ACKNOWLEDGEMENTS

Climate Change Connection sincerely thanks the following individuals and organizations who provided their knowledge, experience, and energy to make this guide relevant and useful to Manitoban agricultural producers:

- Blair Geisel, Gaia Consulting Ltd
- Curtis Cavers, P.Ag., Land Resource Specialist, Manitoba Agriculture, Food and Rural Initiatives (MAFRI)
- Tony Szumigalski (MAFRI)
- Esther Salvano (MARFI)
- Food and Rural Initiatives (MAFRI)
- Allen Tyrchniewicz, Tyrchniewicz Consulting Inc
- Carol Thiessen, Writer
- Cheri Frazer, Editor

Climate Change Connection is a multi-stakeholder project, managed by the Manitoba Eco Network.

Our vision is for a future in which Manitobans will be aware of climate change facts related to Manitoba and will take action to reduce their greenhouse gas (GHG) emissions, both individually and as a community

Tel: (204) 943-4836
Fax: (204) 989-8476
E-mail: climate.connection@mts.net
Web site: www.climatechangeconnection.org

CLIMATE CHANGE CONNECTION IS FUNDED BY:

Manitoba Hydro POWER SMART

Manitoba

TABLE OF CONTENTS

CAN YOU MAKE A DIFFERENCE?

Farming activities account for 32 percent of Manitoba's total greenhouse gas emissions. The good news is that farming practices can be modified to become part of the solution. You can make a difference.

This guide sets out to help you, as a Manitoba farmer, to adopt climate-friendly practices without hurting your wallet. Many recommendations can result in higher yields and fewer inputs, plus you'll be part of a positive movement to pass on a healthier environment to future generations.

In the following pages you'll find the causes and effects of climate change, and suggested actions that you can take to reduce greenhouse gas emissions, specifically on crop production. It includes:

- A brief introduction to climate change
- Predicted changes for Manitoba's climate
- The impact of climate change on Manitoba crop production
- Farm contributions to climate change
- Recommendations on how to reduce greenhouse gas emissions from crop production
- Resource list

In Manitoba...

Agriculture plays a significant role in contributing emissions.

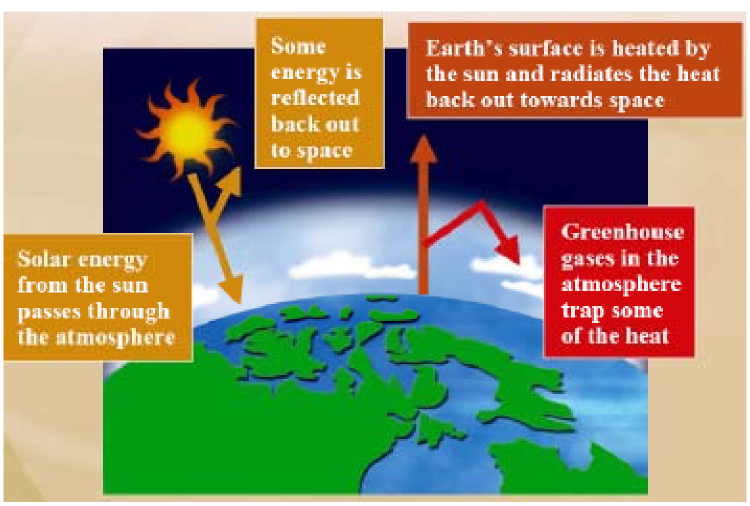
• It accounts for 36 percent of Manitoba's greenhouse gas emissions, excluding vehicle fuel and commercial heat.

• Manitoba's agricultural emissions increased 42 percent between 1990 and 2006.

• Of Manitoba's agricultural emissions in 2004, 55 percent came from agricultural soils, 33 percent from enteric fermentation and 12 percent from manure management. (1)

In Canada, agriculture-related emissions contributed 8.6 percent of total emissions in 2006, an increase of 25 percent from 1990 levels. (2)

WHAT CAUSES CLIMATE CHANGE?



"Warming of the climate system is unequivocal, as it is now evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level."

- Intergovernmental Panel on Climate Change, 2007

The earth has always had a greenhouse system, ensuring that not all energy arriving from the sun escapes directly back into space. Most greenhouse gases, including carbon dioxide, methane and nitrous oxide, are found naturally in the earth's atmosphere. This natural greenhouse effect keeps the earth a balmy 30°C warmer than it would otherwise be. This is necessary for life on earth.

Since the onset of the Industrial Revolution around 1750, however, humans have been contributing to the amount of greenhouse gases in the atmosphere by introducing new sources (mainly by burning fossil fuels) or by removing existing sinks, such as forests, which absorb greenhouse gases. Scientists estimate that levels of greenhouse gas emissions have risen by 31 percent since the start of the Industrial Revolution. (3)

The increase in greenhouse gas emissions means a thicker blanket of greenhouse gases in the atmosphere. And that means more heat is trapped, leading to global warming.

- Temperatures have increased by approximately 0.74°C during the 20th century (4)
- Eleven of the last 12 years (1995–2006) rank among the warmest years on record (5)
- A further rise of between 1.4–5.8°C is expected by the year 2100 (6)

This global warming, in turn, affects other aspects of the earth's climate, such as:

- Changing rainfall patterns
- Melting polar ice cover, snow and permafrost
- Rising sea levels
- Increasing numbers of extreme weather events

These phenomena are all part of climate change. (7)

Carbon dioxide (CO_2) makes up 60 percent of greenhouse gas emissions, followed by methane (CH_4) at 20 percent, while nitrous oxide (N_2O), industrial gases and ozone contribute the remaining 20 percent. (8)

WHAT CHANGES ARE PREDICTED FOR MANITOBA?

