FARMERS FOR CLIMATE SOLUTIONS

Derek Axten and his daughter Kate
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Rooted in Climate Action

An ambitious roadmap for emissions reduction and resilience in the next Agricultural Policy Framework

APF Task Force Summary Report

June 2022

In November, 2021, federal, provincial and territorial ministers of agriculture issued the Guelph Statement outlining the high-level priorities of the next Agricultural Policy Framework (APF), which will guide public policy and spending in Canadian agriculture for the next five years. The ministers identified " Tackling climate change and environmental protection to support GHG emission reductions and the long-term vitality of the sector…" as the number one priority for the next APF.

Farmers for Climate Solutions (FCS) is a national coalition of farmer-led and farmer-supporting organizations that believes agriculture must be part of the solution to climate change. Together our member organizations represent over 20,000 Canadian farmers and ranchers in every province and all production systems. FCS is in a unique position to offer realistic, farmer-centred recommendations to help Canadian governments achieve their climate change mitigation goals.

To this end, Farmers for Climate Solutions assembled a task force of farmers, researchers, economists and policy experts to examine how the next Agricultural Policy Framework (APF) could accelerate climate action in Canadian agriculture. This task force sought to identify beneficial management practices that can reduce greenhouse gas (GHG) emissions, increase carbon storage and increase resilience on Canadian farms, and to suggest policies and programs that will encourage the rapid adoption of these practices. This work complements the findings of FCS's Business Risk Management Task Force, which completed its work in March 2022.

The APF Task Force had the following specific objectives:

- Identify a sector-wide target for GHG emissions reduction by the end of the next APF period in 2028.
- Identify practical and proven beneficial management practices (BMPs) that reduce GHG emissions or increase carbon storage on Canadian farms in order to meet that target.
- Quantify the GHG mitigation potential of each BMP.
- Determine the cost to farmers and governments to incentivize the adoption of these BMPs.
- Identify the policies and programs necessary to induce widespread BMP adoption across Canada.

This report summarizes the major findings and recommendations of the APF Task Force, and draws on data and analysis contained in three associated technical reports. The FCS Emissions Report includes emissions mitigation potential and evidence for each of the BMPs. The FCS Economics Report describes the farm-level costs and benefits of each BMP, proposes targets for BMP adoption, models the cost to induce BMP adoption, and calculates the mitigation cost per tonne of CO_2 equivalent (CO_2e). The FCS Policy and Programs Report examines climate and agriculture policies and programs in other jurisdictions, describes

equity and inclusion considerations, and recommends program delivery models to encourage BMP adoption at scale in Canada.

The task force identified 19 beneficial management practices that have the potential to reduce GHG emissions, increase carbon sequestration, and increase resilience on Canadian farms. All of these BMPs are proven practices that are already in use in Canada, and all are supported by peer-reviewed studies or survey data that quantify GHG mitigation potential. **Together, these BMPs have the potential to reduce GHG emissions from Canadian farms by 10 million tonnes of CO_2 equivalent per year by the end of the next APF in 2028. This represents a 14% reduction from current levels**. The recommended BMPs also have the potential to sequester an additional 6.2 Mt CO_2e per year by 2030, for total mitigation of approximately 16.2 Mt CO_2e per year. This mitigation potential is in addition to the projected mitigation from the current phase of the On-Farm Climate Action Fund (OFCAF). This level of mitigation will require rapid and widespread adoption of the identified BMPs, which will require substantial investment by governments and farmers.

14% REDUCTION IN ABSOLUTE AGRICULTURAL EMISSIONS BY 2028

Absolute emissions reduction:
10,000,000 tonnes CO2e

Carbon sequestration:
6,200,000 tonnes CO2e

Total mitigation:
16,200,000 tonnes CO2e

Mitigation cost:
$40/tonne CO2e

Total Cost:
$2.1 billion

Incentivizing the adoption of the BMPs identified in this report will require annual government investment of approximately $642 million in 2028. Because spending is projected to ramp up over the next five years, the average annual expenditure over the life of the next APF will be $414 million per year, for a total of $2.1 billion during the five-year APF period. These expenditures do not include the cost of program administration and delivery. Federal, provincial and territorial governments must invest in capacity to manage, administer and coordinate the large and complex programs necessary to deliver these emission reduction benefits.

The cost per tonne of mitigation for the BMPs examined in this report is extremely competitive when compared to the government's pollution price and measures in other sectors. Average mitigation cost across all 19 BMPs is approximately $40/tonne CO_2e in 2028, compared to the government's minimum carbon price of $170/tonne in 2030.

The government of Canada has set a target of 30% reduction in emissions associated with nitrogen fertilizer by 2030. It is important to note that the nitrogen fertilizer BMPs proposed in this report would achieve a 33% reduction in nitrogen fertilizer emissions.

The list of BMPs included in this report is not exhaustive. Other opportunities exist for additional GHG mitigation in Canadian agriculture. The task force did not consider BMPs related to on-farm fuel use, an area that produces substantial emissions.

