SPECIAL **REPORT**

CARBON TAXATION

A federal mandate to reduce Canada's greenhouse gas emissions by levying a tax on fossil fuels, emissions and fertilizers has not been well received. Are farmers justified in their fears that the new tax will place undue economic costs on the ag sector?

BY BRIAN CROSS
SASKATOON NEWSROOM

Canada's plan to implement a tax on greenhouse gas emissions has caused a fair bit of hand wringing among prairie farmers.

However, the financial impact of a carbon tax on the western Canadian agriculture sector could be far smaller than expected, according to agricultural economists at the University of Saskatchewan.

That's because biological emissions, which are those associated with growing crops or raising livestock, will not be taxed under Ottawa's proposed carbon tax plan.

In addition, Ottawa has indicated that the consumption of gasoline and diesel fuel by agricultural producers will be exempt from a proposed fossil fuel levy.

For farmers, that means the greatest financial impact will likely be felt indirectly and be reflected in higher costs for some goods and services used by farmers, such as agricultural inputs, nitrogen fertilizers, farm chemicals, transportation services and freight rates for moving grain by rail.

"If you look at where most emissions come from in (the agriculture sector), a lot of them are biological emissions from things like fertilizer applications ... methane emissions from cattle, et cetera, et cetera," said Peter Slade, an agricultural economist at the U of S.

"But all of these things are not going to be taxed under the federal plan or under any provincial plans that I've seen, so all of those types of things would be counted outside of the carbon tax."

Tristan Skolrud, another ag economist at the U of S, agreed.

Although all the details of the federal carbon tax plan have yet to be unveiled, it looks like consumption of fossil fuels on the farm will be tax exempt, at least for the time being, Skolrud said.

"Realistically, they (farmers) are just going to be looking at indirect effects," said Skolrud, an assistant professor in agricultural economics department.

"For example, they might end up paying more for certain farm inputs.... The biggest potential there is for higher nitrogen fertilizer costs because producing nitrogen fertilizer is a very carbon intensive process, and if nitrogen fertilizer manufacturers are taxed, there's a chance that some of those costs will get passed on to the final purchasers."

However, Skolrud said domestic producers of nitrogen fertilizer will be forced to keep fertilizer prices at a competitive level, relative to nitrogen fertilizer products imported from the United States or elsewhere.

Slade and Skolrud said there are many unanswered questions surrounding the federal carbon tax program.

It remains to be seen how things will roll out, but prairie farmers should not assume that the implementation of a carbon tax will be the difference between financial success and financial failure on the farm.

In general, economists agree that it makes more sense to tax pollution, which has a negative impact on society, rather than retail sales, which contribute to a healthier economy.

In theory, a carbon tax would be revenue neutral, meaning revenues that are collected could be used to offset existing taxes in other areas.

Ottawa offered some hints about what form the federal carbon tax will take in the *Technical Paper on the Federal Carbon Pricing Backstop*, available at bit.ly/2suM1bE.

According to the paper, all provinces in Canada will have the latitude to come up with their own carbon pricing systems.

However, the federal government's carbon pricing "backstop" will kick in if a province doesn't come up with its own pricing and taxation plan.

The federal backstop will price carbon dioxide or carbon dioxide equivalents at $10 per tonne in 2018 and increase to $50 per tonne by 2022.

In addition, Ottawa will also introduce:

- A tax levy on all types of liquid, solid and gaseous fuel, including gasoline, diesel fuel, natural gas, propane, fuel oil and coal and even waste tires with exemptions granted on certain types for agricultural activities.
- An output-based pricing system that will apply to all industrial facilities that emit 50 kilotonnes of carbon dioxide equivalent per year.

For gasoline consumers, the fuel levy will be equivalent to a tax of 2.33 cents per litre in 2018 and increasing to 11.63 cents per litre in 2022.

Some groups will be exempt from paying the fuel levy, including "registered farmers" involved in "certain farming activities."

The Saskatchewan government opposes a carbon tax, suggesting it will discourage economic activity.

There are also lingering questions about the value of activities that reduce greenhouse gas emissions and sequester carbons, most notably, the adoption of zero-till or minimum till production systems.

In a recent academic paper co-authored by University of Saskatchewan economists Lana Awada, Richard Gray and Cecil Nagy, the economic value of adopting zero-till in Saskatchewan was estimated at $590 million between 1985 and 2012.

This included the value of sequestered carbon ($542 million), CO2 reductions related to reduced farm fuel consumption ($37 million) and gains from reduced nitrous oxide emissions ($11 million).

The researchers assigned a value of $5 as the social cost of emitting a tonne of carbon dioxide or carbon dioxide equivalent.

By comparison, Ottawa's backstop plan will assign a value of $10 per tonne in 2018, increasing to $50 per tonne by 2022.

Awada said it is unclear if farmers will receive credits or compensation for adopting production systems that sequester carbon and benefit the environment.

However, she thinks their efforts should be rewarded.

"Farmers' adoption of zero tillage has probably made the largest contribution to the reduction of greenhouse gas emissions in Saskatchewan, but to date farmers have not yet been compensated for that," she said.

"Carbon credit programs to reward on-farm carbon sequestration are needed. These programs will help farmers get an idea about the GHG emissions associated with particular practices and the prospects for earning carbon credits."

