Supplementary Material

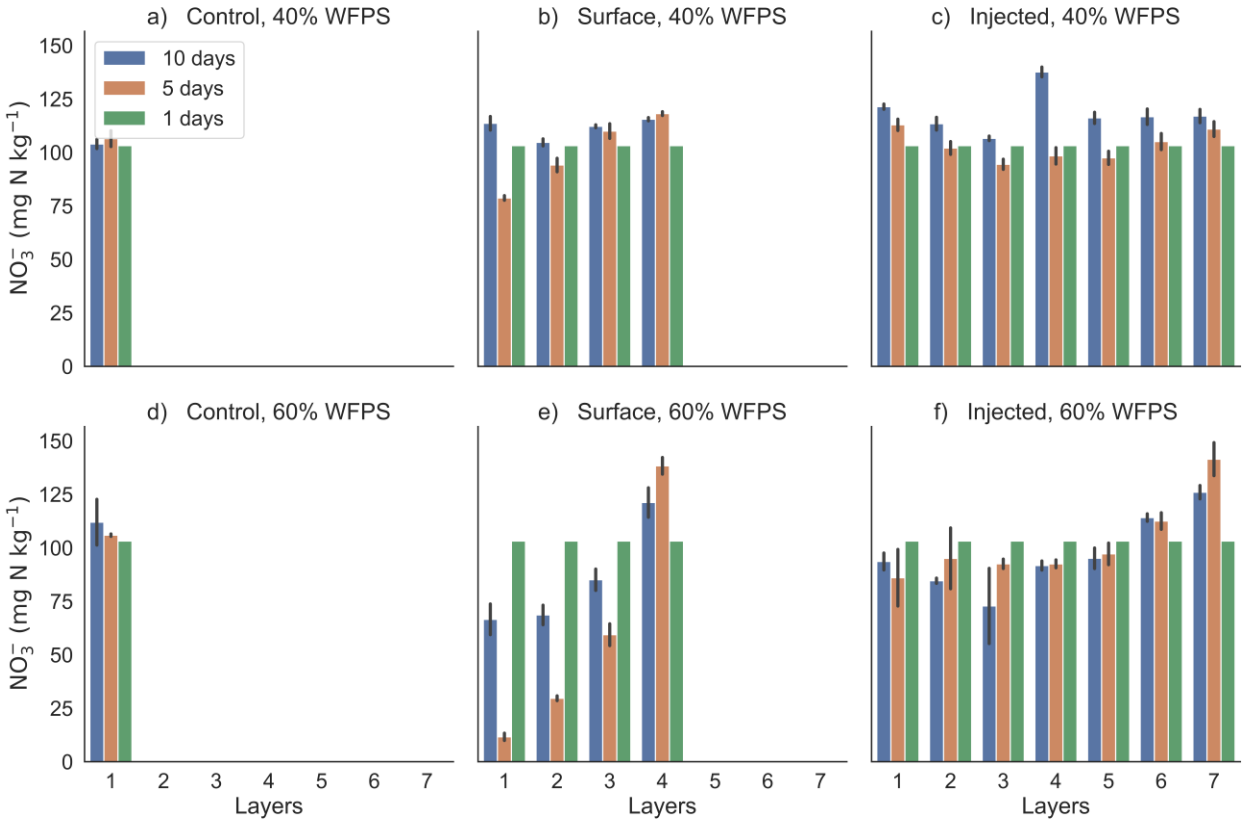

Figure S1. Nitrate concentration differences in soil layers between day 1, 5 and 10 of sampling of the control (one layer), surface (four layers) and injected (seven layers) manure treatments for two water contents (40 % and 60 % WFPS) and the standard deviation of the three parallel samples. The laboratory incubation was conducted with re-packed, sandy, arable soil from Fuhrberg, Germany

