Assessing Nitrogen Emissions from Temperate Grass Silage Systems: Insights from the DNDC Model

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Introduction

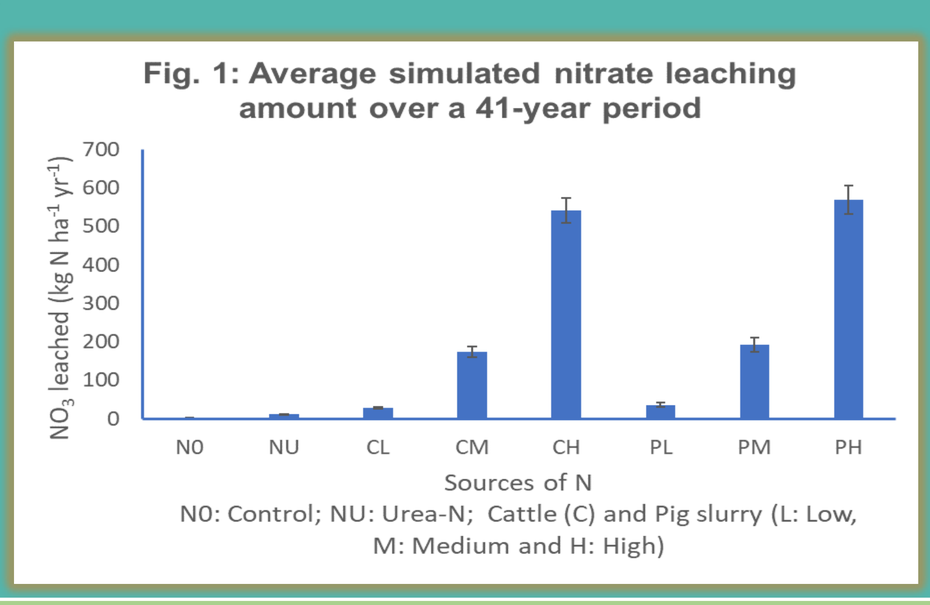
- Maintained grasslands have a significant role in biosphere-atmosphere greenhouse gas exchange.
- Management practices (fertilizer type, soil, climate) influence this exchange.
- Organic farming for GHG mitigation and sustainability; both fertilizer types emit nitrogen to the atmosphere.
- Measurements of NH_3, N_2O, NO and N_2 have limitations.
  - Nitrogen loss from fertilizers reduces efficiency and impacts sustainability.
  - Accurate and verifiable accounting of nitrogen emissions is a global concern.

Methodologies

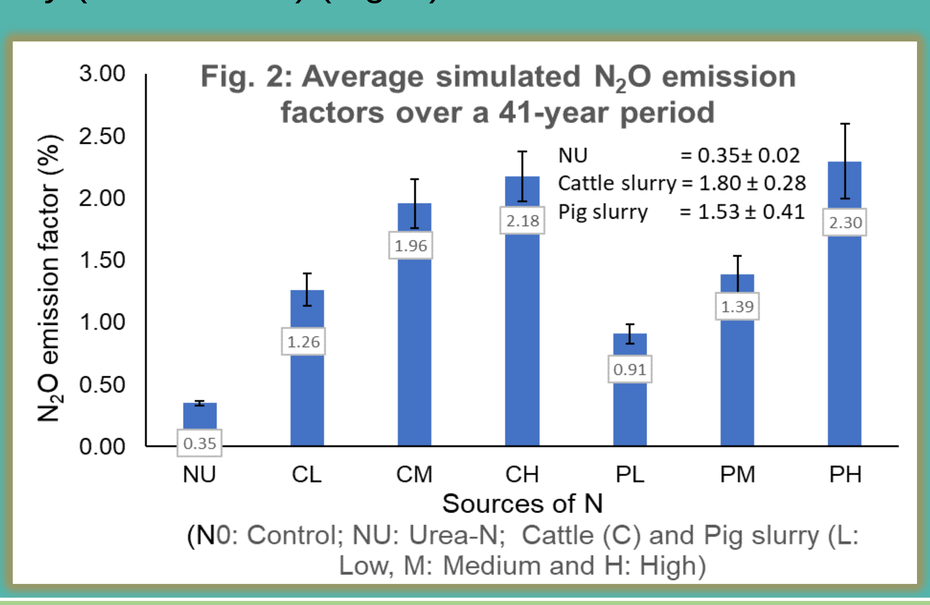
- In Ireland, NH_3 and N_2O emission factors are derived from short-term measurements and limited land use coverage.
- A simulation using the DNDC v9.5 model was conducted to address these challenges.
- The study focused on nitrogen emissions from a 3-cut moist temperate grass silage systems managed for over 45 years.
- Different fertilizers NPK and slurry (cattle and pig at low, medium, and high rates) were applied.
  - The primary objective was to assess annual nitrogen emission factors (EFs) and compare with national/IPCC defaults.