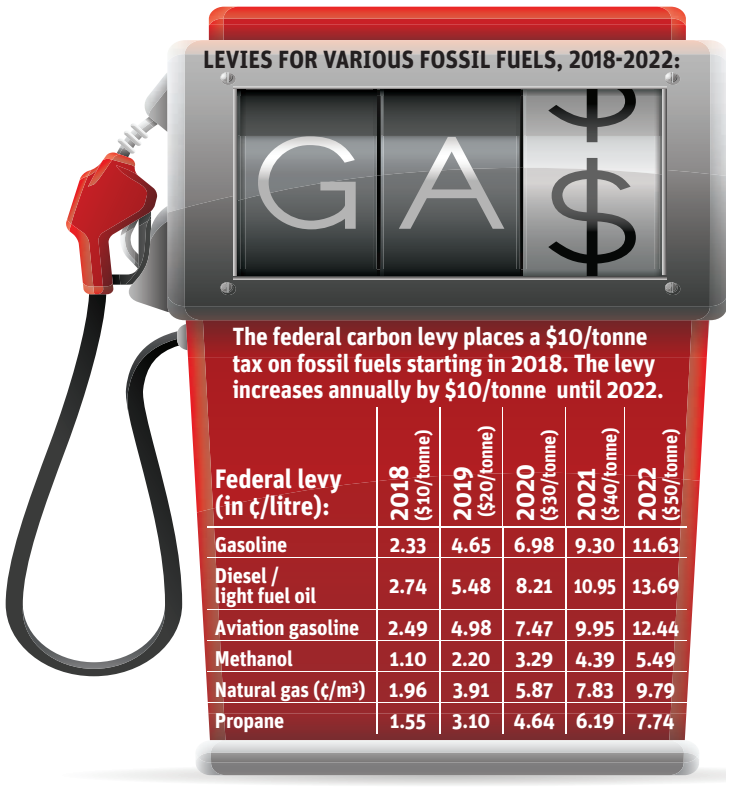
The Saskatchewan Soil Conservation Association has proposed that Saskatchewan farmers, in partnership with the Saskatchewan Crop Insurance Corp., develop a soil carbon registry or bank.

The bank would allow farmers to accumulate and "bank" credits or offsets in exchange for adopting carbon-reducing practices on the farm, such as no-till production.

The credits accumulated in the bank could then be used to pay other carbon related taxes or penalties that are levied by any level of government under federal or provincial carbon tax schemes.

Farmers would not be responsible for calculating their own soil carbon levels. That responsibility would rest with the organization responsible for running the credit program and would be based on farmers' management practices.

brian.cross@producer.com



The federal carbon levy places a $10/tonne tax on fossil fuels starting in 2018. The levy increases annually by $10/tonne until 2022.

Federal levy (in ¢/litre):	2018 ($10/tonne)	2019 ($20/tonne)	2020 ($30/tonne)	2021 ($40/tonne)	2022 ($50/tonne)
Gasoline	2.33	4.65	6.98	9.30	11.63
Diesel / light fuel oil	2.74	5.48	8.21	10.95	13.69
Aviation gasoline	2.49	4.98	7.47	9.95	12.44
Methanol	1.10	2.20	3.29	4.39	5.49
Natural gas (¢/m³)	1.96	3.91	5.87	7.83	9.79
Propane	1.55	3.10	4.64	6.19	7.74

Source: Environment & Climate Change Canada | WP GRAPHIC / GETTY ILLUSTRATION

DID YOU KNOW?

- The amount of nitrogen contained in soil organic matter is generally equal to 10 percent of the carbon stored in the soil. It is estimated that the adoption of zero-till production practices in Saskatchewan has contributed the equivalent of $2.9 billion worth of nitrogen to Saskatchewan croplands since the mid 1980s.

Greenhouse gases (GHG) are atmospheric gases that can absorb and trap solar radiation. This increased atmospheric heat is responsible for the greenhouse effect, also known as **global warming**.

Greenhouse gases include **methane** (CH_4), **nitrous oxide** (N_2O) and **carbon dioxide** (CO_2). Once released into the atmosphere, these gases don't react to changes in temperature or air pressure, so they have a long-lasting impact on climate change.

This is how farming practices can contribute to — or reduce — greenhouse gases:

In 2015, air travel accounted for **2%** of all GHG emissions.

WEATHER SWINGS: Global warming from greenhouse gas emissions are expected to extend growing seasons in Western Canada, but will also cause more violent swings in weather that will lead to drought or flooding.

WARMER WEATHER, BIGGER YIELDS: An increase in the number of growing days will increase crop productivity because plants can grow bigger and set deeper roots in the growing season. This leads to greater **carbon sequestration** — the ability of a plant to pull carbon from the air and store it in the soil. This is what's known as a **carbon sink.**

CARBON DIOXIDE: Released when soils are tilled. **Zero-till practices** can help to reduce CO_2 release.

8% of all GHG emissions in Canada are produced by agricultural practices.

In other words, farming contributes **57 million tonnes** of greenhouse gases each year in Canada out of a national total of **700 million tonnes.**

NITROUS OXIDE: Nitrogen fertilizers contain N_2O and are the biggest contributors to greenhouse gases in crop production. Fertilizers in the soil release some N_2O into the air, but modern equipment and fertilizer products can help reduce this process.

CROP PRODUCTION with modern no-till practices can result in plants taking in more carbon than is released through fertilizers and fossil fuel emissions. This is one way farms could create **carbon credits.**

METHANE: Produced by livestock, mainly ruminants, and also from manure stored in anaerobic conditions.

