N_2O, N_2 and NH_3 emissions following different slurry and digestate application techniques in growing crops

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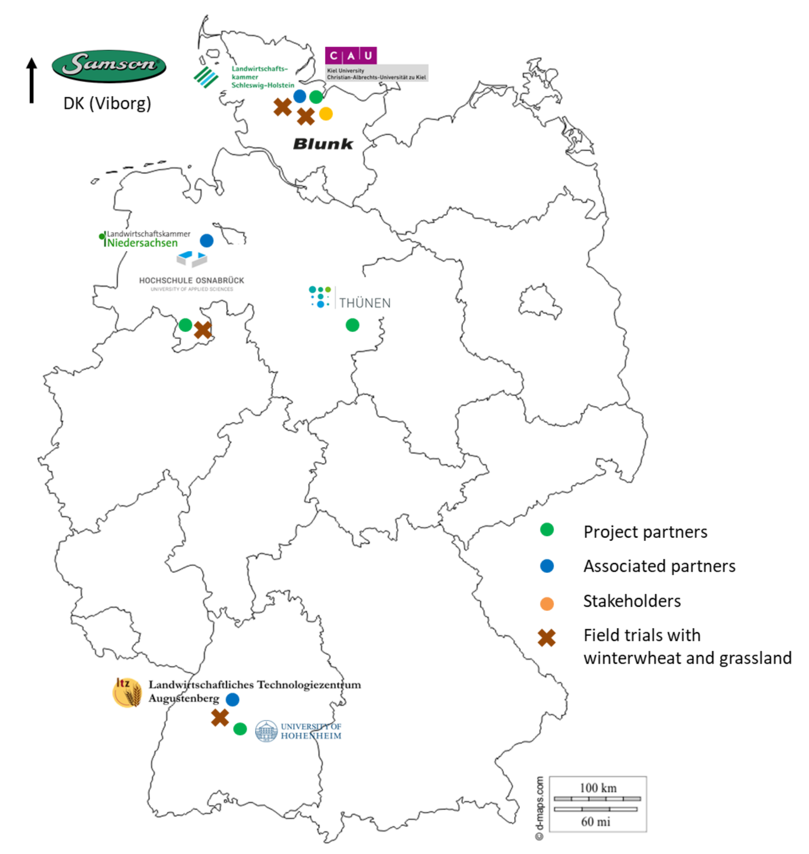
Background

- In Germany, about 95% of ammonia (NH_3) emissions originate from agriculture 40% from the application of slurry and digestate
- In Germany, agriculture accounts for about 7% of total greenhouse gas (GHG) emissions 50% are produced in agricultural soils in the form of nitrous oxide (N_2O)
- With the amendment of the Fertilizer Ordinance 2017, the application of slurry and digestate in autumn on arable land is strongly restricted
- The application of slurry and digestate will therefore increasingly take place in the spring into growing crops with near-ground application techniques and without the possibility of direct incorporation into the soil, which may enhance emissions

Objective

Quantification of N_2O, NH_3 and N_2 emission following different slurry and digestate application techniques

Field sites & Sampling methods



- Randomised field plot trials (plot size: 54 or 81 m²) with four replicates (blocks) were established from 2019-2021 in a permanent grassland (GL) and in a crop rotation with winter wheat (WW) at each site in Schleswig-Holstein (SH), Lower Saxony (LS) and Baden-Wuerttemberg (BW)

Site	Crop	Year	
SH:HO	Winter wheat	2019	2020
SH:BRE			
LS:OS			
BW:HOH			
SH:HS	Grassland	2019	2020
SH:LAG/GH			
LS:OS			
BW:HOH			

Treatments

Substrate	Treatments	
Cattle slurry (CS)	N0	Control
	CAN	Calcium ammonium nitrate
	TH:CS	Trailing hose
	TH:CS+A	Trailing hose + Acid (H_2SO_4)
	SI:CS	Slot injection
	SI:CS+NI	Slot injection + Nitrification Inhibitor (DMPP)

- Application rate was 170 kg N ha^{-1} (split in 2 dressings)

Measurements

- NH_3 fluxes were measured using the “Dräger-tube” and the “Calibrated passive sampling” method (*Pacholski 2016*)
- N_2O fluxes were measured weekly using the “Closed chamber approach” (*Hutchingson and Mosier 1981*)

