What we heard report - Fertilizer emissions reduction

Table of contents

Message from the Minister

Thank you to all of you who participated in the engagement process, sharing your time, energy and insights in support of this important work. High participation in this consultation process provided valued advice and will be considered as work continues towards a strategy to reduce nitrogen emissions from fertilizer application.

In December 2020, we set an ambitious national target to reduce greenhouse gas (GHG) emissions associated with fertilizer application by 30% below 2020 levels by 2030. This is part of the federal government's commitment to reduce total emissions in Canada from all sectors by 40-45% by 2030, as outlined in Canada's Strengthened Climate Plan. I would like to be clear, **there is no mandatory reduction in fertilizer use on Canadian farms.** Instead, we want to support measures that producers can take **voluntarily** to reduce their emissions over the long term, without curtailing growth in crop yields.

Agriculture is at the heart of one of the greatest challenges of our time: increasing our productivity to feed a growing world population in a changing climate. Canadian farmers across the country are taking action on the environment, reducing their carbon footprint, and are important and proactive partners in reducing GHG emissions.

To achieve this target, we will look to voluntary efforts to maximize efficiency, optimize fertilizer use, and encourage innovation. These efforts have potential to maintain or increase output and profitability for farmers and the entire agri-food industry while also lowering GHG emissions, but must be achieved through consistent collaboration with the agriculture sector, provinces and territories, and stakeholders who can help in identifying opportunities that allow us to do both.

Many farmers are already implementing nutrient management practices to ensure that fertilizer goes to the growing crop, avoiding losses to air and water. It makes sense, both ecologically and economically. They are using the latest tools, management practices, and precision technologies, to help align fertilizer rates to the needs of crops.

Fertilizers are an essential input for farmers. We need to ensure that our efforts to reduce emissions do not undermine their competitiveness or their vital work, especially at a time when food insecurity has reached unprecedented levels worldwide, and the fertilizer supply chain is increasingly strained.

We heard a range of views cutting across all demographics through the phases of engagement. Some shared perspectives included improving recognition of Canadian farmers in promoting sustainability, importance of communication between the government and the agriculture sector, accommodating regional challenges of nitrogen management practices, and how to protect farmer's livelihoods as we consider the overall economics of reducing emissions.

As we continue on this journey together, we are committed to working with all farmers and stakeholders to develop an approach to meet the fertilizer emissions reduction target and build upon work already underway in the agriculture sector and beyond.

- The Honourable Marie-Claude Bibeau, Minister of Agriculture and Agri-Food

Acknowledgements

Agriculture and Agri-Food Canada (AAFC) gratefully acknowledges the support from Smart Prosperity Institute in implementing the technical workshops and their contribution to this report.

AAFC would also like to thank Dr. Mario Tenuta, Dr. Claudia Wagner-Riddle, Dr. Dan Heaney, Dr. Craig Drury, Dr. Douglas MacDonald, Dan MacDonald, and Frank Annau for contributing their knowledge and expertise as panelists for the technical workshops.

Executive Summary

There is no one-size-fits-all approach to meeting the target. Canada's agriculture sector varies by crop, soil, and region. As such, a wide range of participants provided unique perspectives based on their experience.

Throughout the consultation process, specific actions to achieve the target were highlighted and include:

- **Increasing adoption of Beneficial Management Practices (BMPs)** with decreased upfront costs and demonstration of their success and profitability on the farm;
- **Supporting innovation** to help the sector on a path forward, with financial **support and improved infrastructure**;
- **Improving measurement and reporting** of greenhouse gas (GHG) emissions from fertilizer application, with **minimal reporting burden** for the farmer, and open data sharing while protecting data privacy; and
- **Engaging frequently with** farmers, involving them directly in research efforts to use their deep knowledge and experience of their soils, landscape and farming practices.