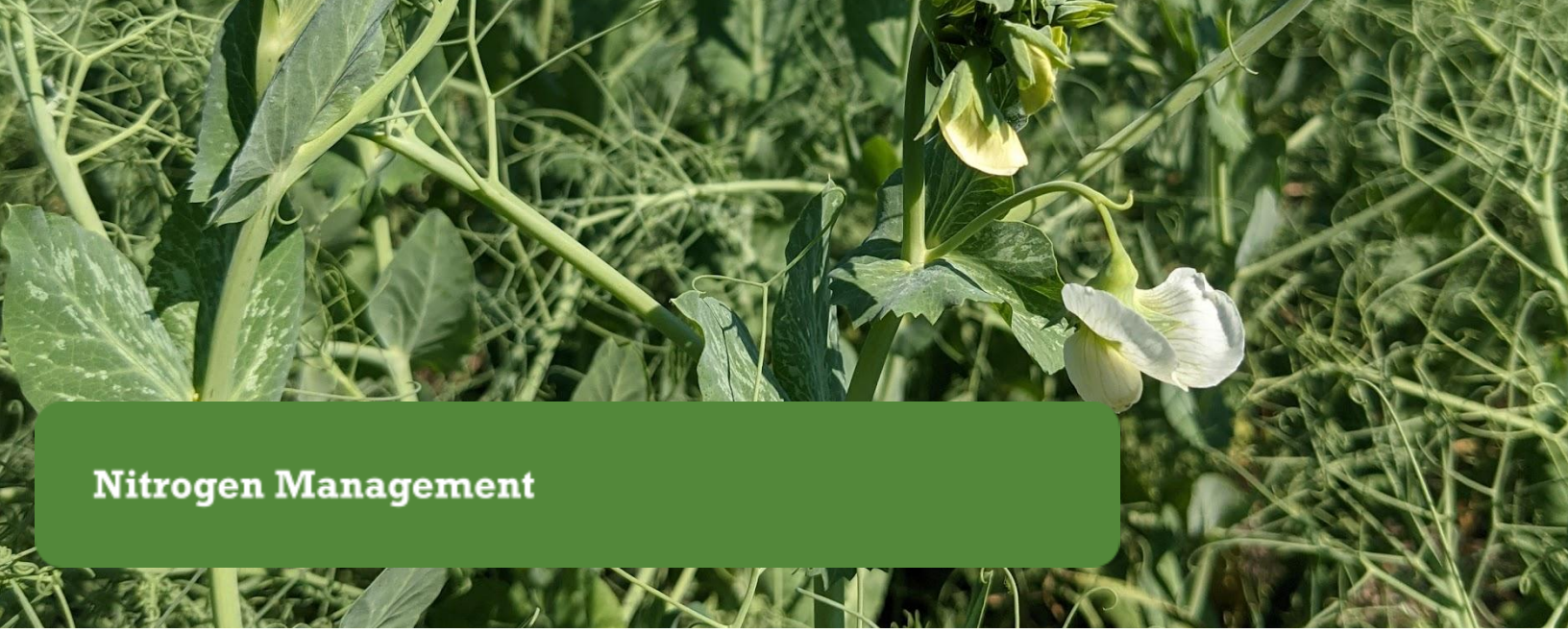
Practice	GHG Mitigation (Mt CO_2e in 2028)	Average Abatement Cost ($/tonne CO_2e in 2028)	Total cost ($/year in 2028)
Nitrogen Management • Quantitative determination of right rate • Precision nitrogen management • Enhanced efficiency nitrogen fertilizer • Elimination of fall nitrogen application • 4R management of manure • Improved crediting of organic N sources	3.8	$47	$180 million
Manure Storage and Handling • Synthetic impermeable floating covers • Acidification of liquid manure	2.4	$14	$34 million
Livestock Management • Increased legumes in pasture • Rotational grazing • Extended grazing period	4.3	$7	$32 million
Soil Management • Cover cropping • Intercropping	4.3	$80	$341 million
Wetland and Tree Management • Avoided conversion of wetlands* • Wetland restoration • Alley cropping • Silvopasture • Planting riparian trees • Avoided conversion of shelterbelts	1.4	$39	$56 million
TOTAL	**16.2**	**$40**	**$642 million**

** The program design considerations for this BMP are complex, and we have a lower level of confidence in the emissions mitigation potential of this proposal than the others.*

Beneficial Management Practices

The APF Task Force identified 19 BMPs across five categories that are practical, implementable and proven to provide cost-effective GHG mitigation. The following section summarizes the findings detailed in the emissions, economics and programs reports for each BMP.

GHG research on a PEI potato farm. Photo: David Burton



Nitrogen Management

Field peas at Faspa Farm in Manitou, MB

Direct greenhouse gas emissions from the use of nitrogen fertilizer represent approximately 14% of all emissions from Canadian agriculture, and are the fastest growing source of emissions. The government of Canada has set a target of a 30% absolute reduction in emissions from nitrogen fertilizer by 2030. Supporting the adoption of the four BMPs related to synthetic nitrogen fertilizer management recommended in this report would result in a 3.5 Mt absolute reduction in nitrogen-related emissions in 2030, 33% below current levels. Additional reductions can be achieved through better management of organic sources of nitrogen, especially manure.

While each of the BMPs described below has emissions reduction benefits, producers will be best supported though a systemic approach that emphasises the importance of better farm-level nitrogen management. We recommend a cost-share program to support producers to work with an agrologist (PAg), certified crop advisor (CCA), or farmer mentor to create a nitrogen management plan that includes as many BMPs as appropriate to their operation. The emissions reduction and economic benefits of all of the recommended BMPs come primarily from the opportunity they provide to reduce the rate of N application without sacrificing yield. Any nitrogen management plan should therefore have rate reduction as a primary goal.