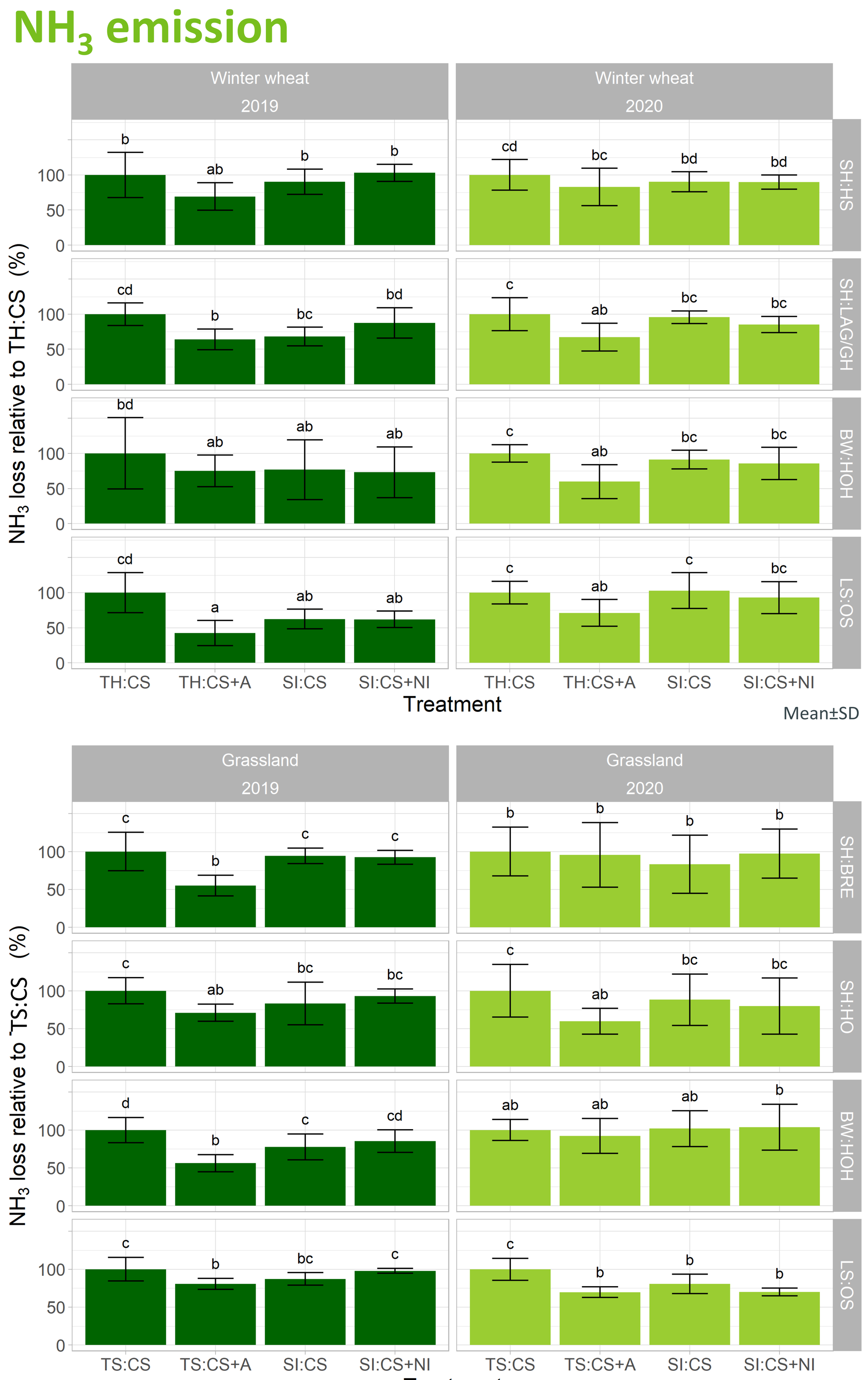
Experimental technology for different slurry application in growing crops: Trailing hose/shoe or slot injection