> Developing federal policy and programs that can achieve widespread success will not be easy. Agriculture and Agri-Food Canada (AAFC) must work closely with farmers throughout policy development. There is no one-size-fits-all approach to meeting this target, and many individual farm-level variables will impact what solutions work for each farmer. **Grain Growers of Canada**

Cutting across all key themes, demographics and phases of engagement, a number of views were shared by a majority of contributors, including:

- **Recognition for Climate Action** — Many respondents recognized the need to act on climate change and the opportunity to reduce emissions from nitrogen fertilizer application. At the same time, improving recognition for the role that Canadian farmers already play in promoting sustainability and taking action to reduce emissions was identified as a clear priority. It was frequently noted that respondents are proud of the role that the agriculture sector plays in fighting climate change.
- **Contributing to Global Food Security** — Many shared that global food security was top of mind, and that Canada has an important role to play in feeding the world.
- **Recognizing the Economics of Emissions Reductions —** Input frequently cited the importance of considering the economics of reducing emissions, and the impact that climate change policies could have if done without considering producer profitability and yield.
- **Communication and Coordination** — Participants emphasized the importance of continuous communication between the Government of Canada and the agriculture sector. They underscored the important role that knowledge transfer, education, and in-person outreach can play in enhancing the adoption of practices to reduce emissions from fertilizer application.
- **Regional Considerations** — Many highlighted the regional nature of Canada's agriculture sector and the need to ensure that the path forward accommodates the diverse soil and climactic conditions across the nation. Respondents indicated that more localized data and increased extension services would assist them to adopt nitrogen management practices.
- **Concern About the Target** — A high amount of input received through email submissions and the online survey questioned whether a fertilizer emissions reduction target was needed. This comment was often coupled with concerns that a mandatory target might later be imposed, and that this could impact production. There were also concerns about the timeline for the target, including an acknowledgement of the amount of work that remains, particularly when it comes to data and measurement. A significant number of respondents preferred an intensity-based reduction in emissions rather than an absolute emissions reduction.

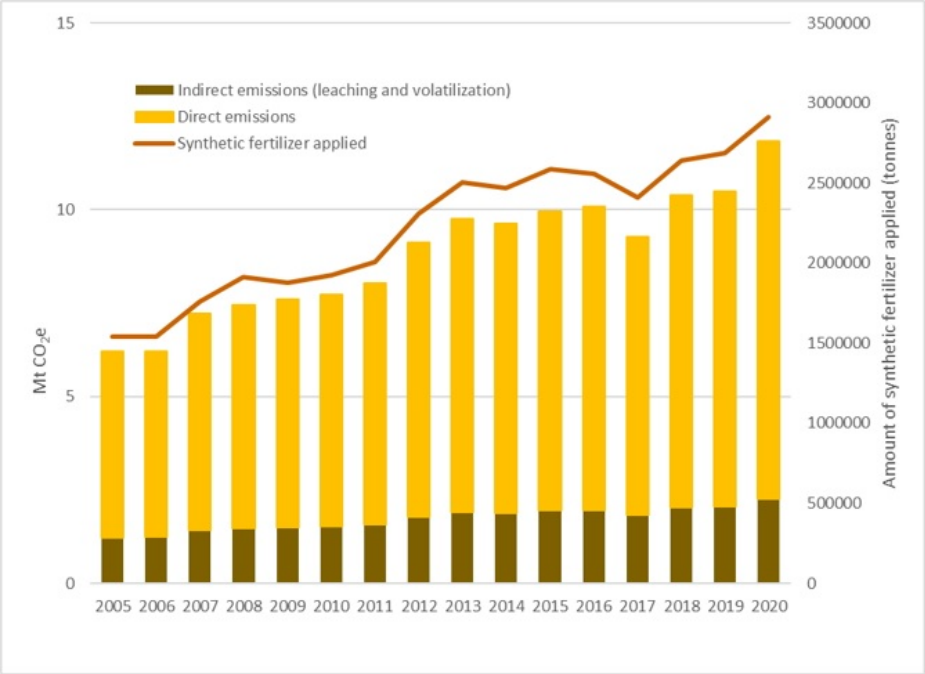
Background

The consequences of climate change are being felt right now, here in Canada, and around the world. The science is clear – existing efforts are not enough to avoid catastrophic impacts. More needs to be done to address climate change, and on a faster timeline. At current rates, global warming of 1.5°C will likely be reached between 2030 and 2052, and it is only with urgent, deep reductions in GHG emissions that global warming can be limited to below 2°C.

