# Soybeans – Good for Lowering Greenhouse Gas Emissions

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**TO BORROW A** line from a famous song in the 1970s, *We've Only Just Begun* to discuss agriculture's role in greenhouse gas reductions and adapting to climate change. Regardless of where you stand on the issues, there will be more public, political and economic attention in the future. A lot has been stated in the media and at grower meetings about the research we've done at the University of Manitoba in 4R nitrogen management to lower nitrous oxide emissions from soil. However, often overlooked is the most important thing farmers can do to lower nitrogen losses and emissions of nitrous oxide – the decision of what crop to grow.

Firstly, what is nitrous oxide? It is more than just the gas that makes canned whipped cream so light and fluffy. Nitrous oxide, or $N_2O$, is a gas produced mainly by bacteria in soil when they convert nitrogen in organic matter, animal manures, green manures, crop residues, and ammonia/ammonium/urea synthetic fertilizers to nitrate (the plant-available form). Yes, basically any source of nitrogen converted to nitrate results in nitrous oxide. The nitrification process is involved in the nitrous oxide production. To a lesser extent, another nitrogen transformation process caused by soil bacteria, denitrification, produces nitrous oxide when soil is wet and warm. So what? From an agronomic view, nitrous oxide emissions amount to a small loss of nitrogen, about 1–3 lbs N/acre in a year. Where the emissions are lost via denitrification, like during spring thaw and when soil is saturated or flooded, nitrous oxide loss is indicative of much greater loss of nitrogen as nitrogen gas ($N_2$). We don't have confident numbers on that loss but indirect estimates based on unaccounted for nitrogen in soil indicate 5–80 lbs/ac and perhaps more could be lost, the higher amounts under saturated wet conditions. The concern for nitrous oxide emissions from soil is more about its effect on the environment. Nitrous oxide is a greenhouse gas that per molecule, is about 300 times more potent than carbon dioxide in warming the atmosphere. Now, we produce much more carbon dioxide globally, primarily from using fossil fuels, but nitrous oxide emissions from soil are about 2–5% of our national emissions of all greenhouse gases in Canada. That's a small but important amount because agriculture is the main emitter of nitrous oxide.

With support from soybean farmers in Manitoba through MPSG, we have examined nitrous oxide emissions from soybean. In particular, we have looked at emissions during the growing season, during spring thaw and from soybean residues in the following crop. In brief, we've found emissions are extremely low during the growing season, at time of spring thaw and from soybean residues the following year. Emissions were similar to spring wheat grown with no nitrogen addition. That is amazing considering a 40 bu/acre soybean crop produces (through nitrogen fixation) 120–150 lbs N/acre. That amount of anhydrous ammonia or urea applied to soil can emit 0.6–3 lbs N/acre of nitrous oxide; the lower amount in a dry year and the higher amount in a wet year. Soybean is a wondrous crop, providing for much of its nitrogen and not resulting in nitrous oxide emissions. That's because most of the nitrogen it produces ends up in the oilseed. Can soybean and its expanding acreage in Manitoba play a role in reducing nitrous oxide emissions from soil? Can soybean help achieve emission reduction targets?

To address these questions, I've done some back-of-the-envelope calculations estimating nitrous oxide emissions from the four major field crops in Manitoba (cereals, canola, soybean and corn) using some rudimentary assumptions. Taking past crop insurance acreage data for those crops, I projected to 2030 lower cereal acreage because of more soybean with