As every farmer knows, it's difficult to predict weather for any given day. So how can scientists possibly predict how climate change will affect overall temperature in Manitoba? First of all, climate change and weather are two very different things. Weather is the specific condition of the atmosphere at a particular place and time. Climate, in contrast, is much less specific. It refers to weather patterns averaged over a long period of time. (9)

That doesn't mean it's easy to predict climate changes, but scientists do have an increasingly clear picture of what to expect. There will still be plenty of variability in Manitoba's daily weather, but the overall climate for Manitoba is expected to change noticeably. In fact, Manitoba's central location in North America, with its northerly latitude, means climate change is likely to occur earlier and more severely than in other parts of the world. (10)

Predicted changes for Manitoba's agricultural regions include: (11)

- Above-normal spring temperatures
- An increase in summer temperatures of 3–4°C
- An increase in fall temperatures of 2–3°C
- An increase in winter temperatures of 5–8°C
- An increase in springtime precipitation of 5–10 percent
- A decline in summer precipitation of 10–20 per cent
- A decrease in fall precipitation in the south, and an increase of fall precipitation in the north
- More extreme heat spells and less extreme cold spells
- More extreme weather, including droughts, heavy precipitation and heat waves
- More intense winter storms

Source: Manitoba government

HOW WILL CLIMATE CHANGE AFFECT MANITOBA CROP PRODUCTION?

As you already know, a changed climate will significantly impact agriculture in Manitoba. Higher levels of carbon dioxide, changing rain patterns, higher temperatures and greater occurrence of extreme weather events will all significantly affect crop production in Manitoba. That's the easy part.

However, making more detailed predictions about how crop production will be affected is an inexact science at best. Generally, climate change models predict an uncertain future for agriculture in Manitoba, with potential benefits likely offset by major drawbacks.

The following summary will clarify both these potential benefits and drawbacks for crop production in Manitoba.

How Higher Levels of Carbon Dioxide Might Affect Your Crops

Yields

Crop species vary in their response to carbon dioxide. C_3 plants, such as wheat, rice and soybeans, respond readily to increases in carbon dioxide, and could produce greater yields. C_4 plants, such as corn and many pasture and forage species, are less responsive to higher levels of carbon dioxide. (12)

Recent open-air field trials in Illinois, however, raise questions about how much yields might increase. The trials involving five major food crops grown under carbon dioxide levels projected for the future resulted in a much lower carbon dioxide fertilization effect on yield for C_3 crops than earlier expected, and possibly little or no stimulation for C_4 crops. (13)

How Higher Temperatures Might Affect Your Farming Operation

Growing season

Predicted changes in Manitoba's temperatures could result in a longer growing season due to more frost-free days and earlier seeding times for most crops. For every 1^{o}C increase in average temperature, the growing season could lengthen by 10 days on the Canadian Prairies. This could mean a wider range of cropping options. (14)

The increased temperatures in the winter could reduce the amount of winterkill of fall-seeded crops.

As well, crop-producing areas may expand northward. It is estimated that for each 1_{o}C increase in mean annual temperature the vegetation zones may move northward by 200–300 km. (15) However, this doesn't necessarily mean it would make economic or ecological sense to expand agricultural production northwards.

Insects and pathogens

The exact impacts of climate change on insects and pathogens is somewhat uncertain—some changes may be favourable to insects and pathogens while others may be negative. Most evidence, however, indicates an overall increase in the number of outbreaks of a wider variety of insects and pathogens. (16)

Weeds

Higher temperatures may encourage new weeds to expand into higher latitudes. (17)

Soil Quality

Warmer temperatures increase soil microbial activity, speeding the natural breakdown of organic matter and other processes that affect fertility. (18) But a longer growing season with more vegetative mass produced may offset the increased breakdown of organic matter.

HOW CHANGING PRECIPITATION PATTERNS CAN AFFECT YOUR CROPS

Water Availability

Of the total rainfall expected, more will fall in intense events, so the length of dry periods between rains will likely increase. Together with warmer temperatures (causing more evapotranspiration), the result will likely be increased drought frequency and severity.

The rise in springtime precipitation, however, could have some positive impacts on groundwater recharge and soil moisture.

Overall, the availability of water for agricultural production is likely to become a major issue. (19)

Soil Erosion

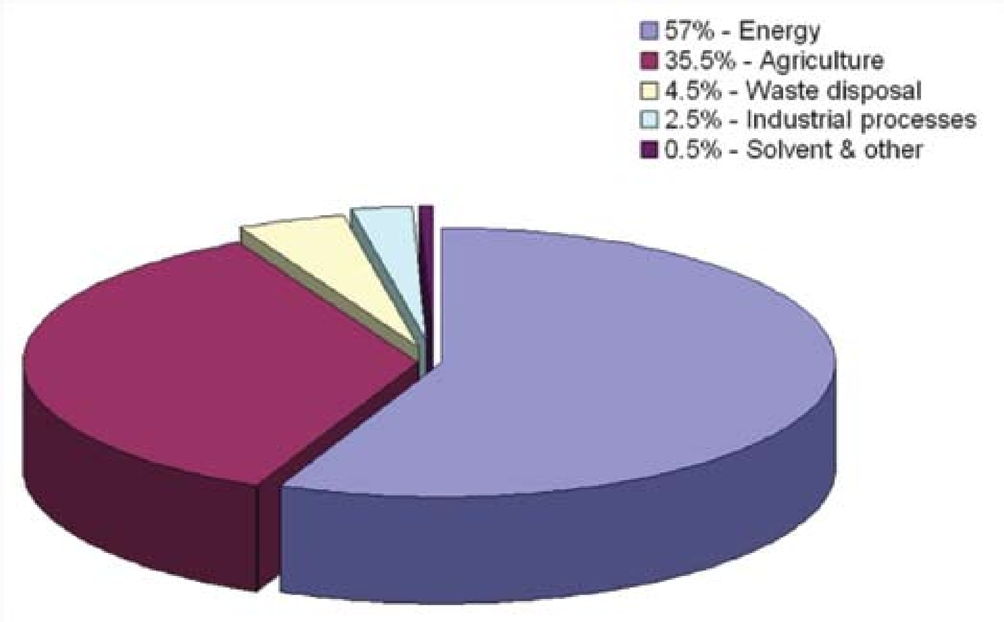
More soil erosion is possible with greater intensity of rainfall and increased risk of flooding. The expected increases in drought will also increase the risk of soil erosion by wind during critical periods.

HOW AGRICULTURE CONTRIBUTES TO CLIMATE CHANGE IN MANITOBA?

Farming activities in Manitoba account for 35.5 percent of Manitoba's total greenhouse gas emissions, as shown in the pie chart.