In December 2020, the Government of Canada announced its *Strengthened Climate Plan, "A Healthy*

Environment and a Healthy Economy." The Plan includes a number of measures for the agriculture sector, to reduce GHG emissions, as well as a national target to reduce absolute levels of nitrogen emissions arising from fertilizer application by 30% below 2020 levels by 2030. In contrast with some other countries who have taken a mandatory approach to fertilizer emissions reduction, this target does not represent a ban nor a mandatory reduction in fertilizer use. Canada's goal is to work in collaboration with stakeholders and partners through the use of voluntary measures and approaches that will contribute to a reduction in emissions while ensuring yields are maintained or enhanced.

Figure 1: Direct and indirect emissions from synthetic nitrogen fertilizer application, 2005 to 2020 (NIR, 2022)



Fertilizers are an essential input for Canada's agricultural crops. They have helped drive increases in Canadian crop yields over time, leading to increased grain sales and exports, record farm gate receipts, and continued profitability for many Canadian farm families. However, the application of nitrogen (N) fertilizer results in nitrous oxide (N_2O) emissions, a potent greenhouse gas with a global warming potential 265 to 298 times that of carbon dioxide (CO_2) over a 100-year period. In 2020, the agriculture sector accounted for 75% of national N_2O emissions, up from 45% in 1990 and 56% in 2005. Since 2005, nitrogen fertilizer use has increased by 89% and N_2O emissions from nitrogen fertilizer use have increased by 92% (National Inventory Report, Part 1 2022). In 2020, direct and indirect emissions associated with the use of synthetic fertilizer amounted to 11.82 megatonnes of carbon dioxide equivalents a year (Mt CO_2e/yr-1) (National Inventory Report, 2022). Applying a 30% reduction translates to 3.5 Mt CO_2e/yr-1, while stemming further increases in emissions between now and 2030 in order to meet the target.

Overview of Engagement

In March 2021, Agriculture and Agri-Food Canada (AAFC) launched a series of informal, targeted engagement sessions to seek early feedback from the agriculture sector, including commodity and grower associations, provinces, industry organizations, and agri-businesses. These sessions informed the discussion paper and plans for consultations.

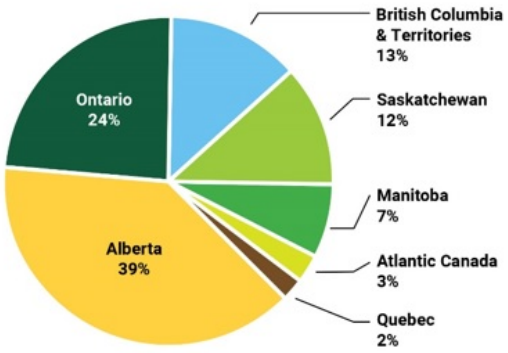
The second phase of the engagement process was launched on March 4th, 2022, with the release of a discussion paper and corresponding online survey which received 1,250 completed responses. The discussion paper shared a number of BMPs that the Government of Canada views as having high potential to reduce emissions (Annex A). The paper also asked several questions related to barriers to adoption for emissions reducing practices, ways to improve fertilizer emissions data collection, and how government can support emerging solutions and new technologies. A full list of questions asked in the discussion document can be found in Annex B.

In April 2022, a virtual town hall was held to hear directly from producers, industry representatives and stakeholders about how to work together to identify a strategy to reduce emissions. Over 120 participants attended the event, comprised primarily of industry representatives from various national and regional commodity associations, as well as agri-food retailers and fertilizer manufacturers. In September and October 2022, a series of three virtual technical workshops were hosted with close to 500 participants across all three sessions. The workshops brought together provincial governments, scientists, academia, industry experts, producers and the public to discuss issues related to nutrient management BMPs and data and measurement in further detail.

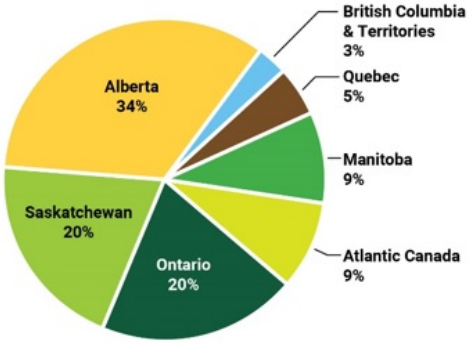
This "What We Heard" report synthesizes key messages received throughout this process and will inform the next steps needed to meet the fertilizer emissions reduction target by 2030.