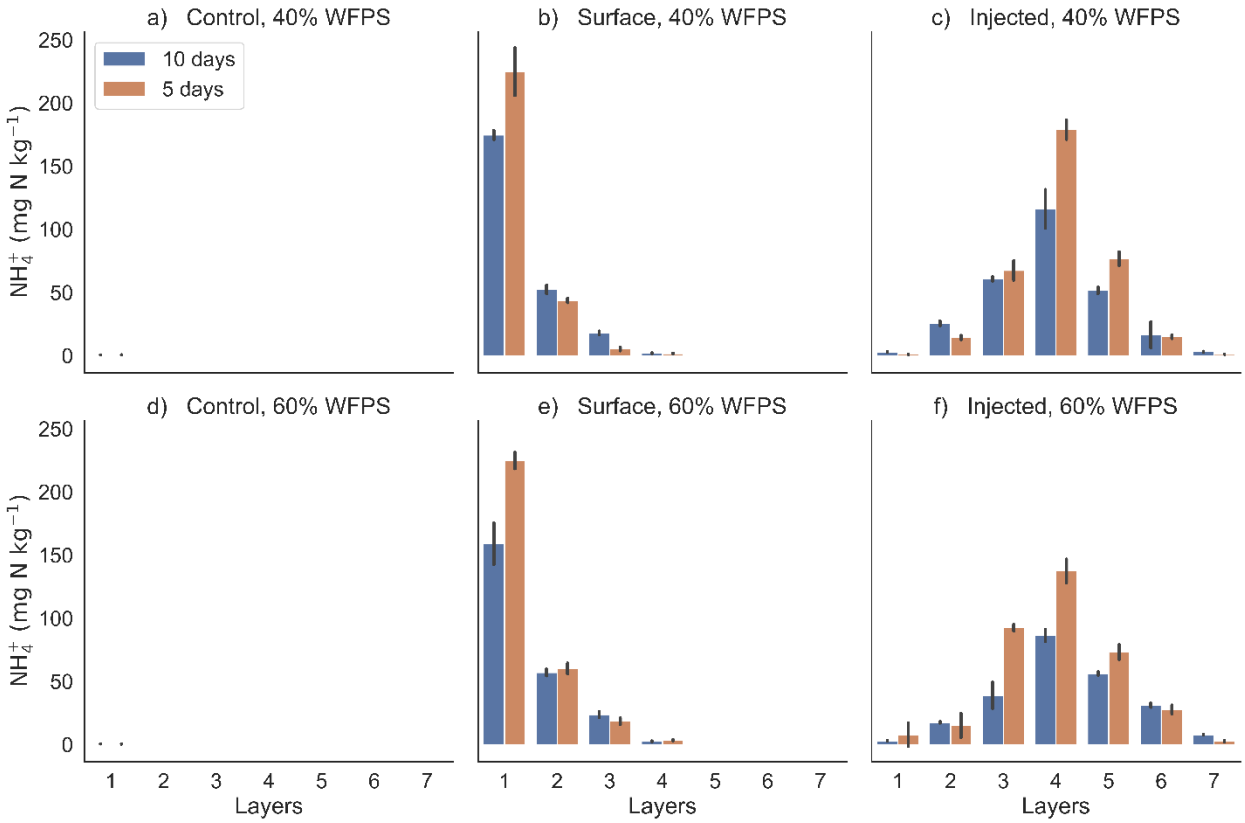

Figure S2. Differences in the ammonium concentration in soil layers between day 5 and day 10 of sampling of the control (one layer), surface (four layers) and injected (seven layers) manure treatments for two water contents (40 % and 60 % WFPS) and the standard deviation of the three parallel samples. The laboratory incubation was conducted with re-packed, sandy, arable soil from Fuhrberg, Germany