The emissions from agricultural sources are 61 percent nitrous oxide and 39 percent methane. (20)

CONTRIBUTORS OF GREENHOUSE GASES



The following chart gives a handy breakdown of greenhouse gases and their agricultural sources. (It includes home heating and farm machinery as sources of CO_2 emissions from fossil fuel burning. Although Canada categorizes these separately from agricultural emissions, they are still sources of CO_2.)

Greenhouse Gas	Global Warming Potential	Agricultural Source	Causes
Carbon dioxide (CO_2)	1:1 (CO_2 equivalent)	- Soils - Fossil fuel combustion	- Tillage, which accelerates organic matter decomposition - Clearing woodlots and soil drainage - Operating farm machinery - Heating farm buildings - Crop residue burning
Methane (CH_4)	21:1 (21 times more potent than CO_2)	- Ruminant livestock (the major source) - Manure - Soils	- Digestion of feeds by ruminants - Decomposition of manure during storage and application - Methane production by bacteria in poorly drained soils
Nitrous oxide (N_2O)	310:1 (310 times more potent than CO_2)	- Manure storage - Nitrification (oxidation of ammonia) - Denitrification (conversion of plant-available nitrate-nitrogen to gases) in the soil	- Saturated soil conditions with warm soil temperatures and the presence of carbon - Production of N_2O during manure storage - Immediate loss to atmosphere shortly after fertilizer application - Use of excess amounts of nitrogen fertilizers No or delayed incorporation of manure

(Source: Ontario Ministry of Agriculture, Food and Rural Affairs) (21)

RECOMMENDATIONS ON HOW TO REDUCE GREENHOUSE GAS EMISSIONS FROM CROP PRODUCTION

Carrying such a heavy load of Manitoba's greenhouse gas emissions may seem overwhelming for the agricultural sector, but there is good news. There are practical on-farm measures that can reduce these emissions. And most are simply good management practices that will also promote long-term soil productivity, protect water quality and preserve profitability.

This section includes suggestions on how you can:

- Manage your soil in healthy ways
- Manage nutrients, both organic and inorganic, to reduce green house gas emissions
- Use agroforestry to make your farm more climate-friendly
- Cut greenhouse gas emissions from vehicles and equipment
- Increase energy efficiency in farm buildings

Manage your soil in healthy ways

Besides storing more carbon and making more efficient use of nitrogen, good soil management will provide economic benefits through increased productivity, more efficient use of nutrients, and improved air and water quality. (22)

Agricultural soils act as efficient repositories for carbon, but under certain conditions soils also release carbon dioxide back into the atmosphere. Plants fix atmospheric carbon into foliage and roots, which eventually becomes soil organic matter. Soil organic matter is fundamental to healthy soil.

While much of the stored carbon is released back into the atmosphere when plants decay, some of it remains trapped in the soil as organic matter. Soil conditions and management will determine how much carbon is stored at any one time.

Through denitrification and other processes soils also release excess nitrogen into the atmosphere as nitrous oxide and nitrogen gas.

The following farming practices can reduce the amount of greenhouse gas emissions from soils.

Adopt Conservation Tillage

In conservation tillage, crops are directly planted into the previous year's stubble, with minimum or no tillage. This practice not only reduces fossil fuel consumption, but also increases soil organic matter that otherwise would be emitted as carbon dioxide. Conservation tillage, along with reduced use of summerfallow, can store from 0.3 to 0.5 tonnes of carbon per hectare per year in the soil, depending on weather and moisture conditions. (23)

As well, research from the University of Saskatchewan has shown there's more available organic nitrogen in long-term zero tillage fields than in fields tilled using conventional methods. (24)

Choosing to seed with narrow, low disturbance openers (knives or discs) has the further advantage of minimal seedbed disturbance. Crops seeded with low disturbance disc and knife openers have shown improved production and fewer weeds over crops seeded with higher disturbance openers, such as spoons or sweeps. (25)

Additional benefits of conservation tillage include enhanced water infiltration, moisture conservation, reduced labour requirements, and less runoff and soil erosion due to wind and water. (26)

Choose Effective Crop Rotations

The best crop rotations should not only effectively manage nutrients and reduce pest problems, but also improve soil quality. While the environmental benefits of certain crop rotations are clear, market constraints may limit which crops are included. Some suggestions:

- Include legume and pulse crops in crop rotations to fix nitrogen. Perennial legumes, such as alfalfa, increase soil organic matter, while the residues contain nitrogen, which can easily be broken down to be used by subsequent crops. (27)
- Use crops with high nitrogen requirements, such as corn or cereals, as a follow-up to legumes to capitalize on the fixed nitrogen in the soil. (28)
- To remove surplus nitrogen, plant a winter cereal or another cover crop after harvest (if timing permits). Cover crops also store nutrients for the crops that follow them, as well as reduce weeds, host beneficial insects, and improve soil quality. (29)
- Consider forage production as a further way to reduce emissions. Increasing forage production not only increases soil organic carbon, but it also uses surplus soil nutrients, reducing the risk of nitrogen losses, including denitrification. (30)
- Try planting crop mixtures, such as alfalfa-bromegrass, to use soil nitrogen more efficiently and reduce the potential for nitrogen losses to the environment. (31)

Consider Organic Farming Methods

Many organic farming methods have good potential to mitigate climate change by reducing greenhouse gas emissions as well as sequestering CO_2. While there are numerous variables that make it difficult to compare the global warming potential of organic and conventional systems there are some key practices that favour organic agriculture. Conventional farms will also benefit from many of these practices:

- The use of legumes is a key practice commonly used by organic farmers. This practice has the potential to reduce agricultural emissions of greenhouse gases by reducing the need for synthetic fertilizers. Global production of synthetic nitrogen fertilizer consumed approximately 90 million tonnes of fossil fuel in 2005. This represents approximately 1 percent of all fossil fuel consumption globally. (32) Growing perennial legumes, such as alfalfa, is a proven way of replacing the need for synthetic N fertilizer in Prairie cropping systems. Research from temperate and tropical agro-ecosystems also suggests that intercropping and off-season cropping of legumes could significantly reduce the need for nitrogen fertilizer. (33)

- A Manitoba study that compared two crop rotation types with organic and conventional production found that the external energy usage was 40-50 percent lower on organic farms. The difference in energy usage was in large part due to the use of synthetic fertilizer in the conventional system. Energy efficiency (energy output/energy input) was also higher in the organic system. (34)

- One of the potential benefits of organic agriculture is higher soil organic matter. (35) The increased use of green and animal manure, intercropping and cover cropping, perennial forage crops and composting techniques in most organic systems may result in carbon gains and help to reduce soil erosion. (36)

- A further benefit is increased water content in organically farmed soils. Soils with higher carbon content can capture more water and retain it for crop plants, giving these soils advantages under dry conditions. In one 12-year study comparing conventional, animal manure and legume-based organic, and legume-based organic, water volumes were substantially higher in the two organic systems. (37) This suggests a superior ability to adapt to climate change. However, the impact of greater moisture retention on emissions of nitrous oxide should also be considered.