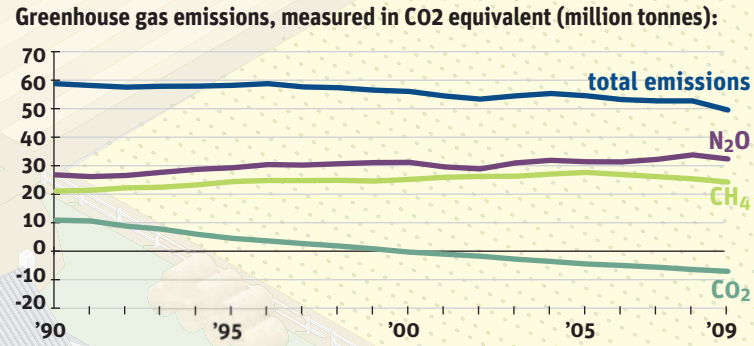
CARBON DIOXIDE: Produced by livestock through respiration.

FARM EQUIPMENT contributes minimal GHG emissions with improved technology.

GREENHOUSE GAS EMISSIONS IN CANADA

This table shows the level of emissions of carbon dioxide, nitrous oxide and methane from 1990 to 2009. Total greenhouse gas emissions declined from 2008-09, largely because of reduced tillage and more efficient fertilizer use.

Greenhouse gas emissions, measured in CO2 equivalent (million tonnes):



Sources: Agriculture Canada, Environment Canada, staff research | MICHELLE HOULDEN GRAPHIC

FINANCES

Alberta's carbon tax plan may offer insight for others

Many Alberta farmers say program exemptions mean the new carbon tax isn't as costly as some feared it would be

BY SEAN PRATT
SASKATOON NEWSROOM

There has been much hand wringing in the farm community about carbon taxes but the experience hasn't been too bad so far in the one prairie province that has one.

"The hit wasn't as hard on a lot of producers as we thought it was going to be," said Lynn Jacobson, president of the Alberta Federation of Agriculture.

Between the exemption for farm fuel and the ability to offset the new tax with carbon credits, many farmers are finding it to be a manageable and in some cases a revenue-neutral program.

"I think agriculture somewhat escaped or dodged a bullet," he said.

Alberta introduced its carbon levy program on Jan. 1 this year. It is the only prairie province to have a program in place.

The federal government says all provinces must implement a program by Jan. 1, 2018. Manitoba is working on one, while Saskatchewan plans to take Ottawa to court over the issue.

Saskatchewan Agriculture contends Ottawa's forced tax would add $10 to $12 an acre in additional costs. Other studies have shown it could increase fertilizer costs alone by $19 per acre when fully implemented.

"That's a significant hit for farmers," said Robin Speer, executive director of the Western Canadian Wheat Growers Association.

He said farmers should be rewarded for sequestering carbon rather than penalized for their activities.

"It's concerning any time new taxes are coming in. It's just one more thing that's going to affect the profitability of farming," said Speer.

The federal government says provinces that do not have their own program will be forced to adopt one based on the model Alberta is using.

Alberta's tax amounts to $20 per tonne in 2017, rises to $30 per tonne in 2018 and will eventually reach Ottawa's mandated $50 per tonne by 2022.

Andrew Leach, associate professor at the Alberta School of Business, chaired the Alberta Climate Leadership Panel that recommended the lion's share of what became Alberta's carbon levy.

The big win for agriculture is that marked farm fuels are exempt from the tax.

Leach was disappointed the government decided to go that route because a farm that uses more fuel than a neighbouring farm is getting a bigger tax break.

"That's sort of backwards," he said.

Leach would have preferred a different type of subsidy program for farm fuel but he is pleased with the overall look of a program that was sensitive to the concerns of industries like agriculture.

"The biggest thing we were looking for in designing the policy was protecting trade-exposed industries," he said.

In addition to getting a break on fuel, farmers can offset the costs of the tax by generating emissions credits, which can be sold to heavy emitters.

The credits are earned by implementing practices such as no-till farming and reduced fertilizer use.

Farmers have been earning credits since 2007 but the amount they are worth doubled to $30 per tonne with the implementation of the new levy.

"That doubling of their value gets them over the hurdle of being really interesting and economically viable for a lot of opportunities on farms," said Leach.

Jacobson said the ability to earn carbon offsets will make the program a wash for some dryland farmers.

"I think we're better off in some ways than other people," he said.

However, he noted that farmers are still paying extra taxes on natural gas and propane and those costs can add up for heavy users, such as greenhouses and irrigated operations.

The province is allowing greenhouse operators to recoup up to 80 percent of the carbon levy during the next two years, keeping them competitive with their counterparts in British Columbia.

The Alberta Federation of Agriculture has been asking the government for a break for irrigators as well.

"They have been talking to us, so it leads me to believe that maybe they're looking at something on that," he said.

Speer said the tax will have a big impact on value-added operations. The Alberta Cattle Feeders Association estimates it will cost feedlot operations between $6 and $7 a head.

The other big concern for farmers was what impact the tax was going to have on fertilizer costs because fertilizer manufacturers are heavy users of natural gas.

Alberta's fertilizer manufacturers had already been paying a carbon tax since 2007 under the province's Specified Gas Emitters Regulation.

They will continue operating under that program until the end of 2017 when the province transitions to another program that is still in the works.

Leach said the government is very much aware that fertilizer is another trade-exposed industry and it doesn't want to introduce a policy that will penalize local production at the expense of imports.

"You're going to see a policy that protects against that," he said.

Alberta has produced a document that states the direct cost of the tax on an average household with a couple and two children will be $338 in 2017 and $508 in 2018. An estimated 60 percent of households will get a full rebate due to their incomes.

