Drainage losses of $\text{N}_2\text{O}$ and $\text{NO}_3^-$ in Ferralsol is a major N-loss pathway

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In a field repacked columns of Ferralsol had 62.8 at. % $^{15}\text{NO}_3^-$ applied at a depth of 75 mm or 200 mm on Day 0. Negligible soil $\text{NH}_4^+$, so $\text{N}_2\text{O}$ was from denitrification. Surface flux and in-soil gas measured frequently, soil moisture and temperature half-hourly (all at 3 depths). All samples analysed for $\text{N}_2\text{O}$, some for $^{15}\text{N}_2\text{O}$ and $^{15}\text{N}_2$.

Results for columns with $\text{NO}_3^-$ applied at a depth of 75 mm – very similar for $\text{NO}_3^-$ applied at a depth of 200 mm.

Total direct emissions (Days 1–23) of excess $^{15}\text{N}_2\text{O}$:
- From 75 mm depth = 0.50 % and from 200 mm depth = 0.065 %, of total $\text{NO}_3^-$ injected
- Below IPCC default of 1 %
- No emitted $^{15}\text{N}_2$ detected
- Highest in-soil content of $\text{N}_2\text{O}$ and $^{15}\text{N}_2\text{O}$ coincided with period of high hydraulic conductivity ($K_{sat} = 71 \text{ mm h}^{-1}$).
- $\text{N}_2\text{O}$ very soluble in water, so potentially leaching $^{15}\text{N}_2\text{O}$ from 75 mm ($\times 155$) and 200 mm ($\times 125$) respective surface fluxes at the time (Day 10).
- The default IPCC indirect emissions by leaching and runoff does not include dissolved $\text{N}_2\text{O}$.
- May help explain discrepancy between ‘top-down’ estimates of 3–5 % of applied N emitted as $\text{N}_2\text{O}$, compared with IPCC default ‘bottom-up’ total emissions of 1.3 % (indirect = 0.325%).