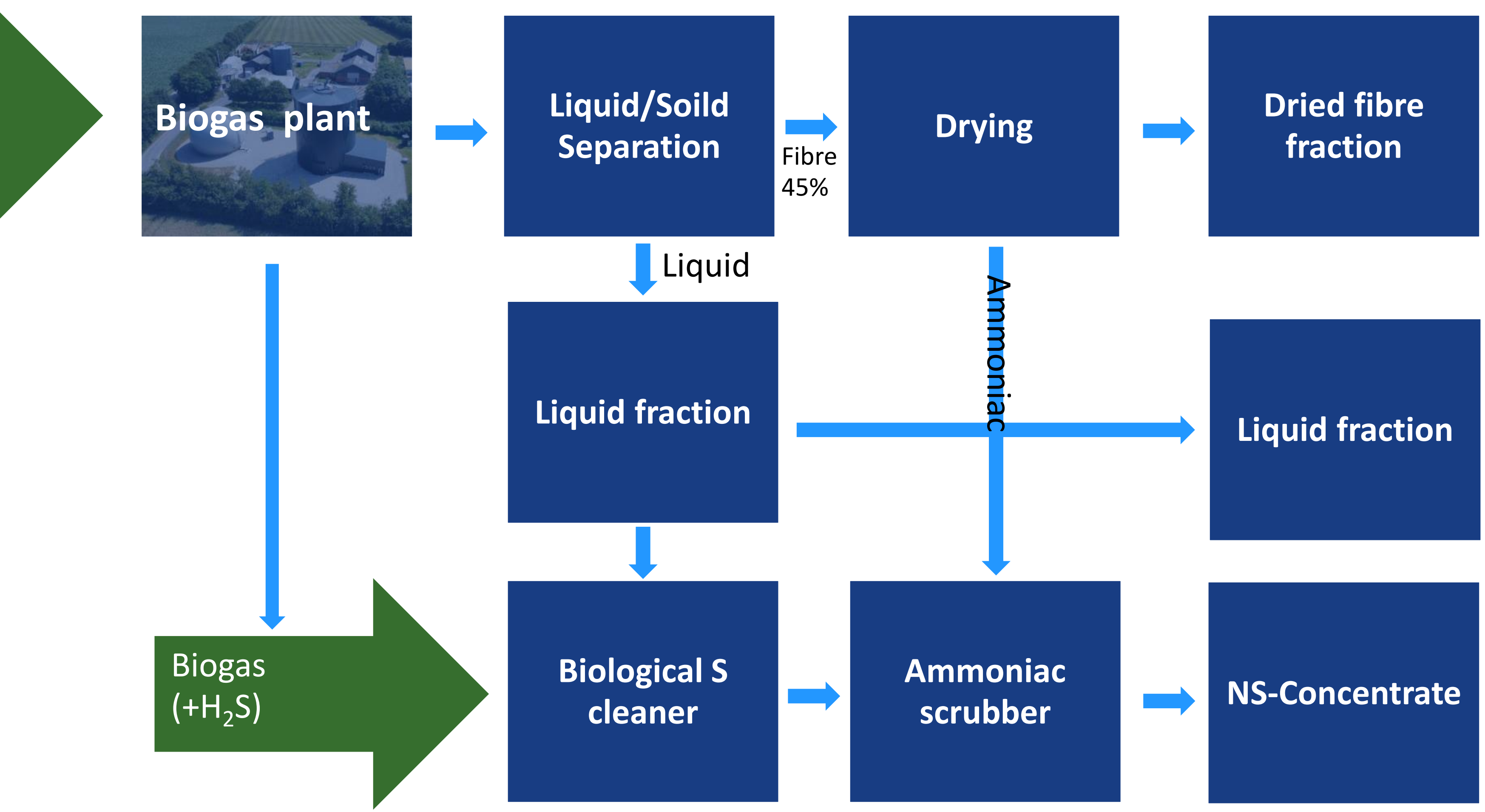
Co-digestion of animal manures with green biomass (e.g., grass-clover)

By-products from desulfurizing filters in biogas cleaning

Investigating fertilizers under organic conditions:

Experiment management (organic vs. conventional management) matters

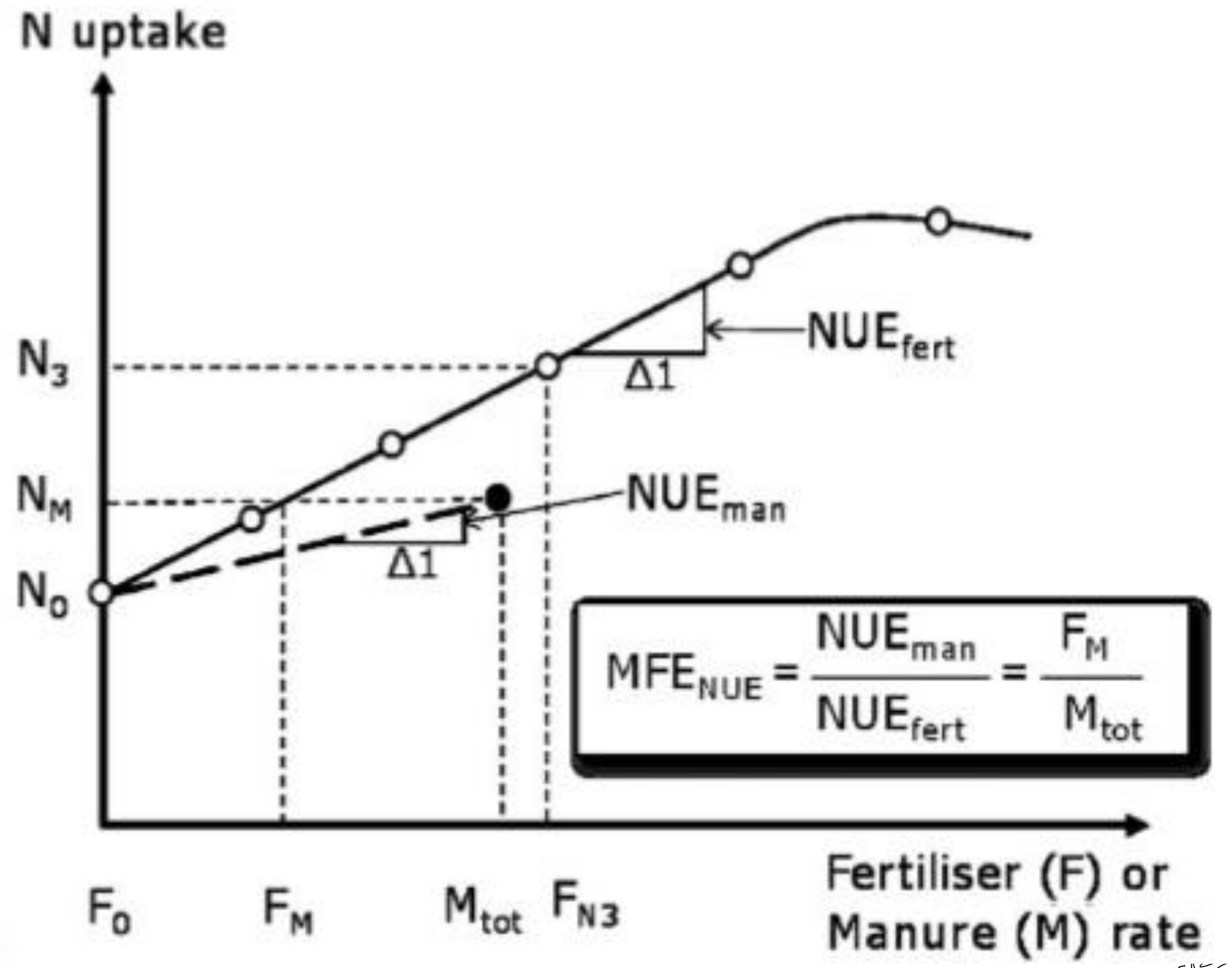
TREATMENT OPTIONS OF DIGESTATES



VÆRDITAL - NITROGEN FERTILIZER REPLACEMENT VALUE

"how efficient an organic fertiliser or manure is in providing available N for the crop compared with a mineral fertiliser source of N."

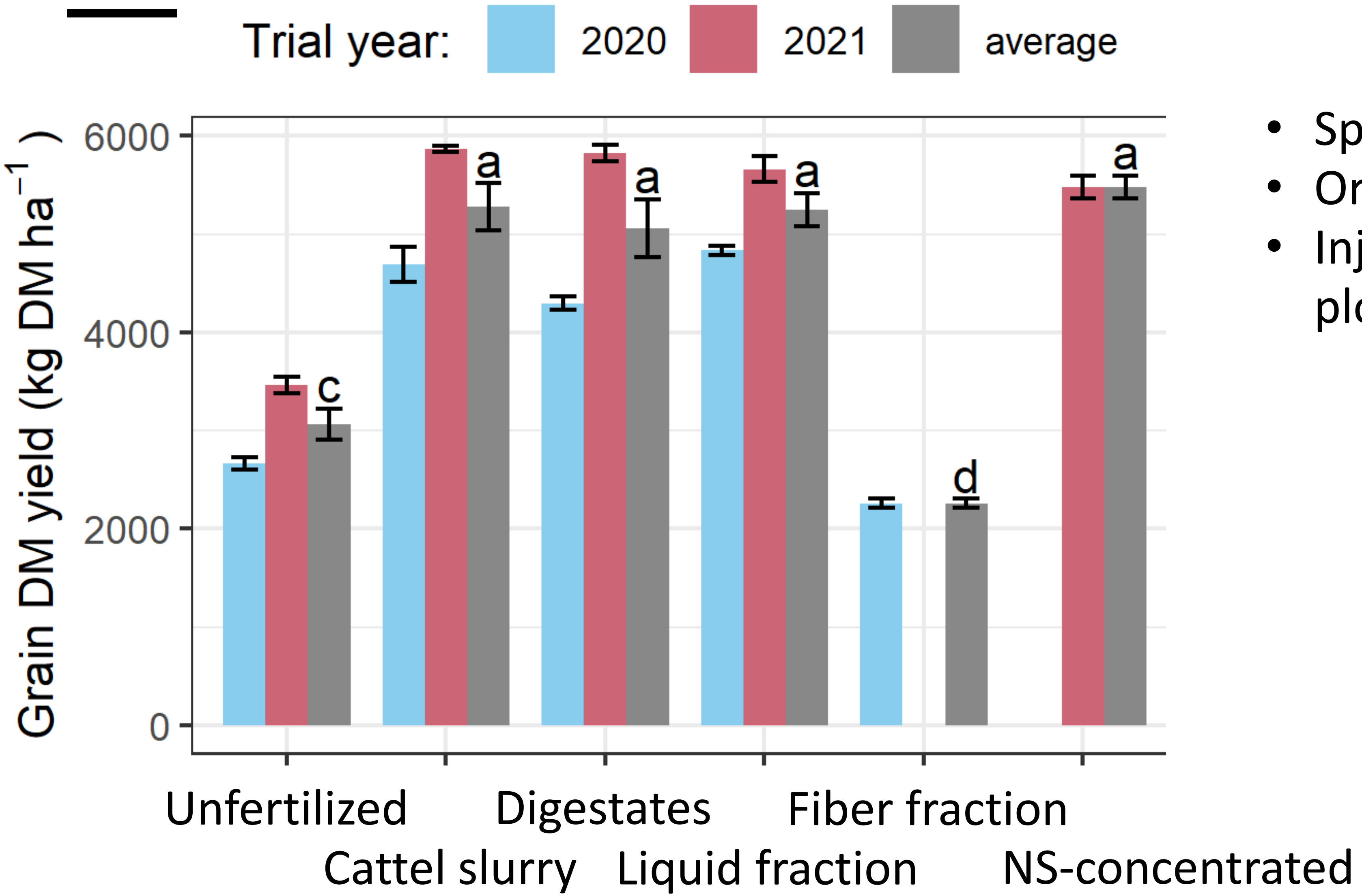
(Jensen 2013)



(Figure: Jensen 2013)

