# Assessment of field-scale nitrous oxide ($N_2O$) emissions under contrasting management practices in the Peace Region of Canada

Ramchandra Neupane[1,3], Bharat Shrestha[1]*, Shabtai Bittman[2], Pyae Aung[2], Scott Chang[3], Kirsten Hannam[4], Nitya Khanal[1], Akim Omokanye[5], Monika Benoit[5]

[1] Beaverlodge Research Farm, Agriculture and Agri-Food Canada, 100038 Township Road 720, Beaverlodge, AB T0H 0C0

[2] Agassiz Research and Development Centre, Agriculture and Agri-Food Canada, Agassiz, BC V0M 1A2,

[3] Department of Renewable Resources, University of Alberta, Edmonton, AB T6G 2E3

[4] Summerland Research and Development Centre, Agriculture and Agri-Food Canada, Summerland, BC V0H 1Z0

[5] Peace Region Living Lab, PRFSA, 401-114 Ave Dawson Creek, BC V1G 2Z7

*Presenting author: bharat.shrestha@agr.gc.ca

## Abstract

Gaseous emissions and leaching losses of nitrogenous compounds are major limiting factors for crop N use efficiency. However, field-scale measurements remain scarce in the Peace Region of Canada. This study assessed field-scale $N_2O$ emissions and N budgets under contrasting management practices on 2 commercial farms (La Glace and Whitemud Creek) over the 2024–2025 growing seasons. Each farm included a paired comparison between conventional annual cropping with fertilizer N applied and an alternative crops (perennial grass/legume integration) which received little or no N. $N_2O$ fluxes were measured at 1–2-week intervals using a LI-COR 7820 from spring thaw through fall snowfall. Concurrent soil sampling quantified $NO_3^-$-N and $NH_4^+$-N, moisture, and temperature, whole plant sampling and farmer interviews supported N budget construction. Time-series analyses identified water-filled pore space (WFPS) and mineral N at 0–15 cm as variables closely tracking $N_2O$ flux dynamics, with volumetric water content at 5 cm as the most responsive real-time indicator. The largest fluxes occurred in June to July during elevated WFPS coincided with high soil mineral N. Annual cropping system with applied 86.7-123.1 kg N $ha^{-1}$ produced substantially higher cumulative emissions (1.49–5.70 kg $N_2O$-N $ha^{-1}$) than perennial and legume phases (0.28–1.01 kg $N_2O$-N $ha^{-1}$) but also produced more harvested biomass (1905 - 4371 kg $ha^{-1}$). The early growing season (May–July) dominated emissions (34–88% of annual totals), while spring thaw (2025) contributed 12–22%. These findings suggest that improved N application timing, optimized N rates crediting residual soil N and legume contributions, and strategic perennial integration can reduce $N_2O$ emissions in Peace Region farming systems.

**Keywords:** alternative management practices. living lab, Peace Region, nitrous oxide, nitrogen budget, nitrogen use efficiency, water-filled pore space