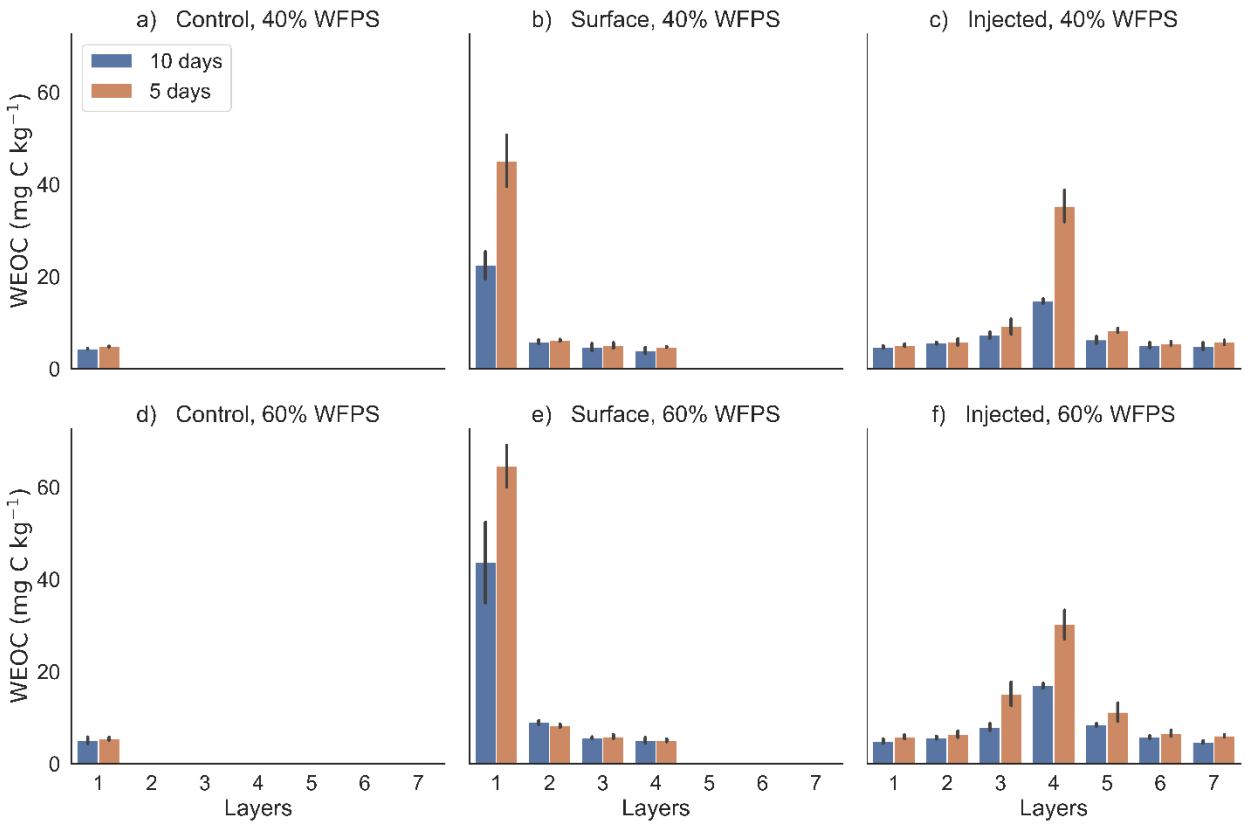

Figure S3. Water-extractable organic carbon (WEOC) concentration differences in soil layers between day 5 and day 10 sampling of the control (one layer), surface (four layers) and injected (seven layers) manure treatments for two water contents (40 % and 60 % WFPS) and the standard deviation of the three parallel samples. The laboratory incubation was conducted with re-packed, sandy, arable soil from Fuhrberg, Germany

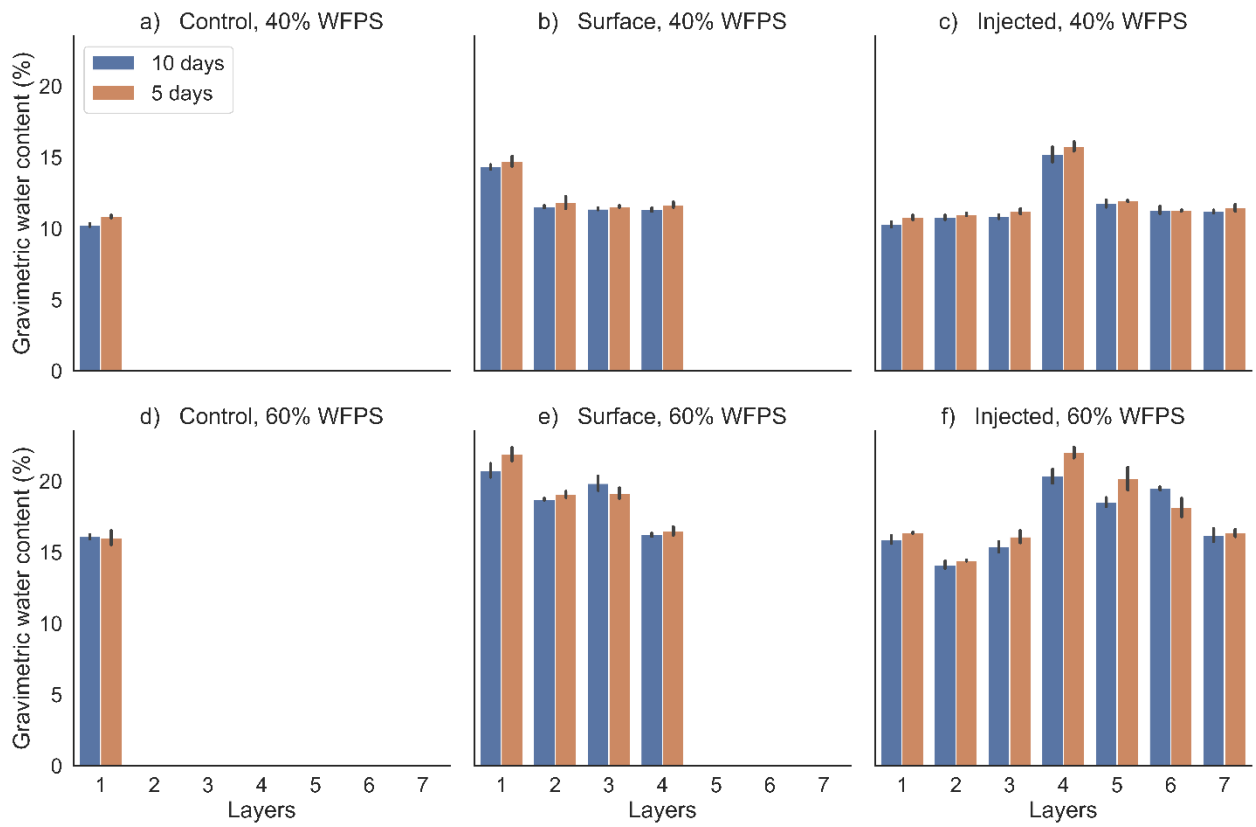

Figure S4. Gravimetric water content of soil layers between day 5 and day 10 sampling of the control (one layer), surface (four layers) and injected (seven layers) manure treatments for two water contents (40 % and 60 % WFPS) and the standard deviation of the three parallel samples. The laboratory incubation was conducted with re-packed, sandy, arable soil from Fuhrberg, Germany