1. Quantitative determination of right rate

Synthetic nitrogen fertilizer is often over-applied on Canadian farms, which leads to nitrogen losses in the form of nitrous oxide. 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

GHG mitigation potential:
1,100,000 tonnes CO2e

Average Abatement Cost:
$66/tonne CO2e

Total cost:
$74,000,000/year

very small yield losses, or no yield loss at all. Nitrogen application rates should be determined by calculating N requirements on a field-by-field basis, using historic yield data (rather than yield targets), utilizing soil tests, and properly accounting for non-fertilizer N sources, such as manure and legumes. Farmers should be encouraged to develop profit-maximizing N prescriptions, rather than yield-maximizing prescriptions.

The cost of adopting this BMP is highly dependent on the price of N fertilizer. In the current environment of very high N prices, most farmers will experience positive net returns from reducing their N rate.

Program recommendations: Because this BMP provides net positive financial returns to most producers, programming should focus on agronomic support, with subsidized soil testing. Quantitative determination of right rate should be a core component of the suggested cost-share incentive to produce a nitrogen management plan with a PAg, CCA or farmer mentor.

2. Precision nitrogen management

GHG mitigation potential:
400,000 tonnes CO2e

Average Abatement Cost:
$44/tonne CO2e

Total cost:
$16,000,000/year

Variable rate nitrogen application uses precision technology to map yield potential within fields and to apply N at appropriate rates to maximize yield and minimize losses. Variable rate technology can reduce N application rates and nitrous oxide emissions. Variable rate application can be technology-intensive, requiring detailed N prescription maps, variable rate equipment and GPS-enabled yield monitors. Most new seeding and fertilizer application equipment has the ability to perform variable rate application, but current adoption rates are relatively low due to the high up-front costs of creating nutrient prescription maps. Variable rate benefits can also be realized from less technical approaches, such as identifying N management zones within fields and applying N at the same rate within each zone.

Most farmers will experience positive net returns from adopting variable rate N application due to overall rate reduction and improved yields, but up-front costs are a deterrent.

Program recommendations: Precision nitrogen management can be seen as a more advanced form of quantitative determination of right rate, and should be included in nitrogen management plans for producers who have the necessary equipment and desire to

implement. The creation of N prescription maps and necessary software upgrades for existing equipment should be eligible for cost-share support.

3. Enhanced efficiency nitrogen fertilizer

GHG mitigation potential:
1,800,000 tonnes CO2e

Average Abatement Cost:
$46/tonne CO2e

Total cost:
$86,000,000/year

Enhanced efficiency fertilizers (EEFs) use nitrification inhibitors, urease inhibitors, or controlled release agents, or a combination of treatments. EEFs result in consistent and substantial reductions in nitrous oxide emissions, but are more expensive. Current adoption rates are very low due to lack of availability of EEFs on the market and higher prices. The emissions reductions and costs outlined here are based on an adoption rate of 25% in 2028 for Prairie wheat, a 40% adoption rate for Prairie canola and 40% adoption for corn in the rest of Canada (ROC). It is important to note that some EEFs use plastic coatings on fertilizer granules to slow release. The government should mandate the use of biodegradable coatings to prevent microplastic contamination of farmland.

High nitrogen prices reduce the price differential of EEFs, and EEFs can be applied at lower rates than non-treated nitrogen due to their increased efficiency, but using EEFs still results in higher net expenses for producers.

Program recommendations: Because the use of EEFs is costly for producers, we recommend a rebate program. Access to rebates should be conditional on the creation of a nitrogen management plan.

4. Elimination of fall nitrogen application

GHG mitigation potential:
200,000 tonnes CO2e

Average Abatement Cost:
$8/tonne CO2e

Total cost:
$2,000,000/year

Some producers apply nitrogen fertilizer in the fall, primarily as a time-saving measure to reduce operations in the busy spring period. Fall application can lead to substantial N losses and high nitrous oxide emissions, but it is a relatively common practice, especially on the Prairies. Survey data indicate that 23% of Prairie canola growers said they applied nitrogen in the fall in 2018.

The cost of applying N is the same in the spring and the fall, but fertilizer is often less expensive in the fall, and some farmers lack capacity to store fertilizer over the winter.

Program recommendations: It is difficult to design a program to incentivize spring application of N, so we recommend that regulations be adopted to prohibit the fall application of nitrogen fertilizer. Producers who currently apply N in the fall and who complete a nitrogen management plan should be eligible for cost-share support to increase fertilizer storage capacity.

5. 4R management of manure

GHG mitigation potential:
80,000 tonnes CO2e

Average Abatement Cost:
$4/tonne CO2e

Total cost:
$300,000/year

Attention to placement, timing and rate of manure application can result in improved nitrogen retention, much like synthetic N fertilizer. Properly crediting the N supplied by manure and a corresponding reduction in synthetic N application rates is key to reducing overall nitrous oxide emissions. Regular testing of manure is necessary to determine and accurately credit N content. Liquid manure should be injected to maximize N retention, and should be applied in the spring to minimize overwinter nitrous oxide emissions. Where lack of storage capacity makes fall application necessary, liquid manure application should be delayed until soil temperature drops below 5℃, or nitrification inhibitors should be added to the manure. Solid manure should be incorporated into the soil as soon as possible after application.