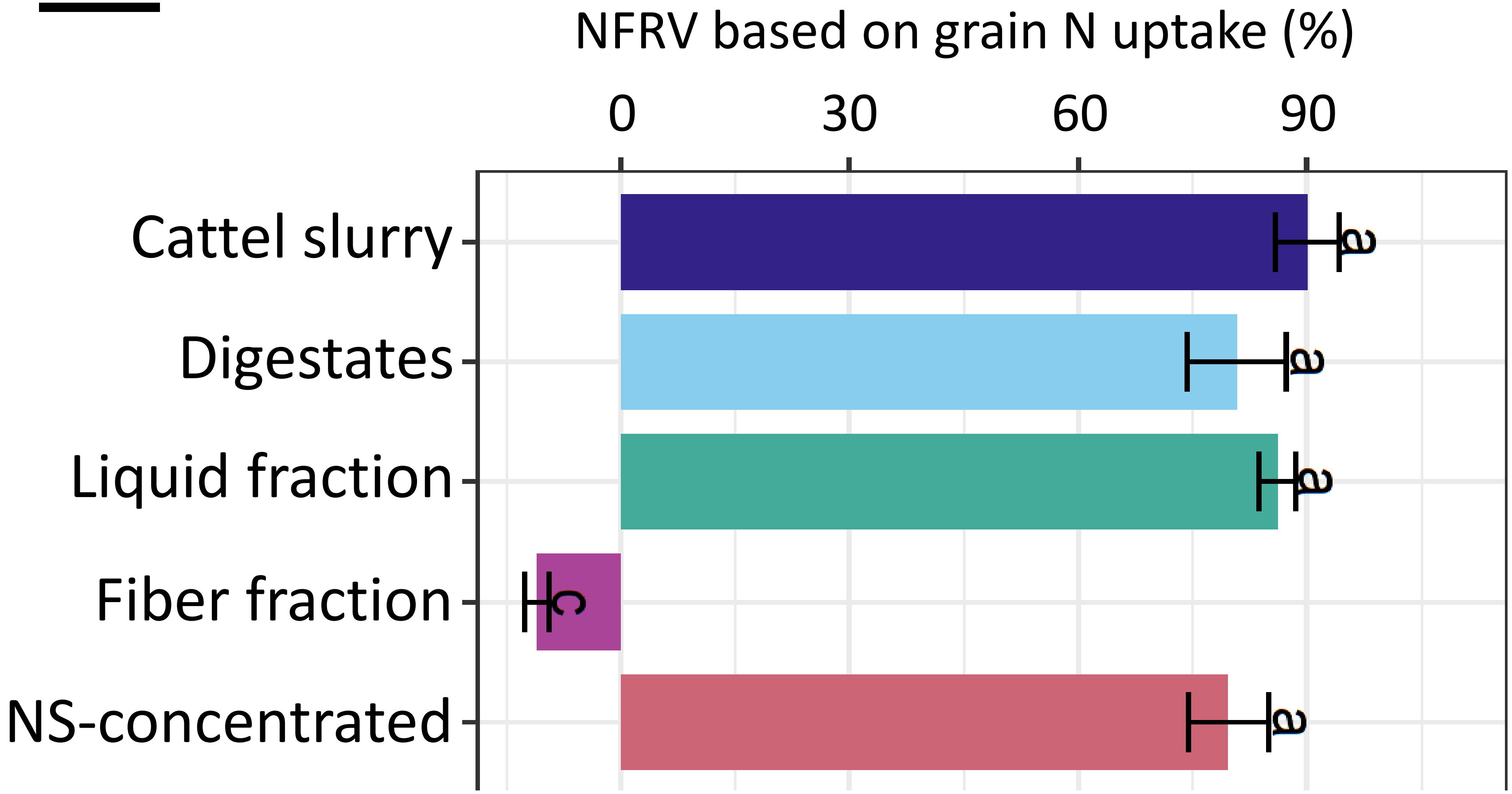
STUDY 1:
FERTILIZER VALUE DUE TO DIGESTION

DM GRAIN YIELD OF DIGESTATES PRODUCTS



- Spring barley
- Organic management
- Injection application after plowing

NITROGEN FERTILIZER REPLACEMENT VALUE (VÆRDITAL)