Take Marginal Land Out of Annual Crop Production

Marginal lands require the same inputs as productive land, but produce lower yields and profit. By planting these marginal or fragile lands to perennial cover, farmers can improve profit margins, create a carbon sink and provide natural habitat. (38)
Consider restoring flood-prone areas or lands with excess moisture back to wetlands. Wetlands can remove carbon dioxide from the atmosphere, reduce downstream flooding, help to clean water and provide wildlife habitat. (39)

Eliminate Stubble Burning

On average, more than 90 percent of all carbon in crop residues is lost (mostly as carbon dioxide) when it is burned. Consider alternate uses for cereal straw, including chopping and spreading back onto the fields, baling, grazing, and using for bio-energy feedstock and bio-fibre. (40)

Improve Soil Drainage

Since saturated soils during the growing season are more prone to denitrification and producing nitrous oxide emissions, improving drainage encourages efficient crop growth and uptake of nitrogen fertilizer. (41)

Drainage improvements may include enhanced surface drainage, installation of tile drains, or the use of trees, shrubs and other perennial crops to remove excess water. These suggestions refer only to soils in active production, not to wetlands. In fact, as suggested in an earlier section, it may make economic and ecological sense for some marginal flood-prone lands to be restored to wetlands.

Maintain Adequate Soil Cover with Crop Residues

Leave enough crop residues on the surface to prevent soil erosion. (42) Manitoba Agriculture recommends that 60 percent of the soil surface should be covered with crop residue in the fall to prevent erosion.

Reduce Summerfallow

Summerfallow is already a dying practice in Manitoba. But it is worth noting that besides leaving fields susceptible to wind and soil erosion, soils that were frequently summerfallowed usually had reduced soil organic matter compared to continuously cropped soils. (43)

MANAGE NUTRIENTS TO REDUCE GREENHOUSE GAS EMISSIONS

Nitrous oxide (N_2O) is the most potent agricultural greenhouse gas. Its global warming potential is 310 times greater than that of carbon dioxide. In Manitoba, nitrous oxide accounts for 61 percent of all agricultural greenhouse gas emissions.

Use of both manure and synthetic fertilizers can result in nitrous oxide emissions.

Nitrous oxide can be produced directly from decomposing manure, either in storage or on the field. It can also be produced through denitrification—the conversion of plant-available nitrogen to gases (including N_2O).

Site characteristics, tillage and fertilizer type and placement will all affect the relationship between the amount of nitrogen-based synthetic fertilizer applied and the level of nitrous oxide emissions. It is common that only 50 percent of the nitrogen supplied by synthetic fertilizer is utilized by the crop in the year of application. What happens to the remaining nitrogen is unclear, but approximately 1–2 percent of it may be lost as nitrous oxide. (44)

Following good management practices for both manure and synthetic fertilizers can go a long way to reducing nitrous oxide emissions.

Alan Ransom – Forage Production

On the hilly, clay loam soils on Alan Ransom's Boissevain farm land, growing forages just makes good sense. "By doing that we're reducing the risk of soil loss to water erosion. We have constant ground cover," he explains.

He has 500 acres of his 1200-acre mixed farm in perennial forages, which he feeds to his cattle.

He knows the constant ground cover also increases the amount of carbon stored in his soil. "The environment is part of the whole picture," he says. "This is something that works very well economically as well as environmentally."

Bob McNabb – Conservation Tillage

Bob McNabb is one of the pioneers of zero-till in Manitoba, sowing his first crop into the previous year's stubble in 1978. "At that time I was motivated more by perceived economic advantages than by a strong environmental thought," he says.

But over the years the environmental advantages became increasingly evident—soil retention during windstorms, greater soil moisture, excellent earthworm activity, and, most recently, carbon storage. "Ag Canada did an extensive three-year program on my farm to test carbon. We were sinking more carbon than conventional farmers," Bob says.

With just one pass needed to seed his 2500 acres, he's also using a lot less fuel. And since he's not digging deep into the soil, he can pull wider equipment using the same horsepower—representing more fuel savings.

The Minnedosa farmer, however, recognizes he makes an environmental trade-off. Despite using a low disturbance hoe press drill for seeding, he still faces greater weed growth with zero till than with other production systems. And that means he reluctantly uses more pesticides. Still, he's confident the environmental benefits of conservation tillage far outweigh the negatives.

This improved efficiency will not only reduce emission rates of nitrous oxide, but for synthetic fertilizers will also indirectly reduce carbon dioxide emissions from their manufacture. And it should represent economic savings, too.
For manure application, many of the following practices are already required by Manitoba's Livestock Manure and Mortalities Management Regulation. (45)

Test Soils

The first step toward reducing nitrous oxide emissions from crop land is annual soil testing for residual nutrient levels. Some nutrients, such as nitrogen and sulphur, can vary greatly from year to year. A soil test will determine appropriate nutrient application rates to maximize yield. (46)

For the Canadian Prairies, soil testing can occur in spring or fall (once soil temperatures are low).

Avoid Excessive Fertilizer Application

Crops have varying requirements for nutrients. So if nitrogen is matched to the needs of a particular crop, there will be much less potential for excess residual nitrogen to be converted to nitrous oxide if the soil becomes saturated.