Most farmers will experience positive net benefits from adopting 4R management practices for manure, with some up-front costs.

Program recommendations: Producers who develop a nitrogen management plan should be eligible for cost-share support for manure testing and the addition of nitrification inhibitors to liquid manure.

6. Improved crediting of organic nitrogen sources

Survey data indicate that few Canadian farmers test manure for N content on a regular basis, with most relying on "book values" to credit N content, or not crediting manure N at all. Similarly, few producers adjust their synthetic nitrogen application rates to account for N provided by preceding legume crops. Cost-share support to complete a nitrogen

management plan with a PAg, CCA or farmer mentor would help farmers to accurately credit N from organic sources and reduce their rates to synthetic N application.

Any opportunity to reduce synthetic N application rates without impacting yield will have a positive net benefit for farmers, especially with high nitrogen prices.

Program recommendations: Producers who complete a nitrogen management plan should be given access to cost-share support for regular soil and manure testing.

GHG mitigation potential:
200,000 tonnes CO2e

Average Abatement Cost:
$11/tonne CO2e

Total cost:
$2,000,000/year

Manure Storage and Handling

Linnaea Farm in Mansons Landing, BC

The management of manure offers extremely cost-effective opportunities for emissions reduction. The two BMPs described below are so effective at reducing emissions from liquid manure systems that we recommend a subsidy program to cover the cost for every producer of liquid manure to adopt one or the other during the next APF period. Such a program would result in over 2.2 Mt CO_2e of avoided emissions by 2028.

The task force studied several BMPs to reduce emissions from solid manure systems, with composting being the most promising, but difficulties in designing incentive programs and the relatively small emission reduction gains that would be realized led us to recommend liquid manure BMPs only.

7. Synthetic impermeable floating covers

Covering liquid manure tanks has long been recommended to mitigate odours and reduce ammonia loss. Inexpensive floating plastic covers can also be extremely effective at capturing methane and reducing nitrous oxide emissions. Captured gas can be treated using gas-phase biofilters, flared, or burned to create heat or electricity. The installation and use of floating covers is costly for farmers and produces little private economic benefit.

GHG mitigation potential:
900,000 tonnes CO2e

Average Abatement Cost:
$13/tonne CO2e

Total cost:
$7,000,000/year

Program recommendations: We recommend a rebate program to cover the full cost of purchasing and installing synthetic floating covers, including infrastructure for gas collection.

8. Acidification of liquid manure

GHG mitigation potential:
1,300,000 tonnes CO2e

Average Abatement Cost:
$20/tonne CO2e

Total cost:
$27,000,000/year

Acidification of manure slurry with concentrated sulfuric acid dramatically reduces GHG emissions and is common practice in some European countries. Lowering the pH of liquid manure inhibits the formation of ammonia and makes the environment less favorable for microbes that produce methane. A recent meta-analysis of the acidification of dairy and swine manure showed that acidification reduces methane emissions by 86%, nitrous oxide emissions by 21% and ammonia emissions by 77%. Acidification retains more nitrogen in the manure, making the acidified slurry a more valuable soil amendment, but this practice is a net cost to producers. The main cost is the sulfuric acid, however, recent studies indicate that most benefits of this practice can be retained with smaller amounts of acid.

Floating impermeable covers and acidification are not additive practices: producers should be encouraged to adopt one or the other.

Program recommendations: Producers should receive a rebate for the full cost of acidification, including the necessary storage and delivery infrastructure for the acid, training, and the ongoing cost of sulfuric acid.

Livestock Management

Grazing cattle at Local Valley Beef in Fredericton, NB

Ruminant livestock – such as cattle, sheep and goats – have microbes in their guts that produce methane. The emissions that come from the mouths of ruminant livestock are known as enteric methane, and are the largest single source of emissions in Canadian agriculture, with cattle accounting for the very large majority of enteric emissions. Improving diet quality can directly reduce enteric emissions, and can also lead to faster growth, better animal health and better reproductive success, all of which lower the emissions intensity of the animal products produced. Improved grazing practices can increase soil carbon sequestration, which reduces atmospheric carbon and provides numerous soil health benefits. The emissions reduction opportunities described in this section are extremely cost-effective.

The BMPs in this section can be "stacked", meaning that the benefits of each BMP are additive. While most BMPs related to enteric methane can reduce emissions by 5 to 10%, adopting several BMPs simultaneously can increase emissions reductions. These recommended BMPs also lead to overall improvements in animal health and reproductive success, which can allow producers to operate with fewer breeding replacement animals and decrease the time to market of their animals, thus reducing the overall enteric emissions of their herd.

9. Increased legumes in pasture

Introducing legumes such as alfalfa, sainfoin, clover and birdsfoot trefoil into grass-only forage stands at rates between 20 and 30% can improve forage quality, increase digestibility and reduce enteric methane emissions in the range of 10%. Legumes also fix atmospheric nitrogen, reducing the need for synthetic nitrogen fertilizer on pasture and reducing nitrous oxide emissions.