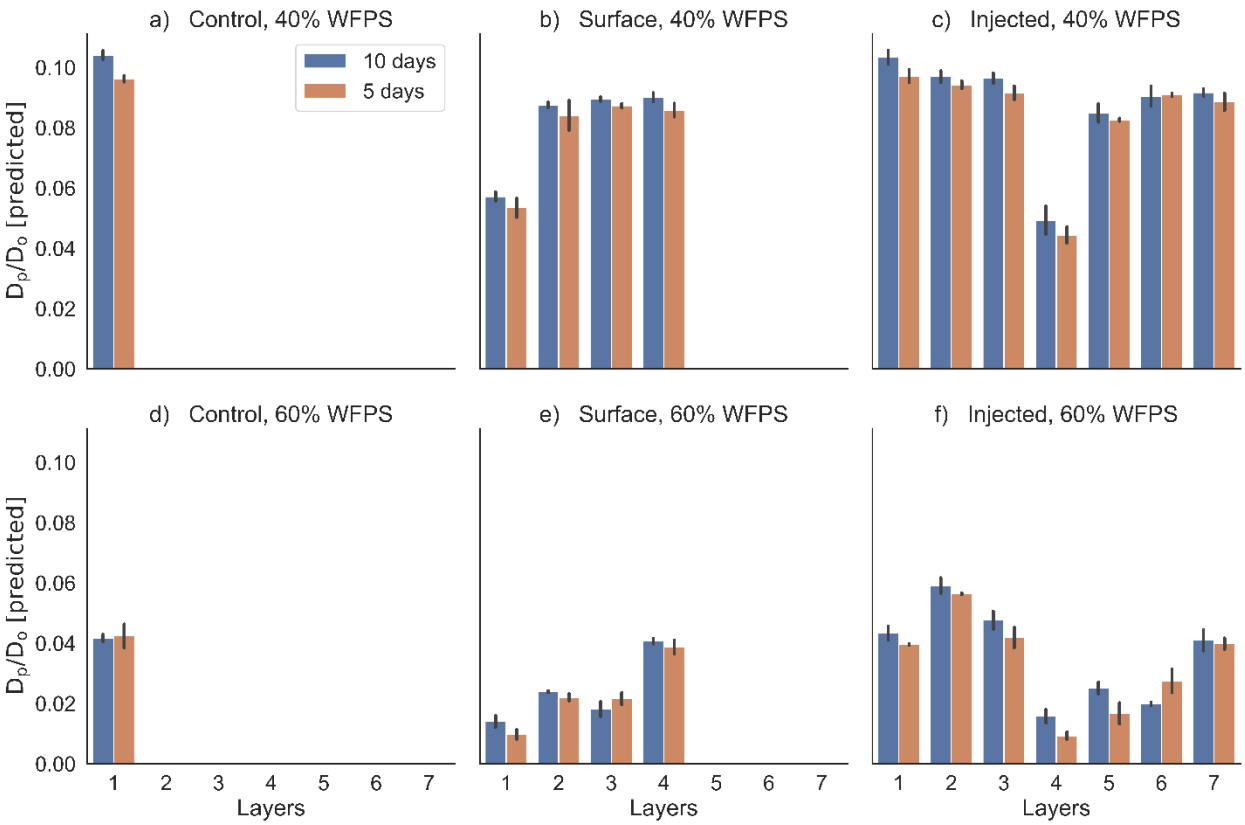

Figure S5. The calculated gas diffusivity based on the measured water content of soil layers between day 5 and day 10 of the control (one layer), surface (four layers) and injected (seven layers) manure treatments for two water contents (40 % and 60 % WFPS). The laboratory incubation was conducted with re-packed, sandy, arable soil from Fuhrberg, Germany