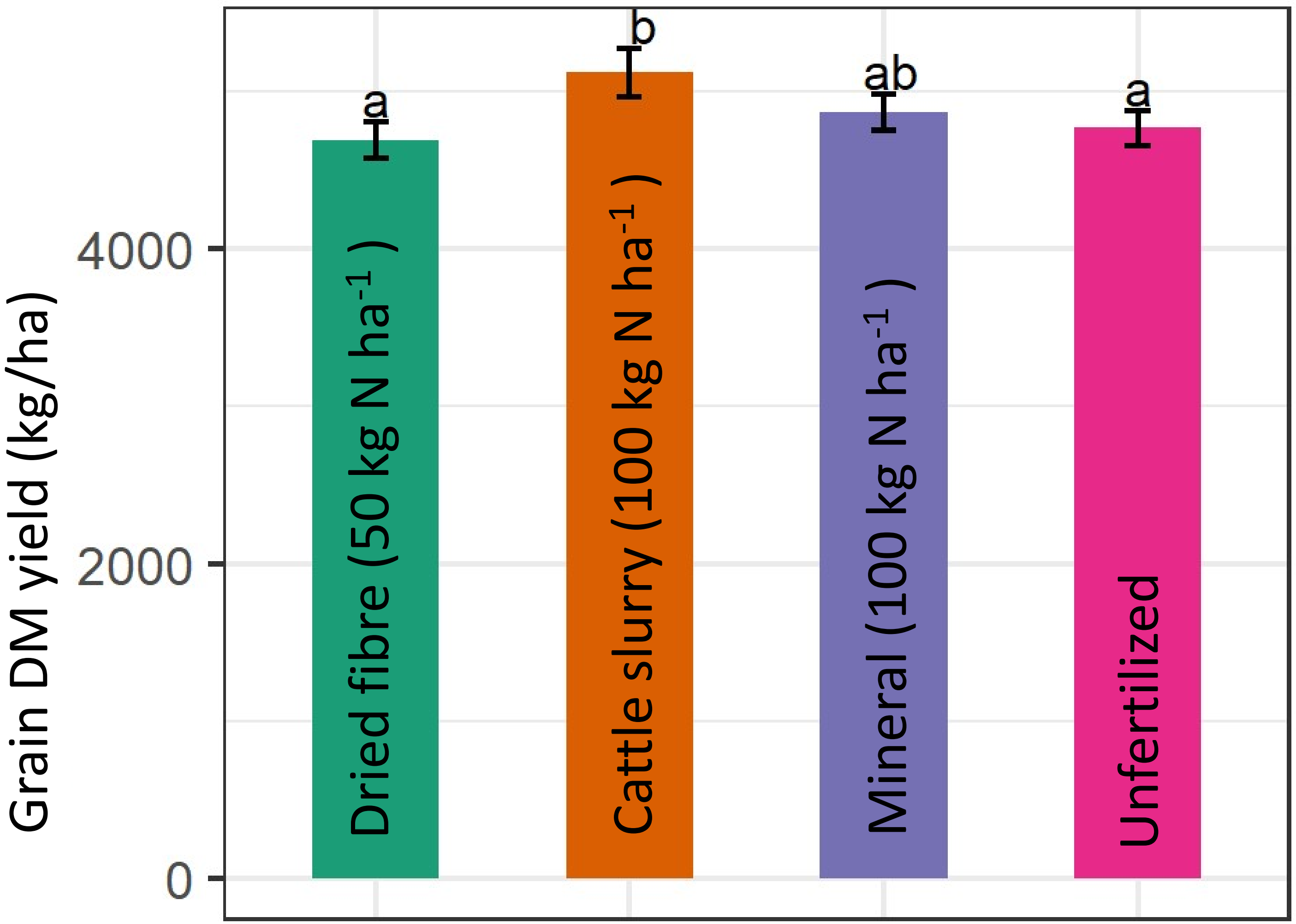
DRIED FIBER FRACTION IN LEGUMES

No yield decrease due to DF

Suitable soil amendment for non-N-dependent crops

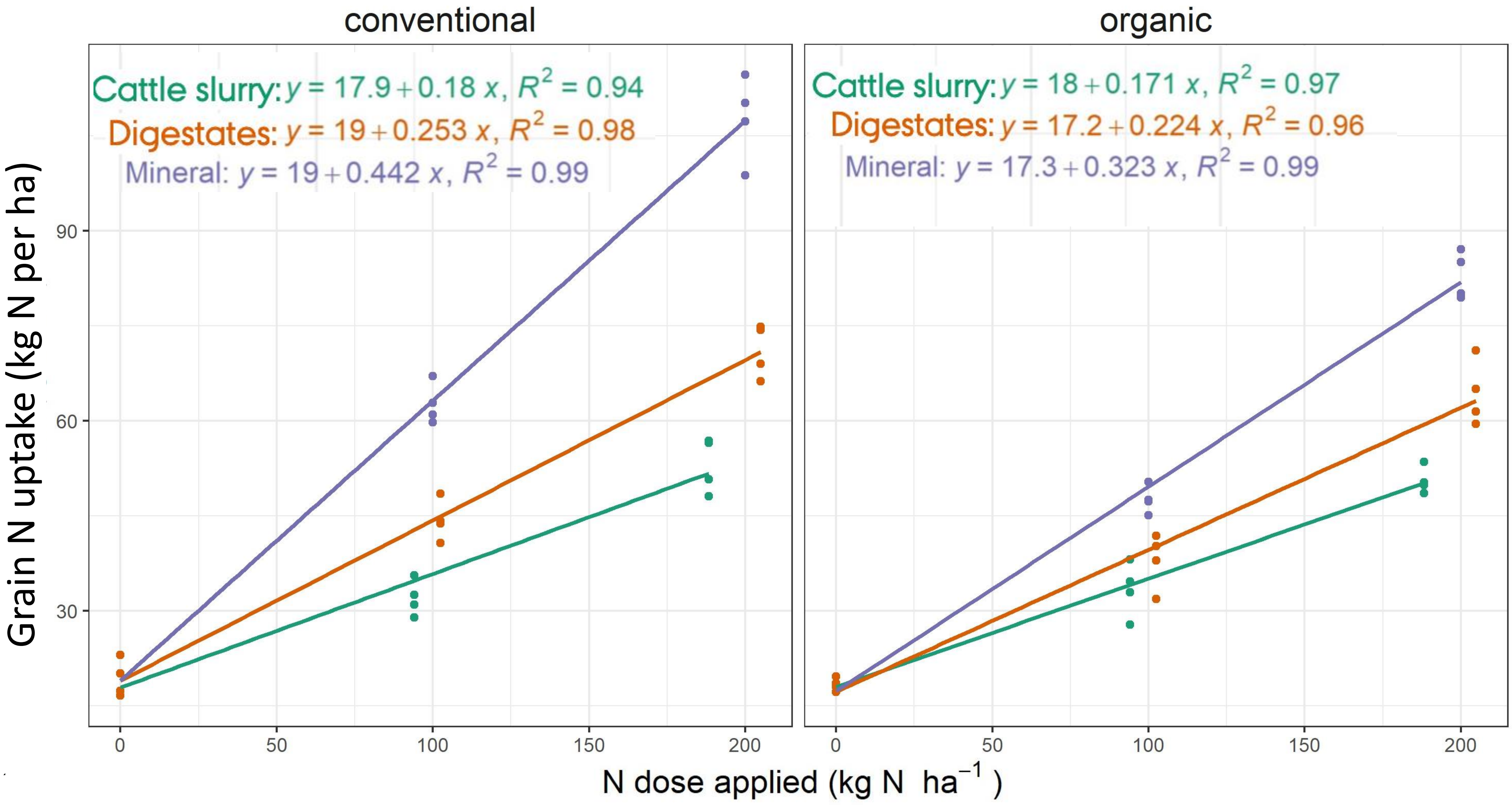
Added amount of nutrients when applied 50kg N ha^{-1}

- 850 kg C ha^{-1}
- 14 kg P ha^{-1}
- 32 kg K ha^{-1}

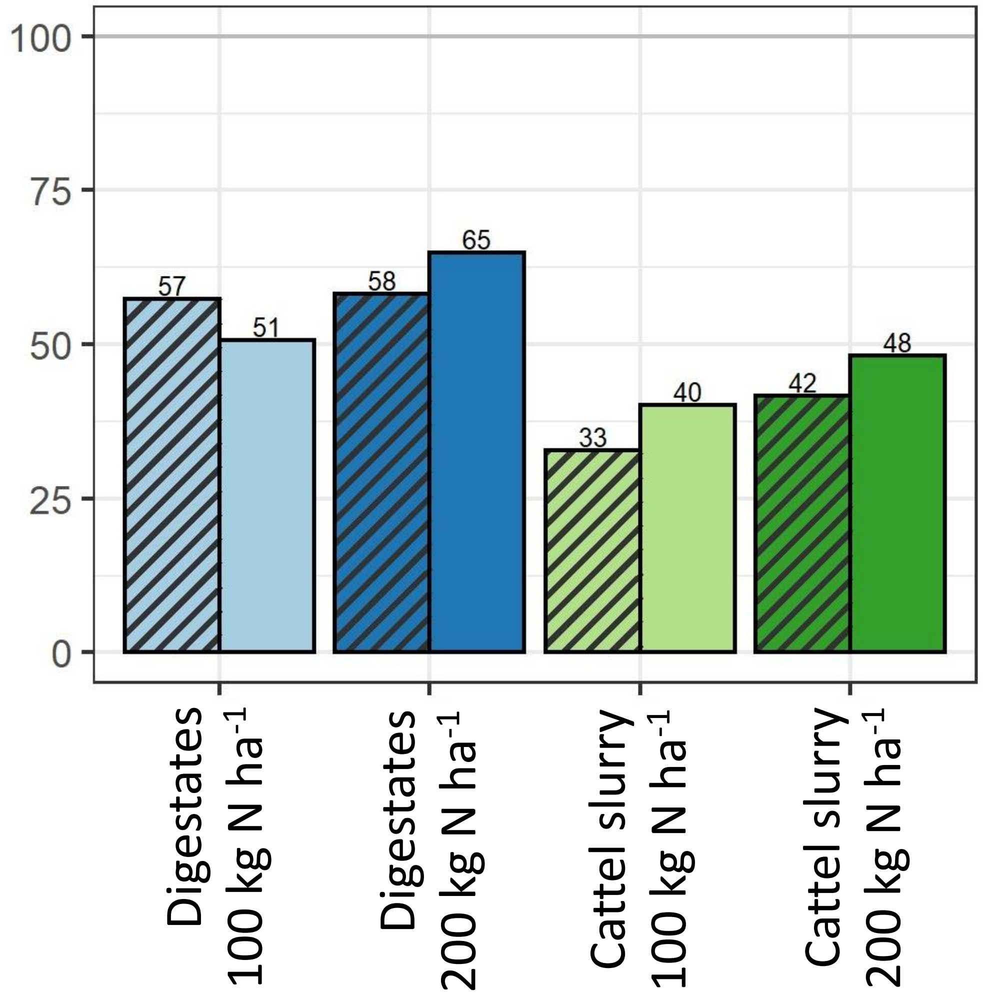


STUDY 2:
DIFFERENT FERTILIZER VALUES IN ORGANIC AND CONVENTIONALLY MANAGED TRAILS

N GRAIN UPTAKE



NITROGEN FERTILIZER REPLACEMENT VALUE (VÆRDITAL)



NFRV based on grain N

→No sig. interaction

→Digestates 16.6% higher

→Organic 5.0% higher

CONCLUSION

Anaerobic digestion can be a valuable tool for increasing nutrient efficiency and availability in organic farming

- Co-digestion of cattle slurry and grass clover silage can increase amounts of fertilizer without lowering quality
- Treatments of digestates result in a diversification of fertilizer products
- NS-concentrate from biogas cleaning promising fertilizer

Spring barley showed high yield potential in organic farming with high N application

Experiment management needs to be considered for fertilizer evaluation

- Underestimation of manures in organic farming due to lower yield potential

Mineral fertilization mostly effected by experiment management

- Weeds profited from broadly spread mineral fertilizer more than from injected organic fertilizers

AARHUS
UNIVERSITY

Ministeriet for Fødevarer,
Landbrug og Fiskeri

gudp

ICROFS
Organic RDD

Climate optimized fertilization in organic cropping systems (ClimOptic) financed by ICROFS Organic RDD 4 through the Green Development and Demonstration Programme under the Danish Ministry of Environment and Food.