GHG mitigation potential:
1,100,000 tonnes CO2e

Average Abatement Cost:
$1/tonne CO2e

Total cost:
$800,000/year

The inclusion of legumes in tame pastures is a common practice in Canada, and topography and soil type make seeding legumes in some pastures very challenging, so the potential for increased adoption of this practice is somewhat limited. However, the mitigation cost is extremely low and the co-benefits should make this an attractive BMP for many producers. Maintaining legumes in forage stands requires ongoing expense and effort.

Program recommendations: We recommend a cost-share program for the cost of legume seed.

10. Rotational grazing

GHG mitigation potential:
2,500,000 tonnes CO2e

Average Abatement Cost:
$5/tonne CO2e

Total cost:
$7,600,000/year

Rotational grazing describes a range of practices that include increasing stocking densities, decreasing the amount of time animals are allowed to graze in a given paddock, and increasing the interval between grazing events. This is in contrast to continuous grazing, where animals are grazed at low densities in the same paddock for months, or even the entire grazing season. Basic rotational grazing might involve dividing the range into three paddocks and moving animals once a month. More advanced systems often utilize temporary electric fences to create small paddocks where animals are allowed to graze for a day or less at very high densities before being moved to new grass, with pasture allowed to recover for an extended period before being grazed again.

Rotation grazing improves the quality of forage over time which can reduce enteric methane emissions by over 10% when compared to continuous grazing, and increases rates of soil carbon sequestration. Rotational grazing also has co-benefits, such as increased stocking rates, improved animal health, reduced parasite loads, and increased biodiversity. These benefits lead to net economic gains for most producers, but high up-front infrastructure costs and increased labour requirements make adoption difficult for many.

Program recommendations: Rotational grazing is one of the BMPs being promoted by the On-Farm Climate Action Fund (OFCAF) through a cost share program that supports the creation of a grazing management plan and infrastructure costs such as fencing and water. This cost-share support should be expanded and continued through the next APF period.

11. Extended grazing period

Keeping grazing animals on pasture for a longer portion of the year has economic and environmental benefits. Strategies include swath grazing, bale grazing, grazing animals in the spring or fall, standing corn grazing and cereal residue grazing. Most extended grazing strategies have been shown to reduce enteric methane emissions, and can also reduce emissions from stored manure because more manure is deposited on pasture, rather than in confinement.
Co-benefits include improved pasture quality, less handling of manure, and lower labour requirements than feeding and managing animals in confinement.

GHG mitigation potential:
600,000 tonnes CO2e

Average Abatement Cost:
$36/tonne CO2e

Total cost:
$23,000,000/year

Extending the grazing period will have positive economic benefits for most producers, but up-front infrastructure costs (especially water) can be a deterrent to adoption.

Program recommendations: Extended grazing should be eligible for similar cost-share support to rotational grazing under OFCAF. Producers should have access to cost-share payments for planning and infrastructure. Extended grazing and rotational grazing are complementary practices and emissions benefits are additive, so increased support should be offered to producers who employ both.

Soil Management

Seeding winter cover crops of oats, rye, and radish at Axten Family Farms in Minton, SK

Beneficial management practices for better soil management mitigate climate change by reducing the need for synthetic nitrogen fertilizer and increasing soil carbon sequestration. While FCS believes that emissions reduction should be prioritized over carbon storage, practices that draw carbon out of the atmosphere and increase soil organic matter are a vital tool to increase resilience and adapt to our changing climate, and provide numerous co-benefits to farmers.

12. Cover cropping

A cover crop is any crop that is grown to provide fertility or increase soil health, rather than for harvest. Cover crops are usually grown at times when cash crops are not being produced, such as after harvest or during a fallow period. Cover crops can "catch" excess nitrogen in the soil that would otherwise be lost as nitrous oxide, and can decrease the need for synthetic nitrogen when they include legumes. They also increase soil carbon sequestration and provide numerous co-benefits, such as erosion control, increased moisture retention, improved soil structure and increased biodiversity.

GHG mitigation potential:
2,700,000 tonnes CO2e

Average Abatement Cost:
$81/tonne CO2e

Total cost:
$216,000,000/year

Cover cropping on the Canadian Prairies presents several challenges, including a short growing season and low soil moisture levels in the fall when post-harvest cover crops are usually sown. The task force targeted lower adoption levels on the Prairies than in the rest of Canada due to these constraints.

Cover crops provide net economic benefits to farmers, but these benefits usually accrue only after several years of continuous practice. The cost of seed, planting and termination make cover-cropping a costly practice for the first three to five years of adoption until the private benefits to the farmer begin to be realized, but public benefits, such as reduced GHG emissions and increased carbon sequestration, begin right away.

Program recommendations: Cover cropping is another BMP being promoted under OFCAF through a per-acre payment for new adoption. This support should be expanded and continued.

13. Intercropping

Intercropping is the practice of growing more than one crop in the same field at the same time, and usually involves growing a legume or pulse with a cereal. The two crops are separated after harvest. Intercropping can decrease the need for synthetic nitrogen fertilizer and increase soil carbon sequestration. Current adoption levels are low, but farmers and researchers have improved the practice in recent years and interest from new adopters has risen.

GHG mitigation potential:
1,600,000 tonnes CO2e

Average Abatement Cost:
$78/tonne CO2e

Total cost:
$125,000,000/year

Intercropping can deliver positive benefits to producers because symbiotic effects between the two crops can mean total yield is higher than growing the two crops in separate fields. Producers may require special equipment for grain separation and storage after harvest, and the somewhat experimental nature of the practice makes some producers hesitant to adopt.