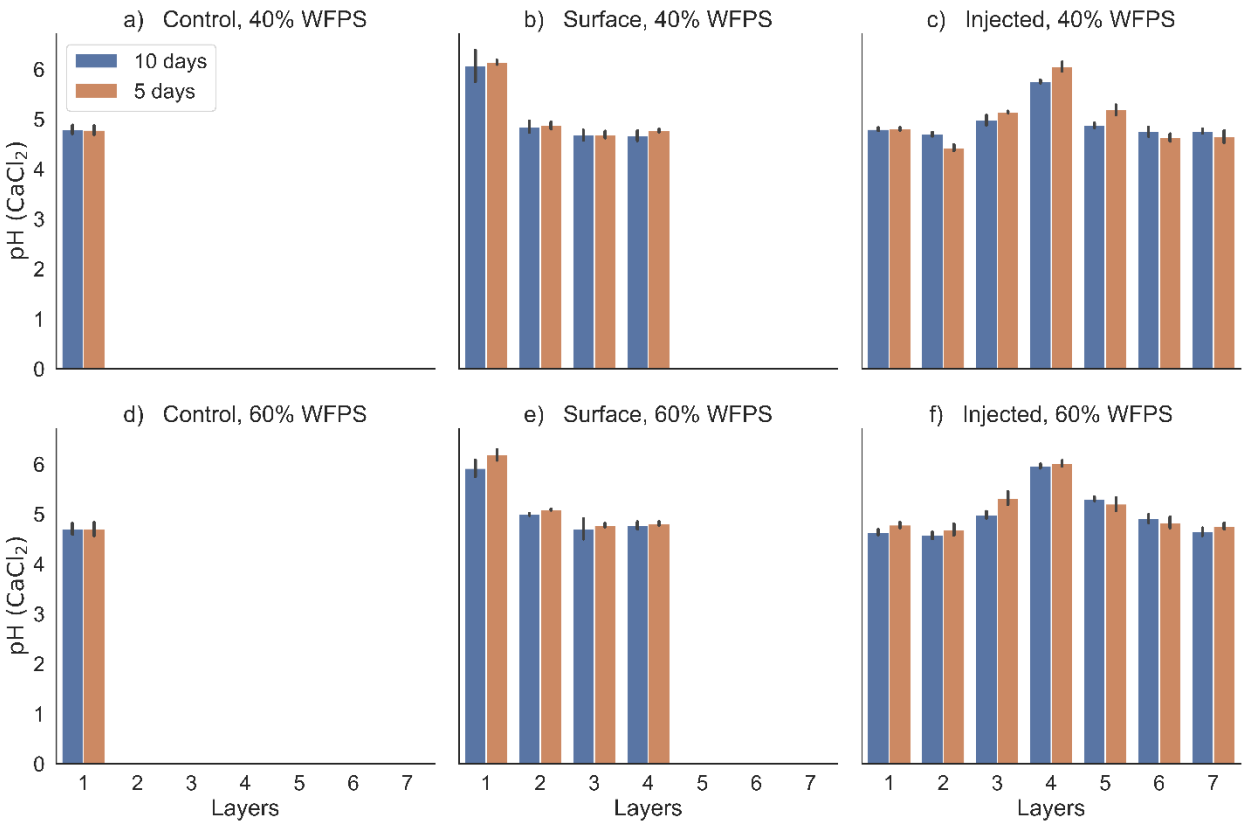

Figure S6. The pH of soil layers between day 5 and day 10 of the control (one layer), surface (four layers) and injected (seven layers) manure treatments for two water contents (40 % and 60 % WFPS). The laboratory incubation was conducted with re-packed, sandy, arable soil from Fuhrberg, Germany