Who We Heard From – Online Submissions [1]

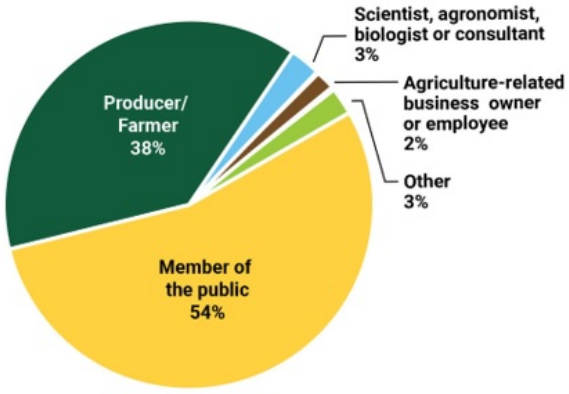
Provincial Territorial Representation of Individual Respondents



Provincial Territorial Representation of Organizations that Responded



Type of Stakeholder



Key Findings by Theme

This section presents key findings from all the fertilizer emissions reduction target engagement activities.

Beneficial Management Practices and Barriers to Adoption

One of the ways to reduce N_2O emissions on-farm is to adopt nutrient management practices to reduce nitrogen losses and increase the amount of nitrogen that can feed the crop. There are many ways to improve nutrient use efficiency, and the discussion document outlined a number of practices that, if adopted in increased numbers, could assist in reaching the target. Outlined in Annex A, these practices were identified by AAFC based on the science and research available to reduce fertilizer related emissions without compromising yield or productivity.

> Canada can raise production levels with aggressive but realistic adoption rates of 4R N management practices and substantially reduce fertilizer N_2O emissions by 1.6 $MtCO_2e$ or 14%. This substantial reduction can be realized with growth in production of key grains and oilseeds, maintenance or improvement of the crop-based economy, and reduction in carbon intensity. **Fertilizer Canada**

Available practices include the optimal timing, rate and placement of fertilizer application, and the source of nitrogen, whether it be from organic (manure) or manufactured fertilizer including fertilizer additives such as urease and nitrification inhibitors. Other promising practices include split application and diversified crop rotations. Producers can also utilize various products that contain urease inhibitors (control urea hydrolysis and ammonia loss to the air), and nitrification inhibitors (help keep nitrogen in the soil for longer by delaying the conversion of ammonium to nitrate).

What we Heard – Barriers to Adopting Beneficial Management Practices

Participants identified a number of opportunities to improve nutrient management and reduce emissions associated with fertilizer application. This includes the 4R Approach, which focuses on the "4 R's" of fertilizer application: right source, right rate, right time, and right place. Throughout all phases of engagement, there was support for the recognition and implementation of Fertilizer Canada's 4R Nutrient Stewardship Approach.

In terms of other practices that were of interest to the sector, in the technical workshops on BMPs, participants rated annual soil testing, enhanced efficiency fertilizers, and nutrient balancing/accounting as the most important currently available BMPs.

The engagement process revealed that, while many of these practices are already being used by some producers, several barriers remain for broader adoption, including:

- Large upfront costs of nitrogen management practices;
- Uncertainty around the use of new practices, including the expected impact on yields;
- Lack of commercial and lab capacity to conduct on farm soil nitrate measurements;
- Lack of recognition for progress already made;
- Insufficient data and measurement to account for future progress;
- Concerns about maintaining yield; and

- Limited perceived benefit associated with changing some management practices.