There have been no estimates on what it would cost the average farm because there is too much variability in farm operations, said Leach.

Scott Hennig, vice-president of communications with the Canadian Taxpayers Federation, said the levy will result in a lot of hidden costs for farmers in the form of things like higher transportation costs.

"Even if you're buying a new piece of machinery, it has got to get here. It's not being manufactured in Olds or something like that," he said.

Hennig said the tax will be built into everything farmers pay for including crop inputs.

"They're planning on pulling a whole pile of money out of the economy," he said.

The government estimates the levy will generate $3.85 billion over the next three fiscal years, all of which will be reinvested in the Alberta economy.

sean.pratt@producer.com

SPECIAL **REPORT**

CARBON TAX: A bitter pill for farmers

Farmers are already using better management practices to minimize their carbon footprints, and many say carbon pricing can't help them to do more

GETTY ILLUSTRATION

BY KAREN BRIERE
REGINA BUREAU

From his west coast vantage point, Stan Vander Waal isn't sure that carbon taxes do what proponents say: change behaviour to reduce greenhouse gas emissions.

The chair of the British Columbia Agriculture Council and owner of Chilliwack-based Rainbow Greenhouses has had nine years to observe the tax in practice.

He said his operation was already using the latest technology to reduce fuel costs when the tax was imposed July 1, 2008.

"On the greenhouse side, the perception was that we would burn less fuel," Vander Waal said. "That's one our highest input costs."

But he had already installed innovations such as curtain and shade systems and double-walled panels to reduce that cost.

"There just isn't anything that would support that next level of efficiency," he said.

Ottawa has said that carbon plans will be mandatory nationwide in 2018. Provinces are expected to design their own systems or the federal government will impose one. It can be a cap-and-trade system or a carbon tax.

In B.C., the initial tax was $10 per tonne of carbon dioxide equivalent on heating and transport fuel, rising to $30 per tonne, where it has been since 2012.

The idea is that a tax will cause people to gradually reduce fuel use and adjust their habits.

It is also supposed to be revenue-neutral, so all money taken in from the tax is returned through personal and corporate income tax breaks.

A Fraser Institute study earlier this year, however, said the tax ceased to be revenue neutral five years ago as the government moved to more targeted tax cuts, away from broad-based cuts that would spur economic growth.

Farmers have long opposed a carbon tax, arguing that with it, they can't compete against producers in jurisdictions without a similar tax.

The B.C. greenhouse sector was successful in obtaining a permanent 80 percent rebate on natural gas but others weren't so lucky.

"A chicken farmer using natural gas is not getting a rebate," Vander Waal said.

The government also later exempted farmers from paying the carbon tax on coloured gasoline and diesel used on their farms.

Vander Waal said that helps only a little because hauling crops to storage, delivering feed and trucking livestock to market are not exempt.

"All these add on layer after layer after layer of carbon tax," he said.

The average farmer is paying about $1,000 per year in carbon tax, so no one is likely to go broke over it, he added, but it cuts into the money that farmers have available to reinvest and make their businesses more efficient.

The Pacific Institute for Climate Solutions, which is funded by the B.C. government, released a study in 2014 that found no evidence agricultural exemptions were needed. It noted there was no change in agricultural trade after the tax was imposed.

The study also said that fossil fuels represent on average only four percent of production costs. A carbon tax, therefore, adds only a small cost. It added that farmers may have changed practices to become more energy efficient.

Farmers across Canada could argue that's exactly the point. In many cases they have taken measures to minimize their carbon footprint through better management practices that use less fuel and sequester carbon.

Yet, they will be paying the carbon tax all along the way without any ability to recover it.

What's happening outside of B.C.?

In Alberta, the $20-per-tonne carbon tax implemented Jan. 1, 2017, applies to heating and transportation fuel but exempts farm fuels. The tax rises to $30 in 2018.

The tax is returned to some low-income residents through a rebate, but most of the money goes toward programs for renewable energy and energy efficiency.

Ontario and Quebec both decided to use a cap-and-trade system rather than a carbon tax. This system caps emissions but allows flexibility in how that cap can be met.

Emitters who exceed their caps can buy credits from others with surplus credits.

The Ontario Federation of Agriculture was initially supportive of this type of system but now says it isn't working. Fuel costs have risen with no way for farmers to offset them; they aren't exempt under the cap and trade program.

The remaining provinces, except Saskatchewan, are still working on their plans.

Saskatchewan maintains it will not impose a tax that will hurt its agricultural sector.

If that is the case, then Saskatchewan farmers can likely look forward to a system similar to Alberta's, according to federal Environment Minister Catherine McKenna's announcement earlier this year.

It will start with a $10-per-tonne tax on fossil fuels and ramp up to $50 per tonne by 2022. The federal government is accepting comments on the proposed plan until June 30 at carbonpricing-tarificationcarbone@canada.ca.

Back in B.C., Vander Waal said he believes all governments would have been better off setting emissions standards rather than taxing inputs.

"The general perception is that most people are just not being more efficient. I think that's nonsense," he said. "Any business is always trying to reduce costs."

He said public perception drove the need for a carbon tax but few city dwellers realize what was already being done in agricultural sectors.

"A carbon tax doesn't drive efficiency," Vander Waal said. "Governments should really learn what's going on on the farm. There's little knowledge of what's really being done."

karen.briere@producer.com

This is the second of three instalments examining the issues surrounding carbon pricing, greenhouse gas emissions and how farmers can do their share without having to pay more than their fair share to do it.
See the entire series online next week at www.producer.com.