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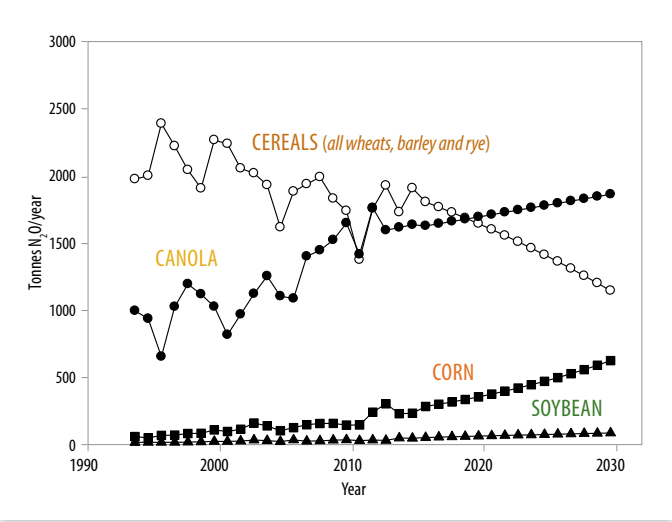
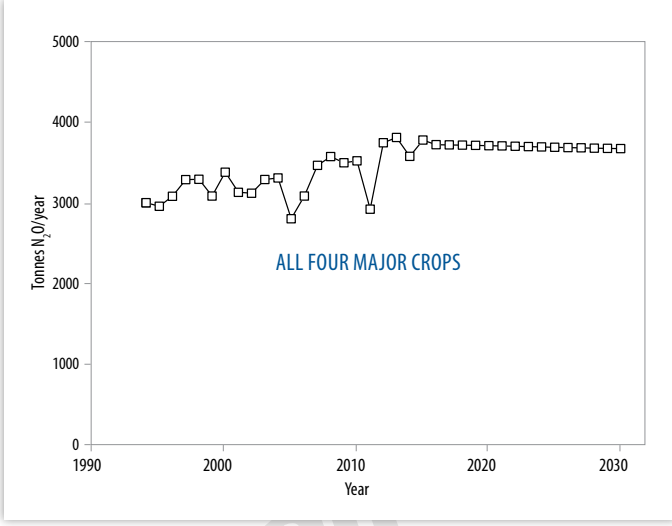
## HISTORICAL (1995–2015) AND PREDICTED (2016–2030) NITROUS OXIDE EMISSIONS

▼ *Figure 1. Individual crops in Manitoba.*




▼ *Figure 2. Across all four major field crops in Manitoba.*




canola being stable since 2006 and moving forward. Also from the crop insurance database, we have been using higher field rates of nitrogen on cereals, canola and corn, about 1.1–1.5 lbs N/acre/year, depending on the crop. Lastly, taking the value for nitrous oxide emission per amount fertilizer added in Manitoba used by Agriculture and Agri-Food Canada and Environment Canada (0.008 kg $N_2O$–N/kg N fertilizer added), the historical and my predicted crop acreages and nitrogen use moving forward, nitrous oxide emissions from the four major field crops to 2030 were estimated (see Figure 1).

Figure 1 shows how nitrous oxide emissions from cereals are predicted to decline because of lower acreage despite higher nitrogen field application rates. Increased emissions for canola in Manitoba is predicted because of greater rates of nitrogen addition for individual fields despite lack of increase in total acres planted. The increase in emissions from corn is due to both greater field application rates and more planting of the crop. It is important to note the emission scenarios are a "business as usual" prediction of emissions that do not take into account better nitrogen use practices such as using more 4Rs of right source, rate, timing and placement to lower nitrous oxide emissions. Readers may know I'm fervent believer based on research that huge reductions in emissions by using advanced 4R practices are achievable. However, the striking result of the prediction exercise is the pretty much lack of emissions from soybean despite an estimated 3.4 million acres by 2030! There are some emissions because of the nitrogen added with MAP for phosphorus nutrition. The impact of little soybean emissions is that since 2012, nitrous oxide emissions have flatlined and under a "business as usual" (i.e., no greater adoption of 4Rs), emissions will remain the same to 2030 (Figure 2). Wow! What an advantage Manitoba has over other areas, since our nitrous oxide emissions will likely remain unchanged all thanks to growing more soybeans. Thus, it is a real possibility that through continued increase in soybean acreage and greater 4R adoption for nitrogen use of cereals, canola and corn, Manitoba has a real chance of reducing emissions from major field crops by 30% of 2005 levels. That's a discussion to continue. ■