Further benefits of proper application rates include optimal crop response, reduced crop lodging, reduced nutrient loading to the soil, and reduced fertilizer costs. (47)

Incorporate Fertilizer Immediately

Injection or immediate incorporation of fertilizer has various environmental benefits, including prevention of direct nitrous oxide loss. (48)

Optimize Timing of Fertilizer Applications

Ideally, fertilizers should be applied as close as possible to the time that plants need the nutrient. Applications in spring will avoid the presence of nitrate-nitrogen during wet spring thaw conditions, when denitrification is more likely. (49) But late fall applications when the soil is cooled are also acceptable. (50)

Adopt Precision Farming Practices

Precision farming techniques use new technologies, such as global positioning system (GPS) and geographic information systems (GIS), to identify different soil management zones and corresponding yields. This technology allows the farmer to determine and apply the appropriate rate of inputs to maximize return for each soil management zone.

Precision farming could reduce nitrous oxide emissions by allowing farmers to apply fertilizers only where they are needed and at appropriate application rates. (51) Guidance systems decrease the amount of equipment overlap, reducing inputs applied, and further reducing costs.

Sieg Peters – Manure Injection

As far as Sieg Peters is concerned, manure is a precious commodity. "We have a lot of land, so we want to get as much coverage out of our manure as possible," he says. "We need the nitrogen so there's no point losing half of it. That's why we directly inject it into the ground."

Sieg, who farms with his brother and their sons near Steinbach, was never that impressed with sprinkler systems. There was too much nitrogen loss. And the odours and view weren't pleasant. So seven years ago he started hiring a custom applicator to come in and inject the manure directly—some of which is pumped through hoses from his storage lagoon three to four miles away.

As part of a large farm—they crop about 3000 acres, and have a 12,000 feeder hog operation—they use all the manure they produce. That means they're reluctant to see any go to waste.

But the environment ranks high on their priorities too. "We know if we put it in the ground it's less likely to leach off, to run off the field. That's a huge consideration."

Manure Management

Some additional practices relate directly to manure management. These suggestions will also contribute to reducing nitrous oxide emissions, the most powerful agricultural greenhouse gas.

Test Manure

Manure testing should be done routinely to determine the amount of available nutrients, particularly nitrogen and phosphorus. (52) Future legislation may require manure application to be based on the manure's phosphorus content, not the nitrogen content. However, generally, nutrient testing will still allow nitrogen levels to be well managed to meet—but not exceed—crop nutrient requirements.

Calibrate Application Equipment

To ensure the proper amount of manure is applied based on a target application rate, application equipment should be calibrated. For liquid manure, this can be done with drag-line or tanker application systems equipped with flow-rate monitors. (53)

Eliminate Winter Spreading

Eliminate winter manure spreading to prevent runoff and spring nitrous oxide emissions.
When manure is applied in spring or after crop emergence, the developing crop will be able to use the nitrogen as it becomes available with minimal risk of loss to the environment. (54)

Synthetic Fertilizer Management

Some further practices relate directly to synthetic fertilizer management. These suggestions will also contribute to reducing nitrous oxide emissions.

Apply Fertilizer in Bands

The best method of nitrogen application is banding. Nitrogen applied in a concentrated band is less susceptible to denitrification. If banding is not possible, then ensure that the nitrogen fertilizer is incorporated into the soil shortly after application. (55)

Use Slow-release Nitrogen Fertilizer

A fertilizer that releases its nutrient slowly over time will make nitrogen available to the crop when it is most needed, and reduce leaching and denitrification. (56) These fertilizers are more expensive, however, so economics may limit their use to high-value crops.

Use Urease Inhibitors and Nitrification Inhibitors

Urease inhibitors prevent volatilization (gassing off) of surface-applied urea. A nitrification inhibitor slows the conversion of ammonia-nitrogen to nitrate-nitrogen. This reduces the risk of nitrogen losses from a variety of paths, including nitrous oxide emissions from denitrification. (57)

Urease and nitrification inhibitors improve the efficiency of nitrogen uptake and are more affordable than slow-release fertilizers, but also improve the efficiency of nitrogen. (56)

Sheldon Wiebe – Synthetic Fertilizer Management

Sheldon Wiebe doesn't like to see fertilizer go to waste. He knows it's costly to him and to the environment. That's why he employs the latest technology to ensure he's applying the right amount of fertilizer to his soils at the right time of year.

First thing in spring, Sheldon hires a soil agronomist to test his soils at the 0–6 inch and 6–24 inch depths. "We GPS the point and go back to the same spot every year for the tests. It keeps a consistency from year to year. That way we can better tell if the soil is changing. And it means we don't put a blanket rate on every field," he says.

He soil tests throughout his McGregor farm's 800 acres of wheat, 800 acres of canola, and 1000 acres of potatoes. But for the potatoes he also goes one step further. He takes a petiole sample during the growing season to have analyzed for nutrient levels in the plant itself. That gives him an even better guide for fertilizing his potatoes.

The soil testing he's been doing for years. The GPS system he introduced in recent years. And this year he's going one step further.

Last year Sheldon used satellite imagery during the growing season to examine crop density. With that information in hand, he tested soil in areas of low density to determine nutrient levels. With the data inputted into his on-tractor GPS unit, he'll apply variable rates of fertilizer this spring.

He says the cost of soil testing based on these density zones will be a third of doing grid sampling because it requires much less labour. And applying variable rates of fertilizer makes economic sense too.

"Our application rates are different on different fields. Some fields may require more fertilizer but others less. It's better for the soil and better for the crop. We try to be very good stewards of the land. And it's just not cost effective to over-apply."

USE AGROFORESTRY TO MAKE YOUR FARM MORE CLIMATE-FRIENDLY

Agroforestry refers to combinations of trees, crops and livestock that are intentionally designed and managed as a whole production unit. Crop production can be optimized when crops are combined with trees and shrubs.

The benefits include increased crop yields, improved soil and water quality, increased biodiversity, as well as lower greenhouse gas emissions and increased carbon sequestration. (58)

In addition, alternate crop uses related to trees and shrubs, including bio-energy, fruits, nuts, horticulture nursery stock, wood fibre and livestock shelter could diversify farms and enhance their profitability.

Plant Shelterbelts

Shelterbelts consist of one or more rows of trees strategically planted on the farm. They are an effective tool for fighting climate change because they remove carbon dioxide from the atmosphere and can moderate the microclimate around the shelterbelt.