GREENHOUSE GASES

Scientists find surprise in soil's freeze-thaw cycle: nitrous oxide emissions

BY ROBERT ARNASON
BRANDON BUREAU

For decades, soil scientists have studied nitrous oxide emissions from cropland during the growing season because they assumed that most emissions occurred from May until October.

A University of Guelph and University of Manitoba study, published earlier this year, suggests that is incorrect.

In cold regions of the Northern Hemisphere, like Western Canada and northeastern China, a third or two-thirds of nitrous oxide from cropland might be released from November till April, when the soil thaws, freezes and thaws again.

"It is possible that 35 to 65 percent of total annual N2O emissions could be attributed to thaw emissions," a collaboration of scientists wrote in the paper, published in *Nature Geoscience*.

One of the researchers and lead author of the paper is Claudia Wagner-Riddle, University of Guelph environmental scientist.

Wagner-Riddle was interested in N2O emissions from thawing soils because nitrogen fertilizer and manure applied to cropland is a significant contributor to global warming.

It's estimated that N2O is 300 times more potent a greenhouse gas than carbon dioxide. In Canada, more than 70 percent of all N2O emissions come from agriculture, almost entirely from cropland soils.

One of Wagner-Riddle's main partners in the study was Mario Tenuta, University of Manitoba soil scientist. The study leaders and their team monitored nitrous oxide emissions every 30 minutes from the Glenlea research station south of Winnipeg and a site in Ontario for nine and 14 years, respectively.

The results from Glenlea showed that emissions were negligible in January and February but spiked in March and April when the soil was thawing.

In certain years, on specific crops, the emissions in March and April dominated the total amount of N2O released for the year.

"In winter wheat for example, one year the emissions from the freeze-thaw were 90 percent," Wagner-Riddle said.

QUICK FACTS

- In 2015 nitrous oxide represented about five percent of all greenhouse gas emissions in the U.S.
- One tonne of N2O released into the atmosphere is equivalent to 300 tonnes of carbon dioxide
- Agricultural soils and the use of nitrogen fertilizers are responsible for about 75 percent of all N2O emissions in the U.S.
- The percentage is similar in Canada

Source: U.S. Environmental Protection Agency

The site in Elora, Ont., also showed more emissions in the winter thaw period, but the spike wasn't as noticeable as the Manitoba results.

The NO2 released was more consistent from January to March in Ontario, possibly because the climate is milder so a thaw is more likely to occur in the middle of winter.

On average, the percentage of annual N2O emissions from the freeze-thaw phenomenon was 53 percent at the Manitoba site and 29 percent in Ontario.

The results surprised experts who had thought that nitrous oxide was released primarily in the growing season, especially in the spring period following fertilizer application.

The results from Manitoba and Ontario showed that colder soils release more NO2 during spring thaw.

Wagner-Riddle said the data from Manitoba show the soil for that site was much colder and emissions there were also higher.

Laboratory results back up the finding. When a soil sample is chilled to -15 C, it releases more nitrous oxide than a soil taken to –5C.

"The intensity of freezing, meaning how low the temperature gets … that impacts what happens at thaw."

The scientists used the results from the Glenlea and Ontario sites to estimate the amount of N2O released globally from agricultural soils from freeze-thaw. Using computer models, they calculated that the freeze-thaw cycle adds 17 to 28 percent to all nitrous oxide emissions for agricultural soils.

Most of those additional emissions would come from Western Canada, the U.S. Midwest, northeastern China, Kazakhstan, Russia and Ukraine.

The area of cropland that freezes is minimal in the Southern Hemisphere, the paper said.

"(But) there are many areas of cropland in the world that freeze (and) where these emissions are important," Wagner-Riddle said. "That has been neglected. There's not been a lot of study on that."

Wagner-Riddle and her colleagues were able to measure emissions in Canada and come up with global estimates, but they don't fully understand what is happening in the soil and why N2O is released during spring thaw.

"We don't know exactly the mechanism," she said.

That will require further study.

The scientists hope to duplicate the research in Saskatchewan to see if results from Manitoba's Red River Valley apply to other parts of the Prairies.

robert.arnason@producer.com

CARBON SEQUESTRATION

Alfalfa, grasses top choices to aid in carbon sequestration

BY BARB GLEN
LETHBRIDGE BUREAU

Farmers with the goal of sequestering maximum carbon in their soil would plant alfalfa or canola.

That was the quick answer to the "best crops to keep carbon" question from Agriculture Canada researcher Brian McConkey.

Alfalfa is a nitrogen fixer that puts lots of resources into its roots, keeps the soil dry so it reduces decomposition and does that job even in degraded soils.

The end result? More carbon kept in the soil.

Among annual crops, McConkey said canola adds more carbon to the soil than other crops because it has more residue after harvest in the form of leaves, empty pods and stems. These are incorporated into the soil, increasing carbon levels.

"Grown under the same conditions, it will produce more carbon than any other annual crop than we're aware of," said McConkey.

That applies to crops under prairie conditions without irrigation, he added.

The production of canola on millions of prairie acres means more carbon is being added to the soil generally.

Crop specialist Ross McKenzie doesn't name canola as the best annual for the job, though its part of the mix.

"We'd probably find that there's not a huge difference," he said.

"The more root material, the more organic matter you'll add and also the more precipitation and the more fertilizer you put on, the better the growth and the better the organic matter added by the roots."