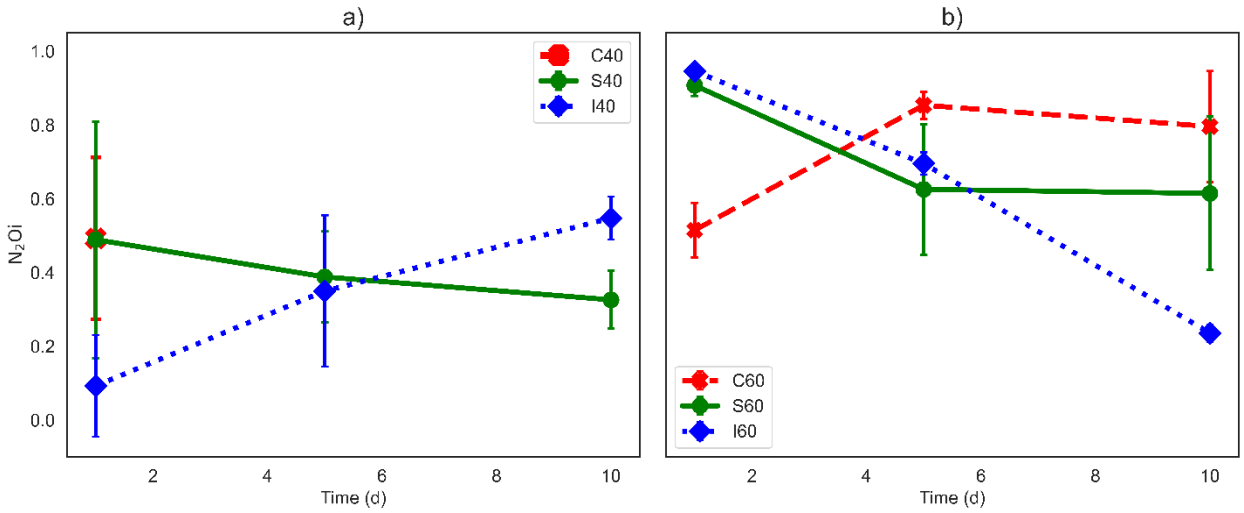

Figure S7. Time course of N_2Oi ($fp\_N_2O/(fp\_N_2+fp\_N_2O)$ at day 1, 5 and 10 of the control, surface and injected (C, S, I) manure treatments for two water contents (40 % and 60 % WFPS). The laboratory incubation was conducted with re-packed, sandy, arable soil from Fuhrberg, Germany

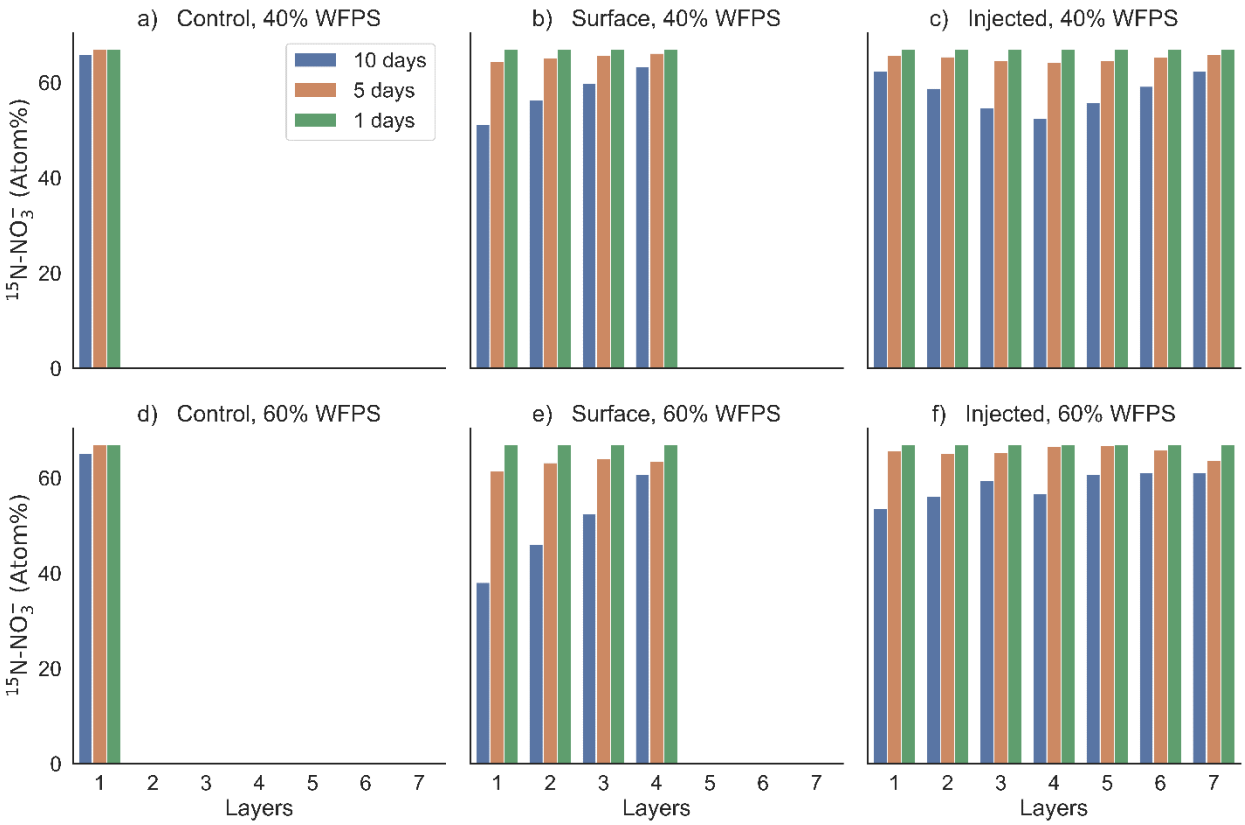

Figure S8. The ^{15}N-NO_3^- atom% of soil layers between day 1, 5 and 10 of the control (one layer), surface (four layers) and injected (seven layers) manure treatments for two water contents (40 % and 60 % WFPS). The laboratory incubation was conducted with re-packed, sandy, arable soil from Fuhrberg, Germany