Studies at Agri-Food Canada's Shelterbelt Centre show that the above-ground portion of a mature poplar tree in a shelterbelt stores about 970 kg of carbon dioxide, white spruce about 520 kg and green ash trees about 230 kg. There is also carbon stored in the roots—about 50–75 percent of the carbon stored above ground. (59)

Shelterbelts also reduce wind, cut soil erosion and nutrient loss, conserve water, control blowing snow, and may provide diversification opportunities, such as fruit production.

The potential drawbacks are increased shade and competition with crops for water and nutrients. (60)

Plant Riparian Buffers

Riparian buffers consist of trees and/or grasses planted between cultivated crop land and a watercourse. The main benefits of these buffers are to filter surface run-off, which may contain sediments, nutrients and/or pesticides, protect stream banks and shorelines from erosion, and sequester carbon. (61)

Consider Alley Cropping

Alley cropping mixes trees, planted in single or grouped rows, with agricultural crops grown in wide alleys between tree rows. This is not commonly practised in Manitoba, but it has potential for both diversifying farm incomes and increasing on-farm carbon sequestration. It may also reduce soil erosion, decrease nutrient loading and protect watersheds. (62)

Diversify into Agro Woodlots

Fast growing woody crops, such as hybrid poplar trees, provide environmental benefits with high rates of nutrient uptake and large amounts of carbon storage over rotation lengths as short as 15 years. (63)

Biomass from trees can also be used as an alternative fuel (bioenergy). Carbon dioxide emissions from a unit of electricity generated from bioenergy are 10 to 20 times lower than from fossil fuel– based electricity production. (64)

Michelle McMechan – Shelterbelts

Michelle and Tim McMechan's farm lies on the western edge of the Lyleton Shelterbelt in southern Manitoba. Over two million trees were planted in the area from the 1930s to '50s as part of a PFRA program. The McMechans have a full 20 miles of multi-rowed shelterbelts on their 3000 acres—some from the original shelterbelt program and others they planted themselves in the 1980s.

"In the winter our trees hold the snow on the land, thereby increasing soil moisture in the spring. In the summer, the shelter means less moisture loss from evaporation and more protection for emerging crops," explains Michelle.

And shelterbelts near the house mean fuel savings in winter. Michelle can go from wearing a t-shirt on her sheltered yard to needing a good jacket outside the shelterbelts. "I know it's making a difference on our fuel bills."

CUT GREENHOUSE GAS EMISSIONS FROM VEHICLES AND EQUIPMENT

Any farm practices that reduce the need for equipment and vehicles, without productivity losses, have benefits for both farm budgets and the environment. Rationalizing the use of vehicles and equipment, and making fuel-efficient choices, will reduce greenhouse gas emissions and improve profits.

Below are some suggestions to cut carbon dioxide emissions from farm vehicles.

- Use bio-diesel fuel to reduce emissions. Using petroleum-based diesel (petro-diesel) puts about 2.7 kg of carbon dioxide per litre into the atmo sphere, while 100 percent bio-diesel may reduce those emissions by more than 75 percent. Using a blend of 20 percent bio-diesel reduces carbon dioxide emissions by 15 percent.

A blended fuel can contain up to 20 percent bio-diesel without problems. Use only bio-diesel that is approved for use by the engine manufacturer; otherwise, warranties could be voided. (65)

- Adopt fuel-saving strategies for farm machinery. For example, choose fuel-efficient engines when buying new machinery, do regular maintenance on machinery and vehicles, make sure tire pressure is optimal, and practice ‘gear up, throttle down’ operations. (66)

- Reduce idling times. Diesels do not need to be kept running, except in extremely cold temperatures (if not equipped with additional heaters).

- Switch to conservation tillage to reduce fuel costs.

- Use low pressure irrigation sprinklers to reduce energy requirements for pumping water.

- Use perennial forages in crop rotations to reduce the overall number of equipment passes.

Increase energy efficiency in farm buildings

Energy efficiency in farm homes and other buildings can reduce demand for fossil fuels, lower carbon dioxide emissions, and save money. Consider using alternative energy sources such as geothermal, solar, wind, biomass energy and waste heat to heat farm buildings.

Windbreaks around farm buildings can significantly increase energy efficiency, reducing heating bills by as much as 25 percent. (67)

For more ways to boost energy efficiency in farm homes and other buildings, please consult Manitoba Hydro’s new ‘Power Smart for Farm Owners’ brochure. This brochure is available at MAFRI ‘GO’ offices.

MORE INFORMATION

For more information on climate change and sustainable farming practices in Manitoba, please check out the following Web sites:

Government of Manitoba Web Sites

Beyond Kyoto – Province of Manitoba Climate Change Action Plan 2002 (PDF)

http://www.gov.mb.ca/beyond_kyoto/index.html

Energy Development Initiative

http://www.gov.mb.ca/est/energy/index.html

Manitoba Energy, Science and Technology's guide to alternative energy, such as agri-energy, ethanol, and wind energy.

Environmental Farm Plan

http://www.gov.mb.ca/agriculture/soilwater/farmplan/fpp00s01.html

Environmental farm planning is a voluntary, self-assessment process designed to help farm managers identify the environmental strengths and weaknesses of their operations.

Manitoba Agriculture, Food and Rural Initiatives

http://www.gov.mb.ca/agriculture/index.shtml

For all things agricultural in Manitoba.

Manitoba Agricultural Sustainability Initiative

http://www.gov.mb.ca/agriculture/research/asi/index.html

The program provides funding to Manitoba producer groups and provincial commodity organizations to carry out sustainable agriculture demonstration or technology transfer projects throughout the province.

Other Useful Sites

C-CIARN Agriculture

http://www.c-ciarn.uoguelph.ca

Clearinghouse of current information on climate change risks and adaptation for the Canadian agri-food sector.

Climate and Farming

http://www.climateandfarming.org/index.php

Resource materials to help farmers make practical and profitable responses to climate changes.

Climate Change and Agriculture

http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/cl9706

Alberta's guide to farming and climate change.

Climate Change Central

http://www.climatechangecentral.com

A public-private partnership based in Alberta that promotes the development of innovative responses to global climate change and its impacts.