McKenzie said prairie grasses and perennial forages should have a prominent place on the list of crops good at sequestering soil carbon. He participated in a wealth of research on soil organic matter, a.k.a. carbon, during his years with Alberta Agriculture.

A crop specialist says drought hardy native grasses excel at carbon sequestration because they put a lot of energy into root growth and root mass as a hedge against drought. | FILE PHOTO

McKenzie said it's estimated that about half the organic matter held in the soil was lost in the first 40 to 60 years after prairie soil was cultivated. Some of that has been regained with the arrival of minimum and zero tillage.

"If you want to build soil organic carbon, the first thing you do is reduce frequency of summerfallow or eliminate it completely," he said.

Crops with good root growth will build more organic matter, thus sequestering more carbon, so providing adequate nutrition aids in that effort.

However, annual crops are bred for above ground yield, not for root growth. That's where drought hardy native grasses excel because they put a lot of energy into root growth and root mass as a hedge against drought.

Growing grass isn't the moneymaker for farmers that annuals can be, so McKenzie suggested farmers consider putting 20 percent of their land in grass all the time and rotating that percentage as a way to build soil carbon.

Even putting land into permanent grass for grazing will require some amount of fertilizer to maximize its ability to sequester carbon by ensuring its productivity.

The best plan for soil carbon sequestration doesn't mean a continual accumulation, McKenzie added. Levels eventually reach an equilibrium where carbon input through organic matter equals carbon output through crop removal and organic decomposition.

McConkey said clay soils are better carbon keepers than other types of soil. As well, Canadian soil is better than some at holding carbon because cold weather ensures that no decomposition occurs over winter.

Ed Toensmeier, author of the *Carbon Farming Solution* and a lecturer on agri-forestry and perennial crops at Yale University, told *The Western Producer* earlier this year that carbon sequestration increases when trees are added to the list, assuming the climate is conducive to growing trees.

He said annual cropping and grazing can add 12 to 20 tonnes of carbon per acre, but when trees are added, 60 to 80 tonnes can be sequestered.

The carbon held in the soil can be a tricky thing to measure, McConkey said.

Precision is needed, and changes in soil carbon are more easily detected over years.

"It takes a lot of measurements to detect changes over short periods of time," he said. "The changes tend to be fairly small in any one year but it can be done."

He sees paying farmers for carbon sequestration as a viable option, as the Alberta precedent shows.

However, if farmers are paid for carbon sequestration, they must be willing to accept a regional average or estimate on how much carbon their land has sequestered because farm-by-farm tests are impractical.

McKenzie said he doesn't favour paying farmers to keep carbon in their soil because good farming practices would ensure that happened anyway.

"I think that should be something farmers should be aware of, using the best rotations to really build up the quality of their soil but not really be worried about getting paid for it," he said.

"They should be worried about maintaining the quality of their soil."

He also wonders if farmers would be asked to pay back the money they received for sequestering carbon if they changed the crops or practices they were using to obtain payments.

barb.glen@producer.com

SPECIAL **REPORT**

Australian farmer Michael Inwood prepares his no-till drill, which is pulled by an electric truck on his farm near Bathurst, about 163 kilometres west of Sydney in May of 2009. Australian farmers were being encouraged by the government of the day to shift their practices to create more carbon sequestration in exchange for soil carbon credits. | REUTERS/TIM WIMBORNE PHOTO

Carbon tax Down Under went under

This is the final instalment examining the issues surrounding carbon pricing, greenhouse gas emissions and how farmers can do their share without having to pay more than their fair share to do it. See the entire series online at www.producer.com.

Australia alters pricing model to include carbon credit system

BY MICHAEL RAINE
SASKATOON NEWSROOM

Some Australian farmers saw their costs rise as new taxes shifted money from producers and processors to carbon reduction projects across that continent.

However, a change in government put a stop to all that.

Half a dozen years ago, a Labour government in Australia brought in an ambitious program that quantified greenhouse gas emissions from across society and set a price on them, transferring greenhouse gas taxes to those who were avoiding emissions or reducing them.

Three years ago this month, a Liberal government canned the idea.

Farmers were exempted from paying the Australian tax directly, but they did absorb costs passed on to them by other industries.

Electricity, steel and other manufacturing sectors shifted their costs onto producers. Irrigation farmers who relied heavily on electricity saw large increases, along with other operations that rely on that power for fans, grain handling and processing.

Under the carbon pricing program, emitters were allowed to earn marketable carbon credits in a scheme that paid them for shifting methane production from livestock to power generation, stopping pasture and field burning and improving carbon sequestration in soils. The hog industry saw government grants flow into some of its manure lagoons to sew those up.

"It didn't last long, the carbon tax. By now we would have seen more costs for farmers, no doubts. Transportation fuels were set to be included," said Don Campbell, a Victoria state crop and livestock producer.

The government said exemptions for agriculture were largely due to the complexity of quantifying greenhouse gas production, but some opponents of the carbon pricing programs felt it had more to do with the tax being unfashionable for food production.

The University of Melbourne and others developed greenhouse gas emission measurement models, which showed that agriculture was responsible for about one seventh of the nation's output.

The government measures, models, encourages producers to reduce emissions and reports results through its department of energy in a process mandated in legislation beginning in 2014.

"It was the irrigators that took the big blow, the ones on the grid. Some electricity prices really jumped after the tax came on," said Campbell.

"There were some tax credits available for us, if you participated in programs or bought new gear."