^{15}N tracing experiment

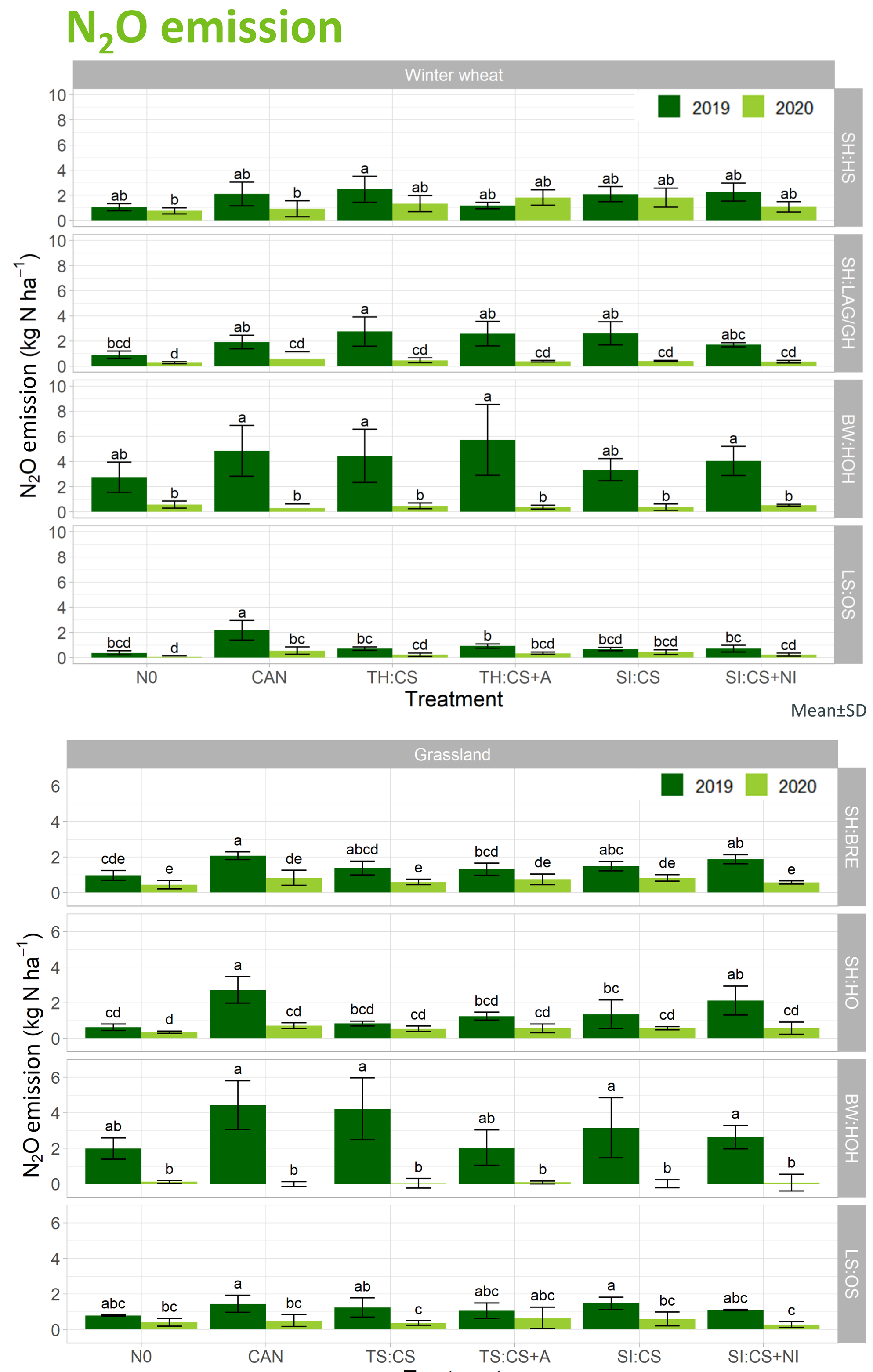
- Experiment was conducted with undisturbed soil cores from the BW:WW-2020 site for 60 days
- Application of a ^{15}N double labelling approach by labelling the NO_3^- pool with $K^{15}NO_3^-$ solution (4 kg N ha^{-1}) and the NH_4^+ pool with ^{15}N-labelled cattle slurry (68 kg N ha^{-1})
- NH_3 fluxes were measured using the „Dräger-tube“ method (*Pacholski 2016*)
- N_2O and N_2 emissions were measured using the modified ^{15}N gas flux method with N_2-depleted atmosphere (*Well et al. 2019*)

Preliminary results

NH_3 emission

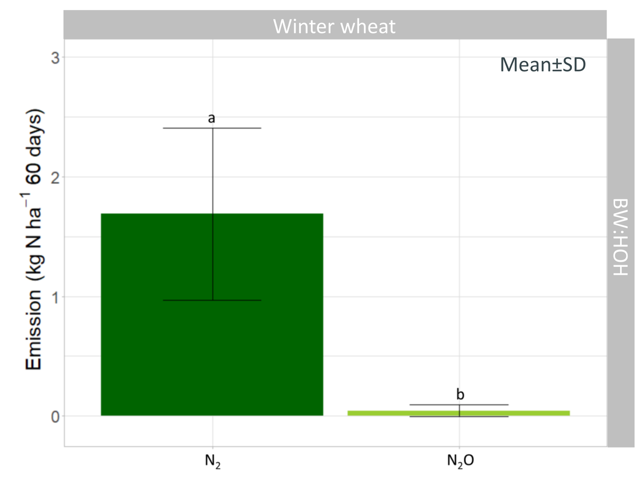


N_2O emission



Results

N_2 & N_2O emission



- No impact of application technique on N_2O and N_2, but 20 times higher N_2 than N_2O emission

Conclusions

- Highest NH_3 reduction potential compared to trailing hose/shoe application (TH/TS:CS) after acidification of cattle slurry (up to 58% at individual sites and years)
- Lower NH_3 reduction potential compared to TH/TS:CS after slot injection (SH:CS) and slot injection with addition of a nitrification inhibitor (SH:CS+NI)
- Large differences in N_2O emissions by site and year, with higher N_2O emissions in 2019, but lower impact of application technique on N_2O emissions
- ^{15}N experiment indicated high N losses via N_2 at the winter wheat site of BW:HOH
- Data will be further evaluated in terms of yields and N uptake

References:
Hutchinson, G., Mosier, A., 1981. *Soil Sci. Soc. Am. J. 45*, 311-316.
Pacholski, A., 2016. *JoVE 109.*
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