# Quantifying nitrogen loss from 15N-enriched crop residues: Developing a case for the lowering of N2O emission factors

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| SPG Contributions | Project Status | Duration/Timeline of Project (Year to Year) | Co-funders | Total Project Cost |
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| $77,587.63 | Completed | April 2011 – January 2014 | Saskatchewan Ministry of Agriculture – Agriculture Development Fund (ADF) | $145,054.63 |

## Project Description

To quantify total- and 15N2O emissions resulting from the decomposition of 15N-labeled pulse and cereal crop residues in Saskatchewan soils; to quantify total- and 15N2O emissions associated with the use of 15N-labeled urea fertilizer in Saskatchewan soils; to calculate emission factors for the plant residues and fertilizer.

Nitrous oxide (N2O) is a potent greenhouse gas that contributes to global climate change. Expressed in CO2 equivalents, it is up to 300 times more potent than CO2 in affecting climate change. Current estimates of N2O emissions in Canada indicate that 17% of all agriculture based emissions are associated with the decomposition of crop residues. Given that the CO2-footprint of agricultural products is now an important factor in gaining and/or maintaining market access, it is very important to accurately determine the actual magnitude of emissions from residues, and to understand the controls on those emissions so their overall contribution can be accurately reported, and effective mitigation options identified.

This work complements and extends "in-field" comparisons of the effect of crop type and cropping sequence on nitrous oxide emissions by providing more precise information on how different components of prairie cropping systems contribute to the overall greenhouse gas balance. Ultimately, the work will support changes (if warranted) to the Canadian greenhouse gas inventory and the quantity of greenhouse gases assigned to prairie crop production potentially influencing government policy.

Emission factors for residue-N would be lower than those for fertilizer-N.

This research consisted of a series of growth chamber studies using 15N-labeled (stable isotope) plant residues. The stable isotope labeling enables us to identify the specific source of N in the N2O emissions. Canola, flax, wheat, and pea residues enriched in 15N were generated by growing these crops in soil amended with 15N-labeled fertilizer.

Preliminary studies were conducted to (i) develop the methodology that would be needed to determine 15N2O production during residue decomposition, and (ii) determine rates of residue decomposition (measured as CO2 production) and N2O production as affected by soil type. The results of these preliminary studies were used to develop the protocols for the main study.

The main study was carried out using soils from the Black, Dark Brown, Brown, and Gray soil zones and was conducted at 50% and 70% water-filled pore space (WFPS). These values of water-filled pore space represent relatively 'dry' and 'normal' soil moisture conditions. The soils were amended with 15N-labeled residues of wheat, pea, canola, and flax and 15N2O production monitored using a Picarro G5101-i isotopic N2O analyzer. Daily and cumulative N2O emissions were calculated for each treatment (i.e., crop residue type/soil-water) combination. Fertilizer and residue induced emissions were calculated by correcting for background emissions; and emission factors calculated for each crop residue/soil water combination.

## Outcome

Overall, the research has demonstrated that there is considerable potential for N2O emissions from decomposing crop residues and that the original hypothesis that emissions factors for residue-N would be lower than those for fertilizer-N is likely not valid. This conclusion is supported by a recent meta-analysis of the published literature that concluded that crop residue amendments did not reduce N2O emissions from soils and that residue effects were "likely comparable with, if not greater than, the effects of synthetic fertilizers". The results also demonstrated that the emission factor for N applied as a crop residue is not a constant, rather it is a variable coefficient that—in addition to the quantity and quality of the residue – depends on a complex interplay of soil and environmental variables.

Both water content and soil type had an impact on N2O production. However, there was a clear and consistent trend in the emission factors for the residues; i.e., emissions were always greatest for the canola residue and lowest for the wheat residue and urea fertilizer; emission factors for pea and flax were intermediate, with the flax yielding values often slightly higher than those for the pea. Therefore, the results of this research demonstrate that— under the right environmental conditions—there is considerable potential for N2O emissions from decomposing crop residues. Moreover, emission factors for the various crop residues tended to increase in the order: wheat ≤ urea

## Research Objective

**OBJECTIVE 1**
To quantify total- and 15N2O emissions resulting from the decomposition of 15N-labeled pulse and cereal crop residues in Saskatchewan soils.

**OBJECTIVE 2**
To quantify total- and 15N2O emissions associated with the use of 15N-labeled urea fertilizer in Saskatchewan soils.

**OBJECTIVE 3**
To calculate emission factors for the plant residues and fertilizer.