A 15 percent tax credit was created for farmers who bought conservation tillage equipment in 2013 and 2014. That ended after the carbon pricing bill was repealed.

As part of the Carbon Farming Futures fund, which was set up during the Labour government's experiment in carbon pricing, dozens of agricultural research programs were initiated by farm groups and universities, looking at mitigation opportunities and carbon credit development.

Australia has had a carbon market since 2006 and has flirted with cap and trade regimes. Agricultural producers can sell credits based on their management practices.

The Clean Energy Regulator now audits and ensures that carbon credits earned are legitimate, but farmers are responsible for providing empirical evidence of carbon emission improvements. The CER also auctions credits and abatement projects.

Louisa Kiely, who runs an agricultural carbon credits firm in Australia, said the Australian model of selling credits has credibility in the global marketplace.

As a result, farmers can earn salable Australian Carbon Credit Units by practicing conservation tillage, finishing beef cattle faster while still on pasture to reduce methane, installing more efficient water and manure pumping systems and planting trees.

The director of Carbon Farmers of Australia said producers can participate in 25 and 100 year projects that generate credits that the government has been guaranteeing on behalf of large emitters, providing producers with 10 years of payments for their credits.

Said Campbell: "It still appears a bit wobbly, but for those that are getting an income from it, I am sure it's great."

The last three CER auctions of Australian carbon credits saw prices of $10.23, $10.69 and $11.82 per tonne.

michael.raine@producer.com

ANNUAL GREENHOUSE GAS CALCULATIONS

The University of Melbourne's modelling offers these projections based on a 6,000 acre Australian farm growing wheat, barley, pulses and oilseeds:

>> Crop details	wheat	barley	pulses	oilseeds
Irrigation used	no	no	yes	yes
Average yield (bu./acre)	55.1	35.2	27.5	45.9
Seeded area (acres/farm)	2,400	480	1,200	1,920
Nitrogen fertilizer used (lb./acre)	55.0	45.8	0.0	73.3

Total diesel consumption (litres) 2400.7

>> Annual greenhouse gas emissions (CO_2 equivalent tonnes farm wide)

Sources of carbon dioxide (CO_2):
Energy 10.5
Lime 0.4
Total annual CO_2 emissions 10.9

Sources of methane (CH_4):
Field burning 147.8
Energy 0.0
Total annual CH_4 emissions 148.9

Sources of nitrous oxide (N_2O):
Fertilizer 533.4
Crop residues 735.4
Atmospheric deposition 53.3
Leaching and runoff 226.3
Field burning 67.7
Energy 0.02
Total annual N_2O emissions 1616.1

>> Net annual farm emissions (tonnes per farm) 1,774.9

Source: University of Melbourne and the Climate Change Resource Centre | WP GRAPHIC

EUROPEAN REGULATIONS

Meeting EU emission standards can be a hurdle

Farmers in export-dependent countries might struggle under tougher European emission laws

BY ED WHITE
WINNIPEG BUREAU

Farmers might find it easier to reduce carbon and phosphate emissions if they live in a country in which the farm sector is stagnant and oriented toward domestic production.

But it's another thing for farmers operating in places like Canada, where agriculture is growth and export oriented.

That's what two European Union countries similar to Canada are grappling with as increasingly tougher EU environmental regulations are imposed.

"The ongoing challenge for the dairy sector to minimize its impact on the environment in more intensively farmed regions in Europe won't end because public vigilance will only continue to increase," said a Feb. 10 commentary by Dutch dairy supply company Hoogwegt Group.

"In the future, a greater focus on innovation to curb per-cow emissions while improving land-use efficiency will be needed."

That's fine for most EU countries where domestic production dominates agriculture. Most farmers in those countries can manage emission reduction targets by increasing per animal or per acre farming efficiency.

But a few countries with smaller populations, like the Netherlands and Ireland, see agriculture a different way. They are similar to Canada in that they have an export-oriented agricultural industry, and they view farming as a business that can provide export growth and new opportunities.

Those hopes run headlong against toughening EU regulations and restrictions on carbon emissions and nutrient runoff.

Not only do the changes make increasing agricultural production problematic on a per-animal-unit basis, but those nations face additional challenges if their overall national agricultural emissions are a significant proportion of total national emissions.

Countries with comparatively small agriculture industries can more easily handle overall carbon and nutrient emission demands by requiring more from other sectors and less from farming. They don't face the same economic hit if they need to reduce their farming sectors.

The EU knows it is walking a fine line between trying to squeeze carbon and other emissions out of agriculture while providing food security.

"The agriculture sector needs to address the twin challenge of reducing its greenhouse gas emissions while at the same time delivering a vital service to society with a growing global population: food," stated a European Commission paper discussing the EU's attempts to both reduce emissions and provide a secure supply of food.

"A significant decline in livestock numbers and more efficient application of fertilizers and better manure management reduced the EU's emissions from agriculture by 24 percent between 1990 and 2012...

"Given the central importance of food in our lives, a further reduction of greenhouse gas emissions from agriculture remains quite challenging. Nevertheless, there is still potential to further reduce the greenhouse gas emissions linked to food production in the EU."

The paper also mentions capturing methane from manure, better efficiency in using fertilizer and higher efficiency in meat and dairy production as examples of where gains could be made.

It also notes that reducing food waste would reduce emissions that the wasted food created during production.

Innovation efforts are going on across the EU, but unless a dramatic decline in emissions can be achieved quickly, countries like the Netherlands and Ireland will have problems increasing food production and meeting reduction targets.