REFERENCES

European Commission (2020) A Farm to Fork Strategy for a fair, healthy and environmentally-friendly food system. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Com-mittee and the Committee of the Regions. European Commission COM/2020/381 final:

Jensen LS (2013) Animal manure fertiliser value, crop utilisation and soil quality impacts. Animal manure recycling: Treatment and management 295–328

Nowak B, Nesme T, David C, Pellerin S (2013) Disentangling the drivers of fertilising material inflows in organic farming. Nutr Cycl Agroecosyst 96:79–91. https://doi.org/10.1007/s10705-013-9578-5

Rahmann G, Reza Ardakani M, Bàrberi P, et al (2017) Organic Agriculture 3.0 is innovation with research. Org Agr 7:169–197. https://doi.org/10.1007/s13165-016-0171-5

Reimer M, Oelofse M, Müller-Stöver D, et al (2023) Sustainable growth of organic farming in the EU requires a rethink of nutrient supply. under revision in Nutrient Cycling in Agroecosystems

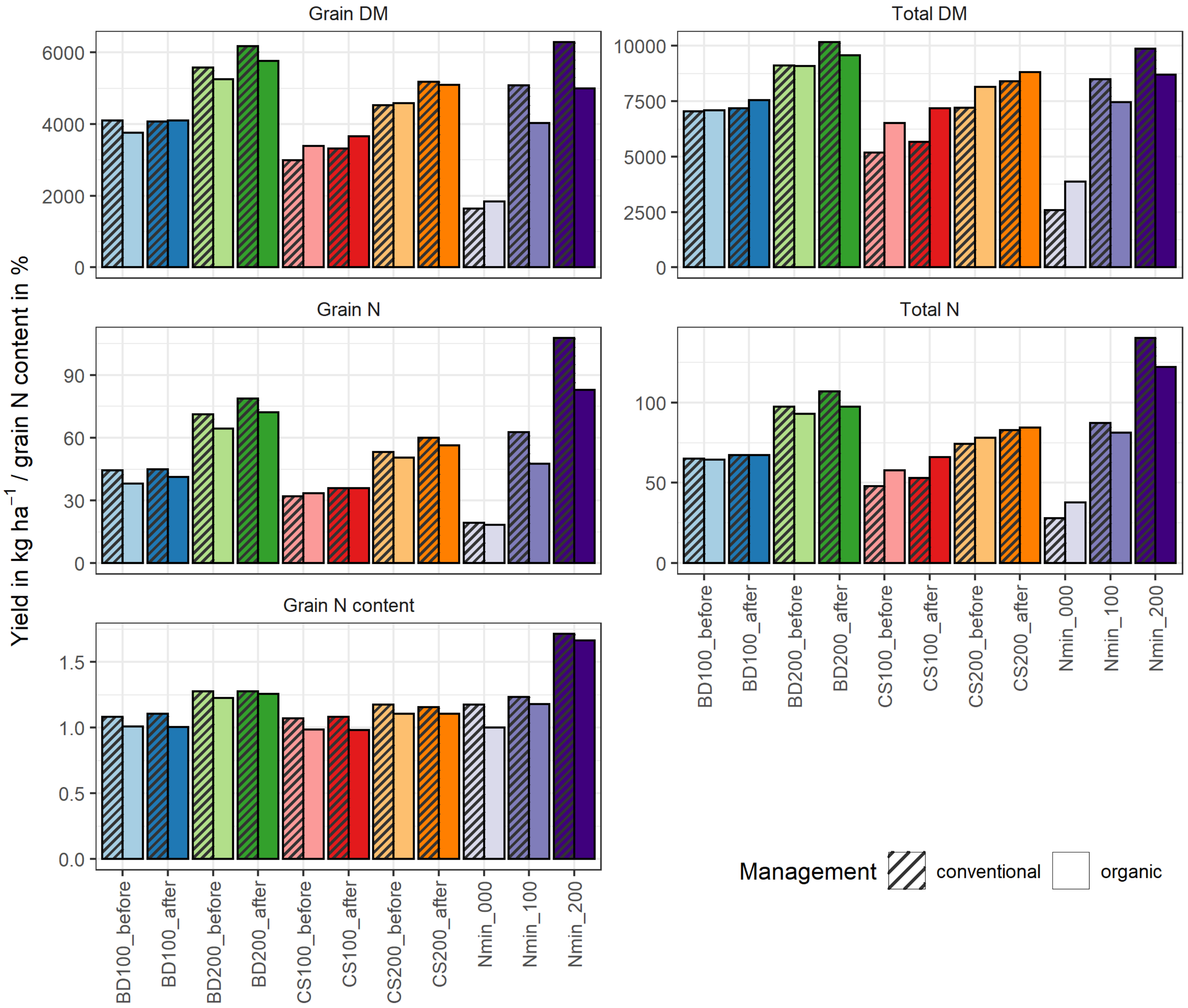
SUPPLEMENT

FERTILIZER DESCRIPTION

Fertilizer	Year	DM	C	C/N	N	NH_4	NH_4/N	P	K
		%FM	%DM		%DM	%DM		g kg^{-1} DM	
Cattle slurry	2020	5.56			6.12	3.42	0.57	9.53	37.4
Cattle slurry	2021	5.17	36.9	7.76	4.84	2.32	0.48	9.86	53.8
Cattle slurry	2022	5.69			5.27	2.28	0.44	8.96	41.3
Concentrate N/ and liquid digestates	2020	3.02			9.27	5.96	0.66	9.27	82.5
Concentrated N/S	2020	1.33			12.0	9.77	0.82	5.26	92.5
Concentrated N/S	2021	1.05	24.8	2.15	11.4	7.62	0.68	7.62	41.9
Digestates*	2020	4.63			7.56	4.10	0.55	9.72	70.6
Digestates*	2021	4.05	38.27	5.58	6.91	3.95	0.56	11.6	82.7
Digestates*	2022	5.74			6.45	3.31	0.52	9.93	47.0
Dried fibre digestates	2020	59.8			1.24			4.95	9.07
Dried fibre digestates	2021	58.9	28.4	17.0	1.67	0.02	0.01	4.72	10.5
Liquid fraction digestates	2020	4.37			8.47	5.26	0.61	10.3	80.3
Liquid fraction digestates	2021	2.74							
Mineral	2020	100			27	13.5	0.50		
Mineral	2021	100			27	13.5	0.50		
Mineral	2022	100			27	13.5	0.50		

