Path to Achieve Net-Zero Emissions by 2050: The Effects of Inhibitors on Farm Financial and Environmental Performance

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BACKGROUND

- The use of fertilizers has significantly increased in recent years, resulting in improved crop yields (Sutton et al., 2011).
- However, this has raised environmental concerns due to significant nitrogen loss to the environment, impacting greenhouse gas emissions.
- Agriculture is a large source of greenhouse gas emissions, generating approximately 10% of Canada's total GHG emissions annually since 1990 (Agriculture and Agri-Food Canada, 2021).
- Canada is therefore targeting a 30% reduction in greenhouse gas emissions from fertilizers in agriculture, utilizing 4R nutrient Stewardship including inhibitors.

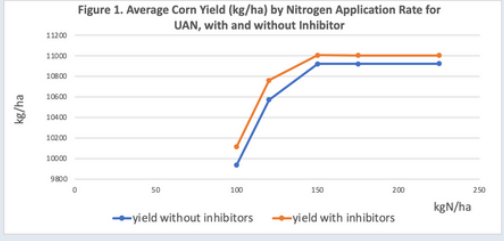
OBJECTIVE

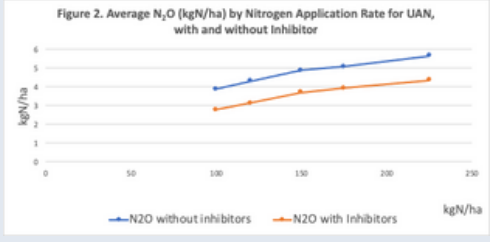
- To evaluate the economic effectiveness of inhibitors as a mitigation strategy for reducing greenhouse gas emissions from agriculture.

METHODOLOGY

- Employed the DNDCv.CAN model to simulate 30 years of weather data to derive corn yields and N_2O emissions under different UAN fertilizer rate and inhibitor use scenarios.
- Crop revenue is calculated from simulated yields and OMAFRA price data, while costs are derived from OMAFRA corn enterprise budgets.
- Net returns is estimated by subtracting farm costs from crop revenue.
- Estimated and compared per-hectare net profit with and without inhibitors to evaluate economic feasibility and emissions mitigation strategy.

RESULTS





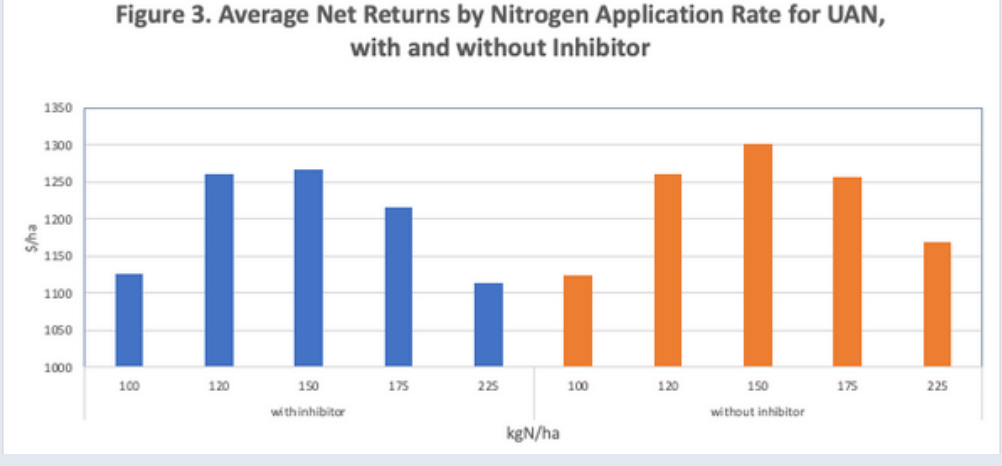


Table 1: Fertilizer Rate and Inhibitor Scenarios for Highest Simulated Corn Yield Returns by Year

Years	Highest Returns ($/ha)	Associated Rate-Inhibitor Scenarios
1992	985	100 without inhibitor
1993	1497	100 without inhibitor
1994	1597	120 without inhibitor
1995	1282	150 without inhibitor
1996	1216	120 without inhibitor
1997	1554	100 without inhibitor
1998	1499	120 without inhibitor
1999	981	150 without inhibitor
2000	1293	120 without inhibitor
2001	1500	100 without inhibitor
2002	1512	120 without inhibitor
2003	978	150 without inhibitor
2004	1479	150 without inhibitor
2005	1462	100 without inhibitor
2006	1391	120 without inhibitor
2007	948	150 without inhibitor
2008	719	100 without inhibitor
2009	1480	120 without inhibitor
2010	1493	150 without inhibitor
2011	1402	120 without inhibitor
2012	1444	150 without inhibitor
2013	1536	120 without inhibitor
2014	1436	150 without inhibitor
2015	1565	150 without inhibitor
2016	1439	150 without inhibitor
2017	1600	100 without inhibitor
2018	1451	150 without inhibitor
2019	1282	150 without inhibitor
2020	1502	150 without inhibitor
2021	1589	120 with inhibitor

Figure 4. Elora Research Station

DISCUSSION

- Inhibitors increased corn yields by up to 188 kg/ha at lower N rates.
- Inhibitors decreased N_2O emissions by roughly 9-21%.
- On average, the most profitable N rate for maximizing returns was 150 kg/ha.
- Overall, inhibitors show agronomic and environmental gains but lack clear economic benefits alone. Optimizing both inhibitor and fertilizer use levels could balance efficiency and environmental care.

IMPLICATIONS

- Findings underscore the complexity of nitrogen management and the need for more coordinated research across disciplines to develop integrated fertilizer/inhibitor recommendations that consider both yield and environmental objectives.
- Potential policy options include providing subsidies for eco-efficient technologies like inhibitors, implementing nitrous oxide emission penalties, and tying inhibitor requirements to fertilizer rate thresholds above optimal agronomic levels.

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REFERENCES

Agriculture and Agri-Food Canada. (2022). *Discussion document: Reducing emissions arising from the application of nitrogen fertilizer.*

Food and Agriculture Organization of the United Nations. (2019). *Fertilizer use to surpass 200 million tonnes in 2018.*