Climate Change Connection

http://www.climatechangeconnection.org

Public education and outreach on climate change issues for Manitoba.

Manitoba Hydro – PowerSmart for Farms

http://www.hydro.mb.ca/your_business/farm/index.shtml

Information on energy efficiency for farm owners.

Manitoba Zero Tillage Research Association

http://www.mbzerotill.com

Farmer-directed research information on zero tillage production systems.

Prairie Farm Rehabilitation Administration (PFRA)

http://www.agr.gc.ca/pfra/main_e.htm

Guides to clean air, clean water, healthy soils and biodiversity.

PFRA Shelterbelt Centre

http://www.agr.gc.ca/pfra/shelterbelt_e.htm

Shelterbelt research, programs and numerous resources.

PAMI (Prairie Agricultural Machinery Institute)

http://www.pami.ca

An applied research, development, and testing organization serving manufacturers and farmers.

Soil Conservation Council of Canada

http://www.soilcc.ca

Wide-ranging producer information from the Greenhouse Gas Mitigation Program for Canadian agriculture, as well as soil conservation knowledge.

University of Manitoba - Natural Systems Agriculture

http://www.umanitoba.ca/outreach/naturalagriculture/index.html

Information on cropping systems based on processes found in nature - specifically the natural grassland ecosystem of prairie Canada.

REFERENCES

1) National Inventory Report, 1990-2006 - Greenhouse Gas Sources and Sinks in Canada, available at: http://www.ec.gc.ca/pdb/ghg/inventory_report/2006_report/ta11_14_eng.cfm

2) Ibid.

3) Williams, M. (ed) (2003) Climate Change Information Kit, Geneva: UNEP and UNFCCC.

4) Intergovernmental Panel on Climate Change (2007), Climate Change 2007: The Physical Science Basis, available at: http://www.ipcc.ch/SPM2feb07.pdf.

5) Ibid.

6) Williams, M. (ed) (2003) Climate Change Information Kit, Geneva: UNEP and UNFCCC.

7,8) Ibid.

9) Grist, Environmental News and Commentary (2006), available at: http://gristmill.grist.org/story/2006/11/19/221636/43

10) International Institute for Sustainable Development and the Manitoba Clean Environment Commission (2001), Manitoba and Climate Change: a Primer, available at: http://www.iisd.org/publications/pub.aspx?id=256

11) Manitoba Science, Technology, Energy and Mines, Climate Change Branch (2001), Climate Change: How Will It Affect Us?, available at: http://www.gov.mb.ca/stem/climate/climate_effect.html

12) Climate Change Connection website, available at: http://www.climatechangeconnection.org/Solutions/Agriculture.htm

13) Food-crop Yields in Future Greenhouse-gas Conditions Lower than Expected (2006), available at: http://www.biologynews.net/archives/2006/07/25/foodcrop_yields_in_future_greenhousegas_conditions_lower_than_expected.html

14) Climate Change Connection website, available at: http://www.climatechangeconnection.org/Solutions/Agriculture.htm

15) Ontario Ministry of Agriculture, Food and Rural Affairs, Greenhouse Gases and Ontario Agriculture, Infosheet #1.

16) Petzoldt, C. and Seaman, A., Climate Change Effects on Insects and Pathogens, available at: http://www.climateandfarming.org/clr-cc.php

17) Ziska, L., Climate Change Impacts on Weeds, available at: http://www.climateandfarming.org/clr-cc.php

18) Climate Change Connection website, available at: http://www.climatechangeconnection.org/Solutions/Agriculture.htm

19) International Institute for Sustainable Development and the Manitoba Clean Environment Commission (2001), Manitoba and Climate Change: a Primer, available at: http://www.iisd.org/publications/pub.aspx?id=256

20) National Inventory Report, 1990-2006 - Greenhouse Gas Sources and Sinks in Canada, available at: http://www.ec.gc.ca/pdb/ghg/inventory_report/2006_report/ta11_14_eng.cfm

21) Ontario Ministry of Agriculture, Food and Rural Affairs, Greenhouse Gases and Ontario Agriculture, Infosheet #1.

22) Agriculture and Agri-Food Canada, Agricultural Soil, Carbon Sinks and the Kyoto Protocol: A Practical Opportunity for the Environment.

23) Greenhouse Gas Mitigation Program for Canadian Agriculture Soils and Nutrient Management Sector (2006), Report to Canadian Producers, available at: http://www.soilcc.ca/downloads/ggmp_section.pdf

24) Prairie Farm Rehabilitation Administration, Economics of Zero Tillage, available at: http://www.agr.gc.ca/pfra/soil/swork1.htm

25) Greenhouse Gas Mitigation Program for Canadian Agriculture Soils and Nutrient Management Sector (2006), Report to Canadian Producers, available at: http://www.soilcc.ca/downloads/ggmp_section.pdf

26) Prairie Farm Rehabilitation Administration, Beneficial Practices which Conserve Soil Quality, available at http://www.agr.ca/pfra/land/practices_e.htm.

27) Soil Conservation Council of Canada (2003), Global Warming and Agriculture: Best Management Practices, available at:
http://www.soilcc.ca/resources.htm

28) Ibid.

29) Greenhouse Gas Mitigation Program for Canadian Agriculture Soils and Nutrient Management Sector (2006), Report to Canadian Producers, available at:
http://www.soilcc.ca/downloads/ggmp_section.pdf

30) Greenhouse Gas Mitigation Program: Soil and Nutrient Management Sector, Manitoba producers learn to make the most of forages, available at:
http://www.soilcc.ca/ggmp_region/mb-01.php

31) Malhi1, SS., R.P. Zentner and K. Heier (2002), 'Effectiveness of alfalfa in reducing fertilizer N input for optimum forage yield, protein concentration, returns and energy performance of bromegrass-alfalfa mixtures' in Nutrient Cycling in Agroecosystems, 62: 219–227

32) Niggli, U., Schmid, H., Fliessbach, A. (2007) 'Organic Farming and Climate Change' (International Trade Centre UNCTAD/WTO, Research Institute of Organic Agriculture), pp. 9. Available at:
http://www.intracen.org/Organics/documents/Organic_Farming_and_Climate_Change.pdf