Program recommendations: Intercropping should be incentivized by per-acre payments, similar to cover cropping under OFCAF. Cost share support could also be offered for equipment purchase.

Wetland and Tree Management

Working around a prairie pothole at McCreary Land & Livestock Ltd. in Bladworth, SK

Wetlands and trees on agricultural landscapes are valuable carbon sinks and provide numerous ecological benefits. The destruction of wetlands and trees and their conversion to cropland is ongoing and results in estimated GHG emissions of over 1.2 Mt CO_2e every year. Canada's National Inventory Report, however, does not capture these emissions.

The BMPs described in this section reduce emissions and increase carbon sequestration. Avoided conversion of wetlands and shelterbelts can result in very significant emissions reduction, while wetland restoration and increasing trees on agricultural lands can store large amounts of carbon.

14. Avoided conversion of wetlands

It is estimated that approximately 15,000 ha of wetlands are converted to crop production every year in Canada, resulting in almost 1.2 million tonnes of GHG emissions. When a wetland is drained and ploughed under, the carbon stored in above-ground biomass and in the soil is released in the form of carbon dioxide over a period of years or decades. Rates of wetland loss are highest on the Prairies, but loss is occurring in all agricultural regions. Anecdotal evidence suggests that the rate of wetland conversion has increased in recent years due to high commodity prices and exceptionally dry weather in some areas that has facilitated clearing and cultivation of wetlands.

GHG mitigation potential:
975,000 tonnes CO2e

Average Abatement Cost:
$77/tonne CO2e

Total cost:
$45,000,000/year

Draining and preparing wetlands for cultivation can be costly, but the net economic returns of conversion are driving destruction across the country. Producers benefit from decreased overlap and more efficient operation of machinery when small wetlands are removed, and high commodity prices encourage farmers to increase their seeded acres. Opportunity cost is therefore the biggest cost of wetland preservation.

Preventing wetland destruction is an urgent priority, but designing programs to protect vulnerable wetlands is difficult. Many wetlands will never be converted due to topography or other factors that would make drainage impractical or extremely expensive. Identifying and protecting only those wetlands that are most at risk of conversion is a challenge. An incentive program to maintain wetlands might waste money on wetlands that were never at risk of destruction, and miss those wetlands most at risk. These uncertainties make predicting the emissions mitigation benefits of this program difficult.

Program recommendations: We recommend a national program to first identify wetlands on agricultural lands that are most at risk of destruction, and then to offer payments to farmers for permanent easements to protect those wetlands. Alternatively, shorter-term agreements for protection could be offered to farmers, with payment rates determined through a reverse auction or using prevailing local land rental rates.

15. Wetland restoration

Creating or restoring wetlands is far less cost-effective than avoiding wetland conversion, but does deliver positive GHG and environmental benefits. Restoration is most practical on the Prairies, where land prices are lower. Restored wetlands emit methane, but increased carbon storage and the elimination of emissions from farming make restoration a net benefit in terms of GHG emissions.

GHG mitigation potential:
22,000 tonnes CO2e

Average Abatement Cost:
$400/tonne CO2e

Total cost:
$5,000,000/year

Program recommendations: Engage a third party organization with experience in wetland restoration to restore wetlands on agricultural lands in the three Prairie provinces.

16, 17, 18. Alley cropping, silvopasture and riparian trees

Alley cropping is the practice of establishing parallel rows of trees on cropland. Silvopasture is the practice of establishing trees on pastures and grazing lands. Planting riparian trees involves planting trees along the margins of watercourses and wetlands. All three practices increase carbon sequestration and provide benefits such as improved water retention, better crop yields, shade and shelter for livestock, erosion control, and increased biodiversity.

Riparian trees also reduce agricultural nutrients and chemicals entering aquatic environments. Alley cropping is most appropriate in eastern Canada, where soil and climate conditions make the establishment of trees practical.

Establishing trees on working agricultural lands is expensive. Costs include tree seedlings, planting, and managing competing vegetation until the trees are established. Trees on grazing land must be protected from livestock for up to ten years. These BMPs will most likely be attractive to farmers who are highly motivated, and may be more appropriate for smaller operations. Planting riparian trees is appropriate for all sizes of operation.

GHG mitigation potential:
406,000 tonnes CO2e

Average Abatement Cost:
$12/tonne CO2e

Total cost:
$5,000,000/year

Program recommendations: A cost-share program to support the cost of planning, trees, planting and protection from livestock. This program should be focused on motivated producers in appropriate climate zones.

19. Avoided conversion of shelterbelts

Shelterbelts and treed fencerows are being lost in all regions of Canada as producers seek to maximize their plantable acres and reduce obstacles to the operation of large machinery. It is estimated that almost 600 kilometers for shelterbelts are being lost every year in the three Prairie provinces alone. When a shelterbelt is removed, large amounts of carbon are released from the soil and above ground biomass. Shelterbelts not only store carbon, they provide valuable ecological services such as wildlife habitat, increased biodiversity, wind and erosion control and improved water quality.

GHG mitigation potential:
30,000 tonnes CO2e

Average Abatement Cost:
$37/tonne CO2e

Total cost:
$655,000/year

The costs to producers of retaining shelterbelts are primarily opportunity costs, as with avoided conversion of wetlands.