*Digestates in 2021 & 2021 based on cattle slurry co-digested with 7.5% clover-grass silage, 2022 only based on cattle slurry

YIELDS STUDY 2



AARHUS UNIVERSITY
DEPARTMENT OF AGROECOLOGY

MEAN DIFFERENCES DUE TO TREATMENT FACTORS

NFRV Grain N yield (%)			
	MD	p	Interactions
CS-BD	-16.6	<0.001	no sig interactions
after-before	8.34	<0.001	no sig interactions
N 100 - N 200	-9.21	<0.001	no sig interactions
conv-org	-4.96	0.110	no sig interactions
NFRV Total N yield (%)			
	MD	p	Interactions
CS-BD	-19.2	<0.001	fertilizer:trial **
after-before	8.64	0.002	no sig interactions
N 100 - N 200	-31.9	<0.001	trial:N dose *
conv-org	-5.22	0.280	fertilizer:trial **; trial:N dose *

Farm-scale Machine for injection after ploughing/harrowing

Experimental injector

Mineral fertilizer

Barley, injection after ploughing (conv)

Barley, injection before ploughing (conv)

Organic plot 24 cm row, injection before ploughing

Higher fertiliser value by slurry injection after ploughing

Session: Measurement of fertiliser value of organic fertilisers

Foto: Anker Vestergaard

Foto: Peter Sørensen

Professor Peter Sørensen,

Department of Agroecology, Aarhus University

Intro

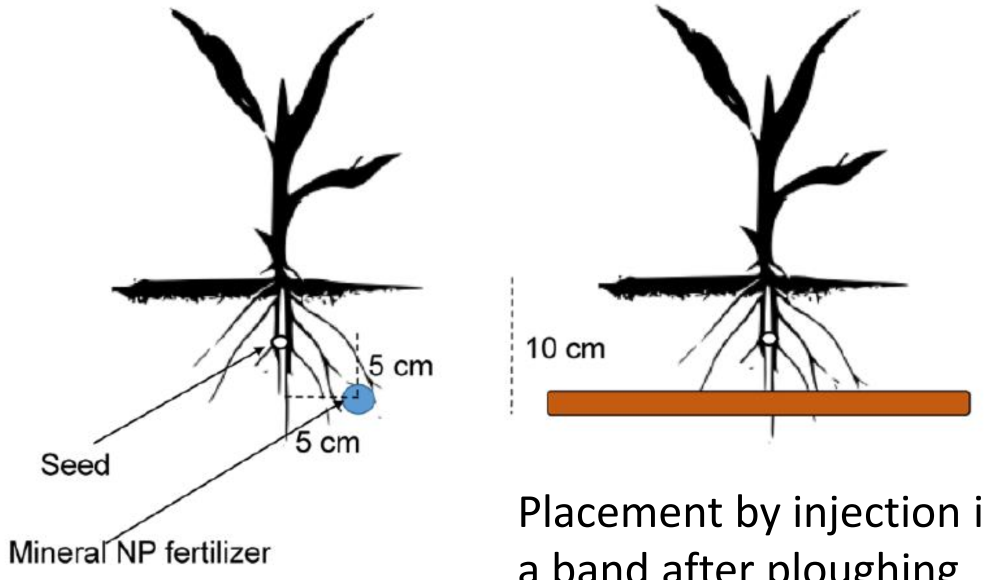
- Practice: Slurry is injected before ploughing.
- Most experiments: Slurry is injected after ploughing, when testing the fertiliser value.

- Effects on fertiliser value!
- Maybe some farmers could benefit from injection after ploughing?

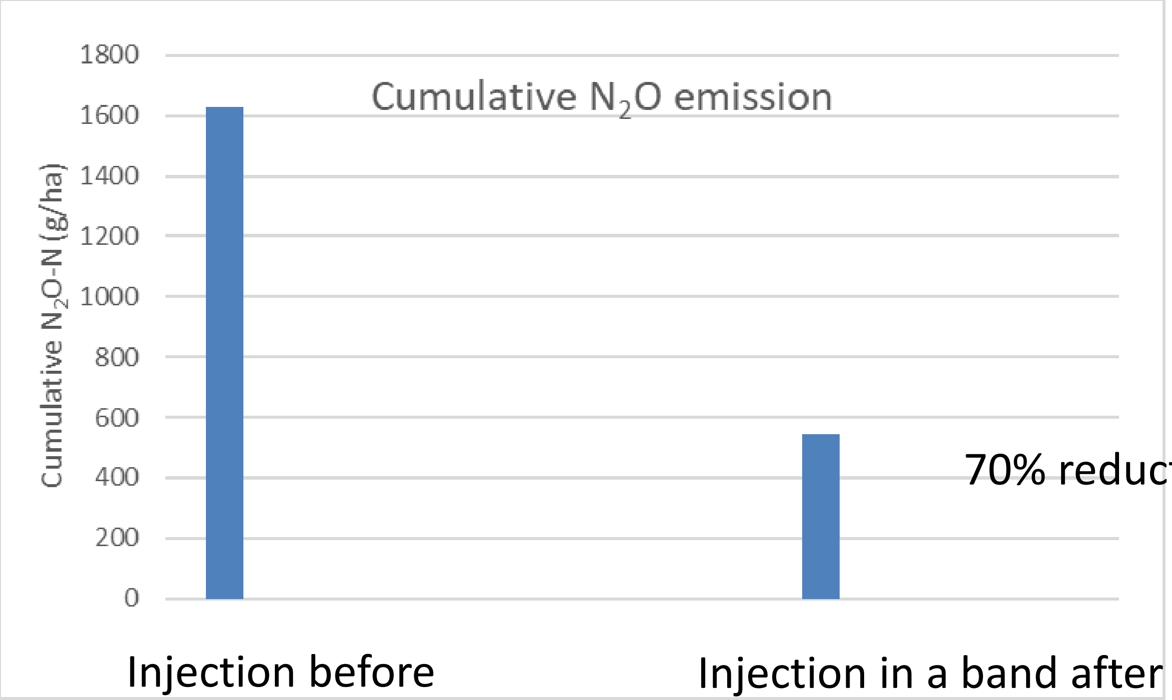
Injection before ploughing

AARHUS UNIVERSITY
DEPARTMENT OF AGROECOLOGY

Lower nitrous oxide by slurry placement in maize by injection after ploughing



Placement by injection in a band after ploughing before sowing maize



Injection before ploughing (traditional injection)

Injection in a band after ploughing

Soil type: JB4
194 kg total N/ha in cattle slurry + 27 kg min N/ha
Only one experiment!