> While many farmers currently apply nitrogen at agronomic rates, the research clearly shows that the average Canadian farmer could reduce their N application rates by 10 to 30% and experience very small yield losses, or no yield loss at all. **Farmers for Climate Solutions**

One common sentiment was that adoption needs to make economic sense for the farm business. It was often noted that investments in BMPs that have environmental impacts must benefit the farmer's operation, in order to incentivize behavioural change. This feedback was often linked to concerns about maintaining yields, profits, and risks associated with adopting new nutrient management practices. Respondents indicated that the government was best placed to support adoption of BMPs by providing financial support for the new equipment and products, including precision agriculture technology and use of enhanced efficiency fertilizers. In the BMP workshop, 59% of participants advised that additional financial support for both the up-front cost of adoption and ongoing costs of implementation is needed. The subsequent discussion raised that longer-term commitments to supporting BMP adoption or leveraging industry initiatives, carbon offset schemes, or other non-governmental incentives could provide certainty on investments and serve as a more effective financial incentive for supporting adoption.

A few other discussions stood out across all phases of engagement. First, was the need to accommodate for regional variations in fertilizer use. This was tied to a desire for information about specific BMPs and how they perform in various regions of Canada – both in terms of adoption (or practicality of adoption), as well as a desire to be able to ask an expert for field or farm specific information on implementing these BMPs in their region.

Relatedly, some respondents pointed out that the availability of extension services had declined in recent years, including a lack of certified crop advisors. All of these factors likely contribute to the workshop polling results suggesting more localized data and more data availability overall would encourage BMP adoption. Respondents also indicated that producers who were already implementing BMPs, or using enhanced efficiency fertilizers may not have opportunities to further reduce their on-farm emissions. As leaders in the industry, they want recognition for their early actions and achievements.

Feedback emphasized a need to increase local engagement on nutrient management and sustainability practices. There was a strong preference for in-person, local events, field tours, demonstration days, and increased extension as methods of communicating with the sector. Many highlighted that a dedicated website or additional virtual engagement meetings would also be an effective way for the government to communicate with producers about low-emissions practices. Specific to engaging with the sector on the fertilizer emissions reduction target, responses flagged that the federal government could do better at collaborating with farm groups, industry, or provincial governments and that working through extension agents or farm advisors could also be beneficial.

In discussions around BMP adoption, many noted a desire for the recognition of the contributions already made by producers nation-wide. There was a clear desire to improve the recognition of the role that Canadian farms play not only in promoting sustainability, but in contributing to domestic and global food security.

What we Heard – Programs and Support

> The combination of savings by farmers from increased fertilizer-use efficiency coupled with targeted incentives and cost-sharing programs from governments can leave farmers better off financially even as we reduce GHG and other emissions from fertilizer use by 30 percent by 2030. Key, though, is a strong partnership with governments to help farmers deal with added costs. Alone, farmers will not succeed in reducing emissions. **National Farmers Union**

Throughout the engagement process, there was acknowledgment that continuing to foster innovation of new products and processes would be an important role for the government moving forward. The majority of feedback in this area stressed that access to government funding is a key part of reducing risk for producers, including subsidizing the purchase of equipment and enhanced efficiency fertilizers. Recommendations included increasing the funding available through existing government programs, such as: Agricultural Clean Technology Program, Agricultural Climate Solutions: On-Farm Climate Action Fund, AgriScience Clusters, and the Living Laboratories Initiative, as well as working closely with provincial/territorial partners.

At the same time, producers told us that lengthy and burdensome application processes were a deterrent to applying for federal funding. Streamlining program application processes, providing greater clarity on eligible programs, and ensuring funding is accessible to smaller farms were popular suggestions to increase efficacy of government programs. Input indicated a willingness from the sector to work with government to develop future programs to ensure their flexibility and that they were able to address regional differences and subsequent needs of producers across Canada.

Many voices highlighted that the expansion of the federal offset system to include protocols related to BMPs that reduce emissions from fertilizer application, similar to Alberta's Nitrous Oxide Emissions Reduction Protocol, would provide an effective incentive to reduce emissions.

Support for Innovation

AAFC Programming

- **$185M** 10 years **Agricultural Climate Solutions, Living Labs**.
- **$670M** 7 years **Agricultural Climate Solutions, On-Farm Climate Action Fund**: nitrogen management, rotational grazing, and cover cropping.
- **$495.7M** 7 years **Agricultural Clean Technology** program: help adopt clean technology and reduce GHGs.
- **Sustainable Canadian Agricultural Partnership** — climate change and environment as key priority areas, including a new **$250M Resilient Agricultural Landscapes Program**: cost-shared with provinces and territories to support carbon sequestration, adaptation, and environmental co-benefits. The new Partnership also includes the **$240M AgriScience Program**, to accelerate the pace of innovation by providing funding and support for precommercial science activities and research that benefits the agriculture and agrifood sector and Canadians.