Program recommendations: We recommend a reverse auction program where producers would bid on the price they would accept to conserve and maintain the shelterbelts on their farm.

Additional Costs

The expenditures recommended in this report are annual costs to incentivize practice adoption in 2028. They do not include program design, delivery and administration costs, the cost to governments to increase internal staffing and capacity to administer the necessary programs, or the cost of enhanced data collection and analysis. Some of the policy recommendations listed below will also require additional investment, such as designing and delivering an enhanced Environmental Farm Plan or establishing a national set-aside program. The FCS Economics Report includes detailed information on how costs and spending recommendations were calculated.

Policy and Programs

The Canadian Agricultural Partnership and previous iterations of the APF have tended to focus on the adoption of individual environmental BMPs, with limited resources devoted to BMP incentivization and little coordination between provinces. A much more ambitious, system-wide approach will be necessary if agriculture is to make a meaningful contribution to achieving Canada's goal of net-zero emissions by 2050. More attention must also be paid to ensuring that farmers from equity-deserving groups have access to programs and support. FCS is recommending a range of policy options – from traditional cost-share programs, to reverse auctions, to collective bonus payments – to incentivize and promote the adoption of climate-friendly BMPs that are detailed in the FCS Policy and Programs Report, but it is important to highlight some broad policy objectives and themes.

Equity and Inclusion

Many farmers have been historically marginalized in Canadian agriculture and left out of government programs, but these same farmers have been some of the most progressive in adopting climate mitigation and adaptation measures on their farms. Young farmers, women farmers, farmers with disabilities, Black farmers, Indigenous farmers and food providers, farmers of colour, small-scale farmers, 2SLGBTQ+ farmers, and new Canadian farmers often experience additional and unique barriers to enter and succeed in our sector. Climate-related programming in the next APF must be accessible to all farmers. For example, cost-share programs should have an advance payment provision for equity-deserving farmers so that lack of up-front capital is not a barrier to participation. Minimum income requirements for cost-share programs should also be lowered or removed. The AgriDiversity program should be expanded, and financial support given to groups that represent equity-deserving farmers to help spread and support climate-friendly practices.

Systems Approaches

The science is clear that much greater mitigation can be achieved through a systems approach that encourages the adoption of a suite of BMPs, rather than focusing on individual practices. For example, as described above, several individual practices can reduce enteric methane emissions from cattle by five to ten percent. However, complimentary practices can be "stacked" or adopted simultaneously to achieve emissions reduction in excess of 15%, and secondary impacts on animal health and reproductive success can push overall mitigation to 23%. Producers should be encouraged to adopt low-emissions farming *systems*, rather than individual BMPs.

In order to encourage such systems thinking, we recommend that producers who adopt a suite of climate-focused BMPs be given access to a bonus payment that could be delivered through AgriInvest. The FCS BRM Task Force recommended that AgriInvest be retooled to promote the adoption of climate-friendly practices. We recommend a tiered approach, with producers choosing from a menu of basic, intermediate and advanced practices that best fit their type of operation and region. Each tier of adoption would result in a higher matching payment through AgriInvest. Producers would still have access to cost-share or per-acre payments to help them adopt individual BMPs. This approach would help to incentivize producers to maintain practices once they are adopted, and reward early adopters, some of whom have been employing climate-friendly practices for many years.

The FCS Policy and Programs report includes recommendations on cost-share programs that will also contribute to systemic change, such as modifying and standardizing caps on program participation and giving farmers who lease land more access to cost-share programs. Consideration should also be given to providing collective adoption bonuses to encourage landscape-level adoption of BMPs. Producers would receive a bonus payment when a given proportion of producers in an area adopt a practice (a watershed or special agricultural zone, for example). This can be especially effective in environmentally sensitive areas.

The Environmental Farm Plan

The Environmental Farm Plan (EFP) is an established framework that could be harnessed to drive systemic change and reduce emissions on Canadian farms. Minimum standards for the EFP should be established, including the addition of climate and nutrient management planning modules and standardized renewal periods, while giving provinces and territories flexibility to adapt the EFP to local conditions. The EFP could be a powerful tool to help farmers understand where their emissions are coming from and how they can be reduced. A complete and updated EFP should be a prerequisite for accessing cost-share and other

support through the APF, programs such as the On-Farm Climate Action Fund, and enhanced payments through AgriInvest.

Farmer Education and Extension

Farmers need information and support if they are to embrace change on their farms. Creating and renewing Environmental Farm Plans offers an opportunity to connect individual producers with agricultural professionals and fellow farmers who can provide practical advice. The long-term erosion of public extension services in Canada needs to be reversed: this is an area where the proposed CFRA or similar body could play a role. In the short term, all sources of agricultural information need to be strengthened and supported, including farmer-to-farmer information sharing networks, independent agrologists and Certified Crop Advisors, farm organizations, and agricultural colleges and universities. Research shows that farmers learn best from other farmers: the creation and expansion of farmer mentorship programs and farmer-led research initiatives should be a priority. The creation of farm-level management plans with a trusted advisor or farmer mentor – such as nitrogen or nutrient management plans, grazing plans or forestry plans – should be eligible for cost-share support.