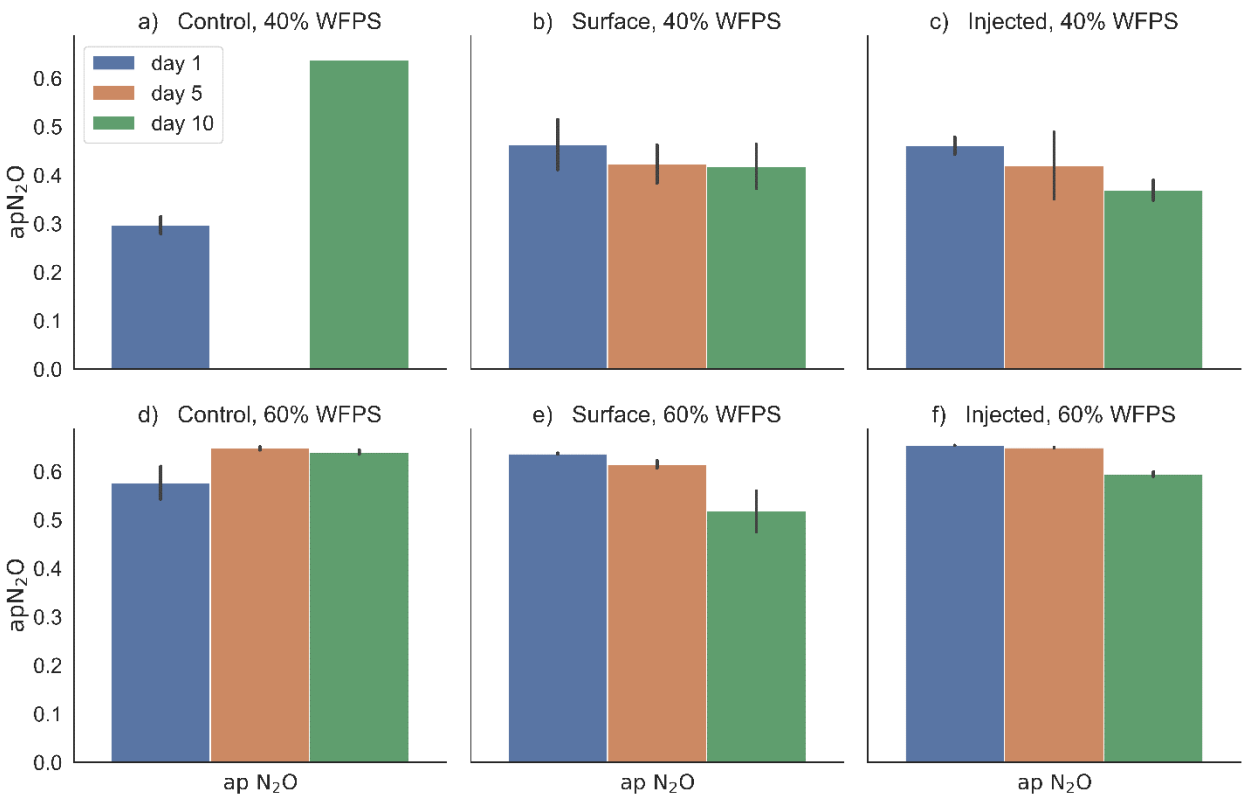

Figure S9. The apN2O values between day 1, 5 and 10 of the control, surface and injected manure treatments for two water contents (40 % and 60 % WFPS). The laboratory incubation was conducted with re-packed, sandy, arable soil from Fuhrberg, Germany