Interest is growing in alternatives to traditional fertilizers, and there are a number of existing and emerging technologies that could help Canadian producers reduce emissions from fertilizer application. This includes enhanced efficiency and slow release fertilizers, wastewater/nutrient recycling systems, as well as more recent innovations like bio-fertilizers that are based on plant probiotics and other microbial inputs that improve crop growth and soil health.

Government programs support fertilizer-related projects along the innovation continuum – from research and testing, to the adoption of currently available technologies and beneficial nitrogen management practices. Given this broader context, the discussion document asked respondents, "What is the best way for governments and industry to support the emergence of new and innovative solutions to address climate goals, such as emissions reductions?"

What We Heard - Innovation

Much of the feedback received on innovation centered around the need for government to provide incentives for technology development, research funding, and potential collaboration between government, academia and producers. Input requested more support for solutions such as digital agriculture, variable rate technology, enhanced efficiency fertilizers, nitrogen fixing microbes, urease and nitrogen inhibiting fertilizer additives and the development of different plant or seed varieties that require less nitrogen fertilizer. Input also noted that a lack of access to reliable internet is a barrier to adopting new or existing technology.

In the technical workshop dedicated to BMPs and novel technologies, there was an in-depth discussion about how the development of novel or emerging practices and technologies could be best supported. Well over half (59%) of the workshop participants indicated that additional research funding, technology development incentives, and research collaborations were necessary for developing new practices or technologies in Canada. Comments included support for private industry research, university research, and more public research efforts from AAFC.

Related to this, many participants stressed that farmers should be directly involved in research efforts and

that field demonstrations of developing technologies were extremely important. Farmers have intricate working knowledge of the landscape and what management changes are realistic for them to implement. In the subsequent discussion, some panelists suggested that universities or research institutes could help with engaging farmers in the research process more fully. There was significant interest in on-farm demonstrations of new technology and practices, linked to concern about the risk of adoption of innovative solutions and ensuring their ability to reduce emissions without reducing yield.

Feedback also included a smaller role for government and instead allowing the market to pick winners amongst new technologies.

Data and Research

Measuring emissions from agriculture is complex. One theme raised during the consultations reflected frustration in the sector that the current available science does not allow for more precise emissions estimates at the farm, regional and national levels. Residual soil nitrogen, nitrogen not used by the crop, is the main source for fertilizer emissions and is impacted by a wide range of factors including soil moisture, temperature and oxygen levels (among others). Matching fertilizer application to crop needs can reduce residual nitrogen and emissions.

Canada's approach to estimating GHG emissions, including from agriculture, follows the Intergovernmental Panel on Climate Change's (IPCC) methodology to which all signatory countries have agreed. While it is the best available internationally-adopted model for estimating emissions, it does not capture regional and crop-level detail to account for varying emissions considerations across Canada. [2]

The lack of available data associated with farm management practices poses a significant challenge for agricultural emissions as data availability depends on field research, benchmark sites to validate models, and quality and access to external data sources. Recognizing the challenges, the discussion document asked the public how data emissions from fertilizer application could be more comprehensively collected, analyzed, and reported, how the government can effectively partner with industry, and how to minimize reporting burden for producers. During the data and measurement workshop participants discussed how to better collect, analyze and report fertilizer emissions data, especially on the farm. We also asked for ideas for effective partnerships between government and industry to collect and share data.

What we Heard

During early phases of consultation, participants frequently raised issues related to data collection and reporting, as well as how emissions reductions will be measured. Many stressed that gaps exist in the measurement and reporting of fertilizer-related emissions, including in the NIR methodology, and that publicly available, high-quality data on fertilizer use are not always widely available. In particular, there was concern that the current NIR methodology does not fully account for emission reductions already achieved. This is due in part to the current methodology's approach to measurement of emissions, and challenges with obtaining and measuring data at the individual farm level and lack of information about the nutrient management practices currently being used. Some feedback indicated frustration with the setting of a national target while there remained questions and room for improvement on data and measurement.