Program Coordination

Canada is far behind its competitors in Europe and the United States when it comes to public spending on agri-environmental programs. However, the past two years have seen a proliferation of new programs aimed at reducing emissions and increasing resilience in Canadian agriculture, and a corresponding jump in public spending commitments. The federal government has pledged close to a billion dollars in new spending on climate change mitigation in agriculture over the next six years. This report is calling for approximately $2 billion in additional investment over the five years of the next APF.

With all this new spending and programming comes an increased administrative burden and the risk of duplication, poor coordination and confusion in the sector. It is imperative that federal, provincial and territorial governments take proactive steps to ensure that climate change mitigation efforts are coordinated and streamlined. FCS strongly recommends that Agriculture and Agri-Food Canada (AAFC) create a central office or agency to coordinate planning and delivery of agri-environmental and climate related programs. This entity could take the form of a Canadian Farm Resilience Agency (CFRA), modeled on the former Prairie Farm Rehabilitation Administration (PFRA).

Voluntary Set-Aside Programs

Several of the livestock-related BMPs recommended in this report have the co-benefit of increasing grazing productivity. If these practices are adopted at scale, producers might be motivated to convert pasture they no longer need to crop production. This could have the unintended consequence of increasing emissions. To avoid this situation, we recommend the creation of a national grassland set-aside program. This program would not have a direct emissions reduction outcome, but would help avoid the conversion of grasslands to annual crop production. Producers would receive an annual payment for a fixed term (perhaps five to ten years), with requirements for pasture preservation and maintenance. Lands in the reserve could be used as a strategic hay or forage reserve in years of extreme drought. This program should only be open to producers who adopt productivity-enhancing BMPs such as rotational grazing.

Consideration should also be given to creating a national cropland set-aside program that would pay farmers to retire marginal cropland, as these areas tend to have the highest intensity of emissions and lowest economic returns for farmers.

Data Collection and Standardization

Environmental programs in Canadian agriculture have a history of poor data collection and inadequate assessment of program outcomes. Robust data collection and analysis requirements need to be built into every aspect of the APF to better identify emissions sources and mitigation strategies. The National Inventory Report (NIR) does not accurately account for all agricultural emissions sources, and in some cases fails to capture significant mitigation practices: this must change as quickly as possible. The BMPs recommended in this report result in well-documented emissions reduction, but most of them are not currently captured in the NIR.

Practice	GHG Mitigation (Mt CO_2e in 2028)	Average Abatement Cost ($/tonne CO_2e in 2028)	Total cost ($/year in 2028)
Nitrogen Management			
Quantitative determination of right rate	1.1	$66	$74 million
Precision nitrogen management	0.4	$44	$16 million
Enhanced efficiency nitrogen fertilizer	1.8	$46	$86 million
Elimination of fall nitrogen application	0.2	$8	$2 million
4R management of manure	0.08	$4	$0.3 million
Improved crediting of organic N sources	0.2	$11	$2 million
SUBTOTAL	3.8	$47	$180 million
Manure Storage and Handling			
Synthetic impermeable floating covers	0.9	$13	$7 million
Acidification of liquid manure	1.3	$20	$27 million
SUBTOTAL	2.4	$14	$34 million
Livestock Management			
Increased legumes in pasture	1.1	$1	$0.8 million
Rotational grazing	2.5	$5	$7.6 million
Extended grazing period	0.6	$36	$23 million
SUBTOTAL	4.3	$7	$32 million

Practice	GHG Mitigation (Mt CO_2e in 2028)	Average Abatement Cost ($/tonne CO_2e in 2028)	Total cost ($/year in 2028)
Soil Management			
Cover cropping	2.7	$81	$216 million
Intercropping	1.6	$78	$125 million
SUBTOTAL	4.3	$80	$341 million
Wetland and Tree Management			
Avoided conversion of wetlands	1.0	$77	$45 million
Wetland restoration	0.02	$400	$5 million
Alley cropping	0.14	$18	$1.6 million
Silvopasture	0.13	$20	$1.6 million
Planting riparian trees	0.14	$23	$2 million
Avoided conversion of shelterbelts	0.03	$37	$0.65 million
SUBTOTAL	1.4	$39	$56 million
TOTAL	**16.2**	**$40**	**$642 million**

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About Farmers for Climate Solutions

Launched in February, 2020, Farmers for Climate Solutions is a national coalition of farmer-led and farmer-supporting organizations advancing policies and programming that support farmers to reduce emissions and build resilience in the face of climate change.

Current members of Farmers for Climate Solutions include:

ACORN Atlantic Canadian Organic Regional Network
BC FARMERS' MARKETS
CAPÉ Coopérative pour l'Agriculture de Proximité Écologique
CFGA
COG Canadian Organic Growers Cultivons Biologique Canada
DIRECT FARM MANITOBA
Ecology Action Centre
EFAO ECOLOGICAL FARMERS ASSOCIATION OF ONTARIO
Équiterre
FarmFolk CityFolk
HOLISTIC MANAGEMENT
MOA Manitoba Organic Alliance
nfu unf national farmers union | union nationale des fermiers
national farmers union Ontario nfu unf de l'Ontario union nationale des fermiers
OCO
ORGANIC BC
ORGANICS NOVA SCOTIA
organic ALBERTA
OntarioSheep FARMERS
Sask Organics Organically Grown in Saskatchewan
Rural Routes to Climate Solutions
SeedChange
RÉGÉNÉRATION CANADA
YOUNG AGRARIANS

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