Results

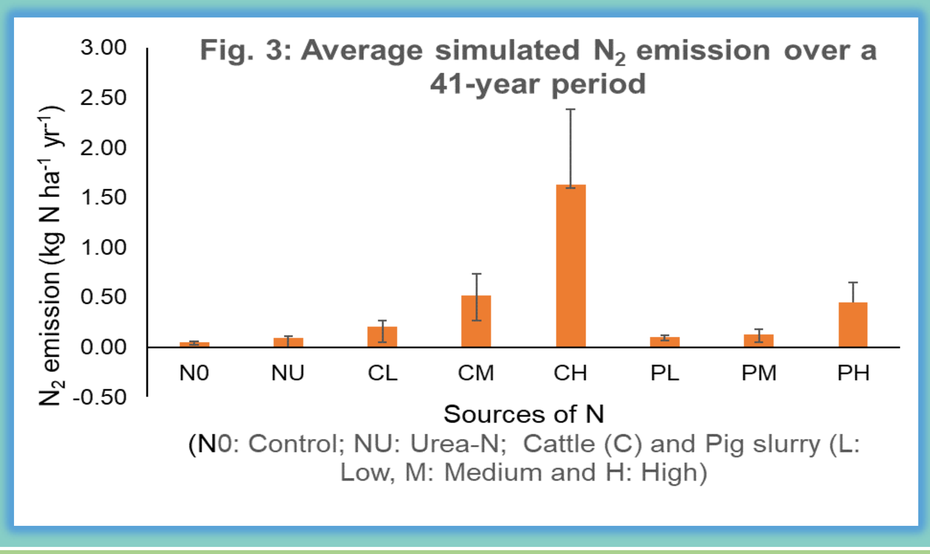
- The DNDC model reasonably predicted NH_3 volatilization from urea (11%) but underpredicted animal slurry values (≤0.1%).
- The model overestimated NO_3 leaching losses, especially for medium to high rates of animal slurry (Fig. 1), affecting indirect N_2O emission calculation.



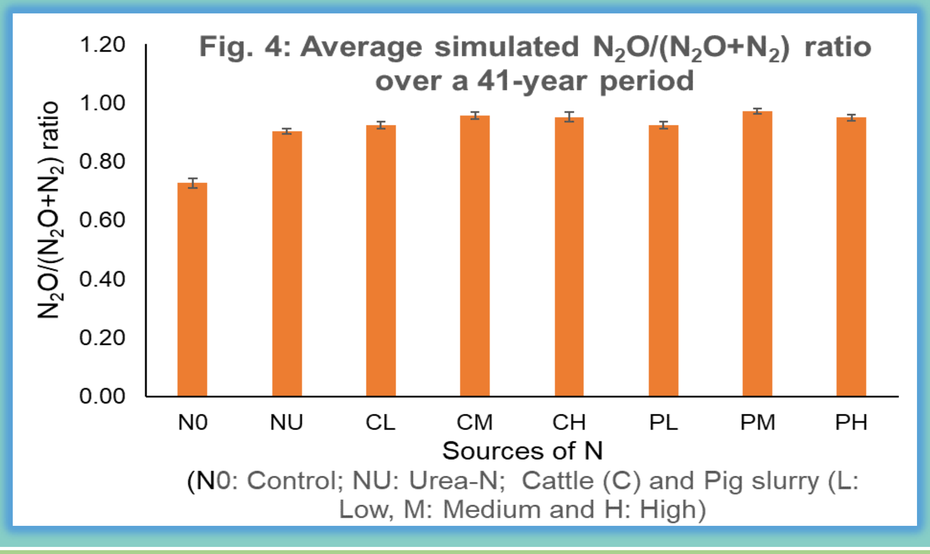
- The model accurately predicted N_2O and N_2 emissions across fertilizer types.
- N_2O emission factors (EFs) close to national and IPCC estimates: urea (0.35±0.02%), cattle slurry (1.80±0.28%), pig slurry (1.53±0.41%) (Fig. 2).



- Denitrification end-product N_2 production/release remained low (0.02-0.25%); higher with more N, especially cattle slurry (Fig. 3).



- Minimal variation in $N_2O/(N_2O+N_2)$ ratio among fertilizer treatments (0.73-0.97) (Fig. 4).



Conclusions

- The updated DNDC v9.5 model effectively identifies key factors affecting nitrogen emissions, improving our understanding of grassland nitrogen dynamics.
- Denitrification dominates N_2O production in Irish grasslands, findings within upper national limits across soil types.
- The model requires refinement for accurate NH_3 volatilization and NO_3 leaching to represent temperate grassland scenarios.

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