Throughout the public town hall and technical workshops, it was emphasized that there is a need to

enhance the measurement of GHG emissions from fertilizer application. This includes developing an accurate baseline of GHG emissions that will account for BMPs currently in place. Input also highlighted a desire to minimize the reporting burden for any data collection and measurement initiatives, particularly by exploring the use of existing mechanisms such as the Farm Management Survey or Crop Insurance, for more detailed data. In the technical workshop dedicated to data, the most prevalent theme in questions from the audience was how to improve collaboration and ensure that data collected by other government departments, industry, and even farmers could be utilized moving forward.

> For any of the nitrogen management approaches described in AAFC's document to have any impact on the industry or on our international reporting there needs to be a means of reflecting nitrogen management in our National Inventory Report. Improved activity data on Canada's agricultural lands being managed would not only allow our efforts to improve nitrogen management to be captured it would also support broader tools such as AAFC's Agri-Environmental Indicators to reflect the current state of our land resources and the sustainability of their management. This should be one of the highest priorities for AAFC and Environment and Climate Change Canada. **Dr. David Burton, Dalhousie Centre for Sustainable Soil Management**

Other themes raised, particularly in the technical workshop dedicated to data, include: concern about the timeframe of the target given the need to collect new data and establish the science behind some management practices, some of the methodological assumptions behind the target, and recognition of the variation in emissions for management practices in different regions. Underlying all of these discussions was a desire for more communication from the federal government about the target, and specifically a desire for better understanding of the data and measurement used to arrive at the target and how it will be improved moving forward. Some respondents suggested that the target should be set once the methodology for data collection and measurement were improved.

> To accurately promote and measure farmers' progress towards the targets laid out in A Healthy Environment and A Healthy Economy, we strongly recommend investment in research and data collection to develop and refine emission factors (EFs) specific to major growing regions and practices to accommodate the non-linear nature of nitrous oxide response to changes in fertilizer input. **Nature United**

Participants highlighted that transparency and data privacy are of the utmost importance. Respondents expressed a strong desire to have clarity on exactly what their data would be used for, now and into the future, and to take enhanced measures to ensure the privacy of producers and their data. Some respondents also indicated that producers who provide data should be compensated for the time and labour required in the reporting process.

Engagement

What we Heard

Feedback indicated that respondents see value in the agriculture sector being actively engaged in sustainability efforts moving forward. Responses in this area included support for a joint government-industry working group to improve timely communication, collaboration, and engage producers on a path forward to reducing emissions.

> Nitrogen is second only to moisture in importance for the productivity and yield of canola. It will be critical that AAFC's final advice and recommendations do not in any way hinder farmers' ability to maintain and increase yields or their profitability. **Canola Council of Canada/Canadian Canola Growers Association**

Communication

What we Heard

All phases of engagement highlighted requests for more communication from the federal government about the target itself, particularly around a few themes: how the target was set, what data will be used to calculate the target, and the methodology behind those calculations. Input expressed a desire to see data and rationale for the implementation of the target, as well as a clearer understanding of what a voluntary approach would entail. When it comes to a path forward on the target, there was a strong desire for clear communication of recommended BMP's with data to support any claims or suggestions. Underlying all concerns about communication was a strong desire for greater transparency from the government when it comes to both the development of the target and a strategy to achieve it.

Concerns noted throughout engagement included a lack of coordination between levels of government, and many suggested that coordination could be improved between the federal government, provinces, territories, and other government departments.

Next Steps

The consultation process has provided important advice on possible actions and opportunities to support progress toward the national fertilizer emissions reduction target. Governments, industry, producers, and the public will need to work together to build on the positive progress already taking place across the country. Reaching the emissions target is ambitious but achievable, and maximizing nitrogen fertilizer efficiency can be beneficial to both farmers and the environment. With only eight growing seasons left until 2030, actions are already underway to support producers in nutrient management and the consultation will help build on this progress.