Data from Taghizadeh-Toosi et al.,2023
Sustainability 15, 15810

Treatments in field experiments with spring barley

2 years experiments at JB4 soil

1. Slurry injection before ploughing
2. Slurry injection after ploughing
3. Mineral N (variable rates, no placement)

Experimental injector used both before and after ploughing

24 cm tine distance

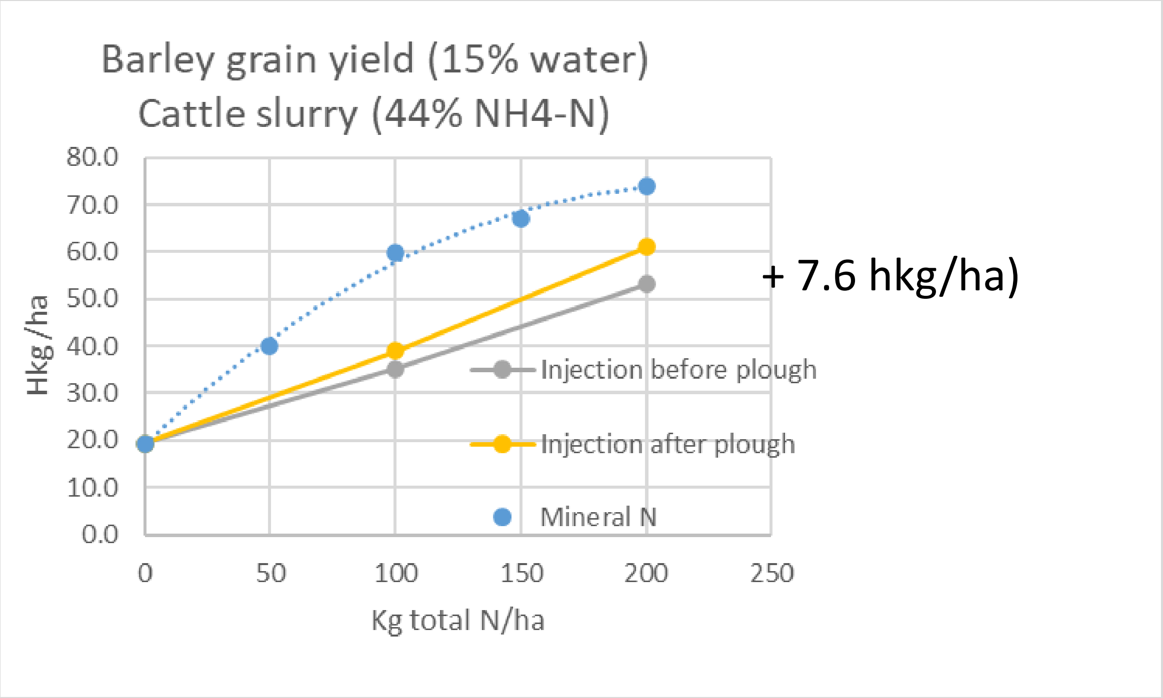
Mineral fertilizer application

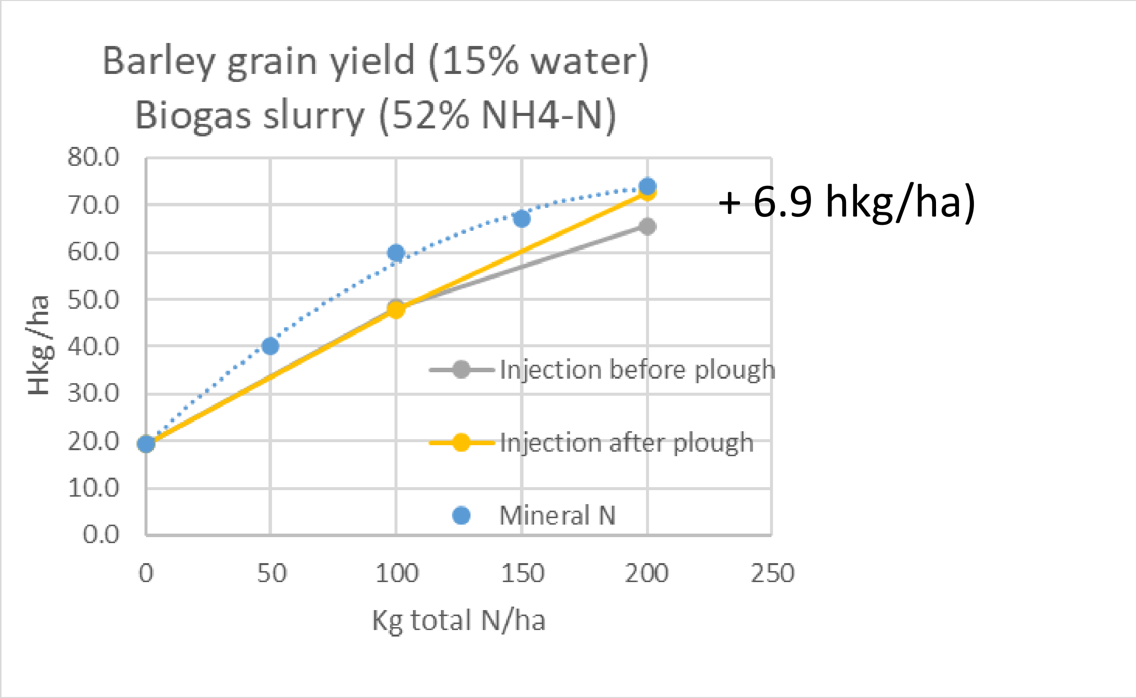
Barley, injection after ploughing (conv)

Barley, injection before ploughing (conv)