Dutch farmers have been given a series of reprieves from EU manure-spreading restrictions, but if another one is not provided by the end of 2017, its dairy farmers will have to reduce phosphate emissions by 8.2 million kilograms. That's roughly equivalent to the elimination of 170,000 cows and a 10 percent reduction in Dutch milk production.

Ireland is similar to the Netherlands in being a relatively small country with a relatively large farm economy. However, agriculture is an even bigger part of Ireland's economy, making carbon emission reduction even more challenging than the challenges Dutch farmers face with phosphate reduction.

Agricultural emissions of greenhouse gases make up about eight percent of Dutch emissions, but more than 30 percent of Ireland's.

France is another country with an out-sized farm impact on national emissions, at about 18 percent.

Dairy is a much bigger emitter of greenhouse gases than other types of livestock and crop farming. That should signal that there are opportunities in dairy to make emission reductions through innovations, but it also makes expansion difficult while also complying with overall emission limits.

Yet the Irish, coming out of the 2008-09 world financial crisis, have been hoping for huge increases in agricultural production. According to Ireland's 2010 strategic plan, Food Harvest 2020, the country wants:

- an increase of 33 percent in the value of primary agriculture
- a 42 percent increase in the value of agriculture and food exports
- a 50 percent increase in milk production
- a 20 percent increase in beef production

By 2015, Ireland was producing 30 percent more milk than in 2007-08 and was on target to hit its 2020 goals.

The EU has shown willingness to treat agriculture as different from other industries because agriculture provides food and security.

It has signalled a willingness to allow agriculture-concentrated member states more leeway on greenhouse gas emissions.

However, if EU restrictions continue to tighten in coming decades, as most expect will happen, how agriculture and emissions controls can learn to co-exist is something many are anxiously watching.

ed.white@producer.com

EQUIPMENT

Can equipment makers do more to make a greener machine?

BY WILLIAM DEKAY
SASKATOON NEWSROOM

Major technological breakthroughs designed to reduce the carbon footprint of diesel engine emissions may not be coming any time soon.

"I don't know of any new technology coming down the pipe," said Harvey Chorney of the Prairie Agricultural Machinery Institute in Winnipeg.

"I think they (equipment manufacturers) have gone as far as they can in terms of reducing the emissions on diesel engines," he said.

From Tier 1 to Tier 4, the emission quality of diesel engines has steadily improved.

Electronics were introduced into Tier 1 engines about 15 years ago to help control fuel-to-air ratios injected into engines. Before this, engine fuel ratios were mechanically controlled.

"Tier 1 immediately eliminated the thick, black smoke after starting," Chorney said.

A few years later, Tier 2 improved on Tier 1.

Then Tier 3 engines with larger cooling systems were introduced, which were designed to enable engines to operate at hotter temperatures.

"The idea of running engines hotter was to get a cleaner burn. So in order to meet those requirements, they were trying to optimize the fuel-to-air ratios and run them very hot so they would essentially burn cleaner."

He said engine performance recovery happened between tiers 3 and 4 with urea being injected, which significantly improved engine efficiency.

Under those systems, a chemical reaction takes place in the exhaust system that combines nitrous oxide with the extra nitrogen from urea, resulting in only nitrogen and oxygen coming out, as well as a significantly cleaner exhaust.

Introduced in 2011, Tier 4, as well as subsequent improvements, saw more focus on the exhaust and the use of urea while burning less fuel and operating under lower engine temperatures.

Chorney compares the progression to the introduction of catalytic converters on motor vehicles during the mid 1970s.

"When they started doing treatments on the exhaust pipes with the catalytic converters, all of a sudden the efficiency started coming back again. That's the same analogy that happened in the diesel emission categories.

"They kind of choked the engines down to try and meet (emissions targets) between Tier 1, 2 and 3 and then they realized the only way they can meet Tier 4 was treatments on the exhaust," he said.

"It was very expensive, which is why they held off as long as they did, but when they did that, they improved the efficiencies of the engines back again. So that's where the fuel consumption came back."

In the future, he said engine installation efficiency will improve by reducing pan sizes and by having smaller cooling packages.

However, he said engine improvements are not necessarily motivated by the need to reduce carbon but by the race to stay competitive.

"It's driven by competition in that they want to take cost out, which probably means the price of the machines is not going to go down, but they may not increase as fast as they've been doing.

"But the other thing that's going to happen is there's going to be an efficiency gain. There's going to be more useful work done for a litre of fuel burnt."

Chorney said while manufacturers were tasked with the burden of trying to meet aggressive targets for reducing greenhouse gas emissions on farm, farmers ultimately incurred the expense.

"Manufacturers have added the cost of these systems into the units. In order to capture the cost the farmer got the benefit of having the lower emissionized engine, but they paid for the cost."

He said farmers pay for their initial machine and also for the ongoing costs of adding urea in their units and setting up an on-farm urea filling station.

"All of those costs were incurred and no benefits from a farm perspective have come back. There has been a lot of contribution by the farms and really not much trumpeting in terms of (the general public) perceiving any benefits by it," he said.

Chorney said farmers have been doing their part for the past 15 years to reduce their carbon footprints.

"Now, talks about a carbon tax that starts from zero and in the meantime, farmers have incurred considerable expenses on farm."

Unlike other businesses, Chorney said farmers are unable to pass the costs of lower emission machines on to their customers.

william.dekay@producer.com

Farm equipment manufacturers have been working to reduce greenhouse gas emissions through better engine performance. | FILE PHOTO