Annex A: Nitrogen Management BMPs

Table 1: Near term (by 2030) implementation of BMPs to reduce N_2O emissions from fertilizer application in Canada

	BMP	Regional Applicability	Current adoption level	Potential new area (Mha)	Potential emissions reduction	Total emissions reduction based on 100 % adoption (Mt CO_2e/yr)	Confidence level	Feasibility of adoption
Rate	Soil N test annual for spring fertilizer application	All regions	low	5.7	5-15%	0.23	high	medium / high
	Accounting for N in previous legume crop	All regions	medium / high	4.9	10-20%	0.63	medium	high
Time	Applying N in the spring compared to the fall	Mainly west	high	3.3	5-15%	0.12	medium	high
	Fertigation (injection of fertilizers with irrigation)	Mainly west	low	0.3	15-25%	0.02	medium	medium
	Split application / sidedress with rate adjustment based on sensors	Mainly east	medium	1.9	15-35%	0.65	high	medium
Placement	Apply in bands/injection accompanied by reduced rate	All regions	high - west medium - east	3.0	5-15%	0.24	high	medium / high
Source	Enhanced efficiency fertilizers, inhibitors or slow release	All regions	very low	18.1	15-35%	2.35	high	medium

	BMP	Regional Applicability	Current adoption level	Potential new area (Mha)	Potential emissions reduction	Total emissions reduction based on 100 % adoption (Mt CO_2e/yr)	Confidence level	Feasibility of adoption
	Replace inorganic fertilizer with manures, compost or digestate	All regions	low	1.4	10-20%	0.15	medium	high
Conservation management	Conservation tillage	All regions	high-west medium-east	1.6	5-15%	0.15	medium	high
	Improved drainage design	Mainly east	medium / high - east	0.6	10-30%	0.13	low	medium
Other	Increasing legumes in rotations	Mainly west	low	1.5	15-25%	0.1	medium	low / medium

Annex B: Questions from Discussion Paper

Issue 1: Developing a Strategic Approach to meeting the Fertilizer Emissions Target

- What are the biggest barriers to the adoption of practices that reduce emissions from fertilizer application and how can these best be overcome?
- What steps can be taken to increase adoption of practices or the use of new, enhanced efficiency fertilizer products that hold the potential to reduce emissions from fertilizer application?
- In addition to existing programs, how can governments best work with industry and producers to mobilize increased adoption of emissions-reducing practices? What are the appropriate roles for the agriculture sector, governments and other partners and stakeholders in meeting this target?

Issue 2: Data, Reporting, and Measurement

- How can important data on the changes in emissions from fertilizer application be more consistently and comprehensively collected, analyzed and reported?
- What would be the most effective way for Government and industry to work in partnership to collect and make public detailed fertilizer use and 4R-related data to better understand areas where there has been success, or opportunities for improvement?
- What considerations need to be taken into account to ensure better and more accurate reporting of farm-level data while minimizing the reporting burden at the individual farm level?

Issue 3: Innovation and Transformation Opportunities

- What is the best way for governments and industry to support the emergence of new and innovative solutions to address climate goals, such as emissions reductions?
- Are there opportunities not listed in this discussion document that you think should be considered as potential pathways for achieving the emissions reduction target for both 2030 and 2050?

Footnotes

1 Figures have been rounded for simplicity. The number of respondents in the following provinces and territories were less than 1%: P.E.I.: 0.48%, NL: 0.24%, Yukon: 0.16%, Nunavut: 0.08%.

2 The model used to estimate emissions from synthetic fertilizer cannot take into the complexity of residual nitrogen as described above because the data simply does not exist and the extreme variability of Canada's agricultural landscape. Instead, the model starts with recommended fertilizer rates for specific crop types, soil types, and location. This approach recognizes, for example, different crops in different regions will have different fertilizer requirements. This initial fertilizer application rate estimate is then proportionally adjusted using Statistics Canada's Fertilizer Shipments Survey. Canada's country specific method then "converts" this information into estimated N20 emissions at subnational levels, taking into account precipitation, tillage and irrigation practices, soil texture and crop type.

What We Heard Report - Fertilizer Emissions Reduction

Agriculture and Agri-Food Canada

Paru également en français sous le titre Rapport « Ce que nous avons entendu » - Réduction des émissions attribuables aux engrais

For more information reach us at agriculture.canada.ca or call us toll-free 1-855-773-0241

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