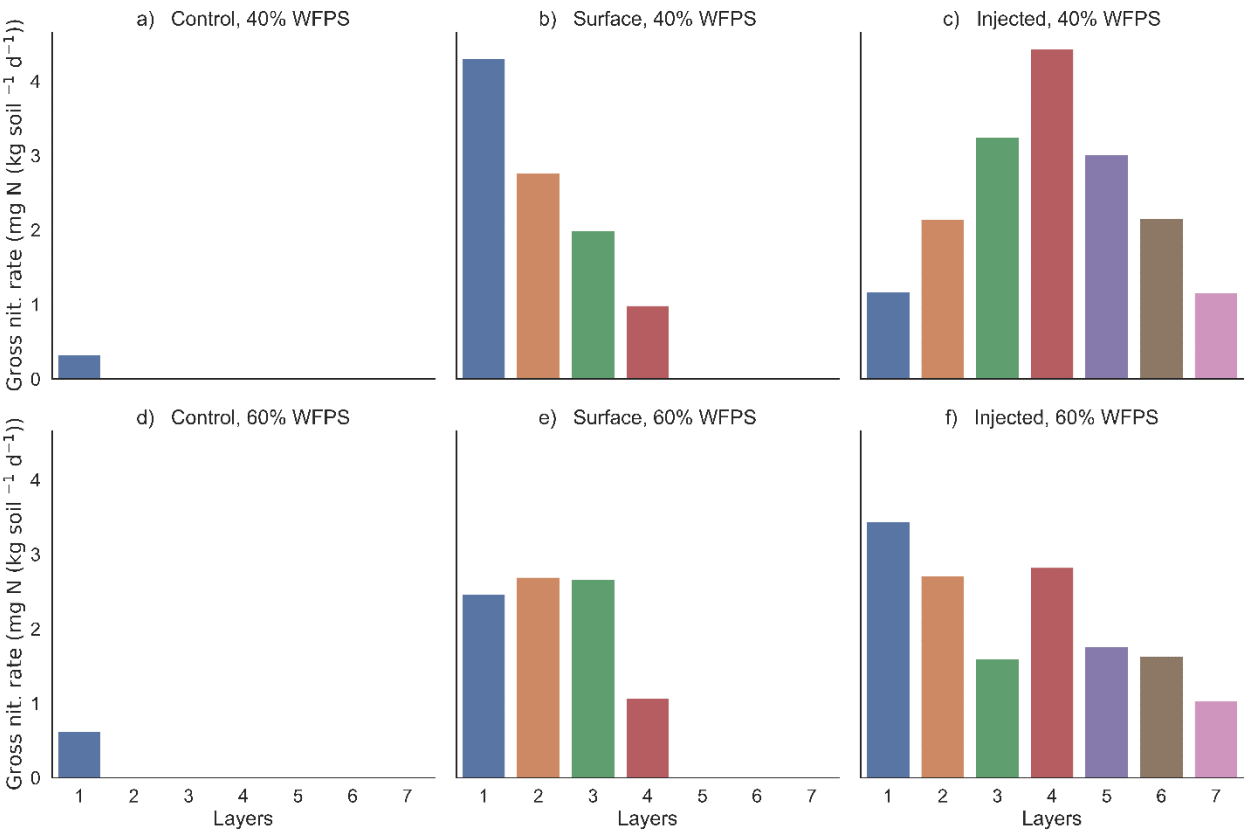

Figure S10. The gross nitrification rate of soil layers between day 5 and day 10 of the control (one layer), surface (four layers) and injected (seven layers) manure treatments for two water contents (40 % and 60 % WFPS). The laboratory incubation was conducted with re-packed, sandy, arable soil from Fuhrberg, Germany

Table S1. Physical and chemical data of four-week matured artificial manure mixture

	Dry matter [%]	**Water content [%]**	**pH ($CaCl_2$)**	**OM [%]**	**N-content [mg N kg^{-1}]**	**NH_4^+-N [mg N kg^{-1}]**
	7.1	92.9	7.9	82.0	2.74	1.85
Measurement method	DIN EN 15934: 2012-11	DIN EN 15934: 2012-11	DIN EN 12176 (S5): 1998-06	DIN EN 15935: 2012-11	DIN EN 16168: 2012-11	DIN 38406-5-2: 1983-10

Data derived from the ^{15}N gas flux method

Calculation

The approach of [1–6] was used to calculate the denitrification source-specific N_2 and N_2O (apN_2O, apN_2+N_2O and apN_2) fluxes from the ^{15}N-NO_3^- enriched active pool (ap).

$$ap = ({}^{30}x_M - a_M * a_{bgd}) / (a_M - a_{bgd}) \quad (S1)$$

where ${}^{30}\chi_M$ is the fraction of $^{30}N_2$ in gas mixture of the sample, a_M describes the ^{15}N abundance in the gas mixture and a_{bgd} describes the ^{15}N abundance of the background (non-labelled N pool gas mixture in the headspace).

$${}^{30}x_M = {}^{30}R/(1+{}^{29}R+{}^{30}R) \quad (S2)$$

$$a_M = ({}^{29}R+{}^{30}R)/(2*(1+{}^{29}R+{}^{30}R)) \quad (S3)$$

The fraction originating from the $^{15}NO_3^-$ pool undergoing denitrification (Fp) of N_2O (Fp_N_2O), N_2+N_2O ($Fp\_N_2+N_2O$) and N_2 (Fp_N_2) within the sample is given as:

$$Fp = (a_m - a_{bgd})/(a_p - a_{bgf}) \quad (S4)$$

The concentration of the pool-derived N_2 (fp_N_2), N_2+N_2O ($fp\_N_2+N_2O$):

$$fp = Fp * cN \quad (S5)$$

where cN *is* the total N_2, N_2+N_2O and N_2O concentration in the sample derived from the IRMS peaks.

References:

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4. Lewicka-Szczebak, D.; Well, R. The 15N Gas-Flux Method to Determine N_2 Flux: A Comparison of Different Tracer Addition Approaches. *SOIL* **2020**, *6*, 145–152, doi:10.5194/soil-6-145-2020.
5. Rummel, P.S.; Pfeiffer, B.; Pausch, J.; Well, R.; Schneider, D.; Dittert, K. Maize Root and Shoot Litter Quality Controls Short-Term CO_2 and N_2O Emissions and Bacterial Community Structure of Arable Soil. *Biogeosciences* **2020**, *17*, 1181–1198, doi:10.5194/bg-17-1181-2020.
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