Higher barley yields by injection after ploughing

2022 experiment

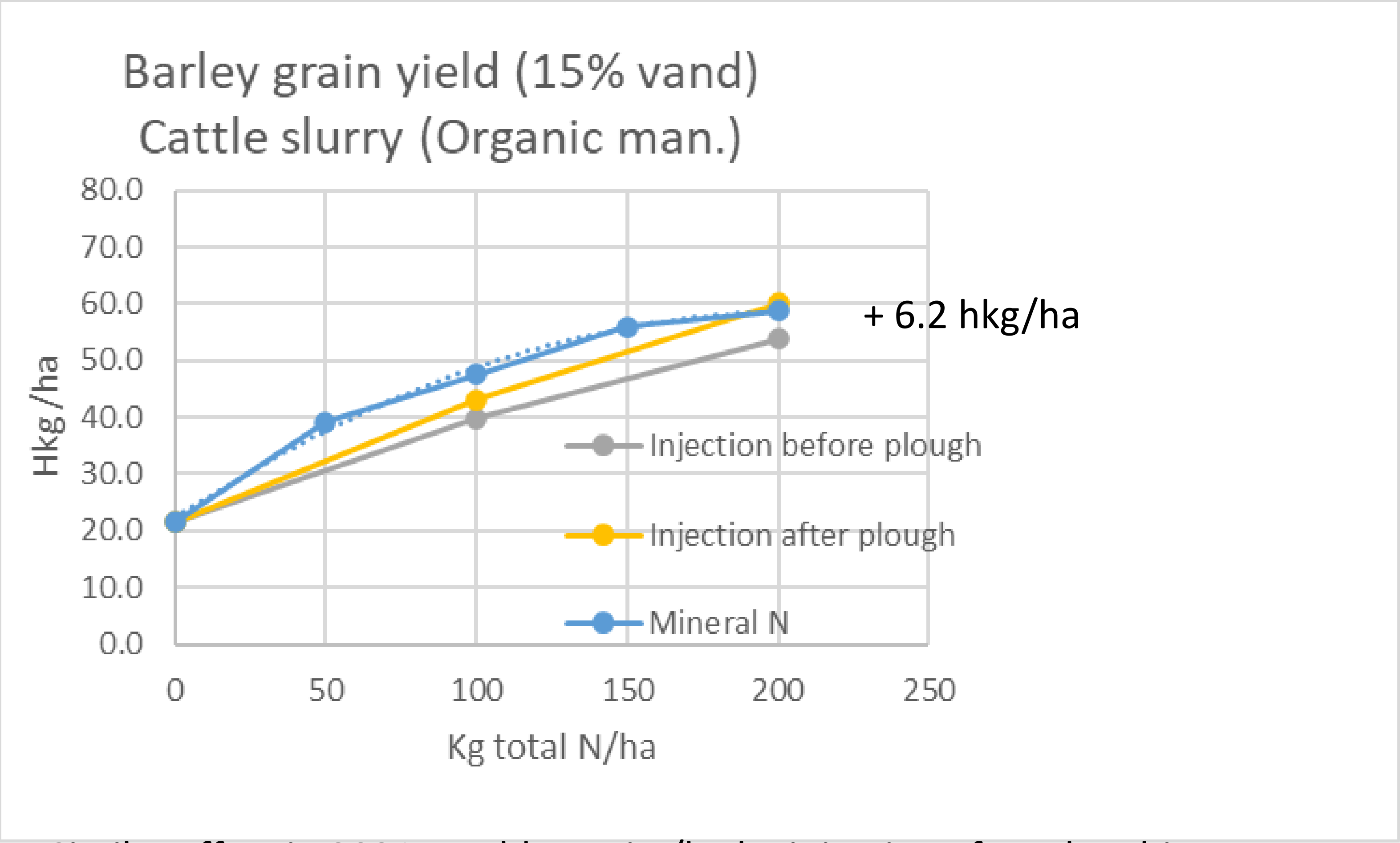




200 kg total N/ha in cattle slurry:
66 ton/ha
88 kg NH_4-N/ha

200 kg total N/ha in biogas slurry:
54 ton/ha
104 kg NH_4-N/ha

Similar benefits of injection by organic management of spring barley 2022



Organic crop management:

- 24 cm row distance
- Hoeing (radrenset)
- No pesticides
- Low perenial weeds
- JB4

Barley with Organic management

Similar effect in 2021: + 7 hkg grain /ha by injection after ploughing (by 100 kg total N/ha in cattle slurry)

Organic barley with slurry injected before and after ploughing

Slurry injection before ploughing (inhomogeneous crop)

Slurry injection after ploughing

N fertiliser replacement values (værdital) by injection before and after ploughing (2022)

Based on barley grain N uptake

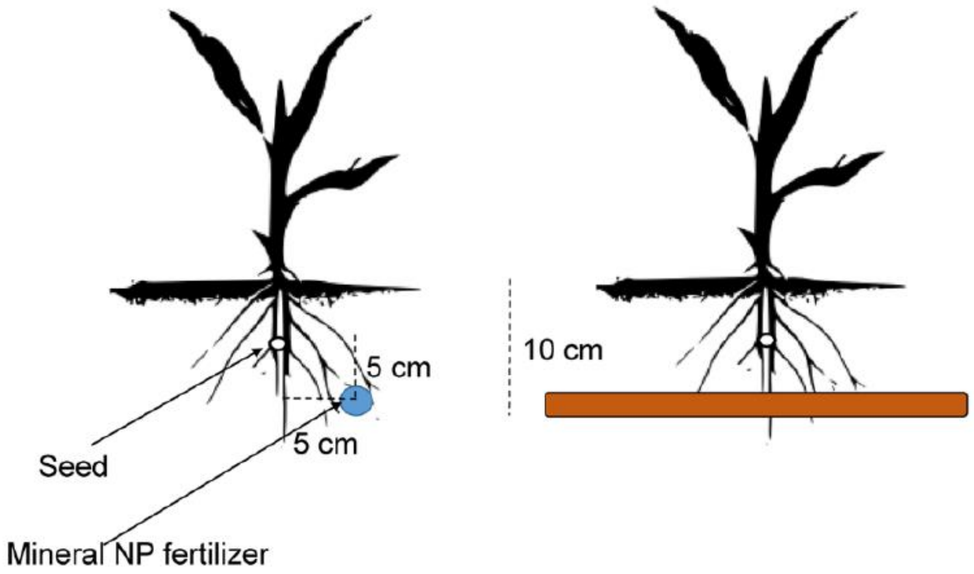
Manure	N fertiliser replacement value (% of total N)	
	Injection before	Injection after
Cattle slurry 100 kg N/ha	33	42 (+9)
Cattle slurry 200 kg N/ha	42	50 (+8)
Biogas slurry 100 kg N/ha	57	59 (+2)
Biogas slurry 200 kg N/ha	58	67 (+9)

Foto: Peter Sørensen

Foto: Anker Vestergaard

Why positive effects of slurry placement after ploughing?

- Placement effect. Good starter effect.
- Less Immobilisation of ammonium-N in slurry (less microbial binding of N)
- In organic farming: Less competition from weeds (ukrudt)



Practical problems by injection after ploughing

- Special injectors needed (”dog walk”)
- Probably only possible on sandy soils
- Dry weather and soil
- Wheel tracks /soil compression?
- Sowing (uneven surface)?
- Systems with reduced tillage/no ploughing?

N fertiliser value of slurry applied to spring barley by incorporation (harrow) vs injection

N Fertiliser value (værdital) estimated from N uptake in barley grain + straw.

Manure	N fertiliser replacement value (% of total N)	
	Trailing hose and incorporation by rotary harrow	Direct Injection
Cattle slurry, 100 kg NH4-N/ha	41	68
Pig slurry, 100 kg NH4-N/ha	63	79

Average of 3 years experiments at Askov Forsøgsstation.

(Grøn Viden no 281)

Conclusions

- Injection after ploughing: Extra yields of 6-7 hkg barley/ha (by 54-66 ton/ha) – no wheel tracks in experiment!
- Negative effect of wheel tracks?
- Larger effects at high slurry dosage.
- Lower Green house gas emission by slurry placement (N_2O)?
- Higher fertilizer value of slurry in experiments than in practice?

Foto: Anker Vestergaard

Thank you for your attention

The ClimOptic project was supported by ICROFS/OrganicRDD4

Foto: Anker Vestergaard

Slurry injection just before sowing