33) Badgley, C. et al (2007) 'Organic agriculture and the global food supply' in Renewable Agriculture and Food Systems 22 (2), pp. 86-108. Abstract available at:
http://journals.cambridge.org/action/displayAbstract?fromPage=online&aid=1091304&fulltextType=RA&fileId=S1742170507001640

34) Hoppner, J.W. et al. (2006) 'Energy use and efficiency in two Canadian organic and conventional crop production systems' in Renewable Agriculture and Food Systems, 21 (1), pp.60-67. Abstract available at:
http://journals.cambridge.org/action/displayAbstract?fromPage=online&aid=692948&fulltextType=RA&fileId=S174217050600007X

35) Pimental, D. et al (2005) 'Environmental, Energetic, and Economic Comparisons of Organic and Conventional Farming Systems' in BioScience, 55 (7), pp. 573-583. Abstract available at:
http://www.bioone.org/perlserv/?request=get-abstract&doi=10.1641%2F0006-3568%282005%29055%5B0573%3AEEEAECO%5D2.0.CO%3B2html

36) Niggli, U., Schmid, H., Fliessbach, A. (2007) 'Organic Farming and Climate Change' (International Trade Centre UNCTAD/WTO, Research Institute of Organic Agriculture), pp. 1-30. Available at:
http://www.intracen.org/Organics/documents/Organic_Farming_and_Climate_Change.pdf

37) Pimental, D. et al (2005)

38) Soil Conservation Council of Canada (2003), Global Warming and Agriculture: Best Management Practices for Coarse Grains, available at:
http://www.soilcc.ca/resources.html

39) Manitoba Water Stewardship, available at:
http://www.gov.mb.ca/waterstewardship/

40) Manitoba Agricultural, Food and Rural Initiatives, Soil Management Guide: Tillage, Organic Matter and Crop Residue Management, available at:
http://www.gov.mb.ca/agriculture/soilwater/soil/fbe01s09.html

41) Soil Conservation Council of Canada (2003), Global Warming and Agriculture: Best Management Practices for Coarse Grains, available at:
http://www.soilcc.ca/resources.htm

42) Greenhouse Gas Mitigation Program for Canadian Agriculture Soils and Nutrient Management Sector (2006), Report to Canadian Producers, available at:
http://www.soilcc.ca/downloads/ggmp_section.pdf

43) Lemke, R.L, Rochette, P. Rochette, and E. VanBochove, Nitrous Oxide Emissions from Canadian Agroecosystems: Understanding the Process, available at:
http://www.agr.gc.ca/policy/environment/air_03_03c_e.phtml

44) Livestock Manure and Mortalities Management Regulation, available at:
http://www.gov.mb.ca/agriculture/index.shtml

45) Manitoba Agriculture, Food and Rural Initiatives (2005), Soil Testing can Improve Crop Profitability

46) Greenhouse Gas Mitigation Program for Canadian Agriculture Soils and Nutrient Management Sector (2006), Report to Canadian Producers, available at:
http://www.soilcc.ca/downloads/ggmp_section.pdf

47) Ontario Ministry of Agriculture, Food and Rural Affairs, Greenhouse Gases and Ontario Agriculture, Infosheet #1.

48) Prairie Farm Rehabilitation Administration, Nutrient Management Planning, available at:
http://www.agr.gc.ca/pfra/water/nutrient_e.htm

49) Saskatchewan Soil Conservation Association, Hog Manure BMP's, available at:
http://www.ssca.ca/agronomics/index.htm

50) Alberta Government: Agriculture and Food, About Precision Farming, available at:
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/sag1950

51) Greenhouse Gas Mitigation Program for Canadian Agriculture Soils and Nutrient Management Sector (2006), Report to Canadian Producers, available at:
http://www.soilcc.ca/downloads/ggmp_section.pdf

52) MacLeod, C. (2005) 'Greenhouse Gas Mitigation Program – Canadian Pork Council' in Advances in Pork Production, vol. 16, pg. 67.

53) Ibid.

54) Lemke, R.L, Rochette, P. Rochette, and E. VanBochove, Nitrous Oxide Emissions from Canadian Agroecosystems: Understanding the Process, available at:
http://www.agr.gc.ca/policy/environment/air_03_03c_e.phtml

55) Ontario Ministry of Agriculture, Food and Rural Affairs, On-Farm Nutrients & Greenhouse Gas Reduction Opportunities for Ontario Agriculture, Infosheet #3.

56) Climate Change Central (2003) Greenhouse Gas Emissions and Opportunities for Reduction from the Alberta Swine Industry, Discussion Paper C3-012.

57) Ontario Ministry of Agriculture, Food and Rural Affairs, On-Farm Nutrients & Greenhouse Gas Reduction Opportunities for Ontario Agriculture, Infosheet #3.

58) Prairie Farm Rehabilitation Administration, Agroforestry – A Sink for Carbon, available at:
http://www.agr.gc.ca/pfra/climate/carbon_e.htm

59) Prairie Farm Rehabilitation Administration, Shelterbelts – A Tool for Climate Change, available at:
http://www.agr.gc.ca/pfra/climate/climatechg_e.htm

60) Farm Shelter, Technical Information Sheet No. 9, Level 2, available at:
http://www.privateforests.tas.gov.au/publications/farm_forestry_info_sheets

61) Ontario Ministry of Agriculture, Food and Rural Affairs, Greenhouse Gases and Ontario Agriculture, Infosheet #1.

62) Prairie Farm Rehabilitation Administration, Agroforestry – A Sink for Carbon, available at:
http://www.agr.gc.ca/pfra/climate/carbon_e.htm

63) Ibid.

64) Alberta Agriculture, Food and Rural Development (2001) Greenhouse Gas Emissions and Agroforestry, available at:
http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/cl9706/$File/GHGBulletinNo8Agroforestry.pdf

65) Verbal and written communication with Ken Thomas, Manager, Fleet Services for Manitoba Hydro.

66) Cheminfo Services Inc. and PAMI (2006), Summary of Fuel-Saving Strategies for Farm Machinery.

67) Prairie Farm Rehabilitation Administration, Shelterbelts – A Tool for Climate Change, available at:
http://www.agr.gc.ca/pfra/climate/climatechg_e.htm